LET'S GET ON FREQUENCY! HOW TO TUNE IN RTTY SIGNALS

BY BILL HENRY , K9GWT

HAL COMMUNICATIONS CORP.
BOX 365
URBANA, ILLINOIS 61801

LET'S GET ON FREQUENCY! HOW TO TUNE IN RTTY SIGNALS

BY BILL HENRY , K9GWT

With the increasing popularity of net-type operations, the RTTY operator often finds himself with a real problem of determining first what his actual RTTY r.f. frequencies are and how they compare with the net "standard." The problem is particularly acute with autostart and mailbox nets where a frequency tolerance of just 10 or 20 Hz must be maintained. The addition of digital dials on our transceivers has both aided and complicated the process. Further complicating the issue is the existence of at least two different ways of specifying the RTTY operating frequency. This article will address both the existing standards and the practical techniques for RTTY operators to set and measure their output frequency.

RTTY Frequency Specification

At present, there are two techniques commonly used to specify the RTTY operating frequency in the 3 to 30 MHz frequency range. U.S. amateurs have long used frequency meters or counters to measure the "rest" or "MARK" radio frequency of the RTTY transmitter. This frequency is easy to determine, since it only requires measurement of the transmitter carrier frequency when the RTTY equipment is in the normal "rest" or "MARK" condition. Furthermore, since the early 1960's, we have all followed the convention of shifting to a *lower* radio frequency for the "SPACE" condition. This was bannered for years in W8CQ's *RTTY Journal* as "LSMFT," or "Low Space Means Fine Teletype." This is the standard that most amateurs still use to this day.

In most commercial and military applications, however, RTTY operating frequency is specified in a much different manner. This standard is to specify the

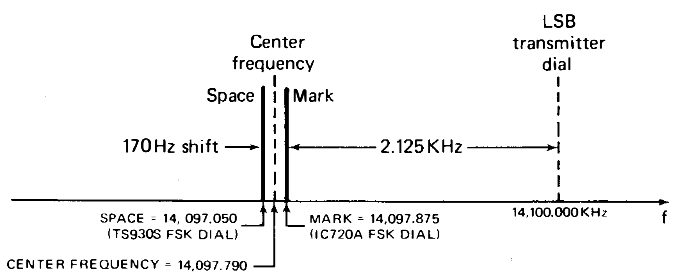

Fig. 1– Frequency relationships for a 20 meter RTTY signal.

center frequency of the "occupied bandwidth" of the RTTY signal. In other words, if you use 170 Hz shift RTTY, the channel frequency would be midway between the MARK and SPACE radio frequencies. This technique makes a lot of sense from a frequency management viewpoint, but is not as easily measured or set up for operation, since the measurable MARK or SPACE frequencies change with the shift selected. Many amateurs discover these problems when they first venture into the Military Affiliate Radio Service (MARS) or when they try to track that elusive shortwave broadcast station.

S.S.B. Transmitters

Most of us on amateur RTTY are using s.s.b. transmitters in LSB (Lower Sideband) mode. Audio tones are connected to the microphone jack to produce the desired FSK output. As has been discussed in previous articles, this output is truly type F1 emission, and it has the advantage of being both convenient and reliable. One of the biggest problems for early RTTY operators was maintaining a standard shift between MARK and SPACE frequencies. This problem has all but disappeared since we started using l.s.b. transmitters, and it is rare to find any amateur signal the shift of which varies by more than a few Hz from 170 Hz. We may determine our output MARK radio frequency simply by using a frequency counter to measure the transmitter output when the RTTY system is in MARK condition, just as we did with a direct FSK transmitter. However, most modern s.s.b. transmitters now include a digital dial readout of "operating frequency." This digital dial is very convenient, but it has greatly complicated and confused the specification of the true RTTY frequency.

