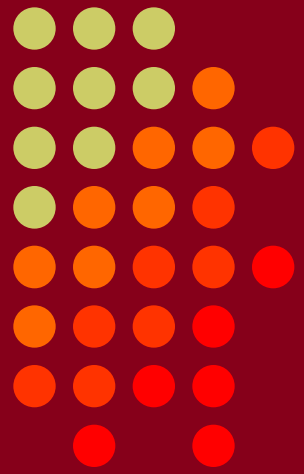
CTU 2019 Presents

Taking Digital Contesting to the Limit

Ed Muns, W0YK



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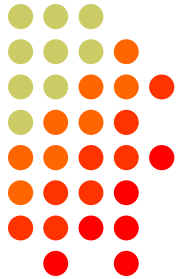
Taking Digital Contesting … to the Limit

- 1st session: *"Digital Contesting is Fun!"*
- Receiver Configuration
- Call Sign Stacking
- Multiple Decoders
- SO2V, SO2R-SOnR
- AFSK vs. FSK
- FSK Bit Timing
- RTTY Transmit Bandwidth
- FT8 Future

Receiver Configuration

AGC; headphone monitoring

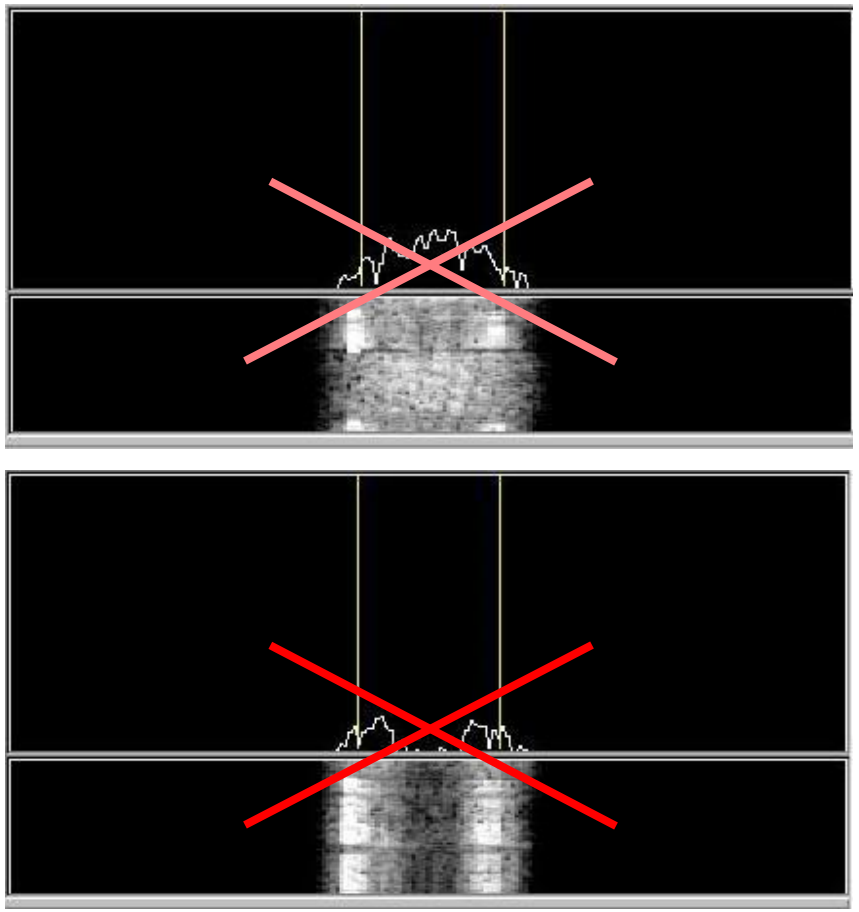


- Turn off AGC
  - or, at least minimize it, e.g., AGC=Slow
  - Fast AGC increases error rate in modern software decoders
- Minimize headphone monitoring fatigue
  - Use minimum discernible headphone volume
    - Only need to know start/stop of signal
  - Low Tones, e.g., 915/1085
    - Possible TX harmonics with AFSK

Receiver Configuration

IF filtering

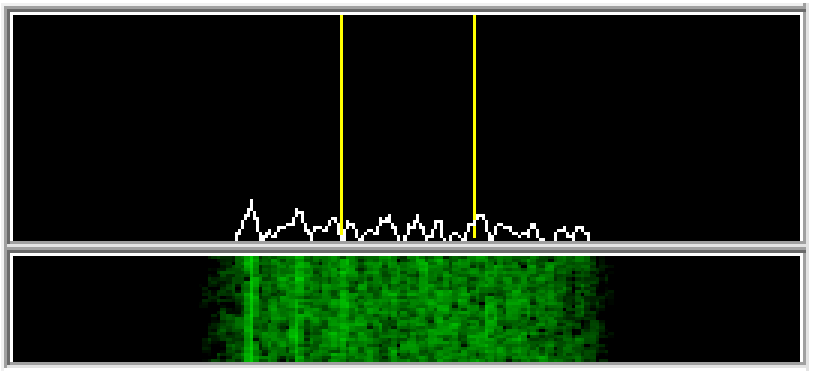
- Narrow IF filters (Roofing & DSP)
  - 500 Hz - normal
  - 250 Hz - extreme QRM only
  - Tone filters – don't use!
    - Icom Twin Peak Filter
    - K3s Dual-Tone Filter



Receiver Configuration

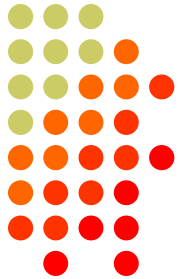
decoder audio level

- Decoder audio level
  - Band noise 5% of full-scale
  - Maximum dynamic range
  - Weak signal decode
- Note 500 Hz IF filtering
  - Decoder optimum



Call Sign Stacking

"Slow Down to Win"



- Sailboat racing analogy:
  - Pinwheel effect at mark-rounding
- Let pile-up continue 1-3 seconds after getting first call sign
  - Increase chance for another call sign or two
  - Increase chance for QSO-phase-skip
- Apply same tactic for tail-enders … pause ½-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)

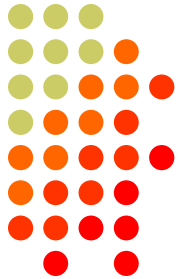
Normal S&P mode flow:

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

Call Sign Stacking

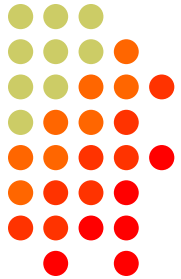
skip 2 phases



Normal	***Shortened***
1. *WPX P49X P49X CQ, or TU P49X CQ*	1. (skip CQ)
2. *K3LR K3LR K5ZD K5ZD*	2. (skip pile-up)
3. *K3LR 599 2419 2419*	3. *K3LR TU NW K5ZD 599 2420 2420*
4. *TU 599 842 842*	4. *TU 599 1134 1134*

Call Sign Stacking

tail-ender



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3. *K3LR 599 2419 2419 K5ZD*	3. *K3LR TU NW K5ZD 599 2420 2420*
4. *TU 599 842 842*	4. *TU 599 1134 1134*

