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*Edited by **Rick Lindquist, N1RL**• Senior Assistant Technical Editor*

ICOM IC-PCR1000 Computer-controlled Communication Receiver

Reviewed by Steve Ford, WB8IMY
QST *Managing Editor*

Five years ago I was engaged in conversation with ARRL Technical Relations Manager Paul Rinaldo, W4RI, about the future of radio technology. He stated, "Someday you'll see a wide-range receiver that will be nothing more than a small black box with an antenna connector and an RS-232 computer port." That day has finally arrived, and the debut of ICOM's IC-PCR1000 demonstrates that this technology is within everyone's reach.

The PCR1000 fits Paul's prediction fairly well. It is small and black with a BNC antenna port and a 9-pin RS-232 connector. The computer-to-radio connection is used for control purposes. The audio signal is handled separately via three paths: a miniature external speaker, an external speaker jack, and a wide-bandwidth data port (for 9600-baud packet).

The radio is shipped with a "wall cube" power supply, an RS-232 cable, a telescoping portable antenna and, of course, the control software (ours was version 1.3). The manual we received initially was very skimpy, but apparently a more comprehensive version is in the works.

The PCR1000 offers the proverbial "dc-to-daylight" coverage, from down in the VLF range to 1.3 GHz in a variety of modes (including AM, SSB CW and FM) and bandwidths.

Installation

Unless you intend to use the small internal speaker, the receiver can be placed entirely out of sight. For this review I opted to route the audio from the PCR1000's external speaker jack to the **LINE INPUT** of my SoundBlaster sound card. The audio characteristics of the tiny built-in speaker are about what you would expect. Running the audio through my computer speakers offered a vast improvement. As it stands, the unit only puts out around 200 mW or so of audio. Other users thought it was a bit low.

Unlike some computer-controlled radios designed for internal installation, you don't have to fiddle with the guts of your PC or sacrifice a motherboard bus slot to use the PCR1000. It was a relief to know that I didn't have to pop the cover on my PC to enjoy the radio. You're also spared the hassle of IRQ and memory conflicts; all you need is an available COM port. This makes the PCR1000 ideal for use with laptops. In fact, the supplied RS-232 cable was clearly chosen with laptops in mind because it has 9-pin connectors on both ends. My desktop PC, however, requires a 25-pin connection for its COM port, so I had to purchase an adapter. One user remarked that the female DB9 connector on the radio was the opposite gender of other equipment in his shack, so he was happy to see that ICOM supplied the cable.

The manual states that the minimum computer configuration is a 486-66 with at least 16 Mbytes of RAM. The *recommended* system is a 100-MHz Pentium, however. We tried the PCR1000 with a 486-66 running *Windows 3.1* and even with a 386-25. The radio worked, but operation was sluggish. Switching to a 90-MHz Pentium made a huge difference. For this review, I used my home PC, a 200-MHz Pentium with 32 Mbytes of RAM and *Windows 95*. The performance was utterly fluid. With this in mind, we'd strongly suggest that you follow ICOM's recommended minimum. The more CPU horsepower and RAM, the better.

I loaded the software (supplied on two 3$^{1}/_{2}$-inch diskettes) and was soon presented with my choice of three radio emulation screens. You can choose to have your screen resemble a scanner, a typical communication receiver or it can manifest itself as a stack of "rack mount" components (see Figures 1-3).

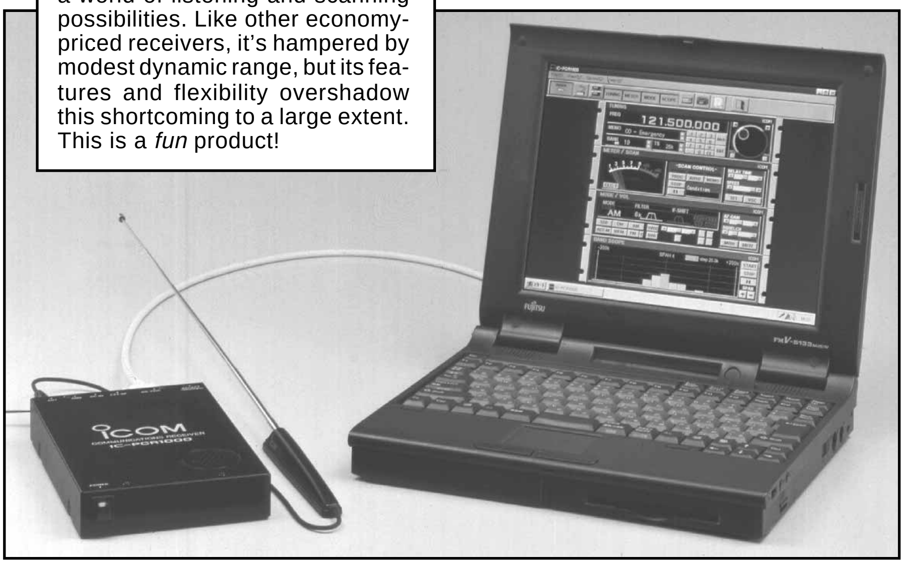
For my first test with the PCR1000 I picked the component screen, clicked on the tool bar to select the proper COM port and then clicked on the **POWER** switch (you must also manually toggle the **POWER** switch on the radio).

