Product Review

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ICOM IC-821H VHF/UHF Multimode Transceiver

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Everyone who keeps up with such matters will recognize right away that the IC-821H is ICOM's sequel to the IC-820H, a 2-meter/70-cm multimode transceiver that debuted in 1994 to an eager audience. Hams who were into satellite operating and VHF/UHF weak-signal work were ecstatic at the prospect of a new multimode transceiver to challenge the Kenwood TS-790 and the Yaesu FT-736. Both were (and still are) respectable radios, but their designs were becoming dated. The word on the street and on the air was that the IC-820H would offer features and performance more in keeping with the needs of modern operator.

We reviewed the IC-820H two years ago (March 1995 *QST*). Although we praised its overall performance (9600-baud packet performance, for example, was outstanding), we faulted the radio in a number of areas. ICOM took the constructive criticism to heart. They took another look at the '820H's design and made several changes. The result is the new IC-821H.

Out of the Box

As I finished unpacking the IC-821H, I made my first pleasant discovery: a *microphone*! In our 1995 review I complained bitterly about the lack of a microphone in the '820H. (It seemed like a gross omission for such an expensive radio.) Obviously, someone at ICOM was listening!

The IC-821H is physically identical to the '820H—right down to the large amber LCD display on the front panel. The rig is compact and extremely light. As with the '820H, the IC-821H lacks an internal power supply, so you must provide a source of 13.8 V dc at 16 A, either from your own power supply or the companion ICOM unit (the PS-85). And like the '820H, the IC-821H front-panel layout is quite clean. You're not overwhelmed with an array of switches and dials.

The IC-821H achieves cross-band full-duplex operation through the use of *Main* and *Sub* bands. The rig offers two VFOs for each band, making it essentially two rigs in one enclosure. By pressing a single button, you can assign 70 cm to the Main band and 2 meters to the Sub, or vice versa. You can set the VFOs to tune in several steps. In the FM mode, you can set steps from 100 Hz to 100 kHz; for SSB or CW, the tuning steps are 1, 10, 50 or 100 Hz. There is an RIT control, but it operates *only* on the Main band. The power-on default is 2 meters on the Main band and 70 cm on the Sub band. You can flip that arrangement in a heartbeat by just pressing the **M/S** (Main/Sub) button.

Separate **VOLUME** and **SQUELCH** controls allow you to adjust the Main and Sub audio levels to suit your needs. If you're wearing headphones, you can hear the Main band in one ear and the Sub in the other (an internal switch allows you to mix or separate the audio channels). Separate Main/Sub external speaker jacks are provided on the rear panel, so you can achieve the same effect without headphones. You can transmit on the Main band while receiving on the Sub band. However, you cannot transmit on the Sub band unless you are in the satellite mode.

The front-panel controls also provide access to the IC-821H's 160 memories. The memory channel lineup includes one call memory and two scan-edge memories for each band. (When you're doing a programmed scan, the scan function sweeps between the frequencies stored in the scan-edge memories.) The '821H also provides 10 satellite memories.

Like the '820H, the IC-821H offers computer control via a rear-panel jack. You'll need a CT-17 level converter and third-party software to interface the IC-821H with your PC.

BOTTOM LINE

With the dualband IC-821H, ICOM has smoothed out the wrinkles on its capable but flawed IC-820H. This is a do-everything box with lots of features for the serious VHF/UHF and satellite operator, and it's Phase 3D-ready.

Analog Satellite Operating

Although the IC-821H is a multipurpose rig, it will probably see its greatest use as a satellite transceiver. For my on-the-air tests I used the '821H to work SSB through the new Fuji-OSCAR 29 satellite. FO-29 works in mode JA when its analog transponder is operating. The bird listens on 2 meters and repeats what it hears on 70 cm. Operating through FO-29 can be tricky because the satellite employs an *inverting* transponder. If you transmit in USB, the satellite repeats in LSB. If you transmit in the lower portion of the transponder passband, you'll find your signal in the upper portion. If you tune your uplink signal down in frequency, your downlink signal frequency will rise! It's as though the satellite is relaying a mirror-image of your signal.

