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Product Review

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Yaesu FT-1000MP MF/HF Transceiver

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These are exciting times for Amateur Radio: the advent of integrated digital signal processing (DSP) technology in high-end MF/HF radios! Yaesu is the third of the "Big Three" Japanese manufacturers to weigh in with a DSP-enhanced radio. In January, we reviewed the ICOM IC-775DSP; in February, the Kenwood TS-870S. Now, we consider the Yaesu FT-1000MP.

Although Kenwood's tack was DSP-based filtering with *no* optional IF filters, Yaesu, like ICOM, has included conventional IF filters along with the DSP filtering (which Yaesu calls *Enhanced* Digital Signal Processing, or EDSP). The FT-1000MP also applies DSP filtering at an IF stage, as do the ICOM and Kenwood DSP-equipped transceivers. For a closer look at how Yaesu implements its EDSP, see the sidebar "DSP in the FT-1000MP" by Jon Bloom, KE3Z.

You might think the FT-1000MP is simply an updated FT-1000. It's not, although Yaesu clearly hopes to parlay the cachet of the original FT-1000 into another success. (Consider how many miles the Ford Motor Company has gotten out of its "Mustang" moniker.) The 'MP suffix, Yaesu says, is to honor Sako Hasegawa, JA1MP, Yaesu's founder, now a Silent Key.

Although the name and the basic appearance are similar, the 'MP only *borrows* from the "original" FT-1000 (Yaesu says the 'MP is actually a hybrid of the FT-990 and the FT-1000). For all intents and purposes, this is a new design. That the 'MP is some five years newer carries its own implications in view of the technological explosion that's transpired. (Dare we say, "This is not your father's Yaesu?")

Does the new FT-1000MP live up to its noble heritage or is it another Edsel? Let's see how the FT-1000MP fared during our "test drive."

Features and More Features

Most review team members were enthusiastic about the FT-1000MP, but it was not necessarily love at first sight. It seems this is a radio that at least some users must learn to love, and it's not without fault.Make no mistake, however; the FT-1000MP is an extremely capable radio with solid DSP capabilities, an in-band sub receiver and other features you've come to expect. Among the high spots: a 100-W MF/HF transceiver with all the usual modes, plus general-coverage receive. The radio comes with three filters and options for lots of others.

Other features include a three-step **RF ATT**enuator; an **AGC** time-constant selector (with off, fast, slow and auto settings); two noise blankers (one for narrow pulse noise such as auto ignition systems, and one for wide-pulse, longer-duration noise); and a variable **RF GAIN** control. A manual **IF NOTCH** is available, or you can select an automatic DSP-based notch filter that kills obnoxious carriers on contact. (More on the DSP and IF filters later.)

The 'MP lets you shift the main receiver's IF passband and adjust the IF bandwidth from either side. It also has a built-in antenna tuner that works capably, quickly and quietly. But why stop there? The radio has *three* receiver preamps, a built-in RS-232 (**CAT**) connector on the rear panel, a memory keyer (but, no way to control it unless you *build* a 12-button remote-control keypad or buy the soon-to-be-available FTT-1000 keypad accessory that also runs other functions from afar), multi-function metering and plenty of clean, distortion-free audio into the built-in speaker or headphones. Speaking of which, two front panel jacks let you use just about any kind of headphone, stereo or mono or both at once, if you'd like. Keyer jacks on the front and rear panels use only three-conductor plugs, but you can trick it into using a two-conductor plug by pulling it partially out. There's a nifty CW spot button plus a tuning meter to help you accurately zero beat, and CW pitch is a front-panel adjustment. The display includes lots of metering options. We liked the pop-up feet under the radio, too.

BOTTOM LINE

The FT-1000MP offers performance and flexibility in a quality radio. The receiver is quiet and good at its job, and Yaesu's EDSP is icing on the cake.

If you're thinking about the 'MP for that next DXpedition, Yaesu's covered that base, too: the 'MP is available in a DC-only model or in the ac/dc version we reviewed. The ac/dc model can be internally switched between 230 V ac or 115 V ac operation, or jumpered for use from a 13.8 V dc supply. Those ac supply voltages are nominal, however; Yaesu says the radio will run properly on 100-125 V and 200-240 V.

Considering all that it has inside, this is a relatively compact box (and it's lighter than the original FT-1000 by 18 lb). One op who hauled the MP home for a weekend of contesting wished for a carrying handle. But, consensus among review team members was that if the FT-1000MP didn't have something, you probably didn't need it.

Getting to Know It

The FT-1000MP's gobs of features and commensurately large number of knobs and buttons—90-some, in all—tended to overwhelm our review team, at least at first. "Too many toys," was a common refrain. Because of this, you don't want to begin your relationship with the FT-1000MP without first touring the *Operating Manual*, because some features are not intuitive (for example, you press **FAST** plus **ENT** to open the menus. *Huh?*). Then keep the book handy. As one well-known contester (who shall remain anonymous) put it: "I actually had to read the manual to figure out how to transmit!"

As we got acquainted with it, the FT-1000MP revealed itself to be a surprisingly complex radio with a rich array of menu choices that give you lots of leeway to configure the radio "your way." In fact, a **USER** button lets you set up a custom environment you can switch to in an instant. But the proliferation of front-panel controls invited a brickbat or two from reviewers who felt that some oft-used smaller buttons were hard to reach next to the larger controls. For example, several reviewers complained that, while using the concentric DSP and noise-reduction controls, the RIT and sub-receiver knobs on the tightly packed panel got in the way.

The most prominent feature of the busy, contoured front panel (it's sort of Euro styling applied to ham radio equipment) is the large **MAIN VFO A** tuning knob, surrounded by a **SHUTTLE JOG** ring to permit rapid frequency excursions. The review team lauded Yaesu for including the ring. The tuning rate depends on how far you advance the ring one way or the other, but at the default encoder rate setting, it's easy to overshoot your mark. With a little practice, most will get the hang of it, and you also can change the encoder rate using the menu. As an alternative, holding in the **FAST** button increases the tuning rate tenfold. The **FAST** button works for both the **MAIN** and **SUB** knobs and also while using the **UP** and **DOWN** buttons. The **MEM/VFO CH** knob also lets you set up the VFO to tune in predetermined increments or channel steps.

The smaller **SUB VFO B** knob is to the right of the **MAIN VFO A** knob. Between the **MAIN** and **SUB** VFO knobs is a keypad that lets you select individual bands and control memory functions, as well as dual-receive capability. Several review team members commented favorably on the **BAND** buttons. Given current design trends, it seems it's commendable that the radio has them at all. **BAND** keys stack two settings for each band, including mode and filter data. By first pressing the **ENT** key, you can use the **BAND** buttons to key in a frequency one digit at a time.

