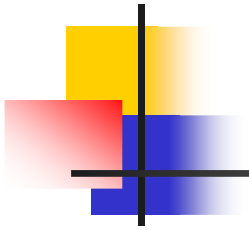
HF Digital Communications

How to work those strange sounds you hear on the air

John Clements KC9ON
Joe Miller KJ8O
Brian Johnston W8TFI
Stephen H. Smith WA8LMF
John Mathieson AC8JW

1 May 2014



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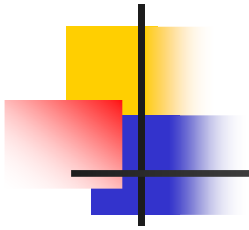
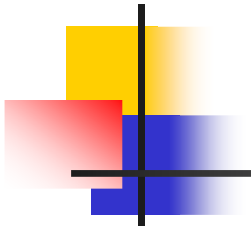
- Introductions
- Why Digital?
- Digital Modes of Operation
- Hardware : Radio, Computer, and interfaces



Contents

- Software
- Tips and Tricks
- Q&A



Introductions

- John Clements KC9ON
  - Licensed in 1979 at age 16
  - Retired from electronics manufacturing and IT systems
  - Active experimenter and home brewer
  - jwc123@gmail.com

Introductions

- Stephen Smith WA8LMF
  - Land-Mobile-Radio Systems & Field Engineer
  - Ham since 1964
  - WA8LMF@wa8lmf.net

Introductions

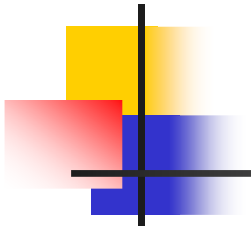
- Joe Miller KJ8O
  - SWL since 1967, first licensed in 2006 and collects QSL cards
  - President of OCARS (W8TNO)
  - Certified Public Accountant
  - kj8o.ham@gmail.com

Introductions

- Brian Johnston W8TFI
  - Licensed in 1976
  - Computer operator for a major newspaper
  - Avid experimenter and home brewer
  - w8tfi@arrl.net

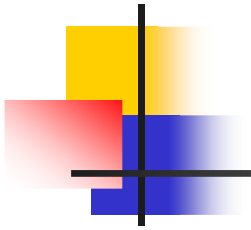
Introductions

- John Mathieson AC8JW
  - Licensed since about 2005
  - Active in CW and digital modes
  - jspokes@yahoo.com



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?

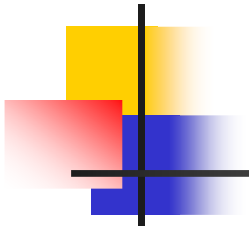
- Some modes can provide error free or reduced error transmissions.
  - Good for Emergency Communications

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!

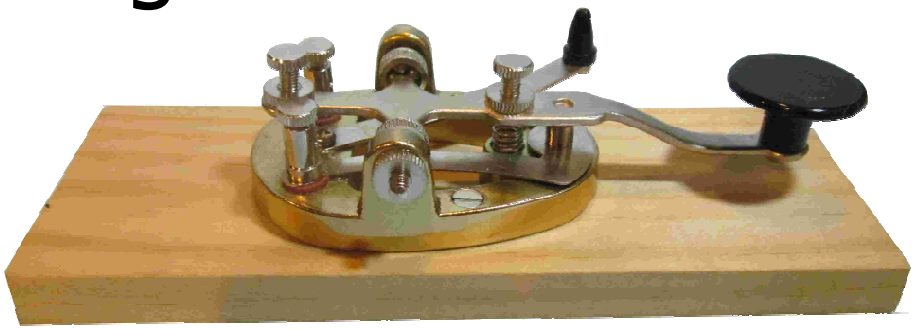


Digital Modes of Operation

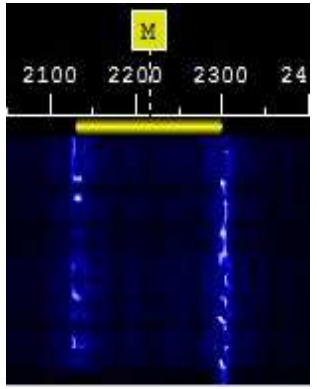
- Each have their own good and bad
- We will just look at a few popular ones……

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

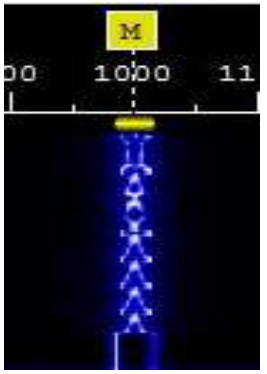


The Old Timers of Digital RTTY (Radio Teletype)



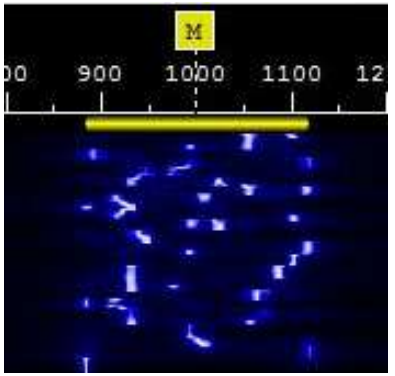
- Became popular in the 1950's using WWII surplus equipment.
- 60WPM / 45 baud (changes per second)
- FSK - Shifts between 2 frequencies, typically 170Hz apart.
- Sensitive to QSB and QRN, no error correction.