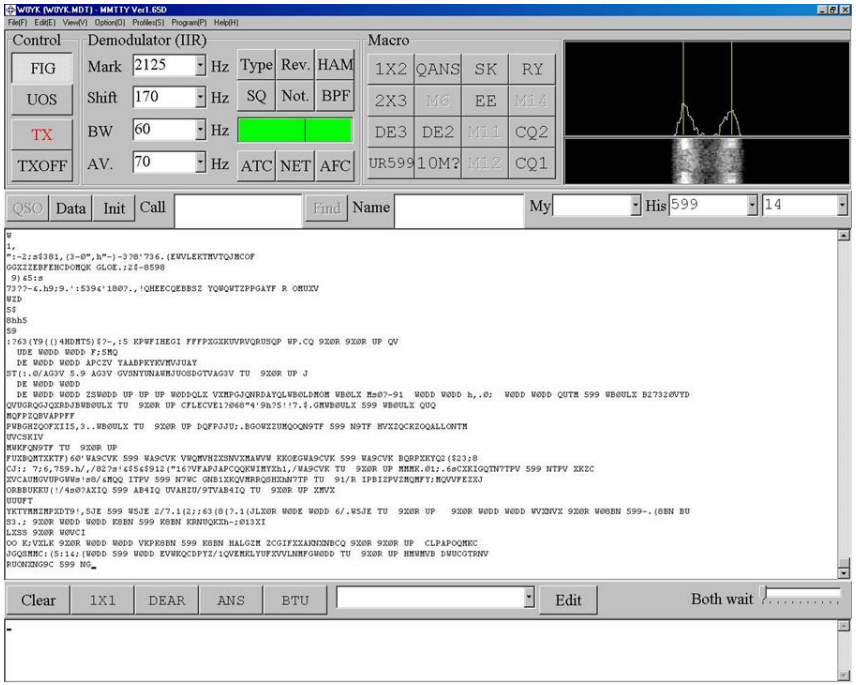
Call Sign Stacking

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

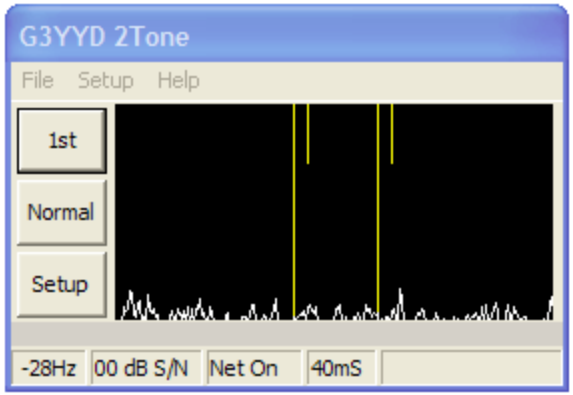
MMTTY

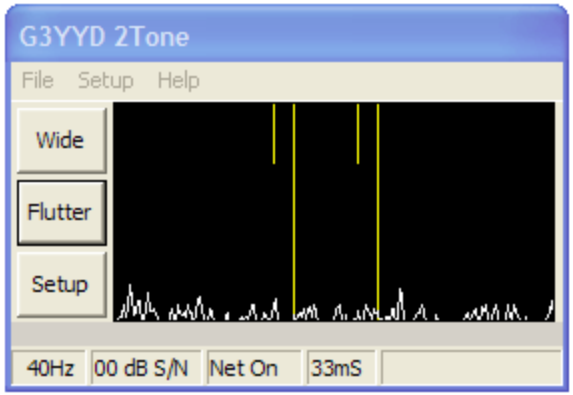


- Dominant SC MODEM
- Standalone, or …
- Contest loggers:
  - N1MM Logger+
  - WriteLog
  - Win-Test
- Introduced June 2000
- Mako Mori, JE3HHT

Multiple Decoders

2Tone

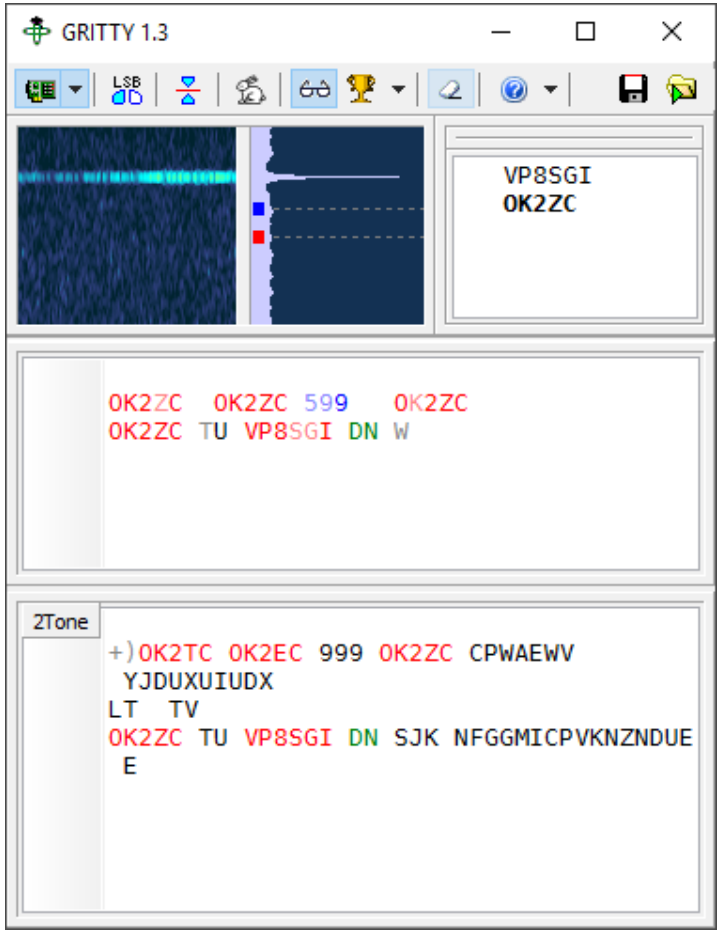




- Outperforms MMTTY ?
- Uses less CPU cycles
- Contest loggers:
  - N1MM Logger+
  - WriteLog
  - Win-Test
- Introduced late 2012
- David Wicks, G3YYD

