

Heath HW-2021 Review

- - a lot of HT for the price

Photos by Jim Gerritz WA4FMA.

When the Heath 2 meter FM HT appeared on the scene, I was in the market for an HT. Many things about the Heath interested me, not the least of which was the price. One hundred seventy dollars (\$170) for a 5 channel receive, 10 channel transmit, 1 Watt HT with "rubber duckie," nicad pack and charger seemed like quite a deal — so I ordered one.

My kit arrived and I was really impressed (and a little intimidated) by the piece of Swiss cheese referred to as a circuit board. After checking the parts, I started on construction. Two things became immediately obvious: First, Heath's warning about this kit being "for the experienced kit builder" is very

true. It is very easy to make a mistake and constant checking of component installation is a necessity. Second, they make a little remark about taking "a short break after completing each half or full section" of the board. The board is a double-clad glass board with plated-through holes. The side of the board where the soldering is done is coated with some goop which is supposed to, and does, keep solder from flowing where it doesn't belong.

The board is marked into six sections. Almost all of the circuitry is on this one board. I found that one section a night was all I could handle without having a fatigue problem. I would recommend that those of us whose arms

get a little shorter each year invest in one of those circular fluorescent lamps with a magnifying glass in the middle.

I had the charger, battery board, and four of the six sections done when it came to my attention that all was not as it should have been. A little investigation and a phone call to Heath showed me my problem. I had an early model with a 00 series number. A little word on the Heath series numbers. These are NOT serial numbers, but identify when the kit was manufactured. The series number is a five digit number, the first two digits of which indicate the revision number. Hence, a series number starting with 00 is an original issue. The third digit is the

year of manufacture and the last two digits, the week of that year. The HW-2021 I have now is series number 01607 which means it is the first revision, manufactured in the seventh week of 1976.

Well, back at the workbench, Heath offered to send me all the changes in parts and instructions to make my kit up-to-date, but I was a little "gun-shy" and asked for a whole new kit, which they promptly shipped upon return of my partially built kit. The new kit had several circuit and part changes, a whole new instruction book, and three pages of changes to the new instruction book. The early kits had problems with the battery saver circuit, the diode antenna switching, and a lack of drive in the transmitter. There were also problems in the instruction manual. However, the 01 series kit corrected all these problems and my kit was assembled and aligned by the book with no problems. There were a few shortages in the parts list, but these were promptly supplied by Heath.

Circuit Description

Referring to the block diagram, you can see that the receiver is a rather conventional single conversion receiver. Diode switching is used in the antenna circuit (look Ma, no relays or multi-pole PTT switches). The rf amp consists of two 40673 dual gate MOSFETs in common source configurations. A third 40673 is used as a mixer. Two monolithic crystal filters are used at the 10.7 MHz i-f to give a 4 pole filter response. A single bipolar transistor and an RCA CA3089 IC is used as the entire i-f chain and detector. A rather novel circuit innovation is the use of a 10.7 MHz crystal to raise the Q of the quadrature detector. The audio amp is a Motorola MC1454 IC.