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

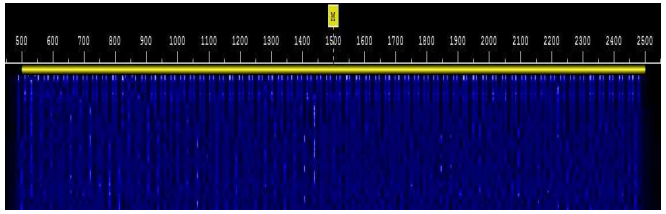
MFSK16



- 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

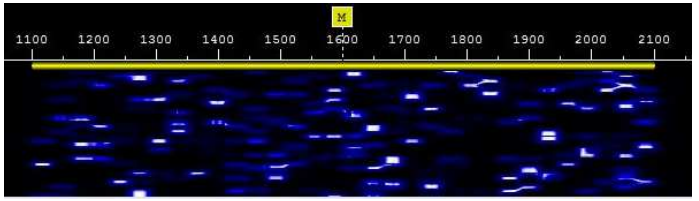


MT63

- 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

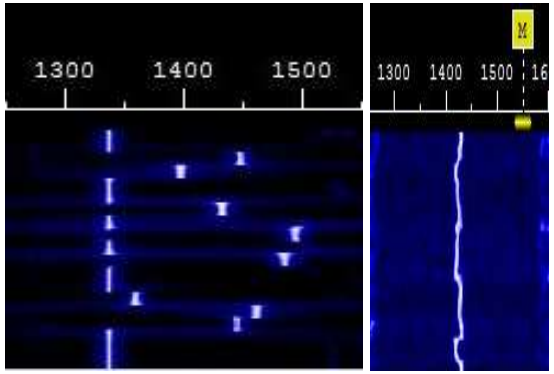
- Another MFSK Variant
- Has forward error correction like MT63
- Good with QSB, QRM
- Will decode 10-14dB below the noise floor

