Amateur Radio
Digital Communication Mode FT8
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Amateur Radio Modes

- CW
- AM
- SSB
- FM
- RTTY
- PSK, JT65, JT9 and many other “digital” modes
- FT8
What is FT8?

• Released June 29, 2017
• Written by
  – Steven Franke (K9AN  University of Illinois - UC)
  – Joe Taylor (K1JT)
• FT8 features:
  – Very narrow bandwidth (50 Hz)
    • 8 tones, spaced 6.25 Hz apart
  – Fast (15s transmit/receive cycle) compared to JT65
• – FT8: Franke & Taylor, 8-frequency shift keying format.
Why FT8?
Weak-Signal Signal/Noise Ratio

SSB: +10 dB
CW: -15 dB
FT8: -21 dB
JT65: -25 dB
JT9: -27 dB
WSPR: -31 dB

* 2500 Hz bandwidth

Doubling power results in a 3 dB increase in SNR
31 dB difference is about $2^{10} = 1,024$
1W FT8 vs 1,024W SSB
Club Log graph showing modes used by radio amateurs in 2017, and the emergence of FT8. Lines on the graph are based on 28-day moving averages. Data were smoothed to reduce the prominence of peaks related to mode-specific contests.
October and November 2017 QST
Two part series on FT8
FT8 – The Math

• 15 second block supports 13 characters
• 15 -12.64 = less than 2.5 seconds to decode & respond
  – Turn ON auto-sequence
• Effective data rate of 5 words per minute
  – Forward error correction (FEC) in FT8 uses a low-density parity check (LDPC) code with 77 information bits, a 14-bit cyclic redundancy check (CRC), and 83 parity bits making a 174-bit codeword. It is thus called an LDPC (174,91) code.
  – Modulation is 8-tone frequency-shift keying (8-FSK). The total occupied bandwidth is $8 \times 6.25 = 50$ Hz.
  – Synchronization uses $7 \times 7$ Costas arrays at the beginning, middle, and end of each transmission ($7 \times 3 = 21$).
  – Each transmitted symbol carries three bits ($8 = 2^3$), so the total number of channel symbols is $174/3 + 21 = 79$.
  – Transmission duration: $79 \times 1920/12000 = 12.64$s
A sidetrip into the FT8 Costas Array

- In addition to Forward Error Correction FT8 uses 7x7 Costas arrays, originally developed to provide better SONAR and RADAR pings by tagging each transmission with unambiguous combinations of frequency hops and time intervals.

- There are 200 unique frequency and time combinations in a 7x7 Costas Array.

- For background visit the Ted Talk “The World’s Ugliest Music” created using a Costas Array, guaranteed NOT to be running through your brain all day long once you hear it.
Let’s use WSJT-X FT8 Mode
Setup and Operating Hints

• Radio w/ SSB, Sound Interface, and a PC are required
  – Rig interface is very helpful (t/r and frequency)
• Download WSJTX
  – Enter your callsign, grid square, sound card, radio interface
  – Select frequency / band
  – Adjust AF input level – receive
• Synchronize your clock!
• Synchronize your clock!!
• Synchronize your clock!!!
• Adjust RF power output
  • 100% duty cycle – full output NOT recommended
    – Adjust AF output level – transmit (barely move ALC)
• Enable logging & reporting to pskreporter.info
• Turn on auto-sequence

• Listen to familiarize yourself with the sequence
What's my Grid Square?
http://www.levinecentral.com/ham/grid_square.php

Amateur Radio Ham Radio Maidenhead Grid Square Locator Map

Latitude: 43.07 / 43° 4’ 12” N Longitude: -89.38 / 89° 22’ 47” W
Grid: EN53hb
Getting Started

Set the band, tune up as normal

Use Tune to check power level

Adjust slider until transmit power drops (half your rig’s power or even 25 or 10% is a good place to start)

Adjust RF gain to keep receive level below red, between 40 and 80 is ok

You will probably need to adjust your sound card’s audio levels to get everything to play. This can take some time and a separate sound card is highly recommended (set and forget)
WSJT-X Main Screen

All QSO activity in the receive spectrum

Stations calling “CQ” will be highlighted in green

Your call will show up highlighted in red

All activity shown on the Rx frequency

Your transmissions are highlighted in yellow

The message transmissions are generated automatically and sent in sequence

Your transmissions are sent in a 50 Hz-wide slot at the base frequency + the audio offset
WSJTX - The Waterfall
References

• WSJT-X Homepage with downloads http://physics.princeton.edu/pulsar/K1JT/wsjtx.html

• FT8 Operating Guide ZL2iFB (very good) www.g4ifb.com/FT8_Hinson_tips_for_HF_DXers.pdf

• FT8 DXpedition Mode JT http://physics.princeton.edu/pulsar/k1jt/FT8_DXpedition_Mode.pdf

• JTAlert Helper App https://hamapps.com/

• PC Time Sync Programs (Windows / PC clock usually not good enough)
  – https://www.maniaradio.it/en/bkttimesync.html (pool.ntp.org)
  – https://sourceforge.net/projects/nettime/
  – https://time.is

• PSKreporter https://www.pskreporter.info

• Grid Square locator http://www.levinecentral.com/ham/grid_square.php

• WSJT-X FT8 Joe Taylor video presentation https://www.youtube.com/watch?v=233HQs_8JGQ

• Video - FT8 Facebook Page Group https://www.youtube.com/watch?v=-dO7m4XZzOI&t=21s
Demonstration
(RealVNC - VNC Viewer)