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QST Compares: Multiband FM Mobile Transceivers
(Alinco DR-650T; ICOM IC-2710H; Standard C5900DA; Yaesu FT-8000R)

Timewave DSP-599zx Digital Signal Processor

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QST Compares: Multiband FM Mobile Transceivers

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Why limit yourself to only one band when you can enjoy the best of two worlds (or, in some cases, the best of *three* worlds)? Hams who live in areas that offer FM activity on more than just 2 meters are asking the same question. The answer is simple: Buy a dual-band or multiband FM transceiver!

For less than the price of separate radios, these modern multiband rigs offer two (or three) bands, plus all the features of single-band units—and sometimes more. It's not uncommon to find such handy items as full-duplex crossband modes that allow you to listen on one band while transmitting on another, scanning features that exploit the ability to conveniently eavesdrop on both bands, detachable front panels for easier mobile installation, and much more. (Detachable panels have become even more desirable in recent years as automakers have made the driver's seat more like a cockpit, surrounded by console-mounted instruments and controls, with little room for ham radios.) Some of this current crop of units provide AM aeronautical reception, while others include extended receive and/or transmit coverage below 440 MHz (critical for working the Russian *Mir* space station repeater and the OSCAR 27 satellite). Others go the extra mile to offer packet operation at 9600 baud with dedicated data jacks. (See our Features table for a side-by-side comparison.) By the way, all of the units in this review have single antenna connectors and built-in diplexers. Since most hams are using dual-band antennas these days, this approach is becoming the norm. You'll need an external diplexer if you want to run separate antennas for each band.

Our last comparative review of dual-band and multiband radios was in our November 1995 issue, when we looked at eight transceivers. This time around, *QST* puts the Alinco DR-605T, the ICOM IC-2710H, the Standard C5900DA (the only triple-bander) and the Yaesu FT-8000R side-by-side. Kenwood continues to offer the two radios we included in our last dual-band review—the TM-742A (which provides 2 meters and 70 cm, plus a choice of 10 meters, 6 meters, 1¼ meters and 23 cm) and the TM-733A. After the ARRL Lab completed its testing, four ARRL Headquarters staffers took the radios and put them through their paces. Our evaluation team consisted of Paul Danzer, N1II; Peter Budnik, KB1HY; Rich Roznoy, KA1OF; and Rick Lindquist, KX4V.

Alinco DR-605T

The Alinco DR-605T offers two bands in an economy package. Although it lacks the luxuries of other radios in the group, you get the essentials at a price that won't strain your budget. It's no slacker in the performance department either (see the table). Alinco has been marketing this radio as "very affordable," and its street price was the lowest of the lot.

The front-panel layout is straightforward and easy to understand, and it has just 10 controls. The main and sub bands have separate **VOL**ume controls. You switch bands by simply pressing the **VOL** knobs. A large VFO knob facilitates quick tuning while the large **FUNC**tion button—off by itself on the extreme left-hand side of the front panel—is hard to miss. Big buttons and knobs are appreciated most when you're trying to adjust the radio without taking your eyes off the road. The single VFO knob, means you have to select the main band before tuning.

Button placement on the microphone could be a problem—depending on how you hold the mike. If you're right-handed, you might inadvertently press the **UP** button by mistake while pushing the PTT button, especially if you normally put the gorilla grip on the mike. Setting the **LOCK** switch on will cure this.

Multiband FM Mobile Transceiver Features

	Alinco DR-605T	*ICOM IC-2710H*	*Standard C5900DA*	*Yaesu FT-8000R*
Bands (MHz)	144/430	144/440	50/144/420	144/430
Extended VHF reception (FM)	S	S	S	S
Extended UHF reception (FM)	S	X	S	S
Aviation band reception (AM)	X	S	S	S
Specified output-power levels (W)				
50 MHz	n/a	n/a	45 / 10 / 3	n/a
144 MHz	50 / 5	50 / 10 / 5	50 / 10 / 3	50 / 10 / 3
440 MHz	35 / 5	35 / 10 / 5	35 / 10 / 3	35 / 10 / 3
Memory channels per band	50+CALL	99+CALL	80	54+CALL
Band, memory and programmed scan	S	S	S	S
Alphanumeric memory naming	X	X	X	X
CTCSS decoder	O	O	S	O
DTMF decoder	X	O	S	X
DTMF autodialer	X	S	S	S
9600-bit/s packet–ready	S	X	S	S
Dedicated TNC jack	S	X	S	S
Crossband repeat	S	S	S	S
Mir/OSCAR 27–ready	S	X	S	S
Detachable front panel	X	S	S	X
Dual speaker jacks	X	S	S	S
Manufacturer's suggested retail price	$512	$857	$1050	$700
Typical selling price as of 10/96†	$453	$700	$ 880	$542

Key
S = Standard
O = Optional
X = Not available
†Typical selling prices represent an average of street prices obtained from three equipment retailers, exclusive of any sales, coupons or rebates.

Alinco DR-605T, serial no. T000646.

Manufacturer's Specifications	*Measured in ARRL Lab*
Frequency coverage: Receive, 136-174, 420-470 MHz; transmit, 144-148, 430-450 MHz.	Receive, approximately 135-173, 400-490 MHz (with some loss of sensitivity at UHF band limits); transmit, as specified.
Power requirements: At 13.8 V dc: Receive, 1.2 A (max); transmit, 11.5 A (max).	At 13.8 V dc: Receive, 0.7 A (max volume, no signal); transmit, 146 MHz, 9.0 A (max); 440 MHz, 7.5 A (max).

Size (height, width, depth): 1.6×5.6×7.3 inches; weight, 2.4 lb.

