Product Review Column from *QST* Magazine

October 1983

Bird Model 4410 Thruline Wattmeter

Morse Code Trainer II

Viewstar VS 1500A Transmatch

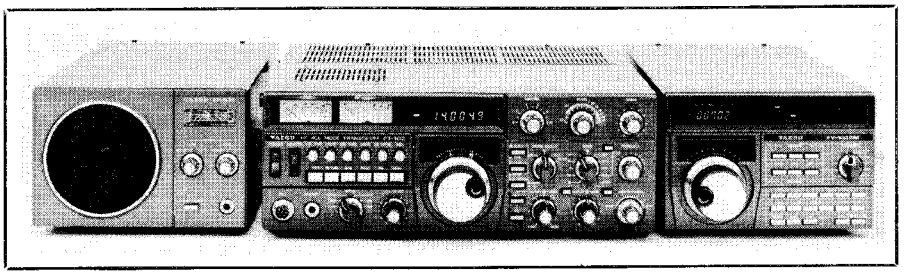
Yaesu Electronics Corp FT-102 HF Transceiver

Product Review

Conducted By Paul K. Pagel,* N1FB

Yaesu Electronics Corp. FT-102 HF Transceiver

I have observed a steady and impressive improvement in the performance of each new model of Yaesu transceiver. The receiver dynamic range has increased markedly, and the transmitter spectral purity has improved similarly. The FT-102 compares favorably in this respect to some other present-day, high-performance commercial transceivers. But most importantly, there is no performance similarity between the FT-102 and the earlier FT-101B and E models. The '102 provides fully competitive performance!



Yaesu Electronics Corp. FT-102 Transceiver, Serial No. 2J-050152

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 160 through 10 meters, plus WARC bands.	As specified, plus additional coverage above and below each band: 1453-2032, 3453-4032, 6953-7532, 9953-10,532, 13,953-14,532, 17,953-18,532, 20,953-21,532, 24,453-25,032 and 27,953-30,032 kHz.
Operating modes: Cw and ssb (a-m and fm optional).	As specified.
Readout: Blue 5/16-inch digital-display numerals.	As specified.
Resolution: 100 Hz.	As specified. 18 kHz per 360° dial rotation.
Power requirements: 100, 117, 200 or 234-V ac, 50/60 Hz.	As specified.
Power consumption: 95 VA receive and 440 VA transmit.	As specified.
Transmitter rf power output (cw with 50-ohm load): 100 W or greater.	150 W on 160-15 meters; 100 W on 10 meters
Transmitter third-order IMD: Better than −40 dB at 14 MHz.	−40 dB
Spurious suppression: Better than −40 dB.	Approximately −44 dB worst case (10.1 MHz).
Frequency stability: Less than 300 Hz during first 30 minutes and less than 100 Hz each 10 minutes thereafter.	Less than 200 Hz during first hour of operation.
Audio output (receiver): 1.5-W minimum at 8 ohms, 10% THD.	As specified.
RIT range: Not specified.	± 3 kHz.
Receiver notch depth: Better than −40 dB.	As specified.
S meter (μV for S9): Not specified.	160 m — 50; 80 m — 43; 40 m — 43; 30 m — 42.5; 20 m — 42.5; 15 m — 39.5; 10 m — 30.
Receiver dynamic range (preamp off): 95 to 102 dB, depending on filter used.	Receiver dynamics measured with optional narrow cw filter installed.

	80 m	*20 m*
Noise floor (MDS) dBm:	−127	−127
Blocking DR (dB)†:		
Two-tone, third-order IMD DR (dB):	96.5	97.5
Third-order input intercept (dBm):	18	19.5

Size (HWD): 5 × 14.5 × 12 inches (129 × 368 × 309 mm).	As specified.
Weight: 33 pounds (15 kg).	As specified.
Color: Not specified.	Dark gray.

†unmeasured — noise limited

Some of the Features

There seems to be no important feature missing. A notable feature is the fm-mode capability. An accessory a-m/fm module can be installed to permit operation in these two modes. The fm function allows the operator to employ fm on 10 meters. It also provides for vhf and uhf fm operation by means of a suitable transverter. A squelch control is included as a standard feature of the FT-102.