Multiple Decoders

GRITTY



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

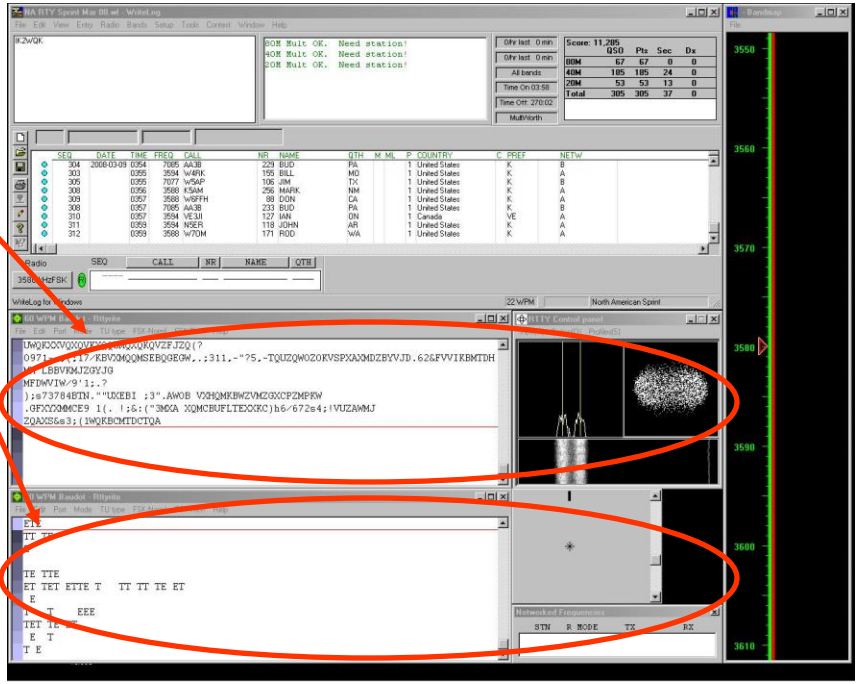
Multiple Decoders

hardware MODEM

Multiple Decoders

MMTTY & DXP38

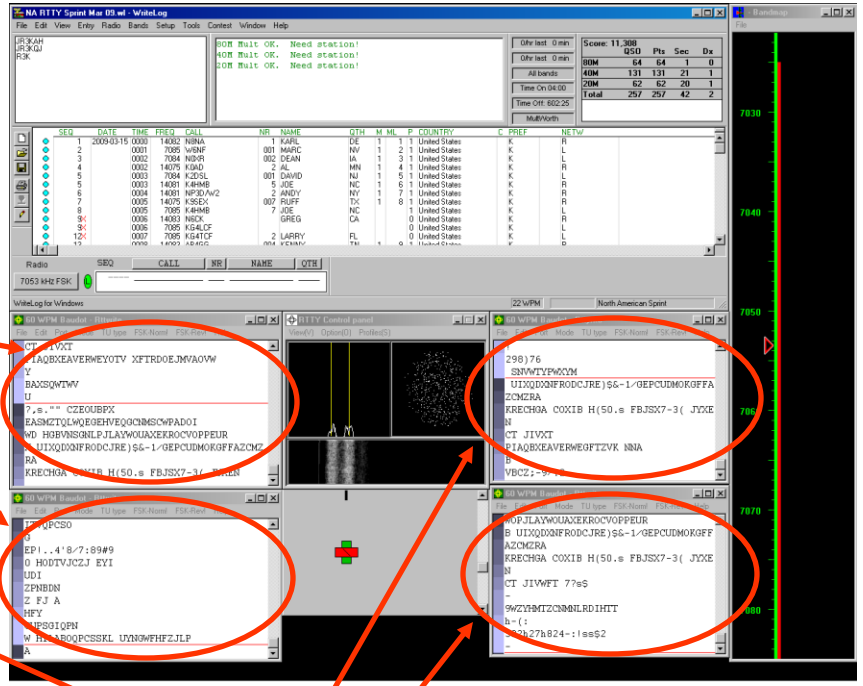
- Parallel decoding
  - Software, e.g., MMTTY
  - Hardware, e.g., DXP38
- Diverse conditions
  - Flutter
  - Multi-path
  - QRM, QRN
  - Weak signals
  - Off-frequency stations



Multiple RTTY Decoders

multiple MMTTY profiles

- Parallel decoding
  - same audio stream
  - switching takes too long
- Multiple profile windows
  - Standard
  - Fluttered signals
  - Fluttered signals (FIR)
  - Multi-path
  - hyper sensitive
  - EU1SA
  - AA6YQ-FIR-512
    - weak signals in QRN



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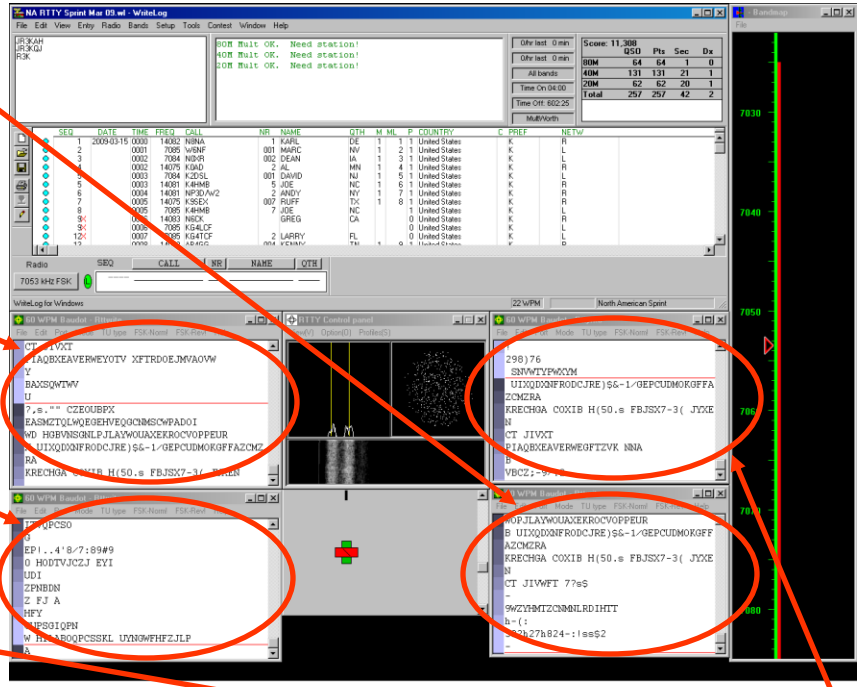
Multiple Decoders

two IF bandwidths

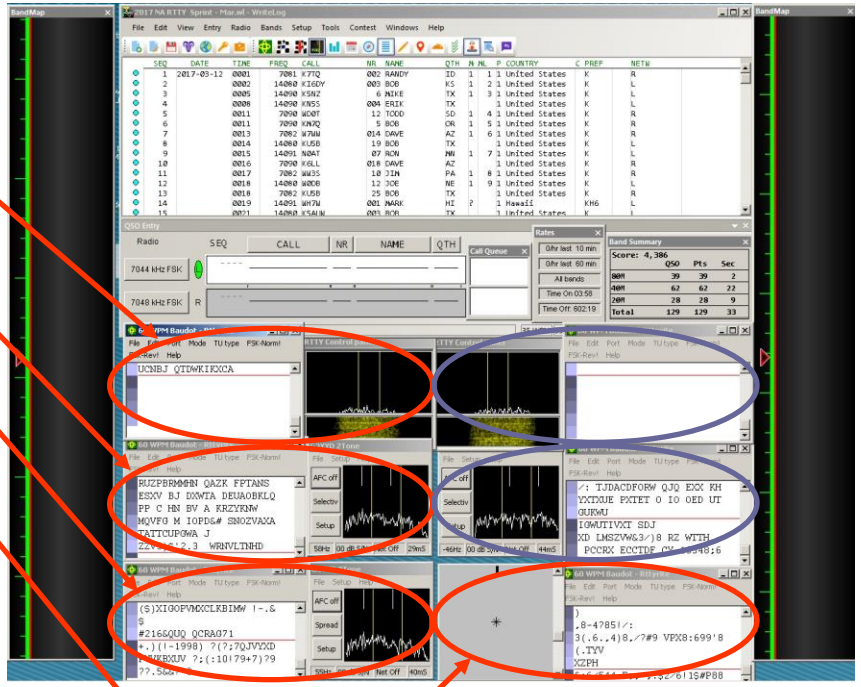
- Narrow IF filtering (main RX)
  - Hardware modem, i.e. DXP38
  - MMTTY profiles:
    - Standard
    - Fluttered signals
    - Fluttered signals (FIR)
    - Multi-path
    - hyper sensitive
    - EU1SA
- Wide IF filtering (sub RX)
  - MMTTY profile:
    - AA6YQ-FIR-512
      - Dual Peak Filter
    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