Receiver	*Receiver Dynamic Testing*
Sensitivity: For 12-dB SINAD, 0.16 μV or less.	For 12-dB SINAD: 146 MHz, 0.16 μV; 440 MHz, 0.20 μV.
Two-tone, third-order IMD dynamic range: Not specified.	20-kHz offset from 146 MHz, 68 dB;* 20-kHz offset from 440 MHz, 64 dB;* 10-MHz offset from 146 MHz, 91 dB; 10-MHz offset from 440 MHz, 77 dB.
Adjacent-channel rejection: Not specified.	20-kHz offset from 146 MHz, 68 dB; 20-kHz offset from 440 MHz, 64 dB.
IF rejection: Not specified.	146 MHz: 88 dB; 440 MHz: ≥134 dB.
Image rejection: Not specified.	146 MHz: 76 dB; 440 MHz: 76 dB.
Squelch sensitivity: 0.1 μV or less.	146 MHz: 0.07 μV at threshold. 440 MHz: 0.06 μV at threshold.
Audio output: ≥2 W at 5% THD into 8 Ω.	2 W at 5% THD into 8 Ω.
Transmitter	*Transmitter Dynamic Testing*
Power output: 146 MHz, 50 / ≈5 W; 440 MHz, 35 / ≈5 W.	146 MHz: 50 / 5.5 W; 440 MHz: 34 / 3.6 W.
Spurious signal and harmonic suppression: 60 dBc or greater.	As specified. Meets FCC requirements for spectral purity.
Transmit-receive turnaround time (PTT release to 50% of full audio output): Not specified.	146 MHz: Squelch on, 140 ms. 440 MHz: Squelch on, 140 ms.
Receive-transmit turnaround time ("Tx delay"): Not specified.	146 MHz, 80 ms; 440 MHz, 83 ms.
Bit-error rate (BER), 9600 baud: Not specified	146 MHz: Receiver: BER @ 12 dB SINAD, 5.2×10^{-4}; BER @ 16 dB SINAD, 1.0×10^{-5}; BER @ –50 dBm, $<1.0\times10^{-5}$. Transmitter: BER @ 12-dB SINAD, 8.4×10^{-3}; BER @ 12-dB SINAD + 30 dB, 4.4×10^{-3}. 440 MHz: Receiver:BER @ 12-dB SINAD, 5.9×10^{-4}; BER @ 16-dB SINAD, 1.4×10^{-5}; BER @ –50 dBm, $<1.0\times10^{-5}$. Transmitter: BER @ 12-dB SINAD, 3.7×10^{-3}; BER @ 12-dB SINAD + 30 dB, 3.4×10^{-4}.

NOTE: For optimal receive performance: BER @ –50 dBm, 1.0×10^{-5} or less; for optimal transmit performance: BER @ 12-dB SINAD + 30 dB, 1.0×10^{-5} or less.

*Measurement was noise-limited at the value indicated.

Reviewers judged the readability of the display as adequate. It's visible in most conditions and at all angles except from below, but you can't change the display's brightness. The only display-related flaw involves the upside-down mirror images of button legends that appear to be reflections from the bottom edge of the plastic bezel. They're very visible when viewing the radio from above.

You won't be able to listen to AM aircraft transmissions with the DR-605T, but it *does* offer extended 70-cm coverage, which places the OSCAR 27 and *Mir* repeaters at your disposal. Using the transceiver's mainband transmit/subband receive function we made several contacts through OSCAR 27 while mobile and portable.

Speaking of listening, the DR-605T uses a *programmed* squelch that you can access only by pressing the **FUNC**tion button, then using the left and right **VOL** buttons to raise or lower the squelch setting for the main and subbands. This was not a hit with users. Unless you set the squelch somewhat high to begin with and are content to leave it that way, this feature can be quite annoying. The DR-605T also does *not* have automatic repeater offset, a common feature these days; you have to set it manually.

Packet operation at both 1200 and 9600 baud is possible with the DR-605T, but during ARRL Lab testing, we found we could not achieve more than 1.8 kHz deviation in the 9600-baud packet mode (see table). The TNC installation scheme is a little odd. The manual advises you to connect 1200-baud TNCs to the microphone jack. For 9600-baud packet, however, you are directed to the rear-panel jacks. One is a data input/output jack using a small stereo plug. The other is the external speaker jack which does double duty as the PTT (push to talk) keying port! If your 1200-baud TNC has a sufficiently high transmit audio level and decent receive audio sensitivity, you can wire it to the DR-605T via the rear panel. The manual doesn't mention this, however.

Like most modern FM rigs, the DR-605T has a built-in CTCSS encoder along with a DTMF encoder operated from the microphone keypad. You can purchase an optional CTCSS decoder for paging and "tone scanning." Curiously, DTMF decoding (for selective calling and other functions) is *not* an option offered for the DR-605T.

On-the-air reports confirmed that the DR-605T's transmit audio was clean and clear. Given the small speaker, the receive audio was remarkably good. It did not distort even at high volume levels.

Other features that won reviewer praise included the crossband repeater mode, versatile scanning functions and easy memory programming. Writing to memory is very easy, almost *too* easy. If you're not careful, you can inadvertently fill all the available memory channels! When you press the **FUNC** button, it automatically selects the last memory channel you were using. Then, if you accidentally press **MW** instead of, say, **SHIFT**, you've just put the current VFO settings into that memory position.

The high-power settings were fine for mobile operating on both 2 meters and 70 cm. If you feel the need to reduce the power level, dropping back to 5 W is a front-panel option.

Manufacturer: Alinco Electronics Inc, 438 Amapola Ave, Suite 130, Torrance, CA 90501; tel 310-618-8616. Manufacturer's suggested retail price, $530.

ICOM IC-2710H

The IC-2710H is a sleek 2-meter/70-cm radio that you can install in any automobile. It's also a rugged radio. The entire top and back of the rig are dominated by a hefty heat sink, which is bolstered by a small

