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QST Compares: Dual-Band Hand-Held FM Transceivers
(Alinco DJ-580T; ICOM IC-W21A; Kenwood TH-78A; Standard C558A; Yaesu FT-530)

Trimble Scout GPS Hand-Held Global Positioning System Receiver

Conducted by Mark Wilson, AA2Z
Editor, *QST*

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Assistant Technical Editor

It's hard to beat the versatility of hand-held transceivers (H-Ts). Although portable by definition, an H-T can also serve as a mobile radio and even a home (base) transceiver. In the "old days" of a few years ago, your only problem was choosing which band you wanted to operate—2 meters or 70 cm—and purchasing the appropriate H-T.

With the explosion of FM activity on both 2 meters and 70 cm, manufacturers were quick to meet the demand for *dual-band* hand-held transceivers. Thanks to their efforts, amateurs don't have to choose a separate radio for each band; they have the ability to operate on either band in the palms of their hands. With improvements in miniaturization, surface-mount component technology and so on, these dual-band H-Ts have been gradually shrinking in size. At the same time, the number of features offered in dual-band H-Ts has actually *increased*.

For hams on the go, dual-band H-Ts are the rigs of choice. Even so, you have to wade through a dizzying array of features to make your purchase decision. Do you want paging capability? If so, do you also want a message display that indicates who's paging you? How about RF output power? Is 2 watts sufficient, or do you need more?

We selected the current crop of popular dual-band H-Ts from a variety of manufacturers and put them to the test. First, the ARRL Laboratory engineers checked the published specifications and measured the characteristics of each radio. You'll see the results reported in tables throughout this review. Then, the radios were turned over to our Headquarters review team: Luck Hurder, KY1T, Deputy Field Services Manager; Glenn Swanson, KB1GW, Assistant to the Manager, ARRL/VEC; Brian Battles, WS1O, *QST* Features Editor; Jay Mabey, NUØX, *Repeater Directory* Editor; and Steve Ford, WB8IMY, Assistant Technical Editor.

Table 1
Dual-Band Hand-Held Transceiver Features

	Alinco DJ-580T	*ICOM IC-W21A*	*Kenwood TH-7t*	*Standard C558A*	*Yaesu FT-530*
Receive coverage (MHz)	130-174 420-480	138-174 440-450	118-174 438-450	115-172 320-474	130-174 430-450
Transmit coverage (MHz)	144-148 440-450	144-148 440-450	144-148 438-450	144-148 438-450	140-150 430-450
Memory channels (per band)	21	35	50	20	41
Band, memory and programmed scan	Yes	Yes	Yes	Yes	Yes
Simultaneous dual-band receive	Yes	Yes	Yes	Yes	Yes
Dual *in-band* receive (monitor two 2-meter or 70-cm signals simultaneously)	No	Yes	Yes	No	Yes
Standard battery capacity	700 mAh	900 mAh	700 mAh	700 mAh	600 mAh
Auto power off	Yes	Yes	Yes	Yes	Yes
Auto transmit power control	No	Yes	Yes	No	Yes
Auto repeater offset selection	Yes	Yes	Yes	Yes	No
CTCSS function	Yes	Yes	Yes	Yes	Yes
DTMF paging	Yes	Yes	Yes	Yes	Yes
Coded squelch function	Yes	Yes	Yes	Yes	Yes
Crossband repeater	Yes	Yes	Yes	Yes	Yes
Aircraft band receive (*without* modification)	No	No	Yes	Yes	No
Max RF output with standard battery	2 W	2 W	2 W	2.5 W	2.5 W
Dimensions (H/W/D) with standard battery (inches)	5.6×2.3×1.3	4.9×2.2×1.4	5.4×2×1.6	5.2×2.2×1.2	5.4×2.2×1.3
Weight with standard battery (ounces)	14.4	13.8	14	13	18.5
Suggested retail price	$519	$623	$599	$689	$569
Typical selling price (average of several *QST* advertisers)	$409	$514	$449	$529	$439

ALINCO DJ-580T

If economy is the driving force behind your purchase decisions, consider the Alinco DJ-580T. This dual-band H-T isn't as feature-laden as the others we reviewed, but the price won't burden your bank account as badly, either. [Although the Alinco's typical selling price is the lowest of the units reviewed here, special coupons and promotions from the other manufacturers tend to blur this distinction. Check with dealers advertising in *QST* for the latest prices when making your decision—*Ed.*]

The DJ-580T makes an attempt at ergonomic design and most reviewers felt that it succeeds. The rig fits well in your hand. A few had difficulty with the close spacing of the volume and squelch controls. On the other hand, the backlighted display and keypad are easy to read.

In terms of programming, the DJ-580T has a steep learning curve similar to several of the other radios reviewed here (this is a recurring theme). You find yourself referring to the manual often to perform basic functions. Unfortunately, the manual received particularly poor marks from the reviewers. Some descriptions are incomplete and the English is often mangled. On the positive side, the manual does include an index and a couple of quick-reference tables.

Like the other radios tested here, the DJ-580T provides crossband repeater capability. When you're using a single radio to act as a crossband repeater, you expect some compromises. In the case of the DJ-580T, the compromise was an increased level of desensitization. When repeating signals from 2 meters to 70 cm, some reviewers found that they had to use the low-power output setting on 70 cm to avoid clobbering the 2-meter receiver.

