CVARC – BASIC RADIO TECH TALK

DIGITAL RADIO OPERATIONS
19 October 2018
Bill Willcox, Rob Hanson, Jaap Goede

Basic Radio Tech Talk
Digital Operations

- Basic Information – Bill Willcox
  - Types of Digital Operations
  - What You Need to Get Started
  - Resources
- HF Digital Demonstration Part 1 – Rob Hanson
- HF Digital Demonstration Part 2 – Jaap Goede

Amateur Radio Digital Operations
Digital Voice Modes

- Digital voice modes encode speech into a data stream before transmitting it.
- The Big Three:
  - DSTAR - Open specification with proprietary vocoder system available from Icom, Kenwood, and FlexRadio Systems.
  - DMR - Found in both commercial and public safety equipment from multiple vendors.
  - System Fusion - Open specification with proprietary vocoder system available from Yeasu.

Amateur Radio Digital Operations
Text and Data Modes

- D-STAR (Digital Data) a high speed (128 kbit/s), data-only mode.

- Hellschreiber, also referred to as either *Feld-Hell*, or *Hell*

- Discrete multi-tone modulation modes such as Multi Tone 63 (MT63)

Amateur Radio Digital Operations
Text and Data Modes - Continued

- Multiple frequency-shift keying (MFSK) modes such as
  - FSK441, JT6M, JT65, and FT8
  - Olivia MFSK
- Packet radio (AX25)
  - Automatic Packet Reporting System (APRS)

Amateur Radio Digital Operations Text and Data Modes - Continued

- PACTOR
- Phase-shift keying:
  - 31 baud binary phase shift keying: PSK31
  - 31 baud quadrature phase shift keying: QPSK31
  - 63 baud binary phase shift keying: PSK63
  - 63 baud quadrature phase shift keying: QPSK63

Amateur Radio Digital Operations
Text and Data Modes - Concluded

- Radioteletype (RTTY)
- WSPR
- And Many, Many More

Amateur Radio Digital Operations
What You Need to Get Started

- A Radio (Transceiver)
  - Good Stability
  - Fast Transmit/Receive Switching Speed
  - High Duty Cycle
- A Computer
  - Sound Card, Keyboard, Monitor, Microphone and Speaker Jacks

Amateur Radio Digital Operations
What You Need to Get Started

- Software - Windows
  - Digipan
  - MixW
  - MultiPSK
  - Fldigi

Amateur Radio Digital Operations
What You Need to Get Started

- Software Macs
  - CocoaModem
  - MultiMode
  - Digital Master 780

Amateur Radio Digital Operations
What You Need to Get Started

- Interface
  - Can be simple PTT home brew or purchased with other features
  - Many Recent Transceiver Models have an interface built in

Amateur Radio Digital Operations Interfaces

The microHAM USB III interface with a built-in sound device.

The MFJ-1204 interface.

Amateur Radio Digital Operations Interfaces

The TigerTronics SignaLink USB interface also includes a built-in sound device.

Amateur Radio Digital Operations Interfaces
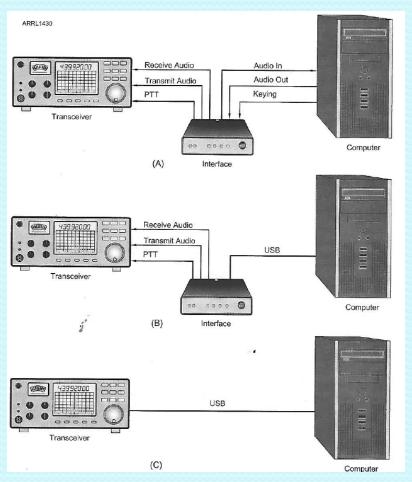
The RigBlaster Advantage interface from West Mountain Radio has a built-in sound device.

A RigExpert interface.

