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Heath SW-7800 General-Coverage Receiver

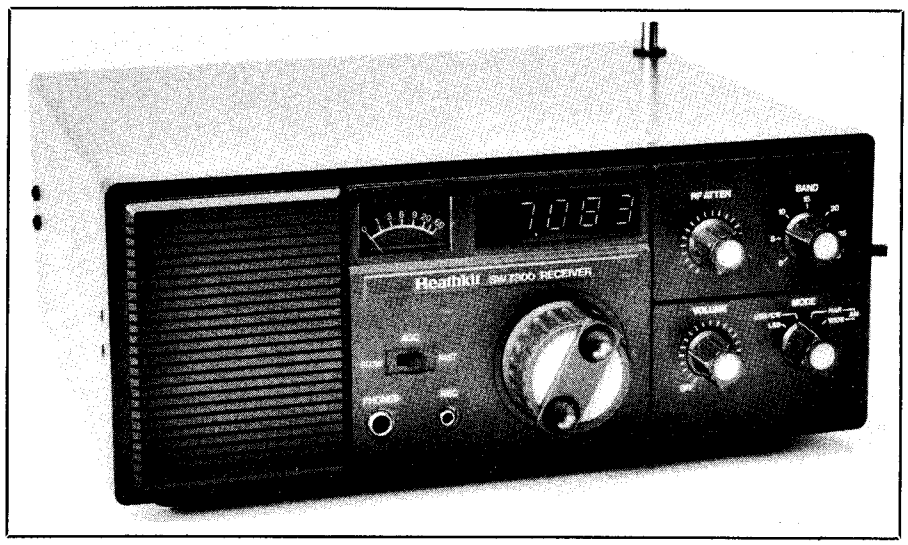
Trio-Kenwood TH-21AT 2-Meter FM Hand-Held Transceiver

Product Review

Conducted By Paul K. Pagel,* N1FB

Heath SW-7800 General-Coverage Receiver

Radio Amateurs and SWLs may have been saddened to see that some of Heath's recent catalogs offered no shortwave receivers. Now, Heath returns to the low-end shortwave receiver market with the SW-7800. It features good sensitivity, a true frequency counter and digital display, envelope and product detectors (for AM and SSB/CW reception), and operation from 117-V ac and 12-V dc sources. These features, and its price, make the '7800 attractive to casual shortwave listeners and electronic enthusiasts.



Heath SW-7800, Serial No. 81-53018

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 150 kHz to 30 MHz.	As specified.
Modes of operation: AM, SSB, CW.	As specified.
kHz/turn of knob: Not specified.	46.
Backlash: Not specified.	Nil.
S meter sensitivity (μV for S9 reading): Not specified.	160 m, 19; 80 m, 19; 40 m, 23; 30 m, 24; 20 m, 25; 17 m, 34; 15 m, 34; 12 m, 39; 10 m, 46.
Receiver sensitivity: (0.15-30 MHz) less than 0.35 μV for 10 dB, (S + N)/N.	

	80 m	*20 m*
Noise Floor (MDS) dBm:	– 131	– 130
Blocking DR (dB):	noise limited	noise limited
Two-tone third-order IMD DR (dB):	74	73
Third-order intercept (dBm):	– 20	– 20.5

Audio output (@ 10% THD): Not specified. 1.8 W.
Color: Khaki.
Size (HWD): 4-7/8 × 11-1/2 × 11 inches.
Weight: 7 lb.

The Kit

Heath's modular packaging and construction techniques continue in the '7800. Many parts come packaged on tape strips, arranged in the order of use. This saves a lot of time and effort during construction.

There are five major assemblies: the chassis and four circuit boards. The front-panel, controller and receiver circuit boards are single sided, while the synthesizer board has traces on both sides and plated-through holes. All boards are solder masked. The coating makes connections easy to spot and confines solder flow.

Along with clear construction and alignment instructions, the manual provides general and detailed descriptions of circuit operation. There are troubleshooting charts, installation instructions (including antenna construction) and a short section on basic radio theory. The theory section covers frequency/wavelength relationships and definitions of AF, RF, SSB and CW.