A rectangular display window nearly the width of the radio reads out both the **MAIN** and **SUB** VFO frequencies as well as the status of some *three dozen* other settings and functions (There's a *lot* going on there). Readouts on the display use colorful fluorescent discharge units. These are attractive, but inactive segments glowed faintly, especially at the high-intensity setting, making readability troublesome at most viewing angles. (This effect even shows up in a picture of the radio in the *Operating Manual.*) We recommend the low-intensity setting.

Speaking of hard to see or read, the radio also has problems in the hard-to-reach department. Several review team members griped about the row of smallish knobs and buttons—several of them controlling important functions—almost hidden along the panel's lower tier. (Yes, the original FT-1000 had a row of buttons and one control in the same location, too, but few were functions you'd use a lot, and the sub-panel was sensibly tilted upward.) Unless you have the FT-1000MP at eye level, it's difficult to see the legends, much less the knobs or buttons themselves, most of which are the same shade as the panel. This tier includes keyer functions, **RF PWR**, **RF GAIN** and **MONI**tor controls, the **DOWN** and **UP** buttons and buttons to select or clear the RIT. However, oft-used controls are in the right place and of the right size, except for the **RF PWR** and **RF GAIN** controls, which could be bigger.

Another whole set of user-adjustable trimmer pots (including one you're not supposed to adjust) is hidden under a little trap door in the top of the transceiver. Under the hatch are the VOX gain, delay and anti-VOX controls, plus headphone audio levels for both the main and sub receiver to the front-panel jacks, adjustments for the tuning meter for various modes and FM mike gain. A trimmer on the bottom panel sets the volume of the "beep" that sounds when you press front-panel buttons.

Three RF preamplifiers are standard. Using the menu, you can set the radio up to use either a single, flat-response preamp for all bands or a pair of preamps, one optimized for 1.8 to 7 MHz and the other for 20 to 30 MHz. When using the optimized pair, the radio automatically selects the proper preamp. Pressing the **IPO** (Intercept Point Optimization) button bypasses all three RF preamplifiers and puts a unity-gain RF stage in place of the front-end preamps.

The **CLAR**ifier (RIT) range is menu-settable, and you can switch in both receive and transmit offsets. One button clears the RIT, even while transmitting.

Some of the radio's built-in flexibility led to a bit of initial confusion. For example, you'd think the VOX delay would also work for CW, but it doesn't. There are separate controls for CW semi-break-in delay and SSB VOX delay—a great feature. The radio offers an **ANT A/B** switch for two antennas and provisions for a separate receive antenna (something serious low-band operators have been asking manufacturers to include for years). Only problem, reviewers found, was that disabling the **ANT A/B** switch also mysteriously disables the separate receive antenna.

Managing Menus

A radio's menus and their ease of use are becoming ever more important criteria in a radio's acceptance and usability. The FT-1000MP's menus permit a *lot* of customizing. You can set DSP transmit and receive parameters, fully adjust CW weighting, set keyer modes (bug, iambic 1 or iambic 2), adjust the carrier point offset, and tweak data-mode parameters, among many other things. All told, there are 80 menu items, and some of those contain submenu choices. Lots of choices seems to be what this radio is all about.

Like other radios, the 'MP makes the most of the display segments it has, which means you'd better keep the manual right there to decipher the menu display. Example: a setting choice for CW [Rx] is rendered "**cu-r**" on the display, while "**SEI-bdil**" means you're supposed to use the **SUB VFO B** dial to step through the various submenu possibilities. In another set of choices, the menu displays **A1** to mean CW and **A3** for AM. (This is a thinking ham's radio, for sure!) The menu display is a bit obscure, maybe, but the FT-1000MP also shows the index number of each menu item, so you can always figure out where you are by referring to the manual. This is extremely helpful.

Learning to Love It

We used the 'MP on CW and SSB to make lots of casual and contest QSOs, and we found it to be a proficient performer. On-the-air observations suggested the DSP transmit options had the intended results on SSB. Menu choices let you set various DSP combinations for IF-level transmit audio processing (at 455 kHz), SSB carrier shift and microphone audio equalization. "Save it for the contest" was the response when using the most "extreme" configuration. But the "default" audio got positive reports during casual QSOs. The built-in monitor receiver makes it simple to set up the right combination, and you can even make the supplied hand mike sound super.

The way Yaesu implements the signal **MONI**tor function in the 'MP is worth noting. Most radios that let you monitor your signal in transmit feed your signal back to your headphones (or speaker) from one of the radio's IF stages. The 'MP picks off the signal as it leaves the driver stage.

It was a joy to operate the FT-1000MP on CW. Keying is clean and smooth (see Figure 2). The internal keyer is terrific, but lacking the outboard keypad, we had no way to program or access the memory keyer—which includes contest-style incremental numbering. (The keypad also duplicates the front-panel VFO/memory functions and **BAND** keypad controls.) Competing radios double up on front-panel buttons to run their memory keyers.

Most reviewers commended the 'MP's "quiet" receiver that didn't leave you feeling wrung out after you'd been using the radio for a while. ARRL Lab data (see Table 1) confirm the excellent receive characteristics.

Yaesu says that during the radio's design phase, the engineers paid special attention to second-order IMD dynamic range performance, in deference to stronger MF and HF broadcast signals and the growing popularity of less-selective multiband antennas. (For a thorough discussion of second-order IMD, see the "Key Components of Modern Receiver Design" series by Ulrich Rohde, DJ2LR/KA2WEU, in May-July and December 1994 *QST*.) The FT-1000MP incorporates both bandpass and high-pass filters to prevent second-order IMD products and images. Yaesu explains that the bandpass filters roll off signals on either side of the frequency range in use (they're selected using PIN diodes), while the high-pass filters roll off signals below the band in use. The high-pass filters are selected using relays to prevent diode-induced IMD. This radio's second-order input intercept and image re-