The oscillator chain consists of a 15 MHz crystal

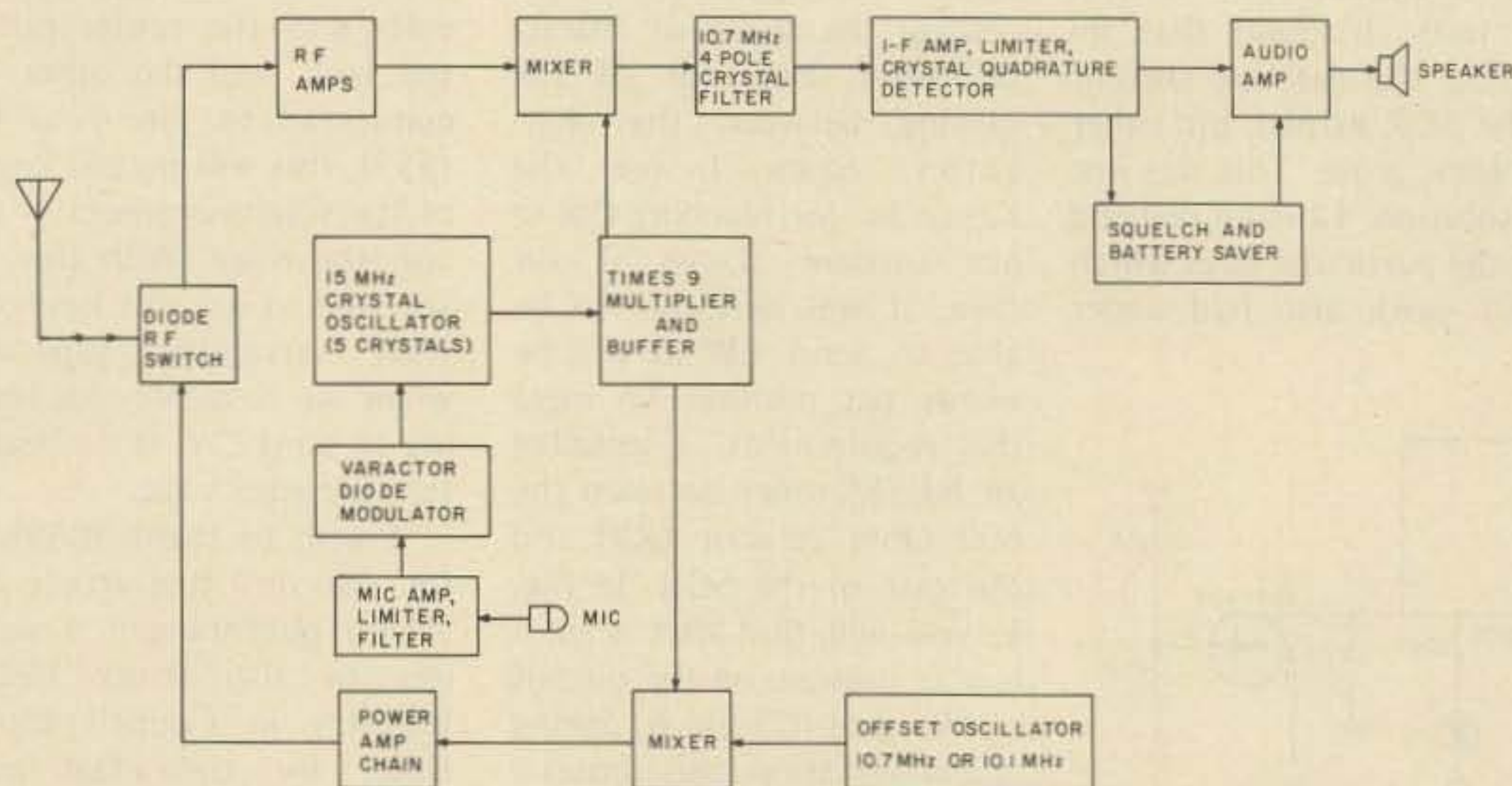


Fig. 1. HW-2021 block diagram.

oscillator followed by two triplers and a buffer. There are five diode selected crystal positions, each with its own netting capacitor. The output of the chain is 10.7 MHz below the receive frequency. The squelch and battery saver circuit is one of the unique features of this HT. As long as the receiver is squelched, there is an oscillator that runs at about 3 Hz. The output of this oscillator turns on the entire receiver for about 20 ms three times a second except for the crystal oscillator, which runs continuously. So for 313 ms out of every 333 ms, the load on the nicad pack is just the crystal oscillator plus a small load in the battery saver circuit itself. The audio amp is not controlled by the battery saver but by the squelch, and when squelched, the load is small. All this adds up to a minimal load on the nicad pack when no signal is being received.

When a signal is received (during one of those 20 ms receiver on periods), the squelch is opened, the 3 Hz oscillator disabled, and the battery saver turns on the entire receiver as long as the squelch is open. The audio amp is also enabled. The signal goes away and the battery saver resumes operation. All in all, a rather cute circuit. (Hmmm — a squelch operated 3 Hz clock oscillator and diode switched crystals. Sounds like half a scanner!) There is an LED on the front panel that flashes when the battery saver is in operation and is on solid when the squelch is open. The squelch itself is a signal amplitude operated circuit rather than the more conventional noise operated squelch.

