Product Review & Short Takes Columns from *QST* Magazine

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Product Reviews

Short Takes

ICOM IC-910H VHF/UHF Multimode Transceiver

Reviewed by Steve Ford, WB8IMY

It's easy to pigeonhole the IC-910H as a "satellite transceiver," but that would be a mistake. This radio offers a range of versatility—not to mention a hefty 100 W output on 2 meters and 75 W output on 70 centimeters—that makes it a truly multipurpose rig.

The IC-910H is disarmingly compact at only $9^1/_2 \times 3^{11}/_{16} \times 9^{13}/_{32}$ inches. Despite its size, all of the front-panel controls and switches are ergonomically placed for effortless operation (even with big fingers like mine). The VFO knob is large and its rotation is smooth. The expansive LCD display is easy on the eyes and readable from every angle. Since the IC-910H is a dual-band radio (actually, it's triband if you purchase the 1296 MHz module), you have separate RF/AF gain and squelch controls on the front panel. The microphone and headphone jacks are on the front panel as well. (A small hand mike is included.)

Turn the radio around and you find antenna jacks for 2 meters and 70 centimeters (installing the optional UX-910 1296-MHz module adds a third antenna jack). There are three accessory sockets, two data jacks for digital communication, a pair of external speaker jacks, the obligatory dc power connector and an interface jack for computer control. All in all, it is a clean, uncomplicated layout.

The IC-910H as Terrestrial SSB/CW Transceiver

The IC-910H is an exceptional tool for exploring the mysteries of the so-called "weak signal" modes. The convenience of being able to jump back and forth between bands is something that could spoil me in a heartbeat. The IC-910H displays both the "main" and "sub" band frequencies vertically (main on top, sub below) along with bargraph-style signal-strength indicators in each section. You can receive simultaneously on both bands, but you can transmit from the main band only (this arrangement is reversed when you are in the satellite mode). Of course, a quick press of the button flips the main/sub frequency assignments. The '910H has *two* VFOs for each band. You can opt to use the main VFO knob to make frequency changes on either the main or sub bands—or assign the **RIT** or **IF SHIFT** knobs to function as the sub band VFO control (clever!). You can even punch your chosen frequencies in directly from the front-panel keypad.

I used the '910H primarily to hunt contacts on 2 meters and 70 centimeters. Even with my puny attic-mounted Yagis, the range was impressive. SSB contacts spanning 150 miles were not uncommon on 2 meters. During a brief band opening on 70 centimeters, I enjoyed an SSB contact on 432.1 MHz over a distance of about 100 miles. With outdoor antennas, low-loss coax and receive preamps, I'm confident that my communicating range would have been considerably greater.

On 1296 MHz I set up a couple of skeds with a local station just to see how the IC-910H played on this band. Reports on my transmit signal were very favorable, and the local station that I was communicating with sounded good as well. The overall lack of activity on the band in my area and my less than optimal antenna (a small helical) gave me less success with unscheduled contacts than I had on the other bands.

Bottom Line

The ICOM IC-910H offers a great selection of capabilities and features for the VHF/UHF enthusiast. Its multiple modes and ample power output—and optional 23-cm coverage—make it a versatile tool for FM, weak-signal terrestrial and satellite operation.

IC-910H as FM Transceiver

The IC-910H is a fully capable FM transceiver. The considerable output power on 2 meters and 70 centimeters gives the radio a formidable punch on FM simplex. For repeater operation the '910H offers most of the same convenience functions you find on many mobile FM rigs. The duplex offset frequencies are programmable for each band. There is a 50-tone subaudible (CTCSS) tone encoder/decoder for use with repeaters that require the tones for access. The stock microphone, however, does not include a DTMF pad for control or phone patch applications.

Testing the '910H on FM was an ideal opportunity to experiment with the memory and scanning functions (although these functions are available for other modes as well). The IC-910H sports 106 memory channels—99 regular channels, 6 scan-edge channels and one call channel for *each* band. The memory channels can be programmed with the frequency, mode, simplex or duplex and subaudible tone frequency. Alphanumeric memory naming is not supported.

There's also 5 (or 10—your choice) "Memo Pad" memories. These are very handy for temporarily storing interesting frequencies. This storage system is set up as "first in, first out." When you program in the sixth (or 11th) frequency, the first frequency that you memorized will be erased.

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Memory programming is straightforward and probably familiar to most FM operators. You can transfer VFO contents to a memory channel, or vice versa. The call channels are convenient memory slots to store a single frequency (or frequency combination) for each band that you use often. To access one of these, you simply push the **MS/BAND** button to select the desired band, then press the **CALL** button.

There are three scanning modes in the IC-910H: memory scan, programmed scan and mode-select scan. The memory scan, as the name suggests, scans through the memory channels, automatically excluding blank, call or scan-edge channels. A "memory channel lockout" feature, for temporarily excluding a specific memory channel from a scan, is not included. The scan resume conditions (what happens after the scan stops on a busy channel) and the scan speeds are selectable. In the programmed scan mode, the '910H scans in the VFO mode between the two frequencies programmed in the scan-edge memory channels. Mode-select scan is intriguing. It allows you to scan through *only* those memory channels that are programmed with a particular mode (FM, SSB or CW). For example, you can set up the '910H to scan only your SSB "hot spots" if that is your interest at the moment!

I've already mentioned that the IC-910H can generate subaudible tones for repeater access. As it turns out, the tone-scan function allows you to *detect* these tones as well. If you don't know the frequency of the subaudible tone in use on a particular repeater, the '910H can scan the incoming signal and alert you to the exact tone frequency. In fact, you can configure the transceiver to activate its own tone squelch function. In this mode, the '910H remains silent until the proper subaudible tone is received.

Related to the various scanning functions is the IC-910H's *simple band scope*. This feature allows you to sweep both sides of a center frequency to check for activity. Detected signals are displayed as part of the signal-strength indicator for each band. This feature is available for SSB as well as FM.

