Product Review Column from *QST* Magazine

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Heathkit HV-2000 Voice Synthesizer

LMW 1296TRV1K 23-cm Transverter Kit

LMW Electronics 2304TRV2 2304-MHz Transverter

Yaesu FT-23R 2-Meter Hand-held Transceiver

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Conducted By Mark Wilson, AA2Z
Senior Assistant Technical Editor

Yaesu FT-23R 2-Meter Hand-held Transceiver

Let's face it: Most hams are gadget freaks. We like to have new toys to play with, and the manufacturers accommodate us by releasing new radios periodically. The FT-23R (and FT-33R for 220 MHz and FT-73R for 450 MHz) transceivers are Yaesu's entry into the tiny-little-hand-held transceiver market.

Features

The FT-23R is rugged. The case is aluminum and zinc, but the battery packs are plastic. A tight rubber gasket seals the controls and top-panel jacks. This is the most sturdily built hand-held transceiver I've ever seen. The metal case makes it a bit heavier than some other hand-held transceivers, but it certainly can take a lot of abuse.

Operating frequency, repeater offset (+ or −), memory number, signal strength and transmitter power output are shown on an LCD on the front panel. Squelch, volume and high/low power controls, as well as earphone and microphone jacks and the tuning dial, are located on the top of the radio. Front-panel switches control priority-channel operation, tuning, repeater shift and continuous tone-coded squelch system (CTCSS) tones (with the optional CTCSS unit).

The transceiver covers 144 to 148 MHz. Power output ranges from 200-500 mW on low power to 2-5 W on high power, depending on the battery pack used. Ten memories store information on operating frequencies and repeater splits (odd splits may be stored in seven of the memories), and continuous scanning operation—including channel lockout—is possible. The FT-23R offers almost all the features I look for in a hand-held transceiver.

Frequency entry is accomplished either with a tuning knob on the top of the radio or with the up- and down-arrow switches on the front panel. Three tuning steps are provided: 5 kHz, 10 kHz and 1 MHz. The front-panel STEP control selects between 5- and 10-kHz steps. "Giant steps" (1 MHz) are entered with the F (shift) key and the up- and down-arrow keys. This tuning arrangement is not quite as convenient as direct keyboard entry or even thumbwheels, in my opinion. Most users will enter their favorite frequencies into the memories and rarely use the tuning knob or arrow keys.

Memory entry is simple. You dial up the desired frequency and press F and the D/MR key (the D/MR key selects between dial and memory operation). A memory number flashes in the upper left-hand corner of the display. Next, crank the tuning knob or use the up- and down-arrow keys until the display shows the number corresponding to the memory you want the frequency stored in. Press the D/MR key again, and the memory is loaded.

Repeater splits are entered with the RPT key. Pressed once, the RPT key enters a plus 600-kHz split. Pressed again, the RPT key enters a minus 600-kHz split. Odd splits may be entered (and stored in the first seven memories) by first storing the receive frequency in memory and then storing the transmit frequency with the PTT switch held down. Perhaps a bit complicated, but at least it *can* be done.

Memory channel 0 is used for the "calling channel." This memory can be instantly recalled with the front-panel "dot" key. Memory channel 1 is the priority channel. With priority operation enabled, the radio checks memory 1 every five seconds.

Scanning operation is started by pressing and holding down the up- or down-arrow key. If the transceiver is not in the memory mode, the receiver begins to scan in increments selected by the STEP key (5 or 10 kHz). When a busy frequency is found, the receiver stops scanning until approximately two seconds after the signal goes away. If the transceiver *is* in the memory mode when scanning is initiated, it scans the memories. Again, when a busy frequency is found, the receiver stops scanning until two seconds after the signal goes away. This is a bit different from other scanning radios I've used (such as Yaesu's FT-109RH 220-MHz hand-held), where the scanner stops for a set period and then continues to scan even if the frequency stays busy. I'm not sure which mode I prefer; it would be nice to have both. Scanning operation can be stopped by pressing either arrow key or the PTT switch.

Memory frequencies can be locked out of a scan by using the F and D/MR keys; once a memory is locked out, however, it must be re-enabled with the keypad before it can be used at all. By comparison, the FT-109 lets you manually step through all the memories while leaving some locked out of a memory scan.

A "burst" switch is located just above the PTT button on the left side of the radio. On the European version, this switch controls a 1750-Hz tone burst. On the American version, the switch opens the squelch to let you check the receive frequency for signals under the squelch threshold.

The 16-key, membrane-type dual-tone, multifrequency (DTMF) tone pad is an option on this radio. Without the tone pad, the radio is quite small—approximately 2.2 inches wide by 5.5 inches long with the FNB-10 battery pack (excluding the antenna). The tone pad adds another 0.8 inch to the length. Embossed bumps in the membrane over each key contribute to the good feel of the tone pad.

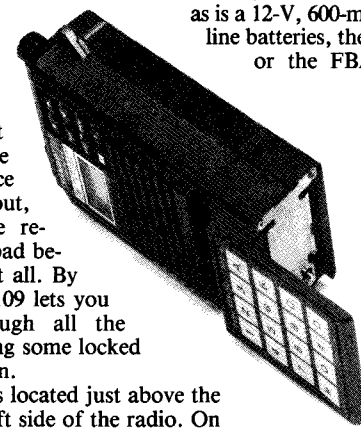
One aspect of the tone pad I didn't like is its mechanical construction. The front of the tone pad hangs in space when the battery pack is removed, as shown in the photographs. This may render the pad prone to damage when the battery pack is being changed.