Table 1

FT-1000MP, serial no. 5F010064

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 100 kHz to 30 MHz; 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 MHz.	Receive, as specified; transmit, 1.5-2; 3.5-4; 7-7.5; 10-10.5; 14-14.5; 18-18.5; 21-21.5; 24.5 -25; 28-30 MHz.
Modes of operation: USB/LSB, CW, AM, FM, FSK	As specified.
Power requirement: 120 V ac.*	
Receiver	*Receiver Dynamic Testing*
SSB/CW sensitivity, 2.4-kHz bandwidth, preamp on, 10 dB S/N: 150-250 kHz, 5 μV; 250-500 kHz, 4 μV; 0.5-1.8 MHz, 2 μV; 1.8-30 MHz, 0.25 μV.	Minimum discernible signal (noise floor), 500-Hz filters at IF 8.2 MHz and 455 kHz: *Preamp off* / *Flat Preamp* / *Tuned preamp* 1.0 MHz: –118 dBm / –123 dBm / –123 dBm 3.5 MHz: –128 dBm / –135 dBm / –124 dBm 14 MHz: –128 dBm / –136 dBm / –136 dBm
AM sensitivity, 6-kHz bandwidth, preamp on, 10-dB S/N: 150-250 kHz, 40 μV; 250-500 kHz, 32 μV; 0.5-1.8 MHz, 16 μV; 1.8-30 MHz, 2 μV.	10-dB (S+N)/N, 1-kHz tone, 30% modulation, 6-kHz bandwidth: *Preamp off* / *Preamp on* 1.0 MHz: 7 μV (–90 dBm) / 4 μV (–94 dBm) 3.8 MHz: 3 μV (–98 dBm) / 1 μV (–106 dBm)
FM sensitivity, 12-dB SINAD: 29 MHz, preamp on: 0.5 μV.	For 12-dB SINAD, 14-kHz bandwidth: *Preamp off* / *Preamp on* 29 MHz: 0.9 μV (–108 dBm) / 0.3 μV (–116 dBm)
Blocking dynamic range: Not specified.	Blocking dynamic range, 500-Hz IF filters at 8.2 MHz and 455 kHz: *Preamp off* / *Preamp on* 1.0 MHz: >135 dB / 139 dB 3.5 MHz: 140 dB / 139 dB 14 MHz: 142 dB / 137 dB
Two-tone, third-order IMD dynamic range: 105 dB at 50-kHz spacing, 500-Hz bandwidth, preamp off.	Two-tone, third-order IMD dynamic range, 500-Hz IF filters at 8.2 MHz and 455 kHz: *Preamp off* / *Preamp on* 1.0 MHz: 83 dB / 84 dB 3.5 MHz: 94 dB / 91 dB 14 MHz: 97 dB / 94 dB
Third-order input intercept: Not specified.	*Preamp off* / *Preamp on* 1.0 MHz: +7 dBm / +3 dBm 3.5 MHz: +13 dBm / +1 dBm 14 MHz: +15 dBm / +5 dBm
Second-order intercept point: Not specified.	Preamp off, 86 dBm; preamp on, 88 dBm.
FM adjacent-channel rejection: Not specified.	Preamp off, 75 dB; preamp on, 74 dB, at 20 kHz channel spacing.
FM two-tone, third-order IMD dynamic range: Not specified.	Preamp off, 75 dB; preamp on, 74 dB, at 20 kHz channel spacing.
S-meter sensitivity: Not specified.	S9 signal at 14 MHz: preamp off, 335 μV; preamp on, 100 μV.
Squelch sensitivity: 1.8-30 MHz, CW/SSB/AM, <2 μV; FM, <0.3 μV.	At threshold, preamp on: FM, 0.2 μV; SSB, 1.5 μV.
Receiver audio output: 2 W at 10% THD into 4 Ω.	3.2 W at 10% THD into 4 Ω.
IF/audio response: Not specified.	Range at –6 dB points, (bandwidth): CW-N (both 500-Hz filters): 448-929 Hz (481 Hz); CW-W (both 2.4-kHz filters): 499-1268 Hz (769 Hz); USB-W (both 2.4-kHz filters): 259-2340 kHz (2081 kHz); LSB-W (both 2.4-kHz filters): 180-2340 Hz (2160 Hz).
Notch filter depth: Not specified.	Manual notch, ≥25 dB; auto notch, ≥45 dB.
Image rejection: 80 dB or better, 1.8-30 MHz.	Preamp off, 125 dB†; preamp on, 124 dB.†
IF rejection: 80 dB or better, 1.8-30 MHz.	Preamp off, 123 dB†; preamp on, 124 dB.†
Transmitter	*Transmitter Dynamic Testing*
Power output: SSB, CW, FSK, FM: 100 W (max), 50% duty cycle; AM, 25 W carrier (max).	CW, typically 110 W (max), <1 W (min); SSB, 118 W PEP (max), <1 W (min), varies slightly from band to band. AM, as specified. FM, typically 114 W (max), ≈2 W (min).
Spurious-signal and harmonic suppression: 50 dB or more for harmonics.	<60 dBc on all amateur bands. Meets FCC requirements for spectral purity.
SSB carrier suppression: ≥40 dB below PEP output.	As specified.
Undesired sideband suppression: ≥50 dB below PEP output.	As specified.
Third-order intermodulation distortion (IMD) products: At least –31 dB at 100 W PEP.	See Figure 1.
CW keyer speed range: Not specified.	≈6-120 wpm.
CW keying characteristics: Not specified.	See Figure 2.
Transmit-receive turnaround time: Not specified.	PTT release to 50% audio output, S9 signal, 23 ms.
Receive-transmit turnaround time ("tx delay"): Not specified.	SSB: 11 ms; FM: 10 ms.
Composite transmitted noise: Not specified.	See Figure 3.

Size (height, width, depth): 5.4×16.4×14 inches; weight, 33 pounds.

*Radio is capable of operation at 120 V or 220 V ac and 13.5 V dc; 120 V ac is the factory default.

†Measurement was noise-limited at the value indicated.

Note: Dynamic-range measurements are made at the ARRL Lab standard signal spacing of 20 kHz.

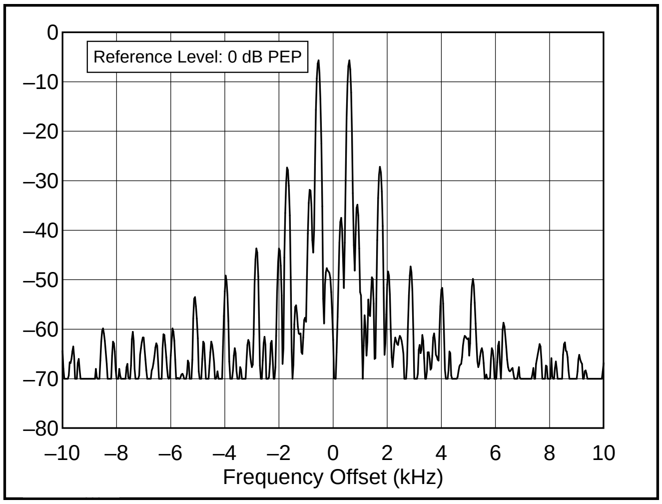

Figure 1—Worst-case spectral display of the FT-1000MP transmitter during two-tone intermodulation distortion (IMD) testing. The worst-case third-order product is approximately 27 dB below PEP output, and the worst-case fifth-order product is approximately 43 dB down. The transceiver was being operated at 100 W PEP output at 24.95 MHz.