Not two, but *three* 6146B tubes are used in the transmitter PA! This permits driving external power amplifiers at the prescribed excitation level without operating the FT-102 PA at or beyond the nonlinear range. This is a shortcoming with many commercial exciters, causing wide signals of poor quality on our amateur bands. The dc input power to the 6146Bs is rated at 240 W (ssb or cw) from 1.8 to 25 MHz. The limit is 160 W from 28 to 29.9 MHz. During SSTV and fm operation, the dc input power is restricted to 120 W on all frequencies. It is reduced to 80 W for a-m transmissions.

The stock i-f filter has a 2.7-kHz bandwidth at the −6 dB points on the response curve. This can be reduced to as low as 500 Hz by means of the SHIFT/WIDTH control. An ssb "narrow" filter is available as an accessory. It yields a 1.8-kHz bandwidth. Additional filters are offered for cw reception in a variety of bandwidths: 600, 500, 300 or 270 Hz. The accessory a-m filter bandwidth is 6 kHz.

An i-f NOTCH control is included. It provides a notch depth greater than 40 dB for reducing the effects of QRM. This, when used separately or in combination with the built-in R-C active audio filter (frequency-variable), has proven to be a tremendous asset when dealing with interference on the cw bands.

Two panel meters are employed in the FT-102. One of them indicates the relative signal strength (S meter) and has a scale for use when setting the alc level correctly. The remaining meter, by virtue of a front-panel switch, can be used to read the high voltage, PA current, relative output power and speech-compression level. If the a-m/fm accessory adapter is installed in the transceiver, this meter serves as a discriminator-tuning indicator.

Some of the controls that are used infrequently are accessible from the front panel, but once adjusted, they are recessed into the panel, where they are safe from accidental "readjustment." A slight inward pressure pops the control knobs out so that adjustment can be accomplished. Pushing gently upon the tips of the knobs will cause the controls to recess and lock in that position. The functions controlled by these knobs are VOX/GAIN, VOX DELAY, MIC GAIN, NB LEVEL and SQUELCH. A row of push-button switches below them permits operator selection of MOX, RF AMP, NARROW filter, PROCESSOR, NB and CW MONITOR.

A vertical row of push buttons at the right of the main-tuning knob provides control of the AGC ON/OFF, AGC FAST/SLOW, ALC metering, RX RIT and TX RIT. Another push-button switch can be used to provide a 500-kHz "upshift" for use

*Assistant Technical Editor

during 10-meter operation. The audio filter and notching features are actuated by means of two additional push-button switches.

Transmitter Tuning

Four tuning controls are involved when adjusting the transmitter to the operating frequency. They are labeled PLATE, LOADING, DRIVE and PRESELECT. The latter is used also for receiver front-end peaking when the 10-dB switchable preamplifier is activated. A definite tuning procedure for ssb operation is spelled out in the operating manual. If the method is followed as prescribed, signal purity will be assured. Generally, it calls for keeping the PA plate current below 300 mA at resonance. This will yield up to 100 W of rf output. During cw operation, the plate current may be increased to 350 mA, which results in substantially greater output power. The maximum output obtained in the ARRL lab was 175 W on the bands below 10 meters.

Receiver-Performance Observations

Real-life testing of the FT-102 was done at the usual severe (former) W1FB proving grounds — two blocks from the simultaneous multiband high-power onslaught of W1AW, which has its 20- and 40-meter Yagis bore-sighted over my house. If ever a receiver will collapse from strong signals, it's at that location! My worst band for survival is 80 meters: I have measured a W1AW signal level of 5-V peak to peak across a 50-ohm termination at the transmitter end of my 80-meter antenna! Only a few commercial receivers could handle this without 10 or 20 dB of front-end attenuation switched in. The FT-102 fared well under these conditions. No problems were noted when the preamplifier was not in use. In fact, I was able to copy weak signals within 5 kHz of the W1AW frequency. When the preamplifier was actuated, there was some evidence of cross-modulation on signals lower than S9, but they were still readable. For the most part, the preamplifier is not needed on the bands below 15 meters, since the atmospheric noise usually exceeds that of the receiver anyway.