IC-910H as Satellite Transceiver

Despite the versatility of the '910H, its use as a satellite transceiver garners the most attention in the amateur community. Considering the innovative satellite-operating features this rig provides, this is easy to understand. I'd be less than honest if I said that I wasn't eager to try the '910H on the satellites as quickly as possible.

I put the IC-910H to work primarily on the Fuji-OSCAR 29 and 20 satellites because these birds operate in Mode J—listening on 2 meters and retransmitting on 70 centimeters. In addition, both satellites use *inverting* transponders. Whatever you transmit on the uplink is inverted on the downlink—LSB on the uplink becomes USB on the downlink; a signal at a frequency in the *lower* portion of the uplink passband appears at the *upper* portion of the downlink passband. Add the considerable Doppler frequency shift that's present on the 70-cm downlink and you have the potential for serious operator confusion. (A condition that may also exist on the new AO-40 satellite—it uses inverting transponders.) The IC-910H promises features to alleviate the headaches. Does it deliver?

Prior to my first Fuji-OSCAR attempt with the '910H, I set the downlink frequency on the main band at 435.900 MHz—the top end of the downlink passband. I entered the uplink frequency in the sub band at 145.900 MHz, which is the bottom end of the uplink passband. By switching to the satellite mode and enabling reverse tracking, I was ready to go. It's worth noting that the '910H includes 10 separate satellite memories that you can preprogram with all the necessary setup information for your favorite birds.

When OSCAR 20 rose above 10 degrees elevation, I was able to hear the CW beacon clearly with my attic Yagis. I began tuning up through the downlink passband and watched as the '910H's uplink frequency stepped *downward* automatically in perfect sync. Despite that fact that I wasn't using a receive preamplifer, I was able to eavesdrop on several SSB conversations without difficulty.

A quick phone CQ brought a response and a 59 report. Doppler shift on the 70-cm downlink was tricky, but the IC-910's automatic reverse VFO tracking made it easy to compensate. I didn't have to remind myself to *raise* my uplink frequency to compensate for Doppler shift on the downlink.

And even with my mediocre antennas, the '910H provided more than enough output for my signal to be heard through the satellite. In fact, I often discovered that I was a little too strong. (The rule of thumb is that your own signal on the downlink should be roughly equal in strength to the satellite's CW beacon.) Thankfully, the '910H's output is adjustable all the way down to 5 W.

Digital satellite enthusiasts will be pleased to hear that ICOM has paid particular attention to data communication in the IC-910H. As you can see in the accompanying ARRL Lab test results, the bit-error-rate (BER) performance of the '910H was impressive. Using a 9600-baud modem and *WiSP* software, I was able to consistently grab large amounts of data during two KITSAT-OSCAR 25 passes.

IC-910H as Contest Transceiver

If the '910H performs well for terrestrial weak-signal and satellite work, would it perform just as well during a contest?

If your contesting interest is more than casual, this transceiver may disappoint. In fairness, however, the IC-910H is not designed to be a competitive contest radio, and it would be unreasonable to compare it to, say, a VHF/UHF contest station based on high-performance transverters. The dynamic range performance on 2 meters and 70 centimeters wasn't adequate to deal with numerous nearby signals. I set up a contest simulation with a couple of stations and it quickly became clear that the '910H wasn't up to the task of sorting through the chaos (even with judicious use of the **IF SHIFT** control and RF attenuator).

It is important to note that our Lab tests revealed that the IC-910H generated a substantial amount of phase noise on all bands. In casual applications, this would not be a problem. Unlike HF phase noise, these signals would not travel very far. However, if you were using the IC-910H in a multioperator contest environment, the transceiver has the potential to create a fair amount of interference to the other radios, depending on the bands and frequencies in use.

Additional Highlights

ICOM has also packed in some features that you may not expect to find in a VHF/UHF transceiver. Some examples are VOX, a sideband speech compressor and a variable attenuator. A speech synthesizer—the UT-102 is available as an optional accessory. This will announce the current operating frequency and mode (and the S meter reading, if desired) at the push of a button. Optional DSP noise reduction boards can also be installed. Separate UT-106 DSP units can be added to the main and sub receivers.

There's even a built in CW keyer. The keying speed is adjustable from about 6 to 60 WPM, and you can vary the break-in delay time, the weighting, the paddle sense, the pitch and the side tone level. In a pinch, you can use the **UP**/**DOWN** buttons on the microphone for sending CW.

Conclusion

With a decent antenna system, feed line and preamp, the IC-910H has the capability to be a worthy contender for point-to-point terrestrial communication on SSB and CW in noncontest environments. On FM its power and features

