Product Review from *QST* Magazine

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ICOM IC-756PRO HF/6-Meter Transceiver

Ten-Tec 1210 10-Meter to 2-Meter Transverter

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ICOM IC-756PRO HF/6-Meter Transceiver

By Rick Lindquist, N1RL
Senior News Editor

A sign on my office door—placed there as a gag (I think) by a colleague—exhorts "Try to keep up!" In the technological arena, where your new PC devolves into trash within 18 months, keeping up is becoming exceedingly difficult. Is the day that far off when we'll view our amateur transceivers the same way we view our PCs—as just so much future techno-junk?

While Amateur Radio manufacturers undoubtedly would love an environment where hams traded in their HF rigs every couple of years, we can't envision that scenario anytime soon. We hams, by and large, want to get our money's worth, and few among us are eager to be the first on the block to shift paradigms.

Hams often are accused of keeping a safe distance from that "cutting edge" we keep hearing about. Manufacturers who must be on the so-called "bleeding edge" to stay competitive in other markets have coaxed us along. Still, when something new and/or different rolls by, many of us view it with flinty-eyed suspicion.

This time, it's the ICOM IC-756PRO, the "all-DSP" progeny of the IC-756. The IC-756PRO offers oodles of creature features, plus you'll never need to buy an optional crystal filter for this transceiver (which can add another kilobuck to the cost of fully outfitting some transceivers). The PRO's heavy reliance on DSP, however, had some in the amateur community wondering if it really can get the job done.

The first Amateur Radio transceiver designed to rely on digital signal processing instead of crystal filters—the Kenwood TS-870 with its then state-of-the-art 16-bit DSP—came on the market a scant five years ago. Subsequently, the PC-controlled Kachina 505DSP—the closest thing yet to a paradigm shift for Amateur Radio—was the hit of the Dayton Hamvention a few years back. Despite being competent performers, neither radio lit the marketplace on fire. More recently, Ten-Tec lowered the bar to ownership of a PC-controlled DSP transceiver when it introduced the under-$1000 Pegasus.

The ICOM IC-756PRO offers an attractive package that contains the fruits of ever-lower manufacturing costs for digital devices and an operating interface that's familiar and fun. It's also a different kind of radio.

What's the Dif?

The natural tendency of most hams will be to wonder if the IC-756PRO is just an updated IC-756 with more digital bells and whistles. The answer is yes—and no.

Yes, all the buttons and knobs are in the same places, but the PRO takes advantage of the economy of digital technology to pack lots more goodies into the same-sized box with a computer-style TFT display that's to die for. Yes, the PRO relies almost exclusively on DSP for receiver filtering. All hardware filters are ceramic types. Crystal filters are not even optional.

The PRO's DSP is the most advanced on the amateur market. At its heart is a 32-bit floating point ADSP chip. The analog-to-digital converter is 24 bit. In terms of what's out there in the Amateur Radio marketplace already, the IC-756PRO offers next-generation digital capabilities. Yes, it's even more fun to use than the "original."

No, this is not your father's '756. For all intents and purposes, this is a totally different radio.

Talk is Cheap

As it is with anything new and different, the IC-756PRO has generated its fair share of Internet chatter. We've observed that the amateur community often muckles onto just about any new HF offering as a potential candidate for sainthood, the end of the search for the Holy Grail, the next great contest or DX box. Manufacturers don't help matters when they tout their products as "the ultimate" or "the finest."

When the transceiver doesn't quite live up to these overblown expectations, there's a tendency to deprecate the transceiver or the manufacturer (or both) for not being all that it could be. Self-appointed technocrats then weigh in with their advice on what the manufacturer *should* have done to engineer a product that meets their demanding tastes.

And so it was when the PRO debuted. Some appeared ready to trade in a TS-850, FT-990, or even an IC-781 and put a PRO in its place. A few bold souls even ventured forth to become the first kids in their respective neighborhoods to own one (we always like to think that everyone first waits for the Product Review to appear in *QST*).

Early postings from these new owners—and from others who had had a chance to at least try out a PRO—gave rise to other reflector threads focusing on the PRO's signal-handling capabilities. This is, after all, where the rubber meets the road in a transceiver. As the old saw goes: "If you can't hear 'em, you can't work 'em."

Concerns were resurrected that, lacking crystal filters, the PRO couldn't possibly perform as well as the conventional transceivers. Some worried aloud whether strong signals within the bandpass of the receiver's 15 kHz ceramic roofing filter would overtake the DSP and continue to trigger an AGC response even though the signals no longer were audible (ICOM says the PRO incorporates multiple AGC loops). Indeed, early observations showed that on CW, the digital brickwall filtering eliminated the signal, but more often than not, some key clicks lived on over a larger portion of the band than with a crystal-filtered radio. "It's not objectionable with one or two strong signals, but everyone wonders what will happen when it's DX contest time, and there are S9+20 dB signals every 500 Hz throughout the band," one early user said. Some fretted about strange noises and "intermod" because of the digital filters.

We found that, by and large, the PRO is able to "hear 'em," even in a band busy of contesters and a multitude of strong signals. In doing so, it can exhibit tendencies—per-

Bottom Line

The ICOM IC-756PRO's DSP is the most advanced currently available in an amateur transceiver. With a 32-bit floating point ADSP chip at its heart, the PRO delivers tremendous filter flexibility, a striking color display and an incredible array of standard features.

