Getting Started with Digital Modes, (aka Sound Card Modes)

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Sound Card Modes Overview

- Definition
- History
 - Popular Modes: RTTY, PSK31, JT modes, WSPR
 - Other Modes: SSTV, Packet.....
- Hardware: Radio, Computer, Interface
- Software
- Operating
- Need Help?

Definition of Digital Modes

- Computer driven modes that use sound cards for generating and decoding messages
- Most ham digital modes are text based messages converted to narrow band USB modulation
 - Performed with a computer generated sequence of tones
 - Bandwidth varies from 30 Hz to a few KHz
 - Some modes are good at maintaining communication through noisy links

In the beginning: RTTY



- RTTY (pronounced: ritty) is short for radio teletype
 - Ham use started with surplus teletype machines
 - Two tones (Mark and Space) are used and spaced 170Hz apart, 2125/2295Hz
 - A 5 bit, Baudot code is used at a baud rate of 45.45 on HF, ~60wpm
 - The teletype is an electromechanical device that uses relays as the interface
 - A Terminal Unit (TU) was the interface between the radio and the teletype relays
 - generated tones for TX and had two narrow audio filters for RX
 - Computer generated RTTY started in the early 1980s using Radio Shack TRS80 and Commodore 64 computers and custom/homebrewed interfaces
 - Later versions used computers with commercial Terminal Node
 Controllers (TNCs) from Kantronics and others

RTTY is the original keyboard to keyboard mode

Model 15 teletype and homebrew TU



Teletype Corporation Model 15



Sound Card Modes & PSK31

- Budget friendly home computers and easy to use software facilitated the genesis of the sound card modes
- RTTY evolved into a sound card mode and was the predominate mode used on the HF bands until
 - PSK31 was introduced in 1998.
- PSK31 is still a very popular, keyboard to keyboard mode
 - narrow bandwidth (approximately 60 Hz) reduces its susceptibility to noise.
 - This was a "game changer", as RTTY was very susceptible to noisy band conditions.
 - Subsequent modes were developed with error correction that have even better performance under noisy conditions, i.e. Olivia, at much greater bandwidths.



WSJT modes

WSJT modes were developed for weak signal work, in the early 2000's

- JT65 used on HF, 1 minute intervals, QSO takes 6 minutes
- FT8, shortened to 15 seconds intervals, QSO takes 1 min
- FT4 is 7.5 sec. interval, at greater (2x) BW, reduced sensitivity
- WSPR- weak signal beacon mode, 2 min intervals, used for propagation reporting. Tx power is typically < 30dBm (1W)
- Other specialty modes for EME, meteor scatter, etc

FT8

- Popularized in 2018, at one of the quietest periods in solar activity
- Can decode extremely weak signals
- Two way communication with pre-canned messages
- Currently, over 50% of all HF activity (QSOs) is on FT8
- "Low profile" HF stations can be successful
- Used extensively by recent DX-peditions in Fox/Hound mode. This mode shortens the QSO exchange, allows multiple Tx streams, with two sets of data per stream. All maximizing the DX station's QSO rate.



Other modes you may want to try:

- SSTV Slow Scan TV
 - <u>https://hamsoft.ca/pages/mmsstv.php</u>
- Packet TNC emulator
 - <u>http://uz7.ho.ua/packetradio.htm</u>
 - easyterm
 - soundmodem
- Free DV hi fidelity digital voice with SSB BW

– <u>https://freedv.org/</u>

- WinLink global radio email
 - <u>https://www.winlink.org/</u>

All the software referenced in this presentation is Freeware

Four Components of a Digital Mode Station

- Radio any transceiver, regardless of age, can be used for digital modes
- Computer Windows, Mac, Linux
 - Sound card (internal or external)
- Interface between computer and radio
- Software
 - Generates and decodes the audio "tones"
 - Radio Tx control & other radio functions
 - Check for compatibility with Mac or Linux

Interface

- Functions
 - Key the radio
 - Get sound in / out of the radio
 - Optional Control: frequency, mode, split
- These functions are performed in different ways depending on the radio
 - Some modern radios use a USB cable for all three functions

Radio connection - options

- Key the Radio Push To Talk (PTT)
 - Accessory jack: keying connection (typically short to gnd)
 - Microphone jack
 - Vox, Voice operated Tx (keys the radio when audio is sensed)
 - USB
- Sound audio in/out
 - Accessory jack: separate audio in and out pins
 - (1) microphone jack: audio in; (2) speaker jack: audio out
 - USB (sound card internal to radio)
- Radio control frequency, mode, split, etc.
 - CAT control (typically a 9 pin DB "serial" connector on older radios)
 - Other serial control (i.e. Icom: remote/CIV interface)
 - USB