I selected the USB mode and then, using the keypad on the middle rack, selected 14.250 MHz. I clicked **ENT** (enter) and heard . . . nothing! I clicked on the **AF GAIN** scroll bar and moved it to maximum. Still nothing. After several minutes of fruitless fumbling I finally did what I should have done in the first place—read the manual. Upon doing so I discovered that SSB and CW audio is muted when the band scope function is active. Ah hah! Clicking off the band scope, I was rewarded with a flood of signals—most of them generated by my own computer.

Some PCs are more RF tight than others. My mongrel homebrew model leaks signals like a sieve. Unless you are blessed with a "quiet" computer, using the PCR1000's portable telescoping antenna is bound to disap-

BOTTOM LINE

A terrific marriage of computer and radio, the IC-PCR1000 opens a world of listening and scanning possibilities. Like other economy-priced receivers, it's hampered by modest dynamic range, but its features and flexibility overshadow this shortcoming to a large extent. This is a *fun* product!



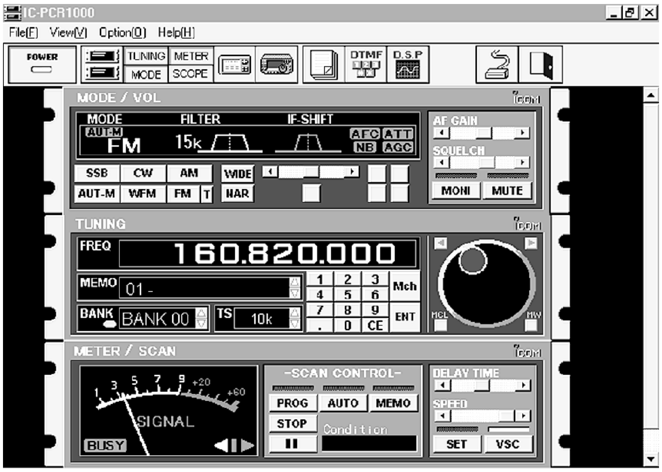


Figure 1—The PCR1000 "component screen."

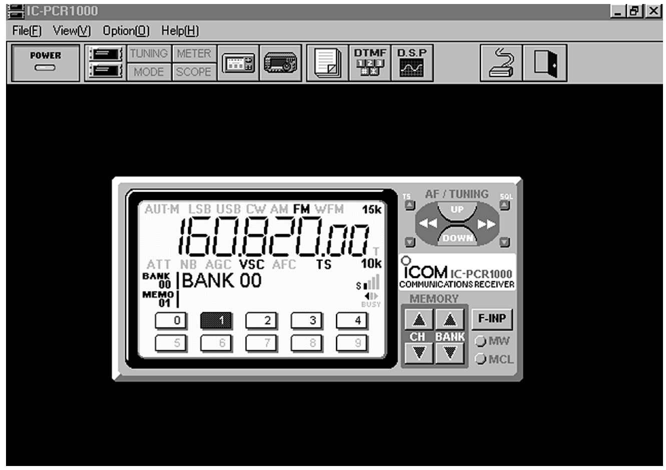


Figure 2—At the click of a mouse button the PCR1000 becomes a "scanner."

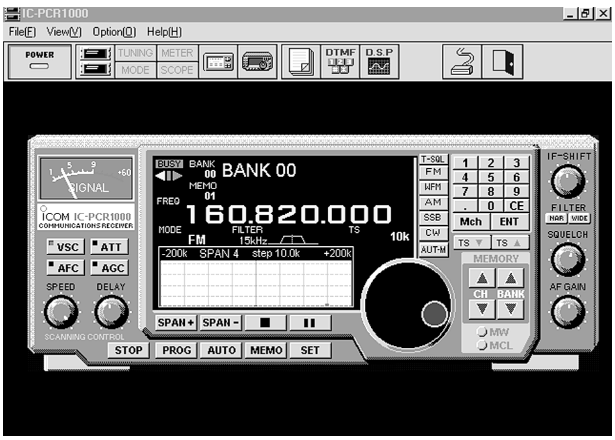


Figure 3—Some find the "communications receiver" format more appealing.

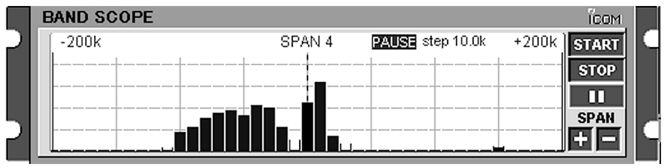


Figure 4—The band scope allows you to "see" signals as much as 200 kHz above and below the center frequency.

