Steve's Scanner Shop

Using The NEW ARD25

A Mod You Can Do- Part 2

By Steve Donnell

In the September issue of *Scanning USA*, we looked at how the ARD25 Project25(P25) digital voice decoder can be use with a wide number of scanners by way of tapping into the IF circuitry of a scanner. We also covered the various command codes that can be used to set a number of the ARD's operating parameters. It still surprises me to no end as to just how little information AOR included in the manual for the ARD25; no information about the command codes, with only a vague reference to the PC interface. Along with only some very limited information about how to (IF)interface it to a few selected AOR and Icom radios. The latter item may partly be explained in that most of the Icom and AOR radios mentioned in the ARD's manual just happen those commonly used in various "spectrum survey" packages, i.e.: communications surveillance packages used by assorted Federal agencies.

One interesting bit of information that I have discovered in studying the ID data the ARD spits out at the end of any P25 transmission is that on "conventional"(non trunked) radio systems. P25 radios can make use of talk groups codes as a means of creating sub groups/fleets on a given radio channel, beyond that of the NAC/NID codes employed within the P25 standard. Based on what I've seen locally, this primarily seems to be used as a way to separate mobile units from the base or dispatch transmissions and appears to be entirely optional. The purpose of doing this may be so that police mobile units in adjoining communities can monitor (mobile) radio traffic from other mobiles, without having to overhear the dispatch transmissions as well. The ARD25 itself does not permit any means of selective monitoring, expect for being able to block analog and or encrypted transmissions.

AOR ARD25

While the use of a 10.7 MHz IF signal is the easiest way to interface the ARD25 to a given radio, the discriminator signal from a given radio can be used just as effectively be used as well. As with many other types of mods, there is more than one way to implement this, depending upon how you want to use the ARD, and just how much drilling and such that you care to do. Normally the 10.7 MHz IF signal that enters the ARD25 goes into an IF Demodulator IC, where it is converted down to 455 KHz, and finally FM demodulated, much in the same fashion as would be done in a typical scanner. The output of FM demodulator, commonly referred to as the "discriminator " signal, what we will from here on refer to more accurately as the "baseband" signal is applied into an Operational Amplifier filter, and then into the DSP(Digital signal Processor) IC where it is decoded. What we will being doing is merely substituting the baseband(discrimintor) signal produced from the ARD's own FM demodulator, with the baseband signal from an external receiver(i.e.: scanner).

To start with you will need to disassemble the ARD25 in order to get at the underside of the PC board. Begin by removing the x6 screws that holds the top cover on, and unplug the speaker as you lift the cover off, and pull of the volume control too. Then you need to remove the x4 screws inside that hold the PC board in place. And finally the x2 screws on the bottom, near the back end of the case. You will also most likely need to remove the rear panel as well. This is done by removing x2 screws on the rear panel itself, the x2 nuts on each side of the DB9, and the nuts on each of the Audio IN/OUT jacks.

