Digital HF

A short Introduction

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What do we mean by Digital HF?

A way of sending information between (amateur) stations where the data is encoded into a digital data stream then decoded for reception.

A long history:

- CW (Morse Code) (5-50 wpm)
- RTTY (Radio Teletype) (45-70 cps)
- Packet Radio (AX25) (300 baud)

Using relatively simple encoding/decoding techniques.

More recent improvements

There has been considerable advances in modulation/encoding techniques – moving from simple on/off, and fluctuating single tones to

Phase Shift Keying (binary, quadrature etc. up to 8) with many variants.

The more well-known applications are:

The WSJT-X suite (FT8/FT4 etc etc)

Fldigi with many possibilities

Winlink – HF messaging, best used with VARA an orthogonal frequency-division multiplexing (OFDM) approach.

So, what happened?

Without going into the mathematics data can be transferred at

- higher effective rates, and/or
- Better S/N ratios and/or
- Compression of information

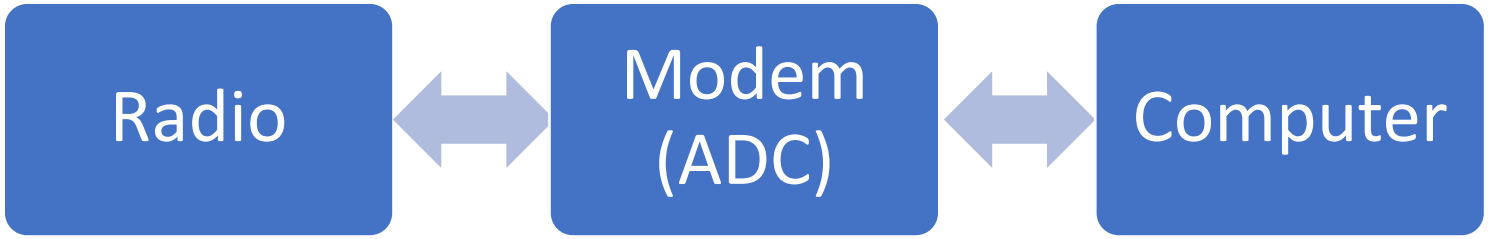
Techniques include:

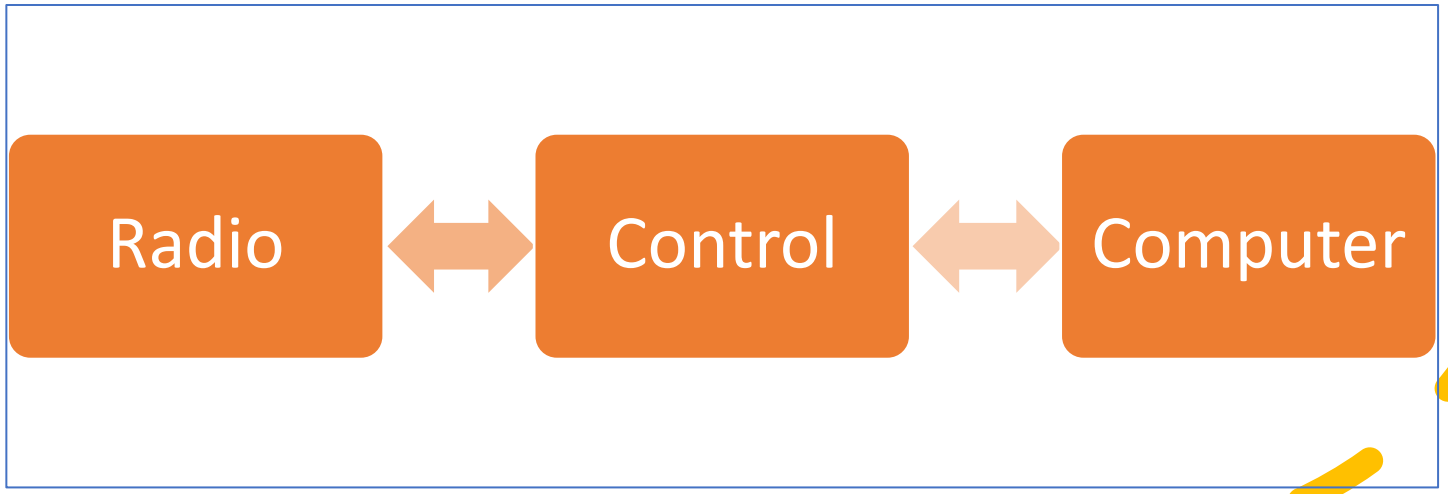
- Reduced bandwidth
- Extended transmission times (slow data rates)
- Software filtering etc. etc.