Table 1
ICOM IC-910H, serial number 01242

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 136-174, 430-450, 1240-1300 MHz;[1] transmit, 144-148, 430-450, 1240-1300 MHz.[1]	Receive and transmit, as specified.
Power requirement: Receive, 2.5 A; transmit, 23 A (max output). 11.7-15.9 V dc (13.8 V nominal)	Receive, 1.5 A; transmit, 21.5 A. Tested at 13.8 V.
Modes of operation: SSB, CW, FM.	As specified.
Receiver	***Receiver Dynamic Testing***
SSB/CW sensitivity, bandwidth not specified, 10 dB S/N: <0.11 µV.	Noise floor (MDS), 500 Hz filter: 144 MHz –141 dBm 432 MHz –142 dBm 1240 MHz –144 dBm
FM sensitivity, 12 dB SINAD: <0.18 µV.	For 12 dB SINAD: 146 MHz 0.13 µV 440 MHz 0.14 µV 1240 MHz 0.17 µV
Blocking dynamic range: Not specified.	Blocking dynamic range, 500 Hz filter: 144 MHz 106 dB* 432 MHz 104 dB* 1240 MHz 92 dB*
Two-tone, third-order IMD dynamic range: Not specified.	Two-tone, third-order IMD dynamic range, 500 Hz filter: 144 MHz 85 dB* 432 MHz 80 dB 1240 MHz 78 dB*
Third-order intercept: Not specified.	144 MHz –6.4 dBm 432 MHz –5.8 dBm 1240 MHz –14.5 dBm
FM adjacent channel rejection: Not specified.	20 kHz channel spacing: 146 MHz, 66 dB; 440 MHz, 73 dB; 1240 MHz, 51 dB.
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz channel spacing: 146 MHz, 66 dB*; 440 MHz, 73 dB*; 1240 MHz, 51 dB*; 10 MHz channel spacing: 146 MHz, 93 dB; 440 MHz, 85 dB; 1240 MHz, 65 dB.
S-meter sensitivity: Not specified.	S9 signal: 146 MHz, 25 µV; 432 MHz, 14 µV; 1240 MHz, 11 µV.
Squelch sensitivity: SSB, <1.0 µV; FM, <0.18 µV.	At threshold: SSB, 144 MHz, 0.58 µV; FM, 146 MHz, 0.14 µV; 440 MHz, 0.10 µV; 1240 MHz, 0.09 µV.
Receiver audio output: 2.0 W at 10% THD into 8 Ω.	2.8 W at 10% THD into 8 Ω.
IF/audio response: Not specified.	Range at –6 dB points, (bandwidth): CW-N (500 Hz filter): 358-1123 Hz (765 Hz); CW-W: 147-3084 Hz (2937 Hz); USB-W: 129-2887 Hz (2758 Hz); LSB-W: 148-3098 Hz (2950 Hz).
IF and image rejection: 144, 430 MHz, 60 dB; 1240 MHz, 50 dB.	First IF rejection, 144 MHz, 91 dB; 432 MHz, 99 dB; 1240 MHz, 126 dB*; image rejection, 144 MHz, 85 dB; 432 MHz, 86 dB; 1240 MHz, 99 dB.
Transmitter	***Transmitter Dynamic Testing***
Power output: 144 MHz, 100 W high, 5 W low; 430 MHz, 75 W high, 5 W low; 1240 MHz, 10 W high, 1 W low.	144 MHz, typically 96 W high, 1.1 W low; 430 MHz, typically 73 W high, <1 W low; 1240 MHz, typically 10 W high, <1 W low.
Spurious-signal and harmonic suppression: 144, 430 MHz, ≥60 dB; 1240 MHz, ≥50 dB.	144 MHz, 68 dB; 430 MHz, 71 dB; 1240 MHz, 71 dB. Meets FCC requirements for spectral purity.
SSB carrier suppression: ≥40 dB.	As specified. >40 dB.
Undesired sideband suppression: ≥40 dB.	As specified. >47 dB.
Third-order intermodulation distortion (IMD) products: Not specified.	See Figures 1, 3 and 5.
CW keying characteristics: Not specified.	See Figure 7.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S9 signal, 70 ms.
Receive-transmit turn-around time (tx delay): Not specified.	SSB, 32 ms; FM, 32 ms. Unit is suitable for use on AMTOR.
Composite transmitted noise: Not specified.	See Figures 2, 4 and 6.
Bit-error rate (BER), 9600-baud: Not specified.	146 MHz: Receiver: BER at 12-dB SINAD, 7.4×10^{-4}; BER at 16 dB SINAD, 1.1×10^{-5}; BER at –50 dBm, $<1.0\times10^{-5}$; transmitter: BER at 12-dB SINAD, 1.5×10^{-3}; BER at 12-dB SINAD + 30 dB, $<1.0\times10^{-5}$. 440 MHz: Receiver: BER at 12-dB SINAD, 7.1×10^{-4}; BER at 16 dB SINAD, 1.7×10^{-5}; BER at –50 dBm, $<1.0\times10^{-5}$; transmitter: BER at 12-dB SINAD, 1.6×10^{-3}; BER at 12-dB SINAD + 30 dB, $<1.0\times10^{-5}$. 1240 MHz: Receiver: BER at 12-dB SINAD, 9.4×10^{-4}; BER at 16 dB SINAD, $<1.0\times10^{-5}$; BER at –50 dBm, $<1.0\times10^{-5}$; transmitter: BER at 12-dB SINAD, 1.7×10^{-3}; BER at 12-dB SINAD + 30 dB, $<1.0\times10^{-5}$.
Size (HWD): 3.7×9.5×9.4 inches; weight, 10 pounds.	

Note: Unless otherwise noted, all dynamic range measurements are taken at the ARRL Lab standard spacing of 20 kHz.
*Measurement was noise-limited at the value indicated.
Third-order intercept points were determined using S5 reference.
[1]With the optional UX-910 1200 MHz Band Unit.

make the ’910H the clear choice for either voice or data communication. For satellite operating, the IC-910H has already taken its place among the elite transceivers for its power and ease of use.

I had only one nit to pick with the IC-910H—and it is a nit this radio shares with many other rigs in its class. As a ham who would like to explore the higher microwave bands (especially on the new AMSAT-OSCAR 40 satellite), I plan to use transmit and receive converters. With that in mind, I would love to see: (A) a low-power (1 W or less) output port on the rear panel to drive a transmit converter and, (B) the ability to select alternate frequency displays that would show the actual frequency being received rather than the frequency of the IF transceiver. In other words, when I am listening to an S-band downlink signal from AO-40, I would prefer to see the 2.4 GHz frequency on the ’910H display, not the 2-meter frequency my receive converter is supplying. These may seem like niggling requests, but they make a substantial difference in operating ease and convenience for satellite operators and terrestrial microwave enthusiasts.

