CTCSS Encoder Board

by Eric van de Weyer VK2KUR

This article is prompted by a recent necessity to add tone squelch to the local repeaters (147.025 and 438.575) to combat interference from various sources.

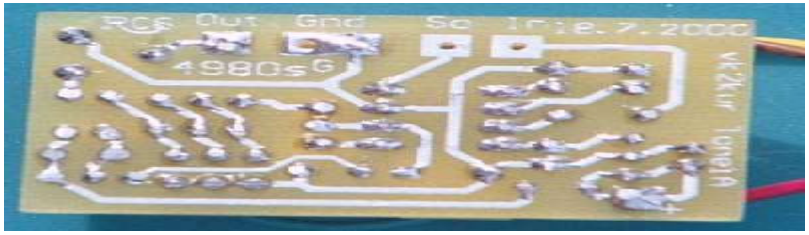
Many of the members of our local club use older, often ex-commercial, equipment on the local 2M and 70cM repeaters, both of which suffer varying degrees of interference due primarily to their proximity to the Sydney CBD. Many of these radios do not have CTCSS (Continuous Tone Coded Squelch System) tones available in them so it was decided to come up with our own encoder board, if possible, at a lower cost than importing ready made ones form overseas. Fig 1 & 3 show pictures of the completed board.

The local repeater initially used 141.3Hz for its tone squelch, however, after some research and looking at was being used around the country it was decided to change to the more common 123Hz which is where we are today. In fact, the latest (2001) WIA Callbook notes that 123Hz is recommended for use where CTCSS is being used to overcome interference problems whereas 141.3Hz is suggested for repeater linking purposes.

A simple CTCSS encoder (See Circuit Fig 2) was described by Will McGhie's Repeater Link column in July 1996 AR (page 46) and this article should be referred to for a full description of the encoder operation. It is based on a NE567 tone decoder IC which has either a square wave or triangle wave output from its oscillator. The triangle output is used and passed through a three stage RC filter which gives a near sine wave output. This is then buffered and fed to the output.

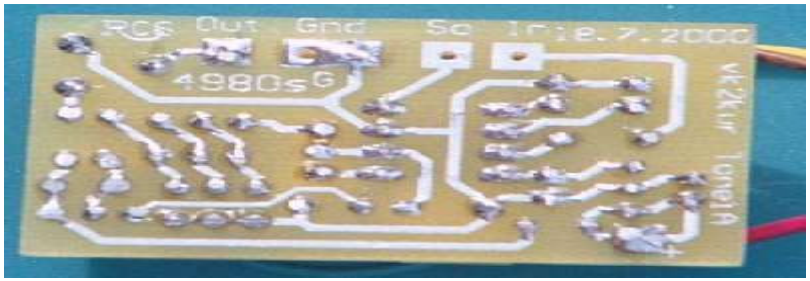
One of the more important features of the encoder is its stability, which is due to the components used most importantly being the 1µ5 MKT capacitor on pin 5 of the IC.

The encoder has two controls. One is a multiturn pot, which is used to set the frequency of the oscillator. It has a frequency range of about 70Hz to about 250Hz . The other pot is used to vary the output level so that the correct modulation level may be set. Depending on the frequency setting they can get up well over 1.5V RMS and usually sit at about .5V RMS at the 123Hz mark. Generally, on FM transmitters, a deviation of between 300Hz and 600Hz is all that is needed to give reliable operation of the tone squelch at the receive end. This is a fairly low level compared to the normal voice deviation of somewhere around 3.5kHz.



The encoder will work on any input from about 8V up as it includes a 5V regulator on board.

I have also added an extra capacitor to the input of the NE567 (pin 3) and bought it to an input pin and also bought out the Squelch output from pin 8 of the IC. This was to make it easier for future experimentation with decoding received tones to enable the radio to be tone squelched as well, although, as yet, I haven't had time to do so.



I set about to design a PCB (Fig 4) for the project resulting in a fairly compact yet easy to assemble board measuring 45mm x 28mm with a component height of 12mm (see attached pictures of the board). This was then manufactured by a local manufacturer and made up into kits for sale to members.

We have now fitted these encoders to several radios with excellent results. The transceivers to which I have fitted them so far include Philips FM900 and FM828, AWA RT80 and RT85, Yaesu FT290 and FT790. I believe that some others have fitted them to other radios as well. Many transceivers include a tone input to feed in such a tone and on those that don't, it is usually a fairly simple matter to find an appropriate place into which to feed it. It is preferable to feed the tone in at a point close to the actual modulator so that it does not go through any pre-emphasis network which may be in the radio.

I have included, on most of the radios I have converted, a switch to turn the encoder on or off so that the tone does not have to be transmitted on all channels although that is usually not a major problem.

As far as setting up goes, I test each unit as it is made and then tune it to the desired frequency using a frequency counter, before installing it. If you don't have a counter, however, you can tune it once it is in the radio by starting off transmitting on the repeater input and gradually tuning the multiturn pot until the repeater starts transmitting and then keeping going until it drops out. Then wind it back to the midpoint between the two positions. It may be necessary to employ a friend to listen to the repeater for you and tell you when the repeater opens and closes either on another band or over the phone.

Following are brief instructions to install in several radios:

Philips FM900:

On the Synthesizer/Control board:

1. Check that R357 (470K) is installed. It is located between the Deviation and Modulation Balance trimmers. If not, install a 470K 1/4W resistor.

2. Locate the option connector U405 (one of 3 rows of holes on the board) and connect the encoder as follows:

Pin 18 - +10V

Pin 21 - Ground

Pin 23 - Tone out

AWA RT80 Receive board

1. Locate S201 the Tone Squelch connector .
2. Connect the encoder as follows:

Pin 3 - Ground

Pin 6 - +9V

Pin 7 - Tone output.

AWA RT85 Receive board

1. Locate J358 the Tone Squelch connector .

2. Connect the encoder as follows:

Pin 1 - Ground

Pin 8 - +8V

Pin 6 - Tone output

Yaesu FT290/690/790

On the these radios there is a tone board connector in the area next to the battery compartment with the following connections:

Black – Ground

Red - +9V

Green - Tone out.

These radios also have a tone On/Off switch on the small board also adjacent to the battery compartment.

The foregoing should give many people a quick start to installing the CTCSS board whilst others will need to look into their radios to determine where to connect it. It seems that many radios both commercial and Amateur already have a means of connecting a CTCSS encoder or encoder/decoder in them so it is just a matter of identifying it.