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Daiwa CNA-1001 Automatic Antenna Tuner

Heath VF-7401 2-Meter Transceiver

Japan Radio Company Model NRD-515 All-Wave Receiver

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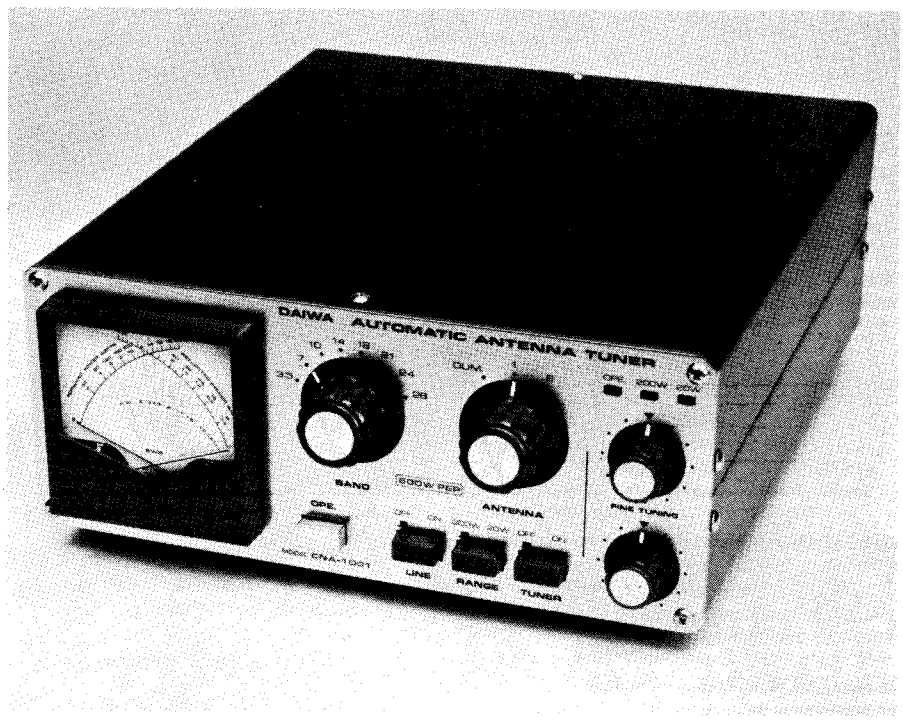
The Daiwa CNA-1001 Automatic Antenna Tuner

The antenna tuner or Transmatch has become a staple accessory in many ham shacks. Until recently, little has been done in Amateur Radio to automate the actual tuning process, but now the amateur operator can rely on electronic means for setting the tuner controls on the band of his or her choice. Daiwa's CNA-1001 represents an interesting new form of electronic Transmatch operation.



Daiwa CNA-1001 Automatic Antenna Tuner Serial No. D08023

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency range: 3.5-30 MHz, WARC bands included.	As specified.
Input/output impedance: 50 ohms.	
Meter scale: Fwd/ref 5:1.	
Meter range: Forward, 20/200 watts; reflected, 4/40 watts.	
SWR detection: 5 watts, min.	As specified for visible reading.
Power rating: 500 watts, PEP.	250 watts dc input.
Insertion loss: Not specified.	0.4 dB at 28 MHz.
Input power for automatic operation: 1-12 watts.	As specified.
Impedance matching range: 3.5 MHz, 15-250 ohms; 7-30 MHz, 10-250 ohms.	As specified
Automatic operation time frame: 45 seconds, maximum.	15 to 30 seconds.
Power requirement: 13.8 V dc at 0.2 A	As specified.
Dimensions HWD: 3-5/8 × 7-7/8 × 9-5/8 inches	
Weight: 8 lb.	
Cabinet materials: Steel and brushed aluminum.	
Color: Blue-gray.	
Output terminals: 2 antennas (SO-239 connectors) plus internal 10-watt dummy load.	As specified.