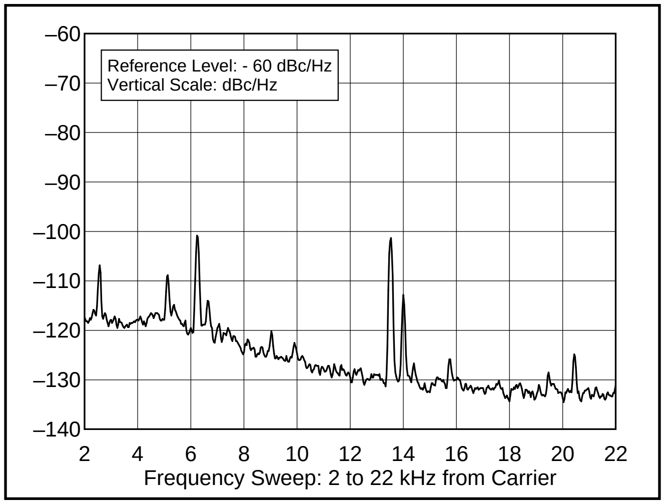

Figure 3—Worst-case tested spectral display of the FT-1000MP transmitter output during composite-noise testing. Power output is 100 W at 3.5 MHz. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.

jection figures are the highest we've measured in the current generation of commercial amateur transceivers, and they reflect the success of Yaesu's design focus.

In third-order IMD dynamic range testing with 500-Hz filters at 50-kHz signal spacing, we measured the Product Review radio at 104 dB and a Yaesu-supplied radio at 105 dB (best case)—excellent numbers by any standard. Yaesu has indicated that the specification should be 105 dB, not 108 dB as stated in the manual. Note that the ARRL Lab numbers reported in the table reflect worst-case measurements at a 20-kHz signal spacing, which is the test standard we use for all MF/HF transceivers.

Other tests showed that the in-band audio IMD was down at least 32 dB.

DSP and IF Filters

The double-whammy of crystal and mechanical filters plus DSP in the FT-1000MP is a killer combination. You also get support from the wide and narrow noise blankers, IF **SHIFT** and **WIDTH**, the **IPO** button, the adjustable **RF ATT**enuator, adjustable **AGC**, and **RF GAIN** controls.

Inside the radio is a 16-bit NEC CMOS DSP chip running at 33 MHz. Outside, concentric **NR** and **CONTOUR** controls let you choose from among four DSP Noise Reduction algorithms and four DSP filter contours steps, simply by pressing the **EDSP** button and turning the appropriate selector. The **CONTOUR** selector graphically depicts the filtering contour in place (band-pass, low-cut, mid-cut and high-cut). You set up the desired **CONTOUR** band-pass filter parameters via the menu, where you specify the desired lower and upper frequency cut-offs or the bandwidth for each mode. The other three **CONTOUR** positions are preset. In general, the choice you needed usually was there, and it's even possible to get extremely narrow (60-Hz) CW filtering that's a bit ringy

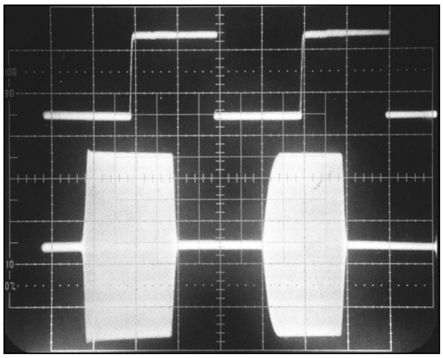

Figure 2—CW keying waveform for the FT-1000MP in the semi-break-in mode, showing the first two dits. The equivalent keying speed is 60 wpm. The upper trace is the actual key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output at 14.2 MHz. Results were identical for the full-break-in (QSK) mode.

(the other choices are 120 and 240 Hz). The noise reduction (**NR**) knob provides you with four predetermined noise reduction algorithms for random noise, static, pulse or man-made noise, and even heterodynes. Some operators disliked the concentric controls. At times, you not only bump other knobs on the panel, but it's also easy to turn the more prominent **NR** selector when you *really* want the **CONTOUR** knob. Other reviewers said they'd prefer continuously tunable noise reduction and DSP filtering, like that on many outboard DSP boxes.

Pressing the DSP-based **NOTCH** button easily eliminated AM broadcast heterodynes on 40-meter SSB. The multiple-notching feature is available only in the SSB mode.

Just to see what the DSP would do, we trolled around 75 meters one evening for weak and unreadable SSB signals. Using the tools the FT-1000MP provides, and especially the DSP, we were able to bring them out of the mud. Since we didn't have the narrow SSB filters installed, we relied a lot on the DSP band-pass **CONTOUR** setting to fight QRM. Most of the time we were not disappointed. On CW, the DSP ably complemented the narrow standard and optional 500-Hz IF filters. During the ARRL 160-Meter Contest, when close-in signals sneaked past the filters, the DSP—with occasional aid from the **SHIFT** and **WIDTH** controls—took up the slack.

For the most part, the review team liked the DSP implementation, but some were underwhelmed by the DSP **NR**. A veteran DXer said he "never did find a situation where the noise reduction position did any good" during one contest. (However, he has bought an FT-1000MP for his own shack and considers it "the perfect radio.") Others on the review team felt the **NR** positions made sometimes subtle but substantive improvement, especially for weak-signal copy. One experienced operator didn't like having to go to the menu to set up bandwidth selections. As he put it, "The ability to select DSP bandwidths with a front-panel switch would be more useful to me than the noise-reduction circuit is."

Besides its DSP, the main receiver has three standard filters in two IFs (8.215 MHz and 455 kHz). These include a 500-Hz crystal CW filter in the 8.215-MHz IF, a 2.4-kHz crystal filter in the 8.215-MHz IF and a 2.4-kHz Collins mechanical SSB filter in the 455-kHz IF. Optional narrow filters include 2.0-kHz SSB crystal filters and 250-Hz CW crystal filters for the 8.215 MHz and 455 kHz IFs, and a 500-Hz Collins mechanical filter for the 455-kHz IF. The sub receiver can be fitted with a 500-Hz Collins mechanical CW filter at the 455-kHz IF. No soldering is needed to install filters. Our review radio had optional 500-Hz filters in both the main and sub receivers.

A front-panel **BANDWIDTH** matrix makes

DSP in the Yaesu FT-1000MP

As with other high-end radios of recent vintage, the FT-1000MP brings the most-wanted processing functions provided by DSP—selective filtering, noise reduction and automatic notch filtering—into the radio. And it uses its internal DSP system to process transmitted audio, too.