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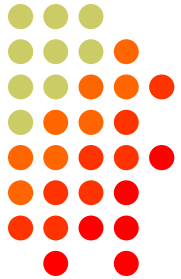
Multiple Decoders

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)

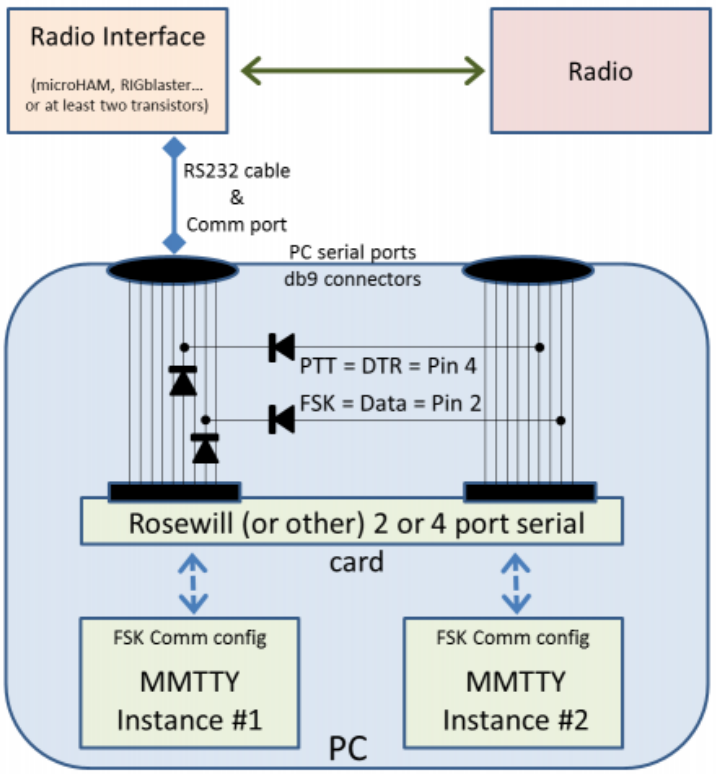
SO2V

1. [single rcvr] If Assisted and running on VFO-A, then
   - A<>B, click spot, tune, ID station, work station
   - A<>B, resume running

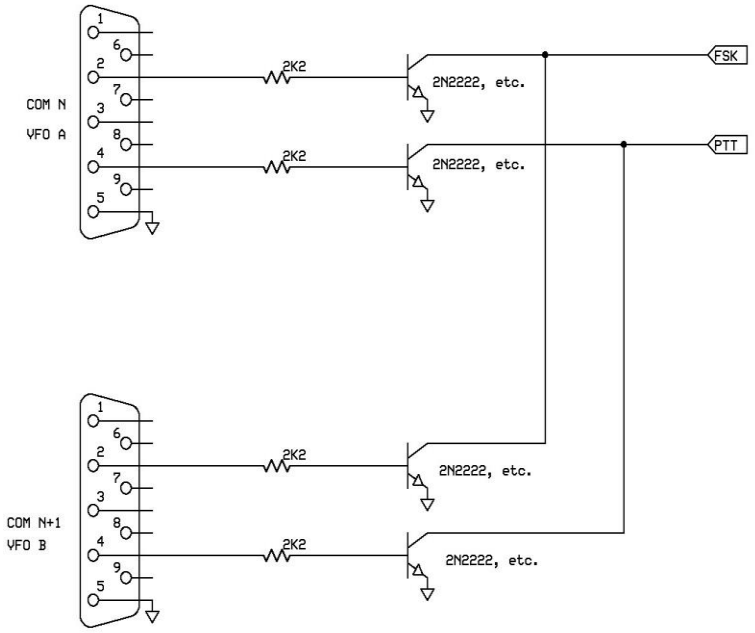
   } Toggle as needed
2. [dual rcvr] Set up decoder windows on VFO-A and VFO-B
   - Radio must have two true receivers
   - Monitor both frequencies simultaneously with right/left channels of sound card
     - Left-click call from 2nd RTTY window into VFO-B Entry Window
   - Two ways to transmit on VFO-B:
     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

SO2V

Wire-OR FSK/PTT



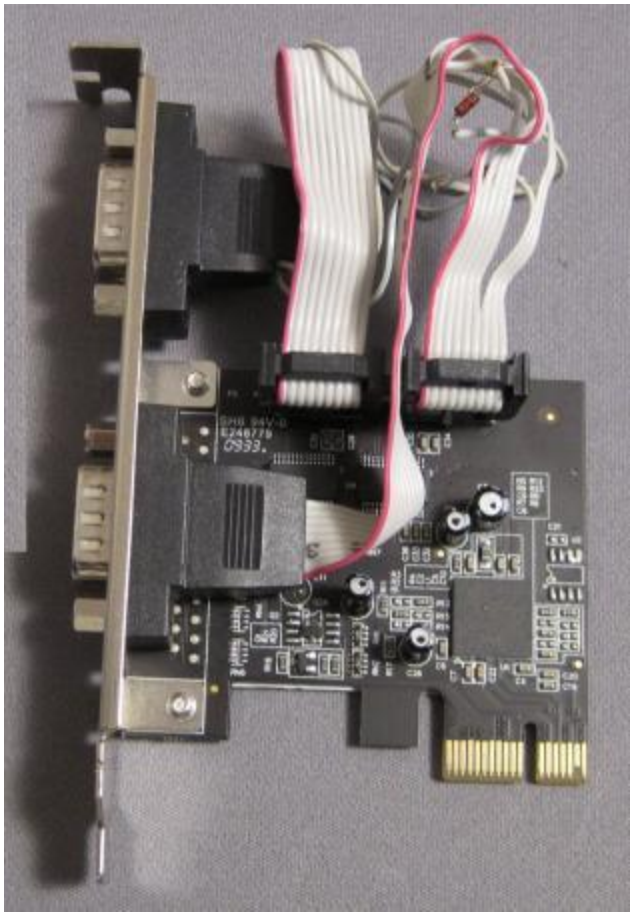
Serial Signals (K8UT)



FSK/PTT Signals (W0YK)

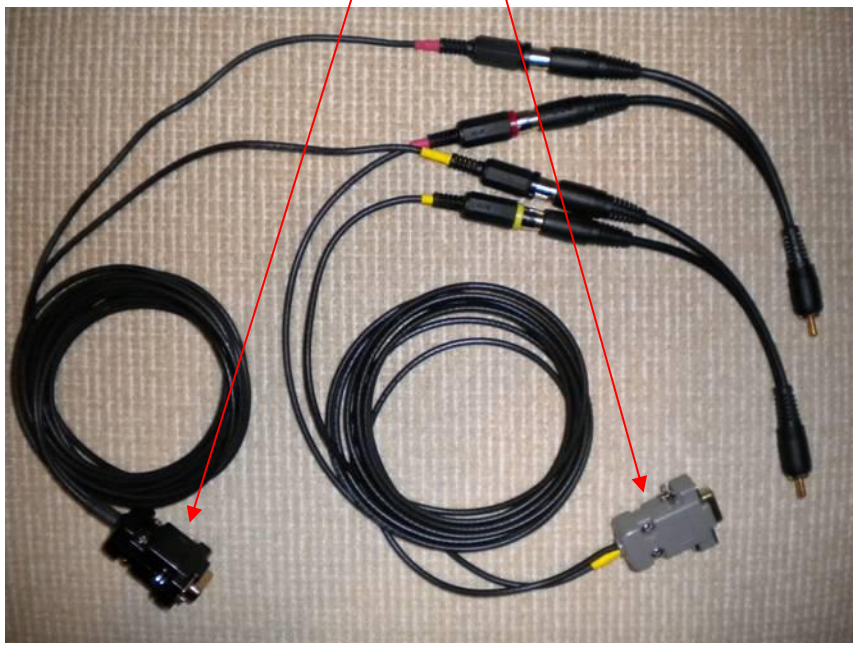
SO2V

Wire-OR FSK/PTT



Serial Signals (K8UT)

Circuitry built into
DE9 hood



FSK/PTT Signals (W0YK)

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

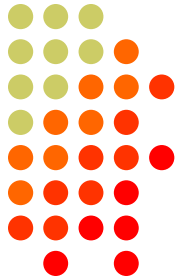
SO2R in the NA Sprint

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

SOnR

Multi-Multi configuration

dedicated to 10 meters

AFSK vs. FSK

which is better?