I detected no dynamic-range problems on the bands above 80 meters, even with the preamplifier operating. The notable exception was when I pointed my 20-meter beam antenna directly at the stacked 20-meter Yagis of W1AW. The problem was resolved when the preamp was turned off.

The audio quality of the receiver is good, even at relatively high output levels into a speaker. There is no evidence (by ear) of reciprocal mixing (buzz between signals when a strong signal is within the receiver passband) when using the FT-102 local oscillator or the outboard FV-102DM memory/synthesizer LO unit. This is important when strong signals are being handled by a receiver, irrespective of how high the receiver dynamic range might be.

Performance of the built-in audio filter is similarly good. There is no ringing evident, and the frequency peaking is sharp, although easy to adjust. Use of this filter greatly reduces the wide-band noise from the overall system, which provides a useful noise-reduction benefit. The audio filter can be switched in during all cw operation. It can't be used for phone operation, and is automatically disabled when changing from the cw to the voice mode.

Noise Blanker

As is the case with most blankers, this one works well on sharp impulse noise, but is ineffective in reducing ordinary QRN. It is not useful when the blanking level is advanced full on, at which time all signals become limited and distorted. The best level setting seems to be about "12 o'clock."

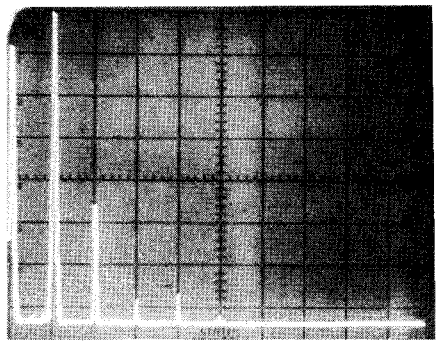


Fig. 1 — Worst-case spectral display of the Yaesu FT-102. Vertical divisions are each 10 dB; horizontal divisions are each 10 MHz. Output power is approximately 150 W at a frequency of 10.105 MHz. All spurious output is at least 45 dB below peak fundamental output. The FT-102 complies with current FCC specifications for spectral purity.

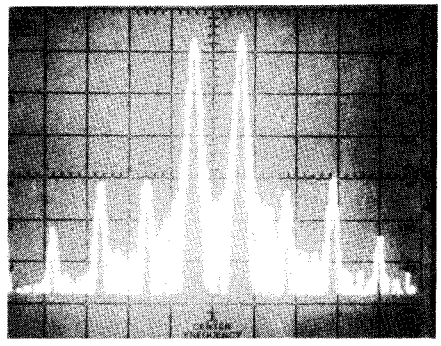


Fig. 2 — Spectral display of the FT-102 output during transmitter two-tone IMD testing. Third-order and fifth-order products are about 40 dB below PEP output. Vertical divisions are each 10 dB; horizontal divisions are each 1 kHz. The transceiver was being operated at rated input power on the 20-meter band.

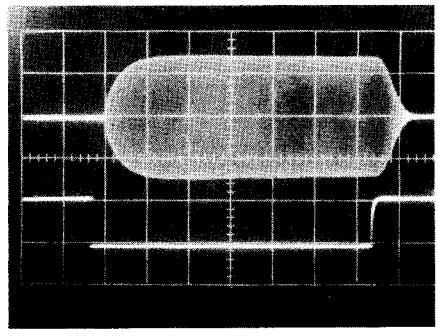


Fig. 3 — Cw keying waveform of the FT-102. Upper trace is the rf envelope; lower trace is the actual key closure. Each horizontal division is 5 ms.

Rear-Panel Ports and Switches

A SEP/NORM antenna switch is located on the rear wall of the transceiver. When in the SEP mode, an outboard receiver may be bridged to the FT-102, permitting the main station antenna to be used with the transmitter and outboard receiver. The FT-102 receiver has no antenna connected under this condition. But, a separate antenna can be attached to the FT-102 receiver if it is connected to the phono jack labeled ANT, near the switch. In the NORM mode, there is no internal connection to the EXT RCVR jack, and the main antenna is used both for transmit and receive with the FT-102.