The FT-1000MP's use of DSP for receiving suffers from the same limitation as does use of an external DSP filter unit. Namely, the filtering of the DSP unit is performed after the IF filtering and *outside the AGC loop*. This means that, while you can filter an unwanted nearby signal out of the receive audio, you can't keep that signal from affecting the AGC response of the receiver or, in the case of strong signals, from causing blocking or IMD generation in the IF. So, the DSP filter alone is not a cure-all interference rejection technique.

The radio does provide *analog* IF bandwidth and shift adjustment, and with its standard 500-Hz filter—or optional 250-Hz filter—can do a good job of rejecting close-in interference. Use of these analog adjustments proves to be the right way to reduce such interference, with the addition of DSP selective filtering serving mostly to augment the IF filtering or to provide a tailored audio frequency response. Control of DSP selective filtering is performed by a combination of a front-panel switch that allows you to select a band-pass, low-pass, high-pass or band-reject filter shape. Menu-selected frequency ranges for each of the filter shapes include the ability to set different cut-off frequencies for the SSB, CW, AM and digital modes.

Along with its selective filtering, the DSP provides noise reduction filtering. Yaesu gives the user a front-panel control to select one of four noise-reduction settings. Experimenting with these settings will usually find one that does a good job of reducing the noise present in the receiver audio.

The FT-1000MP contains both a manually tuned IF notch filter and an automatic notch filter in the DSP unit, which can remove multiple carrier signals from the audio but—again—not from the IF. Both may be used at the same time.

For those occasions when you want to hear the "pure," unprocessed signals being received, all DSP functions can be disabled with a single front-panel button. When the DSP is selected, demodulation of received signals is performed by the DSP at a low (10.24 kHz) IF. When the DSP is off, analog demodulation takes place.

In transmit mode, the DSP system can provide prefiltering of the transmit audio—before modulation takes place. This lets you tailor the radio's response to your voice/microphone combination. You also can opt to use wider transmitting IF filters in conjunction with the audio filtering. The combination should result in cleaner sounding transmitted audio because the wider filters will distort the transmitted signal less.

While the FT-1000MP DSP implementation is clean, and the user interface is convenient, the receive-side DSP performance isn't too different from that provided by an external DSP unit. Still, if you like your signal handling all in one box, the FT-1000MP's DSP provides effective audio signal processing.—*Jon Bloom, KE3Z, Senior Engineer*

it simple to choose IF filter settings and various combinations. The matrix consists of two columns of backlighted *Selectivity Indicators*, one column for the 8.215-MHz IF and one for the 455-kHz IF. Each column lists possible IF filters (**250**, **500**, **2.0K**, **2.4K** and **6.0K/THRU**). To select the same filter for each IF, just push the appropriate filter button (**250**, **500**, **2.0K**, **2.4K** and **6.0K**) to the right. That's it, you're done. If you don't have a particular filter installed, the radio skips to the next widest or narrowest choice. A button at the bottom of each column (**8.215** and **455**) lets you select that column to pick separate filters for each IF. Pressing the **8.215** button makes that column's *Selectivity Indicator*s flash. Press the **500** button to the right to put a 500-Hz filter in the 8.215-MHz IF. Similarly, press the **455** key, the *Selectivity Indicator*s for the 455-kHz IF flash, and you can pick another bandwidth there, say 2.4 kHz. You can choose any filter combination in any mode, except FM, assuming that the filter has been installed.

"Collins Inside"

We're told that Sako Hasegawa, JA1MP, was a disciple of Art Collins, WØCXX, and this, perhaps, makes the use of standard and optional Collins Mechanical filters in the 'MP—and Yaesu's "Collins Inside" approach in its ads—particularly appropriate. Their good shape factor, small physical size, ruggedness, low insertion loss, and other factors make these Collins mechanical filters a good choice for the 455-kHz IF.

A Receiver Times Two?

They might call it a "sub" receiver, but it's a *real* receiver, albeit double-conversion and an in-band-only affair. Unlike the sub receiver in the IC-775DSP, the sub receiver in the FT-1000MP can take advantage of its own (optional) CW narrow filter and doesn't share as much circuitry with the main receiver. As you might expect, ARRL Lab testing revealed that the sub receiver's sensitivity and dynamic range figures were not quite as good as those measured for the main receiver.

One reviewer called dual receive "the ultimate secret weapon in any pileup." However, he also yearned to have at least some of the DSP options on the second receiver, such as notch filtering. Other reviewers were upset that you could not turn off the display when the sub receiver was not in use. Front-panel controls on the FT-1000MP make it easy to listen to signals on either the main receiver or the sub receiver—or both, if you wish (even narrow bandwidth in one ear and wide in the other, using stereo headphones). The concentric **AF GAIN** controls can be adjusted for relative balance between the two during dual reception. (An **AF REV**erse button swaps the two gain settings.)

Going split is as simple as pushing the **SPLIT** button. You use the **RX** and **TX** buttons above each VFO dial to set which one is transmitting and which is receiving (both can receive at the same time, of course). The radio also has a wide range of memory options, including five scratch memories, which Yaesu calls **QMB**, or *Quick Memory Bank*. All memory frequencies are tunable.

Back-panel "Ins and Outs"

Because the front-panel looks so complex, the back-panel of the 'MP seems tame by comparison. Besides the two antenna ports, you'll find the wing nut–equipped ground post. I/O ports include four DIN jacks for RTTY, packet and band data, plus support for the optional digital memory recorder (DVS-2). Several phono jacks access connections for PTT, ALC, phone patch, 13.5 V, external receive antenna, and transmitter ground. There's also a remote port to connect the remote keypad. An amplifier relay switch is provided. The ARRL measured the transverter drive jack (**TRV**) output level at a typical –20 dBm (about 10 µW), some 14 dB less than the level indicated in the *Operating Manual*. This might vary by band.

The back-panel DB-9 computer-aided control (**CAT**) port is fixed at 4800 baud and lets you interface the 'MP to your PC. Plug one end of a serial cable into the CAT port and the other end into your PC's serial port and you're ready to roll. This interface is a great feature, but you'll need to be sure your favorite software includes support for the FT-1000MP.

Documentation

In general, Yaesu's manuals are the epitome of clear, concise, and complete documentation, and the FT-1000MP's 104-page *Operating Manual* is no exception. We'd like to see a bit more text supporting the various software menu choices, however.

Taking It Home

Now that DSP has become the watchword of transceiver technology, it's hard to point to any single feature that distinguishes the FT-1000MP among its DSP cohorts. Its many noteworthy individual features yield an outstanding performer that holds its own among its peers, although someone's always out there to suggest yet another "improvement" the manufacturer *should* have included. Fact is, Yaesu is probably one step ahead of the pundits, making incremental improvements to the radio (and corrections to the *Operating Manual*) even as this review goes to print.