ICOM IC-2710H, serial no. 01117

Manufacturer's Specifications	*Measured in ARLL Lab*
Frequency coverage: Receive, 118-174, 440-450 MHz; transmit, 144-148, 440-450 MHz.	Receive, as specified; transmit, 140-150, 440-450 MHz.
Power requirements: At 13.8 V dc: Receive, 1.8 A (max); transmit, 12 A (max).	At 13.8 V dc: Receive, 1.1 A (max volume,) no signal); transmit, 10.3 A (max).
Size (height, width, depth): 1.6×5.5×8.5 inches; weight, 3.1 lb.	
Receiver	*Receiver Dynamic Testing*
Sensitivity: For 12-dB SINAD, less than 0.16 μV.	For 12-dB SINAD: 146 MHz, 0.12† μV; 440 MHz, 0.14† μV. AM (120 MHz): 0.35 μV for 10-dB (S+N)/N.
Two-tone, third-order IMD dynamic range: Not specified.	20-kHz offset from 146 MHz, 59 dB; 20-kHz offset from 440 MHz, 62 dB;* 10-MHz offset from 146 MHz, 74 dB; 10-MHz offset from 440 MHz, 76 dB.
Adjacent-channel rejection: Not specified.	20-kHz offset from 146 MHz, 64 dB; 20-kHz offset from 440 MHz, 62 dB.
Spurious response: 60 dB or greater.	IF rejection: 146 MHz, 107 dB; 440 MHz, ≥136 dB. Image rejection: 146 MHz, 90 dB; 440 MHz, 89 dB.
Squelch sensitivity: less than 0.13 μV at threshold.	146 MHz: 0.05 μV at threshold. 440 MHz: 0.08 μV at threshold.
Audio output: More than 2.4 W at 10% THD into 8 Ω.	2.8 W at 10% THD into 8 Ω.
Transmitter	*Transmitter Dynamic Testing*
Power output: 146 MHz: 50 / 10 / 5 W; 440 MHz: 35 / 10 / 5 W.	146 MHz: 53 / 11 / 5 W; 440 MHz: 33 / 9 / 5 W.
Spurious signal and harmonic suppression: 60 dBc or greater .	As specified. Meets FCC requirements for spectral purity.
Transmit-receive turnaround time (PTT release to 50% of full audio output): Not specified.	146 MHz: Squelch on, 118 ms. 440 MHz: Squelch on, 118 ms.
Receive-transmit turnaround time ("Tx delay"): Not specified.	146 MHz: 150 ms; 440 MHz: 145 ms.

†Default main receiver performance. Subband receiver performance was comparable.

*Measurement was noise-limited at the value indicated.

cooling fan on the back panel. The fan ran with the radio cool; the radio did not get hot even with long transmissions.

The rather stylish front panel is also detachable (you'll need an optional separation cable). In fact, you *must* detach it to connect the microphone.

The HM-98 microphone supplied with the radio offers tremendous flexibility. Once you remove the cover to expose the DTMF keypad, you can control most of the radio's important functions from the microphone, including direct frequency entry (not something you should try while under way, however). For example, changing bands from the mike is as easy as thumbing the **BAND** button. Function buttons **F1** and **F2** can be programmed to duplicate any front-panel buttons. The DTMF buttons automatically put the active band into transmit and provide audible feedback of the tone. The microphone buttons are backlighted for nighttime operation. An optional infrared wireless microphone system (HM-90 transmitter and EX-1759 receiver) is available for the IC-2710H, but it wasn't tested for this review.

The wired HM-98 microphone uses the increasingly popular RJ11-style jack, or what some refer to as a "telephone jack," and it plugs into the "body" of the transceiver, behind the front panel. In labeling the pin connections, the manual labels one conductor as **DATA IN**. This is obviously for packet operation (no doubt the transmit audio input), but the book doesn't provide further clues. Because there isn't a **DATA OUT** jack on the rig, we're left to assume that you'd have to pick up your packet receive audio from one of the speaker jacks. That implies that the IC-2710H is suitable for 1200-baud packet only.

There are two separate tuning knobs, always a welcome sight on a multiband transceiver. You can designate one to control the main-band frequency and the other to control the subband. (You can transmit only from the main band.) When the transceiver is in the memory mode, twisting the tuning knobs steps you through the memory channels. The tuning knobs also control scan direction. ICOM uses separate VHF and UHF RF receive circuits for both sides of the display, so you can dial up two VHF or two UHF frequencies at the same time and expect comparable receiver performance of either side. The IC-2710H also features separate **SQUELCH** and **VOLUME** controls—one set for each band—adjacent to the tuning knobs.

Other front-panel push buttons control DTMF encoding (on/off), CTCSS encoder (on/off), memory, scanning, VFO step size and so on. Our reviewers praised the fact that these switches—like the tuning knobs—are arranged in duplicate "banks" on the right- and left-hand sides of the panel. In other words, each band has its *own* bank of switches; and each side of the display is essentially a mirror image of the other, with the power switch right smack in the middle. This goes a long way toward reducing operator confusion! Display visibility is good, except it fades somewhat when viewed from above, and considerably from below.

The IC-2710H is packed to the brim with features, but there are several that our reviewers found particularly useful. The ability to receive AM signals in the aeronautical band can provide some entertaining listening, although you must select the AM detector manually. Sub-band muting kills the sub-band audio if the main band is active at the same time. The priority watch function does more than just monitor a single memory channel for activity. You can set the watch to scan *all* memory channels while you monitor other activity with the VFO.

The IC-2710H offers separate jacks for dual speakers. That's a nice arrangement if you need to listen to 2 meters in one speaker and 70 cm in another. Otherwise, you can simply use the radio's single downward-firing speaker.

Among the only negative comments about the IC-2710H concerned the fact that it cannot operate below 440 MHz. Many hams are discovering the powerful 70-cm FM repeater aboard the Russian *Mir* space station as well as the FM repeater on the OSCAR 27 satellite, but both systems operate well below 440 MHz—and beyond the range of the IC-2710H.

There are two optional modules for the IC-2710H that are worth considering. The UT-49 is a DTMF decoder that provides pager and code-squelch functions. It also allows you to use DTMF tones to control an IC-2710H remotely. The UT-104 is a CTCSS decoder that also offers tone squelch functions, "pocket beep" (to find out if someone paged you while you were away) and the ability to decode and display the frequencies of CTCSS tones. The latter feature is quite useful when you're trying to determine which CTCSS tone a repeater system is using to control access, provided the repeater retransmits the CTCSS tone, or you can hear a ham on the input frequency.

Manufacturer: ICOM America Inc, 2380 116th Ave NE, Bellevue, WA 98004; tel 206-454-7619. Manufacturer's suggested retail price: $857; EX-1759 wireless mike receiver, $88; HM-90 wireless mike, $167; OPC-600 separation kit, $36.