Manufacturer: ICOM America, 2380 116th Ave NE, Bellevue, WA 98004; 425-454-8155; fax 425-454-1509; **75540.525@compuserve.com**; **www.icomamerica.com**. Manufacturer’s suggested list price: $1799. Typical current street price: $1450.

Manufacturer’s suggested list pricing for selected optional accessories: CR-293 high stability crystal unit, $380; CT-17 level converter (for computer control), $169; FL-132 500 Hz CW filter (main band), $133; FL-133 500 Hz CW filter (sub band/satellite), $133; UT-102 voice synthesizer, $74; UT-106 DSP unit, $166; UX-910 1200 MHz Band Unit, $599.

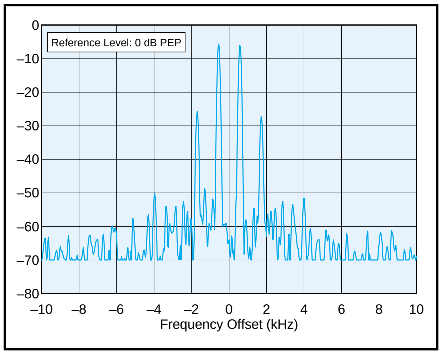


Figure 1—Spectral display of the IC-910H transmitter during two-tone intermodulation distortion (IMD) testing on 2 meters. The worst-case third-order product is approximately 27 dB below PEP output, and the worst-case fifth-order product is approximately 51 dB down. The transceiver was being operated at 100 W output at 144.2 MHz.

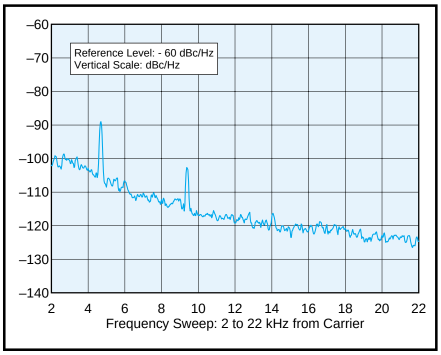


Figure 2—Spectral display of the IC-910H transmitter during composite noise testing on 144.02 MHz. Power output is 100 W. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.

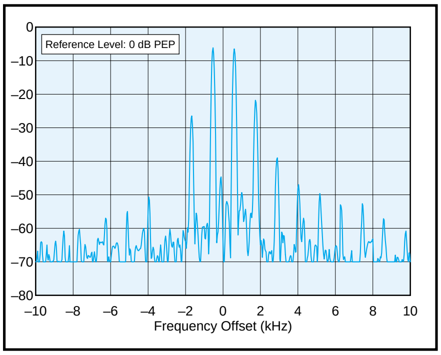


Figure 3—Spectral display of the IC-910H transmitter during two-tone intermodulation distortion (IMD) testing on 70 cm. The worst-case third-order product is approximately 23 dB below PEP output, and the worst-case fifth-order product is approximately 41 dB down. The transceiver was being operated at 75 W output at 432.2 MHz.

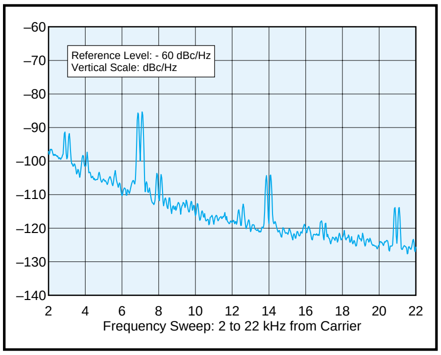


Figure 4—Spectral display of the IC-910H transmitter during composite noise testing on 430.02 MHz. Power output is 75 W. The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 2 to 22 kHz from the carrier.

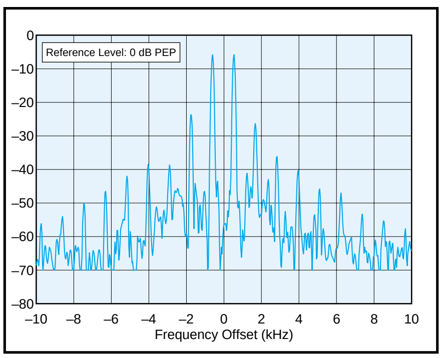


Figure 5—Spectral display of the IC-910H transmitter during two-tone intermodulation distortion (IMD) testing on 23 cm. The worst-case third-order product is approximately 25 dB below PEP output, and the worst-case fifth-order product is approximately 38 dB down. The transceiver was being operated at 10 W output at 1240.2 MHz.

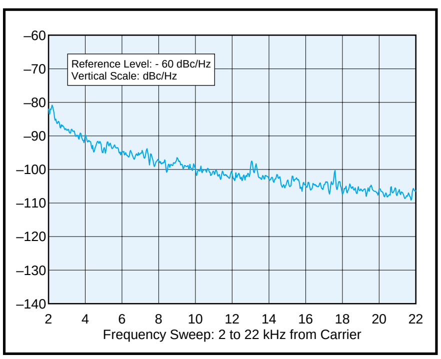


Figure 6—Spectral display of the IC-910H transmitter during composite noise testing on 1240.02 MHz. Power output is 10 W. The carrier, off the left edge of the plot, is not shown. This plot shows composite trans-mitted noise 2 to 22 kHz from the carrier.

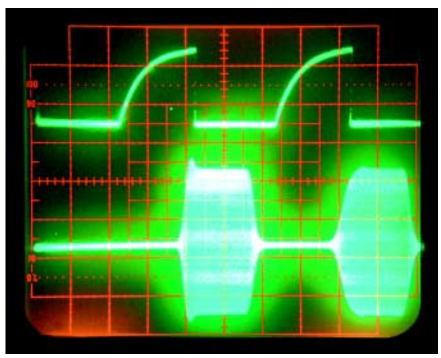


Figure 7—CW keying waveform for the IC-910H, showing the first two dits using external keying. The equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. The transceiver was being operated at 100 W output at 144.02 MHz.

