CTU 2018 Presents

Having Fun with RTTY Contesting

Ed Muns, W0YK
Having Fun in RTTY Contesting

- Introduction: What is RTTY?
- Part 1: Operating
- Part 2: Setting Up
  - Hardware
  - Software
- 2nd session: “Pursuing the Limit in RTTY Contesting”
Three Largest RTTY Contests
Lots of RTTY Contests

> two/month

- Biglies (7)
  - CQ WW RTTY (last weekend in September)
  - CQ WPX RTTY (2nd weekend in February)
  - ARRL RTTY Roundup (1st weekend in January)
  - BARTG (3rd weekend Jan, 3rd weekend March)
    - 75 Baud (April & September)
  - WAE RTTY (2nd weekend in November)
- NCJ contests (4)
  - NAQP RTTY (3rd Sat. in February, 2nd Sat. in July)
  - Sprint RTTY (2nd Sat. in March & October)
- Other popular RTTY contests (20)
  - Ten-Meter RTTY (1st Sat. in December)
  - JARTS, Makrothen, SARTG (2)
  - 15 others
What Makes a Great RTTY Contester?

1) Contester who happily logs casual callers
2) Uses CW & SSB techniques where useful
3) Strives to exploit RTTY uniqueness
   - Auto-decode frees operator time … use it to do things difficult with CW & SSB, e.g., SO3R!
   - Speed is ~2x CW
4) Applies learning back to CW & SSB
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?

- 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

### Figures Shift

<table>
<thead>
<tr>
<th>Code</th>
<th>Control Characters</th>
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<tr>
<td>11111</td>
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<table>
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<tr>
<td>Y</td>
<td>6</td>
</tr>
<tr>
<td>Z</td>
<td>&quot;</td>
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</table>
What is RTTY?

- 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
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?

- 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?

- RTTY RF is independent of local audio tones and whether LSB or USB is used:
  - 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 (14090.000 kHz)
- AFSK displays suppressed carrier which varies with local audio tones and sideband used!
  - For Mark tone of 2125 Hz (Space tone of 2295 Hz):
    - LSB (14092.125 kHz)
    - USB – Mark & Space tones reversed (14087.005 kHz)
What is RTTY?

**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)

**FSK**
- Direct (like CW keying)
- “Modern” radios
- RTTY (narrow) filtering
- Dial = Mark frequency
- PTT
- COM FSK keying cable
- Can use low tones

**NET** (automatic TX tone control)
**Less bandwidth** (depends on radio)

**Easier hook-up; NET**

**Less pitfalls**
What is RTTY?

- Uses 5-bit Baudot (actually, USTTY) code with two sets of 32 characters: Letters and Figures
- Space & Mark frequencies separated by 170 Hz “Shift”
- Local Space & Mark tones analogous to pitch in CW
- Constant 45.45 Baud (60 wpm) asynchronous character stream with 5 data bits and 2-3 sync bits
- Figures Shift & Letters UnShift
  - Use optional UnShift-On-Space (UOS), plus space delimiter
- AFSK vs. FSK transmission (receiving is the same)
  - Radio dial frequency differences
  - 100% duty cycle!
The Cynics Say …

“The RTTY decoder/encoder does everything.”

- however, this attribute …
  - frees the operator to improve other skills
  - enables more contest participants
  - provides mode diversity for contest junkies

“RTTY is a pain to set up and get working.”

… stay tuned, it’s really not that difficult!
RTTY Considerations

Much like CW and SSB, except:

- Non-human decoding implications
  - *serial number repeat, universal “fist” or “voice”*
- Distractions are tempting
  - *watch TV, do email, read, etc.*
- 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
RTTY Sub-Bands

- 10 meters: 28080-28100, during contests 28080-28200
  - JA: 21070-21150
- 15 meters: 21080-21100, during contests 21080-21150
  - JA: 21070-21150
- 20 meters: 14080-14100, during contests 14080-14150
  - JA: 14070-14150
- 40 meters: 7025-7050 & 7080-7100, during contests 7025-7100
  - JA: 7030-7100
- 80 meters: 3580-3600, during contests 3560-3600
  - JA: 3520-3575 and 3599-3612
- 160 meters: No RTTY contesting
RTTY Sub-Bands

don’t QRM!