The transmitter is less conventional. The same crystal and oscillator chain is used as is used by the receiver. There is an offset oscillator with 10.7 MHz and 10.1 MHz crystals supplied with the kit. The output of the main oscillator chain and the offset oscillator are mixed in another 40673 dual gate

MOSFET to give the transmit frequency. The mixer is followed by five bipolar transistors to bring the output power up to the proper level. Note that one crystal will give one receive and two transmit channels and, once one of the transmit channels is trimmed on frequency, the receiver and the other transmit frequency are on frequency within 250 Hz. Purists could probably trim the offset crystals, but I really don't think it is necessary. With my unit there is about a 130 Hz error on one transmit frequency if the other is set on exactly. As an example, the crystal supplied with the kit is 15.1377 MHz, which gives 136.24 MHz (when multiplied by 9), the proper injection frequency for a receiver with a 10.7 MHz i-f, for 146.94 MHz. Mixing the 136.24 MHz with 10.7 gives 146.94 MHz, and with 10.1 MHz gives 146.34 MHz. So you get simplex and the -600 kHz offset for 146.94 MHz with just one crystal. Modulation is accomplished by a varactor diode across the 15 MHz crystal, driven by a mike amp, limiter, and filter consisting of a JFET and a 741 op amp. The HT has a separate microphone for the transmitter, reducing the switching requirements and giving better fidelity than if the speaker had been used as a mike.

The nicad pack consists of 10 AA size, 1.2 volt, 450 mAh cells in series with a simple but effective charger. The only charger circuitry external to the HT is the transformer.

PTT is accomplished by the simple expedient of switching the nicad pack from the receiver circuit to the transmitter circuit. This is done with an SPDT micro-switch under a large aluminum bar on the left side of the unit. The rubber duckie is mounted on the top right of the HT in a threaded 5/16 bushing. On the right side of the unit at the top is a standard miniature closed circuit



