6,400 CHANNELS FOR YOUR PRO-2004 SCANNER

Chicagoan Denny Beringer sent in a few sheets he picked up at Dayton describing a modification to expand the memory in the Radio Shack PRO-2004 scanner from 300 to 6,400 channels.

The new circuitry adds 3 ICs, a 7 segment readout, a ribbon cable, a pushbutton switch, and a few resistors and capacitors.

First, diode D510 is added which expands the scanner from 300 to 400 channels. Then, IC504, the stock memory memory IC (a uPD446G), is removed and replaced by a ribbon cable leading to an added printed circuit board. The additional board contains an HM62256 32Kx8 static RAM IC, which holds 16 groups of 400 channels each. (note: if you don't do diode D510, I think you'll get 4800 channels, though I haven't tried any of this. I heard that the 400 channel mod makes the markings on the 2004 keyboard incorrect. WA2ISE)

A pushbutton switch, attached to a 4060 CMOS 14 bit binary counter IC, selects one of the 16 groups. The 4 counter output leads are used to select the high order 4 bits of the HM62256. The new group select pushbutton switch is mounted on the front panel, in place of the headphone jack.

How can you tell which group you are in? A specially programmed EPROM (type 2716, 2532, or 2732) is addressed by the ouput of the counter. The EPROM output is connected to a 7 segment LED readout, mounted in place of the Sound Squelch pushbutton. The readout indicates groups 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F.

[Note: If I were to expand the memory in my PRO-2004, I would use just the new HM62256 memory IC and a BCD switch instead of the pushbutton. This would eliminate two of the three ICs, and the 7 segment readout. Sorry, I cannot provide further information, nor a reference, as the sheets sent to me contained no name or address. - Bob

CELLULAR MODIFICATION: REALISTIC PRO-2004 SCANNER:

BY CUTTING DIODE D513 ON THE PC 3 SUB CHASSIS IN THE REALISTIC PRO-2004 SCANNER YOU CAN RE-ENABLE THE 825.00 TO 845.00 AND 870-00 TO 890.00 FREQENCY SELECTION. TO SCAN IN 30KHZ STEPS PRESS "STEP-RESET". NOTICE:IT IS NOT LEGAL TO MONITOR CELLULAR TELEPHONE CONVERSATIONS ON THE CELLULAR BAND.

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POPULAR COMMUNICATIONS Magazine published some interesting articles on the PRO-2004. Here is the list:

PRO-2004: 400 Channel memory expansion: December 1988 p.28.

PRO-2004: Search and Store Sodule: march 1990 p.24.

PRO-2004: review + Cellular Modification: August 1987 p.16.

Daniel VE2BAP ' VE2CSC.PQ.CAN.NA

Another cellular mod

In response to numerous inquiries I am posting a short overview of the mods to the Radio Shack PRO-2004 scanner. First, all mods are done at

your own risk. I assume no responsibility. I do not know what effect they (the mods) will have on any warranty, however I would think they would probably void it. Also, one of the mods restores coverage of the cellular phone frequencies.

These mods are detailed in the following articles:
a) POPULAR COMMUNICATIONS AUG 87, PP 18-20
b) MONITORING TIMES OCT 87, P 53
c) MONITORING TIMES DEC 87,P 60

I suggest strongly that you obtain the back issues and read through the letters or articles. I also suggest you subscribe to the mags. They supply a lot of great info and freq lists. Now the mods.

1) Restoring 870 MHz coverage.
First treat the radio as if it were CMOS, that is make sure you and it have no built up static charges. UNPLUG THE RADIO FROM THE AC OR DC POWER SOURCE AND ANTENNA !!!!!!!! Take the radio out of the case by removing the 4 screws on the back. Carefully invert the radio. Locate a box-like sub-circuit. It's near the switch marked "restart". The sub-circuit should be marked PC-3. Carefully pry off the cover of the metal box. Inside there will be a 64 pin dip IC. This is the radio CPU. Be careful not to touch or short out any leads on the chip. Near the chip there will be a row of diodes marked D-502 to D-515. If D-513 is present, cut one lead, separate it so they will not touch, and magic, 870 Mhz is restored. If D-513 is not there and you still do not have 870 coverage, then a little more work is in order. Locate the 9 pin connector "CN-501". Carefully remove it from the sub-circuit. Unscrew the screws holding PC-3 to the main chassis. Carefully invert the sub-circuit board (PC-3). Locate the one lone component on that side of the board. If it is a diode, as it should be, then cut one lead and separate them as above. Re-install the sub-circuit with the screws on to the main chassis. Reconnect the 9 pin connector. Do NOT put the cover back on just yet ?!

2&3) 400 CHANNEL and SPEED MOD !