DB6NT MKU 10 G2 10-GHz Transverter Kit

Reviewed by Zack Lau, W1VT
ARRL Senior Lab Engineer

Kuhne Electronic bills their DB6NT 10-GHz transverter as a "third generation" product, as each iteration of the device has come ever closer to fulfilling the wish list of microwave experimenters. It does an admirable job in meeting this objective—the latest version features a 2-meter IF (a 432 MHz IF version is also available); single board construction; tune up with basic test equipment; and very good transmit and receive performance.

With a transmit power output of 200 mW and a receive noise figure of 1.2 dB, the level of performance is quite adequate for troposcatter work from a good location. I've made numerous contacts on the 3-cm band in excess of 200 km in which the other station was running just 200 mW to a 2-foot dish.

Single board construction is very desirable, as it is highly time consuming and expensive to wire up lots of little subassemblies into a complete transverter system. A successful single board design, however, does require considerable effort, particularly when it comes to eliminating spurious signals. Minute details, such as the exact height of the enclosure, can make a big difference in the stability of high gain microwave circuits.

Design Details

The kit is assembled on a double-sided PC board with plated through holes. There are just a handful of leaded components used though—the vast majority of the parts are surface mount devices. The substrate material is Rogers RO4003. While it is not as low loss as 5880 Duroid, it is cheaper to fabricate with plated through holes. Producing Teflon substrate boards with plated through holes can be quite expensive, especially when a few cycles of prototyping and circuit debugging are typically necessary during the development stages. Plated through holes simplify construction and improve performance by providing repeatable, low-inductance ground connections between the top and the bottom of the board. RO4003 also has a higher dielectric constant, which reduces board radiation problems.

The heart of any transverter—the local oscillator—is well designed in this unit. It uses four helical filters and a microstripline filter. I like to use helicals in my own designs, whenever I can find them cheaply. Apparently Kuhne has secured an affordable supply of these. The relatively large number of filters used in this transverter is actually an advantage—the local oscillator chain can be tuned up with just a voltmeter. This also simplifies troubleshooting—an incorrectly wired stage won't tune up properly. This can be a problem with no-tune transverter designs—the lack of tuning can make it tougher to isolate defective or improperly installed parts.

The MKU 10 G2 transverter incorporates a few innovations that are quite obvious to those of us who have designed our own microwave transverters. One example is the use of closely spaced circuit board traces in place of discrete coupling capacitors. This eliminates the headaches that may be encountered in identifying faulty coupling capacitors. While this might seem to be a minor concern, unlike audio circuitry, signal tracing is much more challenging when a $^{1}/_{4}$-inch is a $^{1}/_{4}$-λ.

The use of a shared filter for transmit and receive is also clever. The receive and transmit chains meet at a Wilkinson divider, and this connects to the balanced mixer through a single filter. Be cautious when you're tuning this filter though, as the image is only 288 MHz—or just 3%—away, so it is quite easy to accidentally align the unit on 10080 instead of 10368 MHz. A procedure in the tune up instructions outlines how to do this properly. A second similar filter, located in the transmit amplifier chain, is used to clean up the output signal.

The receiver uses a pair of low noise NE325684C HEMT transistors driving an MGF-1902 GaAs FET. The transmitter uses three MGF-1902s driving an MGF-1601. The transmit FETs run off a regulated 8-V supply, while a 5-V regulator supplies power to the receive FETs.

A separate 5-V regulator is used for the local oscillator to enhance frequency stability. An ICL-7660 provides the necessary negative voltage needed to bias the FETs. The bias voltage is adjusted with 10 kΩ potentiometers. A built-in directional coupler and diode detector allows you to monitor the power output with a voltmeter.

There are two methods of activating the T/R switching. One is to ground the PTT line. The second is to place a voltage of at least +9 V dc on the 144 MHz IF input. This voltage is available from the Yaesu FT-290 and ICOM IC-402 (432 MHz), but not the more modern FT-290MkII. It is quite possible that an old ICOM IC-2AT will switch the transverter, even though the voltage is below 9 V.

Assembly

Most of the components come packed in two compartmentalized plastic boxes. There were no missing or extra parts. The lids of these boxes have maps that clearly identify all of the different pieces, even the bits of hardware and wire. This is essential for the SMD capacitors, as I was not able to discern any identifying marks. The instructions warned about sharp edges on the tinplate panels that make up the enclosure. I lightly filed the edges of the metal parts to eliminate this hazard.

A disappointment was the quality of the instructions. Not only where they sketchy, but in some cases they were irrelevant or incorrect. Not having assembled a German tinplate enclosure before, I could have used some additional assembly details.

I began by studying the photographs on the Kuhne Web site (**www.db6nt.com**) to determine how the two **L**-shaped components that make up the side panels fit together. Each of the short legs has a small flap, and the instructions do not indicate whether the flaps should be positioned on the inside or the outside of the enclosure. They belong on the inside, so I needed to notch two corners of the circuit board with a nibbling tool to provide room for these seams.