Standard C5900DA

The Standard C5900DA is the only triple-bander in the group, and the only FM mobile on the market that offers standard FM coverage on 6 meters, 2 meters and 70 cm—the three most popular VHF/UHF bands. In addition, the C5900DA has impressive receive coverage—all the way up to around 1019 MHz—and it produced impressive ARRL Lab test results (see table). One notable exception was the +4 dB image rejection we measured at 902 MHz. With its extended transmit/receive range on 70 cm (all the way down to 420 MHz on transmit), you can use the C5900DA to work the *Mir* space station repeater. One reviewer enjoyed a chat through the repeater with a fellow mobiler 500 miles away. While scanning outside the ham bands, another chanced to eavesdrop on what he said sounded like an FBI operation that included some scrambled transmissions.

The C5900DA is big, but it's also lightweight. This transceiver has a detachable front panel, so mounting it in any vehicle should be no problem. Its mike cord already is pretty long, and various extender cables are available—the longer ones include connections for the mike and the speaker. You also can control this unit remotely via the DTMF pad on your H-T! Although it has a tendency to get quite warm during long chats, a sizable cooling fan on the rear panel protects vital components.

With its large size comes a large, easy-to-read LCD display. As with most mobile transceivers, it's best to install the rig (or the front panel) tilted upward at an angle for best visibility, since the display washes out when viewed from below. Standard offers a display mounting bracket (CMB5900) that makes this easy to do. When you're cruising down the Interstate, you won't have to fumble for a hook to hang the microphone. The mike is equipped with a *big* ring—big enough to fit easily over most automotive dashboard knobs, or even over the turn-signal lever if you like! It flips over for a smaller hook.

The single feature of the C5900DA that *really* drew raves was the set of *hyper memory* buttons. These are terrific—just like the push buttons on your car radio. (Why didn't someone think of this sooner?) They provide one-touch memory programming: after you get your settings on the VFO, just press and hold the button for two seconds and you're done. *Hypermemory* stores a left band *and* a right band channel in each memory. If you become a C5900DA owner, we predict you'll use these a *lot*! Storing data in the conventional memories was less convenient, but you can copy from one memory to another and protect memories from overwriting. Another handy feature is the one-touch **SCN** button. The radio offers two scanning speeds, something you don't see much. The RF squelch, which lets you set the squelch according to received signal strength, is a nice touch, and it's neatly implemented.

Like many radios with lots of front-panel control and buttons, the C5900DA could offer a challenge to those with big hands. The front panel is very handsome,

Standard C5900DA, serial no. 64U 020061

Manufacturer's Specifications	*Measured in ARRL Lab*
Frequency coverage: Receive and transmit, 50-54, 144-148, 420-450 MHz.	Receive, approximately 40-100, 100-227, 246-520, 550-1019 MHz (cellular freqs blocked) with decreased sensitivity noted at some band extremes; transmit, as specified.
Power requirements: At 13.8 V dc: Receive, 0.75 A (standby); transmit, 12 A (max).	At 13.8 V dc: Receive, 0.8 A (max volume, no signal); transmit, 8.9 A (max).
Size (height, width, depth): 1.6×5.6×6.9 inches; weight, 2.6 lb.	
Receiver	*Receiver Dynamic Testing*
Sensitivity: 50 MHz, less than 0.25 μV; 144 MHz, less than 0.22 μV; 440 MHz, less than 0.25 μV.	For 12-dB SINAD: 50 MHz, 0.15 μV; 146 MHz, 0.15 μV; 440 MHz, 0.18† μV†; AM (120 MHz): 1.4 μV for 10-dB (S+N)/N.
Two-tone, third-order IMD dynamic range: Not specified.	20-kHz offset from 50 MHz, 64 dB;* 20-kHz offset from 146 MHz, 68 dB;* 20-kHz offset from 440 MHz, 64 dB;* 10-MHz offset from 50 MHz, 97 dB. 10-MHz offset from 146 MHz, 89 dB. 10-MHz offset from 440 MHz, 87 dB.
Adjacent-channel rejection: Not specified.	20-kHz offset from 50 MHz, 64 dB; 20-kHz offset from 146 MHz, 68 dB; 20-kHz offset from 440 MHz, 64 dB.
IF rejection: Not specified.	50 MHz: 64 dB; 146 MHz: 94 dB; 440 MHz: 125 dB.
Image rejection: Not specified.	50 MHz: 79 dB; 146 MHz; 89 dB; 440 MHz, 54 dB.
Squelch sensitivity: 0.16 μV.	50 MHz: 0.09 μV at threshold. 146 MHz: 0.08 μV at threshold. 440 MHz: 0.12 μV at threshold.
Audio output: 3 W at 10% THD (no load specified).	4.4 W at 10% THD into 4 Ω.
Transmitter	*Transmitter Dynamic Testing*
Power output: 50 MHz: 45 / 10 / 3 W; 146 MHz, 50 / 10 / 3 W; 440 MHz, 35 / 10 / 3 W.	50 MHz, 42 / 10 / 3; 146 MHz, 49 / 10 / 3 W; 440 MHz, 32 / 9.5 / 3 W.
Spurious signal and harmonic suppression: 60 dBc or greater.	As specified. Meets FCC requirements for spectral purity.
Transmit-receive turnaround time (PTT release to 50% of full audio output): Not specified.	50 MHz: squelch on, 118 ms; 146 MHz: Squelch on, 105 ms; 440 MHz: Squelch on, 105 ms.
Receive-transmit turnaround time ("Tx delay"): Not specified.	50 MHz: 78 ms; 146 MHz: 60 ms; 440 MHz: 60 ms;
Bit-error rate (BER), 9600 baud: Not specified.	50 MHz: Receiver: BER @ 12-dB SINAD, 1.0×10^{-3}; BER @16-dB SINAD, 3.3×10^{-5}; BER @ –50 dBm, $<1.0\times10^{-5}$. Transmitter: BER @ 12-dB SINAD, 7.1×10^{-4}; BER @ 12-dB SINAD + 30 dB, $<1.0\times10^{-5}$. 146 MHz: Receiver: BER @ 12-dB SINAD, 5.7×10^{-4}; BER @ 16-dB SINAD, 1.5×10^{-5}; BER @ –50 dBm, $<1.0\times10^{-5}$. Transmitter: BER @ 12-dB SINAD, 1.3×10^{-3}; BER @ 12-dB SINAD + 30 dB, 2.2×10^{-5}. 440 MHz: Receiver: BER @ 12-dB SINAD, 3.5×10^{-4}; BER @ 16-dB SINAD, 2.7×10^{-5}; BER @ –50 dBm, $<1.0\times10^{-5}$. Transmitter: BER @ 12-dB SINAD, 3.9×10^{-4}; BER @ 12-dB SINAD + 30 dB, $<1.0\times10^{-5}$.