On the top of the sub-circuit board, locate the slot for D-513. Count backwards from there until you get to the space for D-510. Install a diode at D-510 in the same polarity as the rest of the diodes. There, you now have 400 channels instead of 300 ! Now install a diode at D-514 and you have increased the scan speed to 20 channels/sec from 16 ch/sec. Carefully re-assemble the metal box. Make sure everything else is as it should be. RE-invert the radio so it is right side up.

4) THE SQUELCH MOD !!

Now, locate a sub-circuit box under the sloping front panel. It should have many alignment holes in the top. Pry the cover off very carefully. Locate IC-2 in the left side of the pc board. It should be marked IC-10420. Locate R-148, a 47 K ohm resistor between pins 12 and 13. Cut a lead of this resistor, But be sure to leave enough lead on both sides of the cut to solder to. Patch in a 100K ohm resistor. Make sure there are no solder balls or short circuits. Now your squelch will operate more smoothly.

Again, I STRONGLY suggest you obtain the above mentioned magazines for more details. Addresses appear below. Please ignore any mis-spellings, mis grammer, etc. Good luck and good listening !!!

Manufactured in Japan, by General Research Electronics, the Radio Shack PRO-2004 is a 300 channel, wide coverage scanner radio, incorporating NBFM, WBFM, and AM modes.

Although the catalog description doesn't do the radio justice, the microprocessor circuitry provides features not found in other scanners.

This review, although admittedly subjective, focuses on three broad characteristics: feature set, basic electrical performance, and mechanical construction.

Frequency Coverage

The PRO-2004 literature states that coverage is from 25-520 and 760-1300 MHz. Radio Shack's last minute decision to remove cellular telephone frequency coverage from the PRO-2004 caused a 7 week delay in its introduction. A small card is now packed with each scanner, informing the buyer that the radio will not operate in the 825-845 and 870-890 MHz ranges.

A matrix of diodes, attached to the microprocessor's input port, is often used to configure radios for sale in different markets. From recent flux on the circuit board, it appears that a diode has been added or removed from my PRO-2004, and this may be how the cellular telephone coverage was yanked.

Lots of Memory

The PRO-2004 has the usual features that scanner buffs have come to expect: individual channel lockouts, selectable rescan delay, an external speaker jack, etc. But, the 300 channel capacity of the PRO-2004 sets an industry record! Casual scanner users may scoff at the usefulness of having so many channels, but seasoned monitorists can have those channels filled up in no time flat, especially with frequencies in the vast 225-400 MHz military air band.

With so many channels to program, one dreads the thought of a power failure, which could clear memory in a hurry. Not to worry, the PRO-2004 memory is backed up by a conventional 9 volt alkaline battery (not supplied). The 300 channels are divided into 10 banks of 30 channels each, and one can select or deselect any channel bank from the scan list. Individual channels can be locked out in the customary way, but the PRO-2004 provides a new feature, a LOCKOUT REVIEW. Successive depressions of this key step through the locked out channels.

The owner's manual refers to the ability to delete a channel by storing a 0 frequency in it, not a particularly useful exercise. The scanner will still spend time scanning a "deleted" channel unless it is locked out with the LOCKOUT key, which then means it appears in the lockout list when using the LOCKOUT REVIEW feature.

Scanners worth their keep have a priority feature, with

channel 1 usually designated the priority channel. The PRO-2004 is more flexible; any of the 300 channels may be designated the priority channel. When the PRIORITY key is depressed, that channel will be sampled every 2 seconds, and the radio will stay there if a signal is heard.

The PRO-2004 has two scan speeds, although one would probably use the faster, 16 channel/second speed in most instances. This compares favorably with 14 channel/second speed of the Bearcat 800XLT.

When programming a channel, the PRO-2004 firmware sets the mode automatically, based on its idea of what mode is most prevalent on that frequency. This feature saves extra keystrokes, and makes one appreciate the thought that went into the design of this radio. The default mode can be overridden easily, if need be, like to listen to a NBFM satellite in the 225-400 MHz range, which is mainly populated with AM signals.

Misc mods

Searching

The SEARCH facility found on most programmable scanners allows the entry of a pair of frequencies, then by pressing a key, the radio searches frequencies between those limits. The PRO-2004 allows for 10 pairs of limits! These pairs of limits are stored in their own memory, and don't use up any of the conventional 300 memory channels. One can set up several search pairs, for instance:

- 46.610-46.970 MHz: cordless telephones
- 144-148 MHz: the 2 meter ham band
- 30.01-30.56, 32-33, 36-37 MHz: US Govt

Another unique feature is the MONITOR key, which stops the search and stores the frequency in one of ten special monitor memories. These memories are separate from the 300 main memory channels. The search can be restarted from where it left off by striking the up or down arrow key.