Hardware Configuration

Two paths need to be considered

- The audio path to transfer information
- The control path to run the radio (Frequency, mode, PTT etc.)





What do we need?

- Reasonably Modern HF Radio, preferably with
  - The ability to be controlled by a computer
  - Operate Split
  - Adjustable receive bandwidth

and a Computer…

- Windows/Linux/Mac can be used
- A reasonably fast processor
- USB Ports
- Serial Port can be useful but not essential

Hardware - Control

Radio control

- Inbuilt via USB e.g. ft10DX, IC7300, etc.
- Serial - need either serial port or USB to serial adapter e.g., most rigs
  - Bluetooth HCO5
- Variations – e.g., KX3 comes with USB/serial cable

HC05 Bluetooth Dongle

Hardware - Audio

Analog/Digital Converter

- Digirig https://digirig.net/product/digirig-mobile/
- Imic (obsolete)
- Kmart $2
- Signalink https://tigertronics.com/

Kmart Dongle

Applications

- fldigi
- WSJT-X (JTDX & MSHV)
- JS8Call
- WinLink
- MMTTY
- Digital Voice

fldigi

- http://www.w1hkj.com
- Fldigi, Fast Light Digital Modem Application, pronounced "F L digi", is a cross-platform modem program that supports most of the peer-to-peer (live keyboard) digital modes used on the amateur radio bands.
- Fldigi includes all the popular modes, such as DominoEX, MFSK16, PSK31, and RTTY.
- The software is designed to run on nearly any modern computer and can be easily interfaced with almost any radio.
- Runs on FreeBSD™; Linux™, OS X™ and Windows™.

WSJT-X

- WSJT-X is a computer program used for weak-signal radio communication between amateur radio operators. The program was initially written by Joe Taylor, K1JT, but is now open source and is developed by a small team. The digital signal processing techniques in WSJT-X make it substantially easier for amateur radio operators to employ esoteric propagation modes, such as high-speed meteor scatter and moonbounce. Additionally, WSJT can send signal reports to spotting networks such as PSK Reporter.
- Multiple platforms
- Most used is FT8 mode.

JS8Call
http://js8call.com

- The idea with JS8Call is to take the robustness of FT8 mode and layer on a messaging and network protocol for weak signal communication on HF with a keyboard-to-keyboard interface. JS8Call is heavily inspired by WSJT-X, Fldigi, and FSQCall and would not exist without the hard work and dedication of the many developers in the amateur radio community.
- JS8Call is software using the JS8 Digital Mode providing weak signal keyboard to keyboard messaging to Amateur Radio Operators.
- JS8Call is a derivative of the WSJT-X application, restructured and redesigned for message passing using a custom FT8 modulation called JS8. It is not supported by nor endorsed by the WSJT-X development group.

