

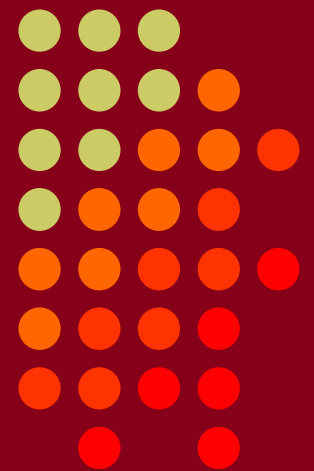
ARROW Communication Association

RTTY Contesting Hints & Kinks
Ed Muns, W0YK

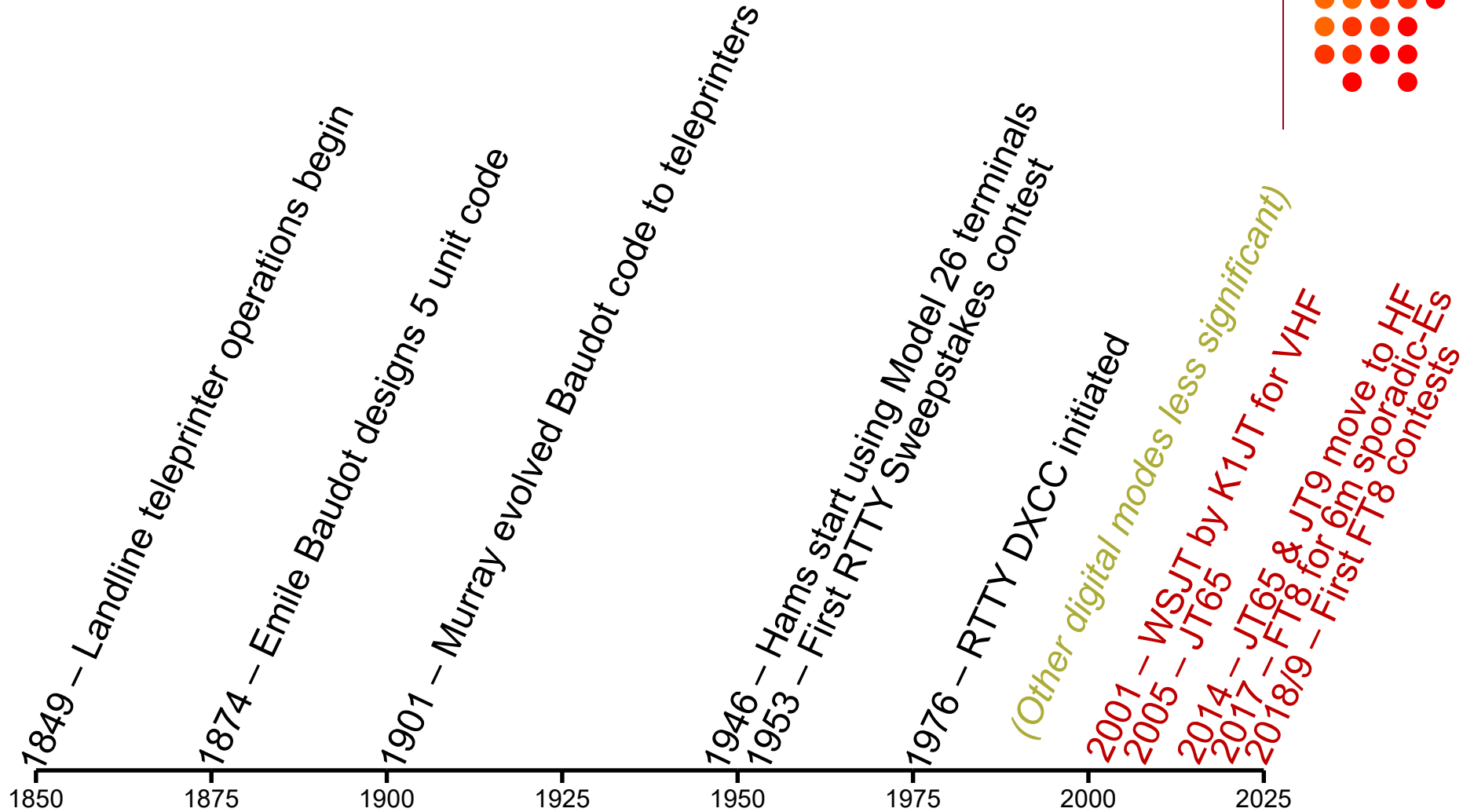
13 January 2021

• CTU •
CONTEST
UNIVERSITY

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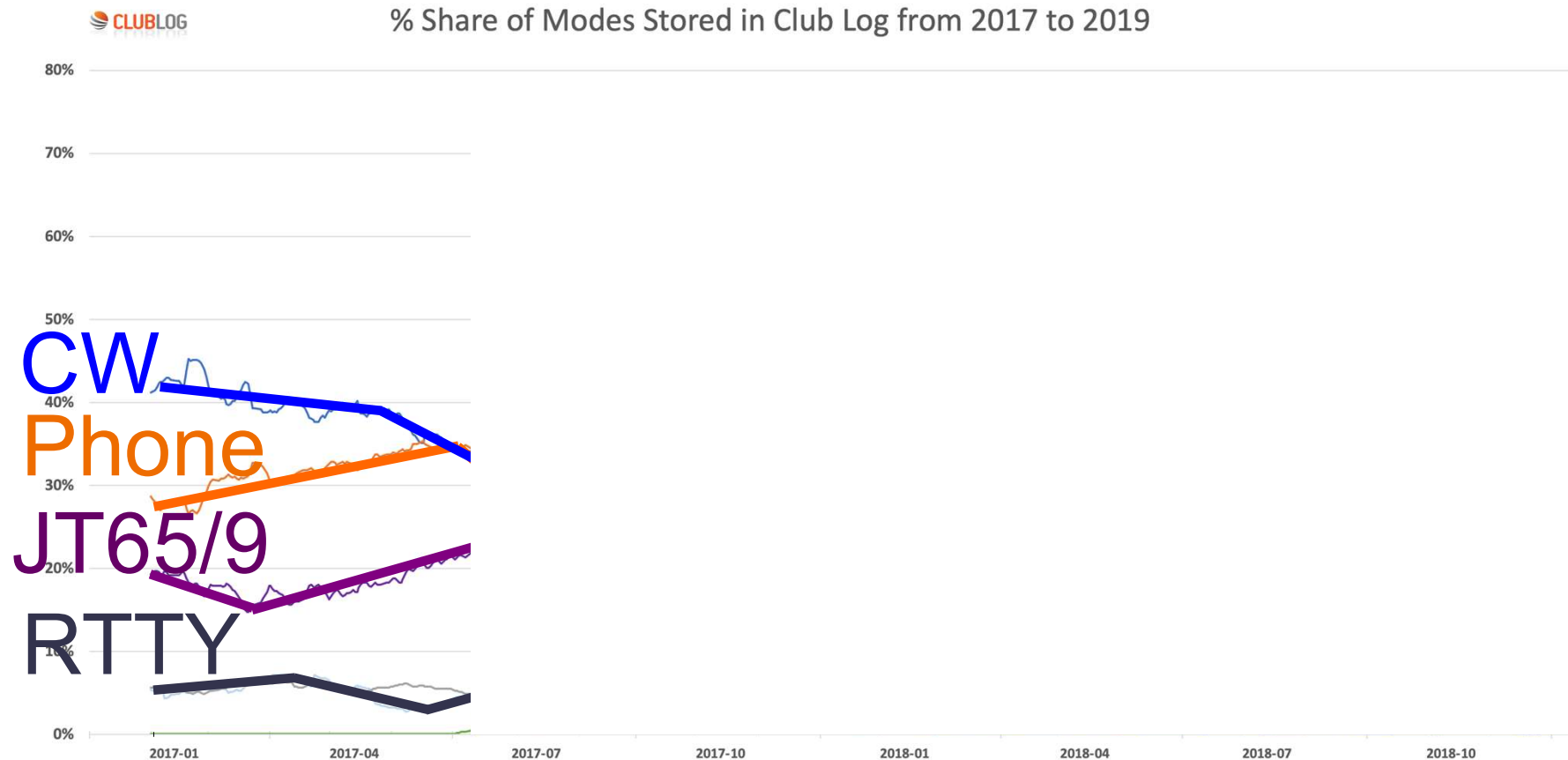
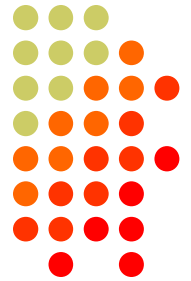


RTTY & WSJT History



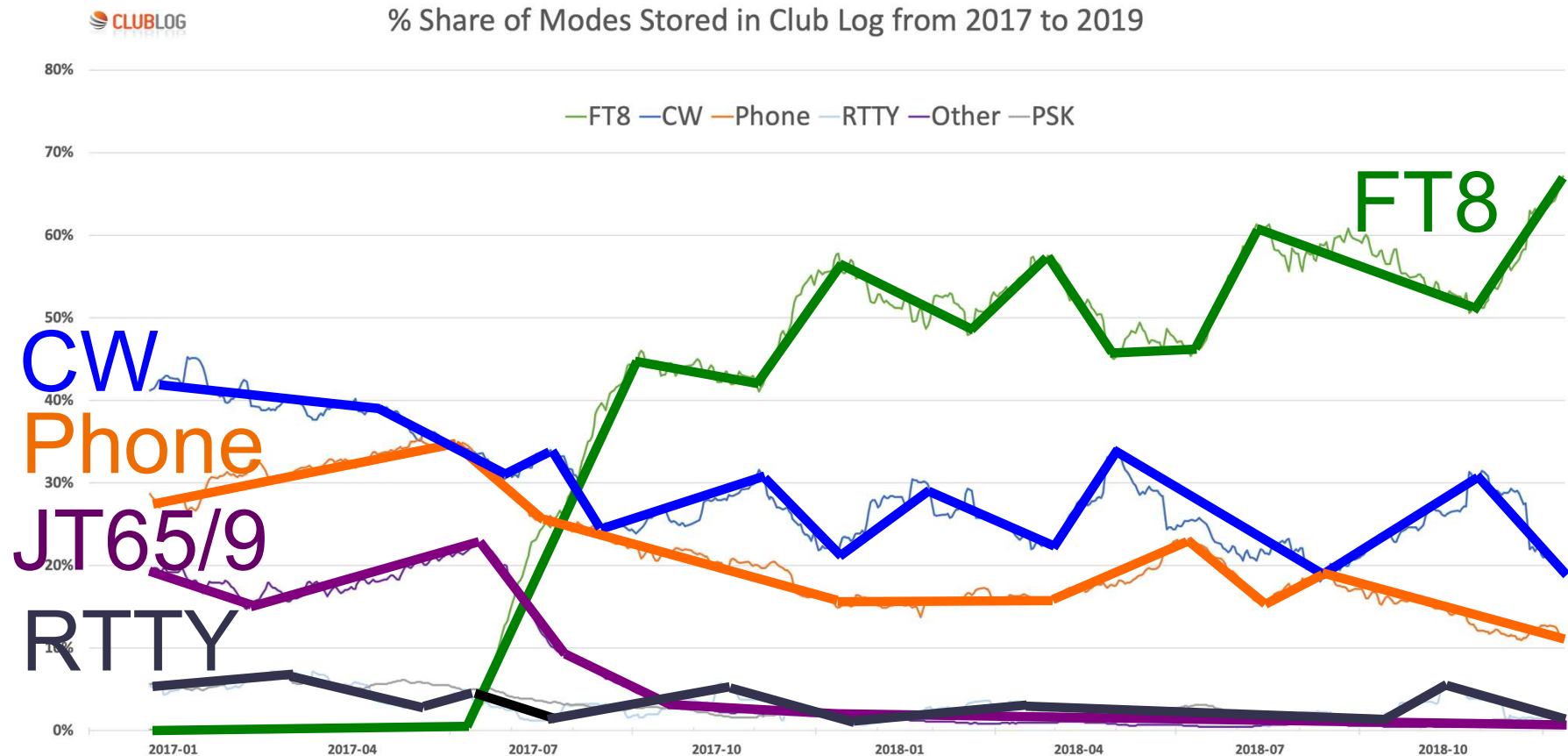
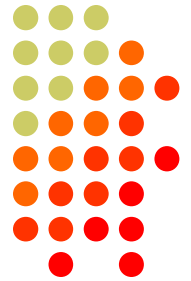
Clublog % QSOs by Mode

2017-2018



Clublog % QSOs by Mode

2017-2018



What is RTTY?

compared to CW



CW

- 1) **One** RF carrier
- 2) Local audio **pitch**
- 3) On **or** off
 - key up is data 0
 - key down is data 1
- 4) **Morse** code
 - typically 25-40 wpm

RTTY

- 1) **Two** RF carriers 170 Hz apart (*Space & Mark; Shift*)
- 2) Local audio **tones**
- 3) One on **and** other off
 - Space is data 0
 - Mark is data 1
- 4) **Baudot** code
 - constant 60 wpm
(or 45.45 Baud)

What is RTTY?

