

Some Notes on RTTY Signal Quality

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We all want a clean RTTY signal, and it's important to know some of the factors that affect that. What I'm considering here is only AFSK (audio frequency shift keying), where the signal is produced by audio modulation not much different from SSB or the FTx modes. Hardware FSK is a different beast, and we'll leave that for another article.

MMTTY Transmit Bandpass Filter

For those that use MMTTY for RTTY signal generation via AFSK, there is a setting that not everyone knows about. In the MMTTY Options menu, open the Setup MMTTY dialog, and switch to the TX tab (Fig. 1). There you will find a the TxBPF (transmit bandpass filter) settings. Be sure the TxBPF box is checked, and set the Tap value to at least 128. You can click the little "f" button to plot the filter response. The number of taps refers to the length of the digital filter processing buffer in an FIR (finite impulse response) filter. Having more taps is similar to having a higher order analog filter with more L and C components and allows sharper filter skirts. This higher-order filter will make MMTTY produce a cleaner modulation signal.

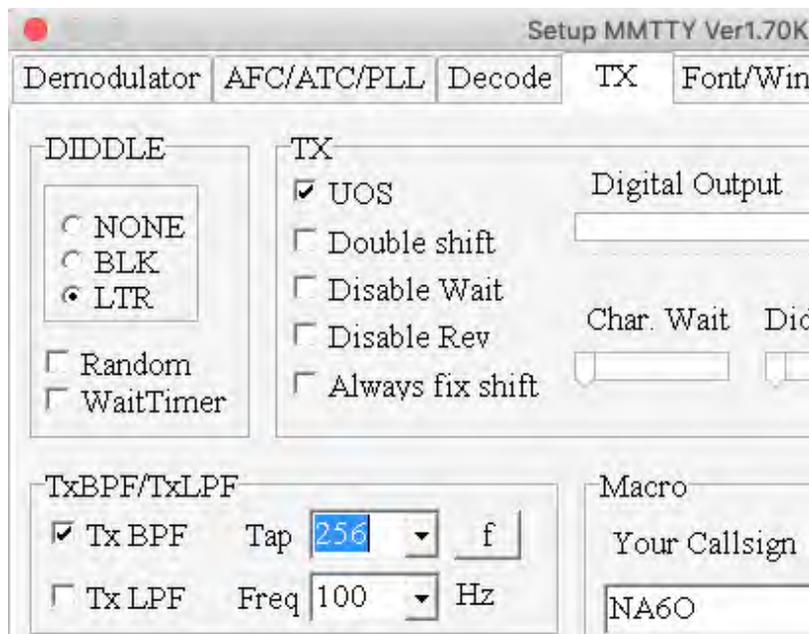


Figure 1. Setting the transmit bandpass filter in MMTTY.

In Fig. 2 I have plotted the actual TxBPF responses for several of the possible settings. Adding more taps clearly reduces the wideband energy. What's the cost of adding more taps? More CPU processing effort. But on today's computers, it's truly negligible. So this is a simple conservative practice to provide your transmitter with the cleanest possible modulation signal.