This is definitely no Edsel. It's more like a "loaded" performance car with "power everything." While a few areas could be "tuned up," its overall performance is impressive. Once we became familiar with the cockpitlike front panel, the lively 'MP handled our "test track" with ease. The 'MP felt stable when "driven hard" (during contests) and seemed well-suited (if not overbuilt) for "everyday driving" (casual operating). Overall, the 'MP was just plain fun to "drive," and it won't wear you out on a long trip either. (Of course, your mileage may vary.)

Our thanks to the following hams for their contributions to this review: Randy Thompson, K5ZD; Larry Wolfgang, WR1B; Dave Newkirk, WJ1Z; Bill Kennamer, K5FUV; Dave Sumner, K1ZZ; Tom Frenaye, K1KI (and his contest crew); Jon Bloom, KE3Z; Ed Hare, KA1CV, and Mike Gruber, WA1SVF.

Manufacturer: Yaesu USA, 17210 Edwards Rd, Cerritos, CA 90703, tel 310-404-2700; fax 310-404-1210. *Manufacturer's suggested list prices:* FT-1000MP, $3599; MD-100A8X Desk Mike, $139; 8.215-MHz IF filters: YF-114SN 2.0-kHz SSB filter, $179; YF-114CN 250-Hz CW filter, $179; 455-kHz IF filters: YF-110SN 2.0-kHz SSB filter, $179; YF-110CN 250-Hz CW filter, $189;YF-115C 500-Hz Collins mechanical CW filter (for the sub receiver), $189; TCXO-4 temperature-compensated crystal oscillator, $119; TCXO-6, $249; DVS-2 digital memory recorder, $329; FTT-1000 remote keypad, price not available.

MFJ-8621 Packet-Only Data Radio

Reviewed by Steve Ford, WB8IMY
Managing Editor, QST

So, you're weary of tying up your 2-meter FM voice transceiver for packet-radio applications. Or, you just got your Technician ticket and want to get into 2-meter 9600-baud packet without spending a truckload of cash. Or, you want to dedicate a no-frills transceiver to do nothing but sit on a 2-meter packet frequency (perhaps your local *PacketCluster* or TCP/IP network channel) 24 hours a day.

Business pros recognize these scenarios as perfect opportunities for aggressive "niche marketing." The formula is simple: You design a product for a *very* specific set of applications and price it to sell. If you're successful, you corner the market in short order. That's been the *modus operandi* of MFJ Enterprises for years. They identify specific needs in the ham community, then create products to fulfill them—everything from affordable antenna tuners to CW keyers. Last year they decided to answer the cravings of packeteers and newly licensed digital-mode enthusiasts who demanded a stripped-down, inexpensive, 2-meter FM transceiver that did *nothing but packet*. The result is the MFJ-8621 Packet-Only Data Radio.

Features

The '8621 is as unpretentious as you can get. The front panel is dominated by a push-button **POWER** switch and two LEDs: **PWR** (power) and **XMIT** (transmit). On the rear panel you find an SO-239 antenna connector, a 5-pin DIN socket for the TNC hookup, and a coaxial dc power socket. That's it! The compact enclosure makes it easy to place the rig just about anywhere, and it weighs less than a pound.

The '8621's transmitter pumps out 5 W of RF. That's adequate for local work and possibly even for more distant targets, if you're using a directional antenna. Transmit and receive frequencies are crystal-controlled. The radio comes from the factory with crystals for 145.01 MHz installed. If that frequency just happens to be the one you need, you're ready to go. Otherwise, you'll need to purchase and install another set. Figure on spending an additional $20-25 for crystals if you order them yourself. For factory-direct orders, MFJ also will install custom crystals for an additional $24.95. An MFJ-8621 already set up for the Automatic Packet Reporting System (APRS) at 145.79 MHz is available from MFJ for $139.95, fully calibrated.

I was impressed when I learned that the transmitter is equipped with *two* modulators: a varactor modulator for true FM at 9600 baud, and a reactance modulator for 1200-baud data signals. Some manufacturers attempt to cut corners by using the same modulator for both data rates, but that approach is a compromise at best, and the cost saving is often offset by mediocre 9600-baud performance.

Installation

I wanted to use the '8621 with my local *PacketCluster* node (KC8PE), so I ordered a set of transmit/receive crystals for 145.71 MHz. The well-written manual provides crystal sources (addresses and telephone numbers) and specific ordering instructions. Three weeks later, I had the crystals in hand.

The next task was to install them in the '8621. Calibrating the transmitter is as easy as installing the crystal, keying the '8621's PTT (push-to-talk) line and using an accurate digital frequency counter to measure the frequency while you adjust a ferrite core. An alternative is to use an HF receiver with a *precise* digital frequency display, tuned to the crystal's fundamental frequency (around 18 MHz). You can tune for a zero beat. For best results, I strongly recommend the counter method.

BOTTOM LINE

The MFJ-8621 is the economical, set-and-forget solution for hams who need a dedicated packet transceiver for 1200 or 9600-baud operation.

To align the receiver, MFJ now recommends a different method from the one in the *Instruction Manual* that used the calibrated transmitter's signal as a reference. MFJ's revised procedure involves using a good calibrated signal generator or an H-T that's on frequency while adjusting a couple of slug-tuned coils inside the radio as you monitor the voltage at the discriminator test point. An alternate method is to use a frequency counter to measure the first local-oscillator injection frequency at a test point, then adding 10.7 MHz (the first IF) to yield the receiver frequency. You can also use an oscilloscope to monitor both incoming and outgoing data. This way, you can compare your relative frequency deviation to that of incoming signals.

The radio comes configured for 1200-baud use. You have to pop the hood and change some jumpers to use 9600 baud. This entails moving two jumpers on the PC board and removing a third, which selects a special noise-reduction filter for 1200-baud operation. (The filter boosts the '8621's weak-signal receive performance at the slower data rate.) Each time you switch data rates, you need to partially recalibrate the unit, so it's probably best to set it up for either 1200-baud or 9600-baud use and leave it there.

Speaking of reception, it's important to note that the '8621 lacks a receive-audio squelch circuit. Conventional squelches open and close too slowly to be useful on most networks at data rates above 1200 baud. (At 9600 baud, you'd probably run your radio unsquelched anyway.) The 8621 does an end run around this problem by avoiding the squelch altogether. However, this shifts the burden of detecting data signals to your TNC. The bottom line is that your TNC *must* have a *data carrier detector* (DCD) to operate with the '8621.