Figures Shift



- 5-bit code → 32 chars.
- 2 sets:
 - Letters set & Figures set
 - 6 common control chars.
 - LTRS (unshifted)
 - FIGS (shifted)
 - Null, Space, LF, CR
- LTRS or FIGS toggle set

Code	Control Characters	Figures	
		ITA2	USTTY
11111	LTRS		
11011	FIGS		
00000	Null		
00100	Space		
01000	LF		
00010	CR		
	Letters		
00011	A		-
11001	B		?
01110	C		:
01001	D	ENQ	\$
00001	E	3	
01101	F		!
11010	G		&
10100	H		#
00110	I	8	
01011	J	BELL	'
01111	K	(
10010	L)	
11100	M	.	
01100	N	/	
11000	O	9	
10110	P	0	
10111	Q	1	
01010	R	4	
00101	S	'	BELL
10000	T	5	
00111	U	7	
11110	V	:	
10011	W	2	
11101	X	/	
10101	Y	6	
10001	Z	"	

What is RTTY?

code history



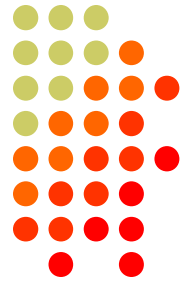
- Bacon's cipher (1605)
- Gauss & Weber (1833)
- Baudot code (1870)
 - Manual bit entry
 - 5-bit ITA1 code
 - Two 32-bit character sets
 - letters
 - figures
- Murray code (1901)
 - Teletype character entry
 - Western Union variation
- **5-bit ITA2 code (1930)**
 - **USTTY variation**
- ASCII (1963)
 - 7-bit ITA5 code

Code	Control Characters		
11111	LTRS		
11011	FIGS		
00000	Null		
00100	Space		
01000	LF		
00010	CR		
	Letters	Figures	
		ITA2	USTTY
00011	A	-	
11001	B	?	
01110	C	:	
01001	D	ENQ	\$
00001	E	3	
01101	F		!
11010	G		&
10100	H		#
00110	I	8	
01011	J	BELL	'
01111	K	(
10010	L)	
11100	M	.	
01100	N	/	
11000	O	9	
10110	P	0	
10111	Q	1	
01010	R	4	
00101	S	'	BELL
10000	T	5	
00111	U	7	
11110	V	;	
10011	W	2	
11101	X	/	
10101	Y	6	
10001	Z	"	



What is RTTY?

Figures Shift



- The *LTRS* and *FIGS* characters do not print
 - The code for the characters “Q” and “1” is the same; which one prints depends on if you are in Letters or Figures set
 - Note that the *LTRS*, *FIGS* and *Space* characters appear in both sets
- Example: “**KI7GUO DE K4GMH**” gets sent as:
 - *LTRS* **K** *I* *FIGS* **7** *LTRS* **G** *U* *O* *Space* **D** *E* *Space* **K** *FIGS* **4**
LTRS **G** *M* *H*
- Why do we care to understand this?
 - If a burst of static garbles the *LTRS* or *FIGS* character, then what prints after that is from the wrong set until the next *LTRS* or *FIGS* character appears

What is RTTY?

UnShift on Space



- UnShift On Space (USOS or UOS)
 - Increases noise immunity for alpha text
 - Space character forces a shift to the Letters set
- Contest exchanges are alpha and numeric
 - Should UOS be on or off?
 - Should Space or Hyphen delimit exchange elements?
 - 599 JOHN NY or 599-JOHN-NY
- *Recommendation:*
 - *Turn on both RX & TX UOS and use Space delimiters*

What is RTTY?

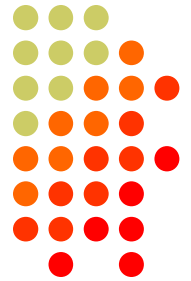
audio tones



- Space and Mark audio tones
 - Default: 2295 and 2125 Hz (“high tones”)
 - Less fatiguing: 1085 and 915 Hz (“low tones”)
- Analogous to CW pitch
 - Operator choice
 - Each operator can use different tone pairs
 - Transmission is two RF carriers 170Hz apart
- Must be same in radio and decoder/encoder

What is RTTY?

AFSK vs. FSK



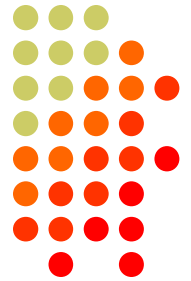
Two methods of transmission:

- AFSK (Audio Frequency Shift Keying)
 - keyed audio tones into SSB transmitter via:
 - Mic input, or
 - Auxiliary audio input. e.g., Line In
- FSK (Frequency Shift Keying)
 - on/off keys the transmitter just like CW

Note: Receiving is the same in either case.

What is RTTY?

AFSK vs. FSK



AFSK

- Indirect (*tones → Mic input*)
- Any SSB radio (*esp. legacy*)
- SSB (wide) filtering
- Dial = sup. car. frequency
- VOX
- Audio cable (*a'la FT8, JT65/9, PSK31*)
- Must use high tones

NET (automatic TX tone control)

Less bandwidth (depends on radio)

Easier hook-up; NET

FSK

- Direct (*like CW keying*)
 - “Modern” radios
 - RTTY (narrow) filtering
 - Dial = Mark frequency
 - PTT
 - COM FSK keying cable
 - Can use low tones
- No audio level adjust*
No disabling speech proc.
No erroneous sound keying

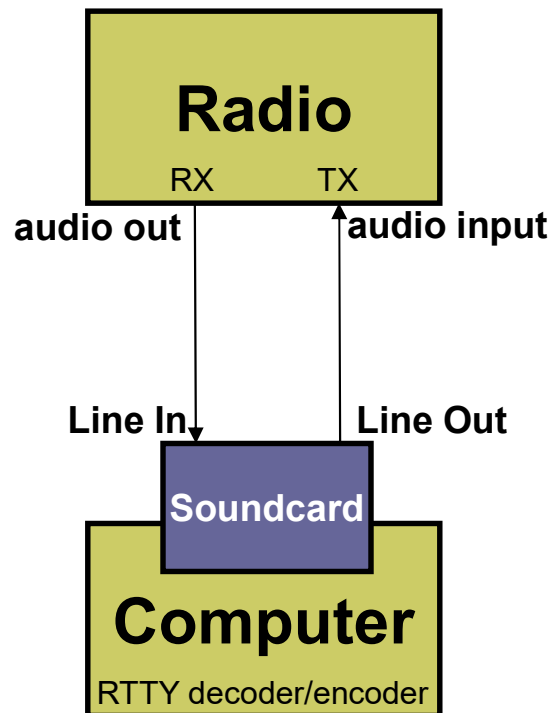
Less pitfalls

AFSK or FSK?

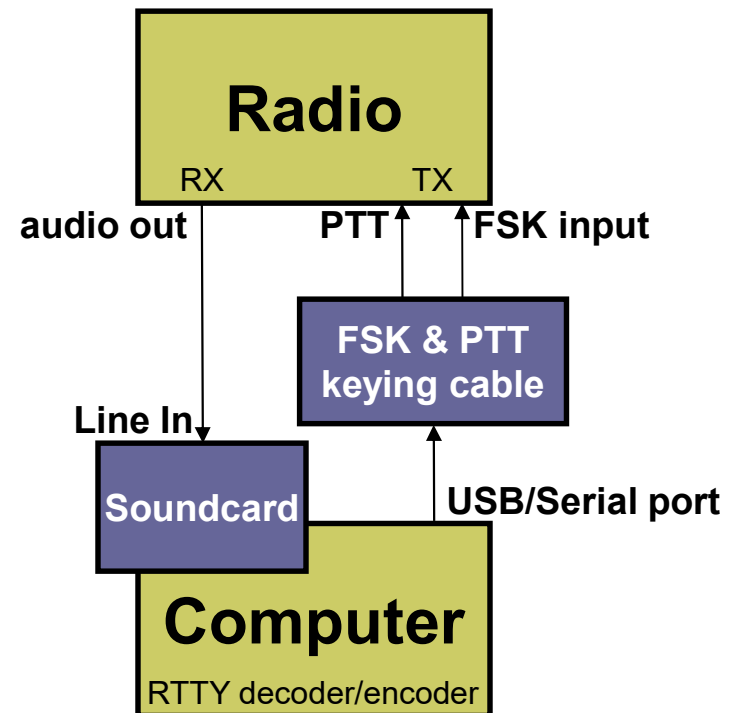
Personal preference



AFSK

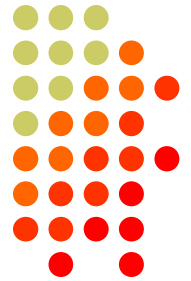


FSK

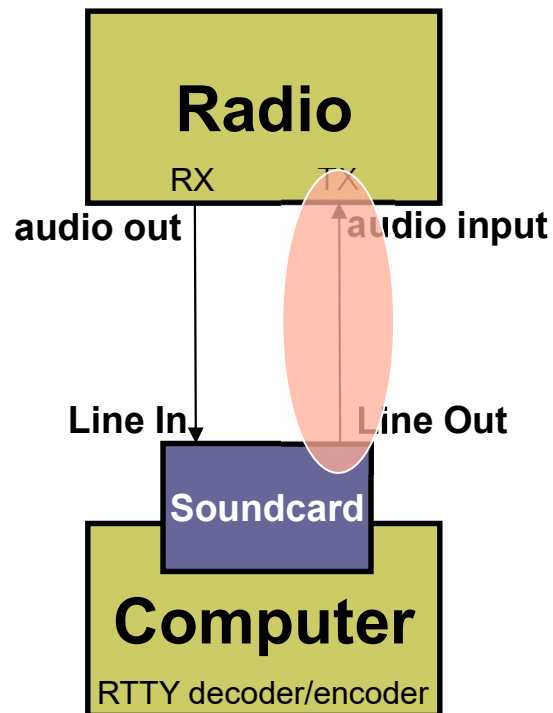


AFSK or FSK?