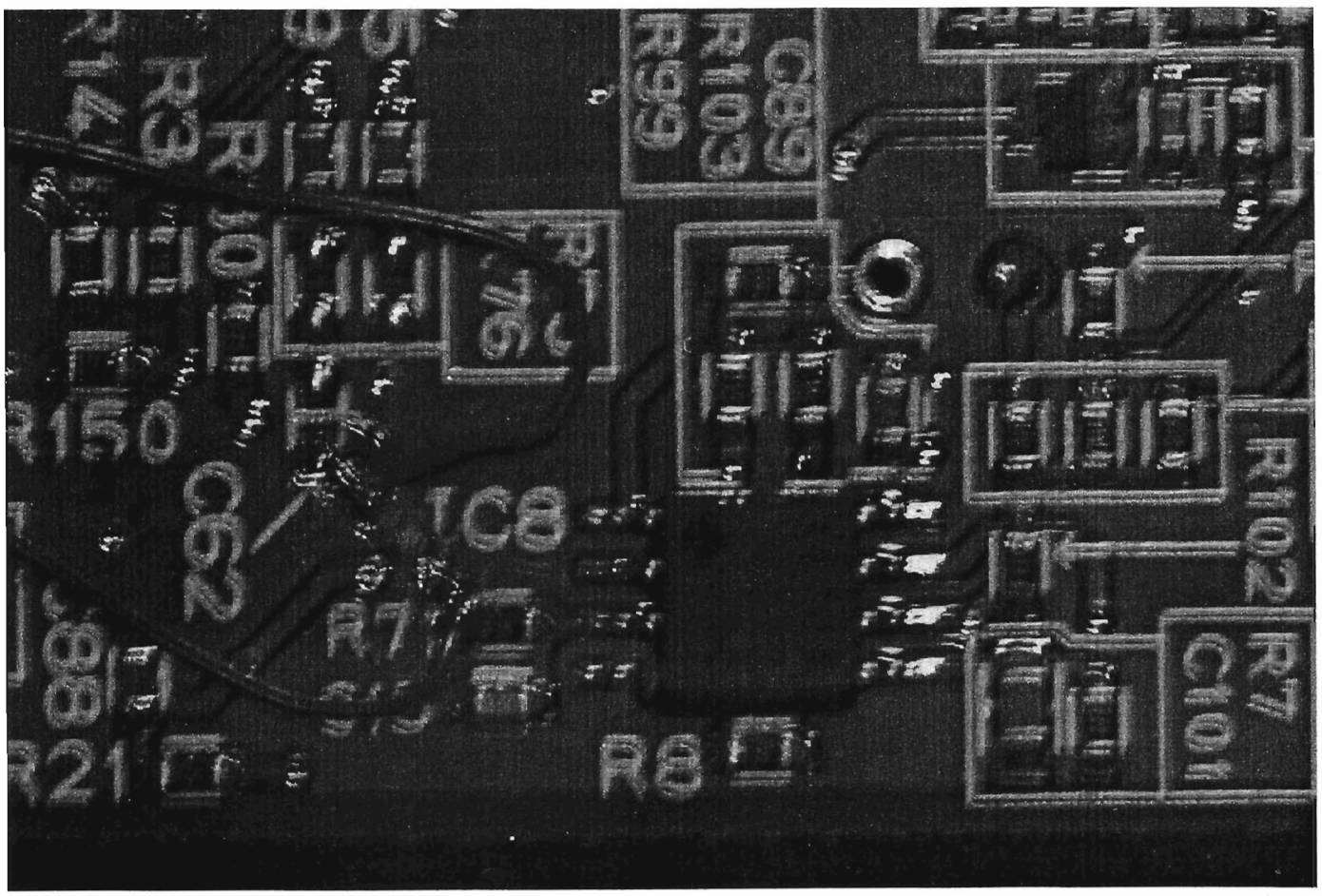
Carefully study the layout of the board, identify IC14

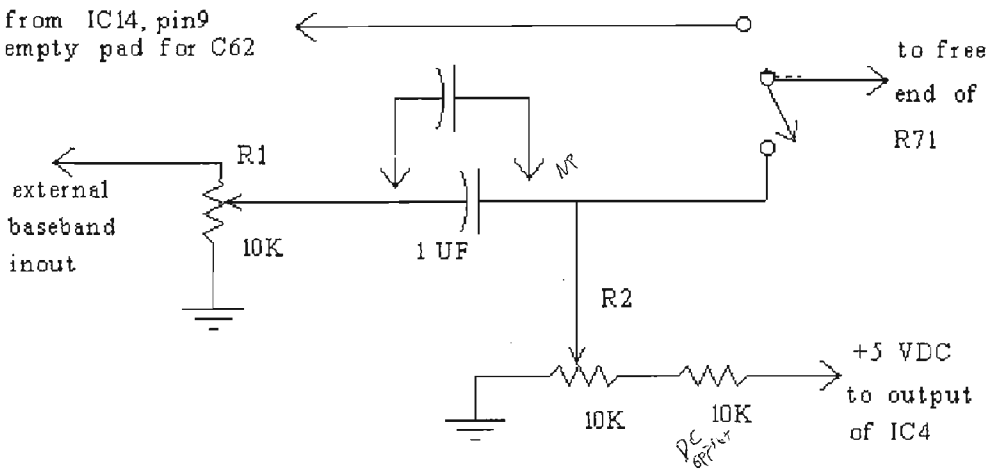
the FM Demod IC, marked as "31136". It's discriminator or baseband output is on pin 9. It's the pin closet to the marking "C94" on the board. Directly from pin 9, the circuit drops down through a "thu hole" where it reappears on the other side of the board. On the bottom, the thru hole connects onto a short PC that can be identified as having one end of a blank space for a capacitor C62. And at the other end as going to one end of resistor R71, marked as "472"(4.7K). Just for reference, the other end of R71 connects into pin 3 of IC8, which is marked as "3404", which happens to be an OpAmp(Operational Amplifier) IC. You will then need to use a fine pointed hobby knife to cut to open the PC trace half way BETWEEN the thru hole and where the trace ties onto R71. This will open the connection between the internal FM Demod, circuit(IC14) and the OpAmp(IC8). Once this is done you can decide as to exactly how you want to interface the external baseband signal into the ARD.