Amateur Radio Digital Operations
Putting It Together

Amateur Radio Digital Operations Resources

- <u>Get on the Air with HF Digital, 2nd Edition</u>, Steve Ford, ARRL

- https://en.wikipedia.org/wiki/List_of_amateur_radio_modes

- http://wb8nut.com/digital/

Amateur Radio Digital Operations FT8 Demonstration – Rob Hanson

- **Since its introduction on June 29, 2017, FT8 use has skyrocketed with over half of all HF QSOs made with FT8**

- **Steven Franke – K9AN, Professor of Electrical and Computer Engineering at the University of Illinois at Urbana-Champaign)**

- **Joe Taylor – K1JT, an American astrophysicist and Nobel Prize in Physics laureate, a retired professor of physics at Princeton University and former Dean of the Faculty there.**

- **Developed a new mode for WSJT-X, FT8**

- **FT8: Franke & Taylor, 8-frequency shift keying format.**

Characteristics

T/R sequence length: 15 s

Message length: 75 bits + 12-bit CRC

FEC code: (174,87)LDPC

Modulation: 8-FSK, keying rate = tone spacing = 6.25 Hz

Waveform: Continuous phase, constant envelope

Occupied bandwidth: 50 Hz

Synchronization: three 7x7 Costas arrays (start, middle, end of transmission)

Transmission duration: 79*1920/12000 = 12.64 s

Decoding threshold: -20 dB (perhaps -24 dB with a priori decoding, TBD)

Operational behavior: similar to HF usage of JT9, JT65

Multi-decoder: finds and decodes all FT8 signals in passband

Auto-sequencing after manual start of QSO

How does it work?

What makes FT8 work are:

Short messages

13 Characters, 15 second transmission.
Known message format

Specific transmit and receive time intervals

Transmit and receive periods are specific so an accurate computer clock to within at least 1 second is necessary in order to decode FT8.
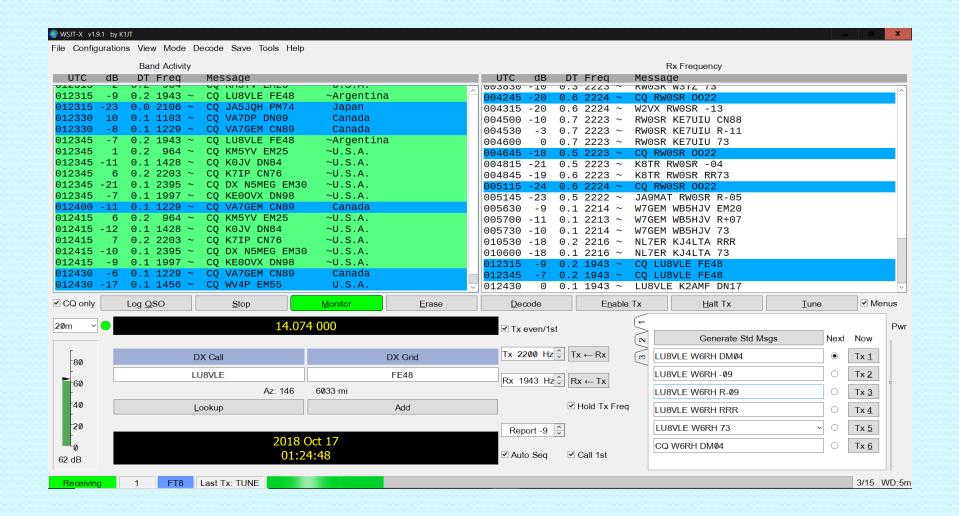
Most modern computers make use of a time servers. Apple, for example, lets the clock drift a few seconds here and there.