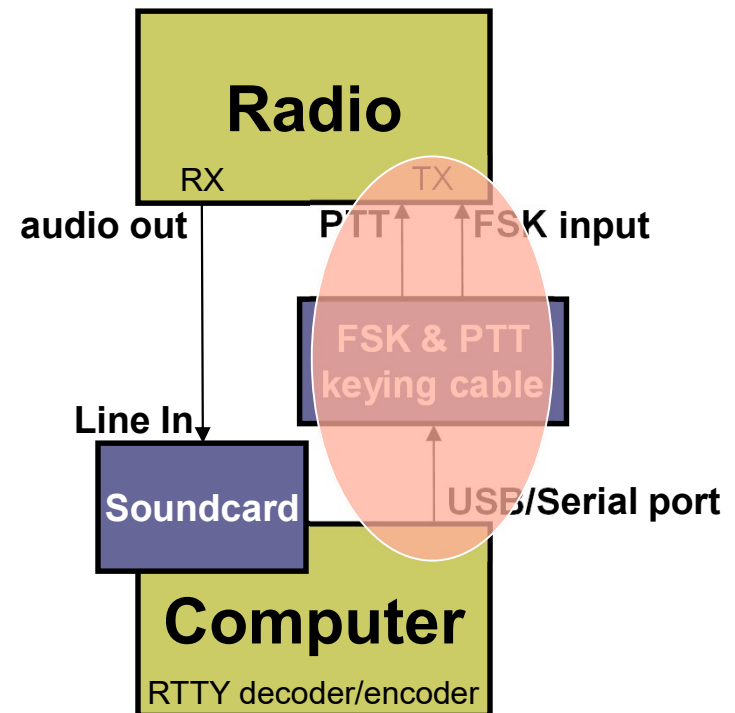
Method to drive transmitter



AFSK

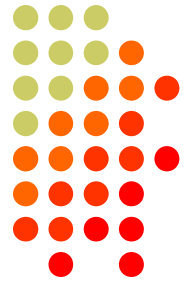


FSK

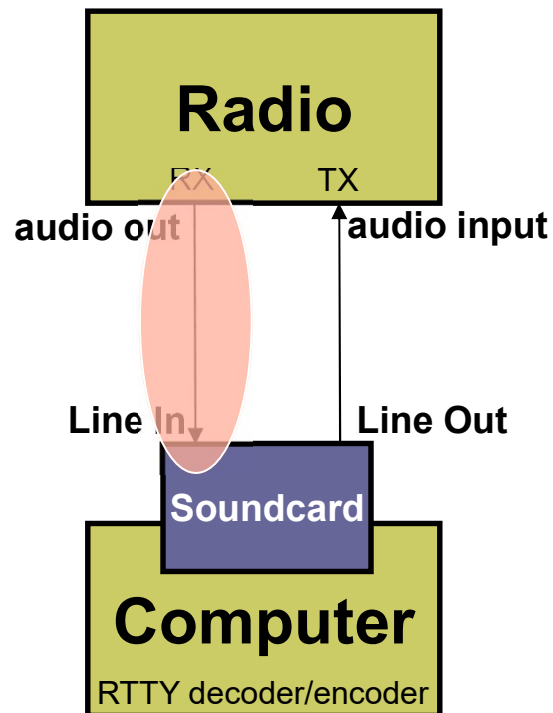


AFSK or FSK?

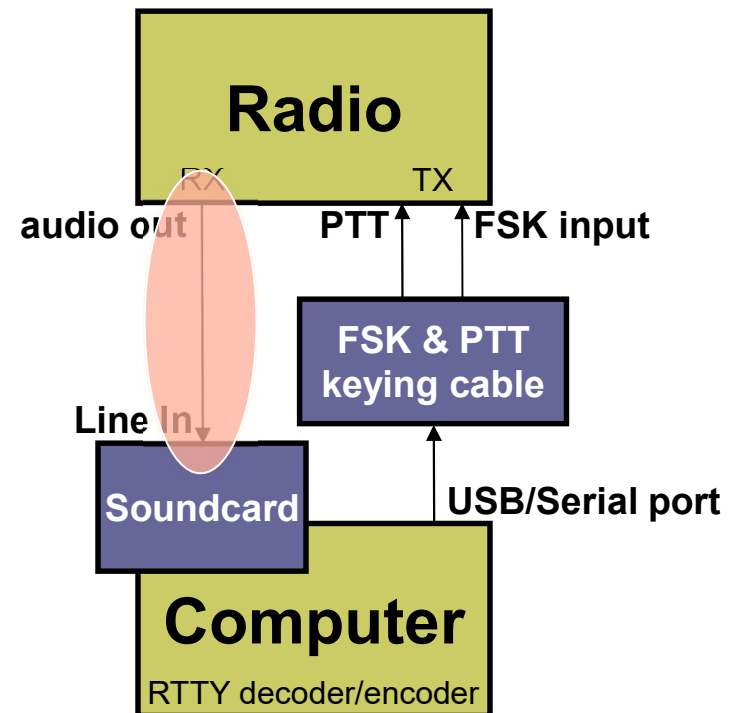
Receive method identical



AFSK

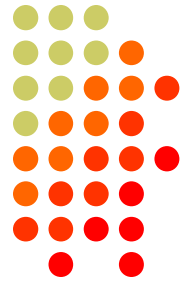


FSK



Dial Frequency

spots are often wrong



- RTTY frequency = Mark frequency
- RTTY radio frequency definition:
 - The higher RF frequency is the Mark (*14090.000 kHz*)
 - The lower RF frequency is the Space (*14089.830 kHz*)
 - The difference between the two is the shift (*170 Hz*)

Dial Frequency

spots are often wrong



- RTTY frequency = Mark frequency
- RTTY radio frequency definition:
 - The higher RF frequency is the Mark (*14090.000 kHz*)
 - The lower RF frequency is the Space (*14089.830 kHz*)
 - The difference between the two is the shift (*170 Hz*)
- FSK displays Mark (*dial = 14090.000 kHz*)

Dial Frequency

spots are often wrong



- RTTY frequency = Mark frequency
- RTTY radio frequency definition:
 - The higher RF frequency is the Mark (*14090.000 kHz*)
 - The lower RF frequency is the Space (*14089.830 kHz*)
 - The difference between the two is the shift (*170 Hz*)
- FSK displays Mark (*dial = 14090.000 kHz*)
- AFSK displays suppressed carrier (NOT the Mark) which varies with local audio tones and sideband used!
 - For tones of 2125 Hz and 2295 Hz:
 - LSB: Mark = 2125, Space = 2295 (*dial = 14092.125 kHz*)
 - USB: Mark = 2295, Space = 2125 (*dial = 14087.005 kHz*)

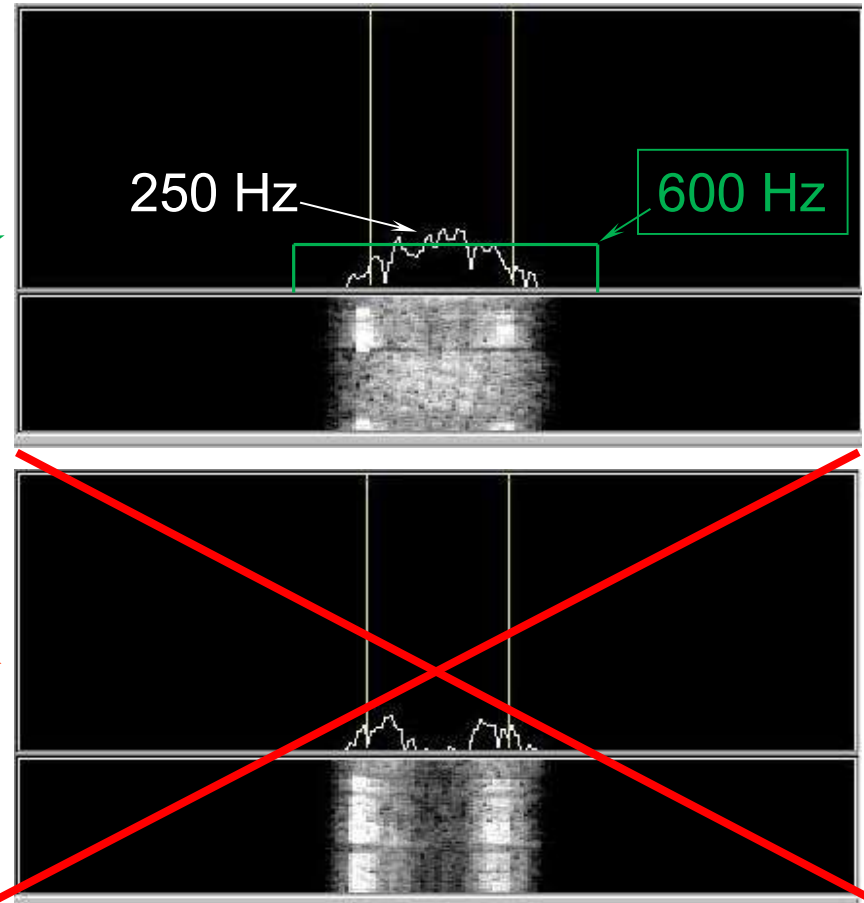
Receiving

radio IF filtering



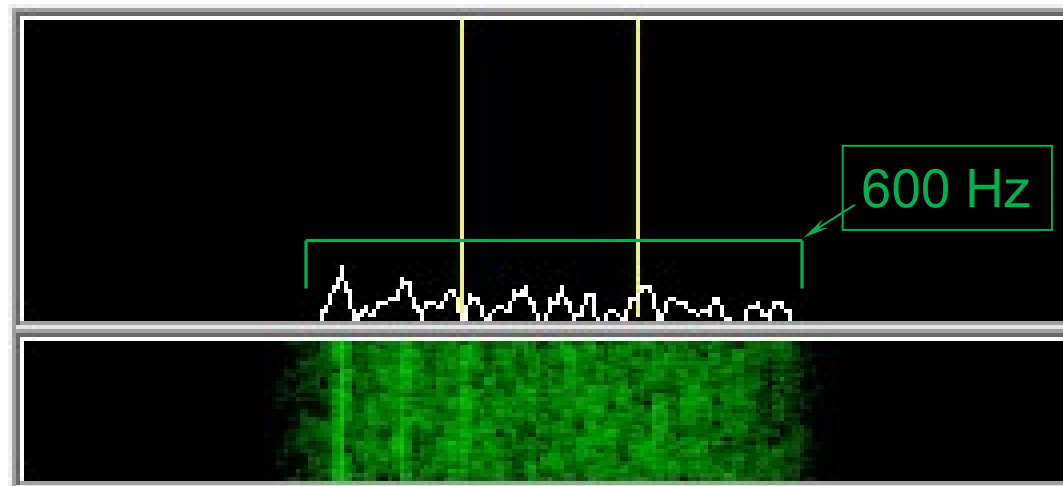
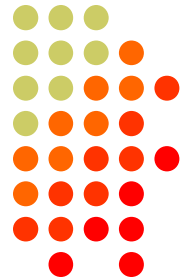
Narrow IF filters

- 600 Hz - normal
- 250 Hz - extreme QRM
- Tone filters – **don't use!**
 - Icom Twin Peak Filter
 - K3 Dual-Tone Filter



Receiving

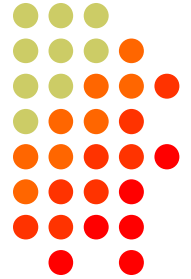
audio level



- Set RX audio level with no-signal at 5% of full-scale
 - Receiver audio out level control, and/or
 - *Windows* Recording Volume Control applet