Any radio can be adapted for digital mode use

Interface solutions

Home brew

- PTT
 - VOX (may not work effectively with some modes) or...
 - simple keying circuit with USB to serial converter
- Audio cables
 - Radio audio (speaker/accy jack) to sound card (mic) input
 - Sound card (headphone) output to radio input (mic/accy jack)
- CIV or CAT control
 - USB to serial converter

Your interface solution will work with any digital mode software

Sample Homebrew Interface



HiLetgo FT232RL FTDI Mini USB to TTL Serial Converter Adapter Module 3.3V 5.5V FT232R Breakout FT232RL USB to Serial Mini USB to TTL Adapter Board for Arduino

****** * 820

\$599

DIY for ~ \$25



Commercial Interface



Interface sources:

Masters Communications - DRA-30 (kit), DIY cables, \$50

Tigertronics - SignaLink, custom cable, \$125

West Mountain Radio – RIGblaster Plug and Play, custom cable, \$130 MFJ, Rig Experts, others......

USB to serial converters: FTDI or RT systems

Commercial Interfaces





Masters Communications DRA-30





Commercial interface features: USB input, integrated sound card, audio in/out and PTT connections to rig

Modern Radio Interface



Many modern transceivers utilize a single USB interface for audio and rig control

Software

- Software packages
 - Fldigi: multiple modes includes most of the HF keyboard to keyboard modes
 - Installation packages available for Windows, MacOS and Linux
 - WSJT-X: multiple modes, focus is on weak signal modes
 - Installation packages available for Windows, MacOS and Linux
 - The WSJT modes require accurate timing. Use an NTP time program like "Meinberg", that runs in the background
- Others:
 - UZ7HO, packet
 - MMSSTV
 - FreeDV, hi-fidelity, digital audio

All the software referenced in this presentation is Freeware

Software/Radio Setup

- Driver installation may be required:
 - Sound card
 - Radio control
 - Follow installation instructions from the interface and/or radio manufacturers
- Audio in/out settings
 - Select audio streams
- Audio levels adjusted from sound card control
- Radio interface settings
 - PTT
 - Com port, method
 - Radio Control
 - Com port (s)
 - Serial port settings (computer and radio)
 - Data bits, stop bits, baud rate
 - Radio hexadecimal address (Icom)

Tip: After everything is working, make a record of your radio settings and take screen shots of your software settings.

Typical sound card settings

Fldigi configuration		- 0	\times						
Configure	Soundcard/Devices								
 Colors-Fonts Contests IDs Logging Modem Misc Operator-Station Rig Control Soundcard Alerts Devices Right channel Settings Signal Level Wav file recording UI Waterfall Web 	⊖oss	Device:							
	PortAudio	Capture: Microphone (USB Audio CODEC)							
		Playback: Speakers (USB Audio CODEC)							
	○PulseAudio	Server string:							
	□File I/O only	Device supports full duplex							
	Audio device shared b	by Audio Alerts and Rx Monitor							
	No	Note: must be selected and enabled for Rx Audio monitoring!							
Collapse Tree	Restore defaults	Save Close	<u><</u>						

In this case, the USB Audio CODECs were generated by installing the drivers from ICOM

Typical rig control settings – WSJT-X

Rig: Kenwood TS-2000 CAT Control Serial Port: COM4 Serial Port Parameters Baud Rate: 4800 Data Bits Data Bits Default Stop Bits Default One Two Handshake Default None Split Operation None None	General Radio Audio Tx Macros Re	porting Frequencies Colors Advanced
CAT Control Serial Port: COM4 Serial Port Parameters Baud Rate: 4800 Data Bits Default © Seven @ Eight Stop Bits Default @ One © Two Handshake Default @ None None @ USB @ Data/Pkt Split Operation None @ Rig @ Fake It	tig: Kenwood TS-2000	← Poll Interval: 1 s
Force Control Lines	CAT Control Serial Port: COM4 Serial Port Parameters Baud Rate: 4800 Data Bits Default © Seven Eight Stop Bits Default One Two Handshake Default One XON/XOFF Hardware Force Control Lines DTP:	PTT Method VOX DTR CAT RTS Port: COM4 Transmit Audio Source Rear/Data Front/Mic Mode None USB Data/Pkt Split Operation None Rig Fake It Test CAT Test PTT

- Settings for CAT: Radio, Com port, baud rate, Number of data and stop bits.
- Settings for PTT, etc.