You at least need to set your computer to get NIST. Better yet is to use a time program Meinberg NTP on Windows machines or Dimension 4.
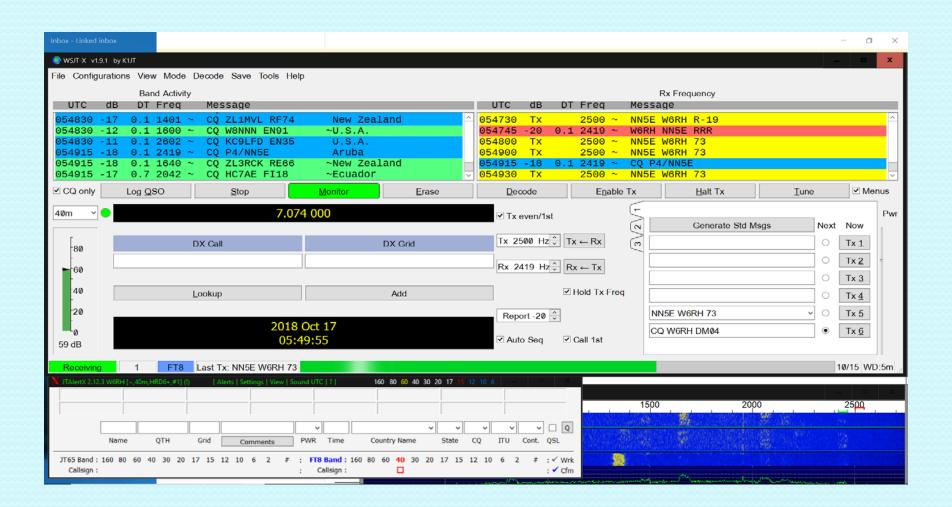
Lower power.
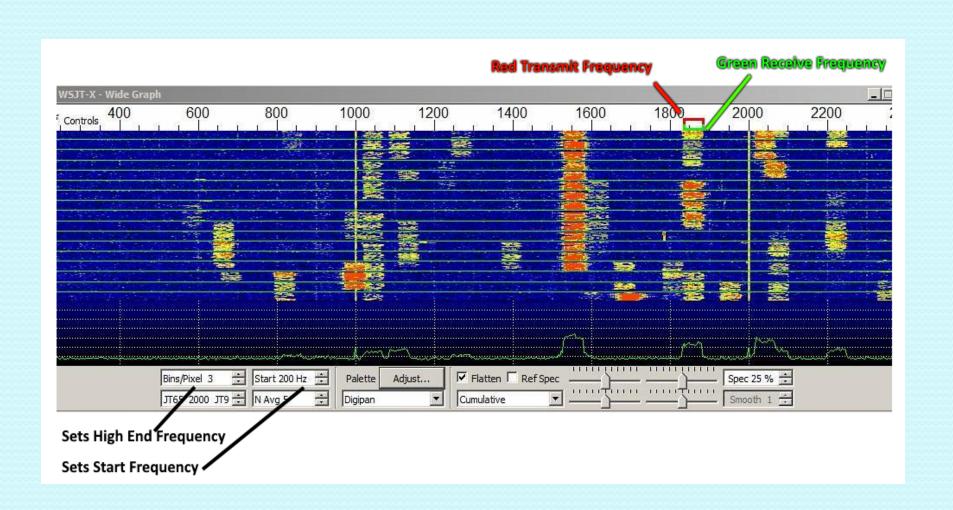
Most stations are running QRP to 100W and 50W is common.
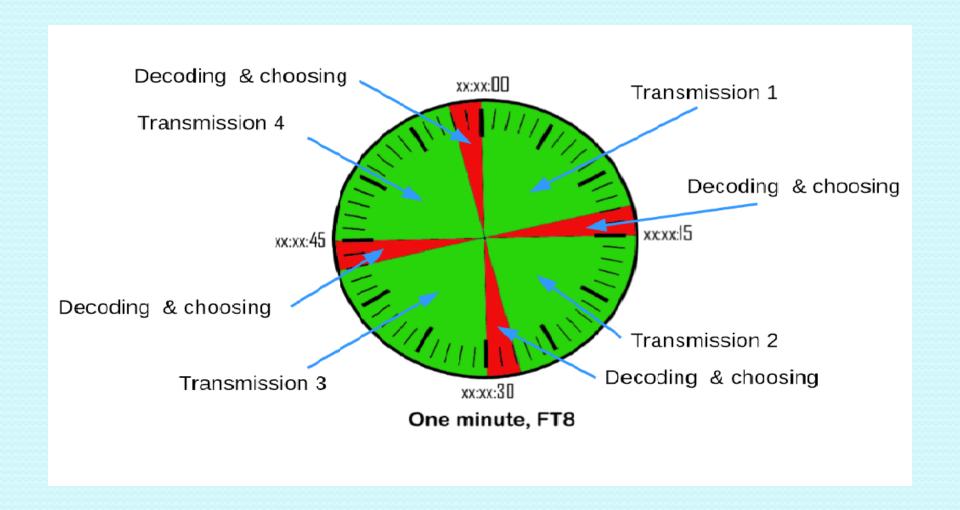
Main program

Main program with add-ons

Waterfall

Sync Your PC to UTC

- You need to sync your PC to ±1 second of UTC

- https://www.time.is/ – to check your PC vs UTC

- The built-in Windows facility for time synchronization is usually not adequate.