Digital Dials and S.S.B. Modes

The modern amateur transceiver includes a very nice digital readout of frequency with an impressive display calibrated in 100 Hz or 10 Hz increments. The high resolution of these dials is comforting to the operator, but in fact it may give some rather misleading indications. First of all, consider that the transceiver and its dial reading are designed primarily for s.s.b. voice operation. The *amateur* standard for specifying an s.s.b. voice frequency is to specify the frequency of the suppressed carrier if it were there. When we use audio tones on an l.s.b. transmitter, the *carrier* frequencies that are transmitted are *displaced* from the digital dial indication. The amount of this displacement is equal to the audio frequency of the tone input.

For example, if "High Tones" are used on an l.s.b. transmitter the dial of which is set to 14,100.000 kHz, the MARK radio frequency output is 14,097.875 kHz and SPACE is 14,097.050 kHz. Thus, the "correct" amateur specification of the RTTY frequency is 14,097.875 kHz, not 14,100.000 as shown on the digital dial. The MARK output frequency is therefore 2.125 kHz *lower* than the dial indication. The commercial or military (MARS) center frequency of this same signal would be 14,097.790 kHz, 2.210 kHz *lower* than the dial. As illustrated in fig. 1, it can be down-right confusing to relate your dial readings to a net frequency specification.

Digital Dials and FSK Mode

Some of the larger (and more expensive) amateur transceivers now include a special FSK mode just for RTTY operation. This can be very convenient to use, especially now that c.w. identification is no longer required (c.w. ID often so complicated the use of the FSK input that many of us chose not to use it). What does the digital dial mean when FSK mode is used? Many different things, it would seem! Some transceivers (such as the ICOM "700" series) show the MARK radio frequency output. Others (such as the TS-930) show the SPACE radio frequency output. Still others (such as the TR7) show a frequency that is displaced by 2.125 kHz! (The TR7 has an "RTTY" mode, but it is in fact a special audio input l.s.b. mode rather than an FSK input.) So, how do we deal with these new variables? The answer is, of course, to read your manual and then make some frequency measurements of your own.

There is another special problem associated with use of the direct FSK inputs on these transceivers. When we used l.s.b. mode with tones, we could be fairly sure that we were transmitting and receiving on the same radio frequency. If our transceiver is correctly set for true voice transceive and if we use demodulator filters the frequencies of which match our transmit tone frequencies, all will be well. However, the FSK mode directly shifts the frequency of an oscillator in the transmit section. When we switch to receive, the transceiver must therefore also switch in a frequency offset so that the tones of our demodulator filters are matched. In the U.S., this offset should be 2.125 kHz to match our standard "High Tone" filters. However, in the rest of the world, the offset should be 1.275 kHz to match the "Low Tone" standard. To date, all of the current models of transceivers I have tested have indeed had the correct 2.125 kHz offset in FSK mode. However, sold outside the U.S. They may be set up for "Low Tones" with a 1.275 kHz offset!

How Do I Get On Frequency?

If you are just interested in normal QSO's on random frequencies, all you really need is a *good* tuning indicator. For most experienced RTTY operators, this means a tuning oscilloscope. A tuning meter such as used on the ST6 demodulator or LED arrays as used on the Dovetron MPC1000 demodulator also work well. A single flashing LED will not get you very close, and two hams with such equipment will often "walk" up and down the band as each station "tweaks" the tuning dial. If you don't already have one, a tuning scope is a very good investment for your RTTY station.

If you want to participate in an RTTY net, you first need to find out how the net frequency is specified. Important parameters are:

1. Is the specified frequency for MARK or for the center frequency of the occupied bandwidth? For 170 Hz shift, there is an 85 Hz difference between the two. Or, is the net frequency specified from the dial reading on an l.s.b. transmitter? This specification will be offset from MARK by the mark tone used (2125 Hz in the U.S.) or by the mid-point between MARK and SPACE from a center frequency specification (2210 Hz for 170 Hz shift).