The DJ-580T offers extended receive coverage—including the upper part of the aircraft band. The manual describes a simple modification that enables full aircraft band coverage. You can store 20 of your favorite simplex and repeater pairs per

Alinco DJ-580T/E, Serial No. T025111

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: Receiver, 130.000-173.995 MHz, 420.000-479.995 MHz; transmitter, 144.000-147.995 MHz, 440.000-449.995 MHz.	As specified.
Receiver	
Receiver sensitivity: Better than 15 dB below 1 μV (–122 dBm) for 12 dB SINAD.	146 MHz, –123 dBm; 440 MHz, –124 dBm.
Two-tone third order IMD dynamic range: Not specified.	20-kHz offset from 146 MHz, 65 dB; 20-kHz offset from 440 MHz, 67 dB.
Adjacent-channel rejection: Not specified.	20-kHz offset from 146 MHz, 60 dB; 20-kHz offset from 440 MHz, 58 dB.
Squelch sensitivity: Not specified.	146 MHz, –130 to –121 dBm.
Receiver audio output: 250 mW into 8 Ω at 10% distortion.	231 mW into 8 Ω at 10% THD.
Transmitter	
Power output with standard battery: Approx 2 W.	146 MHz, 3.0 W; 440 MHz, 2.6 W.
Power output at 12 V (optional battery voltage): Approx 5 W.	146 MHz, 6.0 W; 440 MHz, 6.2 W
Spurious signal and harmonic suppression: Better than 60 dB.	As specified. The DJ-580T/E meets FCC requirements for spectral purity for transmitters in its power-output class and frequency range.
Transmit-receive turnaround (PTT release to 90% of full audio output): Not specified.	Squelch on, approx 140 ms; squelch off, approx 120 ms.

band in the DJ-580T's memory channels. The reviewers found that 40 memories were more than sufficient for average use.

There are eight versatile scanning functions in the DJ-580T. You can scan either band simultaneously, scan the memory channels, scan within certain frequency limits and so on. These scanning features may seem trivial, but they come in handy when you're operating in strange territory. When traveling, for example, you can set up the scan of your choice and let the H-T search the bands for activity while you relax. The scanning (and memory) features are accessible from the optional remote microphone as well.

The DJ-580T's paging and tone-squelch functions are standard. Your friends can use DTMF tones to page you, or subaudible CTCSS tones will serve a similar purpose. The CTCSS decoding feature is handy because it affords you an extra layer of paging privacy. If you want to check activity on the frequency without disabling the paging function, all you have to do is press the front-panel **MONITOR** button.

Overall, the DJ-580T is an H-T with a lot to offer at an affordable price. The programming may drive some users to distraction, but with patience they'll finally triumph. Once the H-T is programmed, you really don't need to change the settings unless one of your regular repeaters makes a few changes, or if you take the rig outside your normal operating area.

ICOM IC-W21AT

The ICOM IC-W21AT attempts to ease the occasional pain of dual-band H-T operating through the use of its AI (artificial intelligence) feature. Whether or not it succeeds is the subject of some debate.

You can't escape the chore of programming the IC-W21AT—AI notwithstanding. The purpose of AI is to minimize the number of keystrokes required to activate a particular function. Let's say you like to scan your favorite repeaters while you're eating breakfast. With most radios you'd have to punch the various keys to start the scan each morning. With AI, however, you run through the keys only once. After that, you can resume the scan by simply pressing the AI button. If you're familiar with computer software, this is similar to so-called "hot key" or "macro" functions where pressing one key starts a chain of events programmed in advance.

Is AI worth it? Does it really make a full-featured H-T easier to use? Some reviewers thought that AI was just a clever gimmick, a frill designed to set it apart from other dual-band H-Ts. Other reviewers found it useful in situations where they wanted to activate the same functions over and over with minimal effort. The answer probably falls somewhere in the middle. AI helps you use the IC-W21AT more efficiently, but it doesn't make initial programming easier.

You'd think that the IC-W21AT's large display would be easy to read, but several reviewers reported some difficulty. The most common complaint was that the H-T had to be held at a precise angle to read the LCD segments clearly. Otherwise, they looked dim and faded. The display can be lighted for night viewing and the keypad is backlighted as well.

The IC-W21AT's "whisper" function drew a number of positive comments. When you're using the H-T in the crossband mode (you're on, say, 70 cm and the other station is on 2 meters), it's possible to operate in *full duplex* much like a standard telephone. You need the optional BP-131 or BP-132 battery pack with the built-in microphone to use this function. With the battery pack installed, you can hold the IC-W21AT to your ear like a portable telephone. The battery-pack microphone is then close to your mouth. With the whisper mode enabled, you hear your own audio plus the audio of the other station. The speaker audio level is reduced to avoid feedback.

Automatic power output control is another convenient feature of the IC-W21AT. When you're talking through a repeater, the IC-W21AT measures the repeater's signal strength and automatically reduces your output to the minimum power required to maintain communications. Like a similar function in the Yaesu FT-530, automatic power control works best when signal conditions are good. Under less-than-ideal conditions, our review unit tended to set the output too low. Of course, automatic control can be disabled. While we're on the subject of power, the IC-W21AT offers a total of five levels of output—from a maximum of 5 watts all the way down to 15 mW. Many reviewers were surprised to find that they could get consistently good results at 15 mW if used near a sensitive repeater.