Olivia

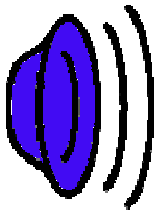
- Common bandwidth, shifts, and speeds

Mode	BW	Shifts	WPM
500/16	500	16	20
1000/32	1000	32	24

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



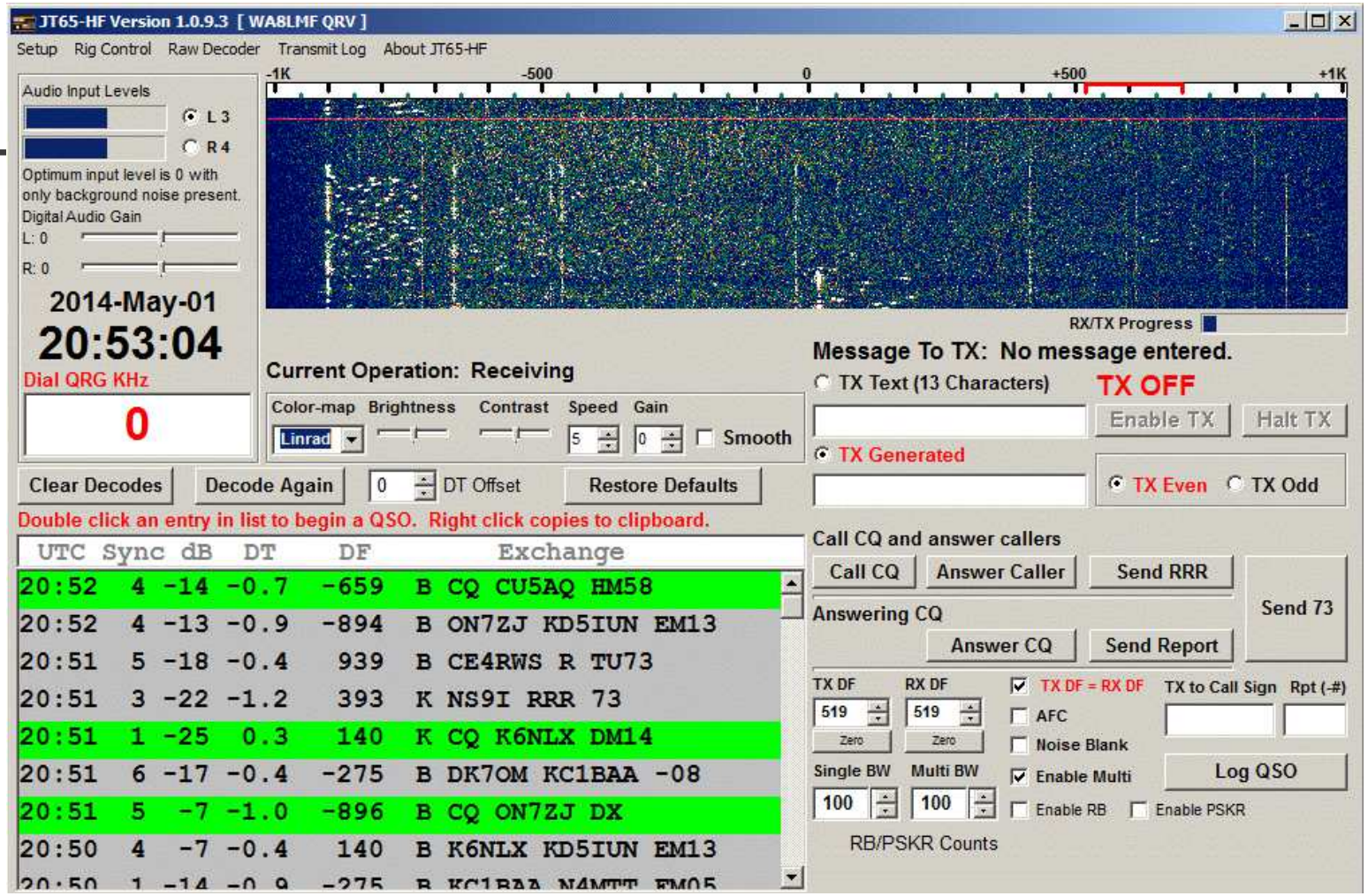
JT65/JT9

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

JT65/JT9

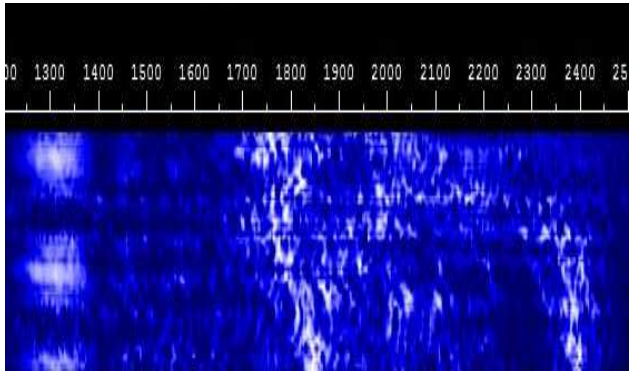
- Now also used on HF
- W6CQZ wrote "JT65-HF" that makes HF operation easy, especially for low power stations.
- http://sourceforge.net/projects/jt65-hf/files

JT65/JT9



- Actual off-the-air RX in central MI with mobile whip on 20 meters.

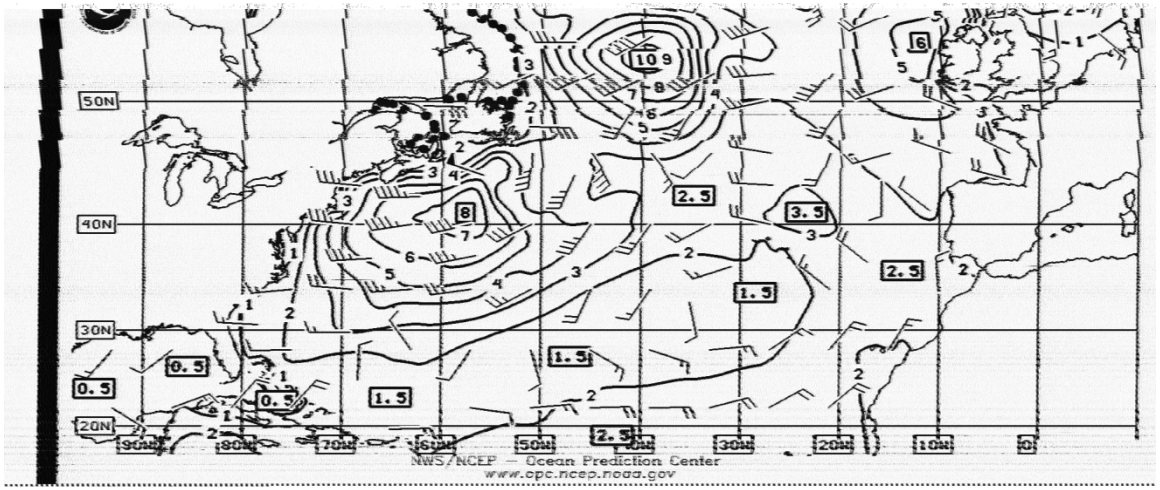
SSTV



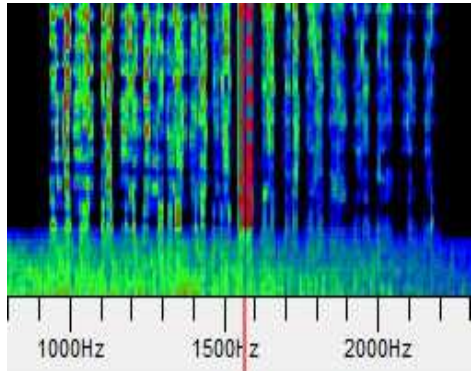
- Started with dedicated hardware using surplus long-persistence RADAR CRT's; now all done with sound-card software.
- Commonly called a "digital" mode, but most SSTV is analog, except for "EasyPal" which is actually a general-purpose digital-file-transfer-over-radio program.
- Various formats of SSTV exist but most software automatically detects and handles formatting

SSTV

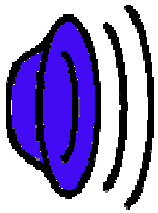
- Weather Fax (WeFax) is a similar mode, not used in amateur radio but can be found on the SW bands.

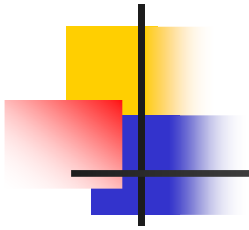


Digital Voice



- 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

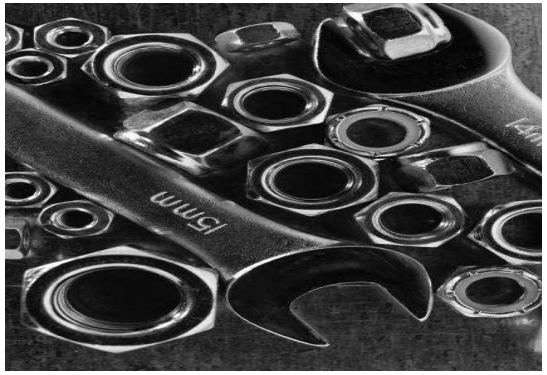




Digital Voice

- 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 **C**omputer **A**ided **T**uning (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

Hardware Radio

- 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

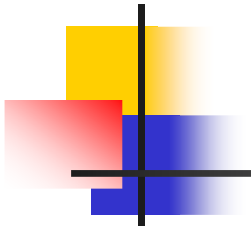
- Big and fast not required
- Most “XP” computers work fine!
- Minimum Requirements
  - Available USB or RS-232 port
  - Sound Card
  - 1GHz CPU, 100MB free RAM
  - 300MB Drive space
  - Depends on software - YMMV