There were three problems with my '7800. The illustrations concerning the installation of D304, D323 and D414 did not match the components supplied. Each of these diodes has a package that resembles a plastic transistor ("D" shaped), while the circuit parts-placement diagram indicates a square package. Close inspection showed a very small mark on the diode case near one lead. This mark designates the cathode, which is indicated by a black band on the circuit board.

The '7800 knobs fit into front-panel recesses. Unfortunately, each nut that secures a control must be tightened without the knob on the shaft. Thus, it is impossible to accurately center the shaft in the hole. The problem is compounded by the fact that the knobs are not precisely concentric when mounted on the shafts. The knobs rub against the panel recesses, and this can be annoying. Smooth control operation can be achieved by carefully sanding the edge of each knob to fit the recess.

A major problem occurred with the frequency display. Once the radio was complete, I found that the display became erratic when the BAND switch was set beyond 26 MHz. As I advanced the BAND switch, the display indicated lower bands (21 and 23 MHz) and drifted 300 kHz, or more, with each count. Checks of components and solder connections revealed nothing that generator showed that the receiver was, in fact, receiving the band indicated by the BAND switch, and the counter worked properly with an injected signal. The fault lay in the mixing chain that precedes the counter.

At this point, I contacted Heath for advice. They informed me that the problem has occurred on a few other '7800s, but it is not common. A permanent cure was in process, but they first suggested that I replace Q214, a buffer transistor, with one having a lower F_T. The replacement transistor Heath suggested I use was not on hand, but a comparison of specifications indicated that a 2N2222A might be a suitable replacement.

I removed the old transistor, installed a 2N2222A and tested the circuit before replacing the synthesizer board on the chassis. The display worked fine. When the board was fastened to the chassis, however, the counter did not work above 28 MHz. I eventually shipped the radio to Heath for inspection. One of Heath's engineers called me after a few days and informed me that I had transposed the center and shield conductors of a coaxial-cable jumper on the underside of the synthesizer board. The cable leads are easily transposed because the conductors are inserted from the underside of the board, while the connection labels are on the top side. Now that the jumper is properly wired and the replacement transistors are installed, the counter and display work fine.

The Circuit

Simplified block diagrams of the receiver (A) and synthesizer (B) boards are shown in Fig. 1. Signals enter the receiver section of the '7800 through one of six diode-switched, one-octave,

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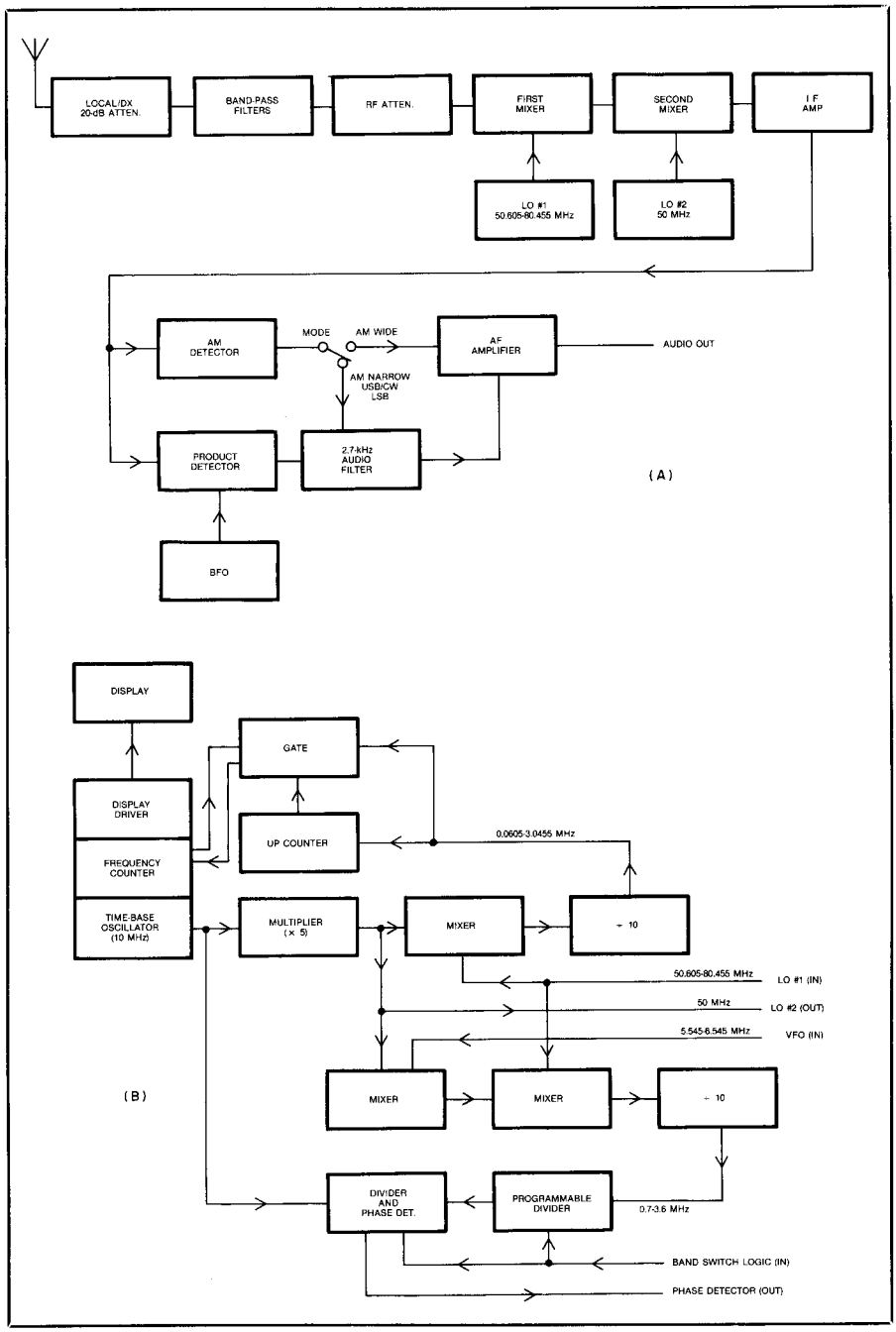