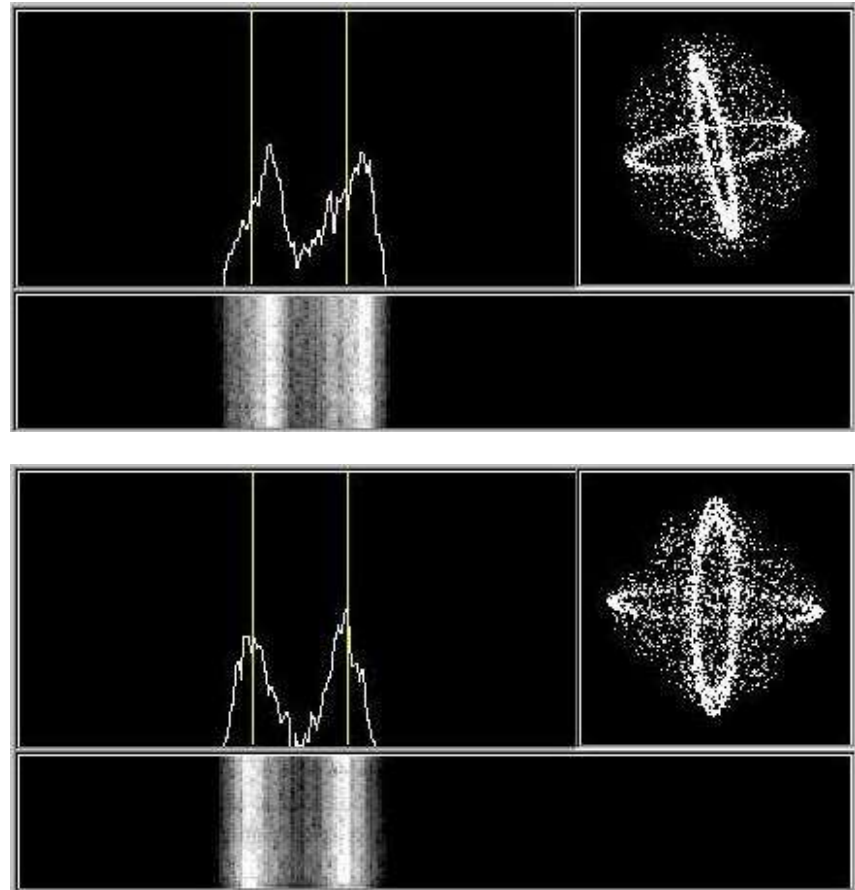
Receiving

tuning a RTTY signal



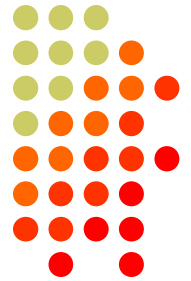
Learn to tune by ear

- practice with eyes closed
- get within 10-20 Hz



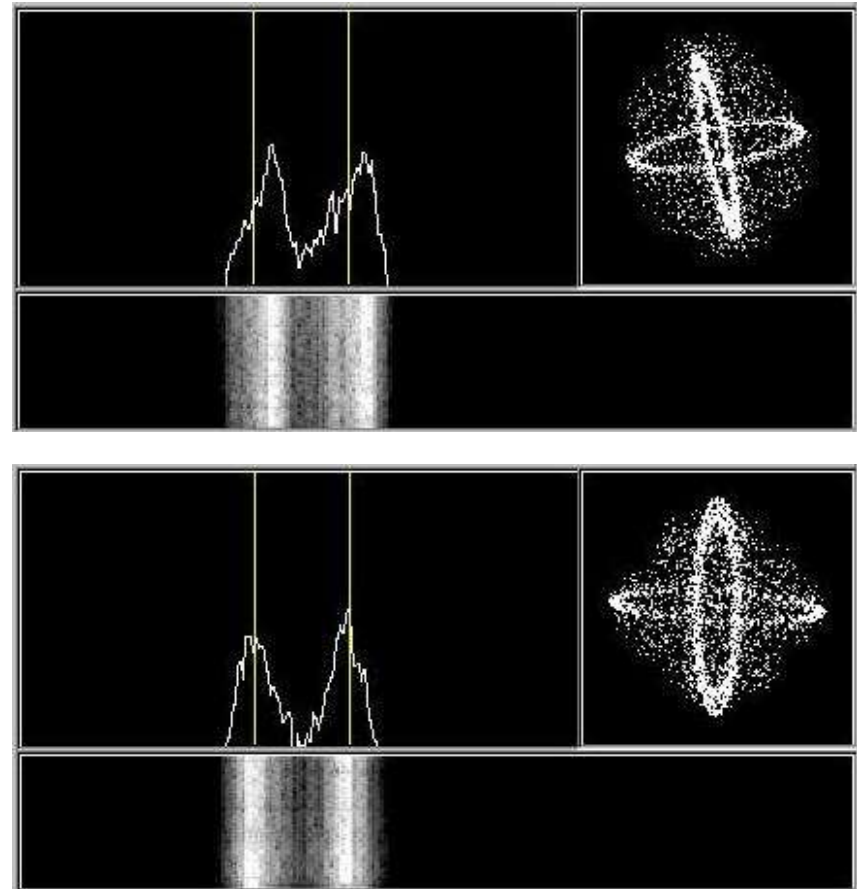
Receiving

AFC



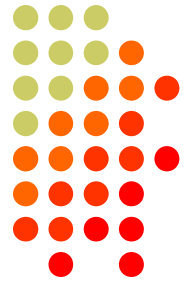
If AFC On:

- Run: NET Off
 - Locks TX freq.
- S&P: NET On
 - Moves TX freq. = RX freq.



Transmitting

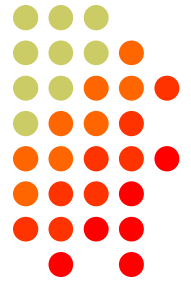
AFSK adjustment



- Insure SSB processor (compression) is Off
- Adjust:
 - the *Windows* Playback Volume control, and/or
 - the transmitter Mic (or auxiliary audio input)
- Such that:
 - ALC is barely above zero, and
 - full power output is still attained.
 - Level too low < full power output
 - Level too high (ALC) = distortion

RTTY Transmit Bandwidth

unnecessary QRM

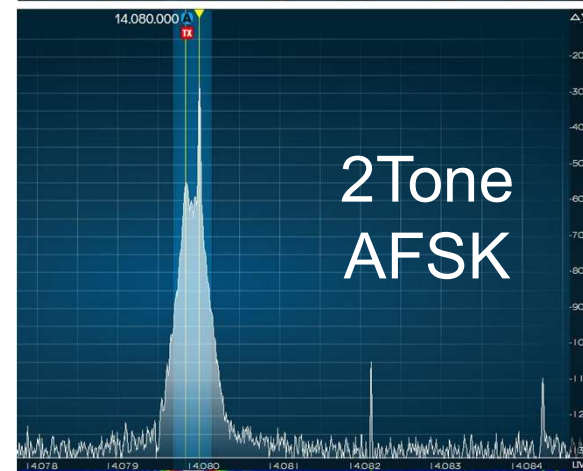
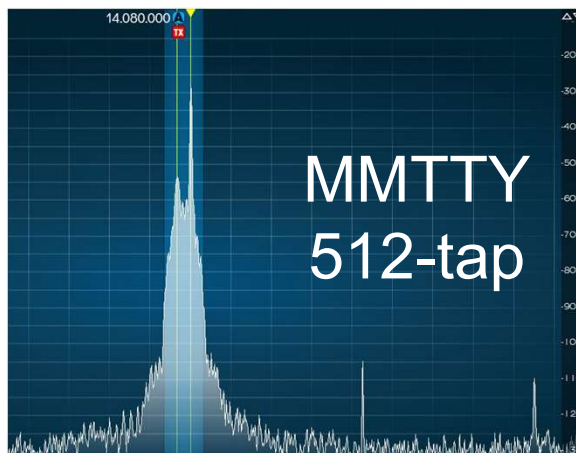
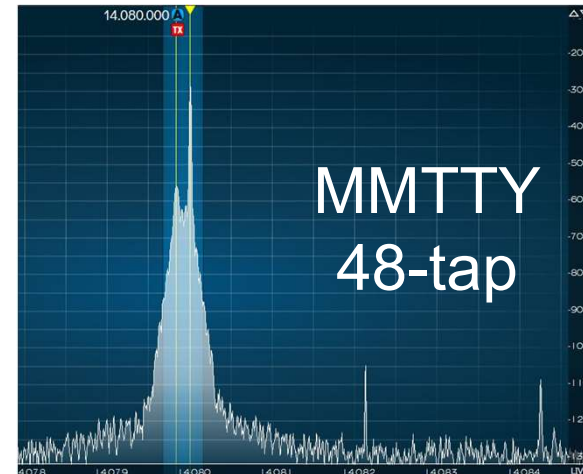
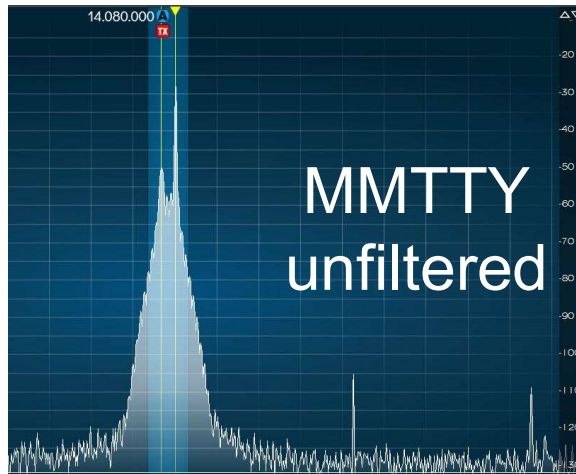


- Wasted power outside receiving decoder BW
 - Suitably narrow TX BW effectively amplifies signal
- Unnecessary QRM
 - Wide 1.5 KW RTTY can QRM 5-10 channels
 - Similar to CW key click problem of the past

Why hurt yourself AND QRM close-by stations?

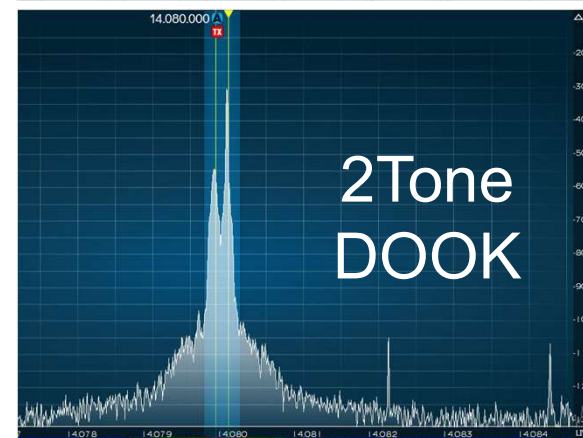
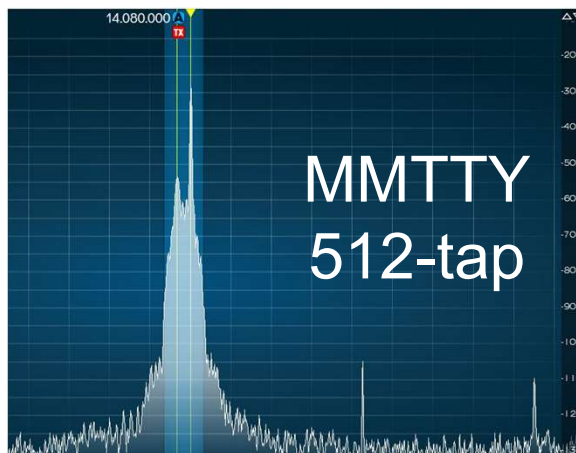
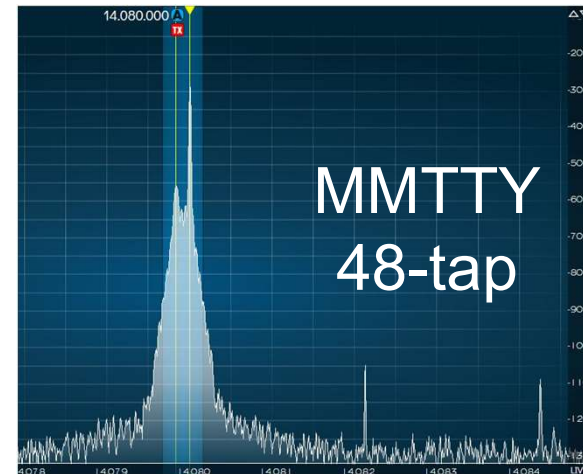
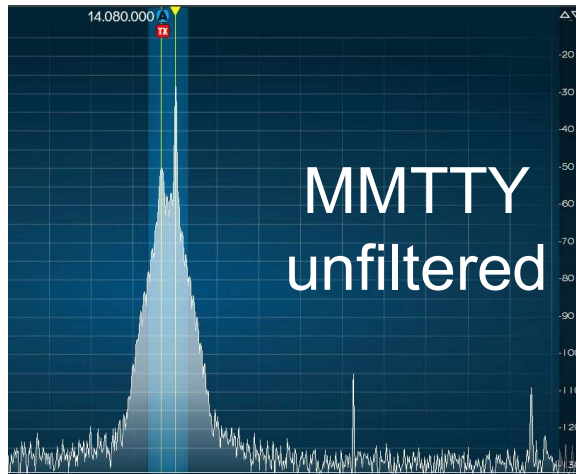
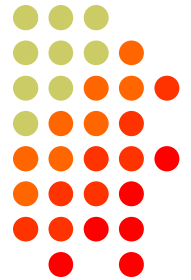
RTTY Transmit Bandwidth