CTCSS operation is possible on transmit and receive with the optional FTS-12 "tone squelch" unit. Any one of 37 standard tones can be selected *and* stored in memory. This is a handy feature if the repeaters in your area use different CTCSS tones. The Product Review radio did not have the CTCSS unit, but the instructions for installing the board did not seem too complicated.

The FT-23R has a very interesting feature not often found in amateur gear. Using a cable connected from the earphone output on one FT-23R to the microphone input of another FT-23R, it is possible to "clone" the memory information from one radio to the other. I'm not sure why you'd want to do this, and it seems to indicate that this is an amateur version of a commercial radio. In a commercial application (such as a police or fire department), the memory information in all the radios in the fleet could be transferred from one master radio. The DTMF pad must be removed to access a switch on the bottom of the radio to enable the memory-transfer feature.

Battery Power

Our Product Review radio was provided with an FNB-10 7.2-V, 600-mAh NiCd battery pack. This battery pack allows 2.5-W RF output with the FT-23R set for high power. A 7.2-V, 200-mAh pack (model FNB-9) is available, as is a 12-V, 600-mAh pack (FNB-11). Cases for alkaline batteries, the FBA-9 for six AAA-size batteries or the FBA-10 for six AA-size units, are available as well.



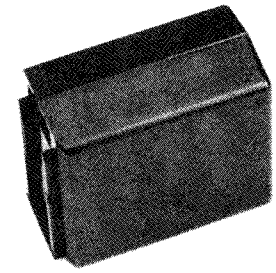


Table 1

Yaesu FT-23R 2-meter Hand-held Transceiver, Serial no. 6N073075

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 144 to 147.9995 MHz.	144-148 MHz.
Mode of operation: G3E (FM).	As specified.
Frequency display: Not specified.	6-digit LCD.
Frequency resolution: 5 kHz.	As specified.
Transmitter	*Transmitter Dynamic Testing*
Power output: Low, 0.2-0.5 W; high, 2.5 W (with FNB-10 battery pack).	Low, 0.4 W; high, 2.6 W (with FNB-10 battery pack).
Spurious signal and harmonic suppression: better than −60 dB.	See Fig 1.
Receiver	*Receiver Dynamic Testing*
Receiver sensitivity: Better than 0.25 μV for 12-dB SINAD.	0.19 μV for 12-dB SINAD. 10-dB quieting 0.14 μV.
Squelch sensitivity: Not specified.	0.06 μV min, 0.19 μV max.
Receiver audio output at 5% total harmonic distortion: 400 mW with 12-V battery pack.	260 mW with 7.2-V battery pack. Not tested with 12-V battery.
Color: Black.	
Size (height, width, depth): 5.5 × 2.2 × 1.25 in with FNB-10 battery pack.	
Weight: 1.2 lb with FNB-10 battery pack.	

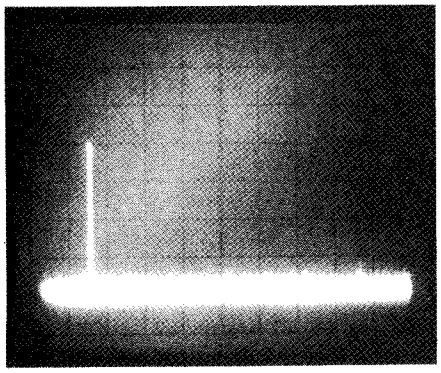


Fig 1—Spectral display of the Yaesu FT-23R operating at 146.0 MHz with approximately 2.6 W output power. Vertical divisions are each 10 dB; horizontal divisions are each 100 MHz. The fundamental has been reduced in amplitude approximately 30 dB by means of a notch filter to prevent spectrum analyzer overload. All spurious emissions are at least 60 dB below peak fundamental output. The FT-23R complies with current FCC specifications for spectral purity.

The FT-23R features a "battery saver" circuit that causes the radio to "go to sleep" for 600 ms between 300-ms receiver checks. In actual use, the battery pack did last quite a while. When the battery voltage drops below 6.5 V, a tone sounds continuously to let you know it is time to change battery packs. There is no battery check feature.

Accessories

The usual range of accessories is available for the FT-23R; a 15-hour battery charger is provided with the radio, and a quick charger is available. A mobile dc adapter (model PA-6) is available, and the operating manual lists five different soft carrying cases (one for each different NiCd pack and two more for use with the DTMF pad attached to the radio). A speaker microphone and "hanger bracket" are available for mobile use.

Operation

The review radio worked well. Several HQ staffers commented that it fits comfortably in the hand. A few minor irritations did show up, however. There is no light for the LCD; this makes night operation a bit difficult. The tuning scheme seemed a bit complicated until I loaded my favorite frequencies into the memory. (After that, tuning was still complicated, but I didn't have to *tune* the radio any more!) If I didn't absolutely need the tone pad, I wouldn't buy it; it makes the radio quite a bit larger and awkward.

Conclusion

This is a well-built radio. Operation is not too difficult, and the array of controls should not be intimidating to a first-time user. There are a few things I might have done differently if I was designing this radio, but everyone has different operating requirements. I'm sure the radio will find enthusiastic users.