Note: mm = inches × 25.4, kg = pounds × 0.4536.

Theory of Operation

The CNA-1001 is comprised of an internal directional coupler and associated VSWR meter, the matching network, and the sensing circuitry that controls motorized tuning capacitors used in the matching network. Metering is accomplished with the Daiwa cross-needle design, which allows simultaneous observation of forward and reflected power and VSWR, the latter corresponding to the intersection of the meter needles. The sensing circuit samples the rectified rf voltage induced within the directional coupler. This voltage, whenever the VSWR is higher than 1.5 to 1, closes a solid-state switch that completes a 12-volt line to the capacitor drive motor. The motor is turned off when the VSWR drops below 1.5 to 1, and the switching circuitry is cut off.

A pi-network circuit is used. It incorporates an 8-position tapped inductance that is controlled manually from the front panel. Additional series capacitance is provided at the tuner output. The 250-pF parallel and series capacitors at the network output that make up the automatic feature of the CNA-1001 are motor driven. Smaller, 30-pF variables are wired in parallel with the motor-driven units; these are set manually from the front panel and are designed to touch up the match once the capacitor drive motor shuts off. The motorized capacitors are geared together in a 30:1 ratio, the series capacitor turning at the faster rate (such gearing appears to be a clever means of eliminating the need for separate drive motors). This arrangement permits the network to "scan" the mismatched condition until a proper match is obtained.

Method of Operation

The instructions provided with the CNA-1001 are brief, but adequate. It is hoped that future models of the tuner will be accompanied with a typeset manual that includes some discussion of the theory of operation — information that is missing in the typewritten instructions provided to this reviewer.

There are seven controls that must be preset before automatic operation may be commenced: The BAND and ANTENNA are selected — the user has the choice of either two antenna inputs on the rear apron, or an internal 10-watt dummy load for testing purposes. The two FINE TUNING controls on the front panel are set to midscale; the meter RANGE is set to read the 20-watt scale. A 200-watt scale is provided, but the tuner will not operate if that level is selected. The CONTROL INPUT LEVEL switch or the rear apron is set for either 1, 5 or 10 watts, sensitivity. The range selected determines the maximum power the sensing circuit may handle. The TUNER control, set ON, places the tuning network on line with the transmitter on transceiver while the OFF position provides a handy bypass should the user wish to take the tuner out of the transmision line. Power may then be applied up to the CONTROL INPUT level selected. An average of 15 to 30 seconds has been required to reach a matched condition from the time the OPERATE switch is depressed,

*Assistant Technical Editor

enabling the automatic operation. In several months of use at AC1Y, I have been able to approximate 5:1 conditions to check the matching range. In all cases, tuning has been accomplished in well under the 45 seconds maximum specified by the manufacturer. The claimed impedance-matching range of the Transmatch is between 15 and 250 ohms at 3.5 MHz, and between 10 and 250 ohms on the 7- to 28-MHz bands. Inductance settings for the new WARC bands at 10, 18 and 24 MHz are included in addition to the currently available ham bands. The 5:1 matching capability makes the CNA-1001 able to follow "QSYs" of some magnitude. This allows ease of operation and is especially useful with broadband, solid-state transceivers.

Operating Impressions

It would appear that much time is spent in presetting the CNA-1001 controls before use, making the name Automatic Antenna Tuner seem a misnomer. Once the sequence of operation is mastered, however, there is no time wasted in putting the unit through its paces. At AC1Y, where dipoles are used on 80 and 75 meters, the CNA-1001 has allowed me to QSY up and down, band edge to edge, with relative ease. The tuner requires a 13.8-volt, 0.2-A supply to power the sensing circuit and the capacitor drive motor, so any small power supply will suffice. In fact, the tuner would be a "natural" during portable battery operation for emergencies or, for instance, Field Day. Since the CNA-1001 is designed for use with unbalanced line only, it would be intriguing to use it for mobile hf operations.