Typical rig control settings - fldigi

Fldigi configuration	
Operator UI Waterfall Modems Rig Audio ID I flrig RigCAT Hamlib XML-RPC Hardware PTT GPIC	Misc Web Autostart IO PSM
	RigCAT
Rig description file: PowerSDR.xml Open	Device: COM10
Retries Retry interval (3 50 Write delay (ms) Init delay (ms) 25 100	ms) Baud rate: 9600
Commands are echoed	CAT command for PTT Toggle DTR for PTT
©RTS +12 v	ODTR +12 v
RTS/CTS flow control Restore Settings on Close	OVSP Enable
Restore defaults	Save Close //

For CAT control, download the XML file for your radio at: https://sourceforge.net/projects/fldigi/files/xmls/

Fldigi with PSK31



Waterfall:

- Vertical = time
- Horizontal = Audio frequency, modulated on the carrier
- Intensity = signal strength

WSJT-X with FT8

3300 Hz Rx passband

Tx and narrow Rx, ~50Hz (cursors)

🕚 WSJT-X v2.1.0	by K1JT	ALC: N. C. MURAN		1000							No.	Ŀ	- - X
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002130 -1	15 0.5 2447 ~	CQ WM1G FN42	U.S.A.			002045	Tx 1437	~ 9G2HO F	3EA R-08				
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Waterfall, each interval is 15 sec.

Pre-canned messages: Grid sq., sig rpt, RR73



181201_180245.wav

WSPR sample



WSPR waterfall, 2 minute intervals, a low level signal is circled

WSPR online reporter

- Weak Signal • Propagation Reporter
- beacon mode
- 2 minute Tx time
- Tx: Call, power, • grid square
- **Rx** signal • reports posted online



Frequencies

Database

USB dial (MHz): 0.136, 0.4742, 1.8366, 3.5926, 5.2872, 7.0386, 10.1387, 14 21.0946. 24 50.293, 70 432.300, 1

Spot Co

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Specify query parameters 1000 spots:

4.0956, 18.1046, 4.9246, 28.1246,	Timestamp	Call	MHz	SNR	Drift	Grid	Pwr	Reporter	RGrid	km	az
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on	2017-04-11 22:42	W2ZQ	7.040052	-12	0	FN20og	1	KB8UVN	EN80ge	665	272
tent	2017-04-11 22:42	W2ZQ	7.040086	-9	0	FN20og	1	N4AU	EM62vp	1325	234
	2017-04-11 22:42	W2ZQ	7.040087	-19	0	FN20og	1	KK1D	FN31vi	249	60
	2017-04-11 22:42	W2ZQ	7.040107	-24	0	FN20og	1	KC8YJJ	EN90	530	275
nline	2017-04-11 22:42	W2ZQ	7.040101	-7	0	FN20og	1	DG2HSI	JO51mr	6359	47
	2017-04-11 22:42	W2ZQ	7.040094	-18	0	FN20og	1	K5CZD	EM32vn	1774	247
currently 136 users	2017-04-11 22:42	W2ZQ	7.040088	-24	-1	FN20og	1	G7RMG	IO80tu	5526	52
	2017-04-11 22:42	W2ZQ	7.040076	-7	0	FN20og	1	K3EA	FN20of	5	180
	2017-04-11 22:42	W2ZQ	7.040095	-22	0	FN20og	1	VK6CQ	OF78xa	18682	310
	2017-04-11 22:42	W2ZQ	7.040090	-16	0	FN20og	1	K4RCG	FM08si	381	237
	2017-04-11 22:42	W2ZQ	7.040088	-11	0	FN20og	1	G4CPD	IO94hc	5488	48
	2017-04-11 22:42	W2ZQ	7.040099	-2	0	FN20og	1	K9DZT	EN52wx	1147	290
	2017-04-11 22:42	W2ZQ	7.040108	-2	0	FN20og	1	KA3JIJ	EM84cj	1029	233
	2017-04-11 22:42	W2ZQ	7.040090	-20	0	FN20og	1	DL1KAI	JO42vj	6251	47
	2017-04-11 22:42	W2ZQ	7.040110	-23	0	FN20og	1	EIRESWL	IO63ri	5179	50
-	2017-04-11 22:42	W2ZQ	7.040088	-19	0	FN20og	1	PAOMLC	JO31aw	6035	49
	2017-04-11 22:42	W2ZQ	7.040063	-10	0	FN20og	1	LX1DQ	JN39cg	6143	51
F	2017-04-11 22:42	W2ZQ	7.040120	-14	0	FN20og	1	DL/PA0EHG	JO32sq	6098	47
	2017-04-11 22:42	W2ZQ	7.040085	-20	0	FN20og	1	VK6QA	OF77vv	18703	310
1	2017-04-11 22:42	W2ZQ	7.040072	-4	0	FN20og	1	DK6UG	JN49cm	6282	51