Joe Bottiglieri, AA1GW ♦ Assistant Technical Editor

Table 1

ICOM IC-756PRO, serial number 01313

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*			
Frequency coverage: Receive, 0.03-60; transmit, 1.8-2, 3.5-4, 7-7.3, 10.1-10.15, 14-14.35,18.068-18.168, 21-21.45, 24.89-24.99, 28-29.7, 50-54 MHz.	Receive, as specified[1]; transmit, 1.8-2, 3.4-4.1, 7.0-7.5, 9.9-10.5, 13.9-14.5. 17.9-18.5, 20.9-21.5, 24.4-25.1, 28-30, 50-54 MHz.			
Power requirement: Receive, 3.5 A; transmit, 23 A (max).	Receive, 2.9 A; transmit, 25 A. Tested at 13.8 V.			
Modes of operation: SSB, CW, AM, FM, FSK, AFSK.	As specified.			
Receiver	*Receiver Dynamic Testing*			
SSB/CW sensitivity, bandwidth not specified, 10 dB S/N: 1.8-30 MHz, <0.16 µV; 50-54 MHz, <0.13 µV.	Noise Floor (mds), 500 Hz filter:	*Preamp off*	*Preamp one*	*Preamp two*
	1.0 MHz	–117 dBm	N/A	N/A
	3.5 MHz	–127 dBm	–135 dBm	–141 dBm
	14 MHz	–128 dBm	–136 dBm	–140 dBm
	50 MHz	–126 dBm	–132 dBm	–140 dBm
AM sensitivity, 10 dB S/N: 0.5-1.8 MHz, <13 µV; 1.8-30 MHz, <2 µV; 50-54 MHz, <1 µV.	10 dB (S+N)/N, 1-kHz tone, 30% modulation:	*Preamp off*	*Preamp one*	*Preamp two*
	1.0 MHz	9.1 µV	N/A	N/A
	3.8 MHz	3.1 µV	1.1 µV	0.6 µV
	50 MHz	2.8 µV	2.0 µV	0.7 µV
FM sensitivity, 12 dB SINAD: 28-30 MHz, <0.5 µV; 50-54 MHz, <0.32 µV.	For 12 dB SINAD:	*Preamp off*	*Preamp one*	*Preamp two*
	29 MHz	1.2 µV	0.4 µV	0.2 µV
	52 MHz	1.2 µV	0.7 µV	0.3 µV
Blocking dynamic range: Not specified.	Blocking dynamic range, 500 Hz filter:	*Preamp off*	*Preamp one*	*Preamp two*
	3.5 MHz	127 dB	125 dB	122 dB
	14 MHz	127 dB	125 dB	120 dB
	50 MHz	127 dB	130 dB	122 dB
Two-tone, third-order IMD dynamic range: Not specified.	Two-tone, third-order IMD dynamic range, 500 Hz filter:	*Preamp off*	*Preamp one*	*Preamp two*
	3.5 MHz	92 dB	92 dB	90 dB
	14 MHz	95 dB	92 dB	88 dB
	50 MHz	93 dB	84 dB	89 dB
Third-order intercept: Not specified.		Preamp off	Preamp one	Preamp two
	3.5 MHz	+13.5 dBm	+4.7 dBm	–5.0 dBm
	14 MHz	+15.4 dBm	+4.3 dBm	–6.9 dBm
	50 MHz	+15.2 dBm	–4.2 dBm	–6.2 dBm
Second-order intercept: Not specified.	Preamp off, +64 dBm; preamp one, +63 dBm; preamp two, +43 dBm.			
FM adjacent channel rejection: Not specified.	20 kHz channel spacing, both preamps on: 29 MHz, 76 dB; 52 MHz, 82 dB.			
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz channel spacing, both preamps on: 29 MHz, 78 dB; 52 MHz, 77 dB. 10 MHz channel spacing: 52 MHz, 105 dB.			
S-meter sensitivity: Not specified.	S9 signal at 14.2 MHz: preamp off, 64 µV; preamp one, 16 µV; preamp two, 8.3 µV; 50 MHz, preamp off, 68 µV; preamp one, 30 µV; preamp two, 7.8 µV.			
Squelch sensitivity: SSB, CW, RTTY, <5.6 µV; FM, <1 µV.	At threshold, preamp on: SSB, 1.1 µV; FM, 29 MHz, 0.4 µV; 52 MHz, 0.4 µV.			
Receiver audio output: 2 W into 8 Ω (THD not specified).	2.2 W at 10% THD into 8 Ω.			
IF/audio response: Not specified.	Range at –6dB points, (bandwidth): CW-N (500 Hz filter): 342-857 Hz (515 Hz); CW-W: 74-1262 Hz (1188 Hz); USB-W: 226-2725 Hz (2499 Hz); LSB-W: 229-2730 Hz (2501 Hz); AM: 65-3428 Hz (3363 Hz).			
Spurious and image rejection: HF & 50 MHz, (except IF rejection on 50 MHz): 70 dB.	First IF rejection, 14 MHz, 102 dB; 50 MHz, 70 dB; image rejection, 14 MHz, 114 dB; 50 MHz, 115 dB.			
Transmitter	*Transmitter Dynamic Testing*			
Power output: HF & 50 MHz: SSB, CW, FM, 100 W (high), 5 W (low); AM, 40 W (high), 5 W (low).	HF: CW, SSB, FM, typically 110 W high, 1.0 W low; AM, typically 37 W high, >1 W low; 50 MHz: CW, SSB, FM, typically 107 W high, 1.0 W low; AM, typically 38 W high, >1 W low.			
Spurious-signal and harmonic suppression: ≥50 dB on HF, ≥60 dB on 50 MHz.	HF, 57 dB; 50 MHz, 66 dB. Meets FCC requirements for spectral purity.			
SSB carrier suppression: ≥40 dB.	As specified. >60 dB.			
Undesired sideband suppression: ≥55 dB.	As specified. >65 dB.			
Third-order intermodulation distortion (IMD) products: Not specified.	See Figures 1 and 2.			
CW keyer speed range: Not specified.	6 to 47 WPM.			
CW keying characteristics: Not specified.	See Figure 3.			
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S9 signal, 23 ms.			
Receive-transmit turn-around time (tx delay): Not specified.	SSB, 20 ms; FM, 11 ms. Unit is suitable for use on AMTOR.			
Composite transmitted noise: Not specified.	See Figures 4 and 5.			
Size (hwd): 4.4×18.4×11.2 inches; weight, 21.1 pounds.				

Note: Unless otherwise noted, all dynamic range measurements are taken at the ARRL Lab standard spacing of 20 kHz.

Third-order intercept points were determined using S5 reference.

[1]Sensitivity degrades progressively below 150 kHz and above 58 MHz. Noise floor at 30 kHz is –89 dBm and at 60 MHz is –100 dBm.

An expanded test result report for this transceiver is available on the ARRL Members-Only Web site. Printed copies are also available for those without Web access.

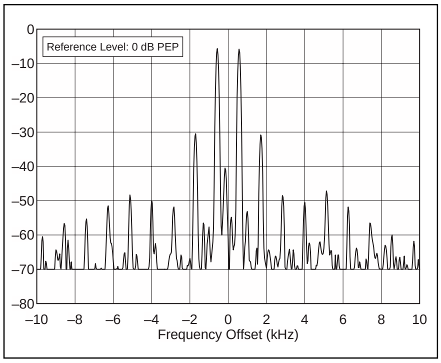

Figure 1—Worst-case spectral display of the IC-756PRO transmitter during two-tone intermodulation distortion (IMD) testing on HF. The worst-case third-order product is approximately 31 dB below PEP output, and the worst-case fifth-order is approximately 49 dB down. The transmitter was being operated at 100 W output at 28.350 MHz.