Fig. 1 — Simplified block diagrams of the SW-7800 receiver (A) and synthesizer (B) circuits.

band-pass filters. A PIN diode, with bias current established by the RF ATTEN control on the front panel, serves as a variable attenuator before the signal passes to the first mixer. There are no RF amplifier stages. AGC is sensed at the AM detector and applied at the IF amplifier. Slow and fast AGC constants can be selected from the front panel, but the AGC cannot be defeated completely. The normal AM bandwidth is 5.5 kHz (between −6 dB points). A three-stage active audio filter reduces the passband to 2.7 kHz for narrow AM, CW and SSB reception. When the rear-panel MUTE connection is grounded, the IF amplifier and active filter are disabled to mute the receiver.

The synthesizer board holds the frequency counter and phase-detection circuits. An ICM7216D LSI IC performs as a 10-MHz time base, counter and display driver. A multiplier increases the time base to 50 MHz for use in the counter and phase-detect chains and as LO (local oscillator) 2. A mixer chain uses LO 1, LO 2 and the VFO signal to provide a counter input 455 kHz above the receive frequency. In order to produce a display of the true frequency, a programmable up-counter and gate prevent those pulses that correspond to the first 455 kHz from reaching the input of the frequency counter. Removal of one jumper and connection of another allows the counter to read external frequencies with amplitudes of 30 mV or more up to 40 MHz, but the count shown is 10 times the actual frequency. The phase-detection process mixes VFO, LO 1 and LO 2 signals to produce a frequency between 7 and 36 MHz. Band-switch information, from the controller board, sets programmable dividers so that the 7- to 36-MHz signal is reduced to 100 kHz for comparison in the phase detector. The resulting error voltage is then routed to the controller board and LO 1, the VCO.

The controller board processes information from the band switch and uses it to select the appropriate input filter and VCO range. Two oscillators, a dc-to-dc converter and an RF detector (for use during receiver alignment) also reside on the controller board. A Hartley configured FET VCO tunes from 50.605 to 80.455 MHz in three ranges. The VFO uses an FET in a Colpitts circuit that tunes from 5.4 to 6.7 MHz. (The VFO is used only in the PLL scheme; it is not used in the actual reception process.) A dc-to-dc converter, running at 30 kHz, changes 13.8 V to 15 V for operation from dc supplies.