The IC-W21AT offers 35 memory channels per band and the ability to scan them at will. In fact, you can set up several different scanning modes depending on what you

ICOM IC-W21AT, Serial No. 01748

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: Receiver, 138-174 MHz, 440-450 MHz; Transmitter, 144-148 MHz, 440-450 MHz.	As specified.
Receiver	
Receiver sensitivity: Better than 0.16 μV (–123 dBm) for 12 dB SINAD.	146 MHz, –124 dBm; 440 MHz, –123 dBm.
Two-tone third order IMD dynamic range: Not specified.	20-kHz offset from 146 MHz, 56 dB; 20-kHz offset from 440 MHz, 61 dB.
Adjacent-channel rejection: Not specified.	20-kHz offset from 146 MHz, 65 dB; 20-kHz offset from 440 MHz, 60 dB.
Squelch sensitivity: Less than 0.13 μV (–125 dBm) at threshold.	146 MHz, –128 to –120 dBm
Receiver audio output: >200 mW into 8 Ω at 10% distortion.	224 mW into 8 Ω at 10% THD.
Transmitter	
Power output with standard battery: Not specified.	146 MHz, 2.8 W; 440 MHz, 2.0 W.
Power output at 13.5 V: 144 MHz, 5 W; 440 MHz, 5 W.	146 MHz, 6.1 W; 440 MHz, 6.1 W.
Spurious signal and harmonic suppression: Better than 60 dB.	As specified. The IC-W21AT meets FCC requirements for spectral purity for transmitters in its power-output class and frequency range.
Transmit-receive turnaround (PTT release to 90% of full audio output): Not specified.	Squelch on, approx 150 ms; squelch off, approx 120 ms.

want to accomplish. The rig has extended 2-meter receive capability, but the low end of its coverage stops just above the aircraft band.

Crossband duplex operation is standard along with power on/off timers and an automatic power-off function. Duplex operation was excellent, with little crosstalk or desensitization. Like the other H-Ts we tested, the IC-W21AT provides a built-in pager function and tone-coded squelch. The page-alert is particularly handy. If you leave the rig unattended with the pager enabled, it will store any incoming pages while you're away.

You'll spend days exploring all the features of the ICOM IC-W21AT, but the down side is that they tend to make the radio difficult to program and use. AI makes a dent in the problem, but it's only a dent. If you enjoy sorting through the myriad functions of the rig, the IC-W21AT may be right for you. This is especially true if you're the type of ham who spends a great deal of time operating FM. If not, a simpler radio will do just as well.

KENWOOD TH-78A

Of all the H-Ts reviewed, the Kenwood TH-78A packed the most programmable features. This plethora of goodies comes with a steep learning curve, though. Every reviewer found the TH-78A difficult to program, even with assistance from the manual. After two weeks of examination, none of the reviewers could say that they had completely mastered the radio.

The TH-78A manual isn't as helpful as it could be. Some of the instructions are unclear and there's no index to assist you. That's why many will rely on the handy "Minute Manual." This informative reference is small enough to fit in a shirt pocket. The "Minute Manuals" are available from dealers or direct from Kenwood.

Once you figure out the programming, the TH-78A is relatively easy to use. The display is large and clear with LED edge lighting for nighttime use. The upper two-thirds of the display indicate the VHF and UHF operating frequencies as well as repeater split selections. The lower third of the display is devoted to various status messages including alphanumeric paging, which we'll discuss in a moment. The backlighted keypad is shielded by a sliding plastic panel.

The TH-78A's scanning functions are extremely flexible. You can scan through its 50 memory channels in a flash. (Memory can be expanded with the optional ME-1 module.) You can also scan all or part of 2 meters and 70 cm, individually or *simultaneously*. When you find a repeater you want to access, the TH-78A selects the correct offset frequency automatically. (Or you can program any other offset you desire.) If you stumble on a repeater that you'll want to use often, adding it to the TH-78A's memory is simple. In addition, you can add the call sign of the repeater or any other six-character label into the alphanumeric memory. This is a real time-saver when you want to hit a repeater in a particular city and you can't remember where you stored the frequency. Just skip through the memory channels and watch the display for, say, "Newton."

The TH-78A offers a DTSS (dual-tone squelch system) for remote access and paging functions. When the DTSS is enabled, you hear audio only when the appropriate three-digit DTMF code is received. This is handy when you want to set up the TH-78A to scan your favorite repeaters while you busy yourself with something else. If a friend needs to reach you, he or she can send the correct code and then give you a call.

The DTSS pager takes the tone-encoded squelch function a step further. By sending the correct DTMF code, you'll not only hear the audio, you'll know who is paging by glancing at the display. If you happen to be away from the rig, the TH-78A will store the information along with the time when the code was received.

And just when you thought the paging system was complicated enough, here's another twist. If your friends also own TH-78As, they can send short messages to you or each other when paging. Although it's a pain to program, this function is one of the handiest features of the H-T. You can leave your TH-78A unattended and still receive messages—just like a portable answering machine. For example, someone can page you and then send a code that translates to **CALL ME** on the TH-78A's display.