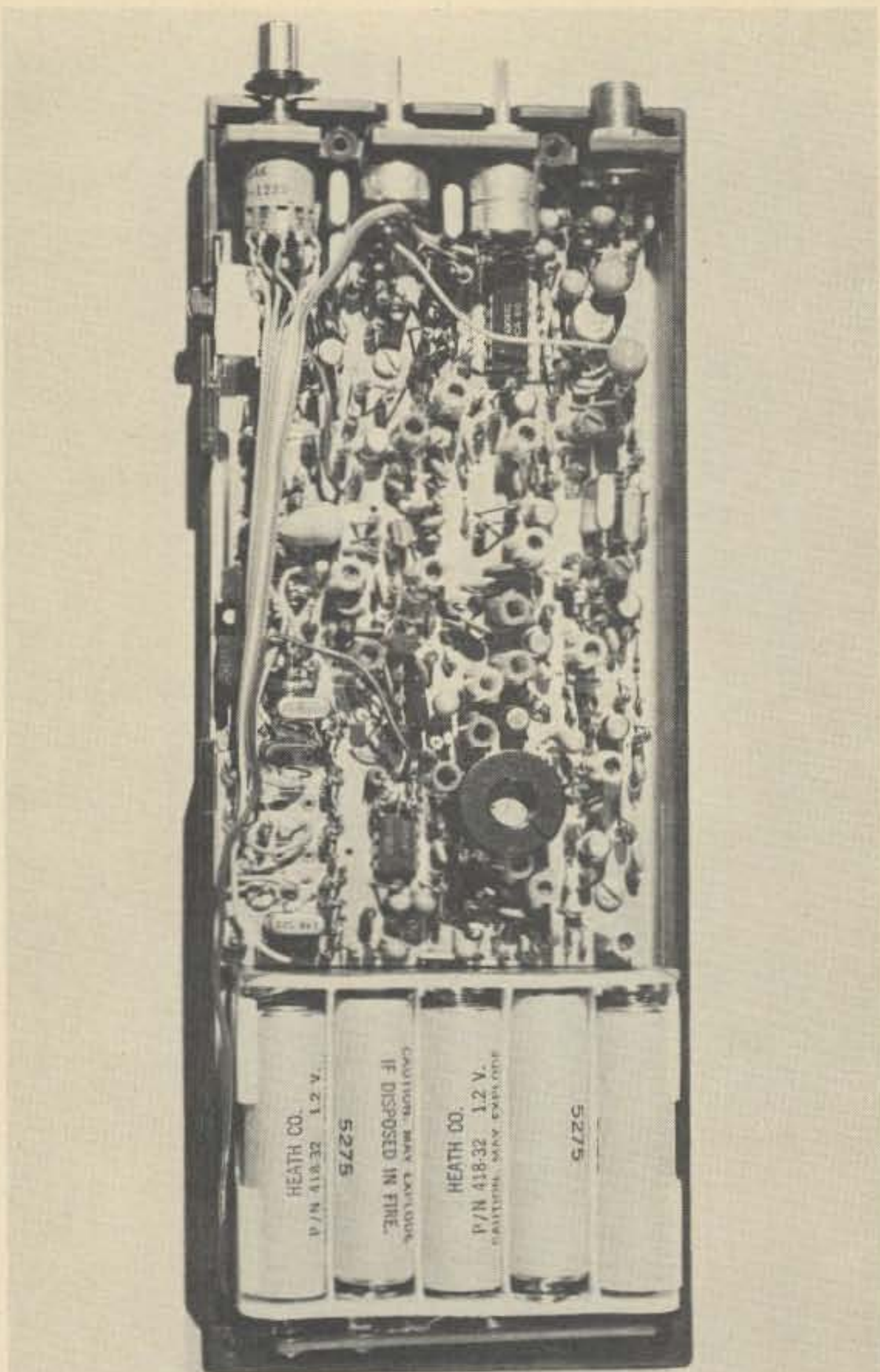
Heath HW-2021 2 meter handie-talkie with HWA-2021-3 autopatch encoder installed. Small slide switch above PTT bar on left side is the simplex/-600 kHz offset switch.

phone jack that is used for external antenna connection. Channel selector, squelch, and volume/power controls are on top. The simplex/offset switch is on the left side of the unit above the PTT bar. The speaker is centered in the grill on the front and the mike is under the top left-hand corner of the grill. The case itself is high quality plastic, sprayed on the inside with a conductive coating. The board is mounted to the case back and the case halves fastened together using threaded inserts and machine

screws. No self-tapping screws are used.

Alignment

Alignment is simple and straightforward. An rf detector and a 51 Ohm dummy load are supplied with the kit. The only test equipment needed is a VOM. The only time exotic equipment should be used is when netting the crystals, which should be done with a frequency counter, although it can be done on the air with a friend. Note: The friend can also talk to you on a repeater if direct



