How and Why We Use CTCSS (PL) in Amateur Radio

Presented by N7MOT – Lenny Gemar

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Covering the history, technical reasoning and details, and uses of Continuous Tone Coded Squelch System.

CTCSS – Continuous Tone Coded Squelch System

aka

- PL – Private Line (Motorola)
- CG – Channel Guard (GE)
- QC – Quiet Channel (RCA)
- ETS - Electronic Tone Squelch (Canadian Marconi Company)
- Quiet Call (Ritron)
- Call Guard (EF Johnson)
- Quiet Tone (Kenwood)

The generic name CTCSS and the EIA RS-220 standard followed much, much later.

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PL was invented in the 1950s by adding a low frequency tone to a transmission that could be used to selectively unmute a receiver.

PL was originally introduced in products around 1952 with 10 distinct tone frequencies ranging from 100.0 cps to 254.1 cps. (Cycles Per Second was later replaced in electronics lexicon with Hz.)

As different manufacturers began using the method, the variety and number of tones grew from 10 to as many as 64.

Commercially PL was supplanted in many areas by DPL or Digital Private Line, aka DCS in many new amateur radios. Though 512 codes are available, only 83 are recommended to prevent falsing.

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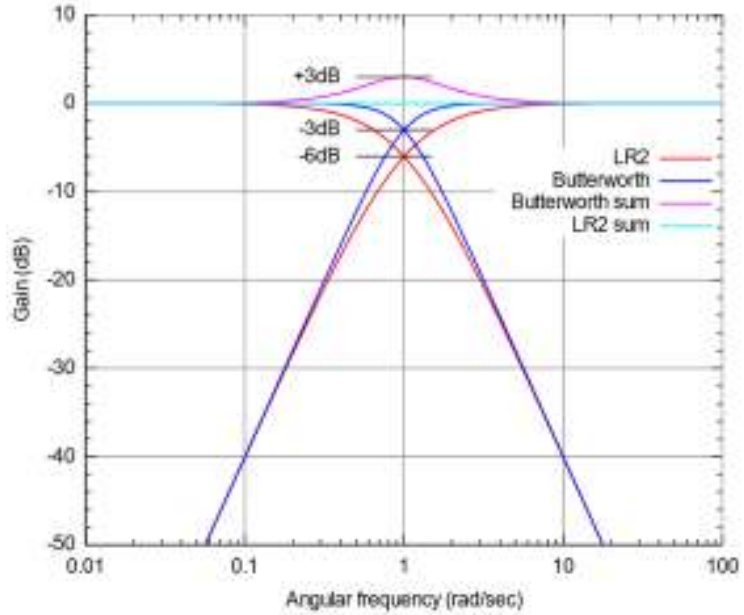
A properly designed FM radio will filter microphone and speaker audio such that end users don't hear the tone. This is done at the transmitter by limiting the frequency response of microphone audio and at the receiver audio amplifier. Voice frequencies are normally held to between 300 Hz to around 3,500 Hz (many radios stop at 3,000 Hz while others extend to 4,000 Hz.) The high end is less important than the low end, since the PL tones will be below 250 Hz.



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PL encoders and decoders were originally mechanical vibrating reeds. The original mechanical vibrating reeds were large and cumbersome. They also tended to be sensitive to road vibration.

The original “Banana” reeds.

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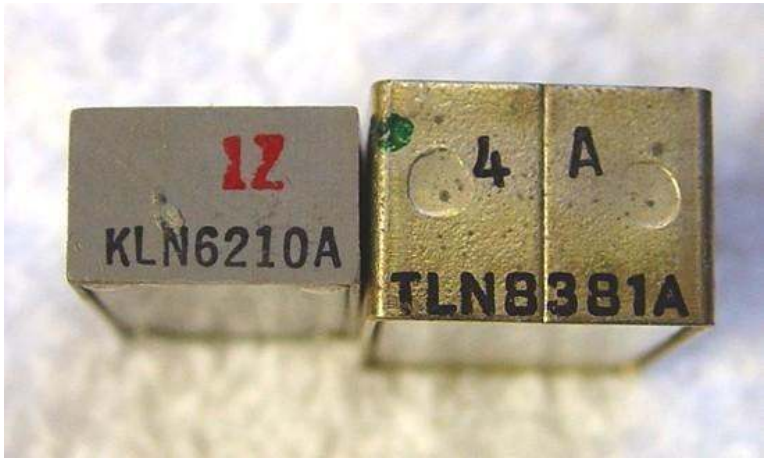
Bramco Corp created a contactless mini-reed. This reduced the vibration issue and facilitated use in portables (Handie-Talkies or HTs).