Winlink Global Radio Email https://winlink.org

- is a network of amateur radio and authorized government stations that provide worldwide radio email using radio pathways where the internet is not present. The system is built, operated and administered entirely by licensed "Ham" volunteers. It supports email with attachments, position reporting, weather and information bulletins, and is well-known for its role in interoperable emergency and disaster relief communications. It can operate completely without the internet--automatically--using smart-network radio relays
- Winlink Express
- RadioMail for iOS
- Multiple Clients available (https://winlink.org/ClientSoftware)

MMTTY and MMSSTV

MMTTY

- Sound card based RTTY encoder/decoder
- See https://hamsoft.ca/pages/mmtty.php

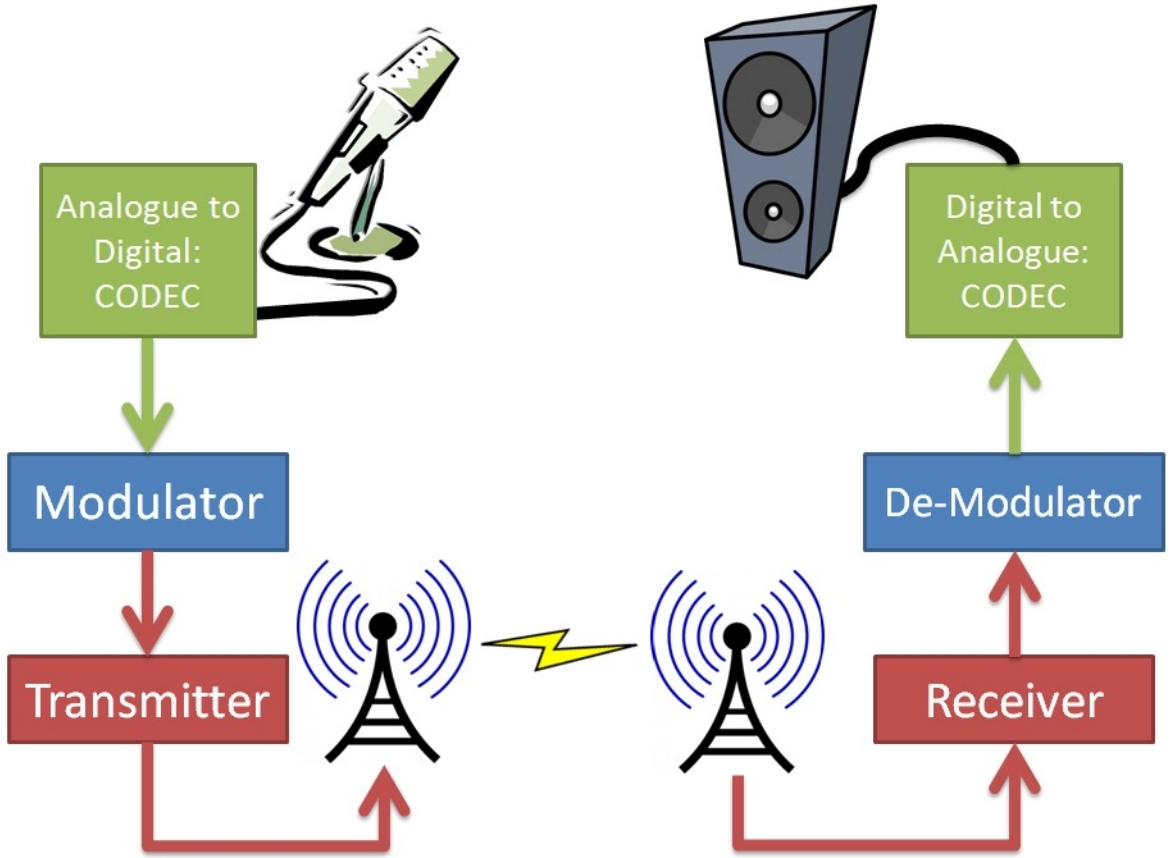
MMSSTV

- https://hamsoft.ca/pages/mmsstv.php

Based on original developments by JE3HHT - Makoto Mori

Windows only.