- Avoid audio-digital operations near:
  - e.g., 14070-14080

- Avoid the NCDXF beacons:
  - e.g., 21150 and 14100

More details:

www.aa5au.com/rtty/rtty-sub-bands
Receiving

- PC Audio isolation
  - Transformer
  - Commercial interface
  - Some radios (K3, Flex)
- Narrow IF filters (Roofing & DSP)
  - 500 Hz - normal
  - 250 Hz - extreme QRM only
- Tone filters – don’t use!
  - Icom Twin Peak Filter
  - K3 Dual-Tone Filter

radio IF filtering

![Graph showing IF filtering frequencies: 250 Hz and 500 Hz]
Receiving

adjust audio

- Set RX audio level for noise 5% of full-scale
  - Receiver audio out level control, and/or
  - Windows Recording Volume Control applet
Receiving tuning a RTTY signal

- Use narrow filtering
  - CW filters ~ 500 Hz
- Set RX audio level
  - noise 5% of full-scale
- Learn to tune by ear
  - practice with eyes closed
  - get within 10-20 Hz
Receiving

- Use narrow filtering
  - CW filters ~ 500 Hz
- Set RX audio level
  - noise 5% of full-scale
- Learn to tune by ear
  - practice with eyes closed
  - get within 10-20 Hz
- AFC On or Off
  - ‘On’ may cause TX frequency to be off
Transmitting

**AFSK adjustment**

Insure SSB processor (compression) is Off.

- Adjust:
  - the *Windows* Playback Volume control, and
  - the transmitter Mic (or auxiliary audio input)

- Such that:
  - ALC is just backed off to zero, and
  - full power output is attained.
Transmitting

FSK adjustment

- None!

(That’s the whole point of FSK.)
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
## RTTY Messages

### CR/LF

- F02: %R%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: %R%Q%V %Z%R.1 %E
- F08: %R %C TU .. NOW%L
- F09: %R%A%G %E
- F10: %R%N%R %E
- F11: %R%N3 %E
Super Check Partial  

*call sign selection*

- SCP (Super Check Partial) enables computer to select call signs in receive window
  - Unworked calls (no mult)
  - New mults and double mults
  - Dupes
- Use main SCP from CW/SSB/RTTY contests
  - RTTY SCP is a subset

<table>
<thead>
<tr>
<th>XYZAB</th>
<th>AA5AU</th>
<th>XYZAB</th>
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<td>XYZAB</td>
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<tr>
<td>XYZAB</td>
<td>W5UKM</td>
<td>XYZAB</td>
</tr>
</tbody>
</table>
Super Check Partial

logger differences

N1MM Logger

WriteLog

Win-Test

• Background option
• Custom colors
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 USERPARA.INI

AFSK: Mic & SC levels; speech processor on

Radio mode, tones, FSK interface
More Tips

● 100% duty cycle … caution!

● Practice
  ● During RTTY contests (~ two per month)
  ● NCCC Thursday night practices (weekly)

● Multi-Ops
RTTY Operating summary

- Many casual RTTY contest participants
- RTTY sub-bands; 10-80 only; avoid audio-digital & beacons
- 500 Hz receive filtering; USOS on
- Messages ("macros")
  - Short, 5NN, unique exchange twice, Space delimiter
- Common problems
  - "Upside-down" (reversed Space/Mark or LSB vs. USB)
  - Figures vs. Letters
  - Audio:
    - RX audio output level and TX (AFSK only) audio input level
    - Unmuted soundcard inputs and outputs
    - Space and Mark tone consistency between decoder and radio
  - Off-frequency tuning (AFC & NET); band conditions
The Cynics Say …

“”The RTTY decoder/encoder does everything.””
however, this attribute …

- frees the operator to improve other skills
- enables more contest participants
- provides mode diversity for contest junkies

“RTTY is a pain to set up and get working.”