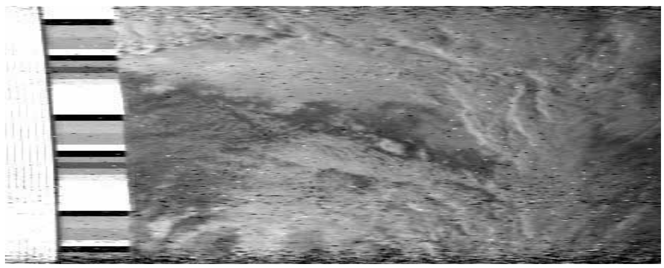


Figure 5—A NOAA-12 image, as received by the PCR1000.

point. With the antenna positioned nearby, you'll likely encounter "birdies" in abundance on almost every band. The solution is to suppress the interference from your computer (a potential exercise in hair-pulling frustration), use a noise-canceling unit such as those made by MFJ or JPS, or simply locate the antenna a considerable distance from your computer. I chose to connect the PCR1000 to my outdoor antennas, which essentially cured the problem.

MF and HF Listening

The PCR1000 opens a remarkable world of listening enjoyment. I began on the AM broadcast band, prowling for stations during the evening hours. As you'll see from the measured specifications, the PCR1000 lacks the kind of dynamic range necessary to hold its own against strong adjacent signals. Most of the numbers were in the 50s, and the third order-intercept point was well into negative numbers (see Table 3). By listening to AM stations in upper or lower sideband mode, I was able to avoid much of the interference. The PCR1000's attenuator function also helped keep the big signals down to a dull roar.

The PCR1000 specifies a tuning range all the way down to 10 kHz. Don't go there, however, because you won't hear much. As we point out in Table 3, the usable tuning range begins at around 200 kHz, so VLF fans likely will be disappointed. We measured the sensitivity on 100 kHz at –106 dBm (1.1 µV); on 10 kHz, it was –36 dBm (3.5 mV).

On the HF bands the PCR1000 really shines. I found myself plugging all sorts of "discoveries" into the PCR1000's virtually endless memories. As a result, I became a regular listener of rugby broadcasts from Radio New Zealand International, political commentary from Radio Sweden and cultural programming from Radio Korea.

By the way, tuning speed and steps were nicely implemented. One veteran radio op called it "one of the better mouse-driven arrangements for tuning that I've used."

For this review we ordered our PCR1000 with the optional UT-106 DSP board. The board installs easily inside the radio and is activated by a button on the software tool bar (this same board also works in the IC-706MkII). When you click the button you are presented with a DSP "panel." On the panel there is a button to activate the automatic notch filter and another to toggle the noise-reduction control, along with a nearby "knob" (shall we call it a "virtual knob"?) to select the degree of noise reduction. The automatic notch filter does its job adequately, but not nearly as well as the notch filters found in many outboard DSP boxes. In contrast, the noise reduction function turned in a stellar performance. By clicking on the switch and adjusting the knob, I was able to bring unlistenable signals into the clear. Yes, the signals were accompanied by the usual "hollow" sound common with this type of audio processing, but it was an entirely acceptable trade-off—particularly compared to not being able to hear the desired signal at all!

Without the DSP option, the PCR1000 is

Table 3—ICOM IC-PCR1000, serial number 01854

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 0.01-824; 849-870; 894-1300 MHz.	Receive, 0.2-824; 849-870; 894-1300 MHz.
Modes of operation: FM, WFM, AM, USB, LSB, CW.	As specified.
Power requirements: 0.7 A (max volume), 13.8 V dc ±15%.	0.6 A (max volume, no signal), tested at 13.8 V dc.
Size (HWD): 1.2x5x7.8 inches; weight, 2.2 lb.	
CW/SSB sensitivity (10 dB S/N): 0.5-1.8 MHz, 0.56 µV; 1.8-30 MHz, 0.28 µV; 30-50 MHz, 0.35 µV; 50-700 MHz, 0.2 µV; 700-1300 MHz, 0.25 µV.	Minimum discernable signal (500 Hz filter): 0.2 MHz, –123 dBm; 0.5 MHz, –124 dBm; 1.0 MHz, –127 dBm; 3.5 MHz, –135 dBm; 14 MHz, –131 dBm; 28 MHz, –128 dBm; 50.1 MHz, –132 dBm; 144.1 MHz, –132 dBm; 222.1 MHz, –133 dBm; 432.1 MHz, –134 dBm; 903 MHz, –130 dBm; 1296 MHz, –127 dBm.
AM narrow sensitivity (10 dB S/N): 0.5-1.8 MHz, 2.5 µV; 1.8-30 MHz, 1.4 µV; 30-50 MHz, 1.8 µV; 50-700 MHz, 1.0 µV; 700-1300 MHz, 1.3 µV.	AM narrow, test signal modulated 30% with a 1-kHz tone, 10 dB (S+N)/N: 1.0 MHz, 1.9 µV; 3.8 MHz, 0.7 µV; 29 MHz, 1.5 µV; 52 MHz, 0.9 µV; 120 MHz, 0.8 MHz; 146 MHz, 1.0 µV; 223 MHz, 0.9 µV; 440 MHz, 0.9 µV; 903 MHz, 1.1 µV; 1296 MHz, 1.4 µV.
FM narrow sensitivity (12 dB SINAD): 28-50 MHz, 0.5 µV; 50-700 MHz, 0.32 µV; 700-1300 MHz, 0.4 µV.	FM narrow, 12 dB SINAD: 29 MHz, 0.4 µV; 52 MHz, 0.3 µV; 146 MHz, 0.3 µV; 223 MHz, 0.2 µV; 440 MHz, 0.2 µV; 902 MHz, 0.2 µV; 1296 MHz, 0.3 µV.
FM wide sensitivity (12 dB SINAD): 50-700 MHz, 0.79 µV; 700-1300 MHz, 1.0 µV.	100 MHz, 1.0 µV.
Blocking dynamic range: Not specified.	CW mode, 500 Hz filter: 0.5 MHz, 68 dB; 1.0 MHz, 72 dB; 3.8 MHz, 66 dB; 14 MHz, 69 dB; 28 MHz, 71 dB; 50.1 MHz, 66 dB; 144.1 MHz, 62 dB; 222.1 MHz, 70 dB; 432.1 MHz, 70 dB.
Two-tone, third-order IMD dynamic range: Not specified.	CW mode dynamic range and third-order intercept point, (500-Hz filter):