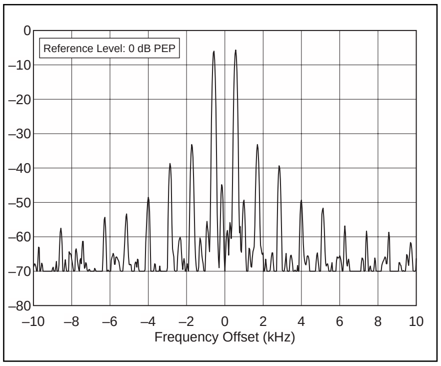

Figure 2—Spectral display of the IC-756PRO transmitter during two-tone intermodulation distortion (IMD) testing on 6 meters. The third-order product is approximately 34 dB below PEP output, and the fifth-order is approximately 40 dB down. The transmitter was being operated at 100 W output at 50.200 MHz.

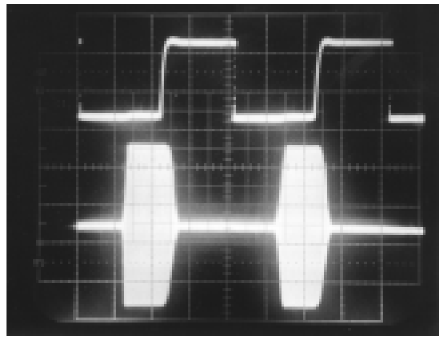

Figure 3—CW keying waveform for the IC-756PRO showing the first two dits in full-break-in (QSK) mode. The equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output at 14.2 MHz. Note that both dits are somewhat shortened. Only the first dit is shortened in semi-break-in mode.

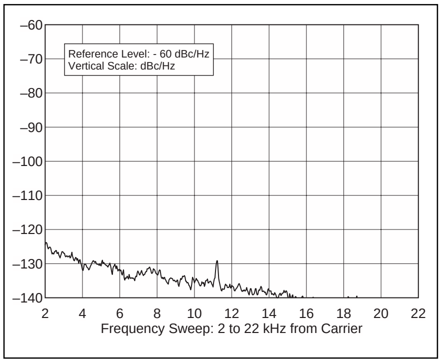

Figure 4—Worst-case tested HF spectral display of the IC-756PRO transmitter output during composite-noise testing at 14 MHz. Power output is 100 W. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.

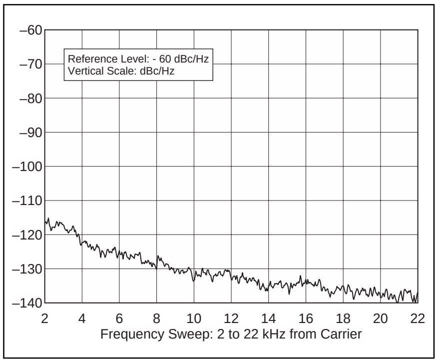

Figure 5—Spectral display of the IC-756PRO transmitter output during composite-noise testing at 50.2 MHz. Power output is 100 W. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.

haps *idiosyncrasies* is a better word—that most can overlook but that some users might find undesirable or even unacceptable. More on those in just a bit.

Where to Start?

The most striking thing about the IC-756PRO is its display. It's easy to get distracted by it—lost in the depths of its beauty, as it were. (Sorry, we were getting carried away there for a moment.) Unlike the monochrome panel of its ancestral namesake, the PRO's approximately $3^1/_4 \times 4^1/_4$-inch screen defaults to a bright and colorful image. But it's not just there for good looks. It's both the focal point of the transceiver and an integral component of the operating interface.

ICOM has carried on its tradition of "F" (function) keys associated with the display—begun with the IC-781—to change operating parameters. This aspect, coupled with the color screen, give the user a bit more of the look and feel of a PC-controlled radio, even without the PC.

The panel layout is essentially identical to the IC-756. Traditionalists will appreciate the conventional analog-style multifunction meter that reads out not only signal strength but power output, SWR, audio compression level and ALC. Modernists will appreciate the fact that you can call up a fully digital "meter" on the display.

Tuning is accomplished using a large, comfortable rubber-trimmed knob equipped with a "finger dimple." You can adjust the drag on the tuning knob using a screwdriver. Smaller analog-style controls—some of them concentric—and a plethora of push-buttons round out the control interface. There are more than 70 front-panel controls.

Users encountered few mysteries while attempting to bend the IC-756PRO to their respective wills. As one veteran user—already an avowed IC-756 fan—put it: "It's one of the more intuitive radios I've used recently. The color screen is terrific, and the ergonomics—including the rear panel—are excellent." Another user judged the ergonomics on the PRO "the best of any Japanese radio in a while."

"Terrific" might be an understatement. The black-background display shows your main frequency in cyan numerals that stand approximately $^1/_4$-inch tall. The other text and numerals on the display are crisp and sharp and easy to see and read at any reasonable viewing angle.

Don't like the display fonts? They're easily changed! (How many other radios let you do that?) The "Basic 1" default is quite readable, but if you don't like the outline font on the sub receiver, you can switch to Basic 2 that renders the sub receiver's frequency in a shaded font. "Pop" is a more happy-go-lucky kind of font. There's also something called "7seg" that lends an LED sort of look to the readout. In addition, there are two italic fonts and something called "classic" (sorry, no Olde English).

In the default setting, the PRO declares the active mode within a small text "blimp"—black text on tan. You'll always know which is the "transmit" VFO—it's marked with a red "TX" inside a red oval. Go to **SPLIT** function and the display presents a bold "SPLIT" alert—black text on red.

RIT is marked with a black text on small green blimp, and the RIT frequency readout is $^3/_{16}$-inch high numerals. By the way, there's receive and transmit incremental tuning, plus a convenient **CLEAR** button that works during transmit.

Functions—which vary with mode—line the left-hand side and bottom of the display screen. These functions—essentially what often would be "menu functions" on a typical transceiver—are associated with keys that rim the display. The F-1 through F-5 keys are immediately below the display. Beneath these are very similar-looking buttons that let you select modes (**SSB**, **CW-RTTY**, and **AM/FM**, plus the all-important

FILTER button and an **EXIT** button that is this radio's version of the Escape key).

As with the original '756, a row of tiny stem controls are on the bottom, left-hand edge of the front-panel apron. These include the **MIC GAIN**, **RF POWER**, **COMP**, **KEY SPEED**, and **BK-IN DELAY** controls.

But enough about the cosmetics.