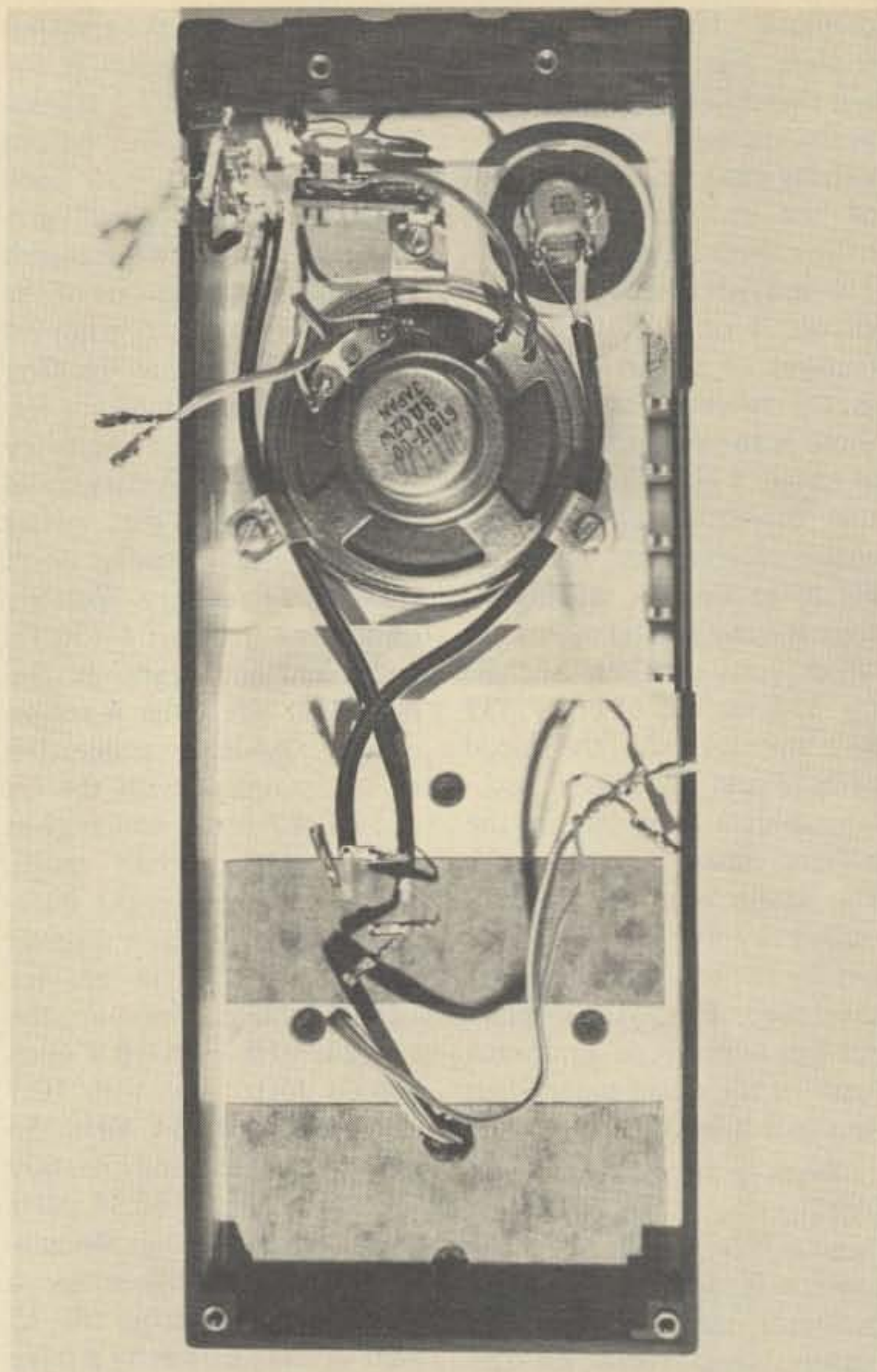
Inside the HW-2021. Frequency controlling crystals are on the left side about 2/3 of the way down. (146.52 crystal is in position 5. Positions 2, 3 and 4 are vacant.) Netting capacitors are just visible under the ribbon cable to the left of the crystals. The offset oscillator crystals are located between the channel switch and the squelch pot. The two crystal-looking things on the right side about 1/3 of the way from the top are the monolithic crystal filters. Note the 2-56 screw in the rubber duckie bushing at the top right — very difficult to get a screwdriver on to connect the rf cable. Transistor with heat sink is rf output.

is used with the HT. No problems were encountered in alignment.

Performance

The published specs on the HW-2021 are not earth-shattering: one Watt output and receiver sensitivity of 0.5 μ V SINAD or 0.75 μ V for 20 dB quieting. This is across a ± 1 MHz range from the alignment frequency. My unit has only been used between 146.16 MHz and 146.94 MHz, but I found the performance quite a bit better.