Manufacturer: Yaesu USA, 17210 Edwards Rd, Cerritos, CA 90701, tel 213-404-2700. Price class: $300 (including DTMF pad). *—Bruce Hale, KB1MW*

LMW ELECTRONICS 2304TRV2 2304-MHz TRANSVERTER

The 2304-MHz (13-cm) band has seen increased interest among UHF weak-signal enthusiasts, VHF/UHF contest operators and, more recently, amateur satellite types. Although there are no US-built transverters or transceivers for this band, there are several fine pieces of equipment being imported from Europe. You no longer have to be a builder to become operational on 13 cm. Although not as easy as getting on, say, 2 meters with a multimode transceiver, it is possible to get on with a minimum of technical expertise and special equipment.

The subject of this review is the 2304TRV2 transverter manufactured in England by LMW Electronics. These transverters are available in a variety of configurations ranging from a "bare bones" kit to a deluxe unit similar to the 2304TRV2, but with a built-in TR sequencer.

Circuit Highlights

The 2304TRV2 is a linear transverter that converts signals in the 2304-2308 MHz range to 144-148 MHz. It works on all modes and is meant to be used with a 2-meter transceiver as a tunable IF. Weak-signal activity centers around 2304 to 2304.1 MHz, so the 2-meter rig is normally operated at about 144 MHz.

The 2304TRV2 is built in several modules. They include:

1) 1080-MHz local oscillator (LO)
2) receiver preamplifier and mixer
3) low-noise receiver preamplifier
4) 2-meter post-mixer amplifier
5) 2-meter IF switching circuitry, transmit mixer and low-level transmitter stages
6) transmitter driver and final-amplifier.

Everything except the receiver low-noise preamp is housed in a compact, attractive aluminum enclosure. The preamp, housed in a rugged die-cast aluminum box, can be connected to the receiver input jack on the back of the transverter. If you have long runs of feed line, the preamp should be mounted near the antenna for best performance. Even 7/8-inch Hardline has significant loss at this frequency.

The receiver preamp uses an NEC NE720 GaAsFET. There are two more bipolar transistor amplifier stages on the receiver mixer board, followed by a filter, followed by a diode mixer. The mixer also doubles the 1080-MHz LO signal to get the required 2160-MHz injection frequency. The IF output of the receive mixer board is routed to the 144-MHz post amplifier, a dual-gate MOSFET.

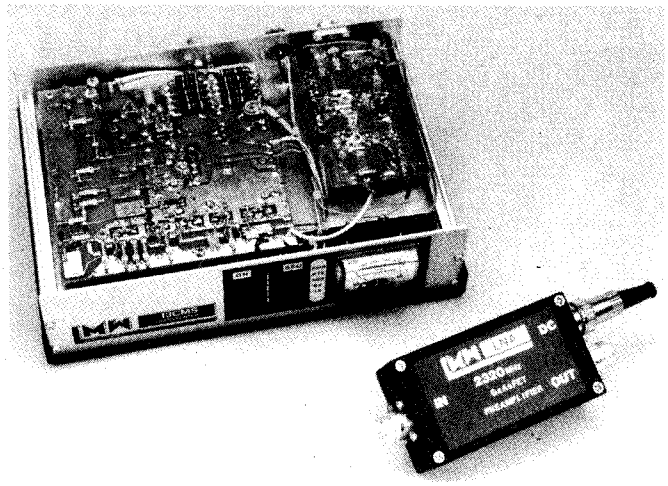
Lab measurements made with a Hewlett-Packard HP8970A automatic noise-figure meter and HP346A noise source indicate that the overall conversion gain is about 21 dB, with a 1.8-dB noise figure (see Table 2). This is good performance at 2304 MHz. Without the low-noise preamp, however, conversion gain is about 8 dB with an 8-dB noise figure. The external preamp is really necessary with this transverter.

The low-level transmit section contains a doubler for the 1080-MHz LO, a diode mixer, filtering and five stages of amplification. Power output from this lineup is approximately 300 mW. Also contained on the low-level transmit board is a TR relay and associated circuitry for the 2-meter IF, as well as attenuators to allow the transverter to work with 2-meter rigs that put out up to 10 W. The final amplifier section is built on a separate board and mounted to a heat sink. It uses a pair of Mullard BFQ68 devices to develop about 1.5-W output, as measured on a Hewlett-Packard HP435 power meter with precision attenuators.

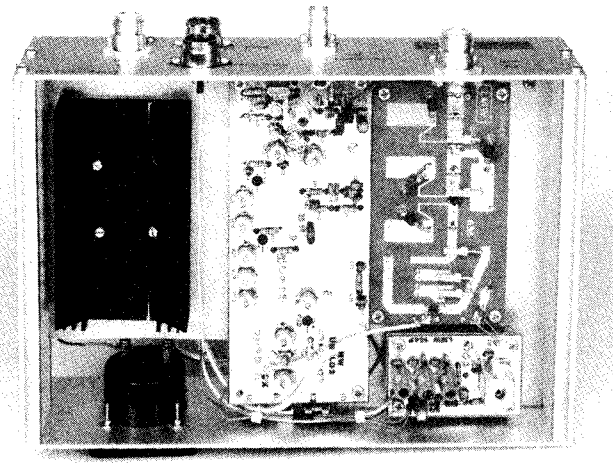
The transverter appears to be solidly built. The receive preamp/mixer, low-noise preamp and transmitter final amplifier are all built on high-quality glass-Teflon® board. The transverter looks relatively easy to troubleshoot, although there are about 40 variable capacitors to tweak.