After soldering the two pieces together, I carefully inspected the parts with a caliper and soon realized that I should

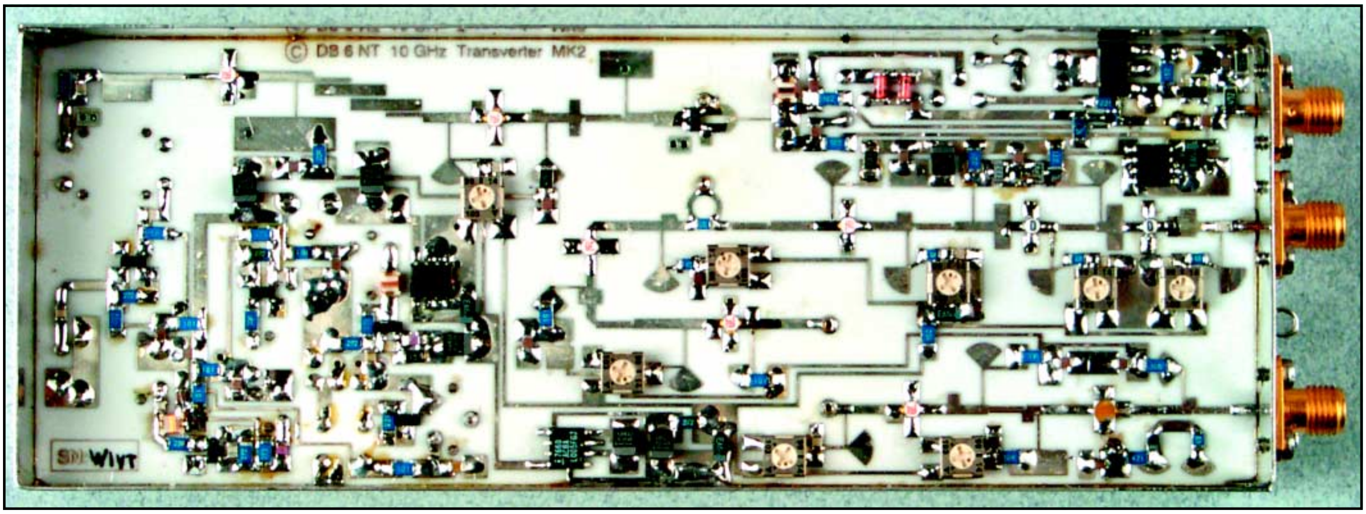


Table 2
DB6NT MKU 10 G2 10-GHz Transverter

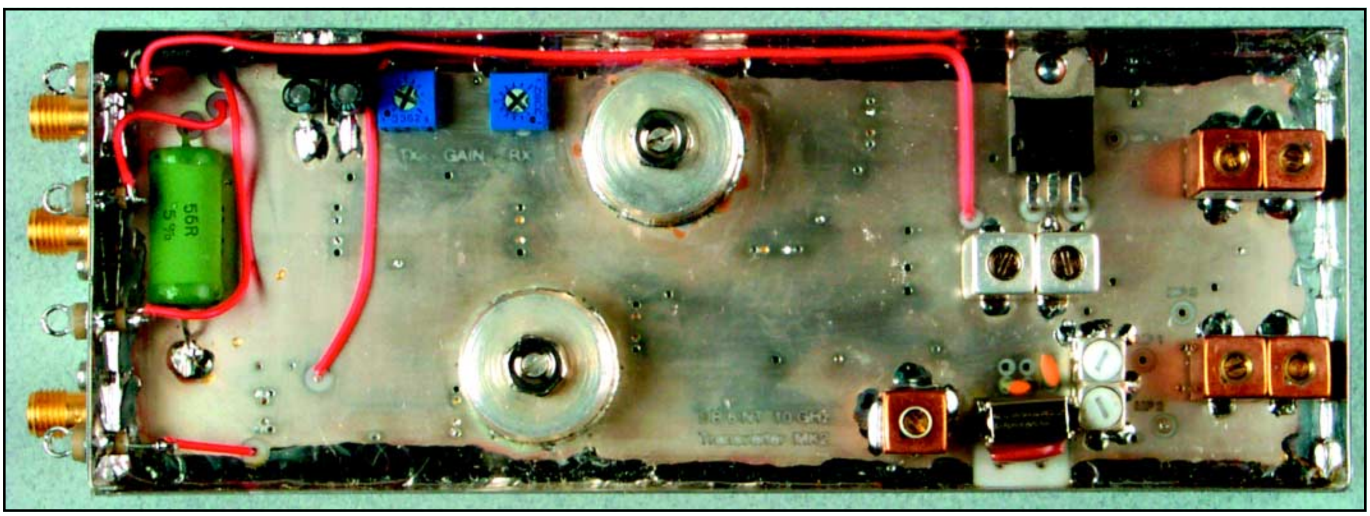
Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency coverage: 10368-10370 MHz.	As specified (for 144-146 MHz IF).
Power requirements: Transmit, 0.35 A (nominal); receive, not specified, at 12 V (nominal).	Transmit, 0.40 A; receive, 210 mA, tested at 12 V.
Size (HWD): $1^1/_8 \times 2^3/_{16} \times 5^7/_8$ inches; weight: 7.0 oz.	
Modes of operation: Not specified.	Tested on SSB and CW.
Receiver	
Conversion gain: 20 dB.	20.5 dB.
Noise figure: 1.2 dB.	As specified.
Transmitter	
Transmit RF input: 3 W (max).	180 mW (min) input at 144 MHz required for typical 200 mW output.[1]
Transmit RF output: 200 mW.	As specified.
Spurious signal and harmonic suppression: Not specified.	45 dB.

[1]Lower drive levels are possible with simple modifications. Contact SSB Electronic USA for details.

have jigged the parts together to achieve a precision fit. I unsoldered them, removed the excess solder with Solder-Wick, and gave it another go.

To assure better results this time around, I made a jig out of a piece of $^1/_4$-inch thick plywood 2.1 inches wide by 5.75 inches long—approximately the same dimensions as the circuit board. I positioned the two side panel components in one of the two covers and slipped the plywood inside. This prevented the tinplate sides from curving. (One side of the plywood wasn't quite straight, so I used a bit of shim stock to straighten out the tinplate side.) I then slipped on the other cover and soldered the outside of the two seams, taking care not to solder the covers to the sides. I then used the same piece of plywood to position the circuit board in the enclosure, so that the center pins of the SMA connectors would just touch the microstrip traces. The center pins of the connectors were too long, so I had to cut them down slightly.