Freq (MHz)	*Dynamic Range (dB)*	*Intercept point (dBm)†*
0.5	54	–24
1.0	57	–23
3.8	54	–32
14	55	–22
28	56	–23
50.1	53	–33
144.1	52	–35
222.1	56	–28
432.1	57	–29

	At 10 MHz spacing, 146 MHz, 83 dB; 440 MHz, 82 dB.
Second-order intercept point: Not specified.	–37 dBm.
IF/audio response: Not specified.	Range at –6 dB points, (bandwidth): AM: 85-4097 Hz (4012 Hz); FM: 259-976 Hz (717 Hz); FM-W: 79-6600 Hz (6521 Hz); USB: 463-4585 Hz (4122 Hz); LSB: 638-4036 Hz (3398 Hz); CW: 425-4249 Hz (3824 Hz).
Spurious and image rejection: Not specified.	IF: 14.2 MHz, 119 dB; Image: 14.2 MHz, 125 dB.
Squelch sensitivity (threshold): SSB/CW, 0.5-1.8 MHz, 14 µV; 1.8-50 MHz, 7.1 µV; 50-700 MHz, 5.6 µV; 700-1300 MHz, 7.1 µV; AM, 0.5-1.8 MHz, 1.8 µV; 1.8-50 MHz, 0.89 µV; 50-700 MHz, 0.71 µV; 700-1300 MHz, 0.89 µV; FM, 28-50 MHz, 0.63 µV; 50-700 MHz, 0.5 µV; 700-1300 MHz, 0.63 µV; WFM, 50-700 MHz, 5.6 µV; 700-1300 MHz, 7.1 µV.	At threshold: SSB, 1.0 MHz, 9 µV; 14 MHz, 3 µV; FM, 144 MHz, 0.3 µV.
S-meter sensitivity: Not specified.	S9: 1.0 MHz, 103 µV; 3.5 MHz, 85 µV; 14 MHz, 157 µV; 28 MHz, 126 µV; 52 MHz, 94 µV; 146 MHz, 92 µV; 440 MHz, 85 µV; 903, 1296 MHz, 85 µV;
Audio output: 200 mW at 10% THD into 8 Ω.	245 mW at 10% THD into 8 Ω.
Bit-error rate (BER), 9600 baud: Not specified.	146 MHz: BER @ 12-dB SINAD, 2.8×10^{-3}, BER @ 16 dB SINAD, 2.6×10^{-4}, BER @ –50 dBm, $<1.0 \times 10^{-5}$; 440 MHz: BER @ 12-dB SINAD, 4.3×10^{-3}, BER @ 16 dB SINAD, 4.0×10^{-4}, BER @ –50 dBm, $<1.0 \times 10^{-5}$.

NOTE: Except as noted, all dynamic range measurements were taken using the ARRL Lab standard spacing of 20 kHz.

NOTE: For optimal receive performance: BER @ –50 dBm, $1.0x^{-5}$ or less.

†Third-order intercept point was determined using S5 reference.

an adequate receiver, but for the noise reduction alone the DSP board probably is worth the extra investment. There is a noise blanker available on the PCR1000 as a standard feature (you just click on the **NB** button), but I didn't find it to be very effective.

You can turn the PCR1000's AGC on and off at the click of a mouse button. In the "on" position the AGC response is rather fast. A much slower AGC—or perhaps a selectable AGC response range—would make broadcast monitoring more pleasurable.