- Try the program Meinberg NTP

- Or Dimension 4 from Thinking Man Software.

Timing

One minute, FT8

Can you hear me now?

- PSK31 is a popular and reliable protocol to exchange messages in free format
- PSK31 does not need high power, 25 to 35 Watts is enough
- PSK31 software like FLDIGI runs on Windows, Apple Mac and iPhone, Linux, Raspberry and maybe more
- PSK31 is used on the National Field Day
- I learned to use PSK 31 on Field day

Phase Shift Keying PSK 31 with FLDIGI
The choice of sound cards

External USB sound card

Requires simple cable with 1:1 Transformer

+Cheap

+No Windows System sound to TX

-Needs CAT or TX Vox to key TX

-Power Adjustment with Sliders

-Receive Sensitivity with Sliders

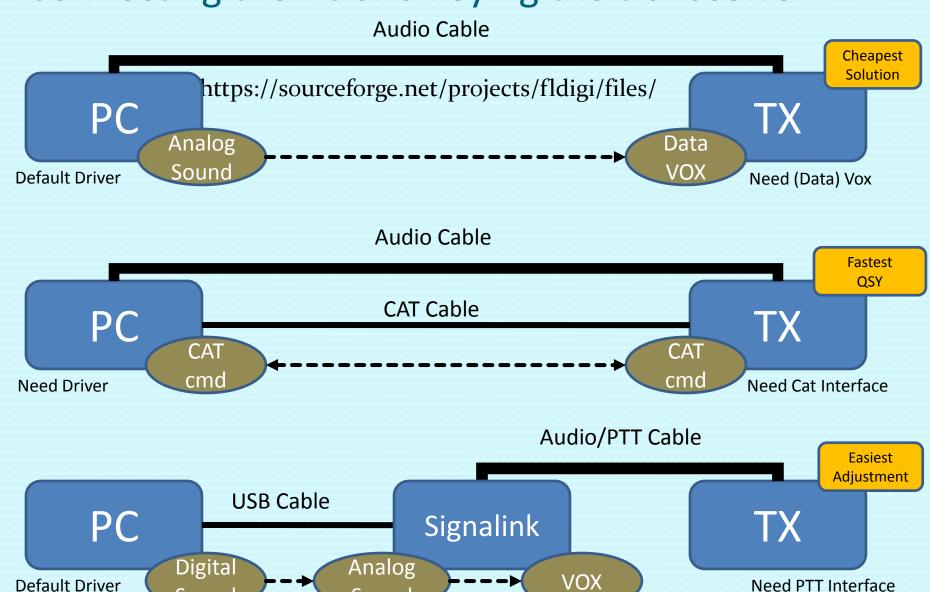## Signalink USB

Comes with all cables

$ 100

+No Windows System sound to TX

+Built in VOX to key TX

+Power Adjustment with knob

+Receive Sensitivity with knob

Better not use PC internal Sound Card, and please do not set the external sound card as default. Both ways might generate unwanted transmission activity and ruin QSO's.
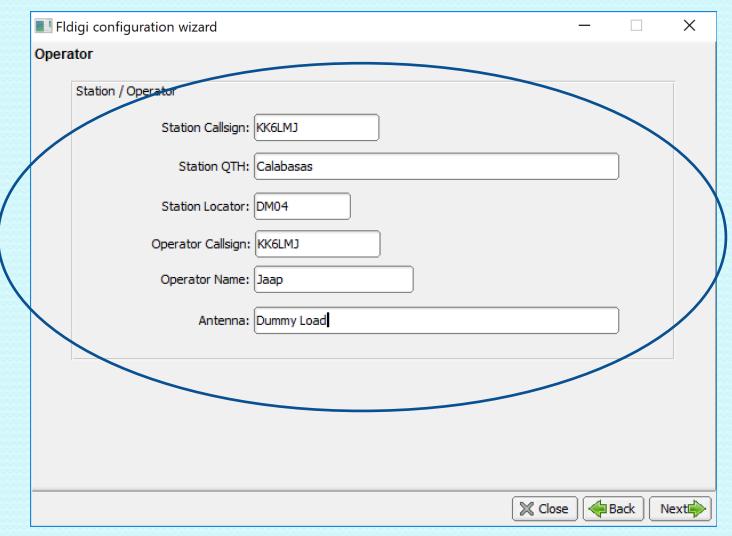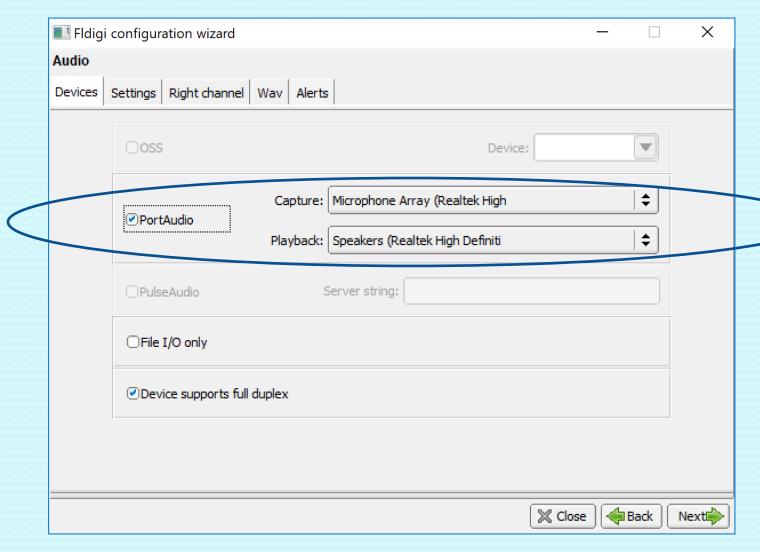
Connecting the PC and keying the transceiver