Other TH-78A features include crossband repeater capability, expanded receive coverage, three output power levels, automatic transmit power control and an automatic shut-down function to save your batteries. There is also a time-out timer will shut down the TH-78A completely if it

Kenwood TH-78A, Serial no. 41200469

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: Receiver, 118-174 MHz, 438-450 MHz; transmitter, 144-148 MHz, 438-450 MHz.	As specified.
Receiver	
Receiver sensitivity: 146 MHz, better than 0.16 μV (–123 dBm); 440 MHz, better than 0.18 μV (–122 dBm).	146 MHz, –123 dBm; 440 MHz, –123 dBm.
Two-tone third order IMD dynamic range: Not specified.	20-kHz offset from 146 MHz, 58 dB; 20-kHz offset from 440 MHz, 69 dB.
Adjacent-channel rejection: Not specified.	20-kHz offset from 146 MHz, 61 dB; 20-kHz offset from 440 MHz, 58 dB.
Squelch sensitivity: Less than 0.16 V (–123 dBm).	146 MHz, –134 to –123 dBm.
Receiver audio output: 200 mW into 8 Ω at 10% distortion.	320 mW into 8 Ω at 6% THD.
Transmitter	
Power output with standard battery: 144 MHz and 440 MHz, approx 2.0 W	146 MHz, 2.3 W; 440 MHz, 2.3 W.
Power output at 13.8 V (optional battery voltage): 144 MHz and 440 MHz, Greater than 5.0 W.	146 MHz, 6.0 W; 440 MHz, 5.9 W.
Spurious signal and harmonic suppression: Better than 60 dB.	As specified. The TH-78A meets FCC requirements for spectral purity for transmitters in its power-output class and frequency range.
Transmit-receive turnaround (PTT release to 90% of full audio output): Not specified.	Squelch on, approx 230 ms; squelch off, approx 110 ms.

transmits continuously for more than 10 minutes.

The Kenwood TH-78A is a good choice if you don't mind spending the time necessary to "learn" the transceiver. It is an exceptional radio for hams who need its full-featured paging capability and other programmable functions. If enhanced paging isn't important to you, but operational simplicity *is*, you may want to look elsewhere.

STANDARD C558A

No one had the nerve to deliberately drop test the Standard C558A, but few doubted that it could take the punishment. The "feel" of this H-T is extremely solid—not unlike commercial hand-held transceivers used by police, fire and other public-safety agencies.

The LCD display is small, perhaps to protect it from damage in a fall. The downside of this design consideration is that it's difficult to read. Of all the H-Ts tested for this review, the C558A received the most complaints about display quality. The frequency digits can be read easily enough if you're in the proper light, but smaller segments, such as the 5-kHz offset indicator, are almost microscopic. The display uses LED edge lighting to assist you in gloomy conditions, but the effect is disappointing.

Programming the C558A is yet another exercise in frustration. Until you truly master the radio, you must have the manual at your side at all times. Many functions require you to go through several steps before you can finally enable them. There is liberal use of the **SET** key to implement multiple functions of single buttons. Some reviewers found the C558A's implementation of the **SET** key to be particularly awkward. For example, you may need to press a button, press and hold the **SET** key, and then press the same button again just to access a single function. To Standard's credit, they provide a "menu" function that helps lower the programming pain threshold. As with the other H-Ts in this review, operation was easy once the radio was programmed.

The C558A offers 20 frequency memories per band, but it's expandable to 100 per band for hyperactive hams. You can set up the C558A to scan in a variety of configurations—including a complete memory scan. The most popular seemed to be simultaneous 2-meter/70-cm full-band scan. You'll be surprised what you can uncover in a evening of listening with the C558A's sensitive receivers. Depending on how you program the scan, you can search between two frequencies (scan the simplex channels between 146.40 and 146.58 MHz, for example). Or, you can sweep through both bands simultaneously.

Many reviewers commented on receiving positive reports about the quality of the C558A's transmit audio. Most listeners described it as "rich" or "full bodied." The audio from the remote speaker/microphone was even better. For those concerned about the effect of its audio characteristics on packet, the C558A acquitted itself well in several tests with 1200 bit/s packet.

The C558A's crossband repeater function features preset audio levels and selectable "hang" times. The combination of the two made its operation seem more like that of a full-fledged repeater. Receiver desensitization during repeater operation was noted, but it was not severe. In fact, the C558A turned in the best crossband performance among all the H-Ts tested.

Like the other H-Ts tested in this review, the C558A includes a number of paging features. You can page (or be paged) using DTMF tones. The proper tone sequence will not only open the squelch, it will identify the sender. You can also set the C558A's squelch to remain closed until it hears a particular subaudible tone. This is handy when you want to know when a particular station is on the air without requiring a page from that station.

The C558A offers a number of other interesting features. For example, when you're operating in an environment where there's lots of RF floating around, you can switch in a 15-dB receive attenuator to cut down the overload. (I wish I had had this feature on the old H-T I took to the Dayton HamVention last year!) Also, if you have a friend who owns a C558A, you can copy the configuration of your C558A to his—*over the air*. The *clone* mode allows you to swap your function and frequency memories to another C558A automatically through the use of DTMF tones. The entire copy procedure takes about four minutes. The catch is that any interference or loss of signal dur-