To make life easier with FO-29, I used the IC-821H's *satellite mode*. With the rig in this mode, the Main and Sub band frequencies track each other, either normally or in reverse. Once you set up the dual VFO functions, a change of frequency on the Main (transmit) band causes a corresponding change on the Sub band. This was pure delight! I began with my 2-meter Main band signal at 145.900 MHz (the bottom of OSCAR 29's transponder passband) and cranked up the Sub-band volume. As I tuned *up* from 145.900 MHz, I watched

Table 1
ICOM IC-821H VHF/UHF Multimode Transceiver, serial no. 01110

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 136-174 (specifications guaranteed for 144-148 MHz), 430-450 MHz; transmit, 144-148; 430-450 MHz.	As specified.
Modes of operation: LSB, USB, CW, FM.	As specified.
Power requirement: Receive, 2.5 A (max); transmit, 16 A (max), at 13.8 V dc, ±15%.	Receive, 1.5 A (no signal, max volume); transmit, 144 MHz, 11 A; 430 MHz, 13 A.
Size (HWD): 3.7×9.5×9.4 in; weight, 11 lbs.	
Receiver	*Receiver Dynamic Testing*
SSB/CW receiver sensitivity (bandwidth not specified): 0.11 μV (–126 dBm) for 10-dB S/N on VHF and UHF.	Minimum discernible signal (MDS) with 500-Hz IF filter: 146 MHz: –144 dBm 440 MHz: –143 dBm
FM receiver sensitivity: For 12-dB SINAD, 0.18 μV, on VHF and UHF.	For 12-dB SINAD: 146 MHz: 0.12 μV 440 MHz: 0.14 μV
Blocking dynamic range: Not specified.	Blocking dynamic range (500-Hz IF filter): 146 MHz: 100 dB* 440 MHz: 114 dB*
Two-tone, third-order IMD dynamic range: Not specified.	Two-tone, third-order IMD dynamic range (500-Hz IF filter): At 20-kHz offset from 146 MHz, 84 dB; from 440 MHz, 87 dB. At 10-MHz offset from 146 MHz, 101 dB; from 440 MHz, 98 dB.
Third-order input intercept: Not specified.	146 MHz, –8.2 dBm; 440 MHz –13.5 dBm.†
FM adjacent channel rejection: Not specified.	At 20-kHz offset from 146 MHz, 67 dB; at 20-kHz offset from 440 MHz, 75 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	At 20-kHz offset from 146 MHz, 67 dB*; at 10-MHz offset from 146 MHz, 89 dB; at 20-kHz offset from 440 MHz, 73 dB; at 10-MHz offset from 440 MHz, 86 dB.
S-meter sensitivity: Not specified.	S9 signal, 146 MHz: 5 μV; 440 MHz, 4 μV.
Squelch sensitivity: At threshold, SSB/CW, <1 μV; FM, <0.1 μV	At threshold: FM, 146 MHz, 0.07 μV; 440 MHz, 0.06 μV; SSB, 144 MHz, 0.4 μV; 440 MHz, 0.4 μV.
Receiver audio output: More than 2 W into 8 Ω at 10% THD.	2.8 W into 8 Ω at 10% THD.
IF/audio response: Not specified.	At 6-dB points (bandwidth): CW-N: 515-1061 Hz (546 Hz); CW-W: 317-2736 Hz (2419 Hz); USB: 161-2546 Hz (2385 Hz); LSB: 434-2864 Hz (2430 Hz).
Spurious and image rejection: More than 60 dB.	Image rejection: 146 MHz, ≥79 dB; 440 MHz, ≥83 dB. If rejection: 146 MHz, 133 dB; 440 MHz, 125 dB*.
Transmitter	*Transmitter Dynamic Testing*
Power output: 144 MHz: SSB, 6-35 W; FM/CW, 6-45 W; 430 MHz: SSB, 6-30 W; FM/CW, 6-40 W; continuously variable in all modes on VHF and UHF.	146 MHz, SSB, ≈4-36 W; FM/CW, ≈5-46 W; 430 MHz, SSB, ≈4-32 W; FM/CW, ≈4-42 W.
Spurious-signal and harmonic suppression: Better than 60 dB.	As specified. Meets FCC specifications for equipment in its power output class and frequency range.
SSB carrier suppression: More than 40 dB.	43 dB.
Undesired sideband suppression: More than 40 dB.	>60 dB.
Third-order intermodulation distortion products: Not specified.	See Figure 1.
CW keying characteristics: Not specified.	See Figure 2.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	S9 signal, 42 ms; for 9600 baud, 7 ms.
Receive-transmit turnaround time ("tx delay"): Not specified.	SSB, 29 ms; FM, 26 ms.
Composite transmitted noise: Not specified.	See Figure 3.
Bit-error rate (BER), 9600 baud: Not specified.	146 MHz: Receiver: BER at 12-dB SINAD, 2.6×10^{-3}; BER at 16-dB SINAD, 1.1×10^{-4}; BER at –50 dBm, $<1.0\times10^{-5}$. Transmitter: BER at 12-dB SINAD, 6.3×10^{-4}; BER at 12-dB SINAD + 30 dB, $<1.0\times10^{-5}$. 440 MHz: Receiver: BER at 12-dB SINAD, 3.5×10^{-3}; BER at 16-dB SINAD, 1.8×10^{-4}; BER at –50 dBm, $<1.0\times10^{-5}$. Transmitter: BER at 12-dB SINAD, 2.0×10^{-4}; BER at 12-dB SINAD + 30 dB, $<1.0\times10^{-5}$.