Controls

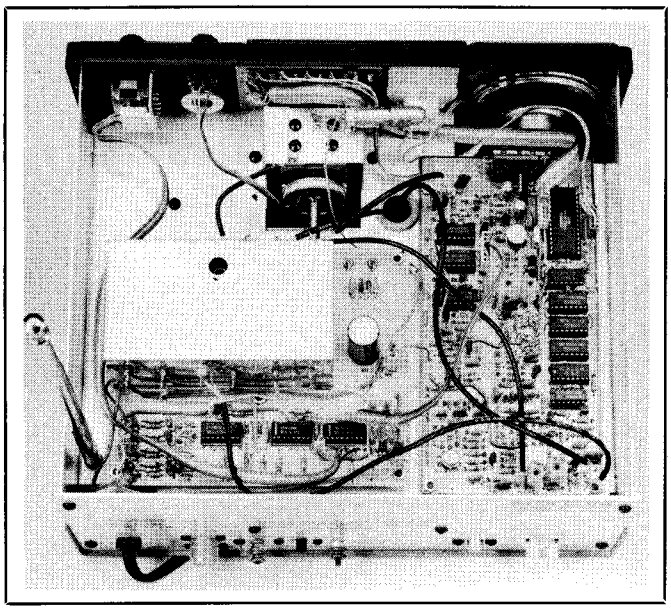
There are few controls on the SW-7800, and most are self-explanatory. The front panel holds the speaker, S meter, frequency display, AGC (SLOW, FAST) switch, PHONES jack (1/4 inch, 8 Ω), RECord jack (1/8 inch, no specified impedance), tuning knob, RF ATTENuator control, BAND switch, MODE switch and VOLUME control. The frequency display has five 7/16-in-high, red LED digits and provides 1-kHz resolution. A LOCAL/DX switch on the rear panel activates a 20-dB attenuator for strong-signal conditions (more on this later). Also on the back panel are terminal posts for HI-Z antenna and GROUND connections, an SO-239 connector for 50-Ω antenna, MUTE (phono jack) and EXT POWER (two-conductor, nylon, 13.8 V, 0.75 A). In addition, a 54-inch collapsible antenna screws onto the chassis through a hole in the top panel.

The true frequency counter in the '7800 eliminates some possible control problems: (1) Some microprocessor-controlled radios take display information directly from the control processor. Such displays have no connection to the oscillator or synthesizer chain and may not reflect a malfunction in those circuits. (2) Dial backlash can cause inaccurate readings in the mechanical frequency displays of some VFO-tuned receivers. The '7800 counter/display circuitry eliminates both of these problems because the operation of all frequency-determining circuits is reflected in the count.

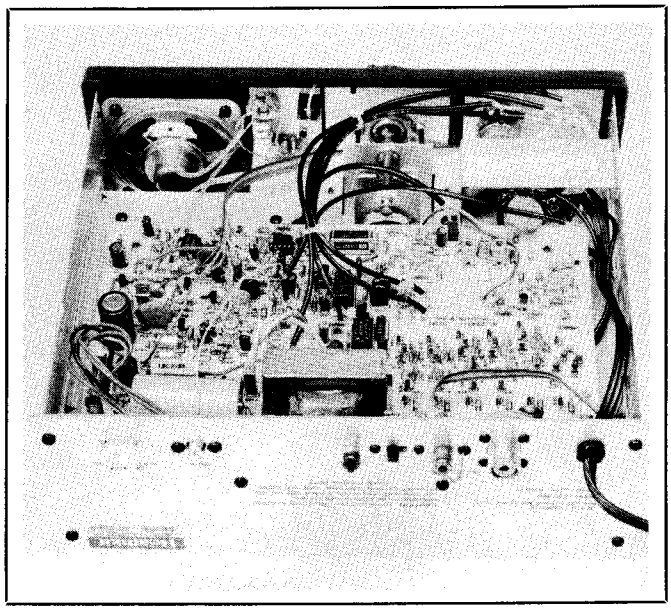
Performance

Heath personnel have told me that sensitivity was a major consideration in the design of the SW-7800. The minimum discernible signal is −130 dBm, which is quite good for a shortwave (non-ham) receiver. Unfortunately, the IMD dynamic range of this radio limits its sensitivity when strong signals are near the weak ones. A fairly strong, clear signal is necessary for good reception.