Digital Voice



Free DV*

- FreeDV is a Digital Voice mode for HF radio. You can run FreeDV using a free GUI application for Windows, Linux and OSX that allows any SSB radio to be used for low-bit-rate digital voice.
- Based on CODEC 2 development by David Rowe VK5DGR
- Article in QST –
- More here
- Or watch at https://player.vimeo.com/video/128064782

*https://github.com/drowe67/codec2/blob/main/README_freedv.md

Free DV

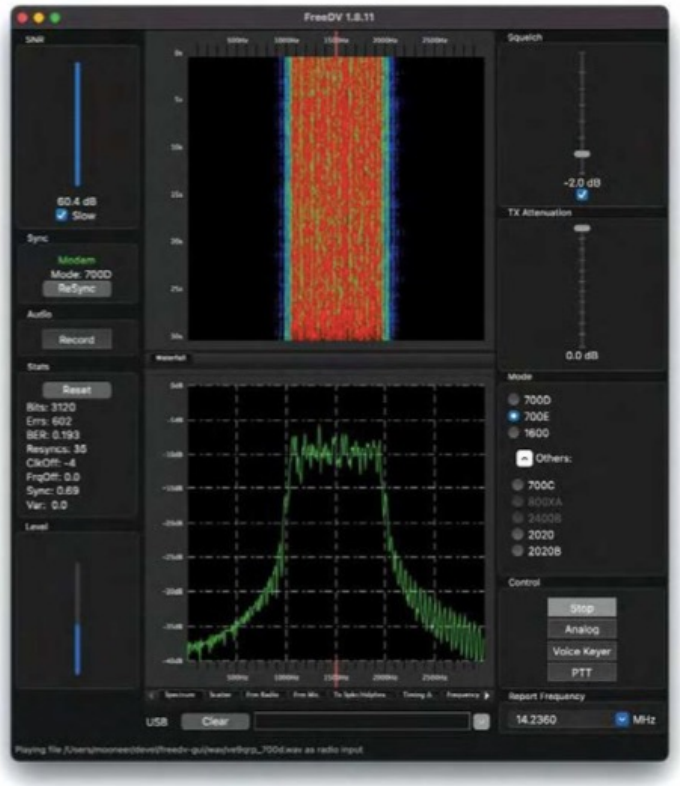


Figure 1 — FreeDV's main control console. At startup, the graphical user interface shows only the waterfall, but additional panes can be added.

Other HF Digital Voice

FDMDV http://n1su.com/fdmdv/

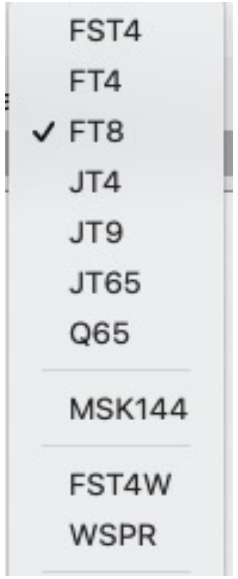
- Requires AMBE chip for encoding/decoding

DStar – essentially using Icom Hardware

So, what about FT8?

- FT8 is the most popular mode available with WSJT-X.
- Features

  According to Joe Taylor, the important characteristics of FT8 are —
  - T/R sequence length: 15 s
  - Message length: 75 bits + 12-bit CRC
  - FEC code: (174,87) LDPC
  - Modulation: 8-FSK, keying rate = 6.25 baud; 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: -24 dB (with a priori decoding)
  - Multi-decoder: finds and decodes all FT8 signals in passband
  - Auto-sequencing after manual start of QSO



Nice Features of WSJT-X

- Keeps an ADI format log for successful contacts
- Keeps a (can be big) logfile of each transmitted and received message
- Colour Coded display showing stations that may be of interest (See JT-Alert for a more comprehensive suite of alerts)
- Interacts with other software on the local network using UDP
- Windows, Mac and Linux available

Other modes

FT4

In 2019, Taylor, et al., introduced FT4, an experimental protocol which is like FT8 but has a shorter (50%) T/R sequence length for faster contest exchanges. FT4 accomplishes this increase in speed by using Gaussian frequency-shift keying and using 90 Hz of bandwidth.