The relative complexity of presetting the controls, however, would tend to make it a distraction while driving, despite its convenience. All controls are clearly marked. The only inconvenience is the location of the CONTROL INPUT LEVEL switch on the rear apron. Inattention to the proper setting of this control could lead to damage to the sensing circuit. It's possible to neglect the switch considering that it's not immediately visible. The switch should really be located on the front panel to afford maximum operator convenience.

All in all, the Daiwa CNA-1001 represents a convenient package. Its use definitely takes some of the drudgery away from operating a Transmatch under normal circumstances. No more hairline tweaking of capacitors; the automatic tuning feature sets up the tuner in little time and has provided better than a 1.5 to 1 match consistently, with little or no use of the FINE TUNING controls. The Daiwa CNA-1001 is imported and distributed by J. W. Miller Division, Bell Industries, 19070 Reyes Ave., Compton, CA 90224. Price class: $370. — *Sandy Gerli, AC1Y*

JAPAN RADIO COMPANY MODEL NRD-515 ALL-WAVE RECEIVER

☐ The NRD-515 is a high-performance communications receiver covering the range of 100 kHz to 30 MHz. Receiver features include digital PLL frequency control, an up-conversion heterodyning scheme and high dynamic range.

Tuning is accomplished by means of an optical interrupter dial coupled to the MHz control switch. The dial tuning rate is 10 kHz per revolution in 100-Hz steps. A momentary switch labeled UP/DOWN is used for changing frequency rapidly. The MHz portion of the operating frequency can be selected by the MHz control or by the main tuning dial. An optional memory unit, included with the review receiver, will store 24 spot frequencies in the receiver tuning range. The bandwidth switch has four positions (two of these being 6 kHz and 2.3 kHz) that are the standard filter bandwidths for the stock receiver. Optional filters in the review model provide cw bandwidths of 600 and 300 Hz. Other useful features are PASSBAND TUNING, DELTA-F (same as RIT), built-in 10- and 20-dB rf attenuators, noise blanker, selectable agc speed, and an adjustable BFO pitch when in the cw mode. Operating modes include a-m, upper and lower sideband, cw, and RTTY.

The heterodyning scheme in the receiver differs from most in that it uses a 70-MHz first i-f. Use of such a high first i-f ensures excellent image rejection. Frequency synthesis in the '515 is done in two stages. One loop controls the first i-f local oscillator frequency; the other sets the VFO frequency. This dual-loop system helps to eliminate many of the spurious responses found on many single-loop systems.

Operation

On-the-air operation with the receiver was a delight. The digital tuning took some getting

JRC Model NRD-515 Receiver Serial No. BR20156

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 100 kHz-30 MHz.	As specified.
Modes of operation: Ssb/a-m/cw/RTTY.	As specified.
Frequency display: Six 7-segment LEDs.	Red, 0.5 inch.
Resolution: 100 Hz.	As specified.
kHz/turn of knob: 10.	As specified.
Backlash: Not specified.	Nil.
Agc auto/manual selection: Not specified.	Selection of slow, fast or manual.
Receiver attenuator: 0-10-20 dB.	As specified.
S-meter sensitivity (μV/S9): Not specified.	80 M—44 μV; 40 M—44 μV; 20 M—25 μV; 15 M—50 μV; 10 M—50 μV.
Receiver sensitivity: Less than 0.5 μV from 1.6 to 30 MHz.	80 M / 20 M
Noise floor (MDS) dBm:	−136 / −136
Blocking DR (dB):	136 / 136
Two-tone, third-order IMD DR (dB):	90 / 94
Audio power output (8-ohm load): 1 W (4 ohms).	1 W.
Audio quality: Not specified.	Excellent.
Power requirements: 117/220/240 Vac, 50/60 Hz, 50 W.	As specified.
Frequency stability: Less than 50 Hz/hour after warmup.	75 Hz from cold start to one hour later.
Size (HWD): 5.5 × 13.4 × 11.8 in.	
Weight: 16.5 lb.	
Color: Black and gray.	