Standard C558A, Serial no. 31U 060019

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: Receiver, 115-172 MHz, 320-474 MHz; transmitter, 144.0-147.995 MHz, 438.0-449.995 MHz.	As specified.
Receiver	
Receiver sensitivity: Better than –16 dBμ (–123 dBm)	146 MHz, –123 dBm; 440 MHz, –123 dBm.
Two-tone third order IMD dynamic range: Not specified.	20-kHz offset from 146 MHz, 70 dB; 20-kHz offset from 440 MHz, 63 dB.
Adjacent-channel rejection: Not specified.	20-kHz offset from 146 MHz, 61 dB; 20-kHz offset from 440 MHz, 58 dB.
Squelch sensitivity: –20 dBμ (–127 dBm).	146 MHz, –132 to –122 dBm.
Receiver audio output: 200 mW into 8 Ω at 10% distortion.	202 mW into 8 Ω at 10% THD.
Transmitter	
Power output with standard battery: 144 MHz, 2.5 W; 440 MHz, 2.2 W.	146 MHz, 2.6 W; 440 MHz, 2.0 W.
Power output at 12 V (optional battery voltage): 144 MHz and 440 MHz, 5.0 W.	146 MHz, 5.5 W; 440 MHz, 5.3 W.
Spurious signal and harmonic suppression: Better than 60 dB	As specified. The C558A meets FCC requirements for spectral purity for transmitters in its power-output class and frequency range.
Transmit-receive turnaround (PTT release to 90% of full audio output): Not specified.	Squelch on, approx 125 ms; squelch off, approx 115 ms.

ing the tone transmissions may result in some strange behavior in your friend's C558A. Cloning is best done with the two radios side by side.

The Standard C558A is a worthwhile transceiver for hams who plan to do a lot of portable and mobile operating. We're all a little rough with our H-Ts, but the C558A is designed to suffer this punishment without complaint. If you happen to be visually impaired, however, an H-T with a larger display is probably a better choice.

YAESU FT-530

The FT-530 is an H-T that's clearly designed for ease of use. Every reviewer praised the FT-530 for its straightforward approach to programming. In fact, several commented that they were able to program basic functions without referring to the manual—a welcome change from the other units reviewed here.

The case design is completely ergonomic. It fits right in the palm of your hand and every key is within reach. The display is fully readable in all lighting conditions. Both the display and the keypad are backlighted for additional clarity. Many dual-band H-Ts include LEDs that light when the squelch opens on either band. On the FT-530 these LEDs are placed side-by-side near the keypad where they're easy to see. This is a thoughtful design feature that endeared the rig to our reviewers.

Documentation is excellent. The manual makes liberal use of large tables that illustrate various features and describe how to use them. Even the writing style is conversational.

The FT-530 provides 41 memory channels per band. That's more than enough to store all your favorite simplex frequencies and repeater pairs. DTMF paging and coded-squelch operation is included in the FT-530. Anyone (using any radio) can open the squelch or page you by simply sending the proper DTMF codes from their keypad. The FT-530 can also be programmed to automatically *acknowledge* a page.

Other programmable functions include an automatic clock/alarm system that will switch the radio on at a particular time of day. (Wake up to the sound of your local repeater.) Scanning functions allow you to search 2 meters or 70 cm separately or simultaneously. The repeater offset selection is automatic (programmed at the factory), but you can override it from the keypad.

The transmit battery saver automatically measures the received signal strength and selects the appropriate output power level for your FT-530. If you can hear a repeater without a trace of noise, chances are good that you don't need to run the FT-530 at full output to communicate. Why transmit at a battery-draining 5 watts when 1.5 watts will do just as well? The transmit battery saver works best when the received signal is strong. When the received signal is moderate to marginal, the FT-530 seems to have difficulty choosing the best output level. With this in mind, you can easily override the battery-saver function and choose your own output level.

Speaking of batteries, the FT-530 offers the convenience of being able to check your battery voltage at a glance. All you have to do is punch the appropriate keys and read it on the display. The Yaesu engineers must have had batteries on the brain when they created the FT-530. They included an easy-replacement function for the lithium memory back-up battery. When the time comes to put in a fresh cell, you simply slide the holder out of the side of the radio and pop in a new one. No disassembly necessary!

If you've found a new repeater and you can't seem to access it, the repeater may be using a subaudible CTCSS (continuous tone-coded squelch system). You must transmit a subaudible tone along with your voice or the repeater won't relay your signal. What tone frequency does the repeater require? The FT-530 can provide the answer. While monitoring the repeater you can enable the H-T's automatic CTCSS tone search. The FT-530 will monitor the subaudible tones the other stations are using and then scan through its memory until it finds a match. Once a match is found, it's a simple matter to program the tone and you're on your way.

The FT-530 adds a useful feature for mobile operating in its optional remote speaker mike. In addition to the usual controls, the microphone includes an LCD frequency and signal-strength display. If that wasn't enough, the FT-530 throws in a VOX (voice-operated transmit) *in the radio* as

Yaesu FT-530, Serial no. 3D131587

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: Receiver, 130-174 MHz, 430-450 MHz; transmitter, 140-150 MHz, 430-450 MHz.	As specified
Receiver	
Receiver sensitivity: 146 MHz, better than 0.158 μV (–123 dBm); 440 MHz, better than 0.18 μV (–122 dBm).	146 MHz, –123 dBm; 440 MHz, –123 dBm.
Two-tone third order IMD dynamic range: Not specified.	20-kHz offset from 146 MHz, 58 dB; 20-kHz offset from 440 MHz, 60 dB.
Adjacent-channel rejection: Not specified.	20-kHz offset from 146 MHz, 64 dB; 20-kHz offset from 440 MHz, 64 dB.
Squelch sensitivity: Not specified.	146 MHz, –125 to –120 dBm.
Receiver audio output: 300 mW @ 13.8 V into 8 Ω for 5% distortion.	296 mW into 8 at 5% THD.
Transmitter	
Power output with standard battery: Not indicated on Specifications page, but a chart on page 23 of the manual specifies power to be 2 W.	146 MHz, 2.6 W; 440 MHz, 2.1 W.
Power output at 13.8 V (optional battery voltage): 5.0 W.	146 MHz, 5.7 W; 440 MHz, 5.0 W.
Spurious signal and harmonic suppression: Better than 60 dB.	As specified. The FT-530 meets FCC requirements for spectral purity for transmitters in its power-output class and frequency range.
Transmit-receive turnaround (PTT release to 90% of full audio output): Not specified.	Squelch on, approx 110 ms; squelch off, approx 65 ms.

standard equipment.