As the name implies, a DCD ignores everything on the audio input line except *bona fide* data signals; it doesn't need a receiver squelch acting as an audio gatekeeper. But DCD-equipped TNCs are not as common as you might think. Many TNCs don't include this feature because they are designed to operate with *squelched* rigs (now we're back to using FM voice rigs as packet transceivers). These TNCs expect absolute silence when data signals are not present. If you connect a DCD-less TNC to the '8621, you'll copy packets—but you'll never transmit! The TNC interprets the unsquelched limiter noise as a continuous packet signal, considers the channel as busy and inhibits transmission accordingly.

So before you consider an '8621 for your station, make certain your TNC includes the DCD feature. And don't base your decision on the TNC's front-panel labeling. Some TNCs include an LED labeled "DCD," that's really nothing more than a "signal-present" indicator.

On the Air

The KC8PE *PacketCluster* node is about 10 miles distant, with several granite ridges in between. This is hardly a line-of-sight path. That's why I selected it as the "test bed" for my MFJ-8621. My normal packet station consists of an ICOM IC-2AT hand-held transceiver driving an RF Concepts 60-W amplifier connected to a ground-plane antenna in my attic. With this hardware I enjoy excellent results with KC8PE in terms of overall throughput. The IC-2AT is blessed with a sensitive receiver, and 60 W is sufficient to go the distance. How would the MFJ-8621 compare?

I set up the '8621 and configured my TNC using the PASSALL command to display all received packet frames, corrupted or otherwise. I noted the number of corrupted frames that I was receiving over a period of several minutes. Then, I reconnected my old equipment and performed the same test. The number of corrupted frames dropped noticeably.

Switching back to the MFJ-8621, I tried a connect test. KC8PE seemed to hear the '8621's 5-W signal well enough, because I connected on the first transmission. Additional frames from my station were being acknowledged with few repeats on my part.

The next step was to request some WWV solar activity reports. I knew these would involve much longer frames—and the longer the frames, the more opportunity for errors caused by marginal reception. If I had a receive problem, this test would run up the danger flags. Sure enough. I could see that the node was sending the same frames repeatedly. (All it takes is a single bit error on the receiving end to render a packet frame invalid. The only recourse is for the sending station to send it again.) I eventually received the complete set of reports, but it took about 30% longer than usual. The performance differential between the '8621 and my IC-2AT was obvious.

Thinking the culprit might be the network activity of the moment, I performed the same tests several times during the next few days. I also enabled the 1200-baud receive (audio) filter. The results were similar each time. I checked my antenna system, but everything appeared to be normal. ARRL Lab tests confirmed my suspicions. The receive sensitivity specification in the '8621 manual *was* 0.25 µV for 12-dB SINAD (MFJ has since lowered the specification to 0.5 µV for 12-dB SINAD). In contrast, the Lab measured nearly *1 µV* at its first crack at the radio. Following consultations with the radio's designer, Rick Littlefield, K1BQT, the Lab did a little tweaking and got it down to 0.6 µV, not far off the revised mark but possibly enough to at least partially explain the marginal data reception over my "challenging" path. MFJ has suggested "desensing" by another nearby node could have caused the spotty results we observed. But, performance remained the same over a period of time. Of course, if you're using the '8621 to connect to local packet stations with reasonably strong signals, you probably won't notice the mediocre receiver performance.

All of my on-the-air tests were conducted at 1200 baud because there is no 9600-baud activity on 2 meters in our area. According to the BER (bit-error-rate) tests performed by the ARRL Lab, the MFJ 8621 turned in good results on both transmission and reception (see Table 2). The 9600-baud figures for the MFJ-8621 compared favorably with other, more expensive radios not specifically designed for data service. Assuming *strong* signals on both ends of the path, the rig also should do a fine job at 9600 baud. Incidentally, the radio's transmit-receive turnaround and transmit delay times are almost nil. "This is the fastest transceiver I have seen," said ARRL Lab Test Engineer Mike Gruber, WA1SVF.

Table 2
MFJ-8621 Packet-Only Data Radio

Manufacturer's Specifications	***Measured in ARRL Lab***
Frequency coverage: Receive and transmit, 144-148 MHz, crystal controlled.	Tested at 145.71 MHz.
Power requirements: At 13.8 V dc, 25 mA max (receive); 1 A max (transmit).	≈35 mA (receive); ≈1.2 A max (transmit), tested at 13.8 V dc.
Size (height, width, depth): 1.8×4.9×5 inches; weight, 13.6 oz.	
Receiver	*Receiver Dynamic Testing*
Sensitivity: Less than 0.25 µV for 12-dB SINAD.	For 12-dB SINAD: 0.6 µV (–111 dBm).
Two-tone, third-order IMD dynamic range: Not specified.	56 dB at 500-kHz offset.
Wideband dynamic range: Not specified.	79 dB, at 10 MHz offset.
Adjacent-channel rejection: Not specified.	30 dB at 20-kHz spacing.
IF rejection: Not specified.	82 dB.
Image rejection: ≥45 dB.	35 dB (1st IF image).
Transmitter	*Transmitter Dynamic Testing*
Power output: 4-5 W.	As specified.
Spurious signal and harmonic suppression: Not specified.	–53 dBc. Meets FCC requirements for spectral purity.
Transmit-receive turnaround time (PTT release to 50% of full audio output): Not specified.	<2 ms.
Receive-transmit turnaround time ("tx delay"): Not specified.	<2 ms.
Bit-error rate (BER), 9600 baud: Not specified.	Receiver: BER @ 12-dB SINAD, 3.5×10^{-3}; BER @ 16-dB SINAD, 1.7×10^{-5}; BER @ –50 dBm, $<1.0\times10^{-5}$. Transmitter: BER @ 12-dB SINAD, 2.5×10^{-4}; BER @ 12-dB SINAD +30 dB, $<1.0\times10^{-5}$.

Conclusions

With receive sensitivity at 0.6 µV, the MFJ-8621 is *not* a super-hot performer. For the sake of comparison, you'd expect a typical 2-meter H-T or mobile radio to be at least 10 dB better on receive sensitivity.

If you only need a radio for local network applications, the MFJ-8621 is an outstanding bargain. For a price that's affordable by any standard, you get a rig that you can use for either 1200 or 9600-baud packet without modification. Once it's crystalled up and ready, the '8621 is truly a set-and-forget transceiver. The '8621 also has great potential as a portable packet station when combined with a miniature TNC and a notebook computer. And when someone figures out a way to keep them warm, I imagine you'll see a few '8621s flying to the edge of space beneath Amateur Radio balloons. My only wish is that MFJ would make a "sister" unit for 70 centimeters to take advantage of all the 9600-baud activity going on up there. Another niche market, perhaps?

