A PIC-based Talk-Through Box for a Cave Radio

*The emergency services are showing an increasing interest in being able to link cave radios with their own radio systems. **Graham Naylor** describes a means of doing this for System Nicola.*

This article describes a circuit to allow automatic interfacing of a cave radio (in this case the System Nicola, but the circuit is adaptable to other cave radios such as the HeyPhone) to a UHF or VHF surface radio, or a single-wire telephone (SWT) link.

A beacon using a PIC microcontroller is attached to the underground cave radio so as to add a 180Hz tone to the microphone input to cause automatic switching of the surface UHF/VHF radio from receive to transmit. The 180Hz tone is below the audible pass-band of the radio.

A simple voice-operating changeover (VOX) circuit on the UHF/VHF receiver audio output, together with an appropriate squelch setting, is used to switch the cave radio on the surface from receive to transmit.

The various operating states are controlled using another PIC microcontroller to avoid conflicts between combinations of states and to add timeouts to avoid lock-ups and to provide a 'sticky' push-to-talk.

The Beacon

This device can be made very compact and is integrated into a connector that connects to the 7-way connector of the Nicola II cave radio. This allows a beacon signal to be added to the microphone input of the underground cave radio. Its circuit is shown below.

The microphone handset of the Nicola is hardwired into the radio and is always available. In this way signals are sent to the audio input of the cave radio transceiver from both the microphone and the PIC based beacon.

The voltage level of the microphone input tells the PIC whether the handset switch is depressed (transmit) or not (receive).

By using a PIC the beacon can be provided with other modes of operation which allow different location or test signals to be transmitted automatically. For example, repeated 6s periods of test signal separated by 6s periods of reception – this would allow the other cave radio to reply during the breaks.

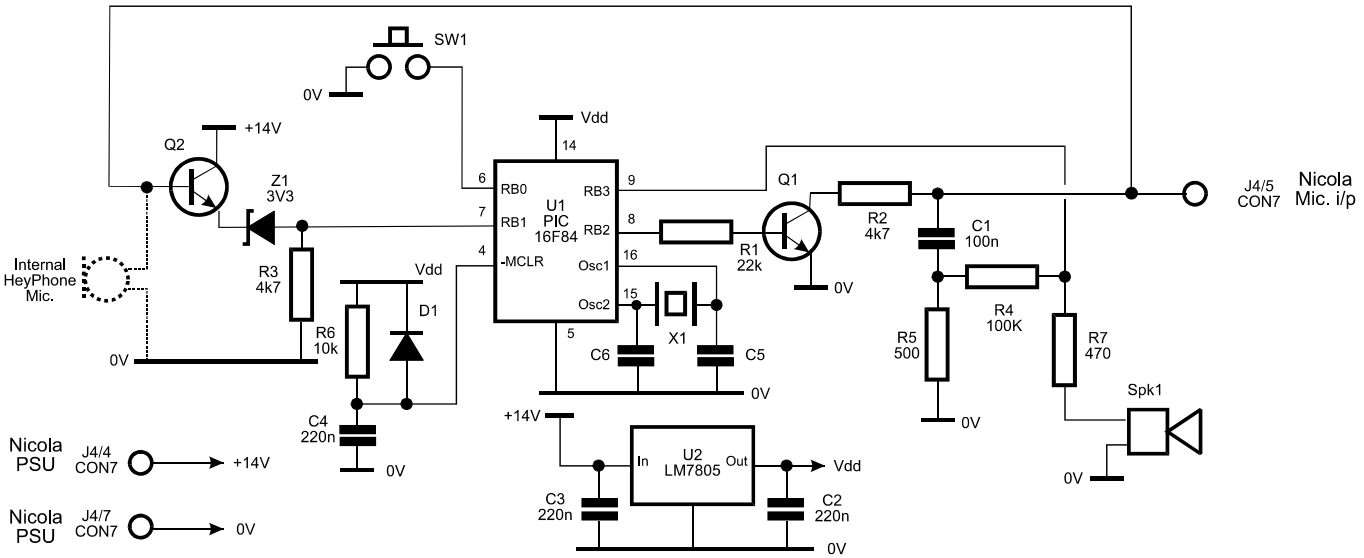
Another mode used for location gives a continuous set of tones. The 5 modes in the current implementation are:

1. alternate 1s low tone, 0.5s high tone, switching TX 6s and RX 6s alternately.
2. sliding tone low to high over 1s, repeating, switching TX 6s and RX 6s alternately.
3. alternate 0.1s low tone, 0.1s high tone, switching TX 6s and RX 6s alternately.
4. alternate 1s low tone, 0.5s high tone, continuous.
5. Sends 180Hz whenever PTT pressed (TxDetect low).