Note: Dynamic-range measurements were made at the ARRL Lab standard signal spacing of 20 kHz.
*Measurement was noise-limited at the value shown.
†Third-order intercept points were determined using S5 reference.

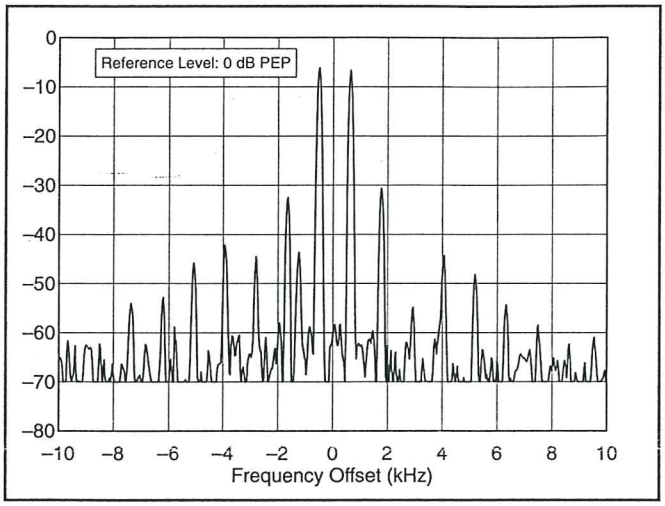

Figure 1—Worst-case spectral display of the IC-821H transmitter during two-tone intermodulation distortion (IMD) testing. The worst-case third-order product is approximately 31 dB below PEP output, and the worst-case fifth-order product is approximately 45 dB down. The transceiver was being operated at 33 W output at 144.2 MHz.