Connections

The low-profile front panel holds a relative power-output meter, an ON/OFF switch



LMW 2304TRV2 transverter with top cover removed. The large board on the left holds IF switching circuitry, the transmit mixer and low-level transmit stages. The shielded compartment at the right contains the transmit driver and power amplifier stages. The low-noise preamplifier is in a separate box for remote mounting.



The underside of the LMW 2304-MHz transverter holds the local oscillator, receive mixer and IF amplifier boards. At the left is a heat sink for the transmitter PA.

Table 2

LMW Electronics 2304TRV2 2304-MHz Transverter, Serial no. 017

Manufacturer's Claimed Specifications	***Measured in ARRL Lab***
Transmitting Converter	
Input frequency: 144-148 MHz.	As specified.
Output frequency: 2304-2308 MHz.	As specified.
2-m drive power: 0.1-10 W.	As specified.
Output power: 1.6 W minimum, 2 W typical.	Maximum saturated output, 1.55 W at 2304.1 MHz.
Receiving Converter	
Input frequency: 2304-2308 MHz.	As specified.
Output frequency: 144-148 MHz.	As specified.
Overall noise figure: Not specified. Low-noise preamp, 1.1 dB max.	1.8 dB at 2304 MHz. Preamp not measured separately.
Overall conversion gain: Not specified.	21.5 dB at 2304 MHz.
Power supply requirements: 13.8 V dc at 2.5 A during transmit, 0.25 A during receive.	13.8 V at 0.9 A during transmit (1.55 W output) and 0.7 A during receive.
Dimensions (height, width, depth): 2.8 × 10 × 7 in (main unit); 1.25 × 4.5 × 2.25 in (preamp).	
Color: Black and silver.	

and a switch to activate the optional TR sequencer. The rear panel has a BNC connector for the 2-meter IF transceiver and N connectors for the transmitter output and receiver input. A multipin socket marked PWR is used for ground, +13.8-V and PTT (ground to transmit) connections. A separate FACILITIES jack is used for outputs from the optional TR sequencer. The preamp has N connectors for input and output and a locking, multipin connector for power.

The 2304TRV2 contains internal switching to connect the 2-meter IF rig to the transmitter attenuator in transmit and to the output of the receiver in receive. There is, however, no internal antenna relay. It's up to you to locate an appropriate relay. Given the cost of a brand-new microwave relay and the desirability of mounting the preamp and antenna relay at the antenna, this is a good move. I used a surplus Transco SMA-type relay purchased at a flea market.

It's relatively easy to get the 2304TRV2 up and running if you've used a similar transverter before. I spent about three hours making cables and lashing everything up. First, you'll need a 13.8-V, 1-A power supply. Next, you'll need to locate an antenna relay and make the appropriate dc connections. If you plan to use the preamp in the shack, you'll need to make up an appropriate cable with N connectors. Note that even RG-8 cable has appreciable losses at 2304 MHz, so try to keep all interconnections as short as possible. A single cable runs between the VHF TRANSCEIVER jack on the rear of the transverter and the antenna jack on the 2-meter rig. To control the 2304TRV2 TR switching from the 2-m rig, you need to connect the PTT jack on the transverter to a line from the transceiver that is grounded in transmit and open in receive. The 2304TRV2 does not contain RF switching—you *must* ground the PTT connection to switch from receive to transmit.

When all of the interconnections are made, connect an antenna and fire it up. You'll need to remove the top cover and adjust the attenuator potentiometer for the correct 2-meter drive level. In my case, 3 W from an ICOM IC-260 in the low-power position worked just fine. Although the transverter will work with transceivers delivering up to 10-W output, it's probably a good idea to use as little power as possible. Why waste a lot of energy heating up the attenuator resistors inside the case?

The manual supplied with the unit is skimpy—a real drawback. The transverter is offered in kit form (kits account for the vast majority of its European sales), and the manual is simply a collection of assembly instructions for each module. What this transverter really needs is an organized manual with step-by-step hookup and operating instructions. The US importer is working on an improved manual, and this should be available by the time this review is published. The assembly instructions are nice, though, because they give complete schematic diagrams and board layouts, as well as tune-up information that would be very handy for troubleshooting or modifications.

Operation

The LMW transverter saw plenty of contest action during the W1XX portable operations during the June and September ARRL QSO Parties, as well as at 4U1UN in the *CQ* Magazine WPX VHF Contest. The transverter was used with an IC-260 as an IF transceiver and a single Down East Microwave 45-element loop Yagi. The feed line consisted of about 25 feet of Belden 9913. The results got better with experience, and the 2304-MHz tally for