VHF/UHF Monitoring

The PCR1000 is a scanning enthusiast's delight. You can configure the radio for a variety of scan modes, including a mode that automatically writes to memory as signals are discovered. The scanning speed and delay (how long the radio pauses when it receives a signal) both are adjustable from convenient scroll bars. By clicking on the **VSC** button (Voice Scan Control), the PCR1000 will stop only when it detects a modulated signal (voice or music). This is a terrific way to avoid wasting time on the ubiquitous "dead carrier" signals.

The band scope function on the PCR1000 (Figure 4) is especially useful. For example, I know that nearby Bradley International Airport uses 125.800 MHz for approach control. I also know that there must be other active aviation channels nearby, but the transmissions are so short, they are difficult to identify. So, one afternoon I set the PCR1000 up on 125.800 MHz and set the band scope to display signals 200 kHz above and below the frequency. Suddenly I saw a sharp spike about 100 kHz down. I clicked on the spike and heard a TWA jet checking in with New York Center. Another click of the mouse entered the frequency into memory, storing the mode, filter setting and other information automatically. Hunting for signals with the PCR1000 band scope is as easy as fishing—*easier* in fact!

The PCR1000 includes 20 scanning-limit pairs—twice the number you'll find on many scanners. If there's a drawback for scanner buffs, it's that the PCR1000 does not let you scan more than one of the unit's 20 banks (50 channels each) at a time.

I found a handy software tool that allowed me to exploit the PCR1000's monitoring capabilities even further. I stumbled across *RecAll*, a shareware program that functions as a VOX (voice-activated switch) with your sound-card-equipped PC. (You'll find a trial version available for download from the Web at **http://www.topsoft.com/main/4015/14763806.asp**.) Sometimes I'd park the PCR1000 on a particular frequency and use *RecAll* to record (as .wav files) whatever the radio happened to pick up while I was away!

Thanks to the PCR1000's variety of bandwidth selections, you can also monitor television audio and FM broadcast signals. The PCR1000 did a superb job with FM broadcast. Too bad it doesn't have a stereo option.

Out of this World

One of the biggest surprises the PCR1000 had in store was its ability to function as a weather satellite receiver. I noticed right away that the PCR1000 permitted FM bandwidths up to 200 kHz (weather satellite reception requires a bandwidth of about 40 kHz). My home weather satellite situation, however, is far from optimal. All I have is a fixed 2-meter beam in my attic. For decent weather satellite reception you need an omnidirectional antenna such as a turnstile. To make matters worse, I didn't have a preamp for 137 MHz, the portion of the VHF spectrum inhabited by the polar-orbiting weather birds.

With my expectations appropriately low, I tuned in an early evening pass of NOAA-12 at 137.5 MHz. To my astonishment, I heard its warbling signal fairly well. Taking the next step, I downloaded a copy of *WXSAT.EXE* from the Web at **http://ourworld.compuserve.com/homepages/HFFAX/toc6.htm**. This is the software featured in the article by Eugene Ruperto, W3KH, "An Easy Way to Copy the Weather Satellites" (see *QST* Aug 1997, page 36). *WXSAT* uses your sound card to decode the weather satellite image data and displays the results on your monitor. Despite using an antenna that was pointing *away* from the satellite, and despite not having a preamp to boost the signal, I was still able to use the PCR1000 to copy several images (see Figure 5). I was left to only imagine what I could have done with a preamp and a good omnidirectional antenna!

Some Amateur Radio astronomers are using the PCR1000's UHF receive and scan features, too. If you go to the World Amateur Radio Astronomer's League site on the Web at **http://www.orion7.com/RA/waral.html**, you'll find a summary plan for a backyard radio telescope that uses the PCR1000 as a means for measuring 21-cm hydrogen emissions in our galaxy.

Ham Applications

The PCR1000 was never intended to be a ham receiver. Still, I was able to use the radio to monitor amateur transmissions from HF to UHF. On HF SSB the PCR1000 was a fine listening tool, but under crowded band conditions the limitations of its poor dynamic range readily became apparent. The PCR1000's IF shift function helps somewhat, but the radio is easily overwhelmed by adjacent signals. CW reception is especially problematic because the narrowest filter available is 2.8 kHz. A strong CW signal even 10 kHz away would "pump" the PCR1000's AGC to an annoying extent. Even so, coupled with a QRP transmitter, the PCR1000 would probably be an adequate companion receiver for casual operating.

Monitoring slow-scan TV (SSTV) on 20 meters was a snap with the PCR1000. The audio was already available at the sound card, so it was easy to fire up my SSTV software and copy images.

On VHF the PCR1000 made a perfect sporadic-E "watchdog." I'd set it up to scan from 50.125 to 50.200 MHz and use *RecAll* to capture the results (*RecAll* "stamps" each .wav file with the date and time). During the Spring Sprints I used the PCR1000 to eavesdrop on 222 MHz CW and SSB.