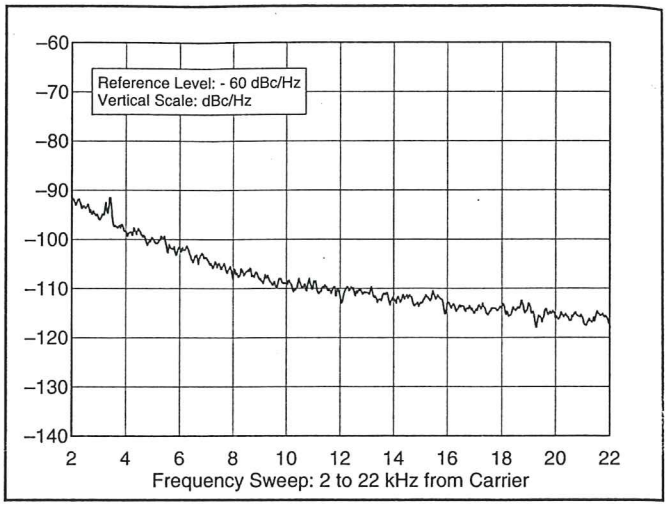

Figure 3—Worst-case tested spectral display of the IC-821H transmitter output during composite-noise testing. Power output is 46 W at 144 MHz. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.

my Sub frequency heading *down* from 435.900 MHz automatically.

During conversations I temporarily disabled this feature so that I could tweak the Sub band frequency to compensate for Doppler shift. A front-panel button makes this possible, although it takes a little getting used to.

If the rig's performance on OSCAR 29 is any indication, the IC-821H is going to be an ideal radio for Phase 3D. Like OSCAR 29, Phase 3D also will employ inverting transponders. Automatic frequency tracking will be a welcome feature.

Satellite Packet

Satellite packet was an area where the IC-820H was most deficient. Would the IC-821H offer a worthwhile improvement?

The problem with the '820H involved the fact that all packet satellites operate in mode JD—listening on 2 meters and transmitting on 70 cm, full duplex. The 1200-baud satellites use PSK on their downlinks, so you must listen in the SSB mode. On the other hand, the 9600-baud birds use FSK, requiring an FM receiver.

The '820H was clumsy from the start. The first thing you had to do was pop the cover and move a slide switch so that SSB receive audio from the Sub band would be available at the rear accessory jack, assuming that you had changed the position of yet another internal slide switch.

Not so with the IC-821H. When you're in the 1200-baud mode (selectable from the front panel), the Sub band receive audio is available at the rear panel. There are no internal switches to monkey with.

Many 1200-baud PSK TNCs use the microphone UP/DOWN lines to maintain a lock on the signal after you've tuned it in. This presented problems with the IC-820H, because the microphone UP/DOWN lines on that radio changed frequency in 100-Hz steps—too drastic a jump for this type of operation. The good news is that the IC-821H offers 50-Hz steps on the UP/DOWN lines. The even better news is that the IC-821H allows you to connect to the UP/DOWN control lines via the rear panel accessory jack. *Bravo*, ICOM!

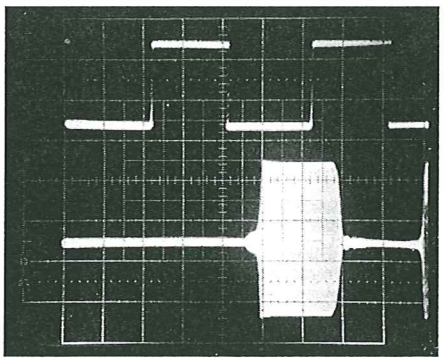

Figure 2—CW keying waveform for the IC-821H, showing the first two dits in semi-break-in (VOX) mode. The equivalent keying speed is 60 wpm. The upper trace is the actual key closure; the lower trace is the RF envelope. Horizontal divisions are 10 ms. The transceiver was being operated at 44 W output at 144 MHz. Note that the first character is completely missing—similar to the CW keying waveform of the IC-820H in semi-break-in mode. This anomaly did not occur when the radio was placed manually into transmit.

When it came to the 9600-baud packet satellites, the IC-820H fell flat on its face. You had to go back inside the radio and throw yet another switch for 9600-baud packet. When you did so, however, you lost the receive audio from the Sub band—your 70-cm FM downlink! You had 9600-baud receive audio on the Main band—your 2-meter FM uplink—but that was utterly useless. The solution was modification. You had to perform minor surgery to the '820H, picking off the signal from the Sub band discriminator and making it available at the rear panel.