NOTE: For optimal receive performance: BER @ –50 dBm, 1.0×10^{-5} or less; for optimal transmit performance: BER @ 12-dB SINAD + 30 dB, 1.0×10^{-5} or less.

†Default main receiver performance. Subband receiver performance was comparable.

*Measurement was noise-limited at the value indicated.

and the radio offers separate tuning controls and concentric **SQL** (squelch) and **VOL**ume controls. The **SQL** control serves a dual function: You press each **SQL** button to make that "side" of the radio the **MAIN** band. The radio can receive two VHF or two UHF signals at the same time. The **PWR** button—on its own protuberance on the far left—could have been more conveniently positioned. Some ops complained that it was too easy to hit more than one button at the same time on the busy front panel. Others would have liked it better if Standard had swapped the **SQL** and **VOL** controls, making the **VOL** control the inner control (and making it longer) and the **SQL** control the outer ring. As it is, the **SQL** controls aren't much more than little bumps, which one op called "impossible." This panel is better suited to dainty fingers.

Our reviewers liked the implementation of the **SQL OFF** button on the mike. It's like a "monitor" button, but, in the C5900DA, you can set the menu to make it double as a "reverse" button for repeater work (this is the factory default). It's also a toggle, instead of a press-and-hold button. This handy switch eliminates the need to fumble for a reverse button if you want to see if a station you're talking to on the repeater is within simplex range, but you might find it's easy to hit this button inadvertently while holding the mike in your right hand.

The **F**unction key is well-implemented. When you press **F**, the subfunction legends pop up on the display behind each button (there is a row below the display), and they're in "reverse video" (ie, light characters on a dark background). This way, you always know exactly what you're about to do!

The C5900DA rounds out its plethora of features with a dedicated packet data jack (using a 6-pin mini-DIN connector) with operation at 1200 or 9600 baud. The manual devotes several pages to a description of TNC interconnections for the C5900DA. The rig offers CTCSS and DTMF encoding and decoding, as well as AM reception when you tune through the aeronautical band (the AM detector is selected automatically). If the C5900DA's 80 memories on each band are not enough, you can buy the optional CMU161 200-channel memory chip.

Audio reports on transmit were good, but we got a few reports that the audio was a bit on the "hot" side, though not distorted. Backing away from the mike seemed to help. One station described it as "really bright and really loud." Receive audio was fine and natural-sounding on the internal speaker.

This is a fairly complex rig (what tribander wouldn't be?), but the manual helps you navigate the features with ease. It could use a "quick start" section, however.

Manufacturer: Standard Amateur Radio Products Inc, Box 48480, Niles, IL 60714; tel 773-763-0081; fax 773-763-3377. Manufacturer's suggested retail price, $1049. CAW591 LCD display extension, $40; CMU161 200-channel memory chip, $48; CMB5900 display mounting bracket, $27.

Yaesu FT-8000R

The FT-8000R is a surprisingly compact dual-bander, despite the fact that it offers 50 W output on 2 meters and 35 W on 70 cm. It offered the widest receive coverage of the pack, allowing you to eavesdrop from around 110 MHz all the way to 1.3 GHz (cellular telephone frequencies are blocked, of course). You can elect to receive on both bands simultaneously, or on two frequencies within the same band. The Yaesu FT-8000R is built to MIL-STD 810 standards for endurance and weatherproofing.

Our review team enjoyed the large, bright *Omni-Glow* display, which takes up most of the front panel and is readable from any viewing angle. This is the largest display of the four transceivers we reviewed. The brightness of the display is variable.

Yaesu FT-8000R, serial no. 6G021530

Manufacturer's Specifications	***Measured in ARRL Lab***
Frequency coverage: Receive, 110-550, 750-1300 MHz (cellular freqs blocked); transmit, 144-148, 430-450 MHz.	Receive, Approximately 112-550, 750-1300 MHz (cellular freqs blocked), with decreased sensitivity noted at some band extremes; transmit, as specified.
Power requirements: At 13.8 V dc: Receive, <1 A (max); transmit, 11.5 A (max).	At 13.8 V dc: Receive, 0.8 A (max volume, no signal); transmit, 8 A (max).
Size (height, width, depth): 1.6×5.6×6.1 inches; weight, 2.2 lb.	
Receiver	*Receiver Dynamic Testing*
Sensitivity: For 12-dB SINAD, main receiver, <0.18 μV;	For 12-dB SINAD: 146 MHz, 0.19 μV†; 440 MHz, 0.17 μV; AM (120 MHz): 0.8 μV for 10-dB (S+N)/N;
Two-tone, third-order IMD dynamic range: Not specified.	20-kHz offset from 146 MHz, 67 dB; 20-kHz offset from 440 MHz, 67 dB; 10-MHz offset from 146 MHz, 84 dB. 10-MHz offset from 440 MHz, 82 dB.
Adjacent-channel rejection: Not specified.	20-kHz offset from 146 MHz, 67 dB; 20-kHz offset from 440 MHz, 67 dB.
IF rejection: Not specified.	146 MHz: 82 dB; 440 MHz: >135 dB.
Image rejection: 70 dB or greater.	146 MHz: 78 dB; 440 MHz: 95 dB.
Squelch sensitivity: Better than 0.13 μV.	146 MHz: 0.12 μV at threshold; 440 MHz: 0.10 μV at threshold.
Audio output: 2 W at 5% THD into 8 Ω.	2.1 W at 5% THD into 8 Ω.
Transmitter	*Transmitter Dynamic Testing*
Power output: 146 MHz: 50 / 10 / 3 W; 440 MHz: 35/ 10 / 3 W.	146 MHz: 52 / 9.5 / 4.7 W; 440 MHz: 34 / 13 / 4.5 W.
Spurious signal and harmonic suppression: 60 dBc or greater .	As specified. Meets FCC requirements for spectral purity.
Transmit-receive turnaround time (PTT release to 50% of full audio output): Not specified.	146 MHz: Squelch on, 85 ms. 440 MHz: Squelch on, 80 ms.
Receive-transmit turnaround time ("Tx delay"): Not specified.	146 MHz: 50 ms; 440 MHz: 50 ms.
Bit-error rate (BER), 9600 baud:	146 MHz: Receiver: BER @ 12-dB SINAD, 1.3×10^{-3}; BER @ 16-dB SINAD, 7.1×10^{-5}; BER @ –50 dBm, $<1.0\times10^{-5}$. Transmitter: BER @ 12-dB SINAD, 4.1×10^{-3} BER @ 12-dB SINAD + 30 dB, 7.2×10^{-5}. 440 MHz: Receiver: BER @ 12-dB SINAD, 1.0×10^{-3}; BER @ 16-dB SINAD, 6.4×10^{-5}; BER @ –50 dBm, $<1.0\times10^{-5}$. Transmitter: BER @ 12-dB SINAD, 7.8×10^{-3}; BER @ 12-dB SINAD + 30 dB, 4.7×10^{-4}.