The PCR1000 includes a jack for 9600-baud data signals, and our ARRL Lab tests indicate that the receiver has very good data-reception characteristics. To test this function in the real world I set up the PCR1000 to copy the 70-cm downlink from the KITSAT-OSCAR 23 satellite. With a steerable antenna and a preamp, I was able to copy the downlink data throughout most of the pass. The most interesting aspect of the PCR1000 in this application, however, is its AFC—automatic frequency control. The PCR1000 will tune in 1-Hz steps, but I configured it for 500-Hz jumps to keep up with OSCAR 23's Doppler shift. Sure enough, with the AFC activated, the PCR1000 automatically retuned in 500-Hz increments to keep the downlink signal "centered" in the FM discriminator indicator. With a suitable 2-meter transmitter for the uplink, the PCR1000 would make an excellent component of a 9600-baud packet satellite ground station.

Remote control is part of the PCR1000's repertoire, too. At the most basic level you can set up the tone squelch so that the receive audio remains muted until the radio detects the correct CTCSS tone. The DTMF remote control is by far the most interesting, though. You can program a particular DTMF string and use it to cause a message to display on the monitor, play a .wav file or launch another program. I used this feature to frighten my wife from several miles away by commanding the computer to produce a shrill scream at earsplitting volume.

A less nerve-wracking application might be starting various station functions via remote radio control. Unfortunately, because of an apparent conflict in my system, I couldn't get the PCR1000 software to launch a program. It would, however, display messages and play .wav files. On other computers, the program-launch function worked just fine. Go figure.

Conclusion

The PCR1000 has something to intrigue and satisfy everyone. Shortwave listeners and scanner buffs will love this little radio (our resident HQ scanner buff called the PCR1000 "pure dynamite" and gave it two thumbs up "because that's all I have"). Yes, operating a radio by mouse clicking on virtual controls takes some getting used to, but you'll be surprised at how quickly you will adapt. Hams will appreciate its remarkable versatility. The PCR1000 is a potential platform for all sorts of Amateur Radio applications. Each day that I had the radio in my possession I was thinking of yet another way to use it. Perhaps one of the most difficult aspects of reviewing the ICOM IC-PCR1000 was trying to keep the radio away from everyone else who wanted to "borrow" it!

Many thanks to Joe Bottiglieri, AA1GW, and Bill Moore, NC1L, plus Mike Tracy, KC1SX, and Ed Hare, W1RFI, of the ARRL Lab for their contributions to this review.

Manufacturer: ICOM America Inc, 2830 116th Ave NE, Bellevue, WA 98004, tel 206-454-8155; fax 206-454-1509; **http://www.icomamerica.com**. Manufacturer's suggested retail price: IC-PCR1000, $599; UT-106 DSP option, $166.

Agrelo Engineering DFjr Professional Radio Direction Finder

Reviewed by Stan Horzepa, WA1LOU
QST *Contributing Editor*

High tech radio direction-finding (RDF) equipment now is affordable, thanks to Agrelo Engineering's DFjr. The DFjr is a radio direction-finding system that uses the Doppler effect to determine the source of a radio signal. Increased attention on fox hunting in the US could enhance demand for this and similar equipment in the future.

The DFjr can be used at a fixed site or while mobile. The system has two main components, the antenna system and the control unit. The antenna system consists of four quarter-wave antennas mounted on cross arms. The base of each antenna has a magnetic mount for attaching the antenna system to a metallic surface, such as the roof of a automobile or other vehicle. At the junction of the cross arms is the antenna switching circuitry that electronically "spins" the antenna system by switching each antenna on and off in rapid succession (the rate is 500 Hz).

If the spinning antenna receives a signal, the Doppler effect is used to calculate the angle of the radio signal. Each component of the spinning antenna receives the radio signal at a slightly different frequency and those changes in frequency are fed into the DFjr's microprocessor to calculate the intercept angle and, thus, the signal direction.

The control unit provides the user interface to the DFjr system. Three push-buttons control the configuration and operation of the DFjr, and 19 LEDs provide feedback to the user. Three LEDs indicate if the unit is powered and if the audio of the received signal is too low or high enough for correct RDFing. The remaining 16 LEDs are arranged in a circle, each 22.5° apart, and they indicate the direction of the received radio signal. The control unit also contains connectors for cabling the unit.

Batteries Not Included

In addition to the DFjr, you need an FM receiver or transceiver, an external speaker, and a cable to interconnect the external speaker to the DFjr.

The bundled cable to connect the radio's audio output to the DFjr control unit uses 3/32-inch subminiature connectors, so I had to obtain a subminiature-to-miniature adapter to connect this cable to the miniature jack of my 2-meter radio's audio output. It was just the opposite with the external speaker connection. The cable of my external speaker has a miniature connector, so I had to obtain a miniature-to-subminiature adapter to connect it to the DFjr control unit's subminiature audio output jack. Subminiature-to-miniature and miniature-to-subminiature adapters are readily available, but the third adapter was a little more worrisome.