AFSK



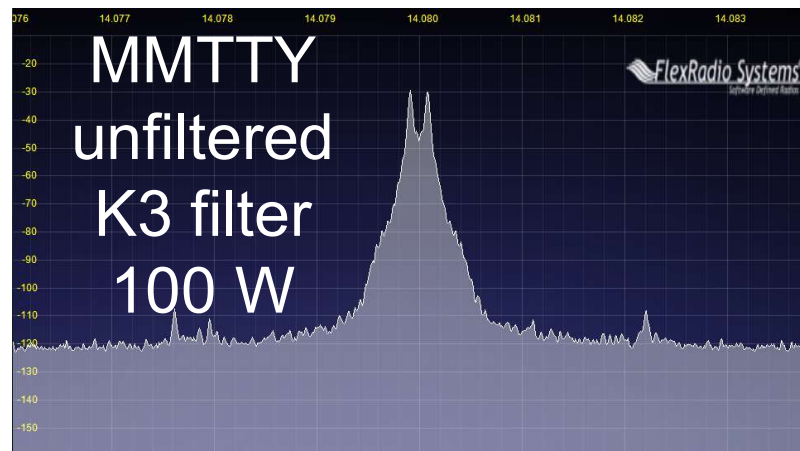
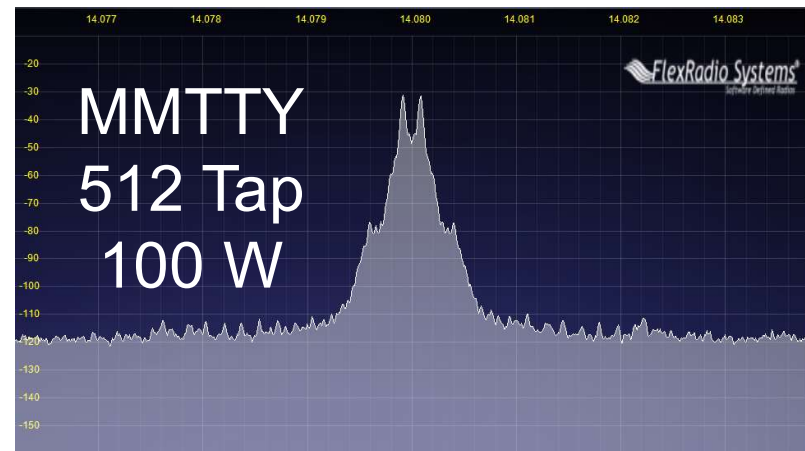
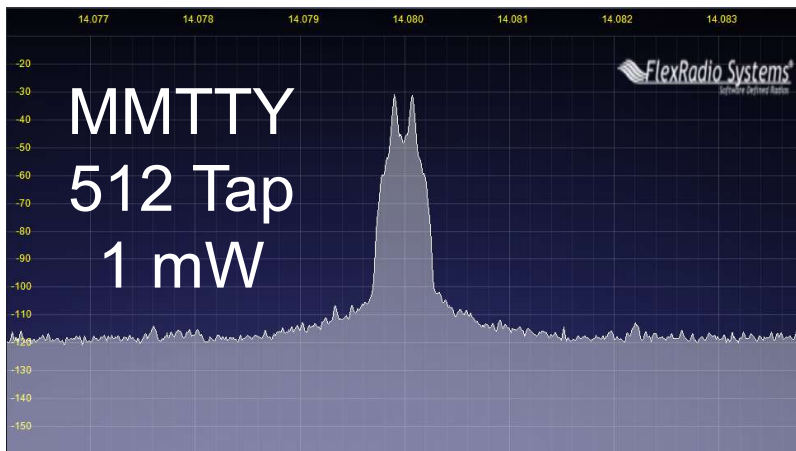
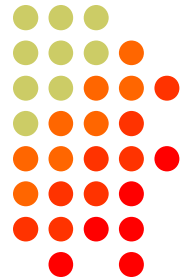
RTTY Transmit Bandwidth

AFSK - DOOK



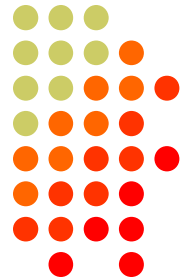
RTTY Transmit Bandwidth

PA IMD effect

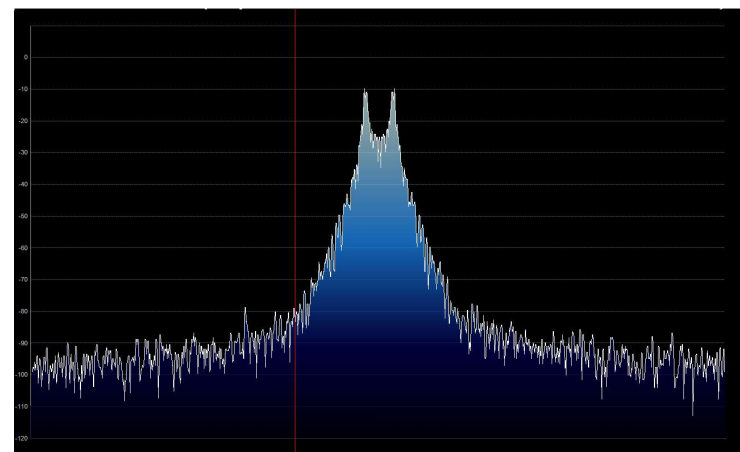
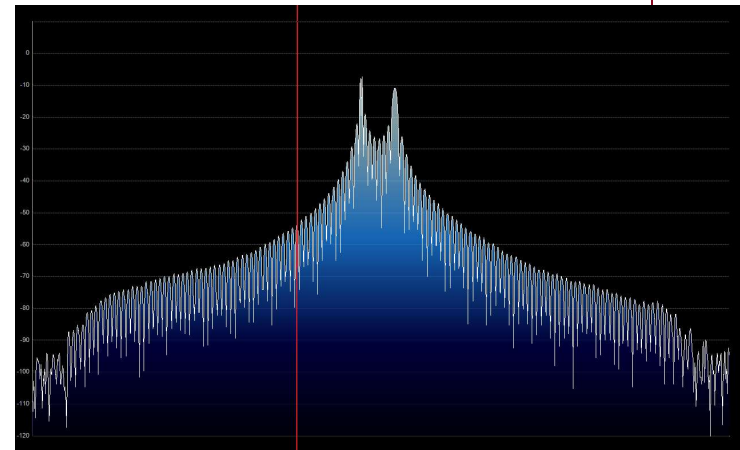


RTTY Transmit Bandwidth

FSK

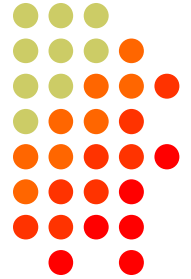


- Old K3 FSK bandwidth
 - No waveshaping
 - < DSP281 firmware
 - Typical of all radios
 - 50 watts
- New K3 FSK bandwidth
 - Optimal DSP filter
 - DSP281 firmware, March 2013



UOS

(Unshift-On-Space)



- Receive UOS:
 - Increases noise immunity for alpha text
 - Space character forces a shift to the Letters set
- Transmit UOS:
 - Sends Figures character after Space, before numeric “word”
- Contest exchanges are alpha and numeric
 - Should UOS be on or off?
 - Should Space or Hyphen delimit exchange elements?
 - 599 1234 1234 or 599-1234-1234
- *Recommendation:*
 - *Turn on both RX & TX UOS and use Space delimiters*

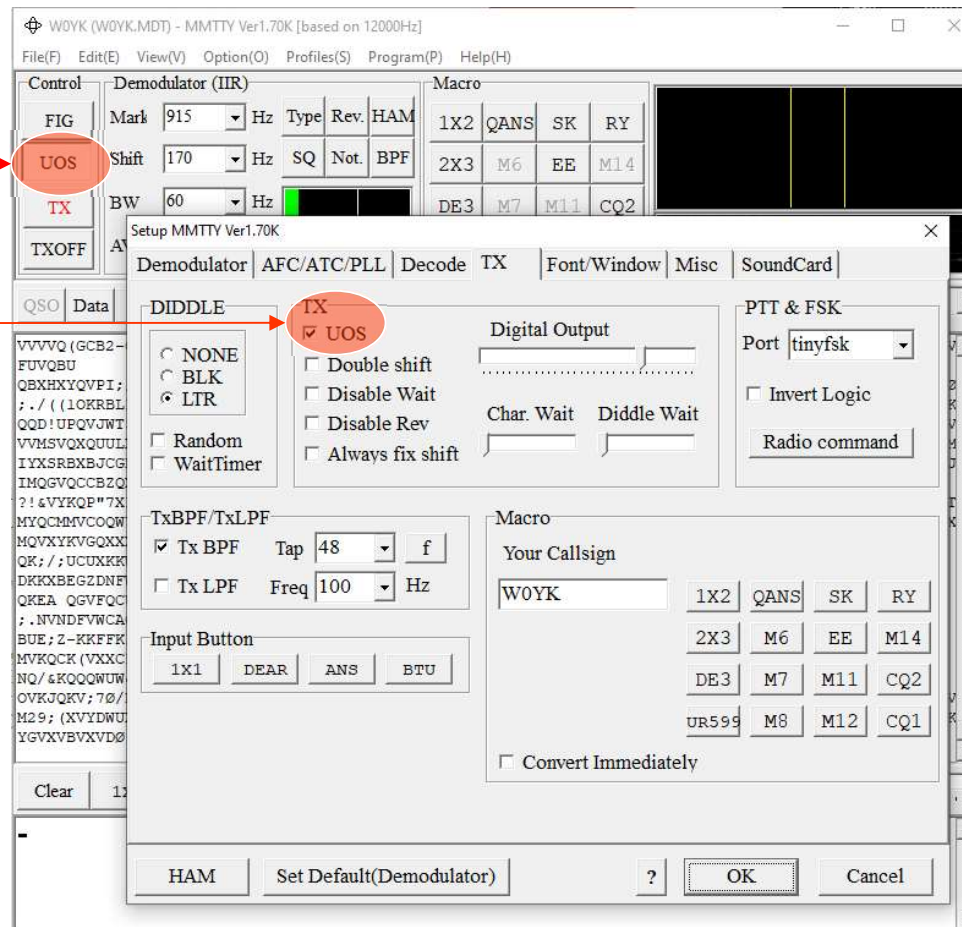
UOS

MMTTY



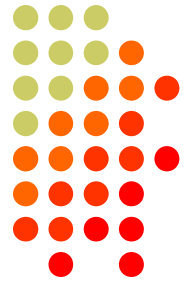
RX

TX



Rag Chewing

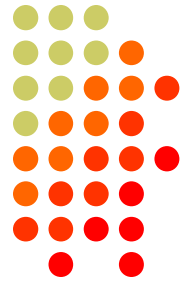
free typing



- Ctrl-k
 - Opens a free-typing window
 - Enables transmit
- To exit, Ctrl-k or ESC
 - Closes free-typing window
 - Disables transmit
- DXing and contesting use fixed messages