As an example, while I was using the radio on 4.993 MHz, I heard a group of loud CW signals. Some of the stations were calling CQ, and I was surprised to hear several W8 prefixes on the call signs. When the 20-dB attenuator was switched on, the extraneous signals disappeared. (Heath recommends use of this attenuator when receiving frequencies below 2 MHz.) Apparently, strong signals at my location demand its use on higher frequencies. (Of course, 20 dB of attenuation decreases the sensitivity to −110 dBm.) I had



A top view of the SW-7800, showing the controller board (lower left) and synthesizer board (right). The screw-on whip antenna is in place at the lower-left corner of the chassis.



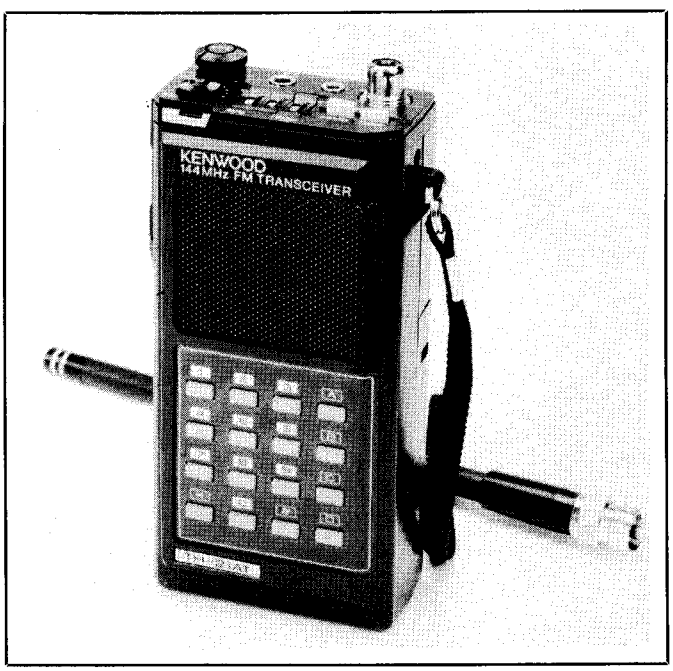
This bottom view shows the back-panel connections and switch. Inside is the receiver board with ac-operated power supply (lower left) and diode-switched band-pass filters (lower right).

a similar experience with an AM broadcast station, which was "received" on 3.6 MHz.

The radio is relatively free from birdies. It has about 10 weak noises per 1-MHz band. Only three or four on each band are loud enough to be disturbing in the SSB mode. When subjected to strong signals, mixing products appear everywhere, but they indicate that the rear-panel switch should be in the LOCAL position.

My SW-7800 drifts about 3 kHz in the first hour after I turn it on. This is not bad, considering that the set has a 2.7-kHz minimum passband. The fellows at Heath, however, tell me that they are working on modifications to further reduce the drift.

The SW-7800 performance is consistent with its price range and market. I would not choose it for my only amateur receiver, however. Most transceivers offer much better performance. The radio is suitable for the casual SWL or as a ham shack add-on. There is extensive use of ICs and digital-control techniques. Much can be learned about control and basic PLL operations from a study of the schematic and circuit description. Thus, the kit should also appeal to the digital-electronics student or those interested in learning about the application of ICs in communications radios. The SW-7800 is available from the Heath Company, Benton Harbor, MI 49022, tel. 800-253-0570. Price class: $350. — *Bob Schetgen, KU7G*



TRIO-KENWOOD TH-21AT 2-METER FM HAND-HELD TRANSCEIVER

☐ Ho hum, another hand-held rig. You've seen one, you've seen them all, right? Wrong! Kenwood's latest offering for the 2-meter FM masses is so small that it fits comfortably in a shirt pocket. Take a quick look at the dimensions in the accompanying table and you'll see that this "baby" radio is only marginally larger than a pack of 100-mm cigarettes.

Features

What else does this tiny jewel offer? For starters, it packs a 2-W wallop and covers the entire band from 144 to 148 MHz, and then some. A DTMF pad is built in for the autopatch crowd; and, of course, it comes complete with a NiCd battery pack and wall charger. Receiver sensitivity is right up there with the best of the mobile and base-station rigs, and the 0.4-W audio amplifier and 2-inch speaker are enough for even the noisiest locations.