My output power was 1½ Watts across the measured range and the sensitivity measured on a Singer FM 10 CS meter was 0.25 μ V for 20 dB of quieting. The squelch operated well below 0.2 μ V. The receiver is quite immune to intermod and adjacent channel rejection is adequate. I can copy the 76 machine in Pensacola, 50 miles away, while the local 79 repeater is operating. It does suffer from desensitization and plain front end overload when operating in the immediate



Inside the front cover of the HW-2021. Small jack at upper left is the external antenna connection. Three wire ribbon cable coming through the bottom is from the HWA-2021-3 auto-patch encoder.

vicinity (100 meters or so) of an off-frequency source of a few Watts. The squelch circuit leaves a little to be desired. Since it is an amplitude squelch, it is more sensitive to external conditions, such as noise levels and hand capacity, than a noise squelch. The setting of the squelch is relatively critical, there being a narrow range between keeping the squelch closed and having it open with a weak but copyable signal.

The audio output is rated at ½ Watt. There is sufficient audio to hear a station in an open car (my wife's VW Thing) at 55 mph. The audio can be run all the way open without objectionable distortion.

The transmitter has only two problems. The modulation is nonsymmetrical. My unit had an upward deviation of 7 kHz while downward was only 3.5 kHz. The other problem is the PTT sensitivity. It is, for me, much too light. Even with the optional installation to increase the pressure necessary to actuate the PTT, it is much too easy to activate the transmitter accidentally.

Opinions

I felt several improvements could have been made in the kit. I don't like using the phone jack for an rf connection. A BNC jack on top instead of the 5/16 threaded bushing with a BNC rubber duckie would eliminate the

phone jack for external rf connection and clean up some of the internal wiring. It would also allow the phone jack to be used as an external mike or earphone jack, neither of which are provided for. This is a change I am seriously considering for my unit. Also, there is no provision for operating from external power while protecting the nicad pack from possible excessive charging current. This means that all operation must be done off the nicad pack. The nicad pack snaps in place easily, but is not particularly easy to replace since the unit must be opened up and several leads disconnected to get to the pack.

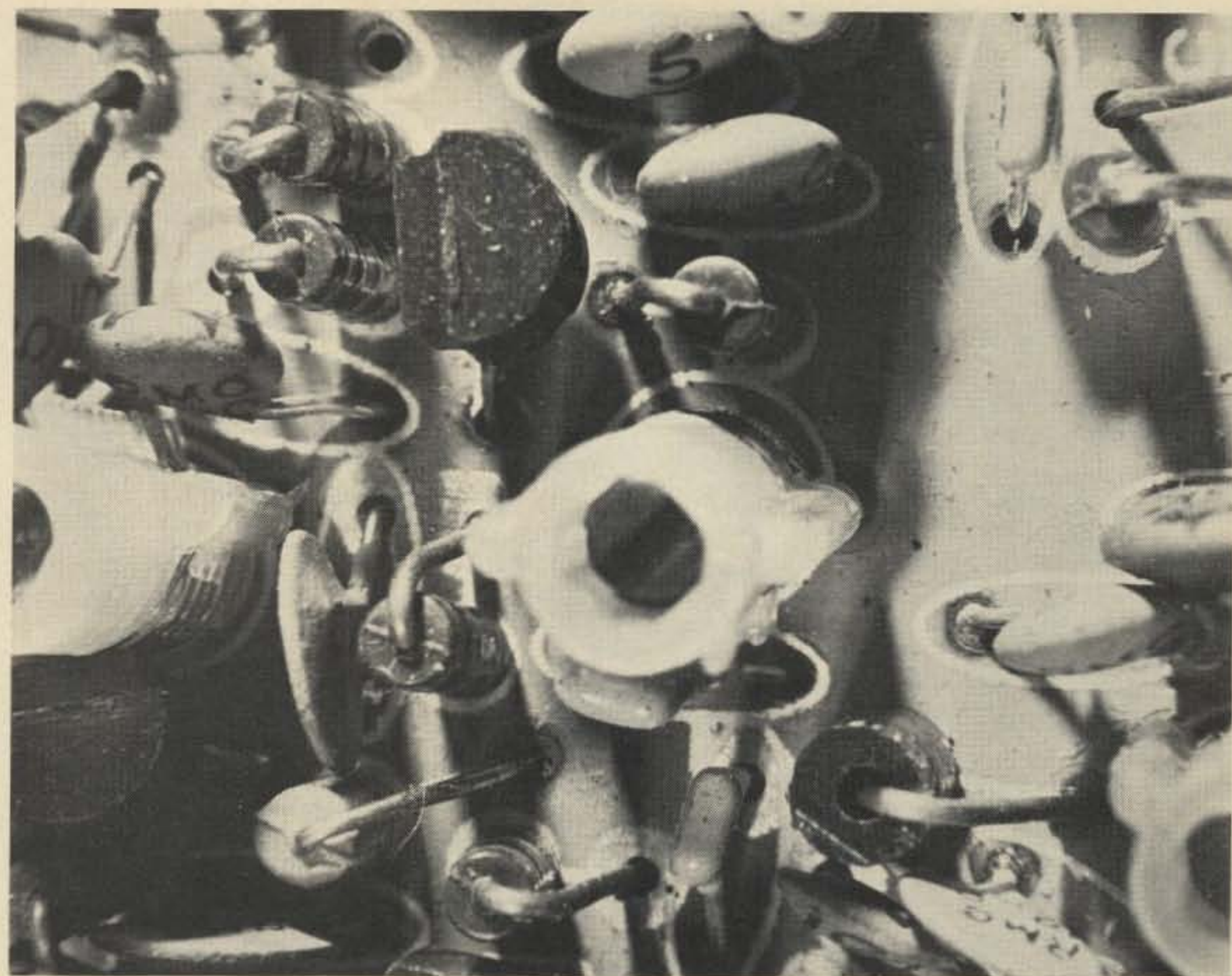
The coax cable used for rf is not to my liking. It's the stuff that has foil instead of braid with a wire running down the foil. This shield wire is rather brittle. I would rather have seen a good high quality subminiature coax used.