The antenna cable terminates in a male BNC connector, so I had to obtain a female-BNC-to-male-PL-259 adapter to mate the antenna cable to my radio. You can find such an adapter easily at many hamfests, but don't look for it at Radio Shack. The store does not list such an adapter in its catalog, although my local Radio Shack "just happened" to have one female-BNC-to-male-PL-259 adapter in the store. Talk about luck! The quick alternative would have been to snip off the BNC and solder on a PL-259, but this was not my DFjr.

Some Assembly Required

Like most antennas you purchase, the DFjr antenna system is shipped entirely disassembled. However, it all came together in well under one hour because of the detailed and well-illustrated assembly instructions.

The antenna whips are approximately 20 inches long. To obtain optimal performance from the DFjr, you should cut them to quarter wavelengths for the frequency of choice. Although all my tests were on 2-meters or 162 MHz, the DFjr is designed to perform from 100 MHz to 1 GHz.

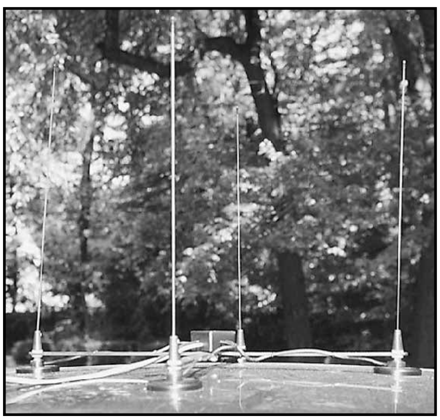
Where you mount the whips on the crossbars varies depending on the frequency of choice. There are three mounting holes for each whip. The outer holes are intended for the 121 to 174 MHz range, the center holes are for the 172 to 285 MHz range, and the inner holes are for the 350 to 550 MHz range. Agrelo says you can track 6 meter signals with whips at the 2 meter spacing "as long as the signal is strong." If you are going to be doing a lot of RDFing, the best approach is to buy additional sets of whips and cut them for each band you use.

Wet Black Noodles

I used my '95 Olds to test the unit. Kids, don't try this at home. I am a professional nut, so it's perfectly fine for me to drive down the interstate at the going rate (which has nothing to do with the posted speed limit) while pushing buttons on the DFjr and watching its display. To RDF with any success (and without a car wreck), you need an assistant. One member of your RDF team drives the vehicle, while the other member mans the DFjr and directs the driver where to go.

BOTTOM LINE

The Agrelo DFjr opens up a world of radio direction finding possibilities at a price that's within the reach of many amateurs.



The DFjr antenna array.

The antenna system sat on the roof of my land barge with plenty of room to spare. Its cross arms are approximately 27 inches long, so the antenna system is small enough to fit on the roof of even the most *compact* compact car. The DFjr can also be used from a base station. At a base station, the antenna system must sit on a ground plane. A sheet of metal will do, with a minimum of 30 inches per side. In either a mobile or base station installation, there should not be any other antennas nearby. I removed my 2 meter and 222 MHz antennas from my car during the test. Luckily, both use magnetic mounts.

After cabling the DFjr, the inside of my Olds looked like someone had dumped in a bowl of wet, black noodles! For starters, two cables from the antenna system must be routed inside the vehicle. The cable terminated with a male BNC connects to the radio antenna output, and the cable terminated with an RJ-11 modular plug connects to the control unit. For my temporary test installation, I simply routed these cables through a car door opening. For more permanent installations, you'd probably want to find a better way of routing the cables inside in order to avoid damaging them when the car door is slammed shut.

In addition to the antenna and control-unit cables, another cable connects the audio output of the radio to the control unit, still another cable connects the control unit to an external speaker, and finally, there's a cable to supply 13.8 V dc to the control unit. The judicious use of cable ties made some order of the mess of noodles.

An important installation note: Transmitting into the DFjr antenna system likely will damage it. To avoid potential damage, store the microphone of the radio out of sight and out of mind.

Finding the Best Way to Find

Learning how to use the DFjr reminded me of learning how to use a metal detector. In the beginning, everything you find is wrong, but after a little practice, your finds are more rewarding.

Before you start, you must calibrate the system with a known radio signal source. This involves aligning your vehicle so its front end is pointed toward the signal source, then pressing the three buttons on the control unit simultaneously. My 2 meter radio receives out of band, so I used a 162 MHz NOAA weather radio station, WXJ42, located about eight miles away on West Peak in Meriden, Connecticut. West Peak is essentially line-of-sight from my driveway. Trees block my view of West Peak from the driver's seat, but if I stand on the roof of my car, there it is!

During my twice-daily 23-mile commute, I drive within a mile of WXJ42. Since it transmits continuously and I can actually see its location during most of my commute, I decided to use it while breaking in the DFjr.

