

A look at a national standard for CTCSS on repeaters

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At Convention 2007, the subject of choosing some standard tones for use on repeaters was suggested¹, and since that time the Group has called for input from interested people. A number of responses were received, and a small forum at a Group meeting also talked through the ideas. I took on the job of collating and analysing the input, and reporting back.

The outcome at the moment appears that the conflicting reasons for implementing CTCSS make it unlikely that a standard could be achieved, and we received input that was against the use of CTCSS.

This paper will cover the main points of input received, as there is some value from understanding the various points of view and the reasons for the suggestions made.

What is CTCSS?

Continuous Tone Coded Squelch System (CTCSS) came from the commercial radio world to enable multiple customers on a single channel, without each customer having to hear all the chatter from the other customers. It is variously called² :

PL™ is the Motorola abbreviation for "Private Line™".

QC is the RCA abbreviation for "Quiet Channel".

CG is the General Electric abbreviation for "Channel Guard".

I have also heard it called sub-audible tone squelch, which is a good descriptive name.

It works by having a specific tone added to the audio, and the receiver decodes this tone and opens the receiver squelch. It is also possible to have dual mode squelch³, where a CTCSS tone opens the squelch, or a relatively strong signal opens the squelch.

There are a few tables of standard tones, and most ham VHF and UHF radios have been equipped with encode on the transmit side for decades, and it is almost standard on the receive/decode in modern rigs. The 1986 Wellington VHF Group issue of Break-In discusses tone usage.

CTCSS is a single, sub-audible (less than 250Hz) tone. The standard Electronic Industries Association (EIA) frequency codes, in hertz, with their Motorola alphanumeric designators are found in various places on the internet.⁴ These EIA tones have been extended, so there is not 100% agreement on the "standard" tones.

One problem the commercial users found was that if you cannot hear other users, people will attempt to talk when the channel is in use. A common trick to prevent this was to have the microphone mount earthed, and when the mic was picked up, the tone squelch was disabled, so the

1 <http://www.vhf.org.nz/node/62> (Under CTCSS on the home page of the Wellington VHF Group)

2 <http://www.metrocor.net/ctcss.htm>

3 <http://www.dra73.org/pl.html>

4 A good description and the tones of various standards explained is at <http://www.geocities.com/euro446/ctcss.html>

user could hear all the traffic. This reduced the number of missed messages due to “doubling⁵” on the channel. Another problem is the delay in decoding, causing missed words at the start of a call.

Why Hams want CTCSS:

This is where the subject gets interesting, and where we found that different reasons were calling for the same solution.

Generally, CTCSS was being proposed as a solution to QRM type signals, being signals from non-amateur sources. This is sometimes RFI from devices like switch mode power supplies and other modern devices. Other times they are illegal users, such as wireless head phones and speakers, that should not be imported into the country. And worst of all are the legal devices, the Short Range Devices (SRDs), that are legal and here to stay. (These caused the need to re-engineer the National System in 2006/2007). The 433 MHz band has an allocation for these and we must live with them (as long as they meet the specs of their GURL, see end note).

Another use for CTCSS is the one that is widely used overseas. This is where frequency allocation has not done a perfect job, and users from a distance are accessing a repeater that they do not intend to. This causes noisy signals, or half a conversation (or both!). CTCSS can be used here by the users to select which repeater they want to use, and the other repeater does not get triggered. Or more likely, the user doesn't have CTCSS on and the repeater is left silent until a user who is either strong or has the tone encoder set uses the repeater.

Of course both of the above uses can be used on the mobile end of the system as well. Here the repeater would transmit a CTCSS tone, and the user can block out local noise or the undesired repeater. This does not solve the interference problem- if a local repeater is triggered, it will capture the receiver and the remote repeater will not be heard, despite the use of CTCSS.

In New Zealand, careful frequency planing⁶ minimises this problem, but it is still possible from some areas to access more than one repeater on a single frequency. In most cases you need to be on a very high site, and/or remote to both repeaters for this to happen.

And a third use is really the original use- a “private” channel! This has been used for decades in New Zealand, and can cause interesting conversations, where one party only hears one other user!

Overseas the CTCSS tone is sometimes used to create private repeaters, where the tone is not advertised. To date this is generally not considered suitable practice in New Zealand.

We did not receive comment on the use of CTCSS in linking, but this is also a common use, but does not require a standard. Multiple tones at once could be an issue in these cases.

So the problem is?:

If you want tones to reduce co- channel interference, that is great, use different tones on each repeater on the same frequency.