Getting Around

As was the case with its predecessors, the IC-756PRO makes it exceptionally easy to get out and move around the available spectrum. You can band hop by pressing the individual band buttons or the **GENE** button (for general-coverage). These summon triple-stacking registers, so each push on a given button sets up another frequency, mode, filter and AGC setting within that band, so you can have a CW, SSB and an RTTY or PSK31 frequency and settings in each register!

To suit any knob spinner, the radio can be set up so that the faster you crank, the faster it changes frequency. Pushing the **TS** (tuning step) button allows even greater alacrity. For slower, finer tuning in CW or RTTY, the PRO offers the **1/4** button.

Of course you can also enter frequencies directly using the keypad.

A Wide, Wide World of Digital Filters

The PRO's digital filters implementation means you'll very likely never be at a loss for a filter that will help you single out the station you want to hear. ICOM calculated that you have 44 different filter combinations for SSB and CW, 32 for RTTY, and three for AM and FM. Three filter settings remain available at any given instant.

Along the top of the display screen the radio's filter settings are spelled out in both text and numerals and by use of a small icon representing the bandwidth in effect. Pushing the **FILTER** button steps you through the three filters in place at that time. For SSB, the default filters are 3.0, 2.4, and 1.8 kHz; for CW, they're 800, 500 and 250 Hz.

Want more detail? Push and *hold* the **FILTER** button and prepare to enter the IC-756PRO's digital dimension (with apologies to *QST* columnist Stan Horzepa, WA1LOU). This action brings you to a "FILTER" subdisplay on the bottom of the screen that shows in text and graphics what filters are in play. Changing them is simple. Say you'd rather have a bit narrower SSB filter for the FIL 1 position. With that filter position selected, press the **BW** key (F-1 in this case) and, while holding it in, turn the tuning knob.

You have a great deal of latitude on SSB and CW—as wide as 3.6 kHz and as narrow as a 50-Hz sliver. The RTTY, AM and FM filters settings are predetermined. For AM, your choices are 9, 6 and 3 kHz; for FM, you've got 15, 10, and 7 kHz; for RTTY, 1 kHz, 500 Hz, 350 Hz and 250 Hz.

But wait! There's more!

A Great Set of (Radio) Knobs

Beyond the filters, the **TWIN PBT** passband tuning controls are the receiver's most potent adjunct weapon to fight QRM, and they work very effectively. These concentric controls let you adjust the passband width of the DSP filter you've got selected, outside of the narrowest filter bandwidth setting. You use the **TWIN PBT** knobs to further fine-tune the basic filter choices, in essence creating *new* filters which the IC-756PRO displays and also remembers for later use. Sometimes, what might be thought of as an "extreme" setting can make all the difference.

The degree of **TWIN PBT** latitude depends on the filter selected and the passband width. Filters are automatically memorized in each mode, and PBT settings are memorized for each filter. The **PBT CLEAR** button illuminates when the PBT is in use. Pushing and holding the button for two seconds clears any PBT settings.

The digital **NOTCH** button is a three-step affair. Press it once and get the automatic notch. Press it again for the manual notch, and use the **NOTCH** knob to vanquish the offender. Press it again and the notch function is off.

Users unanimously appreciated the combination of DSP filter settings, the PBT, and the digital notch. "The notch filter and PBT are outstanding," one user enthused. "I've never used a PBT this effective. Many offending signals are just gone, and it's really easy to use." Declared another: "I was very impressed with the filtering, including the notch filter—wow!"

Doing the Numbers

Some of the test results from the ARRL Lab show that PRO is not about to unseat the (much more expensive) IC-781 or the later IC-775DSP (one of the early generation "IF DSP" radios) from their lofty perches among the best receivers on the market. Strictly on the basis of our Lab testing (see Table 1), the PRO receiver's strong-signal handling capability is not as quite as good as either of these two radios. Our tests revealed a respectable 127 dB of blocking dynamic range and 95 dB of two-tone, third-order dynamic range. The added flexibility provided by its multiple preamplifiers and attenuators however, permits the user to find the right level of receiver sensitivity for nearly any situation. Within its price class, even going just by the numbers alone, the PRO's basic receiver performance holds its own.

But there is more to the story than just those two receiver-performance numbers. (Some of that story is covered here; some of the rest can be read in the Expanded Test Result Report offered by the ARRL Lab.) In some ways, the PRO's receiver performance shines.

One thing that was noted in the course of our Lab testing, and by all of our review team, was that the DSP-based filter performance is very sharp. When you tune the receiver off of a signal that you are listening to, it quickly drops off the edge of a very steep skirt.

Most users agree that the PRO's filters were very solid in the face of nearby signals. "This radio *is* revolutionary in the way it provides the user the ability to design their own filters," one new owner declared. "The razor-thin settings can be exceptional and there is none of the 'blowby' that you generally observe with a crystal filter and its broader skirts. Even a very loud signal is simply not readable 100 Hz away with a 100-Hz bandwidth setting."

When using the wider filter settings, although the passband is wider, the signals still seem to "drop off the edge of a cliff" when the receiver is tuned and the signal falls outside of the filter passband.

During the CQ World Wide 160 Meter CW Contest, we were able to pull out QSOs 200 to 300 Hz apart. Yes, we could still hear some key clicks, but they were not a major issue and were pretty minimal by the time you were 400 to 500 Hz away. The Lab wanted to know, however, whether these clicks were artifacts of the receiver's DSP (as had been rumored in some of the reflector discussions about this radio) or whether they were actual transmitted keying sidebands. Clearly, key clicks could be heard if the receiver was tuned very close to a transmitted signal.

We turned to the Lab for further investigation. They found that if our Lab's test generator was switched on and off, very distinct transients could be heard.

We went back and had a look at some of our published transmitter keying photos from previous reviews. Most modern radios exhibit CW keying rise and fall times that are much sharper than the 5 ms that is often touted as "optimum." Turning our signal generator on and off results in "square-wave" keying—rich in key clicks. Maybe some of what we were hearing could be attributed to the transmitters.

To answer this, we tried an "acid test." On 7 MHz, we generated an S9+30 dB keyed signal, using a function generator and signal generator to create near-perfect CW (virtually no key clicks). Using the PRO's 50-Hz filter setting, we were easily able to copy a weaker signal 100 Hz away from our "local" QRM. On 20 meters, we generated an S5 signal and plunked down our S9+30 dB QRM source nearby. We were able to get within about 400 Hz before copy got problematic. (Don't try this with a signal much weaker than that, however.) In no case were any additional key clicks observed from this "perfect" CW signal, even if we inserted up to two additional S9+40 dB signals 10 kHz away.