Like most of the truly well-engineered things in life, the TH-21AT is simple and straightforward. The only controls are those essential to operation. Frequency display and selection are handled by thumbwheel switches. The first section sets the MHz range — 4 for 144, 5 for 145, and so forth. The second section sets the 100-kHz range, while the third sets the 10-kHz range. For example, 545 on the thumbwheel corresponds to a receive frequency of 145.450 MHz. Just press the +5kHz switch if you need to go in between the 10-kHz steps afforded by the thumbwheel. There's a switch on the back of the transceiver to choose the transmitter offset: −600 kHz, simplex or +600 kHz.

There are only a few other switches on the TH-21AT. The VOLume control doubles as the power switch, and it sits right above the SQuelch control. A TONE switch activates the optional TU-6 tone-burst generator (the review unit was not so equipped), while the HI/LO switch on the rear panel selects full transmitter power or battery-saving flea power.

The review unit was equipped with several useful options. The SC-8T soft case protects the TH-21AT from damage. This vinyl case has cutouts for all the controls and features a clear plastic cover for the keypad area. I had some trouble getting the transceiver to fit inside the case at first, but it was easier after a few tries — sort of like learning to diaper a baby. The SC-8T also includes a belt hook.

If you're going to use the belt hook, check out the SMC-30 external speaker/microphone option. This accessory plugs into the top of the transceiver and functions as an external speaker on receive

Trio-Kenwood TH-21AT 2-Meter FM Hand-Held Transceiver, Serial no. 5042641

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 144.0 to 148.0 MHz.	140.000 to 149.995 MHz.
Mode of operation: FM.	As specified.
Frequency display: Not specified.	Thumbwheel switch.
Frequency resolution: 5 kHz.	As specified.
Transmitter output power: High power, 1.0 W; low power, 150 mW.	High power, 2.25 W; low power, 1.0 W.
Harmonic suppression: Not specified.	68 dB (see Fig. 2).
Spurious suppression: Not specified.	68 dB (see Fig. 2).
Receiver sensitivity: S/N more than 28 dB at 0.5-μV input 12-dB SINAD; less than 0.25 μV.	0.21 μV for 20 dB quieting; 0.17 μV for 12-dB SINAD.
Squelch sensitivity: Less than 0.25 μV.	Min. 0.8 μV; max. 0.31 μV.
Receiver audio output at 10% THD: More than 250 mW.	380 mW.
Color: Black.	
Weight: 9.9 oz incl. antenna and NiCd battery pack.	
Size (HWD): 4.7 × 2.25 × 1.1 in.	

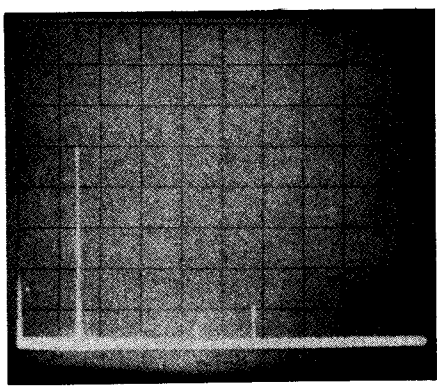


Fig. 2 — Spectral display of the TH-21AT. Power output is 2.2 W at 146 MHz. Horizontal divisions are each 100 MHz; vertical divisions are each 10 dB. The amplitude of the fundamental has been notched approximately 30 dB by means of notch filters to prevent analyzer overload. All spurious and harmonic emissions are at least 68 dB below peak fundamental output. The TH-21AT complies with current FCC specifications for spectral purity.

and a microphone on transmit. The SMC-30 has a coiled umbilical cord long enough to allow freedom of movement with the TH-21AT attached to the belt, and it even has a nifty clip so you can attach it to your shirt pocket or jacket lapel.

The accessory that received the most use during the review period was the AJ-3 antenna adapter. This device takes the threaded phono antenna connector used with the standard "rubber duck" and converts it to a female BNC connector so you can use the hand-held radio with an external antenna.

