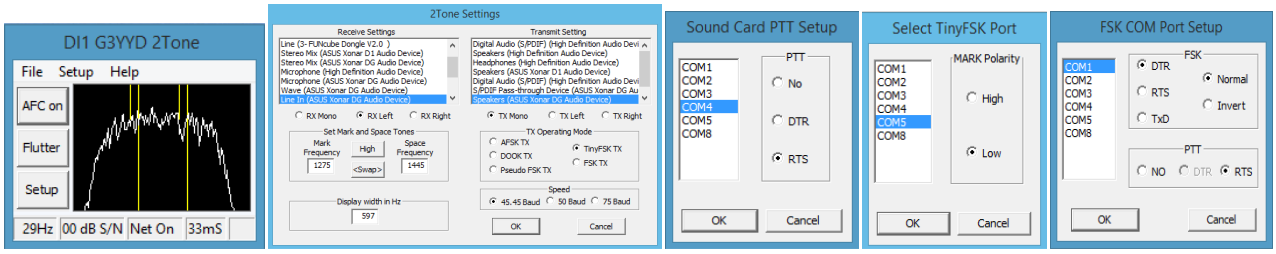
G3YYD's 2Tone, Operational Information



In Use

Top button: toggles AFC on/off. N1MM also controls this button via the Di.
Middle button: optimises the decoder for current signal propagation. Flat is for flat slow fading with mark and space fading at the same time; Flutter for very rapid fading conditions; Selectiv(e) for when mark and space fade independently of each other common on the lower HF bands; Spread not common and more often on the higher HF bands on trans-polar paths - the signal spectrum is spread over a wider bandwidth by the propagation.
Setup button displays the 2Tone settings dialogue, in which clicking FSK TX in TX Operating mode grouping displays the FSK COM Port Setup dialogue.

The FFT display:
Tune the radio so the RTTY twin peaks and the short yellow (or white with AFC off) vertical tuning indicators are near or co-incident with the vertical yellow lines. The long vertical lines are at the set tone frequencies. The displayed band width can be adjusted, click on Setup button, between 449 and 1292Hz at 45.45 baud centred on the tone pair. Bandwidth at 75 bauds is 741 to 2133Hz. It has a 60dB dynamic range and updates every 85 milliseconds at 45.45 baud. **Note** unlike MMTTY FFT the display frequency range is not changed by AFC (Automatic Frequency Control).

Squelch:
Go to Menu Setup, Squelch left click will toggle on/off. Characters are displayed when the signal to noise is 1.5dB or higher. An occasional character will be displayed with a noise input. It takes a while after a signal goes before the output is squelched, this is deliberate to ensure nothing is missed in any replies. When squelched, 2Tone stores the last 4 characters. On squelch opening these characters are sent to the DI followed by newly received characters. Squelch can be disabled go to menu setup, uncheck squelch item.

The AFC (Automatic Frequency Control) gives the best decode performance and will lock onto a signal within 60Hz of the set tones. The status bar - the numeric display along the bottom of the 2Tone window - left hand side shows the direction and value in Hz to tune the receiver to be exactly on frequency. In practice the receiver should be tuned to within 30Hz of the given signal. The AFC will lock onto a RTTY signal that is well below the decode threshold. The short vertical lines at the top of the FFT display shows where the AFC is compared to the set mark and space frequencies. AFC on is yellow while AFC off is White with he decoder tone frequencies unchanged from the set values. When transmitting 2Tone stops updating AFC preserving the AFC value for receive.

Signal to Noise ratio, next to the AFC value in the status bar is the measured signal to noise ratio of the decoded signal in dB. This is an average of S/N measured over several RTTY characters. The threshold to keep in mind is 10dB. Above this the error rate will be reasonable and as it drops below 10dB decode errors will increase very rapidly. Sometimes a seemingly strong signal has a poor signal to noise ratio due to some types of signal propagation. It is a good indicator of why a strong signal has poor decode. A poor quality transmit signal can also have a degraded signal to noise ratio.

NET: It is essential that the N1MM DI, Digital Interface, setup menu has "NET off/on with RUN change ticked". If this is ticked then clicking on the Entry Window's Running box will alter the Net status display in 2Tone's status bar. Unticked (S&P) = "Net ON", Ticked (RUN) = "Net OFF".

Baud Rate: This can be selected in Set up dialogue for 45.45 (normal standard for amateur RTTY), 50 or 75.

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Stop Bit Length: On the status bar fourth in from the left is a display of the received stop bit length. Ideally this should be around 32 to 34 milliseconds. However some RTTY software differs from the 1.5 stop bit standard. Values around 44mS and 48mS are common in contest set ups, but do increase decode error rate. At low signal to noise ratios, this value will move either side of the transmitted value. 2Tone transmit uses the 1.5 stop bit standard.