It looks like some of what is being heard on the air is actually being transmitted. The sharp filter skirts explain this. We did some A/B comparisons between the PRO and our W1INF club station's IC-765, with a 500 Hz filter. The '765's 500-Hz crystal filter is pretty good, but a strong signal 1 kHz away can still be heard weakly (albeit at a 1500 Hz audio tone). That amount of normal filter "blowby" in the IC-765 was enough to mask the weaker keying sidebands generated by a typical over-the-air signal. On the PRO, the nearby signal was inaudible—only the keying *sidebands* remained.

The overall effect is that the sharp skirts of the IC-756PRO's digital filters buy you more than you lose.

We tried the 50 Hz and 100 Hz filter settings to see if we could distinguish among the various calling stations in a huge DX pileup (for XRØZY). Some minor clicking aside, it was possible to pull out quite a few individual stations and hear *only that signal*.

The ARRL Lab tests generally include an "in-band" intermod test in which two signals are present in the receiver passband simultaneously. A spectrum analyzer is used to measure any intermodulation that occurs between these two signals. The test results looked good (they are published in the Expanded Test Result Report), but ARRL Laboratory Supervisor Ed Hare, W1RFI, noted that he could hear intermod. Puzzling.

A bit of further experimentation revealed something unusual—although the in-band IMD was quite good during the "steady-state" conditions of CW signal generators, if one or both of the two tones was keyed on and off, the IMD rose audibly for a fraction of a second. By careful manipulation of the spectrum analyzer, this could be seen, as well as heard. (This was not affected by the AGC settings.) This does appear to be an artifact of the receiver DSP.

How bad is it? That depends. In most cases, the effect can be eliminated by using the very DSP that might be causing it. You simply narrow the receiver IF so that only one signal can be heard. Based on the reports of the reviewers, this does not seem to affect the SSB performance. This could be one of those things that is just "different" about the sound of a DSP radio.

The performance characteristics of the IC-756PRO's transmitter also deserve attention. Although the close-in transmit IMD (third and fifth order) is about average, on most bands, the higher-order IMD (ie, the IMD that might be heard several kHz up and down the band) is reasonably low.

What is especially notable about this transmitter is its low level of transmitted composite noise (see Figures 4 and 5). Particularly on HF, this rig's local oscillator is very clean, a factor that will affect not only how this radio sounds to others on other parts of the band, but also how the band sounds on this radio. Our tests revealed that none of the receiver numbers, even the close-in dynamic range measurements, were noise limited.

We've gone to great lengths to describe the PRO's abilities and limitations in receiving CW. Its CW transmitting characteristics seem to be outstanding. One CW maven described its keying as "perfect in every way." If you enjoy full-break-in CW, the QSK is quiet and "free from clacking relays," one user noted. If you don't think the CW is perfect, the shape of the transmitted CW note can be altered through menu settings.

SSB was where the PRO really shone—receiving *and* transmitting. You can use much narrower filters and PBT settings in SSB than you'd likely be able to get away with using crystal filters and still retain intelligibility. The tighter filters were a bit on the ringy side, and the narrower settings will roll off the higher-frequency audio components, possibly limiting intelligibility. But its 1.8 kHz setting does a superb job of minimizing adjacent QRM. A twist or two on the PBT can eliminate upside or downside QRM.

The PRO can be made to sound stunning on the air. It has provisions to tailor transmitted audio to run the gamut from tightly compressed and equalized contest audio to full-bodied "broadcast" audio. On-air reports confirmed the effectiveness of these various permutations and combinations to suit a particular occasion. There are separate menu adjustments for transmit bass and treble. In addition, a front-panel key lets you choose from wide, medium, or narrow (constricted audio bandpass) modes with the compressor either on or off.

Band Scope

This transceiver has what could be the first "band scope" that's truly useful *and* good-looking. Current signals show up in pale green; if the function is enabled, signal peaks heard—but not necessarily still there—are in the background in pale blue, at least until you change frequency. This also can be deactivated, but it's convenient for locating signals that were there and might return.

You can apply separate preamps or attenuators to the 'scope. One veteran contester and DXer liked the ability afforded by the scope to see what was going on nearby. His station has four phased verticals on 80 and can switch directions instantly. "With the spectrum scope, this means I can tell whether an off-frequency signal is coming from an interesting direction without even tuning to the signal!" he said. "That feature could spoil me in a hurry."

If you want to tune to the signal, it's possible to freeze the display and you can tune the "cursor" or "marker" to one of those "interesting" signals for a listen. It's possible to select a marker for the main receiver or one for the sub receiver. The IC-756PRO also lets you apply up to 30 dB of attenuation to the scope without affecting the received signal. You can adjust the scope's "span" from ±12.5 kHz to ±25, 50, or 100 kHz.

The scope also shows your own signal on transmit, although you can disable this feature.

Digital Voice Recorder

Is it live or is it DVR? The digital voice recorder is yet another "extra" you won't have to buy with the PRO, and it's nothing short of *waaay* cool. Setting up and using the DVR is simple and fun. It's also easy to name a given memory slot—four for transmit, four for receive and each up to 15 seconds long.

The DVR lets you record your own audio to spare your voice during the long contest weekend. You also can record audio from the receiver, but you can't play it back on the air (lest anyone be tempted). A mike level adjustment is available to set your recording level, and a transmit level setting allows you to match your "live" and DVR audio levels. Although the DVR is accessible only in one of the voice modes (ie, SSB or AM/FM), once it's up on the screen, you can switch to CW or RTTY and record away.

One of the really slick aspects of the DVR is that when you record audio off the air, the PRO automatically stamps the memory with the frequency, mode, time of day (but not date) and cut length.

You can apply an up to 20-character name to each transmit memory by pushing the **NAME** key, selecting numbers or letters, and using the main tuning knob to pick the characters you need.

Now for the downside on this fine feature: If you're running the DVR, you can't bring up the band scope or any other menu window at the same time—something you'd most likely want to be doing during a contest. Bummer! Perhaps the DVR can be controlled remotely (via PC) while the band scope or other menu is up on the display.

Memory Keyer

The memory keyer in the PRO appears to be identical to the one in the IC-746. Each memory holds 54 characters. Filling the memories involves pushing an **EDIT** button and using the main tuning knob to select the numerals, letters, characters and spaces. The keyer will generate consecutive serial numbers for contesting, including so-called "cut" or abbreviated numbers (such as "n" for 9 and "a" for 1). Some ops will be disappointed that the PRO keyer does not offer an option to record CW strings sent manually.

The keyer paddle plugs into the **ELEC-KEY** jack on the radio's front panel. Via the menu, this jack can be set up to accommodate a keyer paddle, emulate a "bug" or serve as a straight key jack. A separate, single-function straight key jack is on the rear apron, where it's also convenient for keying the radio from a PC logging program or other keying source.