The user can select the search direction (up or down), and step size of 5, 12.5, or 50 KHz, although the PRO-2004 is intelligent enough to select a default step size based on the frequencies being searched. The owner's manual claims that a step size of 30 KHz is also available, but apparently this step size was disabled when the cellular telephone frequency coverage was removed.

The selected parameters are displayed on the LCD panel. Search speed is switchable between slow and fast, with fast search being about 14 increments/second (versus 12 for the 800XLT). For a 12.5 KHz increment, this translates to 11.2 MHz/minute (versus 9.6 MHz/minute

for the 800XLT).

The DIRECT key allows one to start searching up or down from whatever frequency is on the display. Let's say the scanner is in MANUAL mode, and set at channel 26, which contains 460.100 MHz. Striking the DIRECT then UP-ARROW keys starts the PRO-2004 searching upwards from 460.100. This is a nice feature.

The PRO-2004 contains a "window detector" circuit, which is called into play during a SEARCH operation. This circuit tries to detect when the radio is tuned close to the center frequency of a station, and prevents the search from halting prematurely, off to the side of the signal.

The AFC (automatic frequency control) circuit of the Bearcat 800XLT often causes a search of 850 MHz signals to halt prematurely. Even though the signal sounds on frequency, the display reads the wrong frequency. The PRO-2004 does not have this problem.

Another interesting feature is the SOUND SQUELCH, which may be used during scan or search operations. With the the sound squelch enabled, signified by a red lamp above the pushbutton, the scanner will skip over unmodulated signals. This is handy for skipping over "birdies", or link signals with a constant carrier.

According to the owner's manual:

- "When the PRO-2004 stops at a frequency which has no sound, it remains there for 0.5 seconds, and then goes to the next frequency if" no sound is detected "within that time."

  "When a frequency which contains sound is received, it halts at the frequency. But,

  a. If the sound ceases during the reception, it stays on the frequency for 5 seconds, and resumes scanning."

  b. "If the [station] stops sending a carrier, the unit reverts to scan [or search] immediately if DELAY is off, after 2 seconds, if the DELAY is active."

The manual warns that the sound squelch may be fooled by signals with low modulation, and skip over them. The PRO-2004 SOUND SQUELCH tries to detect the presence or absence of modulation (not human speech), so unfortunately, it thinks that mobile phone idle tones, digital data signals, and paging tones are worth monitoring and will stop the scanner to listen to them.

Taping Facility

A tape recorder can be connected to the TAPE phono jack on the rear panel, which provides 600 mV of audio at a

10,000 ohm impedance. In addition to a rear mounted external speaker jack, there is a headphone jack on the front of the scanner.

Basic Performance

To evaluate sensitivity, the $400 PRO-2004 was compared with a $950 ICOM R7000 and a $300 UNIDEN/Bearcat 800XLT. Since a signal generator was not used, quantitative measurements could not be made. Instead, various antennas were switched between radios, signals from stations were compared by ear, and the results tabulated.

Simply put, the PRO-2004 is sensitive enough to allow one to hear what needs to be heard, and not so sensitive as to be overloaded by strong signals. On 850 MHz, signals were readable on the PRO-2004 which couldn't even be detected on the R7000.

Although the 800XLT is the most sensitive radio of the three tested, it suffers from images and overload much more than the PRO-2004 or R7000. The PRO-2004 has a 10 dB attenuator, operable by a slide switch on the rear, but its use has been unnecessary thus far.

The up conversion design of both the ICOM and Radio Shack units allows use of a very high IF (intermediate frequency), which helps avoid image problems. The PRO-2004 owner's manual doesn't list the IF frequencies directly, but a good guess is that the first two IFs are 610 MHz, 70 MHz. The third IF looks something like 455 KHz when using AM or NBFM, and perhaps 10.7 MHz when the WBFM mode is selected.

The PRO-2004 is slightly more selective on NBFM than the 800XLT. WBFM selectivity is rated at about twice as wide as the ICOM R7000.

The audio output quality is good, although it seems to lack the punch of the 800XLT audio. The top mounted speaker directs the sound at the ceiling, but adding an external speaker would allow the sound to be directed at the user.

Unfortunately, the audio level of AM signals is somewhat below that of NBFM signals, requiring a different setting of the volume control. When scanning both AM and NBFM modes, one has to find a compromise position of the volume control.

The PRO-2004 squelch control has a bit too much hysteresis, a trait inherited from its ancestors. It's like having too much play in a car's steering wheel, or backlash in a gear set. This hysteresis forces one to keep the squelch at a tighter setting, missing weaker signals when scanning or searching. The Bearcat 800XLT has this trait also, but the fix is simple. I've successfully eliminated this problem completely by replacing a single resistor on the 800XLT, as well as

the PRO-2002, PRO-2003, and PRO-24 scanners.