With the +600 offset activity increasing above 147 MHz, a third offset position would have been nice. As it is now, I would have to sacrifice simplex or -600 offset to get the +600 offset.

There were three areas in construction of the kit that bothered me. First, whenever I cut a cable to the specified length, it seemed that when I installed it, it could have been another 1/4 inch longer to make final assembly easier. Secondly, the builder is required to build up a solder bead around a mounting hole to get proper board clearance. Why not a washer? Third, a 2-56 screw is used to attach the rf line to the rubber duckie bushing. It is quite difficult to get to this screw without bending board components this way and that, and you still have to bring the screwdriver in at an angle.

Conclusion

For 170 bucks, the kit is a bargain. It went together, aligned properly, and exceeded spec. The quality is



Close-up of one section of the main board. Not a helluva lot of spare room. Note ferrite bead rf choke at bottom right.

excellent, as is the manual — the kind of equipment we have come to expect from Heath. It's a little larger than most HTs (23.5 cm x 4.8 cm x 8.3 cm) but I would not have cared to build it had it been any smaller. It is sturdy, but not indestructible. I have dropped my unit three times and it broke twice. Once one of the crystal filters broke and the other time one of my crystals broke. Maybe I shouldn't have been so cheap; I should have bought the optional carrying case.

It's not perfect, but its virtues far outweigh its deficiencies and I would highly recommend it for anyone with kit building experience.

THE HWA-2021-3

After my positive conclusions on the Heath HT, I wish I could be as positive about the matching autopatch encoder — however, I can't. It's bulky, technologically obsolete, uses some rather questionable construction techniques, and does not meet the published 1 1/2%

accuracy spec. Much better pads can be obtained for the \$40 the HWA-2021-3 costs.

Circuit Description

The circuitry is rather straightforward and old-fashioned. Two NE555s are used as separate high and low group oscillators. Precision (1%) resistors are switched by a miniature 12 button keyboard to generate the proper frequencies. The charging voltage waveforms across the timing capacitors are mixed in an LM301A which also filters the waveforms to make them approximate sine

waves. There is also a PNP transistor driven by the square wave output of the low tone oscillator which in turn drives an LED. A rather useless circuit that lights the LED when the low group oscillator is running.