A **KEYER CW-KEY** menu accesses the software adjustments for keyer repeat time, dot/dash ratio, rise time, polarity and keyer type, and to let you use the mike **UP/DOWN** buttons as a keying source.

Dualwatch

Dualwatch permits you to listen to two different frequencies in the same band at the same time. This might come in handy for example, if you're working a pileup in split and want to keep half an ear on your transmit frequency, or if you're waiting for another station to show up on another frequency while working someone else.

There are some limitations here. Both signals have to be the same mode and, as we said, in the same band. Pushing the **DUALWATCH** button puts the sub receiver on the same frequency and mode as the main receiver. You then can set up the second frequency. Using the **BAL** (balance) knob, you can then crank in as much audio as you want (up to and including 100%) from the secondary channel you want to monitor. The S meter shows a combined signal strength, by the way. Pushing **CHANGE** or **SPLIT** immediately gives you the ability to transmit on that frequency. It's *that* easy!

It's possible to scan on the main readout all the while conducting your conversation on the sub receiver channel. You do this by employing Dualwatch in combination with split.

When enabled, the *Quick Dualwatch* setting automatically sets the sub receiver to the main frequency and activates Dualwatch when you press and hold the **DUALWATCH** button.

Memories Galore

Memory keyers for CW and voice aside, the PRO also offers 99 regular memories and 2 band-edge memories plus five or 10 "memo pad" memories. All memories retain frequency, mode, antenna, filter settings and, if desired, an alphanumeric memory name up to 10 characters long.

A **MEMORY** screen can let you view the contents of up to 13 memory channels (seven is the default), and you can select a memory channel from that screen if you like, or use the **UP/DOWN** buttons to step through the ones already programmed.

The radio also offers handy scratch pad memories that are great for contesting or DXing.

The Great RTTY Mystery

We were blown away by the built-in RTTY decoder that reads out several lines of conventional 45-bps Baudot code right on the screen. It works so well that we were dismayed that ICOM did not go the full distance and integrate transmit capability as well, such as the Patcomm 16000 (see "Product Review," *QST*, February 1998) did. That would have made it perfect (well, maybe PSK31, too—*then* it would be perfect).

Still, the RTTY decode capability works superbly, and it even includes a snazzy indicator on the display for quick and accurate tuning. One user found the receive-only function very useful for casual monitoring. "A lot of evenings, I'll pop into my shack for a couple of minutes to see what's going on, and it's a hassle to boot up my computer to find out who's transmitting on RTTY," he said. "If I hear someone I want to work, then I can turn on my computer." This user said the RTTY decoder copied very well compared to his PC soundcard software.

The transceiver has five RTTY filters, and you can pick a passband width of 1 kHz, 500 Hz, 350 Hz and 250 Hz. The TPF "twin peak filter" for RTTY can boost the mark and space frequencies to further improve readability.

Idiosyncrasies

Several operators have noticed what we'll call "idiosyncrasies" while using the IC-756PRO. For example, at some wider filter settings and with a band filled with signals, the radio generates a low-level rumble. This was confirmed by looking at the band scope. When no signals were present, the rumble was gone. The more signals in the bandpass, the more rumble. This is especially noticeable when using headphones that have above-average low-frequency response. With headphones or a speaker that rolls off the lower frequencies, you probably won't notice it. One new owner told us he'd sent his radio back to ICOM for repair or adjustment because of this phenomenon. "ICOM indicated that what I'm hearing is an 'artifact' of the quiet receiver design," he reported, adding that reducing the RF gain does eliminate the "minor problem." Other users said they just got used to the rumble and ignored it after a while.

Some operators complained that the PRO degraded the tone of strong CW signals, making them sound "flutey" or even a bit on the rough side. As one user described it, the receiver seemed to be on the verge of overloading, even to the point of occasionally clipping signals, resulting in distortion.

We noticed it too, especially on stronger signals, compared to the same signal monitored on the TS-850 we had on hand. This tends to be just slightly less noticeable with the noise reduction off. Besides the roughness or flutiness, the PRO has a habit of introducing pops on the "make" of each CW element. One user compared it to the sort of effect characteristic of direct conversion receivers employing audio-based AGC systems. Once again, less gain yielded a better-sounding received signal. Adjusting the AGC parameters can help.

The PRO also reacts differently to atmospheric noise. One user speculated that the "crinkling cellophane" noise he was hearing at wider bandwidths was related to "real-noise signals" coming into the receiver. The noise was "an artifact of the way the DSP presents clipped noise peaks in the audio," he theorized.

ICOM attributes this effect to the sharp skirts created by the digital filters. Their response to this statement is: "Poor shape factor results in lots of high frequency hiss. Sharp skirts kill the hiss—all that you hear is the low frequency noise."

This and That

- Not since the days of tube-type transceivers have we had to wait for a radio to "warm up" after turning it on. We've been spoiled by "instant-on" technology. The IC-756PRO's boot-up "DSP calibration" screen took us back a generation. "I thought I got away from this when I sold my Drake C line," one tester moaned. It only takes about 10 seconds, but perhaps to assuage the user's impatience (or stroke his or her ego), ICOM lets you put your name, call sign or other personal legend on the boot-up screen.
- The display features a very accurate 24-hour clock and on/off timer functions.
- A radio like this that's reliant on software/firmware can provide a lot of flexibility, letting you insinuate your particular tastes on various parameters that used to remain sealed off from prying fingers. The PRO offers a table that lets you pick tuning rates and steps for various modes; you also can adjust such parameters as CW keying and AGC time constants within given ranges.
- The radio tends to get a bit warm after extended use. The cooling blower is a bit noisy. It even made the radio shudder at times.
- The noise reduction function was—as one user put it—"awesome." The NR is continuously adjustable, and it can impart some "processor noise" at extreme settings. But users appreciated its ability to ameliorate or eliminate hiss, spatter peaks, atmospherics and other QRN and, in the words of the same user "make the radio easier to listen to for long periods."
- The PRO's noise blanker, like others we've encountered in ICOM radios, tends to be modestly effective (not all users agreed on this—at least one called it "useless"), but on an active band, enabling the noise blanker brings up the same sort of snaps, crackles and pops we heard on the IC-706 series. On the other hand, it worked just fine to eliminate typical household noises such as a vacuum cleaner or an oil burner igniter.
- The PRO includes some convenient FM features. Via the menu, you can set FM split offsets for HF (ie, 10 meters) and 50 MHz and enable the *Quick Split* function. When working repeaters, you just press and hold the **SPLIT** button, and it automatically invokes the proper transmit frequency on the sub receiver. The NR function works in FM. CTCSS encode, decode and tone scan are included.
- The *Instruction Manual* is as easy to follow as it is to handle, with clear, concise language. For relative newcomers, it helpfully defines certain terms many of us take

for granted, such as "AGC" and "attenuator." It includes practical tips (for instance, how to use RIT and transmit incremental tuning or ΔTX, as ICOM calls it) to point up the real-world value of certain features. It's sprinkled liberally with diagrams and graphics, including pinouts for all connectors and large block diagram and schematic fold-out inserts. A separate section details control commands for external control via an ICOM CI-V interface to a PC.