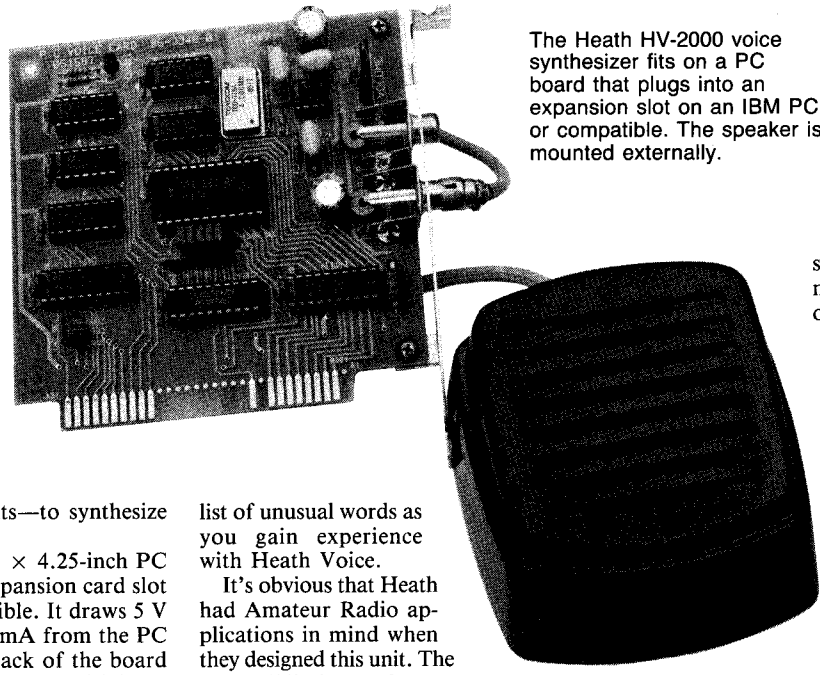
the September event was 7 QSOs in 6 grid squares.

John Lindholm, W1XX, and I also used the 2304TRV2 on several grid-hopping expeditions in the northeast. Our best contact was from Mt Equinox, Vermont; we worked Rick Connor, WB2NPE, at a distance of 250 miles. Not bad for a watt and a half! The LMW transverter proved reliable, even after riding more than a thousand miles in the back of a van, and it was easy to set up and get working. These characteristics are essential for portable operation.

LMW offers a fine way to gear up for weak-signal DX on the 2304-MHz band. US distributor: Down East Microwave, RR 1, Box 2310, Troy, ME 04987, tel 207-948-3741. Price class: $640.—*Mark Wilson, AA2Z*

HEATHKIT® HV-2000 VOICE SYNTHESIZER

I know what you're thinking: "Who needs another voice synthesizer? They're in repeater controllers, cars, soda machines and even refrigerators. Once the initial 'cuteness' of most of these applications wears off, I don't have much use for talking computers." That was my initial reaction to the Heath Voice synthesizer when I was asked to do the Product Review. Now, I'm convinced that this device has legitimate applications beyond the "gee whiz, that's neat" stage. More than just a simple synthesizer, the HV-2000 is a complete synthesizer/software package. It is built around an SSI263A voice-synthesizer chip; this chip uses allophones—or word fragments—to synthesize speech.



The Heath HV-2000 voice synthesizer fits on a PC board that plugs into an expansion slot on an IBM PC or compatible. The speaker is mounted externally.

Heath Voice fits on a 5- × 4.25-inch PC board that plugs into an expansion card slot in an IBM® PC or compatible. It draws 5 V at 275 mA and 12 V at 10 mA from the PC bus. Phono jacks on the back of the board provide 500 mW audio output for driving a speaker and a 10-kΩ line-level output for connection to an external audio amplifier.

The kit is very easy to assemble, as there is no enclosure to worry about. Assembly consists of simply stuffing the PC board and soldering everything in place. All ICs are socketed, and the kit-building directions are very detailed and easy to follow (a typical Heathkit). The project took about two hours to build.

The main difference between this voice synthesizer and most of the cute "toys" I've seen is in its software. As soon as you put the cover back on your computer, you can test the voice box by typing a simple command: SPEAK SPEAKME.TXT. The unit responds by speaking "Congratulations. Your HV-2000 is up and running." The rest of the commands are almost that simple. To have the synthesizer speak a line of text, simply type the command SPEAK followed by the text to be spoken. You can have it speak the contents of a text file by typing "SPEAK" followed by the filename. The voice unit is installed as a device in DOS (like a printer or serial port), so anything you can route to a logical device can be spoken by the voice unit.

Software is also provided to customize the way Heath Voice pronounces words and to build a custom vocabulary. This is handled by Heath's versatile NEWORDS program. When you tell NEWORDS what word you want to change, it responds by pronouncing the word for you and showing you what allophones the HV-2000 is using to create the word. To modify the pronunciation, you change the allophone list. The card then speaks the new pronunciation and asks if it's okay. You can repeat the process until you're satisfied. Once the word sounds right to you, the software enters the new pronunciation into an exception file, and from then on, the word is pronounced using the modified allophone list. This procedure reminds me of using a spelling-checker program. The program is initially "dumb"; you must build a list of unusual words as you gain experience with Heath Voice.

It's obvious that Heath had Amateur Radio applications in mind when they designed this unit. The unmodified software recognizes that any word with a number in the middle of it—such as a call sign—should be spelled out letter by letter, rather than pronounced as a word. Using switches in the configuration file, it is possible to have the box speak all punctuation (dash, comma, ellipsis and so on) and to have all numbers pronounced digit by digit (one-zero-zero instead of one hundred). An "auto-inflection" mode is provided, although I'm not sure if this mode is easier to understand than the monotone.