- First and foremost, a “religious belief”
  - Personal preference, enthusiastically advocated!
- Both are equally high quality on the air, if …
  - They are configured and adjusted properly
- Telegram:
  - AFSK can achieve high quality with any radio
  - FSK minimizes unintended consequences
    - Only K3 has acceptably narrow TX bandwidth

AFSK vs. FSK

comparison

AFSK

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

NET (automatic TX tone control)

Less bandwidth (depends on setup)

Easier cabling; NET

FSK

- Direct *(like CW keying)*
- "Modern" radios
- RTTY (narrow) filtering
- Dial = Mark frequency
- PTT
- Com port FSK/PTT keying cable
- Can use low tones

Eliminates:

audio level adjust
disabling speech proc.
erroneous sound keying

Less pitfalls

FSK Bit Timing Issues

- Issues
  1. Bit jitter (variation of bit length)
  2. 45 instead of 45.45 baud(22.22 vs. 22.00 msec/bit)
- Caused by *Windows* OS:
  1. Task Scheduler injects delays between bits
  2. API interface limited to sending integer parameters
- Increased receive error rate
  - Adequately loud, but incorrectly printed characters
  - Wasted time on fills

FSK Bit Timing Issues

bit generation

- Software FSK
  - Bit transitions generated in a *Windows* program:
    - MMTTY EXTFSK/EXTFSK64
    - 2Tone FSK
    - WriteLog Rittyrite Software FSK
- Hardware FSK
  - Bit transitions generated outside of *Windows*:
    - Hardware modem
    - UART on Serial I/O card or USB-Serial adapter
    - Micro-controller: FSKit, TinyFSK, RpiFSK
    - Psuedo-FSK via AFSK

FSK Bit Timing Issues

software FSK

- Bit transitions generated in a *Windows* program
- Com port signal toggled: TxD, DTR or RTS
- Windows Task Scheduler interrupts bit stream
  - Other programs which need CPU cycles
  - User operations, e.g.:
    - Mouse movements
    - Starting a program
    - Interacting with a program
  - Average deviation close to zero
  - Some instantaneous deviations of a few msec.

FSK Fit Timing Issues

software FSK solutions

- High performance PC
  - Reduces, doesn't eliminate, bit jitter
    - Extent of timing variation
    - Frequency of timing variation
  - Minimize the number of other running programs
- Use hardware FSK
  - May have another timing problem
    - 45 instead of 45.45 baud (22.22 vs. 22.00 msec.)

FSK Bit Timing Issues

hardware FSK

- Bit transitions generated outside of *Windows*:
- 5-bit words sent to hardware bit generator
- Some UARTs don't go below 110-600 baud
  - Modern Serial cards and USB-Serial adapters
    - Clock divider optimized for a higher speed range
- UARTs that handle 45.45 baud
  - Windows API integerizes 45.45 baud to 45
    - Bits are 22.22 msec instead of 22.00
    - Minor impact on receive error rate

FSK Bit Timing Issues

hardware FSK solutions

- Use another hardware FSK alternative:
  - Hardware MODEM (ST-8000, DXP38, PK232, Kam ..)
  - FSKit by K4DSP (PCBs no longer available)
  - TinyFSK (Mortty kit for $18)
  - Pseudo-FSK
    - FSK keying circuits driven by AFSK
      - Jitter-free AFSK[1] without the adjustment issues
      - DIY solutions: FLdigi, 2Tone
- Use AFSK ☻

[1] *AFSK tone timing uses soundcard clock, independent of windows*

RTTY Transmit Bandwidth

unnecessary QRM

- Wasted power
  - Outside receiving decoder bandwidth
  - 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

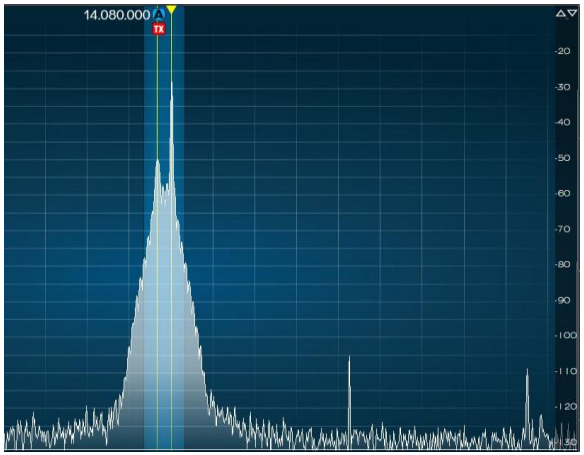
Why hurt yourself AND QRM close-by stations?

RTTY Transmit Bandwidth

AFSK

MMTTY - AFSK

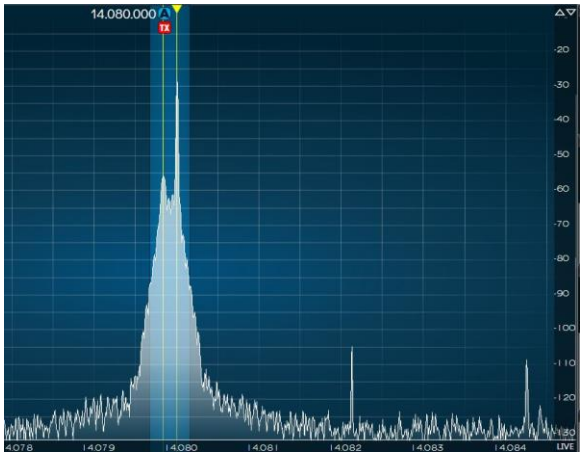
- No filtering
- Flex 6000 @ 60 W



Thanks K9CT

MMTTY - AFSK

- Default 48-tap TX BPF
- Flex 6000 @ 60 W



RTTY Transmit Bandwidth

AFSK

MMTTY - AFSK

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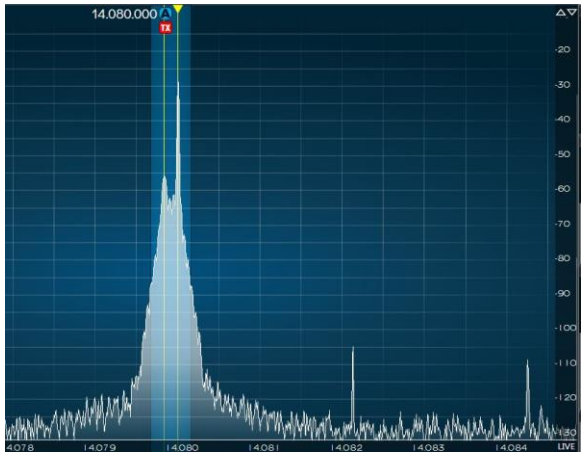