Two-meter receive coverage includes 130 to 174 MHz. This gives you a portion of the aircraft band. To listen to the aircraft band AM signals, however, you must switch the AM detector manually.

The Yaesu FT-530 earned high marks for easy operating and clever, convenient features. Some reviewers felt that the receive audio could have used more output power. (A few complained that it was too "crisp" as well.) These are serious concerns if you plan to use the FT-530 in noisy environments. Otherwise, the FT-530 is a winner for both new and experienced FM operators.

Summary

All of the transceivers featured in this review are quality products. As you can see in Table 1, many of them have the same basic features. What seems to set them apart is ease of use. Hams love gadgets, so we're lured by radios that promise every operational feature under the sun—regardless of whether it really improves the usefulness of the rig. But when you combine a large number of features with a drive to miniaturization, you get "functional overload." In other words, you have too many keys doing too many things simultaneously. The result is operator confusion and frustration—which is exactly what most of our reviewers reported.

As you make your decision to buy a dual-band hand-held transceiver, consider ease of use among your top priorities. Clever features are dazzling, but step back and ask yourself, "Do I really need them? If I do, how difficult are they to use?" If you have the patience and aptitude to deal with the more complicated H-Ts, by all means go for them! But if you're a casual operator who has limited time to learn the tricks of a new rig, think again and buy accordingly.

Every H-T we tested provided the option to use alkaline battery power. This option takes the form of an empty battery case that holds six AA batteries. Alkaline battery performance was outstanding with every transceiver. Not only are alkalines much less expensive than NiCd batteries, they tend to last somewhat longer in normal use. With the advent of *rechargeable* alkalines, the optional battery case is an inexpensive option you should consider.

Each manufacturer offers several NiCd battery options. In most cases it comes down to choosing higher voltage for greater output power, or higher current capacity for longer operating. In addition, all manufacturers offer rapid chargers that will get you back on the air quickly after you've discharged your battery.

Other optional accessories include a variety of remote speaker/microphones as well as headset microphones. The headset mikes are available in VOX and non-VOX models. For complete accessory lists, contact your favorite dealer or the manufacturers.

Finally, a few words need to be said about the crossband functions offered by all H-Ts featured in this review. We were disappointed to discover that *none* of the manuals mentioned the need for frequency coordination when setting up crossband repeaters and links. (Although some cautioned users to "...select frequencies carefully.") The thought of dual-band H-T owners establishing crossband repeaters in random fashion is disturbing. Our 2-meter and 70-cm bands are crowded now—without the added complication of renegade repeaters suddenly appearing on the air. The repeater systems that we all use and cherish can easily be harmed through the thoughtless actions of a few individuals.

Our hope is that most dual-band H-T owners will use the crossband function sparingly. Before you decide to set up a crossband repeater or link, check with your local or regional frequency coordinators. They'll let you know if you'll be interfering with any existing systems. Just because a frequency seems to be quiet at your location, that doesn't mean it isn't in use. Get a copy of the *ARRL Repeater Directory* and check carefully before attempting any crossband operating. Take a look at the bandplans in the front of the book and make sure your input and output frequencies are designated for FM voice operation.

Trimble Scout GPS Hand-held Global Positioning System Receiver

Reviewed by Mark J. Wilson, AA2Z

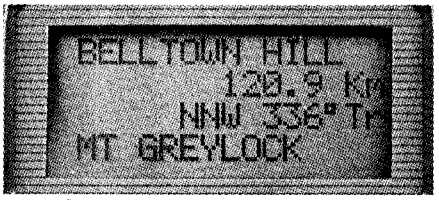
First, some background... In September 1992, Zack Lau, KH6CP, mentioned that he was going to be on Mt Greylock in northwestern Massachusetts for the ARRL 10-GHz contest and said that he had extra rigs to loan. Clarke Greene, K1JX, and I figured that it would be fun to drive around central Connecticut and try to work Zack from locations with a clear shot to the north. (The contest rules allow you to work the same station from multiple locations, if they're over 10 miles apart.) Working Zack and other stations was relatively easy. Determining our precise location turned out to be a big frustration. Unlike other VHF contests that require you to know your 4-character Maidenhead grid locator, or *grid square* (about 70×100 miles; most of Connecticut is in grid FN31), the 10-GHz contest rules require a *6-character* grid locator, or *subsquare* (about 3×4 miles; W1AW is in FN31PR). You also need precise locations because contest scoring is partly based on the distance (in km) covered by each contact. We were able to approximate our latitude and longitude from a US Geological Survey (USGS) topographical map and enter the coordinates into a program running on a notebook computer to calculate the subsquare, beam heading and distance. More often than not, Clarke had the rig set up and had established a 10-GHz contact before I figured out where we were.