Interfaces
Receive

- Start today with a simple attenuator cable
- Parts are about $10 at Radio Shack, cheaper elsewhere!
- wa8lmf.net/miscinfo/Universal-Sound-Card-Cable.pdf

Interfaces
Receive

Interfaces Transmitting



- Transmitting is a little more complex
  - PTT keying
  - Isolate the audio to prevent ground loop issues

Interfaces Commercial

- 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

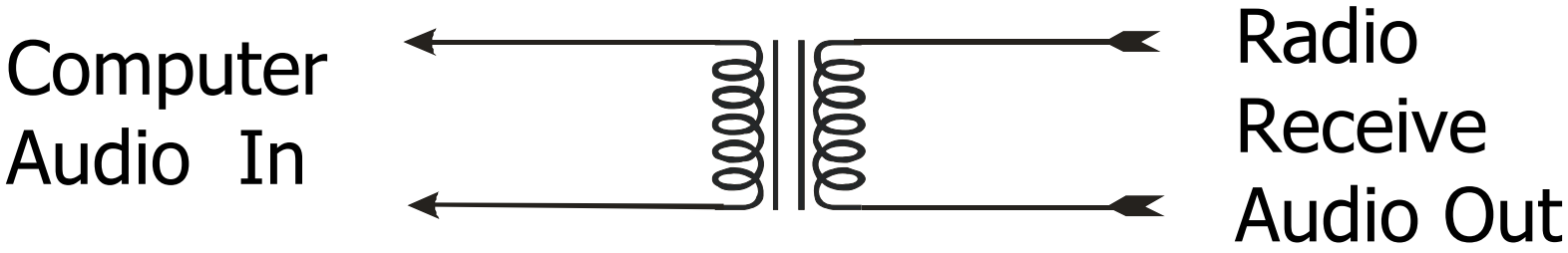
- Older models only handle the TX side
  - These models use a straight RX cable and the PC LINE-IN instead of the MIC jack!
  - An RX attenuator cable is still required to go into the PC Mic jack