An RF OUT jack provides low-level transmitter output for use with a transverter. The output level of the energy is 0.1-V rms (-7 dBm) at 50 ohms. There is also a jack for connecting the FV-102DM outboard VFO (synthesizer) to the transceiver.

A seven-pin DIN jack permits muting an external receiver and supplying sidetone to it. The FT-102 scanning signals can be picked off at this jack for external use. Another jack, the ACC-1, is a six-pin DIN type that permits the operator to utilize the FT-102 control circuits to be used with a transverter.

The ACC-2 socket is a five-pin DIN unit that allows T-R switching and alc input-control connections for use with a linear amplifier. In addition to this socket are a number of phono jacks that provide phone-patch input, wide-band i-f output, constant-level af output (for a recorder), foot-switch control and narrow-band i-f output for use with a monitor scope. There is a 12-V, low-current dc output jack for interface with auxiliary equipment that requires that operating voltage.

Inside a removable bottom cover on the '102 are controls for adjusting the side-tone level and pitch. There is another control that can be adjusted to boost the high-frequency response from the microphone before it is routed to the transmitter modulator. A low-frequency boost control is also available for shaping the audio response.

Comments on Performance

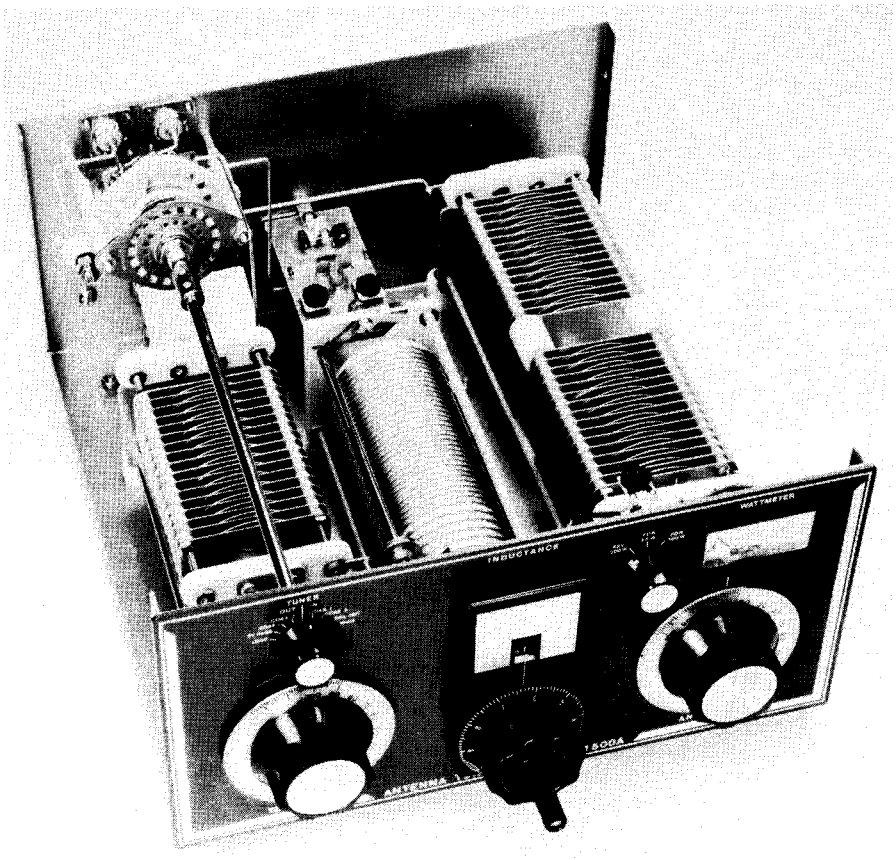
A frequency-jumping problem was observed (30 to 50 Hz) at random intervals when the unit was new. This affected the transmit frequency as well as that of the receive mode. It did not occur when using the outboard VFO. The malady ceased with time (about a week), and it appears that it was caused by a tight tuning mechanism (backlash) on the FT-102, which loosened up after being used for awhile.