… stay tuned, it’s really not that difficult!
How Do I Set it Up?

**overview**

- **Acquire** and set up hardware and/or software to convert between the RTTY signal and text:
  - RTTY *receive* decoder
  - RTTY *transmit* encoder
  - PC-radio interface

- **Configure** decoder/encoder

- **Integrate** decoder/encoder with logger

*The rest of the station setup is the same as for CW and SSB*
How Do I Set it Up?

**RTTY decoder/encoder**

- RTTY *receive* decoder converts printed characters from the two RTTY tones.
  - CW decoders seldom used
  - Ears/brain/hands for CW/SSB

- RTTY *transmit* encoder converts typed characters (or messages) into the two tones (AFSK) or keying (FSK).
  - logger *CW keyers and SSB DVKs are also used, similar to RTTY encoders*
  - Otherwise, brain/hands/mouth for CW/SSB
How Do I Set it Up?

**decoder/encoder terminology**

- The RTTY *transmit encoder* and *receive decoder* is sometimes referred to as a MODEM or a TNC:
  - MODEM = **M**Odulator **D**EModulator
  - TNC = **T**erminal **N**ode **C**ontroller

- MODEMs can be:
  - a hardware box, or
  - a software application driving a PC soundcard
How Do I Set It Up?

**hardware MODEM**

**AFSK**

Radio  
RX  TX  
audio out  audio input  
Line In  Line Out  
MODEM  
Computer  
Term. Em. or Graphic UI

**FSK**

Radio  
RX  TX  
audio out  FSK input  
Line In  FSK output  
MODEM  
Computer  
Term. Em. or Graphic UI
How Do I Set It Up?

hardware MODEM
How Do I Set It Up?

software application & soundcard

**AFSK**

- **Radio**
  - RX
  - TX
  - audio out
  - audio input
  - Line In
  - Line Out

- **Soundcard**

- **Computer**
  - RTTY decoder/encoder

**FSK**

- **Radio**
  - RX
  - TX
  - audio out
  - FSK input
  - PTT

- **Soundcard**

- **Computer**
  - RTTY decoder/encoder

- **FSK & PTT keying cable**

- **USB/Serial port**
How Do I Set it UP?

- **Receive:**
  - RX audio out to soundcard
  - *Optional DSP filter*

- **Transmit:**
  - AFSK: TX audio in from soundcard, *or*
  - FSK: FSK/PTT keying

- **Receive:**
  - 1:1 isolation transformer

- **Transmit:**
  - 1:1 isolation transformer, *or*
  - Keying interface
How Do I Set It Up?

Eliminate ground loops between radio and PC

Otherwise insert 1:1 audio isolation transformer on:
  - RX output
  - TX Mic input (AFSK only)

Alternatives:
  - Bourns LM-NP-1001-B1L transformer → homebrew cable
  - Ground loop isolators
  - W2IHY iBox
  - Commercial RTTY interfaces
  - K3 (uses Bourns LM-NP-1001-B1L on LINE IN & OUT)
How Do I Set It Up?

homebrew audio isolation

Bourns LM-NP-1001-B1L

-90 dBc 3rd order IMD

$1.78
How Do I Set It Up?

**ground loop isolators**

Radio Shack $19.49  or  eBay $6.99

-64 dBC 3\(^{rd}\) order IMD

 eBay $3.35

 eBay $5.50

 eBay $7.45
How Do I Set It Up?

W2IHY iBox audio isolation

$60
How Do I Set It Up?

commercial interface audio isolation

Rascal
How Do I Set It Up?

**radio audio isolation**

K3 audio isolation  \[\text{IN} - \text{LINE} - \text{OUT}\]
How Do I Set It Up?