Interfaces
Homebrew

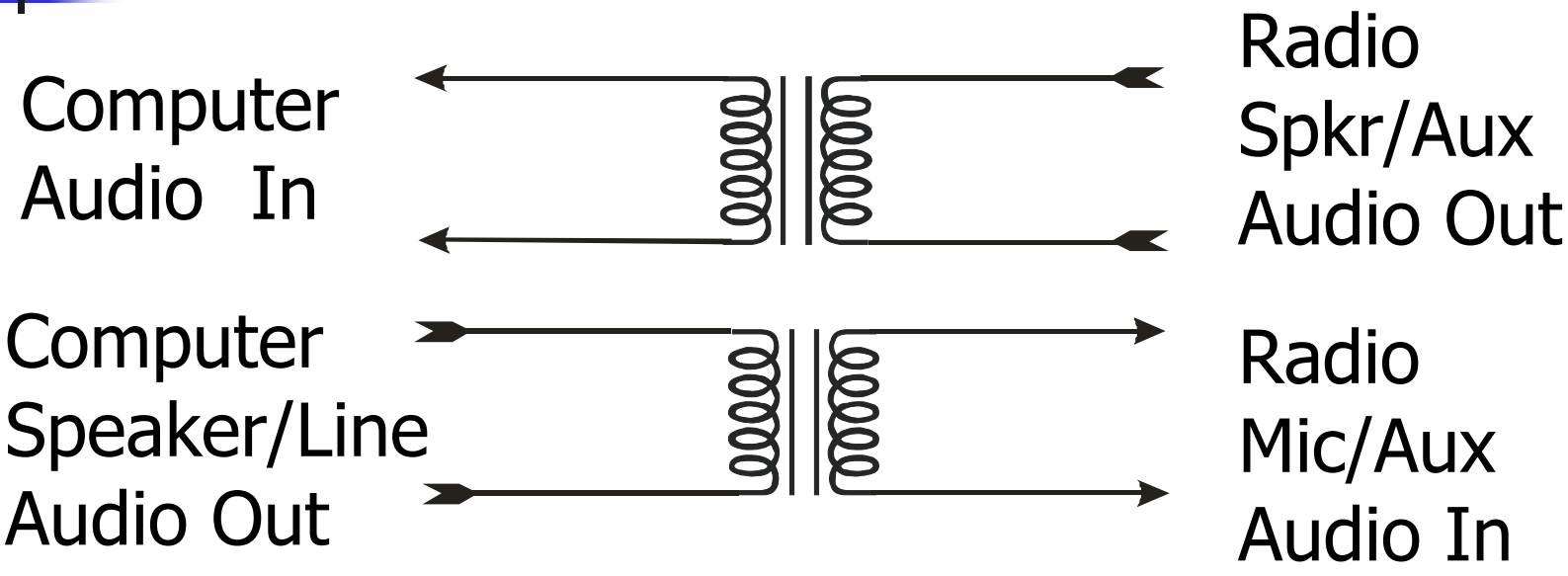
Spoken Here

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

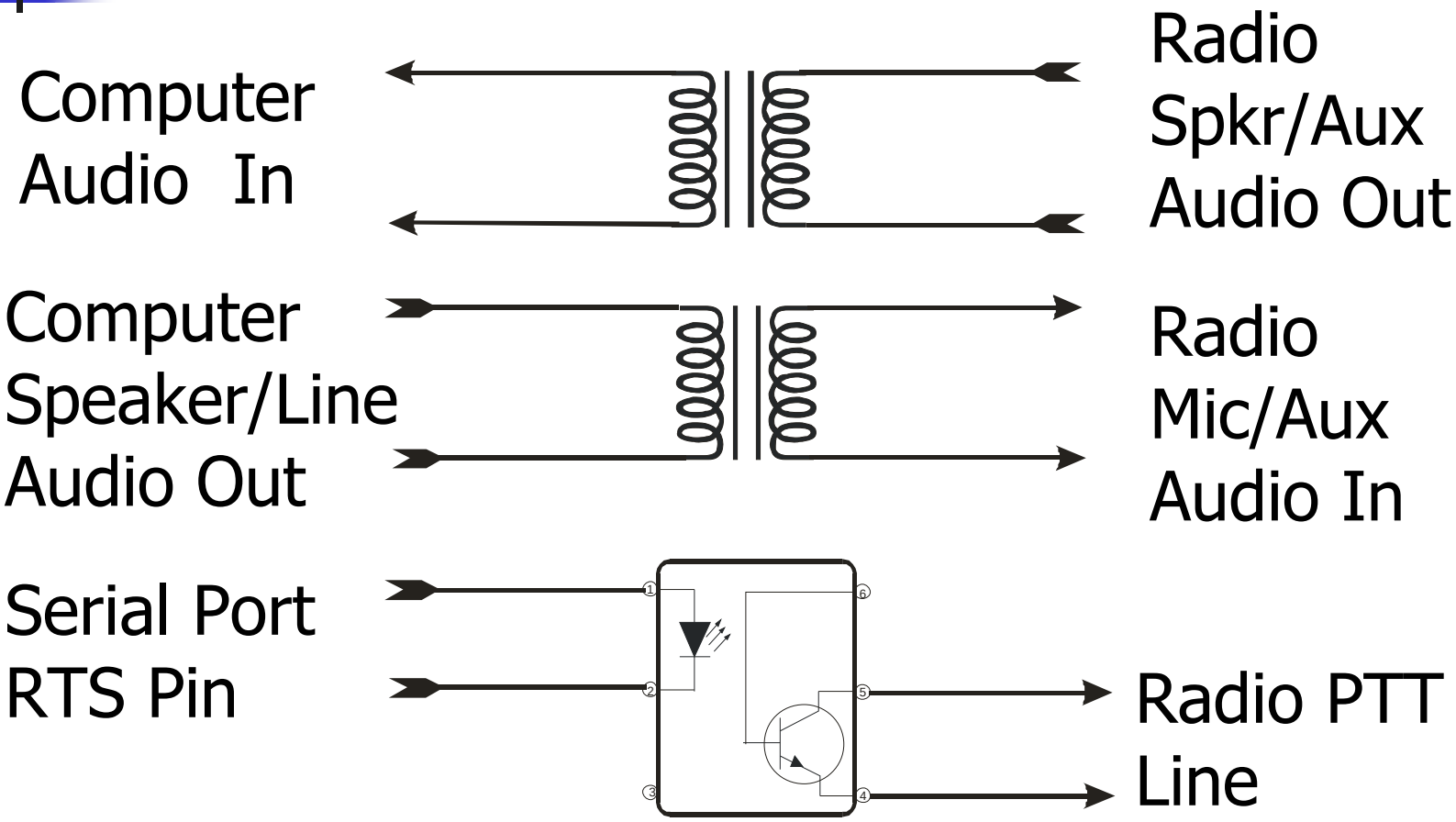
Interfaces
Homebrew



Interfaces
Homebrew



Interfaces
Homebrew



Interfaces
Typical Setup

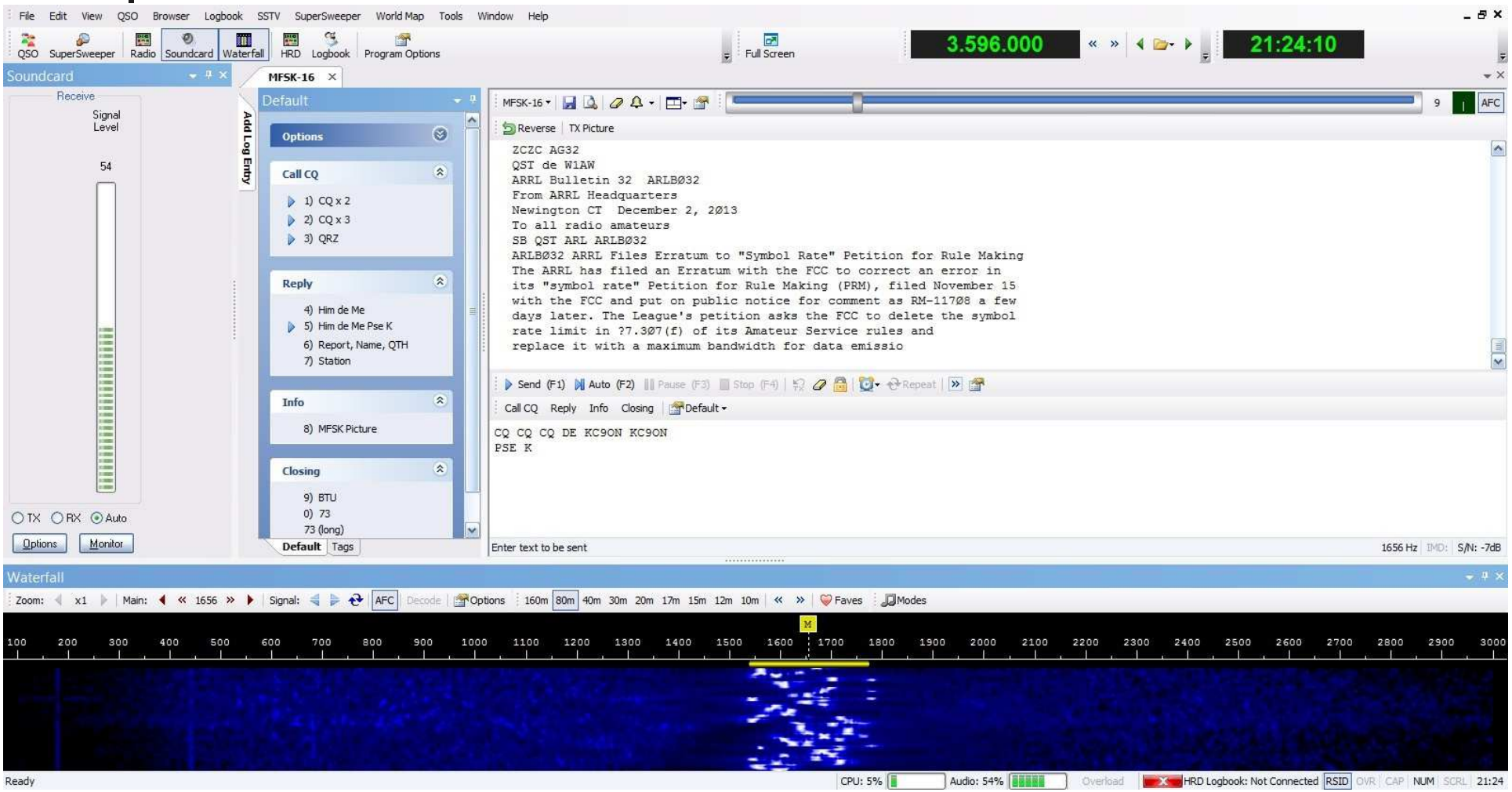
Software
Ham Radio Deluxe

- 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



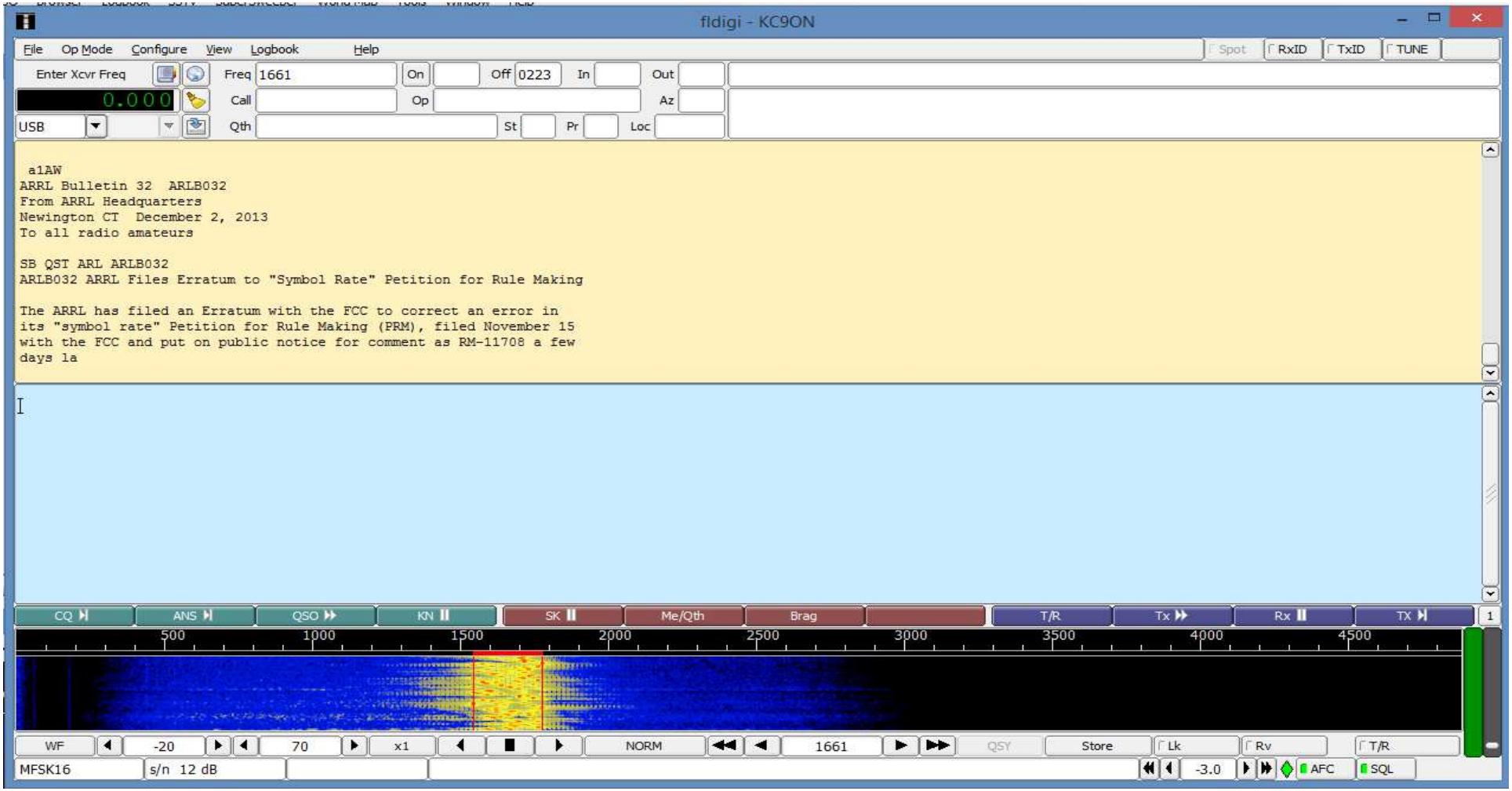
Software
FLDigi

- 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



Software
Others

- Special modes such as JT65/JT9 and digital voice require their own software
- Many other software program exists – 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

PSK	both	Olivia	both
QPSK	both *	RTTY	both
PSKR	**FLDigi** *	RTTYM	**DM780** *
Contestia	both	Thor	both *
CW	both	Throb	both *
DominoEX	both *	WEFAX	**FLDigi**
Hellschreiber	both	Navtex	**FLDigi**
MFSK	both	SITOR	**FLDigi**
MT63	both	WWV	**FLDigi**

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

Tips and Tricks
Jacks

- Use 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

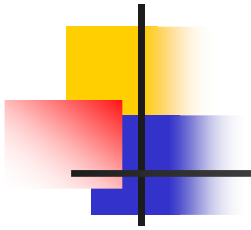
Tips and Tricks
Jacks

- 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!

