go2signals

CASE STUDY 511 V2.2
PROSECUTION OF V/UHF CONTINUOUS TONE-CODED SQUELCH SYSTEM (CTCSS)

INTRODUCTION

This Case Study describes the techniques & procedures employed by the go2signals Operator to successfully recognize, demodulate, decode & report V/UHF FM Push-To-Talk Clear-Speech emissions, when these emissions are also carrying 'Continuous Tone Coded Squelch System' (CTCSS) sub-audio tones..

LEGACY

CTCSS is over half a century old! It's been used in V/UHF Analogue Personal & Professional Mobile Radios since the late 1960's, most often on nets employing 'simplex' working.

The CTCSS system uses sub-audio tones to block ('squelch') other emissions transmitting on the same frequency/channel from being demodulated by the intended receiver, and also enables more than one link (between 2x or more co-operative users) to use the same frequency/channel without causing interference to other users.

There are 50x commonly accepted "industry standard" CTCSS tone-values (i.e. discrete sub-audio frequencies); however, certain manufacturers (e.g. Kenwood) also incorporate non- standard CTCSS tone-values (which can impact interoperability within voice-nets using different transceiver models).

Digital PMR HT with 'FM Clear-Speech + CTCSS' as 'fallback' mode

THE NEED

A pre-selected CTCSS tone is transmitted as soon as the user's handset's Push-To-Talk (PTT) switch is pressed, and continues to transmit until the user's PTT switch is released.

The Receiver components of users' Handheld Transceivers (HTs) or Mobile Units (MUs) are set to open their audio-squelch (i.e. 'unmute') only if the correct preset CTCSS sub-audio tone is detected in the FM PTT Clear-Speech emission being received. Conversely, if another user transmits on the channel with a different or no CTCSS, the receiving radio will not unmute (if the CTCSS function is active

CTCSS is also used by analogue-repeater systems to ease network management & prevent interference; more recently, many Digital Professional Mobile Radio (PMR) models also include FM PTT Clear-Speech with CTCSS for use as 'fallback' modes (see image above).

It is important not to confuse CTCSS with the more recent 'Digitally Coded Squelch' [DCS] system which employs Frequency Shift Keying [usually of excursions between 500 & 800 Hz] to convey squelch information digitally.

CONTEMPORARY USE OF CTCSS

Potentially hostile non-state actors are known to use commercially available analogue V/UHF FM PTT Clear-Speech transceivers employing CTCSS sub-audio tones in contemporary operational theatres.

If the intercepted FM Clear-Speech & accompanying CTCSS tone have a relatively high SNR, then the go2signals auto-Classifiers may report ‚FSK-2'; this is due to CTCSS tones' signaling characteristics.

By applying the ‚Voice F3E-SELCALS' Modem Descriptor File (MDF) to the intercepted link's emissions, the go2signals Operator can successfully extract & report the CTCSS tone being used by the intercepted node or link for Target Development purposes.
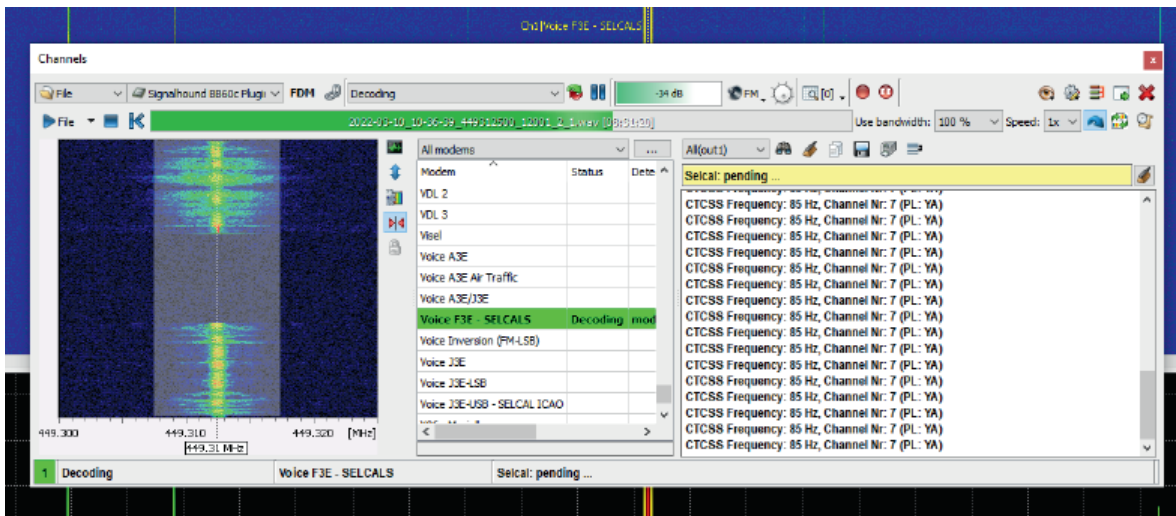

go2signals Operator applies the 'Voice F3E – SELCALS' MDF to successfully extract & report the target users' CTCSS frequency & channel ('85 Hz / Ch. 07')

VISUAL IDENTIFICATION

Using the go2signals spectrum & spectrogram ('spectrographic') displays, the Operator can visualize the targets' Frequency-Modulated Voice-Formants (i.e. speech content) & accompanying CTCSS tone for SOI identification purposes.