NOTE: For optimal receive performance: BER @ –50 dBm, 1.0×10^{-5} or less; for optimal transmit performance: BER @ 12-dB SINAD + 30 dB, 1.0×10^{-5} or less.

†Default main receiver performance. Subband receiver performance was comparable.

There are separate concentric **VOL**ume and **SQL** (squelch) controls for each side of the display; press the left or right **VOL** knob, and the radio shows you the dc supply voltage. The front panel features a single tuning knob that doubles to select memories and function settings. For big excursions, pressing the tuning knob increases the tuning rate—depending on how long you press. A row of eight multifunction buttons, each with an LED, is below the display. The correct legend for each appears on the display window above the appropriate button. The FT-8000R also won praise for its implementation of an RF squelch that uses the S-meter level to determine the squelch's "break" point.

Yaesu's *Intelligent Band Display* was another nice touch: A blinking green LED on each side lets you know when that particular receive channel is active (handy if the volume is turned down). This same LED turns red when you transmit, or remains steady on the main-band side when no signal is heard (you also can turn off this function if you'd like). The front-panel **CNTL** button lets you change the sub-band display without changing the status of the main band. Alternately, you can use this button to set up VHF-VHF or UHF-UHF operation.

The FT-8000R provides 55 memory channels per band (54 conventional channels plus a call or *HOME* channel) to store frequencies, repeater shifts (including odd offsets) and CTCSS tones. If you're traveling in strange territory, or if you're using the rig for the first time, you can press the **SCH** button on the front panel to use the FT-8000R's *Enhanced Smart Search* feature to automatically sweep through each band and store active frequencies in 50 dedicated memories (25 above the starting point and 25 below)! You can set it up to search all or part of a band. It lets you do multiple sweeps, too, an improvement over the *Smart Search* implementation in the single-band Yaesu FT-3000M (see "Product Review," *QST*, Nov 96), which would overwrite its 20 dedicated memories on subsequent sweeps once they were filled.

The FT-8000R provides separate speaker outputs for both bands, a nice touch for mobile or base installations. The upward-firing internal speaker provided adequate audio.

The FT-8000R is equipped for 1200 or 9600-baud packet via a mini-DIN jack on the rear panel. There is no need to disconnect the microphone jack when you're running packet. When your TNC goes into the transmit mode, the microphone audio path is automatically interrupted.

Our review team found the FT-8000R simple to program. If you have a computer running Microsoft *Windows*, you can purchase the optional Yaesu *ADMS-2C* software (includes connecting cable) and program the radio entirely from your PC keyboard. Setting up a rig doesn't get much easier than that!

CTCSS and DTMF encoding is standard in the FT-8000R. If you want CTCSS *decoding*—including the "bell" function that alerts you to incoming calls—you must buy the FTS-22 module. DTMF decoding is not offered in the FT-8000R.

The MH-36B microphone—similar to the one that came with the single-band FT-3000M—is nice and large and plugs into the front panel. It has lighted DTMF keypad buttons as well as **ACC** and **VFO/MR** buttons. You use the **ACC** button to change bands on the FT-8000R. The mike also sports three user-programmable buttons (**P, P1** and **P2**), but, as the manual explains, these don't work when the MH-36B is hooked up to an FT-8000R. Direct frequency entry is not available.

While the wide receive frequency coverage was considered a plus—it includes the ham allocations at 222 MHz, 902 MHz and 1240 MHz—the FT-8000R receiver was not especially sensitive in some parts of its expanded range. ARRL Lab tests showed that sensitivity was 7.4 µV on 222 MHz and got worse in places as the rig was tuned upward in frequency. It was a meager 18.2 µV on 1240 MHz. The radio hears *much* better on 2 meters and 70 cm, and it automatically switches to the AM mode below 137 MHz.

The cooling fan on the rear apron is a bit noisy and ran at times when the radio was stone cold. But the radio never even got warm on long transmissions at full power.

If a "friendly" manual is a valuable asset to any radio—and we believe it is—the Yaesu FT-8000R wins hands down. Nearly everything about the rig is explained in clear, easy-to-understand terminology. This is important when you're grappling with a full-featured transceiver such as the FT-8000R. But the manual authors went much farther. Imagine an instruction manual that explains crossband repeater operating with the proviso—in bold italic type, no less—that you should contact your local frequency coordinators first. For the most part, the FT-8000R manual is a model for others to follow. One shortcoming: It fails to explain how to manually shift to AM mode.

Manufacturer: Yaesu USA, 17210 Edwards Rd, Cerritos, CA 90703; tel 310-404-2700. Manufacturer's suggested retail price, $700. *ADMS-2C* programming software, $39; FTS-22 CTCSS decoder module, $65.