Note: mm = inches × 25.4, kg = pounds × 0.4536.

used to (it results in somewhat "musical" audio). I was skeptical of the performance of a receiver using a digital synthesizer because some other synthesized receivers we tested have had spurious responses throughout the tuning range. Our review receiver was remarkably clean throughout its tuning range. The only objectional spurious signals were found at the extreme low end, just below the 100 kHz lower limit of coverage. Strong-signal performance of the receiver is the best this reviewer has seen in any communications receiver. Observed performance was confirmed by tests done in the ARRL lab. The noise blanker was effective in blanking both ac-line and ignition noise, although when the blanker is on, the dynamic range of the receiver is reduced somewhat. Agc action is smooth, with no popping or lockup noted. Only once during the review period did I observe front-end overloading. A 160-meter dipole was connected to the receiver, and the presence of a 10-kW a-m broadcast station less than 3 miles[1] away was evident throughout the passband. With the 20-dB attenuator switched in, the overload problems disappeared, and the sensitivity was adequate for 160-meter operation. During a "multi-multi" contest operation, the '515 was used as a spotting receiver on 14 MHz and performed very well in the presence of five 1-kW transmitters.

Those amateurs interested in shortwave listening will appreciate the digital display and 6-kHz bandwidth position. A-m sounded quite realistic for such a narrow bandwidth. The af amplifier chain is very clean.

An interesting use for the memory unit is to place the various WWV frequencies into the memory and then quickly check them to see how the F2 layer MUF is changing. Also, net and DX pileups can be stored for future recall.

Shortly after acquiring the receiver I found an urge to open the covers and see what was "lurking" inside. The physical layout of the receiver is exceptionally clean. All pc boards are silk screened, clearly making service or adjustment an easy task. The optional filters mount on a pc edge card connector that I thought would degrade the ultimate attenuation of the filters, but this is not the case!

Observations

The manual for the receiver is quite comprehensive in operation procedures and theory of design explanations, although the English translation used in the manual in quite awkward, making some reading difficult. The NRD-515 represents state-of-the-art performance in communications receivers. JRC has shown that a digitally synthesized receiver can compare in performance to the best analog systems. The receiver is designed to be mated with the NSD-505 amateur transmitter, but may be used with any transmitter with a slight loss in versatility. Gilfer Associates, the U.S. importer of the NRD-515, supplies the receiver in two configurations. One of these is aimed at the shortwave-listener market and is equipped with i-f filters having bandwidths of 6.0, 3.0, 2.3 and 0.6 kHz. The other option replaces 3.0-kHz filter with a sharp 300-Hz filter for amateur and commercial uses. Gilfer's address is P.O. Box 239, Park Ridge, NJ 07656. Price class: $1490; memory unit, $290; optional 300-Hz filter, $70. — *Gerry Hull, VE1CER*

[1]km = miles x 1.609.

HEATH VF-7401 2-METER TRANSCEIVER

☐ My first thought on seeing the new Heath 2-meter digital scanning transceiver (VF-7401) was "Gee, that's pretty." (A preassembled rig was in the lab for advertising acceptance.) And pretty it is! It is not the traditional Heath green that I expected.

After opening the box, the first thing that must be done is to update the instruction manual. There are some additional paragraphs supplied to expand the original instructions, new diagrams and some pages to paste over others. The instruction book is well done; Heath does a magnificent job of preparing easy-to-follow instructions. Components are carefully numbered and labeled. Although this is not a beginner's kit, anyone with an interest and some kit-building background should be able to complete this project within 50 to 70 hours. Heath (and others) makes kits that are simpler, have fewer parts and are easier to assemble than this one. This one is not difficult, but takes some time — and patience!

