HF Digital Communications

How to work those strange sounds you hear on the air

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Introductions

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  - Licensed in 1979 at age 16
  - Retired from electronics manufacturing and IT systems
  - Active experimenter and home brewer
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Introductions

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Introductions

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Introductions

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  - Licensed in 1976
  - Computer operator for a major newspaper
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Introductions

- John Mathieson AC8JW
  - Licensed since about 2005
  - Active in CW and digital modes
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Why Digital?

- Send and receive text, images, data, and audio
- Some modes work very well in noisy and weak signal environments
  - If you can’t hear them you can’t work them is no longer true!
Why Digital?

- Some modes can provide error free or reduced error transmissions.
- Good for Emergency Communications
Why Digital?

- Many modes use smaller bandwidths than voice.
- 97.1(b) contribute to the advancement of the radio art.
- 97.313(a) use the minimum transmitter power necessary to carry out the desired communications.
Digital Modes of Operation

- There are more digital modes than you can shake a stick at!

  - RTTY, PSK, QPSK, MFSK, Olivia, MT63, JT65, Contestia, Hellschreiber, Throb, Packet, WSPR, SSTV, FreeDV and many many more!
Digital Modes of Operation

- Each have their own good and bad
- We will just look at a few popular ones......
The Old Timers of Digital CW

- CW is the oldest digital mode
  - Started before the birth of radio
  - Computers are not required
  - From QRSs in seconds per ‘dit’
  - To QRQ speeds greater than 150WPM
The Old Timers of Digital RTTY (Radio Teletype)

- Became popular in the 1950’s using WWII surplus equipment.
- 60WPM / 45 baud (changes per second)
- FSK - Shifts between 2 frequencies, typically 170Hz apart.
- Sensitive to QSB and QRN, no error correction.
PSK31

- One of the first sound card modes
- Popular for keyboard to keyboard
- Narrow 31Hz bandwidth
- 5 conversations fit in the same space as RTTY
- 30% slower than RTTY
  - 40WPM / 31 baud
- Sensitive to QSB and QRN, No error correction but outperforms RTTY
MFSK16

- Like RTTY but uses 16 different frequency shifts
- Old technology mode - required complicated hardware before sound card software was available
- Speed of 78WPM / 62.5 baud with a 316 Hz bandwidth
- ARRL Bulletins are transmitted in MFSK16
MFSK16

- Uses forward error correction (FEC)
- Typically this is done by sending redundant data
- The cost penalty is extra time to send the data multiple times
- Result is greatly reduced errors from QSB, QRN and Multipath propagation
MT63

- MFSK Variation using 64 frequency shifts
- Great for sending large amounts of data
- Forward error correction, can lose up to 25% and still have perfect copy
MT63

- 3 Modes of operation
  - MT63-500  50WPM 500Hz BW
  - MT63-1000 100WPM 1KHz BW
  - MT63-2000 200WPM 2KHz BW

- Typically MT63-2000 is used by EMCOMM and MARS
Olivia

- Another MFSK Variant
- Has forward error correction like MT63
- Good with QSB, QRM
- Will decode 10-14dB below the noise floor
Olivia

- Common bandwidth, shifts, and speeds

<table>
<thead>
<tr>
<th>Mode</th>
<th>BW</th>
<th>Shifts</th>
<th>WPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>500/16</td>
<td>500</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>1000/32</td>
<td>1000</td>
<td>32</td>
<td>24</td>
</tr>
</tbody>
</table>
JT65/JT9

- QRPP & EME Weak signal mode
- JT65 uses 65 shifts in a 355Hz bandwidth
- JT9 – Fairly new mode
  - Uses 9 shifts in only 15.6Hz bandwidth
  - Sounds like a constant tone
JT65/JT9

- Very slow mode!
  - 45 seconds long to send 72 bits or ~13 characters
  - Standard messages typically contain two call signs, a grid locator or signal report, the message type.
JT65/JT9

- Now also used on HF
- W6CQZ wrote “JT65-HF” that makes HF operation easy, especially for low power stations.

http://sourceforge.net/projects/jt65-hf/files
Actual off-the-air RX in central MI with mobile whip on 20 meters.
SSTV

- Started with dedicated hardware using surplus long-persistence RADAR CRT’s; now all done with sound-card software.

- Commonly called a “digital” mode, but most SSTV is analog, except for “EasyPal” which is actually a general-purpose digital-file-transfer-over-radio program.