ICOM has cured this problem in the IC-821H. When you place the radio in the 9600-baud packet mode, audio from the Main *and* Sub band discriminators is available at the rear panel. Simplicity can be beautiful!

I used the IC-821H with OSCAR 16 at 1200 baud and OSCAR 25 at 9600 baud. Even with my omnidirectional attic antennas, the transceiver worked like a charm. With these changes, the IC-821H has definitely joined the exclusive ranks of the digital satellite transceivers.

FM

FM operating with the IC-821H is unpretentious in the extreme. One switch toggles the FM mode. Then you select which band you want in the Main display (you can only transmit from the Main band in the FM mode). When you tune through a repeater subband, the '821H automatically selects the correct transmitter-offset frequency. Of course, you can change the offset at will, or program nonstandard offsets if you like.

When you tune in a signal, the '821H's analog meter provides an easy-to-read indication (the Sub band has its own S meter as part of the LCD display). In addition, a tiny green LED functions as a center-tuning indicator to let you know when you're precisely on frequency: it flashes when you're off frequency and glows steadily when you finally arrive on target.

CTCSS encoding is standard in the IC-821H. If the optional UT-84 module is installed, the '821H can display the frequencies of CTCSS tones it hears on received signals (tone scan). The UT-84 also permits tone squelch operation, so that the '821H will

only open its squelch to copy a signal encoded with the CTCSS tone your radio is programmed to hear.

Terrestrial SSB/CW

SSB and CW operation is just as easy as FM. The IC-821H provides up to 45 W on CW and 35 W on SSB on 2 meters, and up to 40 W on CW and 30 W on SSB on 70 cm. RF output levels are continuously adjustable from a small pot on the front panel—yet another improvement over the IC-820H. With my dual-band attic beam antenna I was able to work quite a few stations on 2 meters and 70 cm. In fact, I even snagged a station about 300 miles away on 70 cm!

I found the IC-821H's receiver to be more than sensitive enough for my purposes on either band, but a preamplifier might be a nice addition. The IC-821H works with a number of receive preamps. There is a front-panel button that you can use to switch the preamp in or out of the line. It accomplishes this by switching 10 V on either the VHF or UHF antenna lines rather than a through a separate contact closure. Operators who prefer to switch the preamp with a separate contact closure can do this via the SEND output on the rear-panel accessory socket.

It sounded as though ICOM was also using the '820H's effective noise blanker design in the '821H. I suffer from frequent pulse-type noise generated by my oil-fired furnace. The noise blanker worked wonders on this annoyance, making SSB and CW operation much more pleasant. The **AGC** switch (fast or slow) is located in the same row as the noise blanker.

Other bells and whistles on the IC-821H include a switchable RF attenuator. This is very handy for use with a too-hot preamplifier or microwave downconverter. You can switch in a speech compressor for weak-signal work, and an IF shift control is available for Main band receive.

If CW is your favorite mode, you'll be pleased to learn that the IC-821H includes a built-in iambic keyer. This feature came in handy for contacts through OSCAR 29, and will be particularly useful for Phase 3D. (We also installed the optional Main band 500-Hz CW filter; a separate, optional 500-Hz CW filter is available for the Sub band and satellite operation.)

Conclusions

ICOM has done an outstanding job of touching up the rough spots in the IC-820H. The result is a terrific dual-band multimode transceiver for all applications. Not only is the IC-821H an excellent VHF/UHF weak signal or contest radio, it is the cornerstone of a high-performance satellite station (digital or analog). Hams who have the Phase 3D satellite in mind will want to give serious consideration to the IC-821H. It also offers superb FM-voice and 9600-baud packet performance. Combine all of these features with the IC-821H's go-anywhere size and you have a radio that's ideal for almost any application above 144 MHz!