Assembly

What's next? There are six circuit boards to assemble: readout, VCO, power amplifier, receiver, synthesizer and transmitter. These boards range in complexity from the readout board (which has three digital-display chips) to the transmitter and receiver boards, which are both rather intricate. I assembled the optional Micoder II microphone that includes a Touch-Tone pad. The builder has the option of wiring the Micoder to use an internal 9-V battery or to extract power from the rig. I chose the "power-from-the-rig" route.

I've learned (in my Heathkit assembling experiences) never to open a package unless the manual says "OPEN PACKAGE." The problems you could run into. . . . I use egg cartons to hold all the parts while the kit is being assembled, count out different values of resistors and capacitors, sort them, and store them in separate containers. The VF-7401 is a "four-carton kit." Of course, if you run into the built-in problems I have (a three-year old who wants to "help"), you might want to choose some other method!

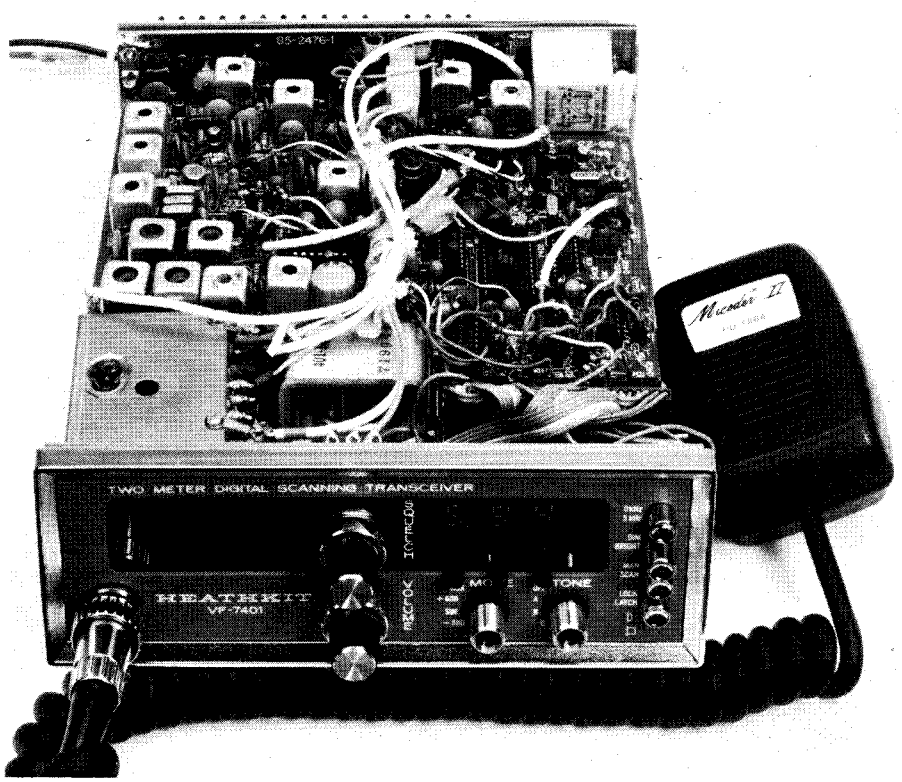
Heath provides very explicit soldering instructions, which is one of the prime factors in assembling any kit. I know what a good solder connection looks like. I know how the iron feels when holding some solder next to a connection along with a tip but . . . the one thing I couldn't understand was why the solder wasn't melting the way it should while I was assembling the VCO board. Afterward, I mentioned the problem to my husband, Pete. He wanted to know why I hadn't said something earlier. The iron was "on the fritz" — a burned out element! I had been using too little heat to melt the solder, but more than enough heat to cause component problems!

Alignment

I started through the alignment routine just like it said in the book. One of the coils didn't tune properly, and the meter readings weren't right. After "playing" for a week, we sent the rig back to the factory. It was back in a few days — fixed, aligned and ready to go. My soldering iron difficulty and one unsoldered connection had caused the problems we encountered.

