DIGITAL COMMUNICATIONS

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Disclaimer:
These are my comments on digital communications and are not necessarily all there is to know on the subject. As with everything computer related – there are at least six ways to do the same thing. Given this caveat, let me say this is opinion and not the complete story. I only relate to you my experience of 5 or more years using digital modes to give you the benefit of my experience. I will leave the rest for you to research as you see fit.

MT63

MT63 is a text only digital radio modulation mode for use in high noise/high reliability situations. It was developed by ***Pawel Jalocha***, ***SP9VRC***. MT63 is perhaps the most elaborate user of error correction techniques of all ham radio public digital modes. It uses a very efficient error correction method that uses character redundant sequences over several data packets. It has ***64 tones*** spaced ***15.625Hz apart***, in the ***1kHz bandwidth***. It is so efficient that even if 25% of the character sent is obliterated, it will give perfect copy. This method of spreading characters from multiple words over several packets is known generally as **F**orward **E**rror **C**orrecting. The FEC error correction employed by MT63 uses a Walsh function that spreads the data bits of each character across all 64 of the tones of the signal spectrum and simultaneously repeats the information over a period of 64 symbols (at maximum interleave) within any one tone. This takes 6.4 seconds. The combination results in superb impulse noise rejection. At the same time, in the frequency domain, significant portions of the signal can be masked by unwanted noise or other transmissions without any noticeable effect on successful reception. In fact, during tests conducted by MARS, data and voice transmissions were successfully received at the same time within the same audio passband. Transmission speed is good because there are so many individual tones to describe the information, while the individual symbol rate per tone can remain slow (which is good protection against QRN).

When conditions are good and audio bandwidth is not an issue, MT63 (particularly the 2 kHz version) using the "long interleave" setting is the best mode to use. The data rate is very rapid and the multiple use of error correction techniques results in the most robust broadcast mode readily available to the amateur at no cost. Although it can be a little tricky to identify by ear or on the decoder waterfall, the mode has a generous tolerance to tuning inaccuracies and its immunity to impulse noise is second to none. General wide band noise is also well tolerated as is coherent noise (e.g. a single tone) in band.

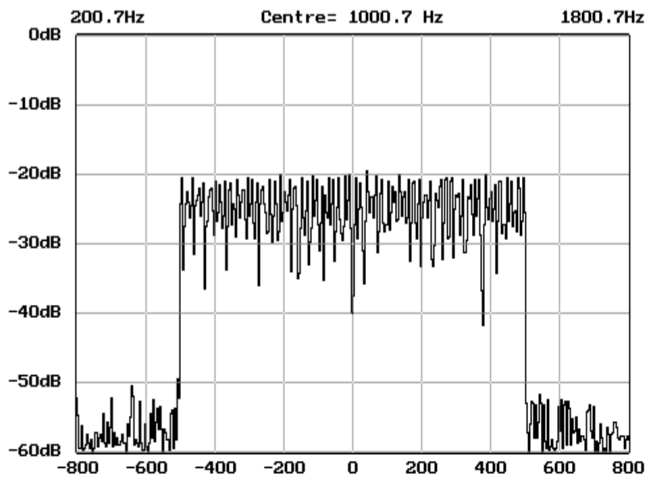
Unlike most HF digital modes where a character can be lost or changed into something else, by a single noise burst, MT63 is inherently very robust, because each character (or symbol as it is sometimes referred to) is spread over many tones (to avoid interference such as other radio transmissions) and over several seconds (to avoid bursts of noise, such as lightning).

MT63's COFDM like properties

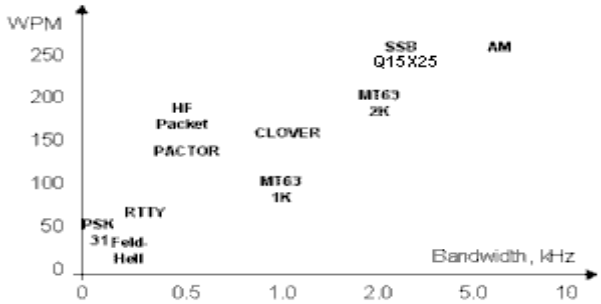
- The MT63 signal is spread both in the time domain (temporally) and the frequency domain (spectrally). To ensure that noise bursts and other time domain interference artifacts have minimal effect, each encoded character is spread over 32 sequential symbols (3.2 sec).
- To ensure that frequency domain effects, such as selective fading and carrier interference have minimal effect, the character is also spread spectrally by using all the tones across the width of the transmission.