The operational example (R) shows a zoomed Narrowband FM PTT Clear-Speech link active in the go2signals spectrum & spectrogram displays. The transmitted CTCSS tone is clearly higher in relative amplitude than the accompanying FM Clear-Speech. To enable 'live' monitoring, the go2signals Operator can, for example, select the chosen go2MONITOR Production Channel's FM Audio Demodulator whilst applying the **'Voice F3E –SELCALS'** MDF to simultaneously prosecute the CTCSS tone being carried.
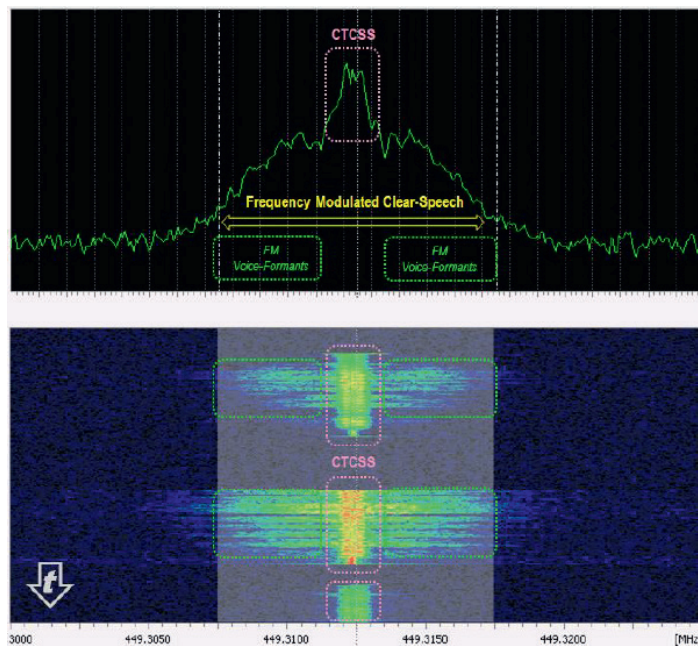

go2signals Spectrum & Spectrogram Displays showing FM PTT Clear-Speech with CTCSS

AUDIO DEMODULATION

FM demodulation of the intercepted PTT Clear-Speech emissions will derive an audio-baseband containing the target users' demodulated clear-speech voice-formants & CTCSS sub-audio tone. This audio-baseband is routed by go2signals to the host-PC's soundcard for 'live' audio monitoring of the Clear-Speech, to the 'Voice F3E SELCALS' MDF for processing of the CTCSS tone, & to the ResultViewer database, enabling 'post-facto' access to the I&Q and audio-recordings for the go2signals Operator's Traffic Analysis & Target Development initiatives.

The example image (below) shows a spectrograph of the resultant demodulated audio-baseband. The 2x target users' clear-speech voice-formants are clearly visible; the go2signals Operator notes that the users' HTs' CTCSS sub-audio tones activate when the HTs' PTT switches are pressed, & de-activate when the PTT switches are released.
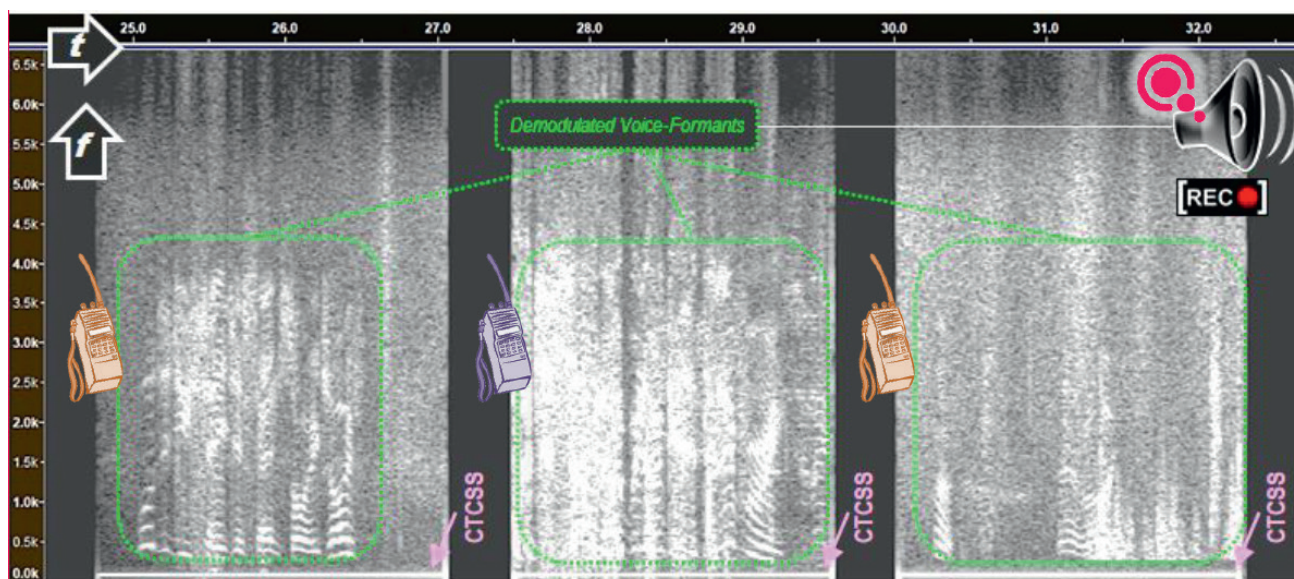
FM-demodulated audio baseband showing Clear-Speech Voice-Formants & HTs' transmitted CTCSS sub-audio tones

OPERATIONAL NOTE

In some contemporary operational theatres, users of V/UHF FM PTT Clear-Speech HTs & MUs unknowingly activate their transceiver's CTCSS transmit function, but without realizing what it is!

Therefore, it is possible that the go2signals Operator may encounter an FM PTT Clear-Speech link or net, seemingly using CTCSS, but with each transceiver node using different or no CTCSS tones (the target transceivers' CTCSS 'readers' having been de-activated or never activated by the users).

HT User - FM PTT Clear-Speech + CTCSS

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FURTHER INFORMATION

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