Part of the SPEAK software is a terminal program. Simply type SPEAK COM1:1200 to speak whatever is coming in on COM1 at 1200 bauds (other speeds can be set at the command line as well). The terminal program works well. It is possible to send and receive disk files and to turn the voice on and off from inside the terminal program. These features (and the other terminal functions) are controlled by the PC function keys.

An obvious Amateur Radio application for Heath Voice and the terminal program is packet radio for a blind ham. How well does it work in this application? I'm not blind, and I had no way to evaluate the unit with a blind ham, but I think it would work well. I used a TNC, 2-meter transceiver and my PC to connect to the W1AW-4 bulletin board. I set the voice unit to speak all punctuation and to pronounce all numbers digit by digit. I also reconfigured the TNC to give each packet the shortest possible header in the monitor mode. The voice unit did very well, and the packet information was quite understandable. The voice took a little getting used to, and I could read the screen much faster than Heath Voice could speak the information, but I was really impressed with the unit. A blind amateur might need some help with the initial set up (building the exception file and other fine tuning).

Another feature of the voice unit is the ability to adjust the rate and duration of the speech. This is done using the simple configuration commands explained in the manual. Using these commands, I made the unit speak more rapidly, but still understandably, for use with the TNC. Again, with a little fine tuning, the unit can be optimized for a particular application.

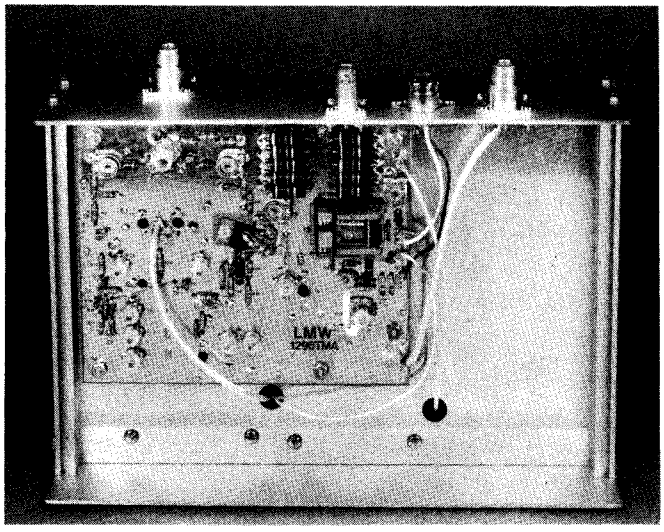
The fact that the voice unit is installed as a DOS device makes it easy to write new software to speak to the synthesizer. The manual includes information on addressing the unit in BASIC, and anyone with a good knowledge of any other computer language should be able to extend this information.

I expect that the HV-2000 will be enthusiastically received by the ham community. My initial reaction that the unit was just another toy changed when I saw what the software could do. Anyone with a little time and patience should be able to come up with a very good voice system using this unit. I think that after the device has been around for a while, we will see people trading exception files and optimized software so that new Heath Voice users can get set up with very little work.

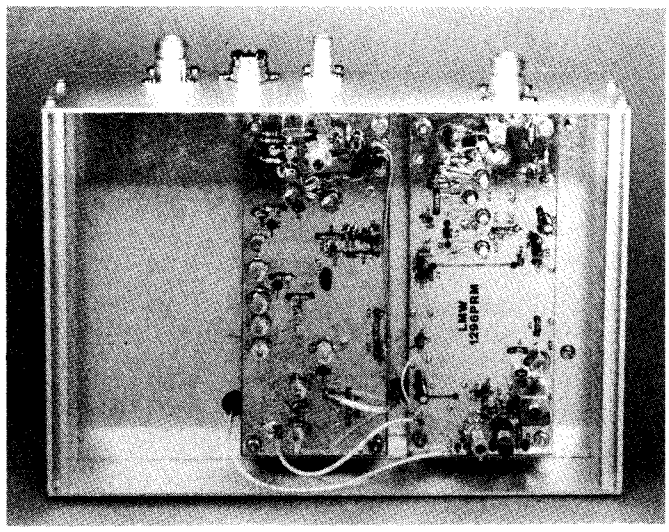
Manufacturer: Heath Company, Benton Harbor, MI 49022, tel 616-982-3411. Price class: $90.—*Bruce Hale, KB1MW*

LMW 1296TRV1K 23-cm TRANSVERTER KIT

I was really intrigued by the reports of a 1296-MHz to 144-MHz transverter kit. After all, can you really expect to build and align a complicated piece of microwave equipment without an RF lab? Although my kit building experience is limited to a Heathkit receiver and some simple projects, I ordered one to



This PC board holds the IF switching and transmitter circuitry for the LMW 1296-MHz transverter kit.



The other side of the LMW 1296-MHz transverter chassis holds the local oscillator and receiving converter.

find out. Admittedly, I have some experience in designing and building RF equipment, as well as full access to the ARRL laboratory.

What this Kit Does

The LMW transverter is a box that converts a 1296-MHz (23-cm) signal to 144 MHz and vice-versa. It is meant to be used with a 2-meter transceiver as an IF rig. An internal relay, keyed by a PTT line, switches the 2-meter transceiver between the 23-cm receive and transmit sections.

The 23-cm input and output (to connect the transmitter and receiver to an antenna) are separate N connectors. The purchaser must supply a suitable TR relay. Since a new low-loss microwave coaxial relay can cost almost as much as the kit, I used a Dow Key BNC relay purchased at a flea market for $10. The transverter runs from 13.8-V dc and needs 0.7 W of 2-m drive, although an attenuator allows up to 10 W of drive to be used.

