CTCSS and other tone-related Acronyms

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If you have a relatively new two-meter radio, say made within the last ten years, you probably have seen references to tone coding in your operating manual. You may have a number of tone schemes available to you, or perhaps just one.

If you have but one, it's likely the scheme that Motorola came up with in the early 1960's to allow multiple land mobile customers to utilize the same frequency at almost the same time. This system is based upon the theory that different groups of customers could coexist on the same frequency if they did not have to listen to each other routinely.

The premise of the system is that a tone is continuously generated by the transmitting station on a pre-arranged audio frequency. If the tone decoder on the repeater detects the presence of the desired tone, it opens the squelch of the receiver and allows the signal to pass to the transmitter to be repeated. If no signal is present, or the wrong signal is present, the receiver ignores the signal and nothing is passed on to be repeated.

The decoder function is also utilized on the individual land mobile units such that the user did not hear anything on the frequency unless it was addressed to him. In such an installation, placing the microphone on its hanger turns the decoder on, and thus mutes the receiver. When the operator picks up the mic, the decoder is disabled and the receiver now hears everything within range. If nothing is heard, the call is made. If another signal is present, the user listens until the traffic clears prior to calling. Base station mics had a "monitor" button next to the PTT button to disable the decoder, allowing the operator to check for a clear frequency before transmitting.

Motorola utilized the resources of Bell Labs and EIA to define the codes. (EIA is the "Electronic Industry Alliance" – an industry standards group recognized by the American National Standards Institute which commonly sanctions design standards for systems utilized in the electronic industry. Much of the audio levels, impedance standards, equalization curves, etc. utilized in the HiFi/Stereo industry were sanctioned by the EIA). A system of 32 codes was devised, choosing frequencies that had no harmonic relationship to each other to prevent falsing the system into accepting an unwanted signal. The list of codes has presently grown to approximately 50, with a few nonstandard ones here and there. Fortunately most all of the ham equipment manufacturers utilize the same codes in their equipment; however, some manufacturers such as Icom omit some codes in their commercial equipment. Be aware that if you purchase a commercial radio for use on the ham bands, you may not have a full set of codes ("PL" frequencies).

Although the system was patented by Motorola, the use of the tones was not, and before long all of the major manufacturers had tone-encoding systems. Motorola called theirs "Private Line" or "PL". Other manufacturers were quick to follow and came up with such names as "Channel Guard," "Quiet Channel," and "Call Guard".

As the amateur radio community began to build repeaters in the early 1970s, it was inevitable that the "PL" concept would indeed come along with the surplus commercial equipment finding its way onto two meters. With the low density of repeaters and the few users encountered in the 1970s, the "PL" function was not needed and was turned off in all but a few amateur systems. Most of the systems utilizing "PL" then were "closed" and only members with the correct tones could access the system.

As repeater density grew, along with the crowding of the VHF and UHF spectrum, the CTCSS system became a valuable tool to reduce the occurrence of intermod and unwanted interference from nearby systems operating on the same frequency. About ten years ago, most of the new amateur equipment offered tone encoding as a standard package. More recently, equipment is also sold with decoders as standard features. Our two-meter repeater imposes a tone code on the output frequency of 147.240 mhz. This tone is 131.8 hz. If you turn on your decoder to recognize this tone, you will hear only the repeater, no intermod, no extraneous signals that are not coming through the repeater. It quiets the mobile system down nicely and you may wish to try it if your radio has tone decoding. The CTCSS system is now over

40 years old and newer systems are emerging for use in both commercial and amateur service. Most VHF and UHF amateur equipment sold today also provides DTMF tones and DCS (Digital Coded Squelch) encoding. Some manufacturers, such as Kenwood, have hybrid systems that provide specific coordination functions between two compatibly-equipped stations such as automatically QSYing to open frequencies and call sign identification.

DCS is digital data that is transmitted with the voice audio. This data is sub-audible with most of its energy below 300Hz and uses digital data or code words. Each code word is unique and all code words may be used on the same channel without interference. At the end of the radio transmission and about 1/2 second before the transmitter un-keys, the radio will encode a 134 Hz tone that serves as a turn-off code.

Unlike CTCSS, DCS signal spectrum occupies considerable more bandwidth. A poor low frequency response in the transmitter or receiver may not seriously distort a single frequency tone signal but may seriously degrade a wide band signal containing multiple frequency components. Low frequency response is the primary requirement for DCS systems.

Also, it is extremely important for the receiver and transmitter to be on frequency to achieve maximum performance of the DCS function.

Some of these restrictions have made DCS less attractive to the amateur community which is still running 20 and 30 year old equipment particularly at repeater sites. However DCS systems are becoming popular for the General Mobile Radio service (GMRS), and even the Family Radio Service (FRS).

Another tone system most often included on VHF and UHF ham gear is DTMF which is short for Dual Tone Multi- Frequency, the system used by touch-tone telephones. DTMF assigns a specific frequency (consisting of two separate tones) to each key so that it can easily be identified by a microprocessor. These tones are seldom utilized for keying the repeater, but are often utilized for selecting features on a repeater such as IRLP, remote base operation, special announcement access, general repeater control, auto-patch, etc.

Well, that is probably more than you wanted to know about tone systems. However, be aware that these systems (especially the CTCSS or PL tones) are going to be an eventual requirement for operation on two meters and 440. The Oregon Repeater Coordinating Council, which also coordinates the repeaters in SW Washington, has determined that all new repeaters will have tone encoding. This action is intended to eliminate false keying, intermod, and general kerchunking that too often occurs in our hobby today. Fortunately, the newer rigs have tone decoders such that you can scan a repeater that is being utilized with the proper tone-encoded signal by the station transmitting on the input. That scanner will then tell you the required tone.

In the meantime, you can look up the required tone in the repeater directory. If you have the electronic version of the repeater directory (Travel Plus for Repeaters), it is possible to electronically cut out information from their data base and plug it into an Excel spreadsheet. If you were to manipulate such a data base to list all repeaters within a 100 mile radius of Vancouver, you would find that there are 81 two-meter repeaters and 105, 440 mhz repeaters listed (coverage in a circular plot centered on Vancouver with northern boundary at Tacoma, southern boundary at Eugene, eastern boundary near Biggs and the western boundary the Pacific Ocean). Of the 81 twometer repeaters, 31 are tone input (38.3%) while also 31 of the 105, 440 mhz (29.5%) require tones for access. Most of the tones utilized fall in the center of the spectrum defined in the CTCSS frequency table. So if you are trying to locate a tone via trial and error, try those between 88.5 and 179.9 hz.

One final precaution relative to tones should be noted for the buyers of used equipment. If it doesn't have tone capability, it will be obsolete soon without an aftermarket tone generator. Also watch out for commercial equipment which may not have a full set of tones that are commonly utilized in ham radio. A full set is generally considered to be 50 CTCSS tones, 16 DTMF (the standard 4 x 4 telephone keyboard) and 105 DCS code words.