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Steve's Scanner Shop

A NEW Way To Monitor Digital
Using The AOR ARD25

By Steve Donnell

The ARD25 from AOR is the first stand alone accessory for permitting older scanners and other FM receivers to demodulate Project 25(P25) digital audio transmissions that becoming commonplace on many Local, State, and Federal radio systems. Previously, the only way of monitoring P25 transmissions was to purchase a two way radio that was designed to be used on a radio system that used P25 type signals. Then in early 2003, Uniden introduced the first scanners that could monitor P25 digital signals, in addition to signals that used more traditional AM and FM "analog" modulation.

The ARD25 is designed to function as outboard accessory by tapping into the IF signal of a receiver. Many scanners marketed by AOR already have an output tap going to the 10.7 MHz IF used in the receiver. This is also true of a receiver such as the Icom ICR7000 and R8500, and conceivably the ICR100 as well, although there is no 10.7 MHz IF signal "tap" on the R100. Most scanner designs moved away from using 10 MHz IFs a number of years ago as a means of combating problems from "image" interference. The afore mentioned AOR and Icom scanners use 10.7 MHz as a 2nd or 3rd IF in their receiver circuitry. Although I suspect AOR designed the ARD25 to work with an IF input specifically to make it easily compatible with the high end AOR(and Icom) receiver products that are popularly used by many different Government agencies. The up front fact is the ARD25 can actually be interfaced by way of the FM Discriminator signal from nearly ANY FM receiver.

For the moment however we will stick with using the ARD25 directly by way of an IF signal interconnection. I find it more than a little ironic the ARD25, that makes it possible to demodulate the most advanced form of digital voice communications, that of Project25(P25) encoding, by way of using a scanner that is as much as 20 years or more old. Although one additional issue that quickly emerges, is that many if not most new Public Safety radio systems that use P25 are also trunked systems, that would require a newer "trunktracking" scanner to permit following of various Talk Groups. Here in New Hampshire where I live, most P25 systems are not trunked and operate on "Conventional" VHF frequencies.

After initially familiarizing myself with the use of the ARD225 using my R7000 receiver, I quickly wanted to see how easily we could interface it with a more simple receiver. I chose my old Regency TS2 TurboScan for the job, as it uses a 10.7 MHz IF. There are two different points at where the 10.7 IF signal can be tapped from. One is where the VHF and UHF Mixers are summed together, just ahead of the 10.7 IF filter. This can be on either side of resistor R143, a 1 ohm resistor. Another spot, a easier to locate perhaps is directly following the 10.7 IF filters, at the input of the MC3359 IF Demod chip, IC U201. The tap point is at pin 18. I found it necessary to connect a 2K ohm resistor to pin 18, then to the center lead of a piece of

shielded cable. This reduces the amount of loading the ARD25 places on the filters and the IF Demod chip. Also be sure and ground the shield of the cable close to the IC. This can be done at pin 17 of the IF Demod chip.

When we initially connected the ARD25 to the IF output of the TS2 scanner, we could not get it to decode any P25 signals. It occurred to me this might be due to the IF signal having the wrong "polarity", based on the orientation of the receiver's Local Oscillator being either above or below the RF carrier. Luckily one of the frequencies I was trying to receive P25 from was 151.400 MHz. This allowed me to program into the TS2 a frequency of 172.800 MHz which permitted us to receive 151.400 MHz as an "image" signal, but more importantly that it would have the opposite polarity as when 151.400 was dialed into the scanner directly. This did allow the ARD25 to decode the P25 signal from 151.400 MHz. Unfortunately this wasn't a practical option as it would not permit reception from frequencies higher up in the 155 MHz area.

A "hardware" level solution was developed by looking within the ARD25 itself; the IF Demod circuit of the ARD25 uses a typical 10.245 MHz crystal to downconvert the 10.7 MHz IF down to 455 KHz. I determined that if we substituted an 11.155 MHz crystal for the 10.245"2nd LO", this would correct the IF polarity issue, at least for using the TS2 as a receiver. This worked fine and allowed us to use the ARD25 to demodulate P25 signals commonly heard on VHF frequencies here in NH, using the old TS2 scanner, and even with our (much)older Plectron Chief receiver.
However I still figured that there must be some type of "software" solution that could correct this by way of a command instruction being applied to the ARD25 through it's data port connector.

Beyond the communications settings needed in order to use Windows Hyperterminal or another "terminal emulator" program, the Owner's Manual for the ARD25 is mysteriously vague as to the purpose of the serial data port on the of the ARD. An additional difficulty is the use of a DB9 male connector on the ARD. This might imply to some that a "null adaptor" is needed as well, but is not the case. You simply need either a cable that has female DB9 connectors on each end, or make an adaptor using two female DB9s and connecting pins 2 to pin 2, 3 to 3, 5 to 5, 7 to 7, and 8 to 8.

When connected to a PC or a PDA running a terminal emulator of some type, using the communications settings supplied in the manual, the data port will spit out a short string of data at the end of each transmission when P25 is demodulated. The data generated by the ARD25 looks like this:
MI: 000000000
AG: 80
KY: 0000
TG: FFFF
SI: 001F41
DI: xxxxxx

The values for MI, AG, KY, and DI don't seem to ever change. I suspect the DI is (supposed to be) the NAC/NID Network Access Code, also known in Motorola circles as the Network ID code. Which is essentially the same as a CTCSS/DCS code, used in the old analog world. I suspect this was intentionally left out due to security concerns for new radio systems. The data produced in the TG and SI fields is however quite interesting and useful. The TG data is a hex based number and as you might have guessed, identifies the Talk Group on a Conventional(non trunked) channel. The SI is also a hex number, and appears to be a unit ID number. That is to say it is different for each radio heard on a given system. However when used on a Motorola 800 MHz trunked system, the SI: line seems to display the (trunked)Talk Group ID number, and the SI: displays "FFFF".