Audio Cable

Cheapest Solution

PC   https://sourceforge.net/projects/fldigi/files/   **TX**

Analog Sound → Data VOX

Default Driver

Need (Data) Vox

Audio Cable

Fastest QSY

PC   **TX**

CAT Cable

CAT cmd ← → CAT cmd

Need Driver

Need Cat Interface

Audio/PTT Cable

Easiest Adjustment

PC   USB Cable   **Signalink**   **TX**

Digital Sound → Analog Sound → VOX

Default Driver

Need PTT Interface

Phase Shift Keying PSK 31 with FLDIGI

https://sourceforge.net/projects/fldigi/files/

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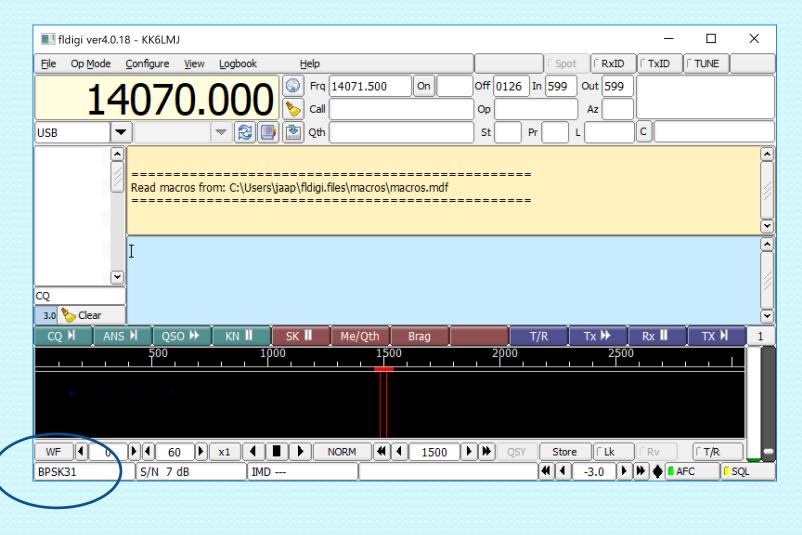