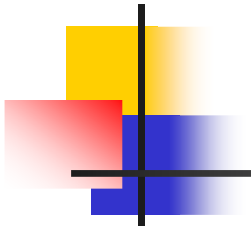
Tips and Tricks
Jacks

- Some radios have an audio out line in the microphone jack. This can help reduce extra cables.

Tips and Tricks
RSID

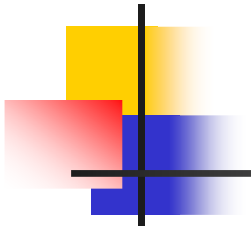
- Use Reed-Solomon Identification
  - Short code at the beginning of a transmission which identifies the mode
  - Several programs automatically detect this and pop up a box

Tips and Tricks
Sound Device



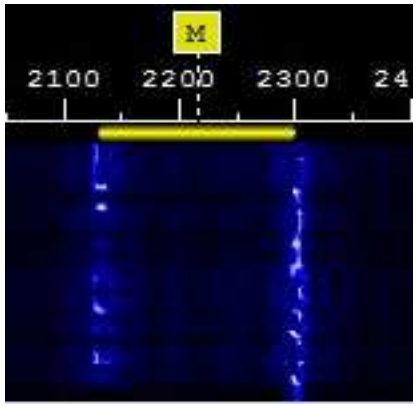
- Check your sound card settings in the control panel!
  - Turn off special effects
  - Turn off pass-thru or “Listen to this device” modes
  - Set rate to 16 bit 48000Hz

Tips and Tricks
Sound Device

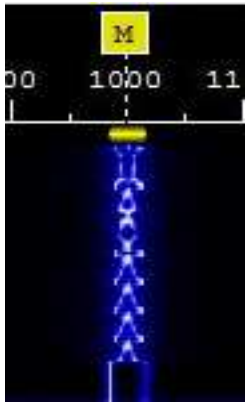


- Use the mixer to adjust your transmit audio using a dummy load and short 5-10 second intervals