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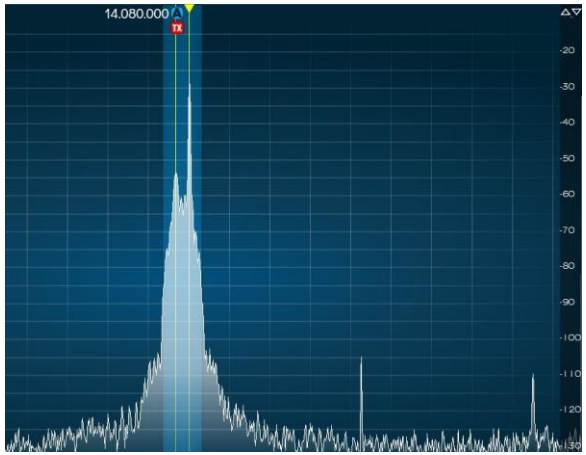
MMTTY - AFSK

- 512-tap TX BPF
- Flex 6000 @ 60 W



RTTY Transmit Bandwidth

AFSK

MMTTY - AFSK

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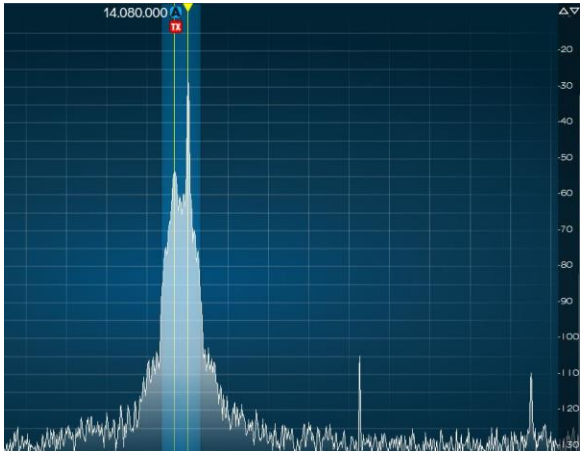
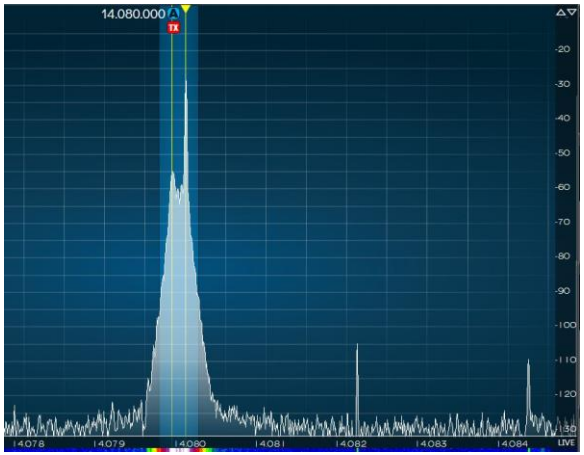


Thanks K9CT

2Tone - AFSK

- Default “AM” setting
- Flex 6000 @ 60 W

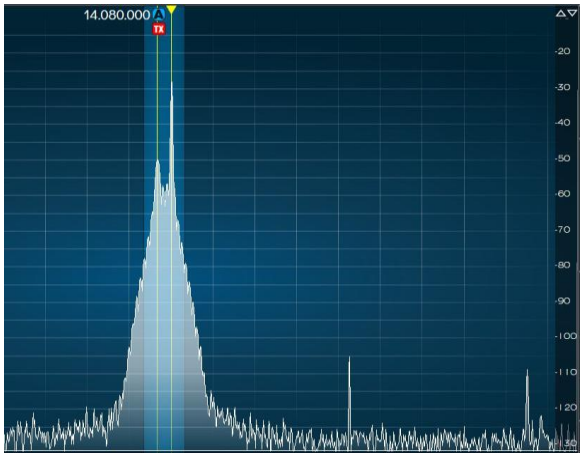


RTTY Transmit Bandwidth

AFSK

MMTTY - AFSK

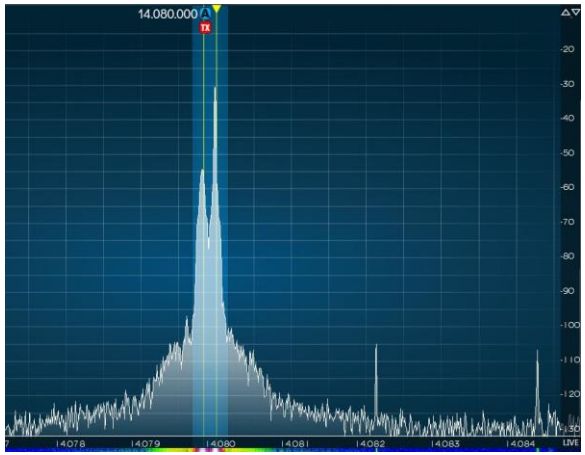
- Unfiltered
- Flex 6000 @ 60 W



Thanks K9CT

2Tone - DOOK

- Default “AM” setting
- Flex 6000 @ 60 W



RTTY Transmit Bandwidth

AFSK

2Tone - AFSK

- 512-tap TX BPF
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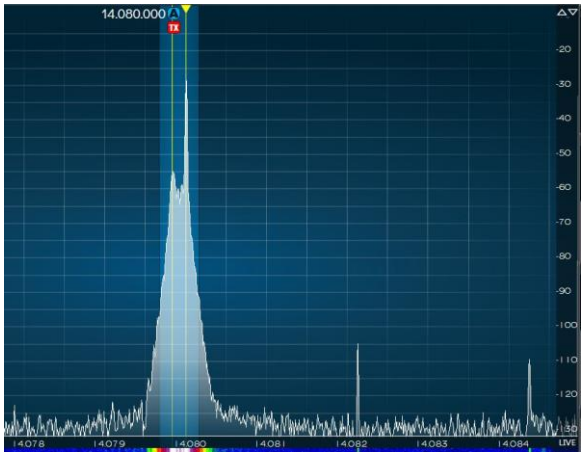

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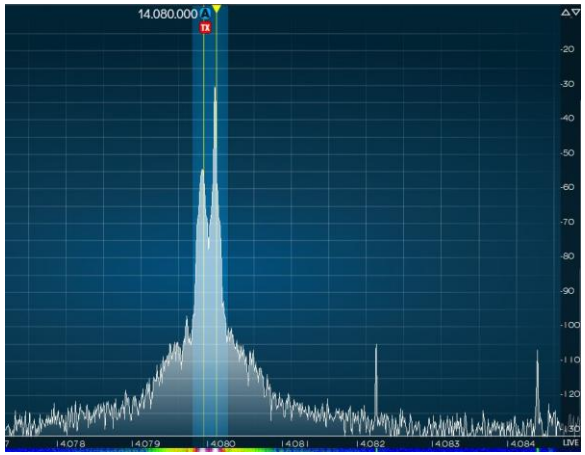