There were also instances of irrelevant instructions. There was no need to mark



or drill holes for the SMA connectors, as the panels came pre-drilled. According to Gerry Rodski, K3MKZ, of SSB Electronic USA, this was the result of product improvements he requested for the US market. Also, the PC board has little index holes for properly locating the resonators so there is no need to mark their positions with dividers, as stated in the instructions.

The instructions were also wrong. The voltage measured at test point MP4 should be tuned for a maximum, not a minimum. As the RF input to this stage is maximized, the FET is moved away from its I_{dss} point, so the *current* actually decreases.

It took me about 8 hours to assemble the transverter. I found it quite useful to have two soldering stations—one with a very fine tip for most connections and another for soldering near plated-through holes to ground, or ground vias. The ground vias require considerably more heat to solder properly. A larger tip helps a lot, particularly when using 2% silver no-clean solder. For the SMD components, I hunted around for the smallest tip I could find—there are many of these small parts to install and no solder mask to ease the task.

As the instructions clearly state, this is no project for a beginner. Indeed, some hams might be intimidated with just the task of properly positioning the components in the right locations. Installing all of the components onto the PC board is just a single step in the instructions. Large parts placement diagrams, however, help to simplify this task.

A Few Assembly Tips...

I ended up having to unsolder and reposition the 1 µF gate bias cap for the receive amplifiers—it got in the way of a 10 kΩ bias adjustment potentiometer.

I had trouble installing the 8 V transmit regulator—it seemed just too big to install in the proper location, even after I filed down the pins and the edge of its case. I solved the problem by slicing off part of its mounting tab with a shear. It turns out that this was the result of the PC board not being installed precisely flat—the circuit board rising up a mm or two is too much. Thus, you should ascertain that the board height is accurate for the regulator, as well as the three SMA connectors *before* you solder its perimeter to the inside of the enclosure.

Debugging and Alignment

Adjustment and debugging took another couple of hours. I had one bit of solder that shorted out the bias for a transistor and other stage that wasn't quite soldered adequately. Both situations were easily identified, as the stages wouldn't tune properly.

After tune-up, I measured the local oscillator frequency and found it to be roughly 60 kHz high. I found it easy to move it down in frequency by tuning the oscillator coil. I initially moved it down a little more than needed, just to verify that it had sufficient adjustment range.

Stability seems good for a simple PTC (positive temperature coefficient) crystal heater. After warm-up stability was within about 4 kHz over a 1.5-hour test.

Sixty-six percent of the drift was observed in a simulated transmit test. After 20 minutes of continuous transmit the frequency drifted upwards by 2.6 kHz. This is not surprising, as the current nearly doubles during transmit, from 0.21 to 0.40 amps.

The current draw is rather low, making this transverter an excellent choice for battery-powered operation. The heater increases the initial current draw by about 0.2 amps, but it takes only about 5 seconds or so for it to drop to 0.1 amps of extra current, according to a room temperature test.

Alignment by voltmeter worked just fine. Without any further adjustment the unit met its claimed specifications of a 1.2 dB receive noise figure and 20 dB gain, as well as 200 mW of RF output from of the transmitter.

Tuning the resonator and locking down the screws was a bit of a challenge. This is somewhat of an art, as tightening down the lock nuts pulls the screws back out of the resonators, detuning them. It was almost impossible to make these adjustments with a digital multimeter. I'd strongly recommend using a 'scope or analog meter for this particular task.

Assembling the Transverter into a 10 GHz System

Attaching a standard SMA relay to the transverter is simplified by the spacing of its receive and transmit ports. The distance between the two connectors on standard SMA relays match those on the transverter, so barrel connectors can be used to make the connection. Most hams purchase these relays on the surplus market. They cost several hundred dollars new, but can usually be found at hamfests for between $10 and $50. The majority of these are designed to operate on 24 V, but 12 V ones have been showing up lately. I used a 24-V relay that I rewound for 12 volts.[1]

The IF transceiver is connected to the transverter through a third SMA bulkhead connector. Four feed through capacitors serve as the connection points for the dc power, manual PTT control, 12 V output on transmit (for controlling additional system components) and **MON** output. This connection allows you to monitor the relative RF power output with a voltmeter.

To mount the transverter near a dish feed, I decided to machine two Lexan plates so that the transverter would fit snugly between them. The plates are held together with screws. One plate provides an attachment point for a mounting bracket.

Is 200 mW Sufficient Power to Make the Path?

Many hams are confused by the path loss equation (there are actually three different equations!). The most intuitive is for an isotropic radiator and a fixed aperture receiving antenna. In this case, the path loss is independent of frequency. The most often quoted example uses isotropic radiators on both ends—in this case the path loss increases with frequency, as the receiving antenna gets smaller. However, with microwave antennas, it is most common for the aperture to be the same size on both ends. In this case, path loss actually decreases with increasing frequency. Thus, in terms of free space loss, a pair of 2-foot dishes exhibits 13 dB less loss on 10 GHz than they do on 2.3 GHz. Similarly, a pair of 2-foot dishes at 10 GHz has 10 dB less path loss than 4-element Yagis on 2 meters (67 dBi – 20 dBi – 37 dB = 10 dB).[2]

A system built around this transverter and a 2-foot dish would be quite adequate for hilltopping. I've heard a pair of 200 mW stations make a 300-mile contact when the band peaked. However, I find that more power is needed to operate from the flatlands of the Connecticut shoreline. I'd consider 3 W RF output, a 2-foot dish and good CW skills the minimum for reliably making 100-mile contacts. Amplifiers up to 10 W output can be purchased from SSB Electronic USA.

In Conclusion

I'd recommend this assembly project only for advanced kit builders who are comfortable installing surface mount parts. Fortunately (for everyone else) assembled and tested versions are also available. Kuhne Electronic has also announced a version housed in a professional quality milled aluminum case that is designed to ease installation in mast-mount applications.