Logging Software

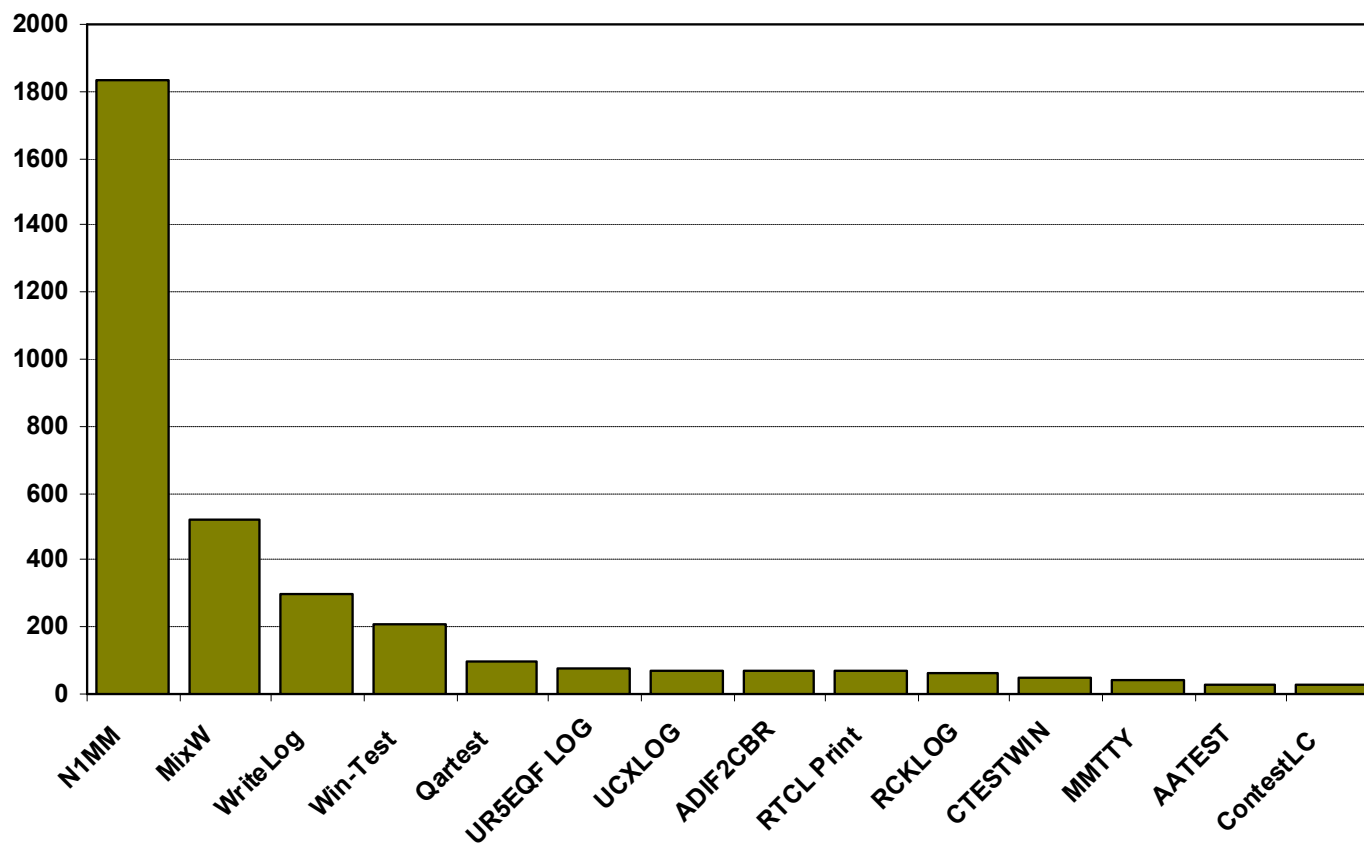
integrated RTTY



- DXing
 - DXLab Suite (2002; free)
- Contesting
 - WriteLog (1994)
 - created for RTTY (CW & SSB came later)
 - www.rttycontesting.com/tutorials
 - N1MM Logger+ (2000; free)
 - dedicated RTTY software designer
 - www.rttycontesting.com/tutorials
 - Win-Test (2003)
 - RTTY is low priority.

Logging Software

2012 CQ WPX RTTY Contest



Logging Software

contesting

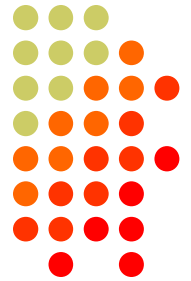


	WriteLog	N1MM	Win-Test
MMTTY	😊	😊	😊
2Tone	😊	😊	😊
other decoders	😊	😊	none
Call sign acquisition	😊	😊	😊
Contests supported	😊	😊	fewer
Advanced RTTY	😊	😊	none

- *All three are entirely adequate for basic RTTY contesting*
- *Use the logger you are already familiar with for CW & SSB*

Logging Software

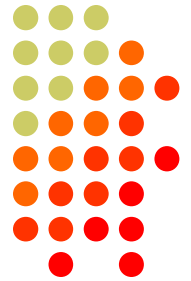
N1MM Logger, WriteLog, Win-Test



- 13 features compared
 - Simplifying assumption: features equally weighted
 - Rated 0 to 5
- All three score '5' on:
 - MMTTY integration
 - Stateful Enter key (ESM: Enter Sends Message)
 - Accelerator keys
 - QRV message parameter
- Another 9 advanced RTTY features distinguish these loggers

RTTY Contest Loggers

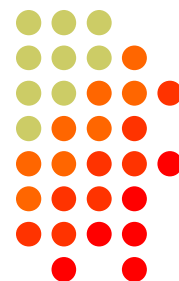
relative ratings



<i>WL</i>	<i>N1</i>	<i>WT</i>	<i>Logger</i>
5	5	5	● RTTY window readability
5	4	0	● Multiple decoders
4	5	0	● MMTTY, 2Tone, GRITTY
0	5	3	● ESM mouse ctrl & Sprint mode
5	5	0	● SO2V
5	3	3	● M2 SO2R configuration
5	4	5	● Re-mapped keys
5	5	3	● Call sign stacking
5	4	4	● AFSK/FSK flexibility
39	40	23	Overall

Basic RTTY Contest QSO

CQ WPX RTTY Contest



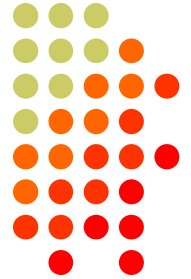
- ***WPX K5AM K5AM CQ***
- ***ZC4LI ZC4LI***
- ***ZC4LI 599 1349 1349***
- ***[K5AM] TU 599 985 985***
- ***[ZC4LI] TU K5AM CQ***

K5AM: running station

ZC4LI: S&P station

RTTY Messages

CQ WPX RTTY Contest



- Short, as with CW/SSB
- No extraneous info
- 599 (not 5NN) once
- Serial number twice
- Space (not hyphen)
- Omit 'DE'
- RTTY chars (%R, %E)

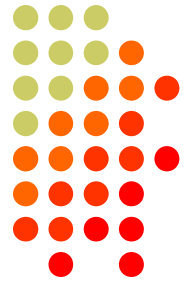
www.rttycontesting.com/tutorials/messages

F02:	%RWFX P49X P49X CQ %E
F03:	%R P49X %E
F04:	P49X %E
F05:	%R%C 599 %N2 %N2 %E
F06:	%RTU P49X CQ %E
F07:	%RQRV %ZR.1 %E
F08:	%R %C TU .. NOW%L
F09:	%RAGN %E
F10:	%RNR? %E
F11:	%R%N3 %E

F02:	%RWFX P49X P49X P49X CQ %E
F03:	%RQSL LOTW OR W0YK %E
F04:	%R%C %E
F05:	%RTU 599 %N2 %N2 %L%E
F06:	%RKB %H P49X CQ %L%E
F07:	%RQRV %ZS.1 %E
F08:	%R%H %C KB .. NOW%L
F09:	%RQRZ %E
F10:	%RCALL? %E
F11:	? %E

RTTY Messages

formatting



CR/LF

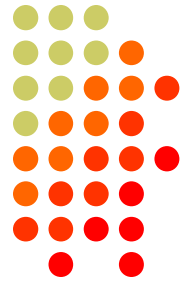
Space

Receive

F02:	%RWPX P49X P49X CQ %C%E
F03:	%R P49X %E
F04:	P49X %E
F05:	%R%C 599 %N2 %N2 %E
F06:	%RTU P49X CQ %O%E
F07:	%RQRV %ZR.1 %E
F08:	%R %C TU .. NOW%L
F09:	%RAGN %E
F10:	%RNR? %E
F11:	%R%N3 %E

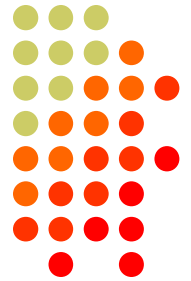
RTTY Sub-Bands

don't QRM!



- Avoid audio-digital operations near:
 - e.g., 14070-14083
- Avoid the NCDXF beacons:
 - e.g., 21150 and 14100
- More details:
www.aa5au.com/rtty/rtty-sub-bands

RTTY Considerations



Much like CW and SSB, except:

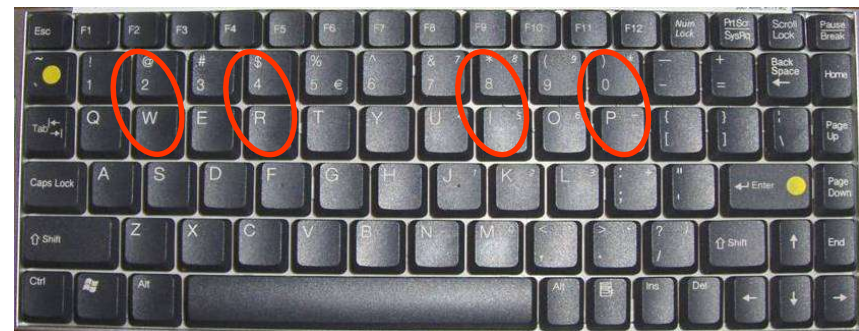
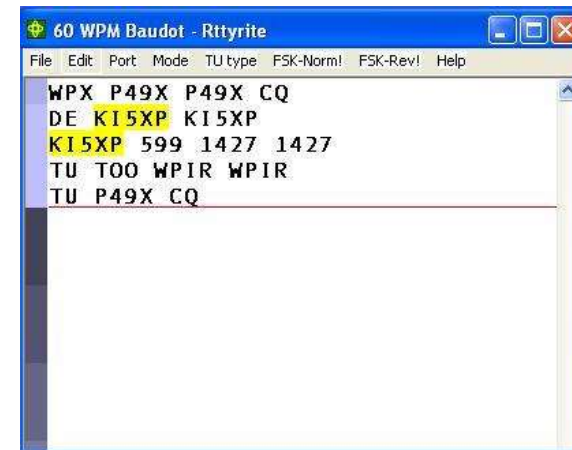
- Non-human decoding implications
 - *serial number repeat*
- RTTY established practice
 - *'CQ' at end of CQ message*
- Whisper-level headphone volume; low tones
 - *just to detect presence & timing*
- Key-down transmission ... 100% duty cycle
- Distractions are tempting
 - *watch TV, do email, read, etc.*

Tips

“All I receive is gibberish!”

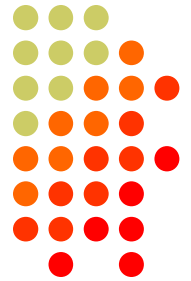


- “Upside-down”
 - Reverse Mark & Space
 - LSB vs. USB
- Figures vs. letters
 - TOO=599, WPIR=2084
 - UOS should be on
 - Shift-click to convert, or look at top two rows
- Audio-In level, tones, flutter
- (Other station’s signal)



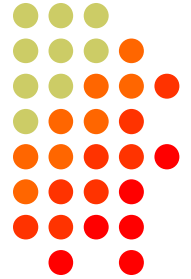
Tips

“They never answer me!”