Timewave DSP-599zx Digital Signal Processor

Reviewed by Paul Danzer, N1II
Assistant Technical Editor

Even though it was just about the time a coastal storm was predicted to pass by, I certainly didn't think twice about going on the air, especially since the 1996 IARU HF World Championship contest was in full swing. The rig was already tuned to 40 CW, so I hit the power switch and jumped—I had forgotten how much QRN accompanies these storms. The rain and wind had disappeared, but not the noise.

Fortunately, I had the new Timewave DSP-599zx installed. I turned it on, adjusted the audio gain control on my venerable Yaesu FT-901 to light the yellow LED on the DSP's front panel, and pressed **RANDOM** (for random noise reduction). The difference was dramatic! The noise was almost completely gone, and suddenly I was able to hear a few European stations calling "CQ TEST." I worked a couple and then, under the QRM and QRN, was a VK—at 6 PM local time in July. No, I didn't work him, but I *heard* him, no small feat in itself, espe-

BOTTOM LINE

The DSP-599zx earns high marks for its filter characteristics, noise reduction, and ease of operation. A *superb* station accessory!

Table 1
Timewave DSP-599zx Audio Noise Reduction Filter, serial number 31255

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Power requirements: 12-16 V at 1 A (max).	As specified. Tested at 13.8 V.
Size (HWD): 1.9×7.6×8.5 inches; weight: 2.5 lb.	
Frequency response:	
CW, 10-600 Hz; attenuation, 55 dB at 60 Hz outside passband	Range at –6-dB points, (bandwidth): at 600 Hz, 384-1020 Hz (636 Hz);* at 500 Hz, 434-973 Hz (539 Hz); at 100 Hz, 634-771 Hz (137 Hz); at 10 Hz, 689-716 Hz (27 Hz).
Voice: High-pass, 100-1000 Hz; low-pass, 1000-5000 Hz; attenuation, 60 dB at 180 Hz outside passband.	300/1800 Hz, 268-1843 Hz (1575 Hz); 300/2100 Hz, 267-2145 Hz (1878 Hz); 100/5000 Hz (max), 47-5050 Hz (5003 Hz).
RTTY: 60-600 Hz; mark/space bandwidth, 60-100 Hz; center frequency, 2210 Hz, plus option of 1300, 1360, 1530, 1700 or 2125 Hz; attenuation, 40 dB at 60 Hz outside passband.	2210/170 Hz; center frequency, 2140 Hz: 2080-2190 Hz (110 Hz); center frequency 2300 Hz: 2250-2360 (110 Hz).
AMTOR, SITOR: Same as RTTY.	Center frequency, 2210 Hz; shift, 200 Hz: 2200-2040 Hz (160 Hz).
PACTOR: Same as RTTY.	Center frequency, 2210 Hz; shift, 200 Hz: 2000-2205 Hz (205 Hz).
SSTV: 1100-1300 Hz and 1500-2300 Hz; attenuation, 50 dB at 75 Hz outside passband.	1100-1300 Hz; 1500-2300 Hz: 1070-1330 Hz (260 Hz); 1480-2340 Hz (860 Hz).
Random noise reduction: Up to 20 dB; varies with noise characteristics.	As specified.
Notch rejection: up to 50 dB; varies with noise characteristics.	Manual notch, ≥50 dB; automatic notch, ≥45 dB.
Time to notch: 5 ms.	≈7.5 ms to 50% points on oscilloscope.
Filter shape factor: Not specified.	(–60 dB/–6 dB): Voice (typical), 1.07:1; CW (typical) 1.1:1.
Input/output delay: Voice (HP and LP), 24 ms; CW (BW >20Hz), 40 ms; Data (FSK), 38 ms; Data (fixed) 20 ms.	CW, 40 ms; voice, 24 ms; data, 37 ms.
Audio output power: 1 W into 8 Ω; 1.5 W into 4 Ω, (THD not specified).	1.3 W at 7.5% THD into 8 Ω; 2 W at 10% THD into 4Ω.
Test instrument functions:	
Audio generator: single or two-tone, single sine wave tunable, 20 Hz to 10 kHz; two-tone, 700 Hz plus 1900 Hz:	As specified.
Audio millivoltmeter: true RMS from 1 mV to 2000 mV, 20 Hz to 10 kHz:	As specified.
CTCSS encoder-decoder: Decodes and displays CTCSS tone, 67.0 Hz to 254.1 Hz.	As specified.

*All CW tests made at 700-Hz center frequency.

cially from my location 300 feet from a major parkway!

During subsequent on-the-air testing, weak stations were worked that might otherwise not even have been heard because of the noisy conditions and QRM. It even yielded excellent results with the transceiver's crystal filter in its widest position, relying only on the DSP-599zx.

The Timewave DSP-599zx is the third DSP box I have had in my shack. The first, several years ago, came from a different manufacturer and belonged to a local ham who wanted me to verify how bad it was—and it was! The filtering was pretty good and the noise reduction fair, but it had no margin on dynamic range. A very small input signal increase overloaded the filter, and the result was garble. In preparation for *The ARRL Handbook* (1996), I also tested the W9GR DSP. No question, the state of the art had advanced. That relatively low-priced unit was a good addition to the shack, and I returned it with reluctance.

Real hams don't read instruction books, so the first thing to do is wire it up and turn it on! The power jack was labeled, so I could not connect the 12-V supply backward. Connectors for two channels of audio—**A** and **B**—were on the back panel. Well, you can't go wrong by choosing channel **A** for both **AUDIO INPUT** and **SPEAKER OUTPUT**. So far, so good.

Next, a quick look at the front panel. There's a neat 2-line-by-16-character backlighted alphanumeric display window that shows mode and settings, so you know right away what you're doing. There is a **GAIN** control with an "off" position, so turn it on and the display reads *Initializing*, followed by a two-line message. The first line is *VCE*, which I guessed stood for "voice." The second line said *HP 300 —2700 LP*. The other two front panel knobs were labeled **HIGH PASS/CENTER FREQ** and **LOW PASS/BANDWIDTH**, so I think we have broken the code. Tune in a sideband station in QRM alley (here, about 14,300 kHz) and start turning knobs.