Construction Details

The kit I purchased consists of kits for three separate modules, an unpunched and unlabeled aluminum case, and Teflon coax and connectors to interconnect the boards. The individual module kits are the UNVLO2 local oscillator, the 1296PRM preamp/receive mixer, and the 1296TMA transmit mixer/amplifier.

Upon unpacking my kit, I noticed several problems. Three regulator chips, a 100-ohm resistor and a piece of "tin-plate" were missing. (Upon notification, the kit's US importer, Down East Microwave, will promptly send replacement parts.) The pins on the IF TR relay were bent. The kit's static-sensitive NE41137 GaAsFET transistors were placed in an ordinary plastic bag with many of the other parts; the Schottky diodes were wrapped in aluminum foil! According to Down East Microwave, these problems have been solved on current kits. A selection of ¼- and ½-W resistors is needed to set proper bias levels. The builder is expected to know when to use ½-W resistors. Thirteen spacers and associated mounting hardware must be supplied by the builder to mount the boards. I used ¼-inch spacers (no particular board-mounting height was recommended).

The documentation is minimal and written in standard British technical terms. This is definitely not a kit for beginners, although there is plenty of information for an experienced builder to follow. You must know how to follow schematics and board layout diagrams to use the documentation. You must be familiar with VHF/UHF construction techniques and component markings as well. I was glad that I had read the last 23 issues of *SPRAT*, the journal of the G-QRP club!

Figuring out how to package the transverter took a little ingenuity. I needed to look at the assembled 2304-MHz transverter reviewed elsewhere in this month's column to find out how the case went together! It turns out that square nuts that mate with the cover screws fit into slots in the extruded aluminum panels. I glued the nuts in place with non-acidic silicone sealant. A suggested layout is supplied, although no dimensions are given. I suggest using the bare circuit boards as marking templates. (Don't forget the hole for T6, the power transistor.)

It took me about 14 hours to stuff the three double-sided, tin-plated circuit boards. A hand drill is needed to enlarge some transistor mounting holes and to make a hole for a diode lead. Stuffing the boards is not difficult because component locations are clearly silk-screened on the component side and parts-placement diagrams are provided. Take care not to lose or damage any of the tiny chip capacitors; no spares are supplied.

You must read the schematic. For instance, you have to look at the transmit-mixer input-network diagram to verify that the ferrite slug in L2 must be removed.

The documentation concerning T6, the BLV91 RF power transistor, could stand improvement. Although the transistor specification sheet on the last page of the manual does mention the beryllium-oxide (BeO) hazard presented by the BLV91's insulation, this is not mentioned in the construction section. Don't damage the BLV91's grayish-white BeO ceramic disc! BeO dust is toxic and dangerous to breathe. Fortunately, dusting is unlikely because of the hardness of ceramics.

Although the use of a heat sink for T6 is mentioned, no information is supplied on how to mount one. I ended up using two large no. 8-32 nuts to attach the transistor stud to the chassis, turning the nuts only to finger tightness to avoid cracking the transistor. This is a poor technique both mechanically and thermally, but I saw no better solution. Ideally, mechanical mounting of the transistor should be completed before soldering to minimize stresses.

Alignment and Testing

According to the instructions, the only test equipment needed is a power supply, multimeter, diode probe, 2-m transceiver and power meter capable of measuring 1 W at 1296 MHz. Unfortunately, my diode probe was never meant to work at 2 meters, much less 1.3 GHz! Instead, I used an HP435 microwattmeter.

The oscillator board almost worked on the first try. It was necessary to use 2-turn coils at L4 and L5 rather than the suggested 1-turn coils. This may be because 1-mm wire was supplied, rather than the specified 0.7-mm wire. (I cheated a bit and looked at the 192-MHz waveform with a scope to optimize the drive to the tripler.) Except for this minor modification, the board tuned up nicely using the multimeter and power meter. A look at the oscillator output on a spectrum analyzer confirmed that tune-up with these simple instruments provides good results. (It was possible to improve tuning slightly with the help of the analyzer's real-time display.) Spurs at 96, 576 and 1728 MHz were down 35, 36 and 30 dB, respectively, and spurs within 200 MHz of the carrier were down at least 62 dB. LO power to the transmitter and receiver boards is +13 and +7 dBm, respectively.

The preamp/mixer board also required minor revision. I trimmed the stripline

Table 3

LMW Electronics 1296TRV1K 1296-MHz Transverter Kit

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Transmitting Converter	
Input frequency: 144-148 MHz.	As specified.
Output frequency: 1296-1300 MHz.	As specified.
2-m drive power: 0.1-10 W.	0.7 W minimum for full output.
Output power: 1 W typical.	Maximum saturated output, 530 mW at 1296.1 MHz.
Receiving Converter	
Input frequency: 1296-1300 MHz.	As specified.
Output frequency: 144-148 MHz.	As specified.
Noise figure: Approximately 2 dB.	6 dB at 1296 MHz.
Conversion gain: Not specified.	9 dB at 1296 MHz.
Power supply requirements: 13.8 V. Current not specified for this configuration.	13.8 V at 0.7 A.
Dimensions (height, width, depth): 2.8 × 10 × 7 in.	
Color: Black and silver.	

associated with variable capacitor VC3 by 1/16 inch on the side with the chip capacitors. This allows greater tuning range. I also added a piece of no. 16 wire to extend the ground to the chip capacitors. The missing tin-plate piece would have been used to form an inductor; I substituted a strip of 0.02-inch silver-plated copper. Changing the dimensions of this inductor slightly had little effect on the transverter's receive noise figure. The biasing of transistor T1 had a large effect on the noise figure, though. Decreasing the bias current only 0.43% resulted in the noise figure dropping from 9.1 to 6.6 dB without additional tweaking! Maximum gain seems to correspond to best noise figure.