- On each of the 64 tones, the transmission data rate is fairly slow, which suits the nature of ionospheric disturbances.

Despite the relatively low data rate, good text speed is maintained, because the text is sent on many tones at once. The system runs at several different speeds, which can be chosen to suit conditions, but 100 WPM is typical.



MT63 sounds unusual, (it sounds like a roaring noise) but the performance is spectacular. It is an asynchronous mode, meaning there is no connection process, as in AMTOR, Packet or PACTOR. Some users maintain that under poor propagation conditions (namely excessive fading) MT63 works better than either PACTOR II or Clover. Under good conditions the performance advantages are less obvious. If the receiver audio passband is of high quality and linear across the entire demodulator audio passband, decoding in high noise situations is of much higher performance. As with other multi-tone modes where many sine waves are transmitted side by side, the transmission audio circuits should be of high quality and with linear gain across the entire audio passband (i.e. no mid-band peaking as with older rigs) to minimize IMD and other passband distortions. The included illustration shows the audio passband spectrum of MT63 in wide band mode. This passband pattern is typical of modern digitally capable ham rigs of medium to high quality.



Performance Comparison With Other Modes

There are disadvantages to MT63. First, the mode is broad and is quite aggressive, (i.e. it causes interference to other modes) but itself is little affected by other modes. MT63 is also far more immune to interference and deliberate “jamming” than any of the more conventional modes. In the long-interleave option, the spreading is over 64 symbols (6.4 sec), with consequent improvement in resistance to impulse and periodic interference, but of course double the time taken for the data to "trickle through" the Walsh encoder and decoder pipeline. Changeover from transmit to receive and vice-versa is therefore considerably slower than most modes due to the data latency in the decoder. It therefore requires some skill and patience in a QSO as it is not a “break-in” mode as you would think of CW or PSK that have virtually no latency time. Correctly decoded text can take up to 15 seconds to appear on the screen. A clue to synchronized reception can sometimes be gleaned if the software has a digital squelch facility. If the squelch is set up to be closed when no MT63 signal is present, it can often be seen to open as soon as it finds MT63 and ideally the text will follow quite a number of seconds later! In order to make the decoder start printing valid text as soon as possible, software should be chosen that has an effective squelch, so as to minimize feeding the decoder garbage before valid text. Latency in this mode is considerably longer than other 2FSK or multi-afsk modes like MFSK16. For instance the shortest latency time for MT63 is 3.2 sec. in short interleave 2K transmission mode. The latency time for RTTY is 330 ms. Unlike OLIVIA and MFSK16 the narrower 500 Hz operational modes are much slower using MT63 than the wide (2K) mode. Olivia is several times faster and more noise tolerant in the narrow band mode yielding a lower latency, while MT63 becomes much more

robust and has a shorter latency time in the wide band mode. Accurate text copy can be obtained from MT63-2K when the tones are near or below the noise level under optimal conditions similar to PACTOR III, although at a much lower text throughput.

MARS has adopted MT63 as a primary mode for ALE operations between other MARS stations. Alternately, PACTOR II and III are used where available. The fact that MT63 is the normal mode for MARS normal digital communication speaks to the reliability and accuracy of this protocol. Military frequencies are not as restrictive (as far as bandwidth goes) as are amateur bands. Nonetheless MT63 can be an important player in emergency communications where adverse conditions exist and where cost may be a factor. Data throughput is well above most keyboard chat modes and exceeds PACTOR I. Partnered with Automatic Link Establishment (see: www.hflink.com), MT63 serves MARS and many branches of the military as the backbone of their digital network. Currently, it is not a significant player in WinLink 2000 system techniques.

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Just stay with us for more next month on other interesting digital modes. We will have something for you as we go along. If you missed some of this, I will make a printed version available if you email me a request.

I am also a technical specialist so you can email me with your technical questions and problems as well.