2. What is the shift used? For amateur transmissions 170 Hz shift is commonly used, but 425 or 850 Hz shift may also be used in commercial and military systems.

3. What is the polarity of the RTTY signal? "Normal" amateur RTTY polarity is to transmit MARK as the higher radio frequency (LSMFT). On an s.s.b. transmitter, use l.s.b. mode for the standard 2125 Hz MARK/2295 Hz SPACE demodulator filters. In commercial and military systems, a "reverse" polarity is often used.

4. How does your equipment dial reading relate to the actual frequency transmitted for MARK? An l.s.b. transmitter's dial will read 2.125 kHz higher than the radiated MARK frequency. FSK transmitter dials may read either MARK or SPACE frequency.

5. Is your transceiver dial accurately calibrated? Most digital dials do *not* read the actual r.f. output frequency, but instead measure the frequency of an intermediate oscillator. The dial accuracy is therefore very dependent upon an accurate alignment of one or more heterodyne oscillators. Check receiver calibration against a standard radio signal (WWV, etc.) and use a frequency counter to check the transmitter output frequency.

6. If you use an FSK input to a transceiver, does the receiver offset match your demodulator filters? For U.S. use, the offset normally will be 2125 Hz.

Once all of the above parameters are known, you should be able to do some simple calculations to determine your correct digital dial reading. Some examples are:

1. K4CZ operates an RTTY mailbox on 40 meters. He specifies that the MARK radio frequency should be 7096.500 kHz. If you have an l.s.b. transmitter and use a "High Tone" demodulator, the correct dial reading will be 2125 Hz higher, or 7098.625 kHz. If you use FSK on an IC-720A, for example, the dial will read 7096.5 kHz; a TS-930 dial in FSK mode will indicate 7096.33 kHz, the SPACE frequency.

2. A 20 meter net of mailbox users operates on an l.s.b. dial reading of 14,087.80 kHz. Actually, the net frequency has been defined by KØVKH as 14,085.625 kHz. Therefore, the correct dial setting for an l.s.b. transmitter is actually 14,087.75, which will be rounded to 14,087.7 or 14,087.8 if your dial has only 100 Hz resolution. An IC-720A used on FSK should be set to 14,085.6 kHz; set the TS-930 dial in FSK mode to 14,085.46 kHz.

3. Suppose a MARS net is to operate on a CENTER frequency of 13,995.500 kHz, 850 Hz shift, with MARK as the higher radio frequency. The MARK frequency is therefore 425 Hz above the center frequency, or 13,995.925 kHz. The l.s.b. transmitter dial should be set to 13,998.05 kHz. The IC-720A dial would be set to 13,995.9 kHz (MARK frequency); the TS-930 dial would be set to 13995.08 kHz (SPACE frequency).

Conclusions

It can be seen that there are at least two different ways that the same RTTY operating frequency can be specified. Also, the digital dial reading of your transceiver may *not* agree with this specification. However, the correct dial setting can be calculated simply once all of the parameters have been defined. The calibration of the transceiver dial and the alignment of its internal oscillators can greatly affect the relation between dial reading and the actual output frequency. Also, not all FSK circuits behave the same, and dial readings may vary between brands of equipment used. If you use an l.s.b. transmitter, the dial reading will be different from that of an FSK transmitter and will also be different between stations using "HIGH" or "LOW" tone demodulator units.

When receiving, there is *no* substitute for using a *good* tuning indicator. An oscilloscope has been the traditional tuning indicator for RTTY; some meter and LED array indicators also work well. A flashing light impresses visitors, but gives you little tuning information. When setting and checking your transmitter frequency, a frequency counter is very desirable. If the calibration is known, a second communications receiver or a heterodyne frequency meter (such as the BC221) also may be used. In order to get on frequency and then stay there, you must know your equipment and be able to check it.

(Reprinted by permission of CQ.)

HAL COMMUNICATIONS CORP.
BOX 365
URBANA, ILLINOIS 61801