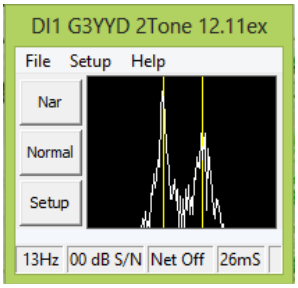
G3YYD's 2Tone - N1MM MMTTY Replacement



In Use

Auto Squelch: Characters are displayed when the signal to noise is 2dB or higher. An occasional character will be displayed with a noise input. It takes w while after a signal goes before the output is squelched, this is deliberate to ensure nothing is missed in any replies.

The Buttons: The top button marked Nar or Wide selects the tone filter bandwidth. The next button down marked Normal or Flutter selects the decoder type and the Setup button displays the setup dialogue.

The FFT display in 2Tone has a bandwidth between 351 and 1294 Hz centred on the tone pair. Use setup to set the bandwidth required. It has a 60dB dynamic range and updates every 85 milliseconds. This FFT is different from MMTTY FFT, it is more responsive and the display frequency range is not changed by AFC (Automatic Frequency Control). You tune the radio so the RTTY twin peaks are co-incident with the vertical yellow lines. Tuning in a RTTY signal feels very natural as the 2Tone FFT display responds immediately.

The AFC (Automatic Frequency Control) is always on for best decode performance and will always lock onto a signal within 65Hz 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 N1MM DI setup menu AFC settings are ignored.

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.

Stop Bit Length: On the status bar third 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. At low signal to noise ratios, this value will move either side of the transmitted value.

NET: As the AFC is always on, 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". At start of N1MM it may be out of sync just click on the Run box twice to correct.

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.

QSB: 2Tone Normal decoder has been optimised for HF use with selective fading. This is when one tone will be weaker or stronger than the other due to multipath propagation. 2Tone will copy with just one tone above the noise. However very rapid QSB often called flutter can confuse the selective fade algorithms. In this case click on 2Tone button Normal to change it to Flutter. But 2Tone will no longer be able to decode with a single tone present so set it back to Normal as soon as conditions allow.

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 Audio: As AFC is always on, the TX frequency has to track the RX frequency during S&P, QED use of TX FSK is not possible and sound card output is used. The use of "AM" transmit audio is preferred as long as the transmitter is suitable for SSB. Ensure the audio input of the transmitter is not overdriven. Set 2Tone to use (audio) FSK TX for a TX with poor linearity.

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.

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.

SO2R/SO2V: More than one 2Tone can be used at the same time by using separate folders for each 2Tone.

Technical Information

The sound card is set for 16bits at 12,000 samples per second on receive and transmit. On receive depending on 2Tone setup this can be for mono or stereo. In the case of stereo 2Tone selects the data for left or right as per setup.

2Tone has been optimised to work with 45.45 baud RTTY and has no other baud setting. Transmit is set for one start bit, 5 data bits and 1.5bit stop length. A bit is 22millisecond long. The timing accuracy is as accurate as the sound card sampling rate.

The receive tone filters used in 2Tone are raised cosine and are optimised for data filtering. The Normal narrow filter is ±22.75Hz at -6dB and ± 45Hz at -75dB. The Normal wide filter is ±30Hz at -6dB and ±60Hz at -75dB. The wider filter allows a wider AFC lock in range. The Flutter narrow filter is ± 45Hz at -6dB and ± 59Hz at -70dB. The Flutter wide filter is ± 45Hz at -6dB and ± 68Hz at -70dB.

On transmit tapered cosine filtering, known as Tukey[1] windowing, is used to minimise occupied bandwidth. In the AM system this filters the amplitude modulation signal while in the AFSK system it filters the frequency modulating signal. The individual tone bandwidth in the AM system is similar to top of the range transceiver on CW. The total bandwidth is wider as this is the equivalent of two differentially keyed CW signals spaced by 170Hz. The AFSK signal occupies a similar bandwidth.

The AM system amplitude modulates the mark and the space tones of the RTTY signal. As one tone reduces in amplitude the other tone increases in amplitude. At mid transition between the two tones both tones are of equal amplitude and phase. This control of phase minimises amplitude modulation during transition and minimises the effects of transmitter non-linearity. AM results in

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

more energy into the narrow receive filters than AFSK(Audio Frequency Shift Keying). FM (AFSK & FSK) sweeps the frequency of an oscillator between the two tone frequencies. In order to minimise occupied bandwidth the modulating signal is filtered so that as the frequency changes slowly from one tone to the other. In (A)FSK a significant amount of the time neither tone filter is receiving transmit energy .

The Normal decoder selective fade algorithm treats 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.

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 you change them, which will then be stored in a new 2Tone.ini file.

More technical information on RTTY modulators and some of the history of technical developments can be found here: http://w7ay.net/site/Technical/RTTY%20Demodulators. By the way MMTTY does not copy on a single tone so does not cope well with frequency selective fading.

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.

David, M7T & G3YYD@btinternet.com
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