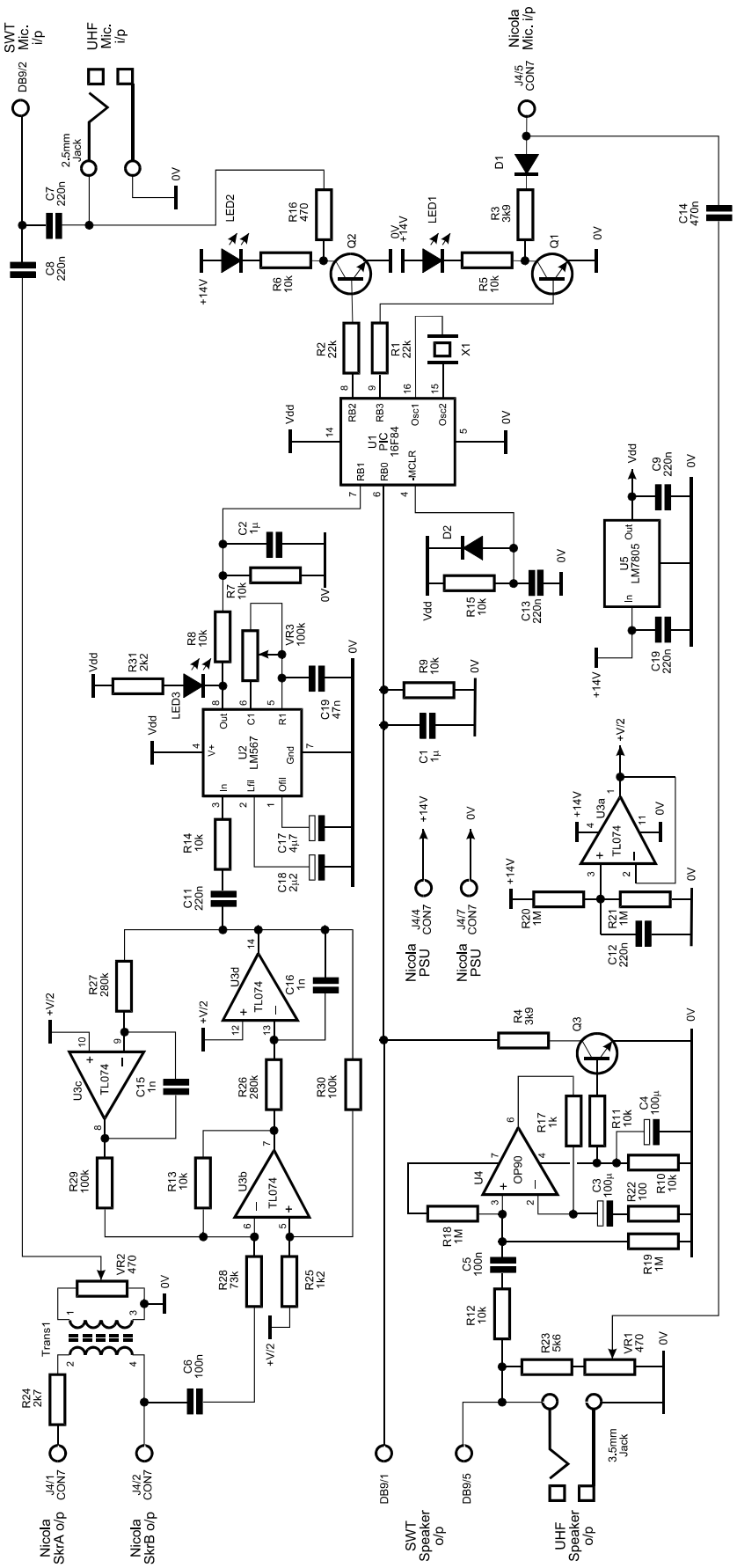
The PIC-based Beacon

Cave Radio-UHF/VHF Interface

The 180Hz tone generated by the underground beacon is detected on the audio output of the surface cave radio using the classic NE567 phase-locked loo. The output of this loop is interpreted by another PIC (16F84) to switch the UHF/VHF set to transmit as soon as a call from the underground is received, and hold it on TX for several seconds following a drop in the detection of the 180Hz tone. This caters for



Schematic of Beacon



Schematic of Talk-through Box

the signal being interrupted momentarily by interference.

The PIC also detects an input signal from the UHF/VHF set using a simple VOX circuit, and switches the cave radio to transmit. This of course will only work if the VHF/UHF receiver squelch is set to an appropriate level.

There may be a problem if there are other stations on the chosen frequency who also might cause the cave radio to switch to transmit, but this can be minimised by using CTCSS to respond only to callers using the correct tone.

VOX operation is achieved simply by amplifying the audio output and measuring the current consumed by the op-amp. It may look confusing to see that the op-amp apparently doesn't go anywhere but into a load resistor, but it is the load resistor that causes the current consumption to change once an AC signal is received.

The circuit diagram is shown in *Figure 2*.

The audio output of the UHF/VHF set is connected to the microphone input of the cave radio, and the audio output of the cave radio to the microphone input of the UHF/VHF transmitter.

In both cases potentiometers are used to set the audio levels and an audio (modem) 1:1 coupling transformer is used to reduce interference.

The circuit shows jack outputs for the connections to the UHF/VHF sets and a D connector to connect to a single-wire telephone.

Software

The programs were written in C using WIZ-C from Forest Electronic Developments (which I recommend highly – with it you can get simple systems with switches and outputs up and running very quickly).

The hex file to program the PIC chips (16F84) will be published on the Nicola Radio web site at **naylorgr.perso.cegetel.net/cave_radio/** (note that this is a new URL). The files are also available by sending me an e-mail at **naylor@esrf.fr**

Artwork for the circuit boards will also be made available.

System Nicola

The System Nicola, for which this equipment was designed, is a cave radio intended for rescue use in France.

One notable difference between the System Nicola and most other designs is that the same line is used for the microphone audio and its PTT. Some modification will be needed, therefore, for use with radios having a separate PTT line.

For more information on the System Nicola, please refer to the following articles:

Naylor, Graham (1998) *Introducing the Nicola System*, CREGJ **34**, pp.3-6.

Naylor, Graham (1999) *The Nicola Mark II – a New Rescue Radio for France*, CREGJ **38**, pp.3-6.

Naylor, Graham (2001), *Add-ons for the Nicola System*, CREGJ **44**, pp.11, 12.

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