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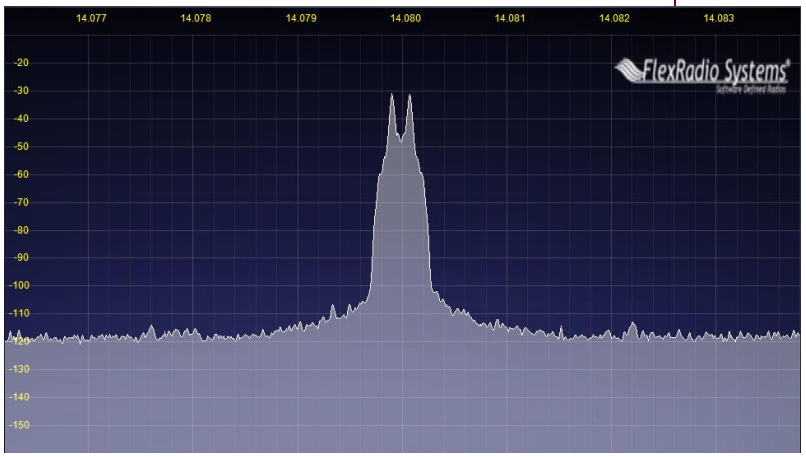
RTTY Transmit Bandwidth

PA IMD impact on AFSK bandwidth

MMTTY - AFSK

- 512 Tap TX BPF
- K3 @ 1 mW



Thanks K0SM (http://www.frontiernet.net/~aflowers/k3rtty/k3rtty.html)

MMTTY - AFSK

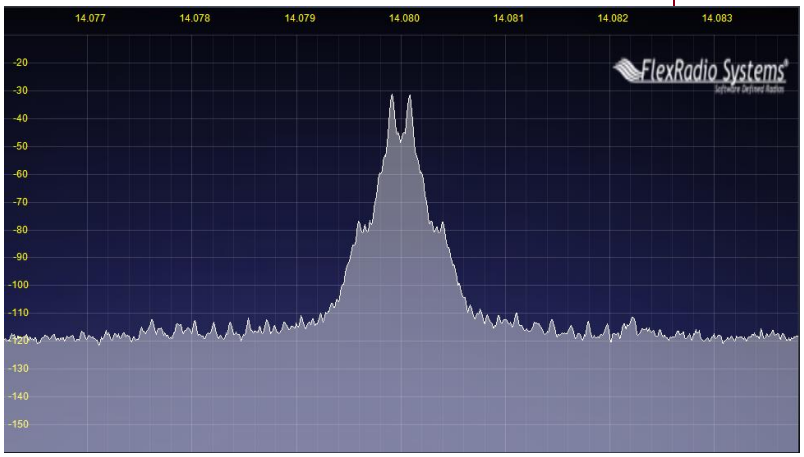
- 512 Tap TX BPF
- K3 @ 100 watts

RTTY Transmit Bandwidth

MMTTY AFSK filter vs. K3 AFSK filter

MMTTY - AFSK

- 512 Tap TX BPF
- K3 @ 100 watts



Thanks K0SM (http://www.frontiernet.net/~aflowers/k3rtty/k3rtty.html)

MMTTY - AFSK

- No MMTTY filter
- K3 AFSK filter
- K3 @ 100 watts

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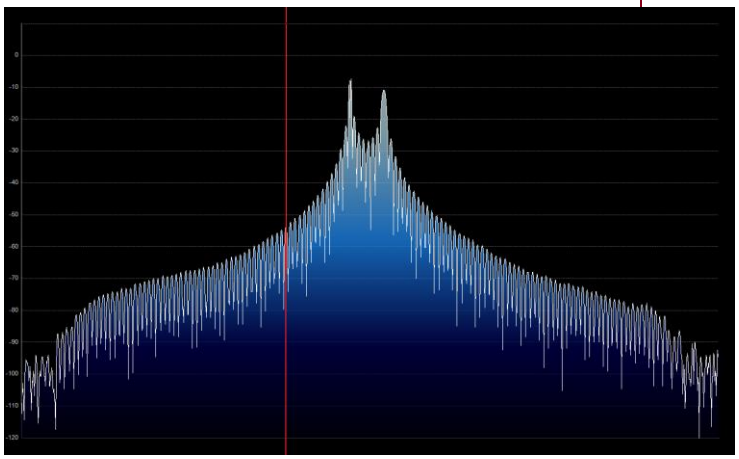
RTTY Transmit Bandwidth

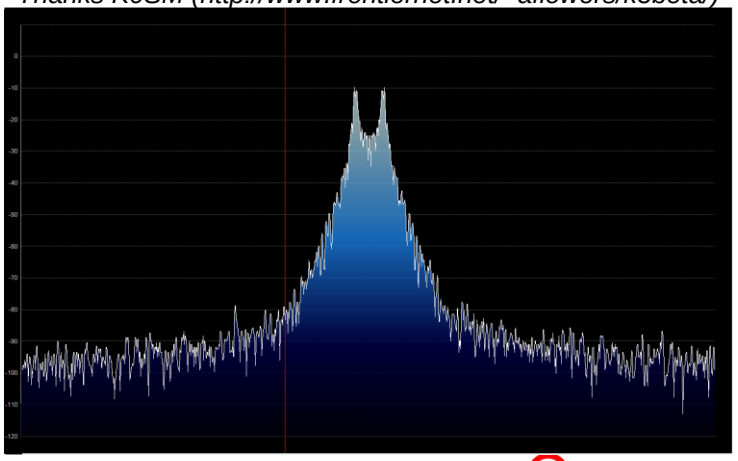
FSK

- Old K3 FSK bandwidth
  - No waveshaping
  - < DSP281 firmware
  - Typical of all radios
  - 50 watts



Thanks K0SM (http://www.frontiernet.net/~aflowers/k3beta/)

- New K3 FSK bandwidth
  - Optimal DSP filter
  - DSP281 firmware, March 2013
  - Lobby other mfrs