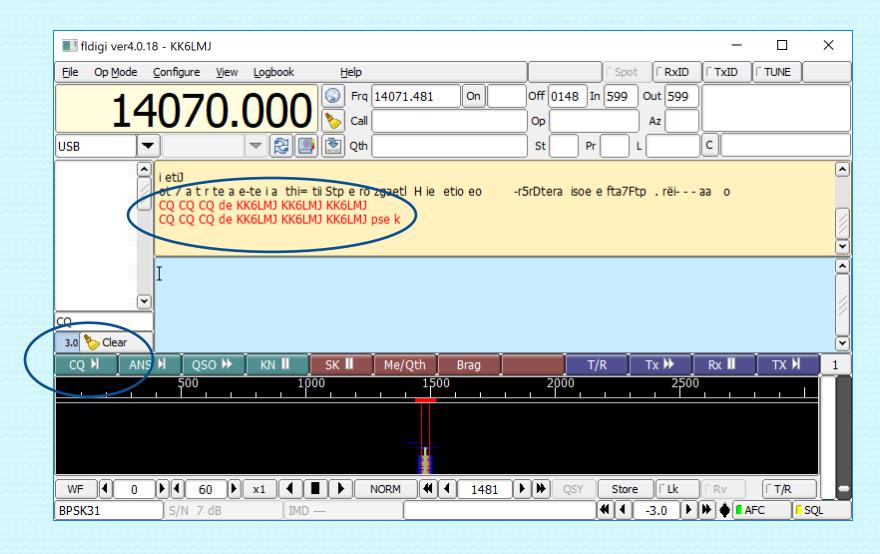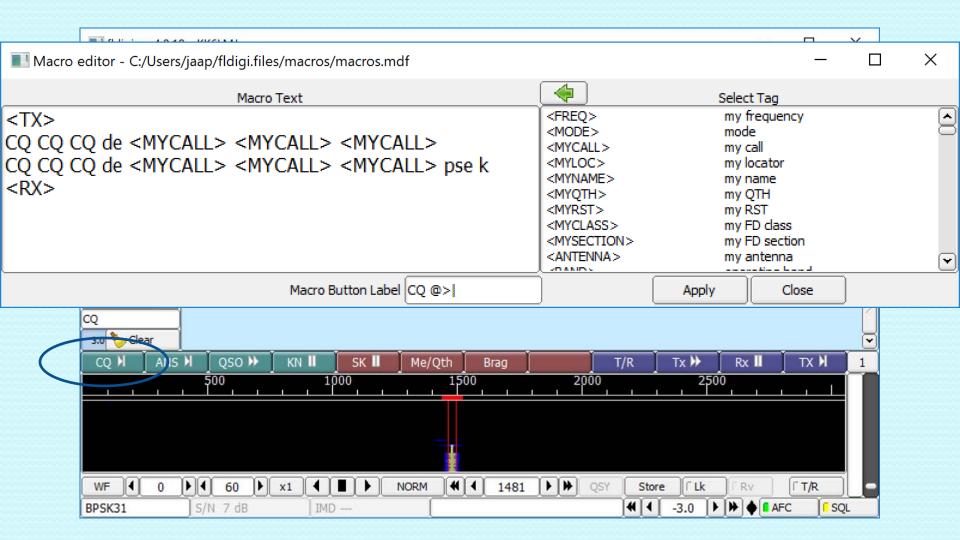https://sourceforge.net/projects/fldigi/files/

- To avoid interference to other HAMs, please:
  - Do not reduce the output Power in the Radio's settings
  - Reduce the Radio's output by reducing the audio volume
  - Check the Automatic Limit Control (ALC)
    - Your ALC indicator should remain ZERO
    - Reduce the audio volume if ALC indicates more than ZERO
  - Optionally check the output power
    - With built in meter
    - With external power meter
  - 35 Watts works, 70 Watts is just 3 dB or 0.5 Signal more

Keeping ALC on ZERO is valid for any Digital Transmission using audio to modulate RF.