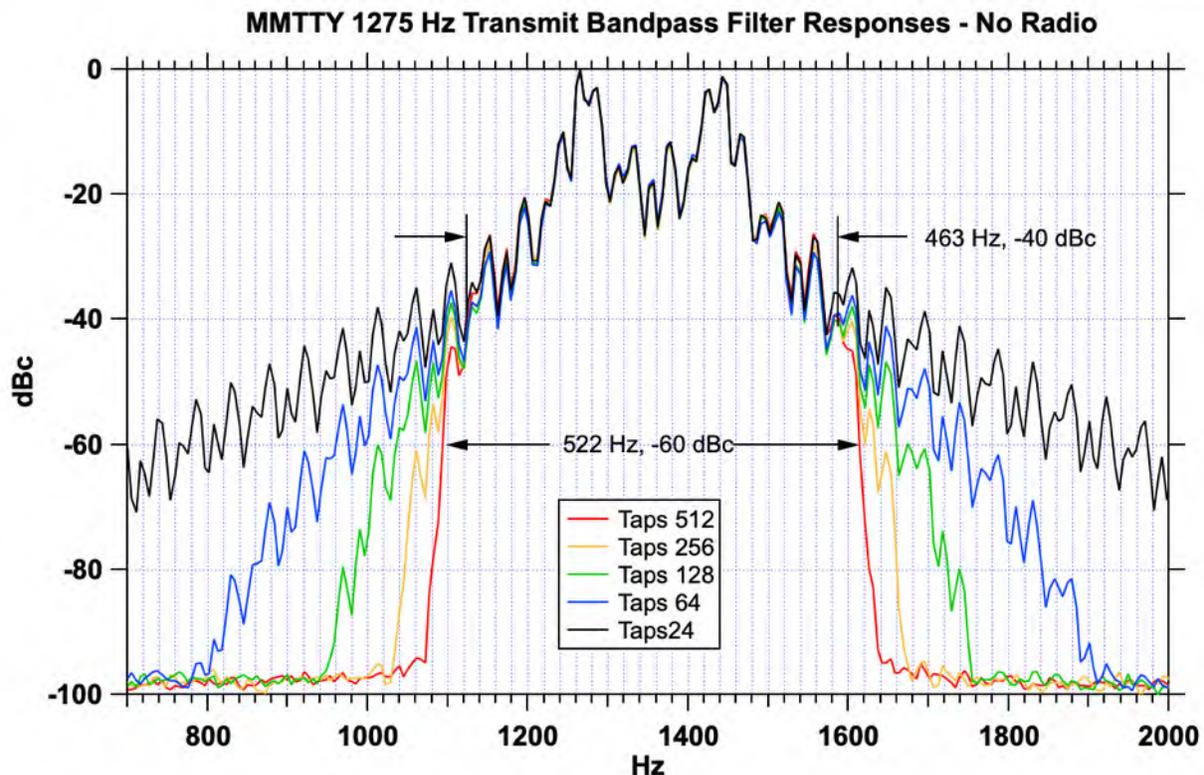


Figure 2. MMTTY transmit audio signal bandwidth for various TxBPF tap settings.

Adjusting Audio Levels

The *really* important setting is the audio modulation level in your transmitter. This is adjusted in several places, which adds more places for Murphy to strike.

1. Windows Sound settings control panel. The sound output device that you are using has a Level control. In MMTTY, there is a menu option that takes you right there: Option >> Soundcard Output Level.
2. The Mic Gain setting on your transmitter. (This may have a different name, depending upon your radio.)
3. If you're using a Flex 6000, there's also a level setting in the DAX control panel.
4. If you're using an external audio DAC such as a Tigertronics Signalink, it may have a knob that adjusts the transmit level as well. Put some tape on that sucker.

All of these are "in series." The worst possible setting is where the first level setting in the chain is way too high, causing something downstream to clip... Disastrous distortion! Your objective is to deliver a clean modulation signal, and to carefully watch the AGC level on your transmitter while gradually increasing the audio level.

I generally start with the Mic Gain knob at 50% or so and the Windows Sound control panel open, with the Level slider fairly low. In MMTTY, there is an RY button that makes it transmit continuously until you click TXOFF. Bring up the Level slider until the proper AGC level is achieved. On the K3, that's four bars steady with the fifth bar flickering. On most radios, it's

where the AGC indicator just barely starts to move but check your manual. After this initial setup, you can dispense with all the many level adjustments and only use the handy Mic Gain for small tweaks.

There is one other thing to check in the Windows Sound control panel: Disable the "Spatial Sound" or other effects. This so-called feature adds all sort of mysterious distortion to audio outputs. You need to get to the lowest-level "additional device properties" dialog to set disable this. And another warning: Windows Updates are notorious for obliterating sound settings, along with COM ports. Always re-check! No wonder I'm a Mac guy...

Radios That Have AFSK Filters

There is another important feature in some radios for AFSK RTTY: An audio bandpass filter, tuned to the selected RTTY modulation frequency. On the K3, you activate it via the AFSX TX menu (it's either on or off). The Flex 6000 automatically does this filtering; I can't speak for other radios. The only drawback to these filters is that you must set the AFSK frequency for the radio to match what you have chosen in MMTTY. If they don't match, you get *no signal at all*. Many have been hopelessly confused by this. Audio in, but nothing out.

This radio-based filter performs the same function as the bandpass filter in MMTTY. Is it redundant? I say no, and here is some evidence. (Fig. 3). I measured the output of a K3 set at 25 W (typical for driving an amplifier) with a spectrum analyzer. A plain carrier is shown for reference and you can see the increase in energy over the full 2.7 kHz transmit bandwidth of the radio when a RTTY signal is applied. What's important is that the extra peaks that appear in the red trace are eliminated by the K3 AFSK filter.