Technical Description

The VCO is the heart of the transceiver. It



Heath VF-7401 2-Meter FM Transceiver Serial No. 0008

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: Any 4-MHz segment from 143.5 MHz to 148.5 MHz (within transmitter/receiver specifications; total coverage 140.000 MHz to 149.995 MHz).	As specified.
Mode of operation: Fm.	As specified.
Readout: Digital; 3-digit, LED (red) display.	3/8-inch digits.
S-meter sensitivity: Not specified.	2 μV/full-scale reading.
Receiver sensitivity: 0.5 μV/12 dB SINAD.	0.55 μV/20-dB quieting.
Squelch threshold: 0.3 μV or less.	Less than 0.1 μV.
Internally generated spurious signals: Below 1 μV equivalent.	As specified (none detected).
Audio output: 1.5 watts at less than 10% THD.	As specified.
Transmitter rf-power output: At least 15 watts, adjustable.	As specified.
Current consumption: 750 mA maximum, receive; 4 A maximum, transmit at 13.8 V dc.	700 mA maximum, receive; 3.2 A maximum, transmit at 13.8 V dc.
Size (HWD): 2-3/4 × 7-1/4 × 10-1/4 inches.	
Weight: 5 pounds.	
Color: Black/gray.	

Note: mm = inches × 25.4, kg = pounds × 0.4536.

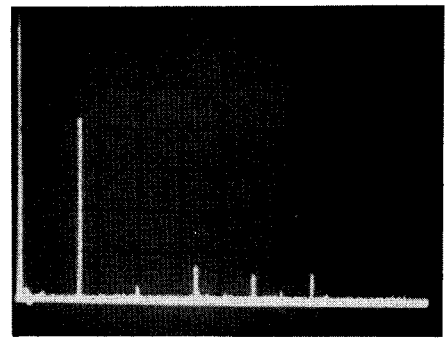


Fig. 2 — Spectral display of the VF-7401. Vertical divisions are each 19 dB; horizontal divisions are each 100 MHz. Output power is 15 W at a frequency of 146.94 MHz. The fundamental has been reduced in amplitude approximately 28 dB by means of notch cavities; this prevents analyzer overload. All spurious signals are at least 63 dB below peak fundamental output.

provides proper frequencies for transmitter and receiver injection. The incoming signal passes through a double-tuned circuit to an rf-amplifier stage where it is mixed with the sixth harmonic of the VCO. Low-sided injection is employed. The resultant 10.7-MHz signal passes through an 8-pole crystal band-pass filter and is amplified. A 10.245-MHz signal is mixed to produce the 455-kHz i-f. A monolithic quadrature-detector IC demodulates the signal and feeds the recovered audio to the audio-amplifier stage. The receiver has a noise-squelch system, which provides excellent squelch action. A green LED indicates an unsquelched condition. The associated voltage is also used to control the scanning functions.

On transmit, the audio passes from the high-impedance microphone through an amplifier stage and a preemphasis network that improves the signal-to-noise ratio. The pre-emphasized audio passes through another amplifier stage and a clipper stage that limits the deviation. A deviation-limit control is used to adjust the deviation level. An astable multivibrator generates the Continuous Tone Coded Squelch System (CTCSS) tones that are used to access some repeater systems. Audio voltage from the microphone and the tone generator is applied to the VCO, which produces the fm signal. The signal is tripled, doubled, amplified and applied to the power amplifier for final amplification to the 15-watt level. Output power is sampled and fed to the meter to give an indication of the output power level. Adequate filtering is provided to ensure that the output signal is clean.

Several safety features are built in. A diode provides reverse-polarity protection. High VSWR will not damage the transceiver. An out-of-lock detection circuit will cause the transmitter to be inhibited if the PLL looses lock. Scanning will cease automatically if the PTT line is keyed during scan.