Manufacturer: MFJ Enterprises, PO Box 494, Mississippi State, MS 39762, tel 601-323-5869. Suggested list price: $119.95. Accessories: MFJ-5100 connector cable, $14.95; MFJ-4110 wall adapter power supply, $39.95; custom crystal installation, $24.95.

Under the Microscope—The ARRL Laboratory's *Expanded Test Result Report*

By R. Dean Straw, N6BV
Senior Assistant Technical Editor

QST readers have a very high regard for the product reviews. Many hams will not even consider buying a new piece of gear until they've seen what *QST* has to say about it. I also think our call-it-as-we-see it approach has helped improve the state of the art. For instance, the harsh glare of publicity in *QST* product reviews over the past 20 years has contributed to the 20 dB or so improvement in receiver dynamic-range. We expect that the recent addition of in-band receiver IMD testing (part of the Lab's overall product review testing) will result in better-sounding radios too. Although a few manufacturers complain—sometimes bitterly—about "harsh" treatment, they usually manage to significantly improve their next offerings! Ham consumers are the ones who benefit, of course.

Something New

In the January 1996 *QST* Product Review on the ICOM IC-775DSP transceiver, the ARRL announced a new product, the *Expanded Test Result Report*. This 30+ page report gives in-depth technical data measured by the ARRL Laboratory, detailed information there's just not room to print in *QST*—but worth knowing, nonetheless.

ARRL Lab Supervisor Ed Hare, KA1CV, recently handed me a copy of the first *Expanded Test Result Report*, for the ICOM IC-775DSP transceiver. Now, Ed is usually pretty animated, but on this occasion he was rather quiet, watching me closely for a reaction. I flipped through the pages. "Wow! There's some really neat stuff here!" I told him. Ed smiled and allowed that he, too, was pleased with how it had turned out.

But Ed also knew I couldn't resist suggesting how an already-great product could be spiffed up here and there. After much discussion, Ed and his team went back to work and upgraded the next report—on the Kenwood TS-870S transceiver—incorporating feedback from many sources, myself included. I promised Ed I'd do a mini-review of the *Expanded Test Result Report*. Here are the highlights I found.

Dynamic Range Graphs

The new dynamic range graphs in the *Expanded Test Result Report* are real eye-openers. The Lab sweeps the receiver and generates graphs that show blocking and two-tone dynamic range versus frequency spacing (see Figure 4, from the IC-775DSP report). Both are generated using computer-controlled test equipment and a highly sophisticated piece of software the Lab wrote.

These graphs reveal—in one place—a great deal about a receiver's performance. Degradation of the signal-to-noise ratio of a desired signal by nearby strong signals can be caused by many things: a lack of linear dynamic range in the receiver's front end; a lack of shielding or discrete spurious responses in various crystal or mechanical filters; discrete spurious signals coming from local oscillators; and local-oscillator phase noise, found most prominently in synthesized radios.

Whatever the precise cause, the bottom line is that you can't copy a weak *desired* signal in the presence of nearby *undesired* signals, which may have phase noise or spurious signals of their own. (Those problems are revealed in the detailed transmitter tests the Lab does.)

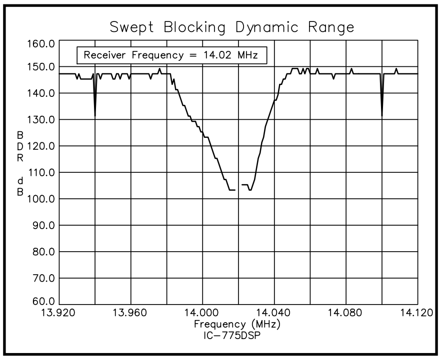

Figure 4—This graph shows the maximum blocking dynamic range for the IC-775DSP is about 148 dB for undesired signals more than 40 kHz away from the desired signal, degrading to about 103 dB when the undesired signals are within about 2 kHz. This is excellent performance. The receiver is in CW mode at 14.020 MHz with 500-Hz CW filters selected. This single graph shows all aspects of the blocking dynamic range, including degradation due to overload, spurious signals and oscillator phase noise.

HF Transceiver Comparative Table

At the end of the *Expanded Test Result Report*, the Lab summarizes the results in a comparative table, showing all transceivers measured in the recent past (see Table 3). The summary is very illuminating indeed! I strongly suspect that many readers will flip to these back pages first, before delving into the details.

Receive Band-Pass Graphs

As Lab personnel gain more and more insight into the wonders of computer-controlled test gear, they continue to add more tests to their bag of tricks. One of these new tests gives an excellent sense of a receiver's band-pass characteristics for both SSB and CW, as well as an indication of the receiver's broad-band audio "hiss." The *Expanded Test Result Report* includes some of this "work-in-progress," giving you a sneak preview of what the ARRL Lab is doing.

Coming Soon to Your Local Product Review

After extensive testing of the TS-870S and the IC-706, the Lab has focused its high-power product review spotlight on transmitter IMD performance for *all* bands, not just 80 and 20 meters, as was the past practice. The full set of transmitter IMD tests was added to the *Expanded Test Result Report* during post-review tests on the Kenwood TS-870S. Those tests revealed that the IMD performance on 12 and 10 meters deteriorated dramatically at full rated power, but improved once the power was reduced.

Four *Expanded Test Result Reports* now are available, for the IC-775DSP, the TS-870S, the FT-1000MP and the IC-706. Individual reports are $7.50 for League members ($12.50 for nonmembers). League members may obtain all three reports for the IC-775DSP, the TS-870S and the FT-1000MP for just $20! Credit card orders *only* can be placed by calling 860-594-0278. Where else can you hire a test engineer with access to thousands of dollars worth of test gear to do 30+ hours of exhaustive testing on a rig you might want to buy? Such a small expenditure prior to purchase of a multi-kilobuck transceiver sounds like a really sensible investment to me.

Table 3
Typical Data Available from the HF Transceiver Comparative Table:

Model	*Review Date*	*Bands*	*Modes*	*Typical Output Power*	*Xmit IMD (20 m) 3rd/5th*	*MDS 80 m/20 m Preamp on*	*Blocking DR†† 80 m/20 m Preamp on*	*IMD DR†† 80 m/20 m Preamp on*
IC-775DSP	1/96	All HF	SSB/CW	200	30/45*	–143/–143	135/132	104/103
TS-870S	2/96	All HF	SSB/CW	100	32/47†	–141/–139	124/123	95/95
FT-1000MP	4/96	All HF	SSB/CW	100	29/44‡	–124/–136	139/137	91/94

*Worst-case tested.
†Worst-case was 18/30 on 12 meters.
‡Worst-case was 27/43 on 12 meters.
††Blocking and IMD dynamic range measurements are made at the ARRL Lab standard signal spacing of 20 kHz.