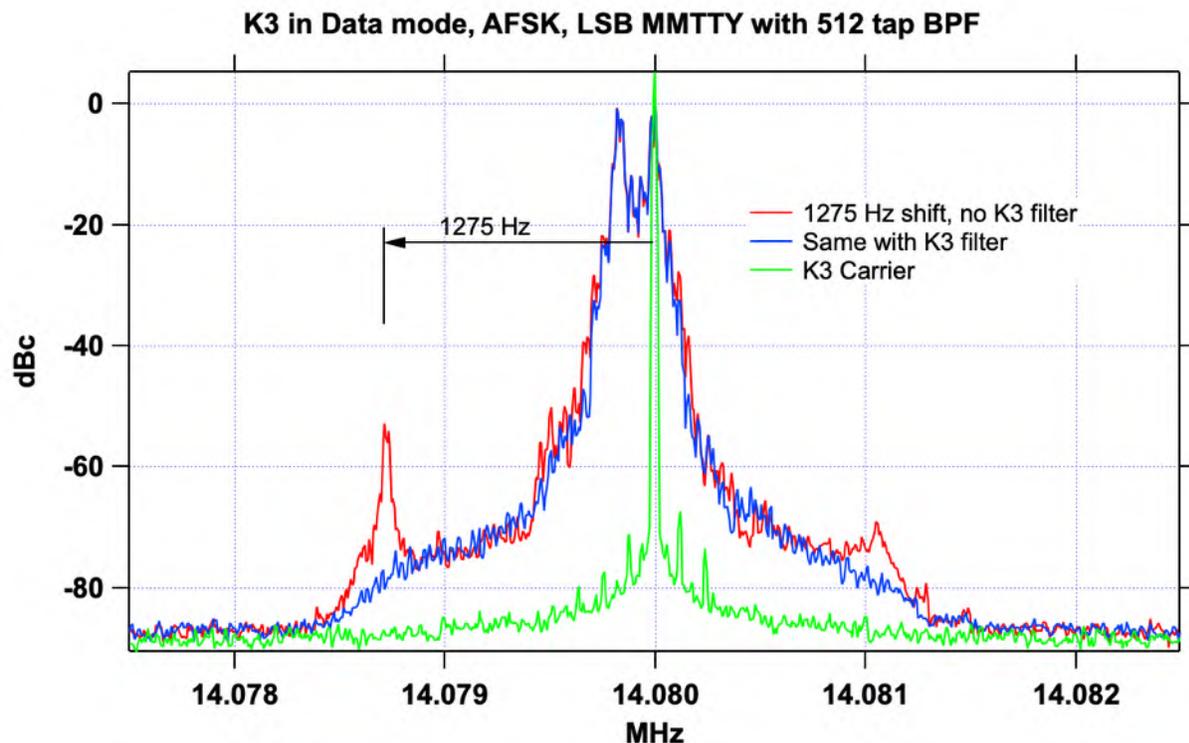


Figure 3. RF output of a K3 at 25 Watts, showing the effect of its AFSK filter.

The Dirty DAC

But it gets even better. What happens if your audio source (DAC) happens to supply signals outside of the audio spectrum? One would think that it would never happen, and even if it did, surely the radio would not respond. FALSE!

As a lifelong analog engineer, I learned to test everything well beyond its ratings, expecting the unexpected. So connecting an RF spectrum analyzer to the output of an audio DAC is definitely my style. Also, I had seen "something funny" when I connected a Behringer UMC-404HD to my K3: Extra distortion on the rig's output. I had on hand several DACs and tested them all. Here is what I found.

Figure 4 shows significant RF output on the UMC-404HD outputs, starting below 100 kHz and extending out to several MHz. Even worse was a little Behringer UA202. The signal you're seeing is characteristic of a modern oversampling DAC where the designer failed to include the mandatory lowpass filter. I looked at the circuit board in the 404 and it was obvious that they had in fact not bothered to implement a proper filter. This is unconscionable and incompetent on the part of the designers. Jim, K9YC, serves on an Audio Engineering Society standards group, and will be using this as evidence for stricter standards.



Figure 4. Significant RF energy is present on all DAC outputs of this Behringer UMC-404HD.

I also checked the built-in audio outputs of my MacBook, a rackmount computer, a Dell laptop, and an Asus Xonar SE PCI board. All were squeaky-clean. But that noisy DAC was driving my K3 nuts. I saw all sort of unexplained spurious audio signals on the rig's output. What must be

happening is that this directly-injected RF energy into the Line In of the K3 is coupling into the modulation subsystems. Here, again, I found that turning on the AFSK filter in the K3 completely eliminated the distortion. So that it is another reason for enabling that filter.

The Final Test

Your final defense against dirty RTTY signals is to have a friend listen to you on the air, preferably with a waterfall display and a receiver that is not overloaded. And don't forget to do it *before* the next contest!