Commenting on my QTH, my wife's cousin once said it isn't at the end of the earth, but you can see the end of the earth from where I live. It is the boondocks, and about a third of my commute is on narrow roads lined by very tall trees with limbs that reach out across the road and shake hands with each other. This scenario is *not* ideal for RDF, and my initial impressions of the DFjr were not good, But as the roads widened and the trees thinned, I became more impressed with the DFjr's capabilities.

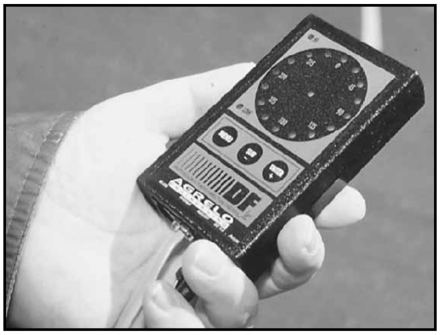
Out in the open, I watched the DFjr display pointing at WXJ42. As I swung the Olds left and right, the DFjr display swung right and left, constantly pointing at the WXJ42 transmitter. (If the display swung left and right as my vehicle swung left and right, this meant that the display was inverted. Simply pressing two push-buttons on the control unit corrects/inverts the display's orientation instantly.)

The DFjr could not properly find WXJ42 when I was closest to it! That was because I was in the shadow of West Peak (my guess is that the highway is 500 feet below the peak of West Peak where WXJ42 is located). To make matters worse, the side of West Peak that I commute by is not a gradual slope. Instead, it is composed of sharp vertical cliffs, which makes matters worse for RDF.

Fine-Tuning the DFjr

As I became more familiar with the DFjr's capabilities, I was able to compensate for the shadows of West Peak, as well as operation in the boonies around my home.

The DFjr uses a statistical analysis feature that performs averaging, vector summing, and multipath detection while an RDF vehicle is in motion. Adjusting the quality factor threshold of the DFjr affects how the unit performs these functions. In areas where there is a lot of multipath (signals bouncing off buildings, trees, cliffs, and other objects, thus confusing the DFjr), I adjusted the quality factor threshold of the DFjr to be more "selective." This meant the system used a higher number of statistics before outputting a result. The higher the threshold is set, the



The DFjr control unit.

more likely it is that the multipath readings get averaged out. Although the results (the calculated direction of radio signal) appear less frequently with a higher threshold setting, they are more accurate.

In addition to the statistical analysis mode, the DFjr has a raw mode, in which the DFjr displays "raw" Doppler data without performing any statistical analysis. As a result, real signals and multipath signals show up on the display. The advantage of the raw mode is that the Doppler data show up on the display quickly. Unless you are out on an open plain or in the desert, however, multipath will frustrate you. In my area, I found the raw mode to be useless unless I was right on top of the radio signal source.

Simulating Real Life RDF

After breaking in the DFjr, I tried some more difficult RDFing. Instead of using a radio signal that was transmitting continuously, I used one that transmitted short bursts of RF intermittently: my 2-meter APRS digipeater. I found that the DFjr performed just as well locating my digipeater as it did locating WXJ42. The only difference was that due to the intermittent nature of my digipeater's transmissions, the DFjr display was not being updated constantly as it was when locating WXJ42. But this was to be expected, and this was more akin to real-life RDF situations—locating a repeater jammer, for example.

The DFjr also performed very well when I had an accomplice transmit randomly from different locations using a 2-meter hand-held transceiver.

In general, I was very impressed with the performance of the DFjr. Practice makes perfect, and if you persist and practice RDFing with the DFjr, you can become an RDF expert. I do have a couple of minor nits to pick:

• Terminating the antenna cable with a BNC connector seemed like a poor choice to me. All my radios use SO-239 connectors for antenna connections. I asked Agrelo Engineering about this, and Joe Agrelo responded, "When we introduced the DFjr, we did a survey of the most commonly used receivers and most of them used BNCs. In the very beginning we used the PL-259 and everyone complained." And, so it goes!

• There is no power switch on the DFjr. To power off the DFjr, you must disconnect its power cable from the power source (or install an in-line switch to control the power).

APRS-Compatibility

The DFjr is also APRS-compatible. Add Agrelo Engineering's multiport adapter to the system and you can interface the DFjr to an APRS station. The DFjr control unit has an RJ-11 RS-232 connector for this purpose.

When configured with APRS, the DFjr's data result in the display of bearing lines on an APRS map. These bearing lines start at your vehicle's position on the APRS map and radiate in the direction of the received radio signal as determined by the DFjr. Two mobile APRS stations equipped with DFjrs could triangulate their bearing lines and quickly accomplish an RDF task.

Manufacturer: Agrelo Engineering, Box 231, Pattersonville, NY 12137; tel 518-864-7551; fax 518-864-7553; **http://www.agrelo.com**. Manufacturer's suggested retail price: Agrelo DFjr, $390.

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