Grand Finale

The IC-756PRO can wear a lot of hats, as we found out. As we've suggested, this might translate into compromises on the features or performance *you* desire for *your* particular type of hamming. That said, however, we found that the PRO can hang tough in a contest, will hear the DX, sounds fabulous on SSB and CW, and has bells and whistles that most amateurs only dreamed about a decade ago.

It's an easy and enjoyable radio to use. All but the most particular operator likely would enjoy owning one. "Other than the feeling that the receiver could be better, I love this rig," said one experienced contester. "And it has been a long time since I used a radio where I felt like I wanted to go out and buy it."

We would like to thank Randy Thompson, K5ZD; David Sumner, K1ZZ; Mark Wilson, K1RO; Dave Patton, NT1N; John Bloom, KE3Z; Tony Brock Fisher, K1KP; Ed Hare, W1RFI; and the ARRL Lab staff for their help in preparing this review.

Manufacturer: ICOM America, 2380 116th Ave NE, Bellevue, WA 98004; 425-454-8155; fax 425-454-1509; **75540.525@compuserve.com**; **http://www.icomamerica.com**. Manufacturer's suggested retail price: $3600. Typical current street price $2975. UT-102 Voice Synthesizer Unit, $74; CT-17 CI-V Level Converter for PC control, $169.

Ten-Tec 1210 10-Meter to 2-Meter Transverter

Reviewed by Joe Bottiglieri, AA1GW
Assistant Technical Editor

If you were to engage the average ham in a lightning round of *word association*, I'd bet dollars to donuts (a wager that seems to be getting precariously close to even odds) that the reflex response to the phrase "two meters" would almost universally be "FM."

Admittedly, the vast majority of the activity on this band is frequency modulated. Ask any of us who have had the chance to experiment on 2 meters using sideband and CW though, and we'd regale you with tales of long-haul tropo openings, the brief signal bursts of meteor scatter, watery-sounding aurora and even the thrill of hearing your own signals beamed back to earth by a satellite. You *can* experience some of these propagation modes on FM, but SSB and CW didn't earn the title "the weak signal modes" for no reason.

Nearly all of us have 2-meter FM equipment. When initially shopping for radios for this band however, few are willing to ante up the added green stamps necessary for the purchase of a multimode 2-meter transceiver. Even used multimode VHF gear seems to command near ransom sums.

An Alternative

If you've already got HF equipment, a *transverter*—a device that will take receive and transmit signals from one band and convert them to receive and transmit signals on another—is a viable alternative to a standalone radio.

There are a handful of manufacturers that offer transverters. These units are designed to allow you to use your existing HF (and sometimes VHF) gear to gain access to individual bands of frequencies ranging from 6 meters up to the extreme microwaves.

Ten-Tec currently offers three: the 1208—a transverter that will allow you to convert the 20-meter band coverage of an HF transceiver to 6 meters; the 1209—a similar unit to convert 2 meters to 6; and—the subject of this review—the Ten-Tec 1210.

Connect the 1210 to the antenna jack of a multimode HF transceiver that covers the 10-meter band, a 12 V dc power supply and a 2-meter antenna; adjust the radio's RF output to between 4 and 20 W and *presto!*—instant 2-meter multimode.

Kit or Assembled?

The 1210 is available in two versions—either factory assembled or in kit form. The price difference is considerable—a C-note—so if you don't mind spending some time (my construction time was around 14 hours) at the workbench, you can save yourself about 40%! Personally, I find building equipment nearly as much fun as operating it. We ordered the kit.

Ten-Tec has been in the kit business for a long time, and their experience shows. The quality of the components, the board, the enclosure and the manual is excellent.

The $4 \times 5\frac{1}{4}$-inch glass-epoxy PC board is plated-through and clearly silk-screened with the component numbers and position outlines.

The rugged three-piece enclosure has a textured black finish and the power and transmit LED indicators, the power switch, and the antenna and transceiver connectors are labeled with bold white lettering. The finished kit has the look and feel of a commercially built unit.

> **Bottom Line**
>
> The Ten-Tec 1210 transverter lets you add 2-meter multimode operation to your existing 10-meter or multiband HF transceiver at a fraction of the cost of a standalone transceiver.

The $5\frac{1}{2} \times 8\frac{1}{2}$-inch spiral-bound 48-page *Instruction Manual* is very well written and covers related topics far beyond just the assembly, alignment and operation of the transverter. The documentation also includes an 11×17-inch sheet of paper with a complete schematic on one side and parts placement diagrams (copies of those printed within the manual pages) on the reverse. These duplicate diagrams allow you to quickly determine a specific part's location without constantly having to flip through the pages of the manual.

Along with the manual and schematic sheet you'll find a *Kit Addendum* and two *Special Bulletin* sheets. Read them very carefully and pencil in corrections or "SEE ADDENDUM" notices in the manual before you begin assembly. Failure to do this will lead to dire consequences—details later!

Laying the Groundwork

In addition to a very basic selection of electronics hand tools, you'll need a volt-ohm meter, digital voltmeter or digital multimeter (*VOM*, *DVM* or *DMM*). A wattmeter capable of making measurements at VHF, a 2-meter transceiver (your FM H-T or mobile radio will do) and a frequency counter or a receiver that will cover 116 MHz are also required.

While it's tempting to dive right in and pull parts from the various plastic bags and stuff them into the board, do yourself a favor and take a complete inventory first. Use your favorite method to sort and organize the parts to make them easy to locate when their number comes up.

If you near the end of the assembly process and end up with extra parts, you'll know you've left something out somewhere. If you get down to the last resistor or capacitor and discover that the one you've got left is the wrong value, you'll know that you've put the desired part in the wrong location. (Trust me on this. I inadvertently swapped a couple of the molded inductors and discovered it this way.)