Being a firm believer in using technology to simplify my life, I was happy to learn that Trimble Navigation had released the Scout GPS, a hand-held global positioning system (GPS) receiver just prior to the September 1993 10-GHz contest weekend. GPS technology, originally developed for the military, is fast finding its way into the civilian marketplace—especially as a navigation aid for pilots and boaters. GPS receivers use 1227 and 1575 MHz spread-spectrum signals transmitted by a network of 24 satellites. The satellites act as precise reference points for triangulation of positions on Earth. By measuring the travel time of signals from each satellite, the receiver computes its distance from that satellite. With distance measurements from at least three satellites, the receiver can calculate your location and speed. With signals from at least four satellites, the receiver can calculate your elevation as well. How accurate is the system? For security reasons, the Department of Defense introduces satellite timing and position errors that degrade the accuracy to ±100 meters much of the time. Trimble rates the Scout's accuracy at ±25 meters (with good data).

Low-cost GPS receivers from ICOM, Sony, and others are showing up in the ham marketplace. Several ham applications have been described in *QST* and *QEX*.[1,2] What attracted me to the Scout is its ability to report coordinates using 6-character Maidenhead grid locators—perfect for the 10-GHz contest! You can choose from eight other coordinate styles, including latitude/longitude (either degrees, minutes and seconds or degrees and minutes to three decimal places) and a number of systems designed for use with various kinds of maps. You can save a location in memory in any coordinate style and look at it later using other styles.

At 6.8×3.3×1.3 inches (HWD), the Scout is easy to carry and hold. Trimble obviously spent some time on the package design. The Scout is a comfortable fit and can even be used one-handed. It weighs 14 ounces and feels very solid. Four AA alkaline cells provide 5 to 10 hours of use. If the batteries are removed for more than 30 minutes, information stored in memory may be lost. Trimble offers an accessory kit that includes a cigarette lighter cable and battery eliminator to run the Scout to run from 12 or 24-V dc.

The Scout GPS automatically displays Maidenhead grid locators.



Using the navigation functions, the Scout calculates the distance and bearing to a location stored in memory.

At power-on, the Scout searches for satellite signals and informs you as it finds them ("Have 1 satellite" and so on). Any time I was in the open, the Scout found the three satellites needed for position location well within Trimble's 2-minute specification. Most of the time it eventually found signals from four, five or six satellites. It won't work inside buildings, but most of the time, the Scout found three satellites from the dashboard of a car. You'll need the external antenna included with the accessory kit for indoor operation.

You communicate with the Scout via an eight key keypad, and it communicates with you via an informative four-line alphanumeric LCD screen. At power-on, you get the main menu and use the right and left arrow keys to move among six "modes": location, navigation, library, setup, route and advanced. Press the return key to enter a mode, the diamond key to select the options list within each mode, and the up and down arrows to scroll through the options. It may sound confusing, but with a little practice I found my self zipping through the menus without a second thought. The Scout's manual is excellent.

In the location mode, the Scout tells you how many GPS satellites it's receiving, displays your location, and shows the calculated elevation to the nearest 100 feet (if you have acquired four or more satellites). Another screen shows the date, time and GPS accuracy (more often than not, ±100 meters). Submenus in the location mode allow you to select coordinate style, north reference (true or magnetic), and a mapping datum (123 choices cover most of the world). You can save your current location from one reading, or for greater accuracy you can save the average of up to 99 readings. And, finally, you can display data about the satellites the Scout is currently tracking, including received signal strength, elevation angle and azimuth.

In the navigation mode, the Scout displays real-time information for navigating from your current location to a selected goal, or from point to point along a route. The display shows the goal, distance and direction to the goal, current speed, time, steering information and estimated time of arrival. You can also see the distance and bearing between any points stored in memory. I entered the coordinates of Mt Greylock into memory and used the navigation mode to calculate antenna pointing information and distance (for scoring) in the 10-GHz contest. It also came in handy to verify that I had indeed moved 10 miles or more since the last contact.

In the library mode, you can save and display up to 250 locations in memory. The locations can be entered automatically (from GPS signals), or manually (from known coordinates). The Scout assigns a sequential number to each stored location, and you

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[1]R. Flanagan and L. Calabrese, Jr, "An Automated Mobile Radio-Direction-Finding System, *QST*, Dec 1993, pp 51-55.

[2]B. Bruninga, "Interfacing GPS or LORAN Devices to Packet Radio," *QEX*, Feb 1994, pp 9-14.

Building fat monopoles at HF may require special construction techniques because the element diameter is large. Instead of a continuous conducting cylinder as the radiator (a form covered by metal foil, for example), an acceptable, easy-to-build alternative consists of wires parallel to the cylinder axis equally spaced around its circumference. This configuration is sometimes referred to as a cage monopole, because of the resemblance to a bird cage. The greater the number of wires, the better the approximation to a continuous conductor. As a rule of thumb, at least eight wires should be used.

Another consideration in building any kind of monopole is the size of the ground plane. Theoretically, it should extend infinitely in all directions; but, as a practical matter, a circular ground plane of a few wavelengths radius usually works well. Just as the cylindrical radiating element should be a continuous conducting metallic surface, the ground plane should also be continuous, but in many cases this is not practical. Ground planes of wire mesh or radial wires are frequently used, and they provide good performance if properly constructed. Mesh openings should be a small fraction of a wavelength, typically $^1/_8$-wave or less. If radials are used, a large number is required—at least 16, preferably more.

The predicted monopole bandwidth performance has been verified experimentally, with theoretical and measured data showing excellent agreement, typically within 5%. The measured BW for a 476-MHz antenna was actually somewhat greater than predicted. Of course, actual and computed performance will not agree well if modeling assumptions are violated. For example, if the ground plane is too small, or if continuous metallic surfaces are poorly approximated by wire structures, then the agreement between measured and theoretical data will be degraded.