Operation

The microphone is a high-impedance type. All operating controls are located on the front panels, including a meter that shows relative transmitted and received signal levels. A three-digit, red LED display shows the receive frequency (for instance, with the receiver set at 146.88 MHz, the display will show 688). The transmit frequency is not shown. The knobs on the VOLUME control (on/off switch) and SQUELCH control have a "good feel" and are large enough to be adjusted comfortably.

The mode switch contains four operating positions: −600, SIM (simplex), +600 and AUX (auxiliary). The AUX position is provided for an alternate (e.g., MARS, CAP and so on) frequency split. Owners may contact the Heath technical consultant department for information about wiring the transceiver for other desired offsets. One frequency pair (of interest to me) is 143.99/148.01 MHz, used by Army MARS repeaters. I found Heath's instructions for modifying the wiring very easy to follow.

The TONE switch permits the user to choose among three standard CTCSS (or PL in general amateur parlance) tones or no tone. CTCSS is in use by more and more repeaters these days. Heath should be commended for providing this as "standard."

The DIM/BRIGHT switch makes the display readable in bright light without "blinding" you at night. This feature is useful to the mobile operator. Three black push-button switches mounted beneath the corresponding digit are used to select the 1-MHz, 100-kHz and 10-kHz digits of the desired receive frequency. Touch the switch, and the display will scan up frequency until pressure is released.

When the MAN/SCAN switch is in, the transceiver operates in the manual mode. Any frequency may be selected by pushing any combination of the frequency-selector switches located below the LED display. When the MAN/SCAN switch is out, the transceiver scans upward continuously in the 10-kHz steps for the full range of a 1-MHz segment. At the "top" of the segment, it jumps back to the "bottom" of that same segment; e.g., 146.99 is followed by 146.00.

The LOCK/LATCH switch permits selection between two types of scanning action. With lock engaged, the VF-7401 scans until a signal opens the squelch. The receiver remains on this frequency until the LOCK switch is released. If LATCH is selected, the unit scans until a signal opens the squelch. The transceiver stays on this frequency until the signal disappears and the squelch closes. After an additional few seconds delay with the squelch closed, the VF-7401 resumes scanning.

One other feature that is most useful is the "power-up" function. Without this function, the VF-7401 could "come up on" any frequency between 140.00 and 149.99 MHz each time it is turned on. With this circuit operating, the VF-7401 always "powers up" on the same frequency. The user chooses this frequency by selecting and properly attaching wires on the synthesizer board. The Heath manual contains detailed information for setting the chosen frequency.

Operating Report

I use the VF-7401 fixed and mobile. Four adhesive-backed rubber feet were installed on the bottom of the radio case to prevent marring supporting surfaces. Heath provides a gimbal bracket that can be used to mount the transceiver under the dash of an automobile. The gimbal bracket comes with four predrilled mounting holes and matching self-tapping screws. The lip under our dash is large enough to mate with only two of the screws. I used a small hand drill to form two pilot holes for mounting the bracket. Thus far, the two screws are holding the bracket firmly in place, with no evidence of problems. The gimbal bracket may also be used as a supporting stand if mobile operation is not contemplated. In that case, Heath recommends that four adhesive-backed rubber feet be attached to the gimbal bracket.

A large screw is welded to each side of the case of the VF-7401. The screws slide into slots in the bracket when mounting. One-inch cork washers prevent the bracket from marring the side of the VF-7401 case. The transceiver is held firmly in place by means of two 1-1/4-inch thumbnuts. The first time I mounted the VF-7401 in our car, I did not tighten the thumbnuts sufficiently. The radio "swiveled" when we hit bumps in the road — we were traveling in New York and Heaven knows that New York has a lot of bumps in the road! After that first experience I remembered to tighten the nuts firmly when installing the radio in the bracket. No further problems were noticed. This system makes it quite convenient to remove or install the radio when desired.

I have not encountered any problems when using the rig either mobile or as a base station. The scanner function is great while driving. Right now, the rig is set up in the dining room instead of the shack. I told you it was pretty. — *Sally O'Dell, KB1O* QST