**SDR digital audio isolation**

digital: soundcard

analog: IN – LINE – OUT
How Do I Set It Up

optional radio AF filtering

- PC Audio isolation
  - Transformer
  - Commercial interface
  - Some radios (K3, Flex)
- Narrow IF filters (Roofing & DSP)
  - 500 Hz - normal
  - 250 Hz – extreme QRM only
- Tone filters – don’t use
  - Icom Twin Peak Filter
  - K3 Dual-Tone Filter
- Audio filtering
  - JPS NIR-10/12
  - Timewave DSP-599zx
  - Modern DSP rigs
How Do I Set It Up?

- Set RX audio level for noise 5% of full-scale
  - Receiver audio out level control, and/or
  - Windows Recording Volume Control applet
How Do I Set It Up?

adjust AFSK audio

Insure SSB processor (compression) is Off.

- Adjust:
  - the *Windows* Playback Volume control, and
  - the transmitter Mic (or auxiliary audio input)

- Such that:
  - ALC is just backed off to zero, and
  - full power output is attained.
How Do I Set It Up?

**PTT vs. VOX**

- AFSK uses VOX or PTT
  - radio Mic input will allow VOX
  - rear panel auxiliary audio input may not; then PTT
  - PTT can usually be keyed via the radio CAT cable

- FSK uses PTT
  - Serial port controls FSK and PTT signals
How Do I Set It Up?

*homebrew FSK & PTT keying cable*

- **FSK:** TXD (3)
- **PTT:** RTS (7)

**FSK input**

**PTT input**

(DB9 pin #)

Gnd (5)

(on radio)

![Diagram of FSK & PTT keying cable setup](image)
How Do I Set It Up?

W3YY FSK & PTT keying cable
How Do I Set It Up?

commercial interfaces
How Do I Set It Up?

*RigExpert Interfaces*
### How Do I Set It Up?

**commercial interfaces**

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Model</th>
<th>Price</th>
<th>PC In/fo</th>
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*See May-June 2012 NCJ, “RTTY Contesting” column*
How Do I Set It Up?

microHAM interfaces

One Radio

SO2R
How Do I Set It Up?

_RigExpert & microHAM interfaces_

<table>
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<tr>
<th>Vendor</th>
<th>Model</th>
<th>Price</th>
<th>PC In'fc</th>
<th>PTT</th>
<th>Soundcard</th>
<th>Level ctrl</th>
<th>FSK</th>
<th>CW</th>
<th>WinKey</th>
<th>Voice</th>
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</table>

See May-June 2012 NCJ, “RTTY Contesting” column
How Do I Set It Up?

**summary - receive**

1. Connect receiver audio output, via isolation, to …
   - MODEM Audio In,
   - or
   - MMTTY via Soundcard Line In (or Mic In with pad):
     - Enable/adjust soundcard Line In (or Mic) input, disable/mute other inputs

2. Optional receive audio filtering
How Do I Set It Up?

summary - AFSK

1. Connect radio’s Line In (or, Mic In with pad), via isolation, from:
   ● MODEM Audio Out
     or …
   ● Soundcard Line Out

2. Speech processor off

3. Enable/adjust SC audio level
   ● Disable or mute all other SC outputs
How Do I Set It Up?

**summary - FSK**

1. Connect the radio FSK and PTT inputs to:
   - the MODEM FSK and PTT outputs and connect the MODEM Serial port to the PC (USB adapter)
     - or, if MMTTY …
   - the RTTY interface FSK and PTT outputs and connect the interface Serial port to PC (USB adapter)

2. If no PC Serial port, then use a USB-Serial adapter.
   - Beware that some won’t key FSK properly.
   - Edgeport USB-Serial adapters are known good.
Decoders

- Dominant soundcard MODEM in use today
- Exceeds performance of most other MODEMs
- Freeware since introduction in 2000
- Written by Mako, JE3HHT
How Do I Set It Up?

**MMTTY standalone**

- Leave UOS on
- Turn off: NET, AFC

Don’t click inside display

received text

transmitted text
How Do I Set It Up?

**MMTTY Option menu**

- **Soundcard levels**
- **MMTTY setup**
How Do I Set It Up?