Receiver AGC: This should be set to slow as fast will confuse the selective fade algorithms and cause AGC generated IMD (Intermodulation Distortion). Normal SSB AGC setting is good but not CW fast setting.

Carrier QRM: Tuning in a carrier without any modulation and little QSB will result in no output from 2Tone, the AFC and S/N will not update. If a RTTY signal is QRM'd by a carrier on one of the tones, 2Tone will often decode the signal correctly even when it is weaker than the carrier. But do not expect miracles!

TX Sound Card PTT: Selecting AFSK, DOOK or pFSK button will open a dialogue for COM port PTT. If VOX or other PTT (e.g. N1MM) is used then select no, otherwise select COM port and output line required

TX AFSK: The use of AFSK transmit audio is preferred as the audio amplitude is constant and with Net on will track the received signal frequency. Ensure the audio input of the transmitter is not overdriven. Use of tone frequencies above 1500Hz is preferred so that audio harmonics are removed by the rig's SSB filters.

TX DOOK: This stands for Differential On/Off Keying of mark and space tones. The signal waveform varies in amplitude and both tones are present at the same time during transition from one tone to the other. This requires the use of a linear transmitter as Intermodulation Products will broaden the signal width. Again use frequencies above 1500Hz.

TX pFSK: The Pseudo FSK setting outputs a 5KHz tone on both left and right channels of the selected sound card. Tone is on for space and off for mark. A suitable detector circuit can be found at https://groups.yahoo.com/neo/groups/N1MMLogger-Digital/files/G3YYD/

The output connects to the FSK input of the rig. **Search & Pounce:** as the transmit frequency does not change with AFC, tune the rig so the small vertical AFC lines are co-incident with or very close to the long vertical lines. Not doing this will result in off frequency transmission.

TX TinyFSK: TinyFSK system developed by Andy K0SM using an Arduino board. Clicking on the button will bring up a dialogue to select COM port and Mark tone polarity. The TinyFSK PTT has to be used. Larry K8UT is in the final stage of development of a compatible system using a Raspberry Pi. There is essentially no timing jitter using this system compared to FSK and so is the preferable version if you have to use Radio based FSK.

TX FSK: This makes use of a COM port's DTR, RTS or TxD lines to key a radio's FSK input used via a keying transistor. Normal keying is -12v for Mark and +12v for Space with Invert being the other way round. Open Setup and click on FSK TX in the TX Operating mode group to open a dialogue for setting Com Port, DTR or RTS and Normal or Invert shift sense. A CPU with 2 or more processors will minimise timing jitter. Excessive timing jitter will cause received character error.

TX FSK with Digikeyer II, microKEYER II, MK2R+ and micro2R (microHAM Router): Clearing the "Stuff" box tells Router (and the "keyer's" controller) that 2Tone will be directly driving the TxD interface line. Failure to do this will result in corrupted FSK. Also make sure that the USB root hub is now shared with other devices, e.g. wireless dongle, disk, drive etc.

TX PTT: This only works on FSK and is selected when FSK is setup. -12v PTT off, +12v PTT on.

RX Sound Card: Select the correct input and tune in a strong RTTY signal. Adjust the receiver and sound card gains so the peaks on the FFT (spectrum display) are about 90% of the maximum height of the display. The FFT has a

degree of AGC (Automatic Gain Control) so that the gain settings are not critical. Beware very cheap sound cards can create their own spurious QRM (I found this the hard way).

Display: 2Tone checks on start up that it is within the display area of your monitor(s), if it is not it will automatically centre itself on the nearest monitor. If the 2Tone window is not visible it is because it is either behind another window on the display or has been minimised. Going to Menu Setup, Topmost on? Checking this item will put 2Tone always on top.

SO2R: More than one 2Tone can be used at the same time by using separate folders for each 2Tone. By using one 2Tone for Di1 and in the Setup dialogue to use line in left and line out left for the left rig with another 2Tone for the Di2 with line in right and line out right for the right rig. This is in conjunction with wiring the left rig to the left Line in/out and right rig with the right line in/out. See also notes under **TX FSK** above.

Play WAV file: This will read in a sound file that has been saved via the 2Tone command (see below) and play it at full PC speed through 2Tone. Just select the file to play and open it. Good idea to clear the Di window before playing. Use it for post contest analysis. Will only play 2Tone saved files.

Save Text: The decoded text can be saved to a file use menu File, Save Text. While saving text this menu item will be checked. To stop go again to File, Save Text and left click. The setting is lost when 2Tone is closed.