If you want it to stop the “noise”, people want a single tone (or a simple set of tones) to be used. To standardise the first aim would cause users to have to program a frequency and tone for each

5 Where two users talk at the same time

6 FMTAG perform this task for NZART and other amateurs in New Zealand.

<http://www.nzart.org.nz/nzart/nzart/fmtag.html>

instance of a frequency being used. For the second aim, hams have requested a common tone either across NZ or at least across a region, such as the old ZL1/ZL2/ZL3/ZL4 areas. A look at the repeater maps on the NZART website⁷ or in your Call Book will show this to be a unworkable solution, as radio waves do not stop at NZPO boundaries! There is a good degree of re-use in New Zealand, and much of this is based on repeaters being engineered as either “local coverage” or “wide coverage” in their applications for co-ordination. Many high sited repeaters cover multiple districts.

Other groups around the world have tried to manage this problem, and here is an example of guidance on a website⁸ that shows the problem of CTCSS co-ordination. The first paragraph below pleads for CTCSS. The second pleads for standardised tones, which would somewhat defeat the reason for CTCSS given in the first paragraph!

“MetroCor strongly recommends the use of PL on repeaters' receivers. PL is a minor inconvenience when you consider how many potential problems it can eliminate. The use of PL may be required for a coordination to be granted if conditions so warrant, such as proximity to a co-channel repeater, or in an area where band openings frequently aggravate co-channel interference problems.

MetroCor hopes that repeater owners / trustees in a given area will standardize on a particular PL tone and incorporate it into their operational plans. The reason for this is to make it easier for users to operate the local repeaters in an area, as some older radios are only capable of a single PL tone as compared to modern radios which can have PL tones selected on a per-channel basis.”

Of course the users figure it out, but the two aims do work against each other!

Some proposals and comments:

The National System Specifications⁹ do not allow for CTCSS on stations of the National System, and all input that mentioned the NS agreed with this requirement. In the past, CTCSS was called for to solve the SRD problem, but no input for was received in this round of discussion.

Use of “good” tones. Higher tones decode faster, but can be heard in some cases. Stay away from 100Hz! (or other 50 Hz multiples). 88.5 Hz and 123 Hz were both suggested as “good” tones.

Use the same tone in an area. Makes it simple, unless you move around, but dual mode squelch will solve this in most cases. This will require some co-ordination, but is a good aim.

If you use CTCSS on the repeater, make it Dual Mode Squelch.

Don't use CTCSS, as it hides problems of interference until they are so bad that you have to move frequency. Examples of un-usable repeaters (overseas) were given, where the noise has got so bad that the repeater was effectively deaf. CTCSS make the repeater quiet, but useless. The suggestion is to only turn on CTCSS when a problem occurs, and chase the problem. But those against argued the problem would not be chased, and suddenly users would find the repeater required a tone when it hadn't in the past.

7 Refer to the repeater maps at <http://www.nzart.org.nz/nzart/repeaters/index.html>

8 <http://www.metrocor.net/ctcss.htm>

9 These are available from the Wellington VHF Group. Email Z12WA@clear.net.nz if you would like a copy.

Have CTCSS on the output of (all) repeaters, and always make it the same as the input tone if one is present. Others suggested having one output tone for the entire country.

Allow trustees to choose a tone with regard to other repeaters on the frequency. Dual mode squelch would be required in all cases. Publish the tones in Call Book.

Next Steps:

The aim of this paper is to present the ideas put forward, and to see if there are more comments or proposals that we can consider. The working group is always happy to hear your comments and ideas.

Before the next VHF Convention, we would like to publish an updated paper, which would cover the current implementations of CTCSS in New Zealand, as well as some possible extensions to what is already working. This would allow us to move towards a published standard or guide for trustees and users.

Thanks and request:

Thank you to all the hams that responded and provided input at the meetings and via email.

As we have not been able to meet our goal of defining a standard for CTCSS usage, we encourage trustees to continue the discussion and information sharing on this subject. Future input will be collated and summarised for the next VHF Convention.

Input can be sent to ZL2WA@clear.net.nz with CTCSS in the subject.

End note:

From the SRD GURL

Radiocommunications Regulations (General User Radio Licence for Short Range Devices) Notice 2007, Schedule 1,

| Frequency Range | Peak Power | Designated Use |
|-----------------------|--------------|-----------------------|
| From: (MHz) To: (MHz) | e.i.r.p (mW) | |
| 433.05 434.79 | 25 | Telemetry/Telecommand |
| 444 444.925 | 25 | Biomedical Telemetry |