- Various formats of SSTV exist but most software automatically detects and handles formatting.
SSTV

- Weather Fax (WeFax) is a similar mode, not used in amateur radio but can be found on the SW bands.
Digital Voice

- The future of radio??
- About ½ the bandwidth
  - 1.25KHz wide using a 16QPSK signal
- FM-quality noiseless voice on HF!
- Most activity on 14.236MHz
- Free software at: [http://freedv.org](http://freedv.org)
Digital Voice

- Requires 2 sound cards
  - One for radio-to-speaker (RX)
  - One for mic-to-radio (TX)
- USB sound cards are cheap
  - From $1.80 to $25
Hardware

- Only 3 components needed
  - Radio
  - Computer
  - Audio / PTT Interface
- Optionally a Computer Aided Tuning (CAT) interface
  - Not required but nice to have if the radio supports it
Hardware

- How much does it cost?
  - Assuming you have the radio and computer.......  
  - Build your own interface from free to $25  
  - Buy commercial interfaces from $60-300
Almost any USB HF Transceiver

- Older mechanical analog VFO rigs may NOT be stable enough for narrow modes like PSK31 but work well on modes like RTTY and SSTV.

- Newer radios with stable frequency synthesizers are best.

- Some high end rigs have PSK and RTTY built in!
Hardware Computer

- Big and fast not required
- Most “XP” computers work fine!
- Minimum Requirements
  - Available USB or RS-232 port
  - Sound Card
  - 1GHz CPU, 100MB free RAM
  - 300MB Drive space
  - Depends on software - YMMV
Start today with a simple attenuator cable
Parts are about $10 at Radio Shack, cheaper elsewhere!

ww8lmf.net/miscinfo/Universal-Sound-Card-Cable.pdf
Interfaces
Receive

Mic In  Attenuator  Speaker out
Interfaces

Transmitting

- Transmitting is a little more complex
  - PTT keying
  - Isolate the audio to prevent ground loop issues
Several Manufacturers
- MFJ
- West Mountain (Rig Blaster)
- TigerTronics

Some models include cables
Other models require purchasing cables for your rig
Interfaces Commercial

- Better models include a sound card built in
  - Your internal PC sound card is available for regular use
- Prices from $60 - $300
Interfaces
Commercial

- Older models only handle the TX side
- These models use a straight RX cable and the PC LINE-IN instead of the MIC jack!
- An RX attenuator cable is still required to go into the PC Mic jack
Interfaces
Homebrew

- As basic as two 600-600 ohm audio transformers, a few resistors, and a $1.00 opto-isolator chip for PTT keying.
Interfaces
Homebrew

Computer Audio In

Radio Receive Audio Out

Diagram showing a connection between Computer Audio In and Radio Audio Out.
Interfaces
Homebrew

Computer Audio In

Computer Speaker/Line Audio Out

Radio Spkr/Aux Audio Out

Radio Mic/Aux Audio In
Interfaces Homebrew

- Computer Audio In
- Computer Speaker/Line Audio Out
- Serial Port RTS Pin
- Radio Spkr/Aux Audio Out
- Radio Mic/Aux Audio In
- Radio PTT Line
Interfaces
Typical Setup

USB or Serial for PTT
PC Spkr Out to TX Audio In
RX Audio Out to PC Mic In
Mic In
TX Out
RX In
Speaker Out
Ham Radio Deluxe includes a program called Digital Master 780 (DM780)

- Current Commercial version 6 $100
- Older version 5 is free!
- Handles most modes including SSTV
Software
Ham Radio Deluxe

Also contains:
- Integrated radio (CAT) control
- Log book
- Satellite Tracking
- PSK31 super sweeper
- Remote Control
- And more.....
Software
Ham Radio Deluxe
FLDigi is FREE!