Save sound files: As long as the N1MM Logger.ini file is correctly set – see the N1MM install.pdf near the bottom of the first page – 2Tone can be set to save sound files on a per QSO basis. Go to File, save WAV File a dialogue box will open. Use Browse button to set the folder (or create the folder) where the .wav files will be saved. Set recording time before and after the QSO is logged (maximum of 30 seconds). Do this for RUN and also for SnP (Search & Pounce), smaller time values uses less disk space. Then OK. While working, the menu item is checked, click on the menu item to stop saving. File names are in the form YYYYMMDD HHMM SS BB CALL.wav, where YYYY=year, MM=month, DD=day, HH=hour, MM=minute, SS=second, BB=band in MHz, CALL=callsign of logged station. Example: 20130816 2036 39 14 M7T.wav. Saving will only occur for the parent Di. If using SO2R, i.e. Di1 and Di2 are used, and then need to set 2Tone for each Di. Different save folders for the two Dis can be used.

Technical Information

The sound card on transmit is set for 16bits at 12,000 samples per second at 45.45 baud and proportionally faster for 50 and 75 baud. The receive sample rate is 48,000 for all baud rates. On receive and transmit sound card channels are chosen in 2Tone setup for mono, left or right.
2Tone has been optimised to work with 45.45, 50 and 75 baud RTTY and has no other baud setting. Transmit is set for one start bit, 5 data bits and 1.5bit stop length. Bit timing accuracy is as accurate as the sound card sampling rate for AFSK, DOOK and pFSK. FSK timing accuracy is as accurate as the CPU crystal plus some unavoidable jitter caused by Windows operating system.

The receive tone filters used for Flat, Flutter and Selective use 2nd Order Nyquist filters bandwidth of baud rate in Hz. Spread decoder uses a raise cosine Beta=0.5 with twice baud rate bandwidth. Flutter and Spread decoders also use post detection filtering with a bandwidth that varies with the measured signal to noise ratio.
The Selective decoder processes both tones separately using a threshold value derived from signal and noise amplitudes averages and then combined with the current tone amplitude. The individual mark and space tone values are combined to produce a final mark or space result for asynchronous decoding. Unlike standard FSK mark/space determination this system makes use of the absence of signal as well as the presence of signal and by treating the two tones separately and combining them together single tone copy is possible. This is sometimes called in-band diversity.

On transmit AFSK tapered cosine filtering, known as Tukey[1] windowing, of the keying waveform is used to minimise occupied bandwidth. The filtered keying waveform is used to frequency modulate a carrier tone generating a FSK waveform with no amplitude variation.

[1] https://en.wikipedia.org/wiki/Window_function#Tukey_window

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Transmit DOOK uses raised cosine low pass filtering of the keying waveform that then amplitude modulates the mark tone and an inverse keying waveform modulates the space tone. During Mark/Space transitions both tones are present at the same time and the amplitude of the transmitted waveform varies, which will result in some broadening of the transmission due to transmitter IMD products.

While the pseudo FSK mode outputs a 5KHz tone with tone on for space.

The transmit start up sequence is one character length (165mS at 45.45 baud) of space tone followed by one character length of mark tone and then a shift character appropriate to the following printable character. The start up sequence has been optimised for 2Tone type decoders (FLdigi RTTY mode uses a similar technique) and is also suitable for MMTTY type decoders. All transmit characters are one start bit, 5 data bits and 1.5bit stop length.

Configuration settings of 2Tone are stored in 2Tone.ini file in the same folder. If you delete this file programmed defaults will be used until they are changed. Corruption of this file can impact adversely on 2Tone.

More technical information on RTTY modulators and history of technical developments can be found here: http://w7ay.net/site/Technical/RTTY%20Demodulators.

The saving of the sound .wav files makes use of N1MM network UDP broadcast function so that data on each QSO and the current Run/Search & Pounce state can be used. Editing the N1MM Logger.ini file adds port number 12061 and 12062. 12061 is used by 2Tone on Di1 and 12062 is used by another copy of 2Tone on Di2. For more information on UDP broadcast go to N1MM document link:
http://n1mm.hamdocs.com/tiki-index.php?page=UDP+Broadcasts

The version number of N1MM uses YY.MM.VV, where YY=year, MM=month & VV is issue in that month. 2Tone version control is similar YY.MMa. The "a" goes a, b, c etc for each up issue in the month. This is done to show that 2Tone version is not related to the N1MM version.

Peter Martinez, G3PLX was most helpful in guiding me on Windows and sound card programming. Rick Ellison, N2AMG help me overcoming a problem on the N1MM DI/MMTTY interface and Chen W7AY helped on Extended Nyquist filtering.

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