MMTTY Option/Setup/Demodulator

Set tones (radio same)
How Do I Set It Up?

**MMTTY Option/Setup/TX**

- TX UOS on
- FSK/PTT port
- Soundcard
- Line Out level
- AFSK PTT
- 512 Tap, if PC has perf.
- Select LTR
- TX BPF Tap
- 48 Hz
- Input Button
- 1X1, DEAR, ANS, BTU
- HAM, Set Default (Demodulator)
- Conv. Immediately

**MMTTY Ver 1.66G**

- Demodulator
- AFC/ATC/PLL
- Decode
- TX
- Font/Window
- Misc
- SoundCard
- DIDDLE
  - NONE
  - BLK
  - LTR
- Random
- WaitTimer
- Digital Output
- Char. Wait
- Diddle Wait
- Radio command
- Macs
- Callsign
- W0YK
- 1X2, QANS, SK, RY
- 2X3, M6, BE, M14
- DE3, M7, M11, CQ2
- UR599, M8, M12, CQ1
- CTU
- CONTEST UNIVERSITY

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How Do I Set It Up?

**MMTTY Option/Setup/Misc**

![MMTTY Setup Screen](image)

- **Soundcard**
  - Device Identifiers:
    - RX
    - TX
  - Source:
    - Mono
    - Right
  - Clock:
    - 11025 Hz
    - 0.00 Hz
  - Priority:
    - Normal
    - Highest
    - Critical

- **Soundcard Format, 4x**

- **AFSK**
  - Transmit Port:
    - Sound
  - Source:
    - OFF
    - Int.
    - Ext. (SAT)

- **FSK**
  - Transmit Port:
    - Sound + COM-TxD (FSK)
    - COM-TxD (FSK)

- **System Font**
  - Window:
    - Times New Roman
  - Fixed pitch:
    - Courier New
  - Japanese
  - English
How Do I Set It Up?

**MMTTY Option/Setup/SoundCard**

- **Select receive Soundcard**
- **Select transmit Soundcard (AFSK only)**
2012 CQ WPX RTTY

3550 submitted logs
RTTY Contest Loggers

- **WriteLog** (1994)
  - created for RTTY (CW & SSB came later)
  - [www.rttycontesting.com/tutorials](http://www.rttycontesting.com/tutorials)

- **N1MM Logger+** (2000; dedicated RTTY software designer)
  - Free
  - [www.rttycontesting.com/tutorials](http://www.rttycontesting.com/tutorials)

- **Win-Test** (2003; RTTY is low priority)

*All three integrate MMTTY and have similar functionality for basic RTTY contesting.*
A Blizzard of Details!

Start Simple, then Enhance

- MMTTY *(free)*
  - get RX working *(std audio cable from radio to PC)*
  - get TX working; use either:
    - AFSK *(2nd std audio cable from radio to PC)*
    - FSK *(keying cable or commercial interface)*

- Integrate MMTTY with logging software

- Enhance later
  - Audio isolation *(highly recommended)*
  - Higher capability interface *(DIY or commercial)*
  - Advanced setup: SO2V, SO2R, multiple decoders, ...
Resources

- **www.rttycontest.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/](http://hamsoft.ca/) (MMTTY)
  - [n1mm.hamdocs.com/tiki-index.php](http://n1mm.hamdocs.com/tiki-index.php) (N1MM Logger+)
  - [www.writelog.com](http://www.writelog.com) (WriteLog)
  - [www.win-test.com](http://www.win-test.com) (Win-Test)
- Software Email reflectors
  - [mmtty@yahoogroups.com](mailto:mmtty@yahoogroups.com) (MMTTY)
  - [N1MMLoggerplus@groups.io](mailto:N1MMLoggerplus@groups.io) (N1MM Logger+)
  - [Writelog@contesting.com](mailto:Writelog@contesting.com) (WriteLog)
  - [support@win-test.com](mailto:support@win-test.com) (Win-Test)