Battery

The TH-21AT is equipped with a 180-mAh NiCd battery pack and wall charger. A full charge takes eight hours and can last all day or less than an hour, depending on how much transmitting you do. An optional BT-2 battery case that holds AAA alkaline cells is available. For extended portable operation, Kenwood recommends the optional BB-2 C-cell holder. Neither of these options was tried during the review.

Nominal supply voltage is 7.2, so the transceiver does not have an external power jack. Kenwood does offer, however, an optional dc-to-dc converter (DC-21) for operation from a 12- or 13.8-V dc power source.

Operation

The TH-21AT performed flawlessly during the review period. It took me only a few minutes to read the manual and become familiar with the controls. This rig is so small that you can take it virtually anywhere without worrying about nonhams pointing and talking in hushed tones about the radio on your belt. Remove the antenna and the TH-21AT becomes practically invisible in a shirt, suit or coat pocket. If you want to leave it in the car, it will lie concealed under the seat of even the smallest sport coupe. Perhaps the greatest worry is remembering where you left it.

A versatile piece of gear, the TH-21AT is just the rig to take for portable operation at a hamfest or mobile (with or without a roof antenna). It's also the heart of a functional base-station setup, especially with an external power supply, the SMC-30 speaker/mic and an outdoor antenna. I had no problem keeping in touch with friends from the car when I used the rubber duck antenna and several Hartford-area repeaters. From home, with an outdoor antenna, I could work into the W1AW repeater, 20 hilly miles away. The repeater was excellent copy, and I was practically full quieting with low power.

Like other hand-held rigs with thumbwheel switches, the TH-21AT is not so convenient when you want to change frequency. It's difficult to select the right frequency when driving (especially at night), but it is possible with some practice. Safe driving must always come first, so in that regard a transceiver with a lighted display and memories might be better.

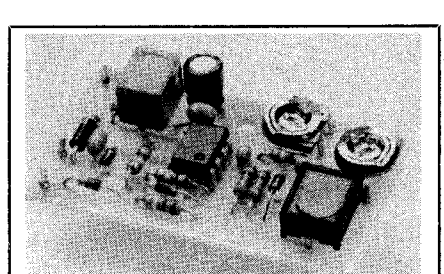
That's it in a nutshell. This small wonder does the basics very well without all the bells and whistles. If you can live without the gadgets, the TH-21AT offers basic value and performance in an unmatched package. Manufacturer: Trio-Kenwood Communications, 1111 West Walnut St., Compton, CA 90220, tel. 213-639-9000. Price class: TH-21AT, $230; SMC-30, $35; SC-8T, $10; AJ-3, $6.50. — *Mark J. Wilson, AA2Z*

New Products

AMATEUR ASSOCIATES LTD. PEP MODULE

☐ Amateur Associates Ltd. brings to the amateur market a module that can turn practically any in-line wattmeter into a PEP-reading wattmeter. The module consists of a PC board with one IC and a number of discrete components. Measuring only 1-1/4 by 2-1/8 inches, the board can be mounted inside most wattmeter housings; a single screw and standoff (provided) or double-sided tape will hold it in place.

Wiring this module to a wattmeter is easy. First, remove the wire leading to the (+) terminal on the back of the analog meter (providing dc to the meter movement). Reconnect this wire to the input of the PEP module. Next, solder the two wires leading from the output of the module to the (+) and (−) terminals of the meter. That's all there is to it! Sensitive RF portions of the wattmeter are left untouched. The instruction sheet gives additional information for wiring a DPDT switch to allow either PEP or normal wattmeter readings to be taken.



Any voltage between 3- and 14-V dc will power the circuit. Three AA penlight cells are suggested, and will provide about nine months of continuous-duty operation.

To calibrate the PEP module, only a CW transmitter and dummy load are required. Simply record a power reading from the wattmeter before installing the module; after installation, adjust the coarse- and fine-tune potentiometers for this same power reading. In operation, the PEP module will cause the wattmeter needle to travel rapidly up scale but slowly down scale, allowing the peak power of an SSB signal to be monitored.

The PEP module is available from Amateur Accessories Ltd., Glan Conway, Colwyn Bay, Clwyd, Wales LL28 5LS, U.K. Price class: $15. — *Greg Bonaguide, WA1VUG*