WSPR

Weak Signal Propagation Reporter (WSPR) is a protocol, used for weak-signal radio communication between amateur radio operators. The program is designed for sending and receiving low-power transmissions to test propagation paths on the MF and HF bands.

Transmissions carry a station's callsign, Maidenhead grid locator, and transmitter power in dBm. The program can decode signals with a signal-to-noise ratio as low as −28 dB in a 2500 Hz bandwidth. Stations with internet access can automatically upload their reception reports to a central database called WSPRnet, which includes a mapping facility.

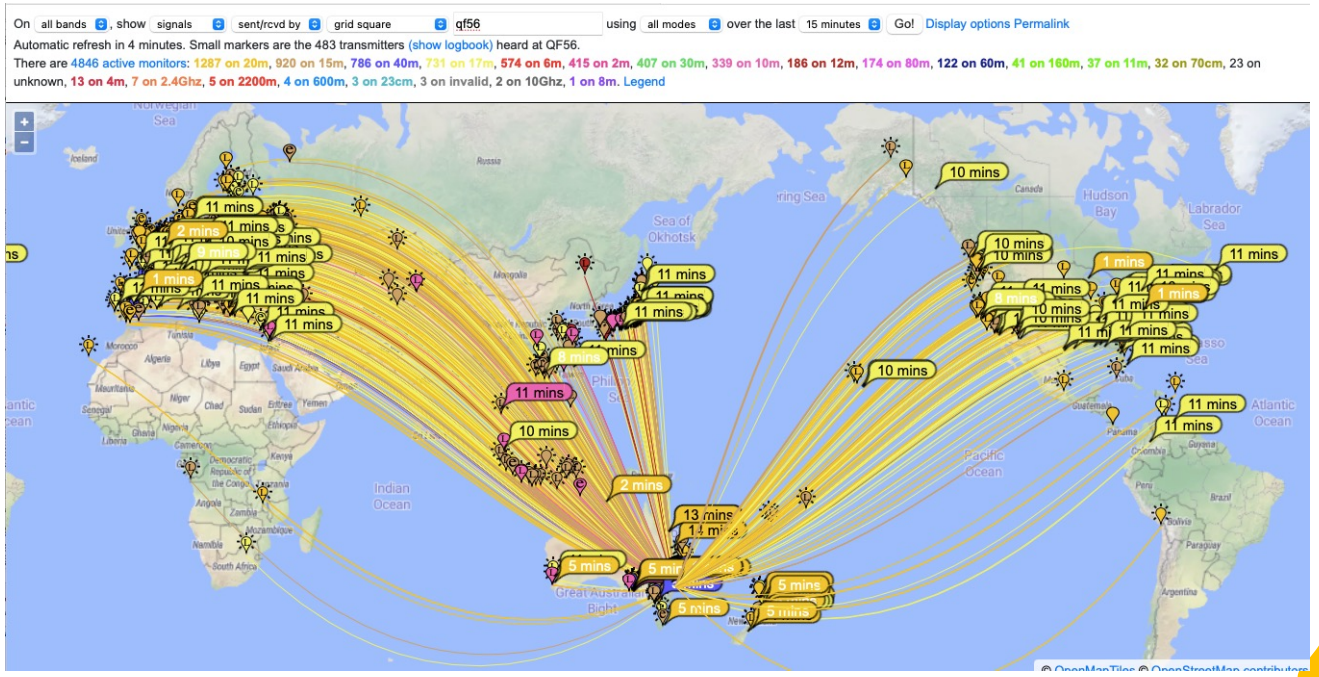
The emission is “F1D”, frequency-shift keying.

Tools, Logging and Special Award schemes

PSK Reporter

A fantastic tool to see what is happening in (almost) real time.