Initially I opted for an arrangement where we made use of the External Speaker IN jack. The Speaker IN/OUT jacks are intended to permit the speaker audio from a scanner to be looped through the ARD. When an analog signal is present, the original speaker audio will pass through the ARD. But when the ARD decodes a P25 signal, the audio that appears on the Speaker OUT jack(or the ARD's own internal speaker) will be the audio decoded from the P25 signal. But since locally in NH, almost all police communications are now P25 mode, I really did not need to do mixed analog/digital selecting. The Speaker IN jack can easily be isolated by removing capacitor C19, which is located adjacent to where the ARD's internal speaker lead plugs onto the PC board.

This gave me a jack with switched contacts, which I connected the leads from each side of PC trace that I had cut which connected the internal FM Demod and the OpAmp. Of course I included a 2K resistor inline with the lead from the FM Demod, so as to protect the output from any momentary shorting when a plug was inserted. When there was nothing plugged into the Speaker IN jack, the connection between the FM Demod and the OpAmp functioned as usual, where an external 10.7 MHz IF signal was needed. But we could also insert a mini plug into the Speaker In jack, which carried the discriminatror baseband signal from a scanner that did not have a 10.7 MHz IF signal available.

One problem that I quickly noticed however was an external baseband signal needs to meet two requirements in order for the ARD to decode: One that it needed to be of the correct amplitude, which the ARD can readily accept a fairly wide range of, without problems. But the other second more critical factor is the external signal needed to have a "DC offset" that closely matched the offset seen from the internal FM Demod, which is just about 1 volt. One additional issue that may further add to this is if the scanner you are trying to interface to the ARD uses





discriminator signal tap that includes a capacitor in line with the signal, there will not be any DC offset voltage available. Of course if you have been following our recommendations (from day one of SUSA) for tapping the discriminator of a receiver, the signal tap that you have will have been done using a 1 to 2K ohm resistor, which not only provides the least degree of distortion of the waveform, but also permits the DC offset level to pass through as well.

If you can look a discriminator output, with an oscilloscope(DC coupled mode), you will notice the waveform does not go all the way down to zero volts, but typically rests between 3 to 5 volts. This is a normal condition of all FM Demod ICs. The good news is the ARD's internal FM Demod produces an offset of only 1 volt, which is what the OpAmp expects to see from any signal that is fed into it. Since the discriminator outputs of most other FM Demods is somewhat higher than that, a very simple solution that I initially used was using a potentiometer; one leg tied to Ground. The other leg tied to the external baseband discrimnator source, and the wiper/slider leg of the pot connected to a mini plug that was inserted into the Speaker IN jack which connected to R71. The pot was then simply adjusted so the baseband signal from the external scanner's FM Demod would produce a DC offset value of 1volt as seen at the wiper of the pot.

One problem that could be encountered however was that as you adjust the DC offset value down, you also are reducing the peak amplitude value of the baseband waveform as well. This partly can be compensated for by adjustment of trimpot RV1 on the ARD's PC board, but I thought it best if this was not needed to be done, particularly since the trim pots in the ARD are so tiny and fragile. So the solution that I came up with is the circuit shown in the schematic diagram. This allows you to independently adjust the DC offset value(R2, set for 1 volt) and the amplitude of the external baseband signal(R1). If you are not able to find a non polarized capacitor for the 1 Uf capacitor. You can parallel a pair of .47's or .68s, or even x5 .22 Uf's. The switch that selects either the internal or external Demod source can be mounted on the rear panel, just above the holes for the Speaker IN/OUT jacks. The jack External baseband/Demod can be installed in place of the screw that is located just above the DC Power jack.

Two additional mods for the ARD25 that you might find useful are these: I find the gain of the internal speaker amplifier(IC23, LM386) far too high. By removing resistor R87, located behind the volume control, on the top of the board, the volume level can be adjusted in a much smoother manner.

Also, an easy way to generate a control logic signal that will indicate when a P25 signal is being decoded can be done by attaching a 4.7 K resistor to lead of the Busy LED nearest to the Volume control. The other end of the resistor is then tied to the Base lead of a 2N3904 or similar transistor, with it's Emitter lead grounded. The Collector can then serve a low current "pull down" line. I use it to key a low power 900 MHz transmitter that will rebroadcast what the ARD25 decodes to where ever I am located around the house.

Please be aware BEFORE starting any of these mods, that while they is not particularly complex, they do require someone who is skilled at working with surface mounted components and fine printed circuit trace lines. Enjoy.

Photo By T. Finnegan

Agencies using APCO systems can be monitored with the ARD25!