Alignment

Alignment is simple. A trimpot for each group is set at the highest tone of each group. The other tones supposedly will then be within the $\pm 1.5\%$ spec. The pots are mounted on the bottom of the board with the adjustment screws facing each

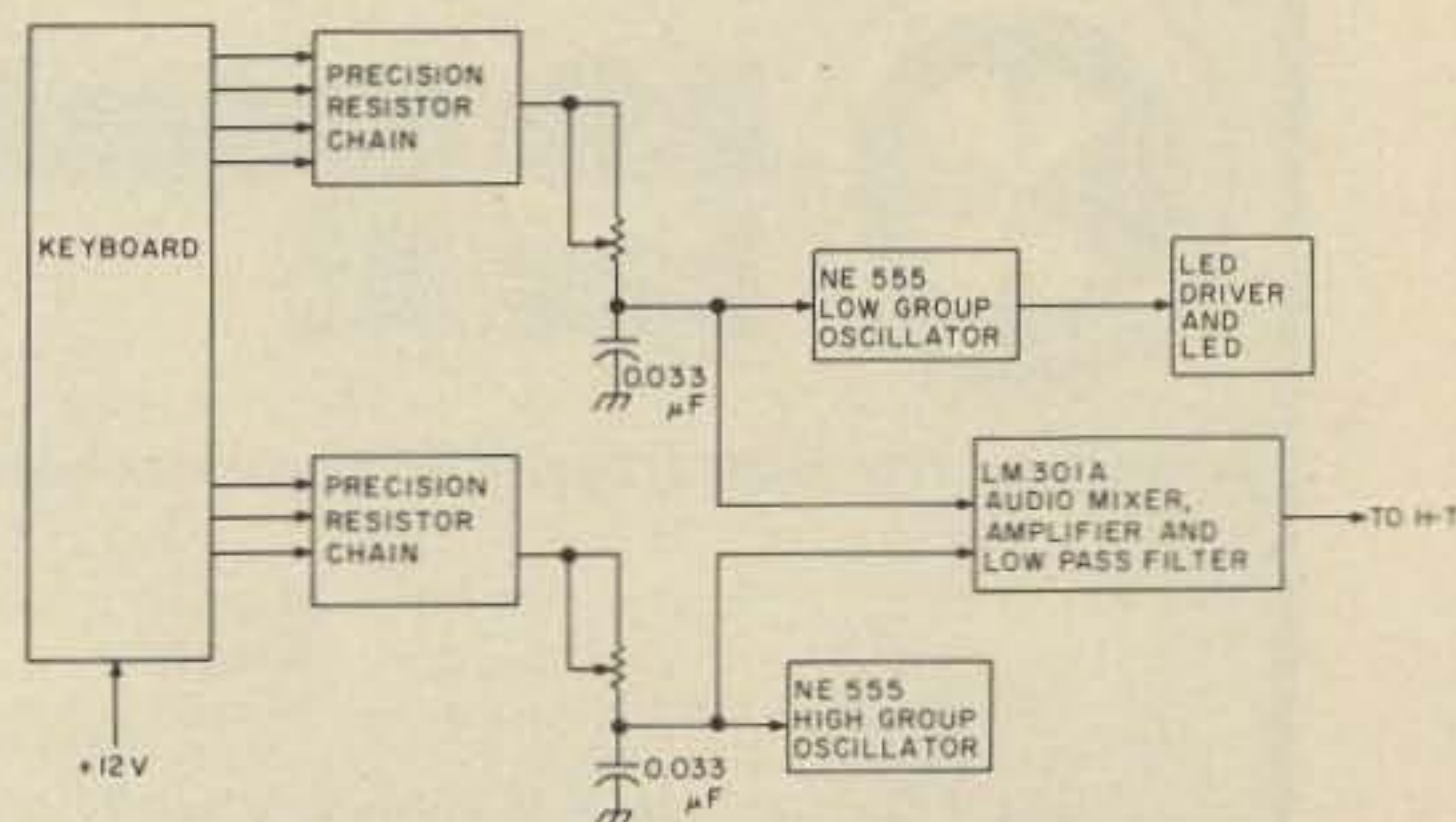


Fig. 2. HWA-2021-3 block diagram.