Mechanical Construction

The PRO-2004 is heavy. It is enclosed in a metal cabinet, but has a plastic front panel. If one is going to pay $400, one deserves to own some metal. The entirely plastic cabinet of the older PRO2003 allowed wideband noise to radiate out of the scanner and into nearby shortwave receivers.

There is a single BNC antenna connector on the rear of the PRO-2004, and a single telescoping antenna is supplied. This differs from the 800XLT which has 2 "Motorola type" antenna connectors, one reserved for the 800 MHz band.

Internal construction is excellent. Most stages are completely enclosed in their own individual shielded boxes. Interstage shielding is very important in a wide band receiver, to prevent it from "hearing itself", an undesirable phenomena which results in "birdies".2 The shielding is much better in the PRO-2004 than in the 800XLT, which uses no shielding around the 800 MHz converter stage, and probably accounts for some of the birdies in the Bearcat.

Frequencies and other indicators are displayed on a backlit LCD (liquid crystal display) panel, and the level of backlighting can be dimmed by a pushbutton switch.

The flat membrane keyboard has a nice feel. Only slight pressure is required for actuation, and key depressions are confirmed by a mild "beep" audio tone.

The PRO-2004 might be too large to fit under the dashboard of compact cars. Although it can be operated on 12 VDC, neither a mobile power cord nor mounting bracket are provided. These items were included with earlier Radio Shack models. The AC power cord is not detachable, and would have to be bundled up to keep it out of the way in a mobile installation.

Owner's Manual

The user manual suffers from Japanese to English translation problems, but is fairly good, resembling other Radio Shack scanner manuals.

A single page frequency allocations chart is included, but is not current. There is a very simplified block diagram, but no schematic. The Maintenance section contains a useless troubleshooting chart, accompanied by advice like "keep it dry" and "do not drop". Thankfully, detailed service manuals for Radio Shack scanners are usually available for $5.00 or $7.50.

The PRO-2004 is warranted for 1 year, which is reassuring.

What's Missing?

So with all these neat features, what's missing from the PRO-2004? A "search and store" mode, like that on the ICOM R7000 and older Bearcat 250 would have been nice. A lighted keyboard and a signal strength meter would also be welcome.

Having a COR (carrier operated relay) output, like ICOM R7000 and old Bearcat 250 have, would be useful for actuating a tape recorder.

Summary

If all one wants is a scanner to monitor local police and fire, there are certainly cheaper and simpler models than the PRO-2004. This scanner is for those who enjoy actively exploring voice communications in the VHF/UHF spectrum.

The PRO-2004 has the right features and performance, especially for scanning the wide 225-400 MHz military aircraft band. Good design should not to be taken for granted. GRE engineers used the power of the microprocessor to implement useful features in the PRO-2004.

Similar processing horsepower was not used so wisely in a recent Yaesu scanner.

At about $400, the PRO-2004 provides a good alternative to those not wishing to spend $950 for an ICOM R7000.

TABLE 1. Sensitivity of Radio Shack PRO-2004 vs. ICOM R7000

Band	PRO-2004	R7000
47 MHz	slightly less sensitive	slightly more sensitive
72 MHz	more sensitive	less sensitive
Commercial Air Band	(not tested)	(not tested)
150-165 MHz	equal	equal
223 MHz	less sensitive	more sensitive
460 MHz	equal	equal
855 MHz	much more sensitive	much less sensitive
953 MHz	more sensitive	less sensitive

TABLE 2. Sensitivity of Radio Shack PRO-2004 vs. UNIDEN/Bearcat 800XLT

Band	PRO-2004	800XLT
47 MHz	equal	equal (many images)
72 MHz	N/A	N/A
Commercial Air Band	(not tested)	(not tested)
150-165 MHz	less sensitive	more sensitive
460 MHz	less sensitive	more sensitive
855 MHz	slightly less sensitive	slightly more sensitive

<h3>Still Another Cellular Mod.</h3>

The PRO-2004 scanner can be used to receive cellular telephone conversations. Originally, the scanner was able to receive in this band, but at the last minute, it was decided to delete cellular coverage from the PRO-2004.

The procedure to re-instate the cellular band is simple for anyone with a pair of cutters, and a phillips screw-driver.

1. Remove the four screws from the back of the radio, and slide off the cover from the chassis.

2. Turn the radio upside down. You will find a metal box-like sub-chassis in the center of the main chassis. Remove the cover and you will be looking at the CPU, a 64-pin integrated circuit.

3. Examine the component side of this board, and you will find a row of diodes and resistors. On one end of the row you will find a diode labeled D-513.

4. Clip the accessible end of D-513, and pry apart the ends so they don't touch. You have just restored cellular coverage to you scanner.

5. If D-513 is not there, it may be located on the underside of the circuit board.