- “Upside-down”
 - FSK: polarity switch in radio
 - AFSK: LSB vs. USB; polarity select in software
- Off frequency
 - AFC on with NET (AFSK only) off [recommend RIT instead]
 - AFC & NET are on by default; changes non-sticky
 - Change defaults in MMTTY userpara.ini file
- AFSK: Mic & SC levels; speech processor on
- Radio mode, tones, FSK interface

More Tips



- Practice
 - During RTTY contests (~ two per month)
 - NCCC Sprint each Thursday night (30 min.)
- Multi-Ops

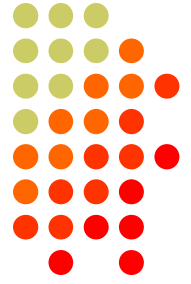


Advanced Topics

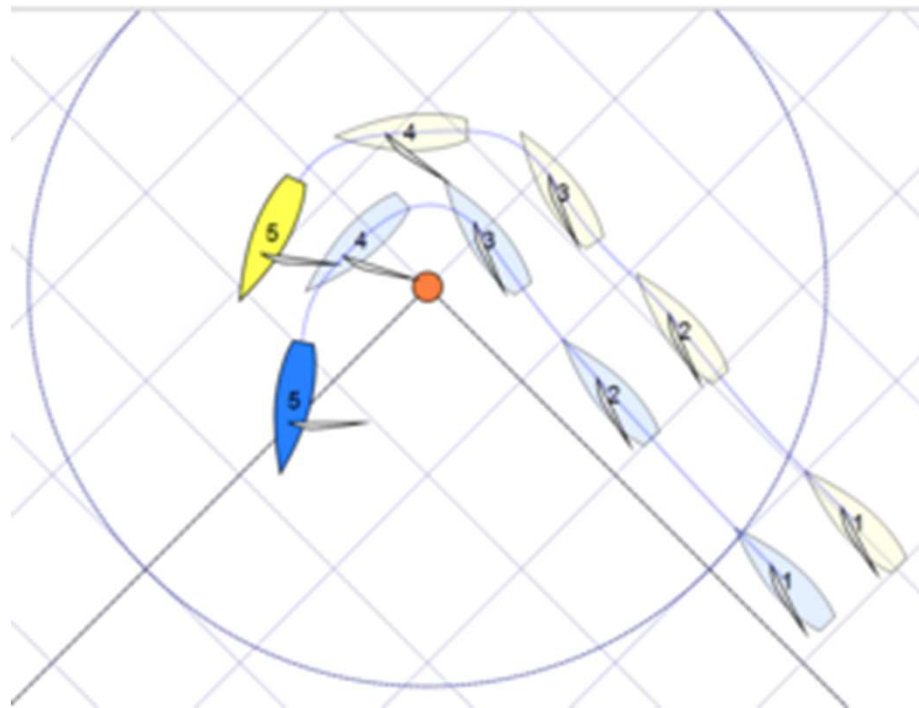
CONTESTING

Sailboat Racing

mark rounding

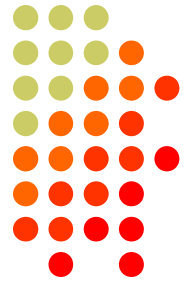


*Yellow falls
behind by
keeping up
with Blue*



Call Sign Stacking

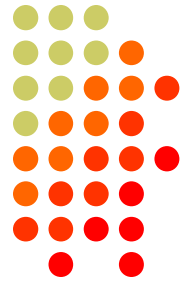
“Slow Down to Win”



- Sailboat racing analogy:
 - Pinwheel effect at mark-rounding
- Let pile-up continue a “beat” after getting the first call sign
 - Increase chance for another call sign or two
 - Increase chance for QSO-phase-skip
- Apply same tactic for tail-enders ... pause 1/2-second before sending TU/CQ message

Call Sign Stacking

The 4 Phases of a QSO



Normal Run mode flow:

1. CQ msg
 - repeat
 - AGN?
2. pile-up
3. Exchange msg
 - Send fill(s)
4. receive his Exchange
 - AGN? or NR? or QTH? or NAME?

1. TU/CQ msg (logs QSO)

Normal S&P mode flow:

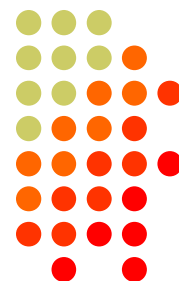
1. CQ
2. <mycall> msg
 - repeat
3. receive his Exchange
 - AGN? or NR? or QTH? or NAME?
4. Exchange msg
 - send fill(s)

1. find next CQ

transmit
receive

Call Sign Stacking

Pileup



Normal

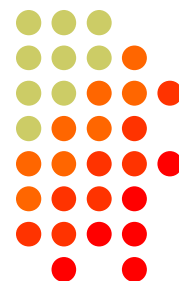
Shortened

- | | |
|---------------------------------------|-------------------------------------|
| 1. WPX P49X P49X CQ, or
TU P49X CQ | 1. (skip CQ) |
| 2. K3LR K3LR K5ZD K5ZD | 2. (skip pileup) |
| 3. K3LR 599 2419 2419 | 3. K3LR TU NW
K5ZD 599 2420 2420 |
| 4. TU 599 842 842 | 4. TU 599 1134 1134 |
- A blue dotted line connects the start of the 'Normal' list to the start of the 'Shortened' list. A blue arrow points from the end of the 'Normal' list (item 4) to the start of the 'Shortened' list (item 3). A blue bracket on the right side of the 'Shortened' list groups items 3 and 4.

transmit
receive

Call Sign Stacking

Tail-end



Normal

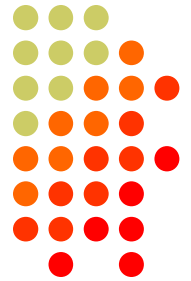
Shortened

- | | |
|---|-------------------------------------|
| 1. WPX P49X P49X CQ, or
TU P49X CQ | 1. (skip CQ) |
| 2. K3LR K3LR | 2. (skip pileup) |
| 3. K3LR 599 2419 2419
K5ZD (<i>tail-end</i>) | 3. K3LR TU NW
K5ZD 599 2420 2420 |
| 4. TU 599 842 842 | 4. TU 599 1134 1134 |

transmit
receive

Call Sign Stacking

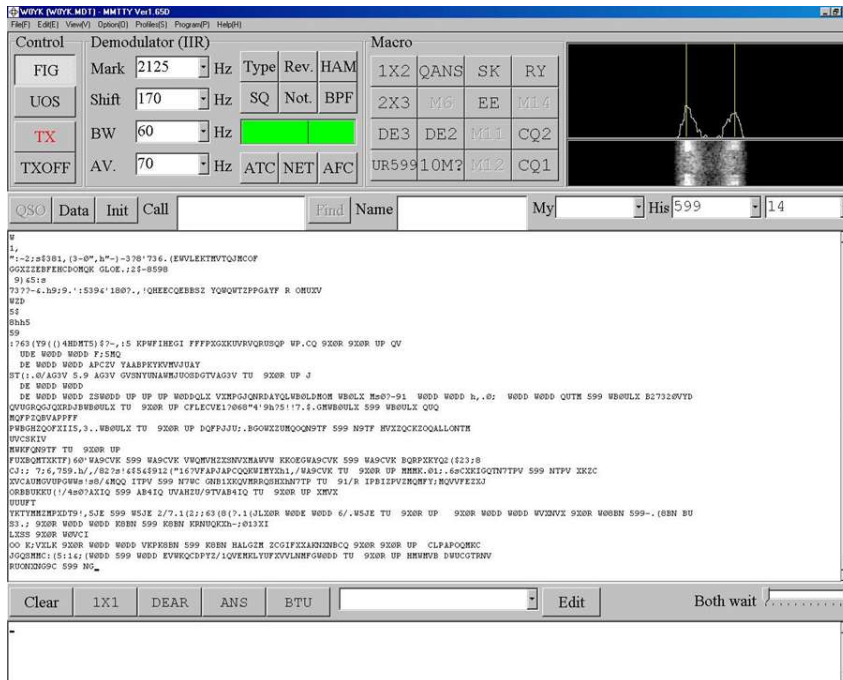
summary



- Efficiently work:
 - multiple callers in a pile-up, and
 - tail-enders to a completing QSO
- Calls **pushed** onto the stack as they arrive
- Message parameter **pops** call off of the stack into the Entry window
- Eliminates 2 of 4 QSO phases, which doubles short-term rate

Multiple Decoders

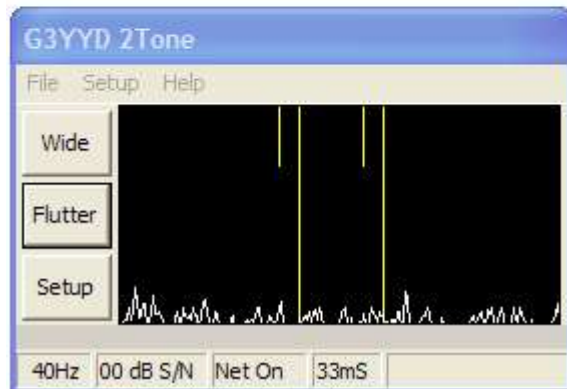
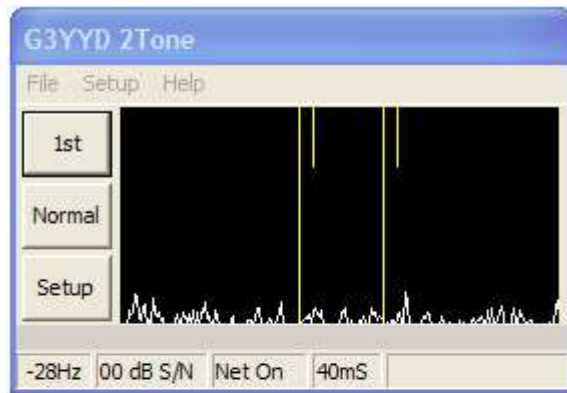
MMTTY



- Dominant SC MODEM
- Standalone, or ...
- Contest loggers:
 - N1MM Logger+
 - WriteLog
 - Win-Test
- Introduced June 2000
- Mako Mori, JE3HHT

Multiple Decoders

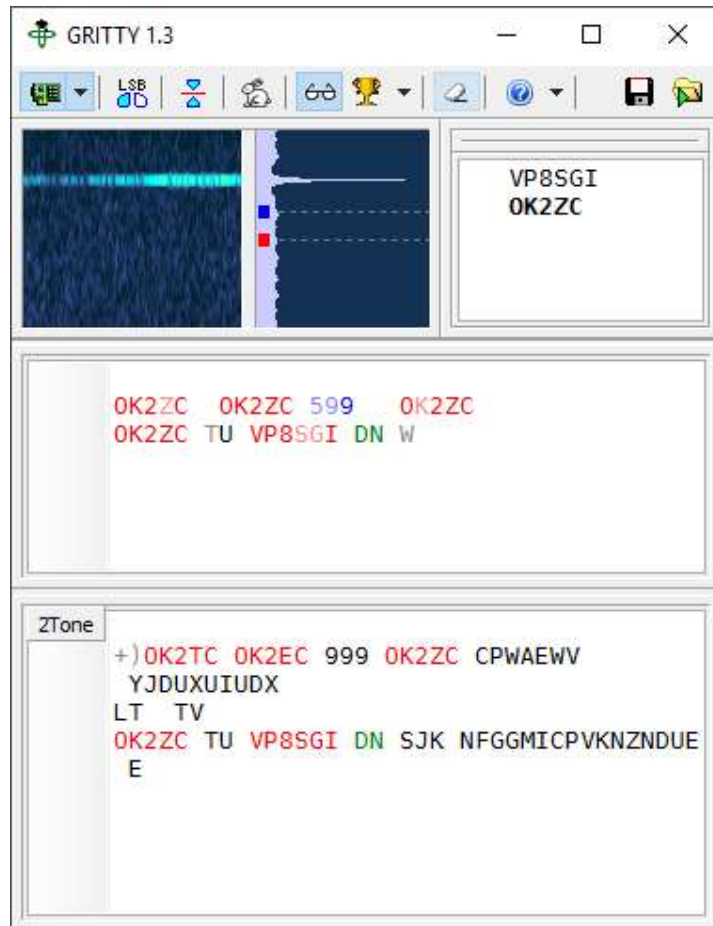
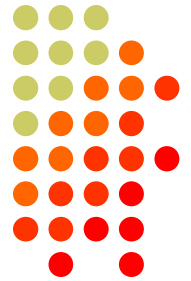
2Tone