The DSP-599zx passed my first test—can I figure out how to turn it on? For people like me—and perhaps you—the instruction manual has a one-page summary right up front. It starts by saying: "Here is the absolute minimum information you need to get started," So I guess I am not alone.

DSPs, Yes or No?

The primary advantage of a well-designed DSP box is a good filter. The primary *disadvantage* is the filter's location—in the transceiver's audio output line—where it cannot undo any mixing of signals and AGC action that occurs inside the receiver itself. The Timewave DSP-599zx is no different; if the interfering signal and the desired signal are within the dynamic range of the receiver (by whatever definition), then the signals will not mix. In this case, unwanted signals may be attenuated by as much as 60 dB with little perceptible distortion, which makes this filter seem like a dream, compared to what was available a few short years ago.

Analog-to-digital (A/D) range is one of the key numbers used to compare the models of different manufacturers. Timewave uses a 16-bit A/D converter, and the performance is naturally better than earlier units with 10-bit A/Ds. The other key number is the processor speed, and Timewave claims a capacity of 36.8 million instructions per second (MIPS). As with many computer numbers, the *real* test is not only the processing speed, but the algorithms

(mathematical equations) used and the resulting performance. Certainly a DSP with a higher MIPS capability will be able to implement a better filter, all other things being equal.

It's Fast, But What Can It Do?

The answer in a nutshell: The DSP-599zx can make interfering signals disappear. With a moderately strong signal, but not one driving my receiver to saturation, the filter provides what DSP proponents (and filter manufacturers) like to call a *brick wall.* As an example, in the *Data* mode, the mark/space bandwidth can be set as small as 60 Hz. Tune 60 Hz up or down from the initial frequency, and the claimed 40-dB rejection makes the signal go away, in actual on-the-air tests. Although I could not find a live example on the air, two 170-Hz shift RTTY signals could be interlaced (ie, mark 1, mark 2, space 1, space 2) and this filter would probably separate them!

One of the best features of this unit is that the LCD window, which displays the mode and the low-cut and high-cut frequencies (or, alternately, the notch frequency and notch width). Unlike most other units, the **HIGH PASS/CENTER FREQ** and **LOW PASS/BANDWIDTH** controls are continuously tunable optional encoders that set the desired filter frequencies in 5-Hz steps. This gives you a lot more precision than fixed-rotation pots, but some ops might find them "touchy" at first. They turn very easily, so you have to be careful. Some also might find the tiny front-panel labels hard to see or read.

The CW filter claims to have a 10-Hz (!) minimum bandwidth (the ARRL Lab measured it at something greater than that—but not much greater), so you have to tune very, very carefully to take advantage of it. Scrunching the bandwidth imparts a ringy quality to the signal, but you won't hear another station except the one you're tuned to. Even at the 50-Hz setting, it's difficult to monitor two stations in QSO, unless they're on exactly the same frequency. The CW center frquency can be set between 200 Hz and 2095 Hz. As with other DSP boxes, we found the results less striking on SSB than on CW. It won't replace good crystal filters inside your receiver, but it will ease reception in the face of QRN and QRM.

More than a DSP box

The Timewave DSP-599zx offers a range of modes and submodes for voice, CW and data reception, but it's also an RTTY TNC and a test-bench instrument—modes you won't find in run-of-the-mill DSP boxes. For voice modes, it has both high and low-pass filters; noise reduction, line-noise reduction (for AM only); and heterodyne-eliminating notch filters. For CW, it offers a band-pass filter, noise reduction and a manual notch filter as well as a CW marker tone (to make it easy to match the filter's center frequency to the pitch of the received signal) and a tone pitch shift. You also can bypass the unit altogether.

The unit also has specific filters for all data modes, including RTTY, the various 'TOR modes, HF packet and Clover, plus SSTV and WEFAX. In addition to functioning as an RTTY TNC (we did not test this mode), the DSP-599zx also can *remodulate* a received RTTY signal as clean AFSK that your TNC should find easier to handle (especially if you didn't spend a lot of money on your TNC).

The DSP-599zx also can be used as an audio test and RTTY FSK test signal generator, as a millivoltmeter and as a CTCSS-tone decoder. The unit can deliver a two-tone output (700 and 1900 Hz), but you cannot independently adjust the level of each tone, which limits the value of this feature for SSB transmitter alignment. The audio millivoltmeter can measure the voltage, frequency and bandwidth of a signal (up to 2000-mV RMS maximum). You won't find those modes in similar units, and they could come in handy.

Each mode is selectable from the front panel, by pressing (you guessed it!) the **MODE** control. As already noted, noise reduction and tone or heterodyne reduction are available in all modes. It can really be fun—at least here on the East Coast—to tune the 40-meter 'phone band at night and never hear a broadcast station carrier. The automatic notch nails each one—even as you tune—and its 50-dB rejection really does a job. The manual notch filter is equally superb, but accessing it is not a one-button operation.

Own two receivers? No problem. Both can work through the same box. There are *two* set of inputs and outputs, selectable on the front panel. Have a CW sked at 0100Z and a SSB net at 0130Z, and need a different set of filters for each one? There are six memories to store a complete configuration setup. Hit a few buttons to recall your favorite setting.

Like some other DSP boxes, this unit has an automatic gain control (AGC) feature. One failing of many earlier units was a high sensitivity to audio input levels. As the signal increased, so did the distortion and noise. This AGC seemed to work smoothly without marked side effects. By the way, both the line and headphone output levels are adjustable to match your needs.

In Summary

The Timewave DSP-599zx is a modern DSP box, with the emphasis on the *P* for *processor*. As with any audio DSP unit, however, it can only make the most of what it hears. The unit offers a wide variety of modes, logically controlled, and provides memories to store your favorite selections. The built-in RTTY modem and test instrument capabilities are interesting and helpful additions.

Manufacturer: Timewave Technology Inc, 2401 Pilot Knob Rd, St Paul, MN 55120; tel 612-452-5939; fax 612-452-4571; Web, **http://www.timewave.com** (includes manual and technical data on the DSP599zx). Manufacturer's suggested retail price: $379.