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As technology improved, semiconductor versions were developed that required much less space and allowed simpler tone changes. One of the major players in the aftermarket was Communications Specialists, or CommSpec. Their TS32 and TS64 were extremely popular in the late 70s and through the 80s, until ham radio manufacturers began integrating their own encoders and decoders.

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The “standard” tones.

Limitations:
Power frequencies and multiples
60 Hz, 120 Hz, 240 Hz

Don't use 131.8 Hz or 136.5 Hz on a mixed mode channel (both CTCSS/PL and CDCSS/DCS/DPL).

GMRS community has adopted 141.3 Hz as the nationwide "travel tone.”

Though not a standard per se, open amateur repeaters most often use 100.0 Hz.

Standard PL / CTCSS Tones (42 total)			
Tone Frequency - Motorola Code			
67.0 - XZ	97.4 - ZB	141.3 - 4A	206.5 - 8Z
69.3 - WZ	100.0 - 1Z	146.2 - 4B	210.7 - M2
71.9 - XA	103.5 - 1A	151.4 - 5Z	218.1 - M3
74.4 - WA	107.2 - 1B	156.7 - 5A	225.7 - M4
77.0 - XB	110.9 - 2Z	162.2 - 5B	229.1 - 9Z
79.7 - WB	114.8 - 2A	167.9 - 6Z	233.6 - M5
82.5 - YZ	118.8 - 2B	173.8 - 6A	241.8 - M6
85.4 - YA	123.0 - 3Z	179.9 - 6B	250.3 - M7
88.5 - YB	127.3 - 3A	186.2 - 7Z	254.1 - 0Z
91.5 - ZZ	131.8 - 3B	192.8 - 7A	
94.8 - ZA	136.5 - 4Z	203.5 - M1	

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Reverse Burst™, "Chicken Burst", Squelch Tail Elimination™, Squelch Tail Eliminator™, or STE™ (see Industry Standard EIA/TIA-603C)

Created to eliminate the “squelch tail” noise. The phase was reversed for a brief period causing the reeds to stop vibrating quickly. 180° was originally chosen, but this caused the decoders to “pop.” 120° was eventually standardized (at least by Motorola) in order to allow a silent muting of the audio.

While all commercial radios can respond to reverse burst, many amateur receivers can not, hence the creation of “Chicken Burst.” Chicken Burst simply allows the TX to stay on for a period of time after dropping the tone. This results in squelch action while there is still a carrier present.

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Community Repeaters and Hang-up Boxes

PL allowed commercial users to more efficiently occupy spectrum. Two or more user groups with low or intermittent usage could occupy a single frequency but use different tones.

As long as their microphone was in the hang-up box or in the microphone clip, users would be in PL decode mode and only hear traffic directed at them.

Once the microphone was picked up, the receiver switched to carrier squelch, allowing all traffic to be heard. This reduced the likelihood of inadvertent interference to other co-channel users.

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PL or DPL Does Not Equate to Open or Closed Repeaters

While PL stands for "Private Line," there is nothing inherently private about it. Your transmissions can still be heard by anyone receiving in carrier squelch, including scanner listeners.

PL is primarily used on repeaters to mask any site intermodulation or other interference.

It can also allow two different repeaters with overlapping coverage to be independently selected.

It is used in subscribers (mobiles and portables) to mask distant co-channel repeaters or to mask localized RF interference (the buzz of lights, for instance.)

Presence of PL on a repeater is no reflection of its status (Open, Closed, or Private)

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Thanks for your attention.

This presentation is available on the K7ID.org web site under Presentations.

If you're interested in more details not covered this evening, the majority of this presentation was derived (with permission) from the excellent work of Mike Morris, WA6ILQ.

His page, "A Historical and Technical Overview of Tone Squelch Systems - A primer on tone systems, with a little on digital systems" is available at

http://www.repeater-builder.com/tech-info/ctcss/ctcss-overview.html

Questions?