- Outperforms MMTTY ?
- Uses less CPU cycles
- Contest loggers:
 - N1MM Logger+
 - WriteLog
 - Win-Test
- Introduced late 2012
- David Wicks, G3YYD

Multiple Decoders

GRITTY



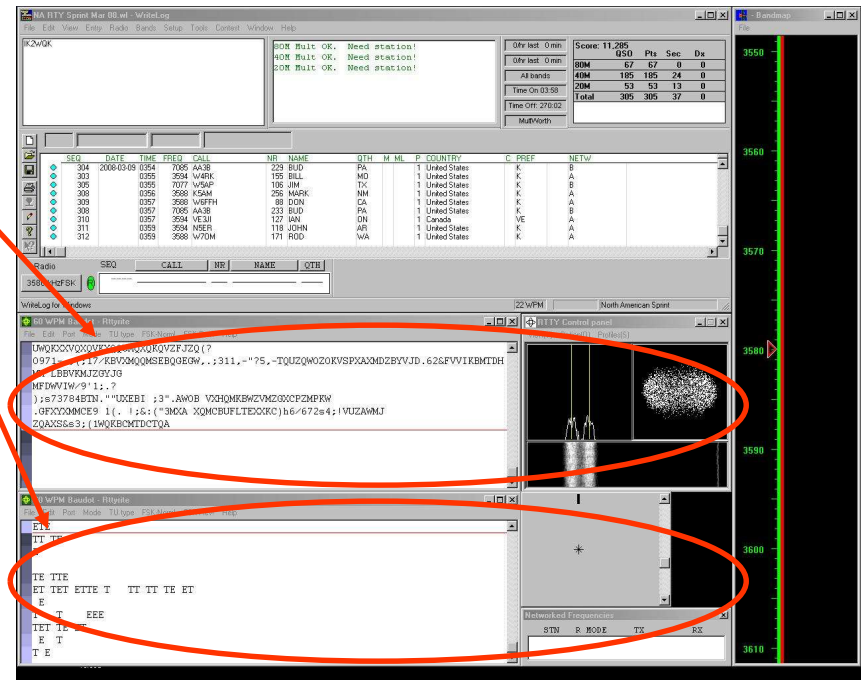
- Best accuracy ?
- Bayesian statistics
- Standalone, or ...
- Contest loggers:
 - N1MM Logger+ only
- Introduced late 2015
- Alex Shovkoplyas, VE3NEA

Multiple Decoders

MMTTY & DXP38



- Parallel decoding
 - Software, e.g., MMTTY
 - Hardware, e.g., DXP38
- Diverse conditions
 - Flutter
 - Multi-path
 - QRM, QRN
 - Weak signals
 - Off-frequency stations



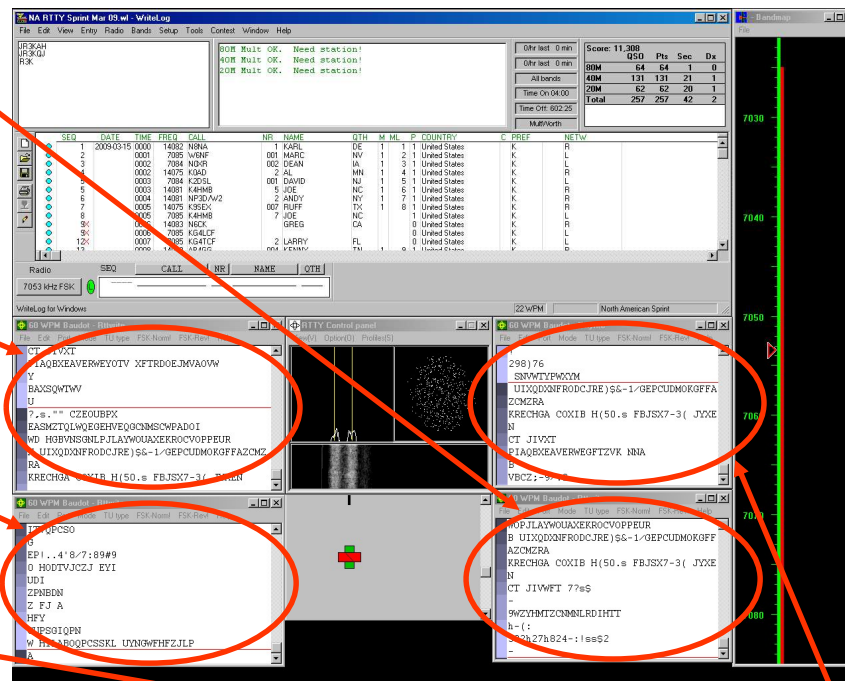
- [illegible]

Multiple Decoders

two IF bandwidths

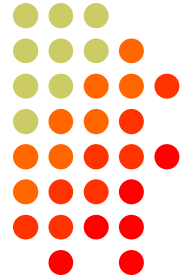


- Narrow IF filtering (main RX)
 - Hardware modem, i.e. DXP38
 - MMTTY profiles:
 - Standard
 - Fluttered signals
 - Fluttered signals (FIR)
 - Multi-path
 - hyper sensitive
 - EU1SA
- Wide IF filtering (sub RX)
 - MMTTY profile:
 - AA6YQ-FIR-512
 - Dual Peak Filter
 - "Matched filter"

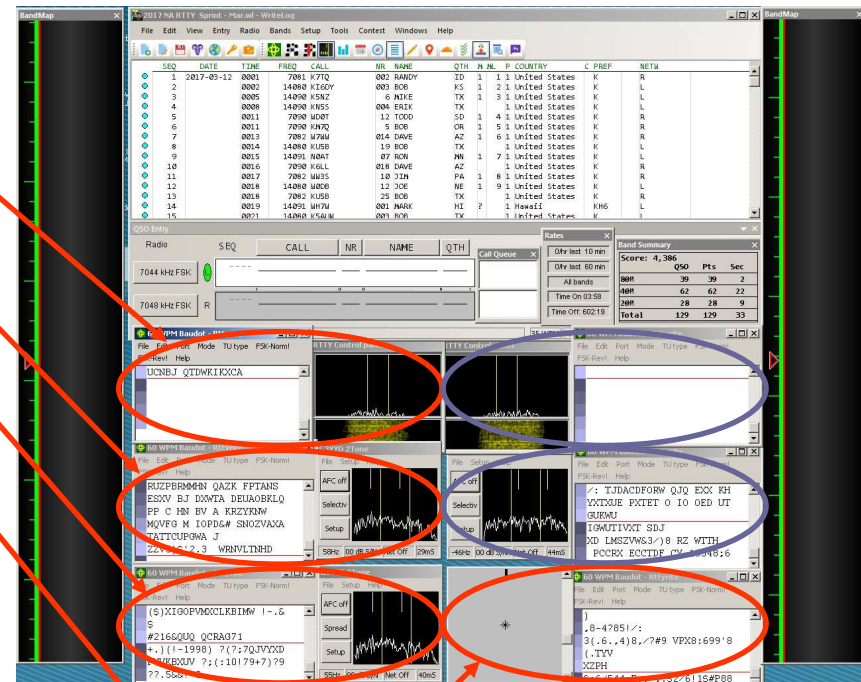


Multiple Decoders

SO2V

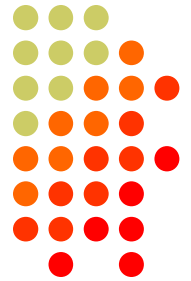


- VFO-A (main RX)
 - MMTTY Standard profile
 - 2Tone Flutter profile
 - 2Tone Selective profile
 - DXP38
- VFO-B (sub RX)
 - MMTTY Standard profile
 - 2Tone Flutter profile
- 6 decoders
 - A→B



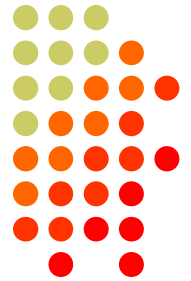
Multiple Decoders

Tone choices for monitoring



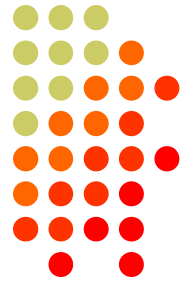
- Low tones are less fatiguing
 - Use high tones for secondary audio stream(s)
- Low/High tones can be mixed to put two audio streams in one ear:
 - SO2R plus SO2V per radio (4 streams)
 - SOnR (3+ streams)

SO2V



1. [single rcvr] If Assisted and running on VFO-A, then
 - A<>B, click spot, tune, ID station, work station
 - A<>B, resume running
2. [dual rcvr] Set up decoder windows on VFO-A and VFO-B
 - Radio must have two true receivers
 - Monitor both frequencies simultaneously with right/left channels of sound card
 - Left-click call from 2nd RTTY window into VFO-B Entry Window
 - Two ways to transmit on VFO-B:
 - I. A<>B, work the mult, A<>B
 - II. SPLIT, work the mult, un-SPLIT, resume running
 - Requires “wire-OR’d” FSK or AFSK and two transmit RTTY windows
 - WriteLog **Shared Com Port** obviates the wire-OR
 - K3/WriteLog invokes SPLIT when VFO-B call is clicked

SO2R

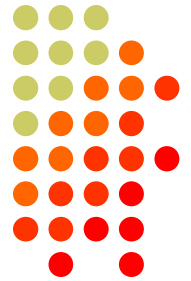


- Eliminates SO1R RTTY boredom
- Think beyond run and S&P:
 - Dueling CQs; run on two bands simultaneously
 - S&P on two bands simultaneously, esp. w/Packet
 - SO2V on one or both radios (SO4V!)
- Two networked computers:
 - Eliminates swapping radio-focus
 - Display room for more decoder windows per radio
 - RTTY doesn't require much typing; mini-keyboards
 - 2 x SO2V=SO4V for picking up mults on both run bands
 - Easily extendible to SOnR

No time to watch TV or read spy novels!

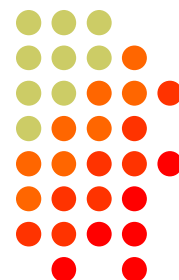
SO2R

“M2” configuration



SO2R in the NA Sprint

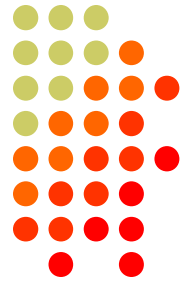
maximize TX duty cycle



- Set VFOs at least 10 kHz apart on both radios
- Find a clear spot on one radio and CQ while you tune the other radio for a station to work
- If you don't find a station to work before the CQ finishes, find a clear frequency and duel CQ
- After a QSO, swap VFOs on that radio, search during other transmission, then resume dueling CQ
- Don't waste time trying to work the "couplet" ... CQing is OK in Sprint!

SOnR

> 2 *radios*



- Simplify antenna/filter band-decoding:
 - Dedicate a band/antenna to the 3rd (or 4th) radio
- Networked PC/radio simplifies configuration
- RTTY (vs. CW or SSB) easier for operator
 - PC decodes for operator
 - Low tones & high tones allows two radios per ear
 - Classic audio headphone mixer (per ear) provides radio A, radio B or both

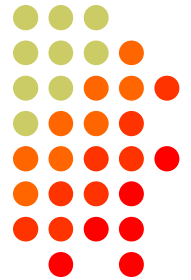
SO_nR

Multi-Multi configuration



dedicated
to 10 meters

Resources



- www.rttycontesting.com premier website
 - Tutorials and resources (beginner to expert)
 - WriteLog, N1MM Logger+ and MMTTY
- rtty@groups.io Email reflector
 - RTTY contester networking
 - Q&A
- Software web sites
 - hamsoft.ca/ (MMTTY)
 - n1mm.hamdocs.com/tiki-index.php (N1MM Logger+)
 - www.writelog.com (WriteLog)
 - www.win-test.com (Win-Test)
- Software Email reflectors
 - mmtty@yahoogroups.com (MMTTY)
 - N1MMLoggerplus@groups.io (N1MM Logger+)
 - Writelog@contesting.com (WriteLog)
 - support@win-test.com (Win-Test)