RTTY Transmit Bandwidth

recommendation for minimum QRM

FSK

1) K3, or
2) QRP with other radios
3) Otherwise, use AFSK

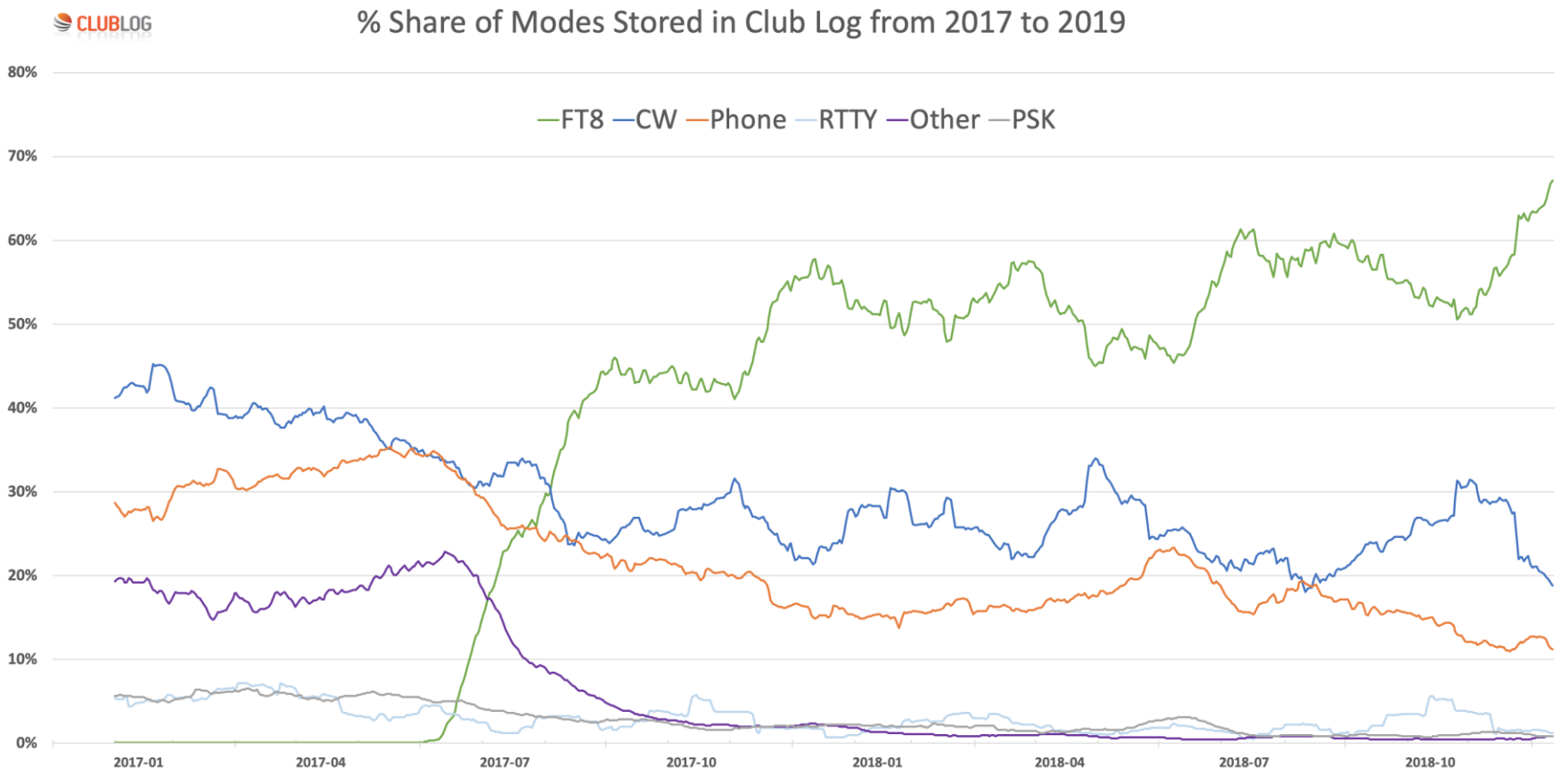
AFSK

1) K3 or Flex
   a) Enable K3 AFSK filter
   b) 2Tone DOOK or AFSK
   c) MMTTY 512-Tap
2) Other radios
   a) 2Tone DOOK or AFSK
   b) MMTTY 512-Tap

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)

Clublog QSOs by Mode



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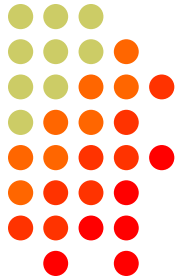
FT8 Contest Technology Future



- TU, NW
- Multi-streaming transmission (Fox-Hound DXped.)
- RTTY replacement, or additional mode?
- Synchronous vs. asynchronous Tx/Rx cycles?

FT8 Contest Technology Future

- **TU, NW**
  - **CQ RU K1ABC FN42**
    K1ABC W9XYZ 579 WI
  - **W9XYZ K1ABC R 589 MA**
    K1ABC W9XYZ RR73
    K1ABC G3AAA 559 0013
  - **TU; G3AAA K1ABC R 569 MA**
    K1ABC G3AAA RR73
    K1ABC P43A 599 2145
  - **TU; P43A K1ABC R 599 MA**
    K1ABC P43A RR73
    K1ABC K9CT 579 IL

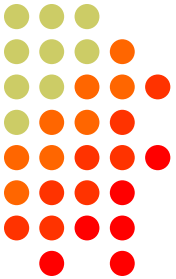
2 cycles; 120 Q/hr

2 cycles; 120 Q/hr

FT8 Contest Technology Future

- TU, NW
- **Multi-streaming transmission (Fox-Hound DXped.)**
  - **Many Foxes, many Hounds (DXped: 1 Fox, many Hounds)**
  - **Moderate incoming rate (DXped: very high incoming rate)**
  - **Split freq. problematic (DXped: split freq. feasible)**
  - **Therefore:**
    - ***Multi-signal or single-signal multi-partner?***
      - ***Multi-signal: Signal voltage/n → Signal power/n^2***
    - ***Limit to 2 or 3 or n streams?***
    - ***Run or S&P per stream?***
      - ***Run vs. S&P could be dynamic per QSO partner***
      - ***Run & S&P mixed within stream***

FT8 Contest Technology Future

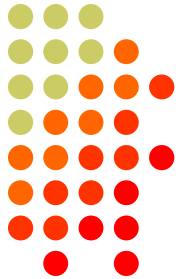


- TU, NW
- Multi-streaming transmission (Fox-Hound DXpeditioning)
- **Additional mode or RTTY replacement?**
  - ***Choice:***
    - ***Exploit inherent multi-channel strengths, or***
    - ***Reduce Tx cycle time by widening BW and lowering sensitivity***
  - ***How much QSO rate is needed?***
    - ***Service rate >> incoming rate***

FT8 Contest Technology Future

- TU, NW
- Multi-streaming transmission (Fox-Hound DXpeditioning)
- **Additional mode or RTTY replacement?**
- **Synchronous vs. asynchronous Tx/Rx cycles?**
  - ***0, 15, 30 and 45 seconds vs. operator initiated like RTTY***

Synchronous vs. Asynchronous



Synchronous

- *multi-streaming*
- *SO2R “lockout”*
- *signal density*
- *better decoding*
- *auto sequencing*
- *QRM immunity*
- *even/odd cycle usage*
- *no “doubling”*

Asynchronous

- *higher rate?*
- *no clock sync*
- *no time lost for unsync’d clocks*
- *no decoding time lost each Tx cycle*
- *high CPU demand at end of each Rx cycle*
- *easier integration with contest loggers*

FT8 Contest Rules Future

- Multi-channel → Assisted/Unlimited?
- How much automation?
  - Operator initiate each QSO?
  - Or, allow maximum automation and allow SO to run a MM?
- Multi-mode digital contests?
  - CW/SSB/“Digital” or CW/SSB/RTTY/FT8 modes?
- 100 watt limit?
- Participation determines which mode(s) prevail

Conclusions

- **FT8 is controversial**
  - ***Explosive adoption threatens RTTY***
  - ***Fear of robotic, unattended operation***
  - ***Threatening to many "legacy" hams, but more appealing than CW/SSB/RTTY to new hams***
- **FT8 has instantly entrenched itself as:**
  - ***A primary amateur mode***
  - ***The pre-eminent digital DXing mode***
- **Will contest rules let FT8 be all it can be?**
- **Will FT8 subsume RTTY in digital contesting or become an additional mode? *(Contest participation will determine)***
- **Multiple digital modes in a single contest:**
  - \+ **Increases overall participation**
  - \- **Dilutes per-mode participation**
  - = **Net?**

Resources

- **WSJT-X 2.0 web site with download link:**
  https://physics.princeton.edu/pulsar/k1jt/wsjtx.html
- **WSJT-X 2.0 Quick-Start Guide:**
  https://physics.princeton.edu/pulsar/k1jt/Quick_Start_WSJT-X_2.0.pdf
- **MSHV web site:**
  http://lz2hv.org/mshv
- **FT8 Roundup web site with tutorial:**
  https://www.rttycontesting.com/ft8-roundup
- **ARRL FT8 Press Release:**
  http://www.arrl.org/news/ft8-to-be-permitted-in-2019-arrl-rtty-roundup