Scanners that can be interfaced w/ the AOR ARD25

Radio/Scanner	Y/N	Notes
Regency TS1,2	Yes	ANY older scanner w/ a 10.7 MHz IF
BC760	Yes	
IC-R100	Y	
BC245	Yes	
BC9000	Yes	
BC780	Yes	*W/ WFM filter change
PRO2004/6	Y	
RELM MS200	Y	

After contacting AORUSA, they sent us the information for "soft setting" the polarity of the IF signal. However the instructions were incomplete, and did not(initially at least) provide an answer. However it did get us pointed in the right direction. After a lot more investigative work we came up with our own answers: The ARD25 can have a number of settings commanded by way of an external data terminal. Most of command consist of three letters, followed by a "space", then either a YES or NO, followed by a Return/Enter key.. All of the commands and the yes/no need to be in upper in case characters. Here are the commands used by the ARD25:

ADC Displays a list of all the commands and their current settings.
AVR Displays the firmware version used in a given ARD25; 403B.
ADA Analog Decode ON/OFF. If set O, the ARD will also pass analog voice audio.
ADE Detect (P25) Encryption.
ADS Digital Squelch Level (0_25), sets threshold for P25 detection.

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ASM Squelch mode.
APR Parameter Int; master reset, sets ARD25 back to default settings.
Note: The ARD25 must be switched OFF briefly after sending the command in order for the command to take effect.
APN Polarity Normal Corrects for polarity of the IF input signal Note: The ARD25 must be switched OFF briefly after sending the command in order for the command to take effect.
ADI Display Info; If OFF, the ARD will not generate the information string at the end of each P25 transmission.
AAS Analog Squelch Level Signal threshold level. 0_25
AEC Voice Echo Sets a voice regeneration filter ON/OFF.
ASL Received signal level; Bit Error Rate(?)
AMF Median Filter, Sets a digital voice filter feature ON/OFF.

The ADA(analog decode) setting is particularly helpful as the commands the ARD25 to pass only P25 digital signals and ignore analog FM ones. This is useful in blocking out reception of non_P25 signals that often share the same channels with P25 signals. This is a feature that none of the current crop of P25 scanners is able to do and hopefully helps to illustrate the usefulness of the ARD25.

It is possible to use your Uniden 780XLT with the ARD25

We recently had a request to see if the ARD25 could be interfaced to the hugely popular BC780 scanner. There are actually TWO ways to do this: One is by way of a Discriminator tap; the Discriminator signal from the BC780 is fed into the ARD, in place of the ARD's own Discriminator signal. However this requires a modification to the internal circuitry of the ARD25, which is rather simple, but we will have to cover in detail next time. The good news is that by doing this mod, you open up the ARD25 for use with a wide range of other scanners; some of the ones we have tested using the discriminator mod with to date include the old BC760, and the newer BC245 and 9000, along with the TS2. It should also work with some of the common Radio Shack scanners like the PRO204/6 as well.

The other way to interface the BC780 to the ARD25, without any internal changes to the ARD, is by way of interfacing the ARD with the Wide FM IF in the BC780; the Wide FM IF in the BC780 does have center frequency of 10.7 MHz, however it is only turned ON when the 780 is set to Wide FM mode. One problem that I realized about this approach is that while WFM mode can be selected when the BC780 is operating in Trunking mode, it appears however the 780 is unable to actually "track" a given trunk system unless FM or NFM mode is selected. I suspect this CAN be worked around, however it requires a more detailed modification that involves keeping the FM/NFM IF "hotwired" ON.

One additional hurdle is with the IF filters FT3 and FT4, located towards the back of the 780's PC board, see diagram. As Wide FM filters they are designed to pass signals that are within 150 KHz of whatever frequency the 780 is tuned to, and as a result, will likely cause the 780 to stop scanning when any adjacent frequencies are active. The solution here is to simply replace one or both of these filters with ones designed for "normal" voice FM, having a bandwidth of 25 KHz or less, from an old scanner such as one made by Radio Shack or Regency, which used a 10.7 MHz IF. The 10.7 MHz IF can be tapped off from the PC trace that connects between FT3 and FT4. Use a 2K ohm resistor to prevent loading on the filters, and connect out to the ARD25 using a piece of shielded cable. The bandwidth of the standard WFM filters may not be an issue if you are merely interested in decoding P25 that is increasingly found on some Federal Government frequencies that don't have any other active signals close by.

This same type of WFM mod can also be done on the popular PRO2004/6 series scanners; here you would need to change out the WFM filter CF1, and replace it w/ a 10.7 MHz one intended for "normal" voice FM. The IF output tap can easily be reached at pin 4 of IC1(HA12413).

One additional receiver that can directly(IF) interface to the ARD25 which seems to have been overlooked in the ARD25 owners manual, is the Icom ICR100. The good news is that this one doesn't require any IF filter changes. The R100 uses a 10.7 MHz as it's 2nd IF. You merely need to tap onto the output of the 2nd Mixer transistor, Q2.

Next time we will cover in detail how to do the external discriminator input to the ARD25.