Welcome to the Weak Signal Pro

Online WSPR reporting



- 20 meters, one hour of data from Eastern PA
- Online users can center the map for any location. Can be used as propagation tool for anyone!

Operating on digital modes

- Start out slow......become familiar with the software and start with receive only
 - For receive you only need one cable: audio output from radio to sound card input
- On transmit, These modes are 100% duty cycle
 - Use 50% or less of transmitter maximum output

Where to operate:

- On HF, above the CW bands. i.e. 14.070 to 14.100 MHz
- On VHF, just below the SSB calling frequencies, i.e. 144.150 to 144.200 MHz
- Consult the ARRL band plan, a voluntary plan, for suggested frequencies. The frequencies will be designated as RTTY/data
- During certain contests there is increased activity on the digital modes, i.e. ARRL VHF contest
- Specific contests for: RTTY, PSK31 and FT8/FT4 and Feld Hell

The best place to start is on 20 meters.... 14.070 for PSK31 14.080 for RTTY 14.074 for FT8

HELP !

- Get a copy of the ARRL's "Get on the Air with HF Digital", 2nd edition.
- Ask a DVRA key holder to give a demo at the club station.....
 - Sunday, Tuesday and Thursday, 1-4pm
 - Tuesday and Thursday, 6-8pm
- There are lots of local hams and club members that are available to help
- Someone else has already done it....check the internet

There's help out there

For example, a quick search on "WSJT and IC7300 settings"..... the first result from K5TMT:

WSJT-X Settings for the IC-7300

These are my settings for running FT8 on Windows. Some of them are personal preference, but either way, it should help you get up and running.

IC-7300

RF POWER: 35% MODE: USB-D FILTER: FIL1 (3.6k) P.AMP/ATT: (leave default) AGC: FAST NB: OFF NR: OFF USB MOD Level: 40% DATA OFF MOD: MIC/ACC DATA MOD: USB USB Serial Function: CI-V CI-V Baud Rate: Auto CI-V Address: 94h CI-V Transceive: ON CI-V USB Port: Unlink from [REMOTE] CI-V USB Baud Rate: 115200 CI-V USB Echo Back: ON PTT Start: ON (except on 6m where tuner can't be used with my MFJ-929)

<u>WSJT-X</u>

Baud Rate: 115200 Data Bits: 8 Stop Bits: 2 Handshake: None PTT Method: CAT Mode: Data/Pkt Split Operation: Fake It

Windows

Set Windows audio playback device to 100%, disable all enhancements, and set default format to 1 channel, 48000 Hz. Set Windows audio recording device so that the green RX bar in WSJT-X is around 30% on a quiet band/frequency. Set default format to 1 channel, 48000 Hz. Label the audio devices as "IC-7300".

When transmitting, adjust Pwr slider in WSJT-X until it begins to tickle the ALC meter. Forward power should now be around 28W.

Why try digital?

- It's fun
- It's a challenge
- Lot's of activity
 - Over 50% of all HF contacts are on digital
 - Over 80% of all weak signal contacts on 6 meters are on FT8
 - There are contests specifically targeting digital modes
- QUESTIONS??

Resources

- "Get on the Air with HF Digital", 2nd ed., Steve Ford
- <u>http://www.w1hkj.com/</u> (flidigi home page)
- <u>http://www.w1hkj.com/beginners.html</u> (fldigi Begninner's Guide)
- <u>http://www.w1hkj.com/modes/index.htm</u> (Identifying Digital Modes)
- <u>https://physics.princeton.edu/pulsar/k1jt/wsjtx.html</u> (WSJT-X home page)
- <u>https://physics.princeton.edu/pulsar/k1jt/wsjtx-doc/wsjtx-main-2.5.2.html</u> (WSJT-X users guide)