Manufacturer: ICOM America, 2380 116th Ave, Bellevue, WA 98004, tel 206-454-8155. Manufacturer's suggested retail prices: IC-821H transceiver, $2040; PS-85 power supply, $325; CT-17 level converter, $135; UT-84 CTCSS tone squelch unit, $88.

Order the IC-821H *Expanded Test Result Report* from the ARRL Technical Department, 225 Main St, Newington, CT 06111; $7.50 for members and $12.50 for nonmembers, postpaid. Credit card orders *only* may be placed by calling 860-594-0278.

QST Compares: Four High-Power Antenna Tuners

Okay, let's get something out of the way right up front: An antenna tuner does not *tune* your *antenna*, although it does tune your antenna *system*. An antenna tuner (also called an antenna coupler or trans-match) is a narrow-band, variable-impedance transformer that presents your transmitter or amplifier with the proper load (typically 50 Ω). It will not make the antenna system on the other side of the tuner circuit radiate any better.

There are tradeoffs here, however. Under some circumstances, the antenna tuner itself (or its built-in balun) can eat up a significant part of the RF you'd like to have winging its way into the ether. Typically, this energy is dissipated instead as heat (as we confirmed during testing).

Not everyone needs an antenna tuner. You don't need one if you have a resonant antenna (such as a coaxial-cable-fed single-band dipole) and the SWR is 2:1 or less at the frequencies you operate most often. While a tuner *can* help to reduce harmonics, it won't magically "clean up" your signal. While it is true that *some* antenna tuner configurations act as low-pass filters, it's unrealistic to expect the antenna tuner to cure problems it was never intended to fix.

We looked at four units that are touted as among the most rugged antenna tuners available. These units, designed to handle serious power, are marketed to hams who typically run maximum-power amplifiers for contesting and DXing and who have a demonstrated *need* for an antenna tuner. In these situations, antenna tuners often find their most frequent use on the lower bands—80 and 160 meters—where matching often can be difficult. On the test bench for comparison are the MFJ-989C Versa Tuner V, the Nye-Viking MB-V-A (reviewed previously; see "Product Review," *QST*, Jun 1994), the Tucker T-3000 (Vectronics manufactured the T-3000 we tested. The T-3000 is no longer available, but the Vectronics HFT-1500 is very similar), and the N4XM XMatch, the most expensive amateur tuner on the market and the only one with a US patent (more on that later).

In addition to subjecting these units to "real-world" conditions, we conducted 10-minute "endurance" tests at several common load configurations at power levels in excess of 1000 W. In all cases, we power tested the units on 160, 20 and 10 meters at 1250 to 1500 W (depending on the band), using a 40% duty cycle (40 ms on, 60 ms off) to simulate

Table 2
Maximum-power Antenna Tuners—Features:

	MFJ MFJ-989C	***Nye-Viking MB-V-A***	***Tucker T-3000***	***N4XM XMatch***
Circuit type	T-network	Pi-network	T-network	T-network
SWR/wattmeter	Yes	Yes	Yes	No
Switch to select different antennas for tuning	Yes	Yes	Yes	No
Balun type	1:1 current	1:1 voltage	4:1 voltage	No balun
Dummy load	Yes	No	No	No
"Mark-on" front panel to record settings	No	No	Yes	Yes
Manufacturer's PEP rating (matching range)	1500 W (35-500 Ω)	3000 W (40-2000 Ω)	2000 W (range not specified)	1500 W*
Physical dimensions (HWD) in inches	5×10.6×15.1	6.7×14.6×12.2	5.9×12.6×11.5	5.6×14×14.4
Manufacturer's suggested retail price	$350	$830	$349	$1045
Typical selling price as of Jan 1997†	$298	$746	$‡	$1045▲

*See text for details.

†Typical selling prices represent an average of street prices obtained from three equipment retailers, exclusive of any sales, coupons or rebates.

‡The T-3000 is no longer available. The similar Vectronics HFT-1500 typically sells for $380.

▲The XMatch is only available from the manufacturer.