Another potential source of error is making measurements through a long run of coaxial cable. Resistive losses artificially reduce the SWR and increase the bandwidth at the cable input by dissipating some of the reflected power in an unmatched system. The SWR reference point in this note is the monopole input, so that only data measured at the monopole's base can be compared directly.

These simple design rules should encourage experimentation with broadband monopoles throughout the amateur bands. Multiband or single-band antennas are easy to design and build, and can be fed directly with 50-Ω coax without an antenna tuner or matching network. This note also emphasizes the importance of the L/D ratio in determining the bandwidth of wire radiators generally. Similar considerations apply to other wire antennas, such as dipoles, parasitic arrays, or active arrays. Even though the monopole design rules are not directly applicable, paying attention to L/D should be a design consideration for any wire antenna, because selecting the right value may result in significantly improved bandwidth.—*Richard A. Formato, K1POO, PO Box 611, Shrewsbury, MA 01545-8611*

TOROIDAL-CORE COLOR CODES

◊ Powered-iron toroidal cores are frequently used in construction projects, and many home-brewers quickly learn to associate core color with certain characteristics. For example, a red core is type 2, with an initial permeability (μ_i) of 10, and yellow is type 6, with a μ_i of 8.[2]

Although we may *think* we know this color code well, there are times that it can backfire on us. Let's say you're at a hamfest and see a box full of surplus cores at attractive prices. Since they are a certain color, you *assume* you know what they are, but if you take some home and put them to work in a project, you might be in for a nasty surprise.

The problem is that the color code we "know" is only used by a very few manufacturers; *there is no universal color code for powdered-iron and ferrite materials.* Not all hams are aware of this, perhaps due in part to the fact that we usually get all our cores from the same sources, well-known retailers who advertise in *QST*. The code we know is actually the one used by Micrometals; Arnold Engineering also uses many (but not all) of the same color designators.

Let's say you come across a red core of unknown origin. Depending on who the manufacturer is, it could be the familiar type 2 powdered-iron core, with a μ_i of 10; but it could also be a *ferrite* core with a μ_i of 850, 1800 or 10,000. A yellow core could be a powdered-iron type 6 with a μ_i of 8, or a ferrite core with a μ_i of 10,000. Type 7 material is white, and gaining popularity for building VFOs because of its better temperature stability compared to type 6 (yellow). But a white core could also be a ferrite with a μ_i of 750 or 5000, with a much worse temperature stability to boot.

So be suspicious of a colored core if you don't *positively* know who made it, or where it came from. Instead of the familiar friendly form you're fond of, it could be something entirely different.—*Michael A. Czuhajewski, WA8MCQ, 7945 Citadel Dr, Severn, MD 21144*

[2]Incidentally, tan-colored, type-0 cores with a μ_i of 1, are actually made of *phenolic*, not powdered iron, and have the same permeability as air, even though these cores are usually listed with powdered-iron cores in brochures and catalogs.

Note: All correspondence addressed to the Technical Correspondence column should bear the name, call sign and complete address of the sender. Please include a daytime telephone number at which you can be reached if necessary.

Keep the author(s) in the communications loop. Whether praising or criticizing a work, copy the author(s) on comments sent to Technical Correspondence. QST

Product Review

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can change the name to any 14-character alphanumeric combination.

In the setup mode, you can change the Scout's display language (seven choices); set your time zone; set the clock style (12 or 24 hour); set speed, distance and elevation to US or metric units; see how long the current batteries have been in use (and reset the timer); set the GPS update rate (1.5 or 5 seconds); set screen contrast; toggle the screen light on or off; set the Scout to turn off automatically if no keys have been pressed within a set period (5 to 90 minutes, or never).

In the route mode, you can set a sequence of locations (way points) that you want to pass through. The way points are selected from the library, and you can preset up to 10 routes with 10 way points each. Once entered, route information is used in the navigation mode.

In the advanced mode, you can calculate the position of the sun and moon (azimuth and elevation) from your location (or any location in memory). The "over and up" feature allows you to find the coordinates of locations on standard topographical maps without having to interpolate latitude and longitude. To use this feature, you enter the reference point (lat/lon) from the southeast corner of the map and the map scale. The Scout will then tell you how many inches over and up from the reference point you are.

As you can see, the Scout packs a wealth of features into a tiny package. It greatly simplified 10-GHz contesting by providing grid locator, distance, bearing and time information. I found other uses for it as well: In the course of hunting for a new house (something high and without VHF/UHF radio obstructions in key directions), the Scout identified a number of possibilities. Armed with that data, I was able to locate each on topographical maps. A friend has access to a nationwide terrain database; with the GPS coordinates he was able to print out a terrain profile for miles in each key direction. In addition, I was able to use the sun position data for antenna alignment.

With falling prices and growing availability and applications, you'll probably be hearing a lot more about GPS receivers in the near future. The Trimble Scout GPS is well-made and easy to use; that, coupled with its Maidenhead grid locator feature, makes it useful to hams. The only possible drawback is that it's designed for portable operation and offers no provision for communicating with an outboard computer.

Manufacturer: Trimble Navigation, 9020-II Capital of Texas Highway North, Suite 400, Austin, TX 78759; tel 1-800-959-9567; fax 512-345-9509. Manufacturer's suggested retail price: $795; accessory kit (external antenna, dc power cord), $225. QST