See https://www.pskreporter.info/pskmap.html



JT-Alert

- A local development by Laurie VK3AMA
- Available on Windows platform only at http://hamapps.com
- Feeds into Hamspots database https://hamspots.net which displays digital calls made and received by stations, includes data from PSK Reporter
- Feeds log data into applications that can’t communicate with WSJT-X via UDP

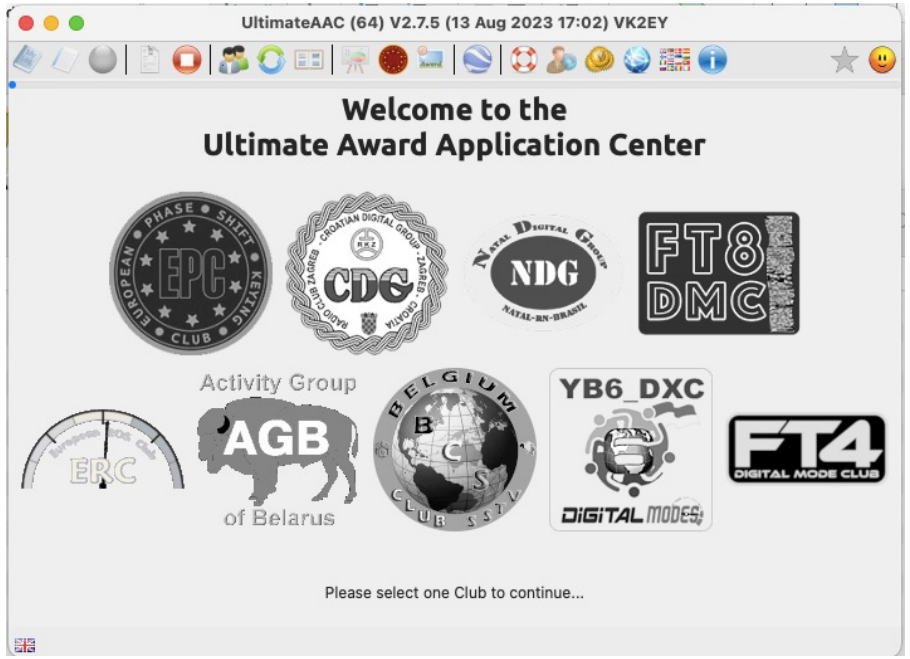
For Mac Users

- Aether Logging Program https://www.aetherlog.com
- MacLogger DX https://dogparksoftware.com/MacLoggerDX.html
- JT-Bridge – Connects to WSJT-X via UDP, presents a who is calling display (similar concept to JT-Alert) and then can log into any of
  - Aether
  - RumLogNG
  - MacLoggerDX

Specialist Awards

- European Phase Shift Keying Club
  - https://ft8dmc.eu
  - https://ft4dmc.com

Uses Ultimate AAC Application

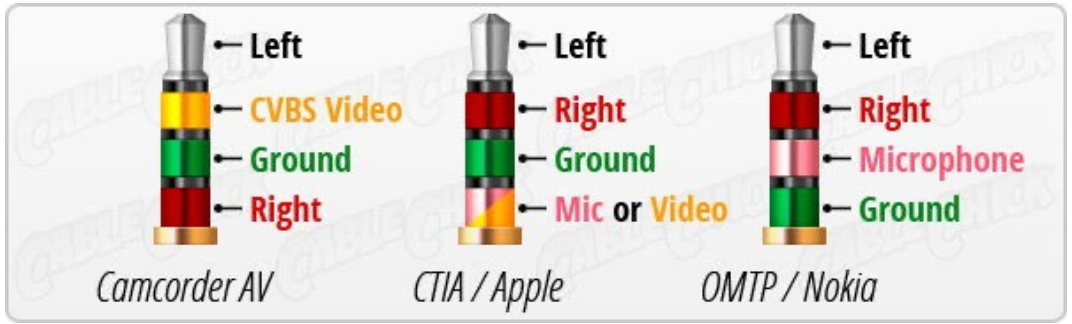


Footnote

3.5mm TRRS plugs

Two styles:

- One called CTIA (Apple),
- one called OMTP (as used by Digirig).



Converters are available on-line