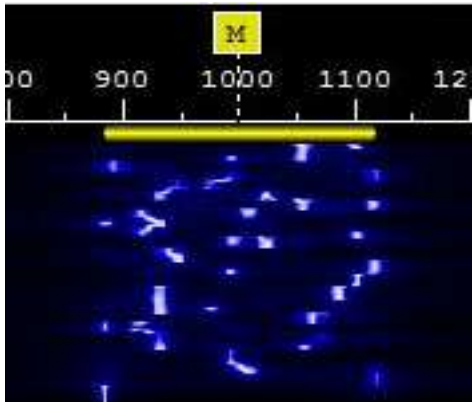
Tips and Tricks
Waterfalls



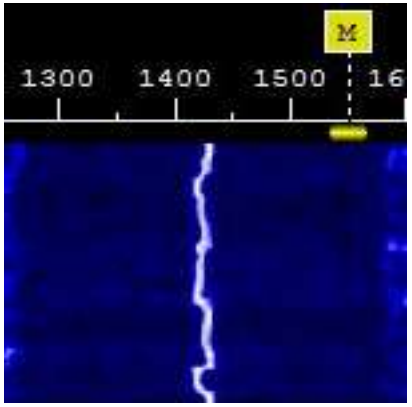
RTTY-45



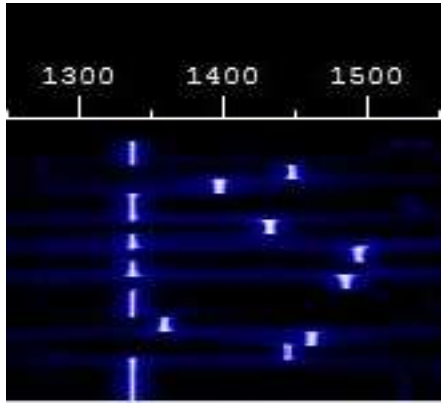
PSK31



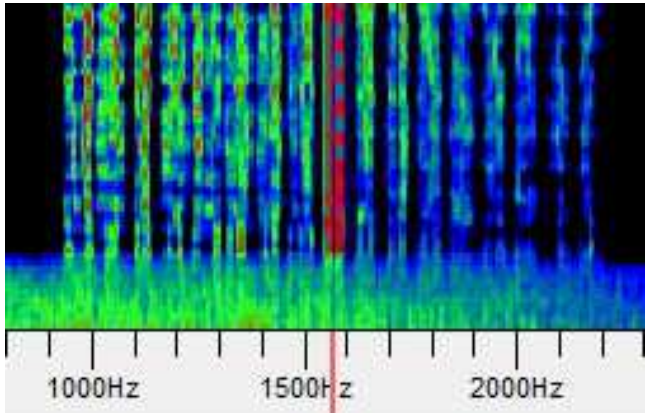
MFSK16



JT9



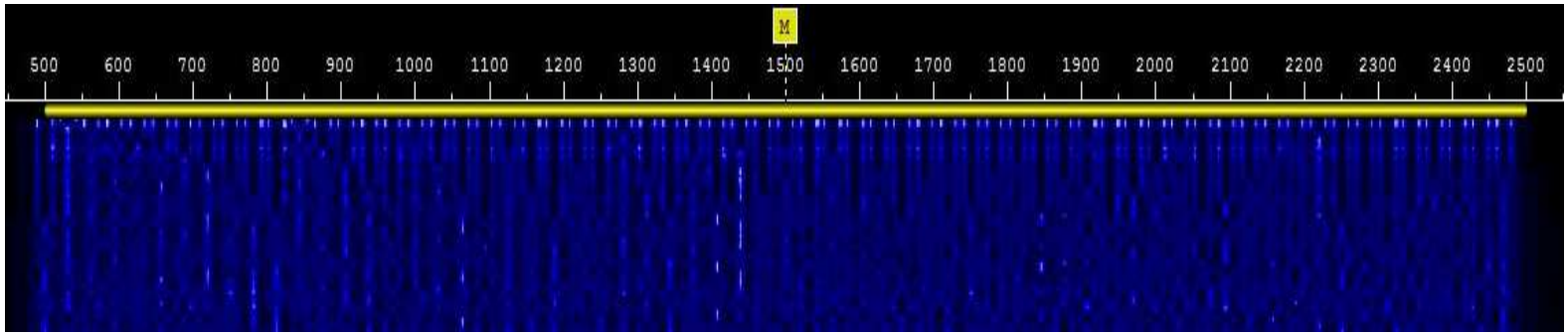
JT65



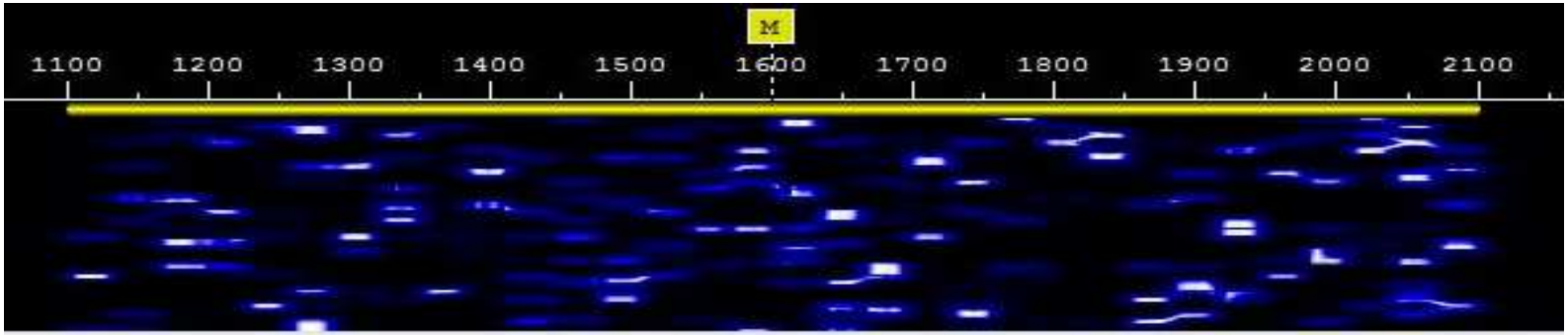
Digital Voice

Tips and Tricks
Waterfalls

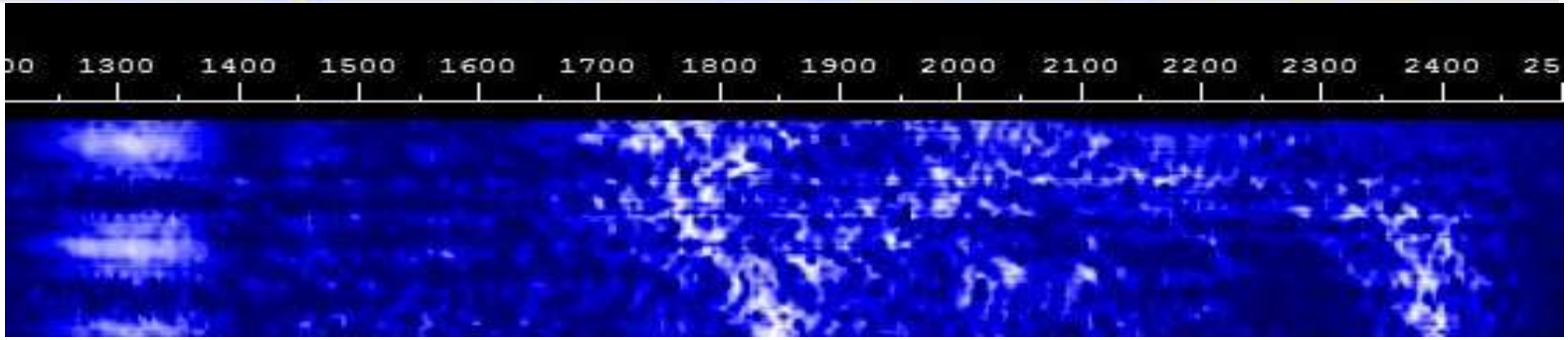
MT63



Olivia



SSTV



Tips and Tricks
Frequencies

- Common PSK31 frequencies

1.828	10.140	21.070
3.580	14.070	24.920
7.035	18.100	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/

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

Tips and Tricks References

Commercial Sites

- Software:
  - Ham Radio Deluxe V6 www.hrdsoftwarellc.com
- Interfaces
  - MFJ www.mfjenterprises.com
  - RigBlaster www.westmountainradio.com
  - SignalLink www.tigertronics.com

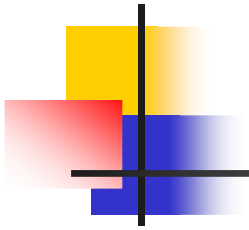
Getting started on FLDigi

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

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

Beginners' guide:
http://www.w1hkj.com/beginners.html

Questions?



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- This presentation and other notes can be found here:
  - http://kc9on.com/ham-radio/hf-digital-modes/
  - http://WA8LMF.net/miscinfo