The transmit mixer/amplifier board also required a bias current change for best performance. The bias on the BLU98 driver was increased from 15 mA to 50 mA. The bias on the BRF91s was increased from 8 to 10 mA. This was done to increase the gain of the amplifier chain, increasing the power output from 150 to more than 400 milliwatts.

On-the-Air Testing

I used the transverter in the June 1987 VHF contest with an ICOM IC-251A 2-meter rig, an external 2.5-W amplifier and a 14-element loop Yagi at 18 feet. (The amplifier and the loop Yagi are versions of *ARRL Handbook* projects.) Operating from my apartment in the center of Newington, I worked W1AW and N1DPM on SSB, and W2SZ/1 and K1TR on CW. Best DX was W2SZ/1, about 90 miles away. I have since contacted other stations in the 100-mile range. Ed Hare, KA1CV, operating at nearby W1AW, did not find the transmitter's IMD products to be objectionable, even though I operated the transverter near its saturated output.

Transversion frequency error in my unit was about 22 kHz. This meant that the IF transceiver had to be set to 144.078 MHz for operation on 1296.100 MHz. An additional inductor in the oscillator circuit may eliminate the error, but degrade the transverter's frequency stability. I considered frequency stability more important than dial accuracy. Drift measurements over a period of several days (checked against the 9th harmonic of a 2-meter hand-held transceiver) indicate that the unit's frequency stability is fine.

Conclusions

Tests in the ARRL Lab (see Table 3) indicate that the LMW kit does not meet some of the manufacturer's specifications. According to Bill Olson of Down East Microwave, some of the specifications published by the manufacturer are optimistic. Experience with several units indicates that the figures I measured are typical, and Bill is revising the specification sheet to reflect this. He is also working with the manufacturer to improve the design.

This kit provides an inexpensive way to get on 23 cm, although it may be too difficult for some builders. Someone accustomed to building from scratch with appropriate test equipment will find it to be an interesting project that gives some insight into microwave techniques. On-the-air performance is fine, although an external GaAsFET preamplifier and a power amplifier would be helpful for DX work. Assembled versions are also available. US distributor: Down East Microwave, RR 1, Box 2310, Troy, ME 04987, tel 207-948-3741. Price class: $220 with enclosure; $170 without the enclosure. —*Zachary Lau, KH6CP*

SOLICITATION FOR PRODUCT REVIEW EQUIPMENT BIDS

[In order to present the most objective reviews, ARRL purchases equipment "off-the-shelf" from Amateur Radio dealers. ARRL receives no remuneration for items presented in the Product Review or New Products columns.—Ed.]

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Please clearly identify the item you wish to bid on, using the manufacturer's name, model number, or other identification number if specified. Each item requires a separate bid and envelope. Shipping charges will be paid by the successful bidder, FOB Newington. The successful bidder will be advised by mail of the successful bid. No other notifications will be made, and no information will be given by telephone to anyone regarding final price or identity of the successful bidder.

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Tono 777 communications terminal (see Product Review, Apr 1987 *QST*). Minimum bid $153.

Yaesu FT-109RH 220-MHz hand-held transceiver, s/n 6M010430 (see Product Review, Nov 1987 *QST*). Minimum bid $207.

Trio-Kenwood TH-31BT 220-MHz hand-held transceiver, s/n 7100172 (see Product Review, Nov 1987 *QST*). Minimum bid $160.

Kantronics KPC-2400 packet communicator, s/n 57534 (see Product Review, Nov 1987 *QST*). Minimum bid $217.

New Books

SAILING WITH HAM RADIO

By Ian Keith, WA6DNV and Derek Van Loan, WB6VXS. Published by Paradise Cay Publications, 1001 Bridgeway #404, Sausalito, CA 94965. First edition, 1987. Soft cover, 9 × 6 inches, 152 pages, $9.95.

This book has been written by two experienced radio amateurs for the reader who is a sailor first and an aspiring Amateur Radio aficionado second. Most of the book explains electrical principles, Amateur Radio history, techniques and operations, amateur transceivers and antenna principles in such a fashion that it all won't seem like so much mumbo jumbo to the sailor who is a rank novice in the field of shortwave communications. Although this discussion of technical subjects for the non-technical person will help many a reader, perhaps the most useful part of the book for many of us is the discussion on how to install an antenna on a sailboat, an antenna that will radiate satisfactorily on the HF bands and yet won't weaken the standing rigging.

We applaud the thought that all users of Amateur Radio aboard yachts be licensed—this book points out that achievement of that goal isn't too difficult. We recommend the book to the sailor who wants to become a radio amateur, and to anyone who wants some good information on how to install an HF antenna on board a sailing vessel. —*Richard L. Baldwin, W1RU*