Manufacturer: Kuhne Electronic, Birkenweg 15, D-95119 NAILA/Hölle, Germany. Kuhne Electronic products are available in the US from SSB Electronic USA, 124 Cherrywood Dr, Mountaintop, PA 18707; 570-868-5643; fax 570-868-6917; **www.ssbusa.com**.

Price: $580 assembled and tested, $385 in kit form. Similar transverters for other microwave frequency ranges are also offered.

[1]Harvey W. Lance, K7IT, "Conversion of Surplus Relays to Other Operating Voltages," Technical Correspondence, *QST*, May 1980, p 34.

[2]Rick Campbell, KK7B, "Does Path Loss Increase with Frequency?" Technical Correspondence, *QST*, Jan 1991, p 38.

N4PY Pegasus Control Program, version 1.45

In February 1999, *QST* published a Product Review of the TenTec 550 Pegasus transceiver based on the user software provided by Ten-Tec. The Ten-Tec folks have generously made their software "open source" so that others can use it as a guide to fashion their own versions. Carl Moreschi, N4PY, took up the challenge and the result is a remarkable piece of software known as the *N4PY Pegasus Control Program*. Not only is it easy to use, the software adds a number of features to the Pegasus, many of which are not available in any other transceivers on the market.

A Guided Tour

Figure 1 shows a screen shot of the front panel display. You can see three columns of band-change buttons on the right side. Note the heading on each column (CW, SSB and SWL). Clicking on the "20" button under SSB causes the button lettering to change color (default is blue) as you're suddenly transported to the phone portion of the 20-meter band. Likewise, if you want to operate in the CW portion of 15 meters, you only have to click on the "15" button under the CW column. When a selection of a band is made under SSB, the sideband (upper or lower) is automatically selected for the band. The "SWL" mode configures the Pegasus for shortwave listening on any given band.

If you use your Pegasus with VHF transverters, you'll appreciate the "6" and "2" meter buttons. They configure the Pegasus' frequency display to show the actual 6 or 2 meter frequency being worked, not the 10-meter "IF" frequency. The frequency display can be adjusted to zero beat to WWV at 10 MHz, then independently adjusted to compensate for any frequency error generated by the transverters themselves.

The N4PY software adds a new function that causes the analog frequency scale to vary with the step size. You can now define your license class and have your transmit privileges displayed on the analog frequency scale! You can also decide to have your transmitter follow your license class. That is, the background of the frequency scale will be blue for CW and digital mode-only operation, green for phone operation and burgundy for "forbidden" spectrum. (A constant incentive to upgrade!) If you select this feature, transmit will be blocked when you tune to a frequency that is not authorized by your current privileges.

The *N4PY Pegasus Control Program* adds a configurable RTTY button. The label for this button can be specified, the actual operating mode can be set to USB or LSB, and the frequency offset in hertz can be specified. A second RTTY mode has been added as well. If you right click on the RTTY, you'll be allowed to define a second digital mode. In other words, you can define one mode as RTTY and the other, for example, as PSK31.

Finally, I was impressed with the added ability to run the frequency sweep continuously and stop when a signal reaches a user-selectable threshold. Very handy!

This review only summarizes the highlights of the *N4PY Pegasus Control Program*. Other fascinating features include an ID timer and the ability to personalize the "front panel" with your own call sign.

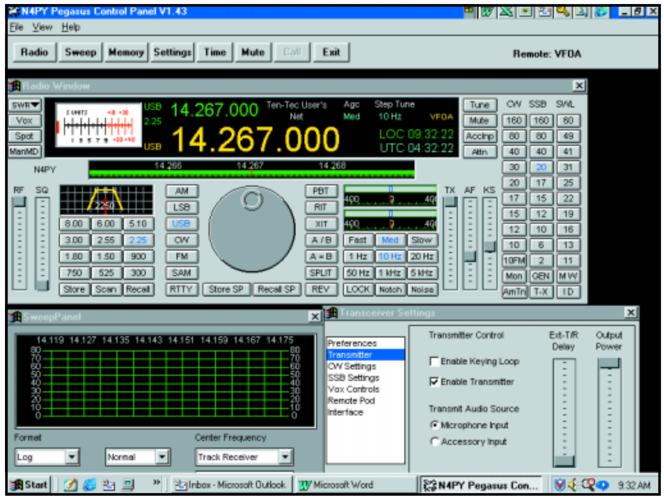
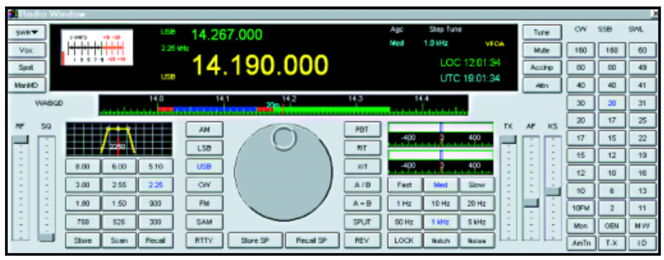


Figure 1—The *N4PY Pegasus Control Program* with the sweep and transceiver-settings windows enabled.



In this view, the *N4PY Pegasus Control Program* is configured for a General licensee. Note the red colored "forbidden" Amateur Extra areas at the bottom of the 20-meter phone and CW subbands.

Outstanding Work

Carl Moreschi, N4PY, has done a great job with this software. It adds extraordinary convenience and functionality to the Pegasus at a nominal cost.

Manufacturer: Carl Moreschi, N4PY, 173 Cody's Way, Franklinton, NC 27525; **n4py@earthlink.net**. *To order the latest registered version, send a check for $25 to Carl at the address indicated along with your e-mail address. The software will be e-mailed to you. You can also download a free demo version on line at* **www.qsl.net/tentec/** *(go to the "software" section).*

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