Handles most modes including SSTV and WeFax

Also contains a log book and radio control
Software
FLDigi

- The program of choice for EMCOMM
- Handles radiogram and ICS forms
  - Note: additional software needed for these on the FLDigi site.
Software
FLDigi
Special modes such as JT65/JT9 and digital voice require their own software. Many other software programs exist—both free and commercial.
Software

Others

- MultiPSK, Digipan, MixW, mmSSTV, and WinPSK are a few
- Most choices are personal preference
## Comparison of modes found in DM780 versus FLDigi

<table>
<thead>
<tr>
<th>Mode</th>
<th>DM780</th>
<th>FLDigi</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSK</td>
<td>both</td>
<td>Olivia</td>
</tr>
<tr>
<td>QPSK</td>
<td>both</td>
<td>RTTY</td>
</tr>
<tr>
<td>PSKR</td>
<td>both</td>
<td>RTTYM</td>
</tr>
<tr>
<td>Contestia</td>
<td>both</td>
<td>Thor</td>
</tr>
<tr>
<td>CW</td>
<td>both</td>
<td>Throb</td>
</tr>
<tr>
<td>DominoEX</td>
<td>both</td>
<td>WEFAAX</td>
</tr>
<tr>
<td>Hellschreiber</td>
<td>both</td>
<td>Navtex</td>
</tr>
<tr>
<td>MFSK</td>
<td>both</td>
<td>SITOR</td>
</tr>
<tr>
<td>MT63</td>
<td>both</td>
<td>WWV</td>
</tr>
</tbody>
</table>

* indicates a feature unique to that device.
Tips and Tricks
Power

- Reduce your power!
  - Unlike SSB, these modes either run at 100% duty cycle, or use multiple tones sensitive to intermodulation distortion!
  - Be kind to your finals!
  - Keep **peak** power out well below key-down CW maximum to minimize distortion.
  - Keep ALC to zero
- Turn off speech processing or compression
Uses the Auxiliary, Accessory, “Data”, or “Packet” jacks on the radio.

- Most radios from the major manufacturers have one or more of these jacks on the rear panel.
- May have constant audio input, output, and PTT lines.
Tips and Tricks
Jacks

- Typical Jacks
  - 6-pin Mini-DIN
  - 13-Pin Full-size DIN
Tips and Tricks
Jacks

- No need to adjust the volume or mic gain all the time
- No need to unplug the speaker to hear the radio
- No need to swap the mic in and out
  - You may need a mic switch!
Some radios have an audio out line in the microphone jack. This can help reduce extra cables.
Tips and Tricks
RSID

- Use Reed-Solomon Identification
  - Short code at the beginning of a transmission which identifies the mode
  - Several programs automatically detect this and pop up a box
Tips and Tricks
Sound Device

- Check your sound card settings in the control panel!
  - Turn off special effects
  - Turn off pass-thru or “Listen to this device” modes
  - Set rate to 16 bit 48000Hz
Use the mixer to adjust your transmit audio using a dummy load and short 5-10 second intervals.
Tips and Tricks
Waterfalls

RTTY-45
PSK31
MFSK16
JT9

JT65
Digital Voice
Tips and Tricks
Waterfalls

MT63

Olivia

SSTV
Tips and Tricks

Frequencies

- Common PSK31 frequencies
  - 1.828
  - 3.580
  - 7.035
  - 10.140
  - 14.070
  - 18.100
  - 21.070
  - 24.920
  - 28.120

- Other modes are usually a few KHz from this area
Tips and Tricks

Frequencies

- SSTV 14.230 is popular
- Digital Voice 14.236
- MI Digital Traffic Net (MIDTN)
  - 3.583Mhz Olivia 8/500
  - Tu, Th, & Sa 8PM local
- [http://www.midtn.ws/](http://www.midtn.ws/)
Tips and Tricks

References

- ARRL  www.arrl.org/hf-digital
- Ham Radio Deluxe – Free V5
  - www.amateurlogic.tv/MISC/HRD/HRD_Archives.htm
- FLDigi
  - www.w1hkj.com/Fldigi.html
Tips and Tricks

References

- JT65/JT9  hflink.com/jt65/
  - www.physics.princeton.edu/pulsar/K1JT/wsjtx.html
- FreeDV (Digital Voice)
  - www.freedv.org
- Olivia  www.oliviamode.com
Commercial Sites

Software:
- Ham Radio Deluxe V6
  www.hrdsoftwarellc.com

Interfaces
- MFJ
  www.mfjenterprises.com
- RigBlaster
  www.westmountainradio.com
- SignalLink
  www.tigertronics.com
Getting started on FLDigi

Home: http://www.w1hkj.com/

Downloads: http://www.w1hkj.com/download.html

Beginners’ guide: http://www.w1hkj.com/beginners.html
Questions?
This presentation and other notes can be found here:


- [http://WA8LMF.net/miscinfo](http://WA8LMF.net/miscinfo)