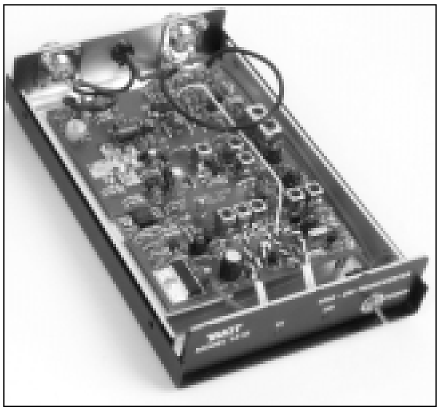

Figure 6—Inside the Ten-Tec 1210 10- to 2-meter transverter. Nearly all the unit's components are mounted on a single 4 × 5½-inch glass-epoxy PC board.

Table 2
Ten-Tec T-Kit 1210 10-Meter Transverter

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Power requirements: Transmit, 2.0 A; typical output); receive, 100 mA, 12-14 V dc.	Transmit, 1.9 A (at 10 W) receive, 100 mA. Tested at 13.8 V.
Size (hwd): 1.5x5.0x8.0 inches; weight, 2.0 lb.	
Frequency coverage: Receive and transmit, 144-145.7 MHz.	As specified (determined by transceiver).
Modes of operation: CW, SSB, FM	Tested on CW, SSB, AM and FM.
Receiver	*Receiver testing*
Conversion gain: ~17 dB.	19.0 dB.
Noise figure: Not specified.	7.6 dB.
Image rejection: ≥60 dB.	90 dB.
Transmitter	*Transmitter testing*
Transmit RF input: 20 W (max).	5-20 W input required for typical 10 W output.
Transmit RF output: 10 W (max)	As specified.
Spectral purity: ≥56 dB.	58 dB at 10 W output. Meets FCC requirements.

Just Going Through Some Phases

Assembly is accomplished in seven "phases." Five of these end in *Progress Tests* of the various subsystems. The last includes the final alignment.

This construction method really helps alleviate the "is-this-thing-going-to-work-when-I-finally-finish-putting-it-all-together?" jitters. If you *do* run into a situation where a particular stage fails a progress test or exhibits unusual behavior, the search for trouble can usually be limited to that phase.

The seven-phase construction procedure also provides convenient stopping points to take time out for life's other distractions—eating, sleeping and working for example!

Toriod-a-phobia

Looking back over *QST* product reviews on kits that have appeared in previous issues, it's usually at about this point in the story where we begin describing the trials and tribulations of winding toroidal coils. Not so this time around folks—no toroidal coils are wound in the building of this kit.

The three coils that are builder constructed are made by simply winding some bare wire around the threads of a #6-32 screw in two instances and some enameled wire on a ¼-inch drill bit or dowel rod in a third. It's actually kind of fun!

Fair Warning

Assembly of this kit went very smoothly. If you've got even rudimentary circuit board soldering skills and access to some basic tools and test gear you should have absolutely no problem at all transforming this collection of parts into a working transverter.

There are a couple of details I'll bring up here that may save you some grief.

One of Ten-Tec's *Special Bulletins* involves a modified mounting method for Q10; a stud-mounted RF transistor (MRF2628). The installation discussion is on page 39 of the manual.

The new mounting scheme involves positioning a washer on the stud of the transistor between the underside of the circuit board and the aluminum heat sink and then bending the leads down to the surface of the board. Don't (as I did) overlook your handwritten note in the manual reminding you to refer to the *Special Bulletin* and solder it flush with the board.

Also on page 39 is a step describing the installation of Q9, a 2SC1970 transistor used for RF drive. This component needs to be carefully positioned if the hole in its case and a required insulating washer are to line up with a mounting hole in the previously mentioned heat sink. While the manual explanation seems to indicate that doing a test fit of the heat sink is optional, the odds of locating this transistor properly without actually temporarily mounting the heat sink seem *Powerball* slim. Moving the transistor even the slightest amount after soldering it in place is a serious pain! (I know this from experience.)

CQ 10—*err, ah*—2 Meters!

Set-up and operation of the 1210 is easy. The antenna connector of your 10-meter radio—a Kenwood TS-570S in my case (don't read too much into this—I own a wide variety of makes, models and vintages) is jumpered to the SO-239 connector marked **10M TRANSCEIVER 20 WATTS MAXIMUM** on the rear panel of the transverter. A suitable 2-meter antenna is plugged into the **2M ANTENNA** jack. A 12 to 14 V dc supply capable of at least 2 A is required for power. The only control on the 1210 is the **POWER** switch.

The HF transceiver's RF output power *must* be set to 20 W or less—much more than that and you'll be breaking out the soldering iron and test equipment again. The transverter is capable of about 10 W of RF output on 2 meters.

To determine the 2-meter frequency that corresponds to the 10-meter frequency shown in the HF radio's display, you simply add 116. If your 10-meter frequency display shows 28.000 MHz, the 2-meter frequency will be 144.000 MHz (28.000 + 116 = 144); if the display indicates 29.700 MHz, the resulting 2-meter frequency will be 145.700 MHz.

This brings up an important point: the 2-meter frequency coverage of the transverter is limited by the frequency agility of the connected HF radio. Most HF transceivers will cover from 28 to 29.7 MHz on 10 meters—a few stock radios might go as high as 30 MHz.

As most of you already know, nearly every current HF transceiver can be modified to extend the range of transmit frequencies beyond the US amateur band limits. Since the transverted signal will be within our allocations on 2 meters, it's perfectly okay to modify your HF radio to expand the frequency range for transverter operation.

While nearly all terrestrial SSB and CW activity occurs below about 144.3 MHz, some may want to extend the limit above 145.7 MHz to access the satellite subband between 145.8 and 146 MHz. An HF radio with extended coverage might also provide wider coverage of the 2-meter repeater and FM simplex frequencies.

One of the neatest things about using a transverter is that you get to enjoy all of the features and modes that are already built into your HF rig. Multiple memories, split frequency operation, IF shift, DSP, noise blankers, memory keyers and more—are all still available. In the case of my TS-570S, there's even a "transverter" menu setting that allows me to display the actual 2-meter operating frequency directly, and the radio already has built-in CTCSS tone encode and decode capabilities for the 10-, 6-, and now 2-meter repeaters. What could be cooler?

Manufacturer: Ten-Tec Inc, 1185 Dolly Parton Pkwy, Sevierville, TN 37862; 800-833-7373; 865-453-7172; fax 865-428-4483; **sales@tentec.com**; **http://www.tentec.com**.

Price: Model 1210 transverter kit, $139; Model 1210A transverter (factory assembled), $239.