Some of the earlier releases of the FT-102 had severe key clicks on cw. Apparently, this has been resolved. Yaesu states that owners with this problem should contact the company for instructions concerning a cure. Not all FT-102s had the problem. It was a sporadic type of anomaly that was cured easily. The review unit has a good cw wave form.

One might be baffled by the excellent receiver dynamic range after examining the receiver front-end circuit. There is nothing unusual about the mixer, for it contains only a pair of source-driven FETs in a singly balanced mixer arrangement. The rf amplifier is similarly mundane upon cursory examination: It employs two more JFETs, this time in series. The reason for the strong front-end performance comes clear when you trace the dc supply line to the pc-board terminal strip: Yaesu uses + 24 V for the rf amplifier and mixer rather than the usual 12-V dc! The higher operating voltage greatly enhances dynamic range.

FV-102DM Outboard LO

This unit is a remarkable accessory. It contains



a synthesizer and CPU designed especially for use with the FT-102. This product allows tuning by the dial, scanner, keyboard or memory 100 kHz beyond the band edges during transmit, receive, transceiver or RIT operation.

A dual-function, 17-button keyboard on the panel permits push-button frequency entry along with 5- or 20-kHz stepping, four-speed scanning, frequency lock, last-digit blanking and RIT operation. There are six extra keys to allow convenient receive and transmit frequency-source selection of the FT-102 internal VFO, the FV-102DM dial or one of the 12 memory channels of the FV-102DM. LEDs indicate the operating status.

The FV-102DM includes an internal-battery holder to provide dc backup for retaining the data stored in the memories when the transceiver is turned off, or if a power failure occurs. The five-digit frequency display indicates kilohertz with resolution to 10 Hz, or 100 Hz if the last digit is blanked. Scanning can be controlled from the front panel of the FV-102DM or by means of the FT-102 scanning microphone, if the latter is used. No outward indications of reciprocal mixing caused by synthesizer noise in the FV-102DM were observed. Similarly, nearby stations were unable to detect wide-band noise on the transmitter signal.

This transceiver is fully modern, and the performance is outstanding. Price class: $1150 (stock FT-102). Manufacturer: Yaesu Electronics Corp., 6851 Walthall Way, Paramount, CA 90723. — *Doug DeMaw, W1FB/8*

VIEWSTAR VS 1500A TRANSMATCH

☐ The VS 1500A Transmatch looks functional from the front, even at a quick glance. However, it isn't until one gets the cover off that the cleanliness of design and layout strikes the eye.

Truly a first-class job of design and construction, the matching network employs some of the highest-quality components available. This is also the first commercially made Transmatch I have seen that makes use of the SPC configuration. The SPC arrangement, developed by Doug DeMaw, W1FB, is the result of an effort to design a circuit that would maintain a band-pass response under all load conditions. Some readers may be interested in reviewing W1FB's explanation of the SPC circuit, which appeared in Technical Correspondence, *QST,* July 1980.

Features and Flexibility

The VS 1500A will handle the "legal limit" and a bit more. It is generously rated to handle 1500 W continuously. A 1:4 balun is incorporated to handle balanced feed lines. The range of antennas that may be connected to the VS 1500A includes dipoles, inverted Vs, Yagis, whips and random-length wires.

The built-in wattmeter will read 300 W or 3 kW in the FORward position, and 300 W in the REVerse position; it is always in the circuit. A front panel switch selects one of two coaxial-cable-fed antennas (direct or through the tuner), a balanced line or a random-wire antenna. The LOAD and BYPASS positions provide for connection to an external dummy load, and to a coaxial-cable-fed antenna that is connected to, but not *through,* the Transmatch. In the LOAD, BYPASS, COAX 1/OUT and COAX 2/OUT positions, the tuner is bypassed.

Instructions

The manual that accompanies the VS 1500A is detailed and complete, and includes a large schematic diagram of the unit. There are a few minor errors in the manual, and some terminology doesn't quite agree with the labels on the equipment. These have been called to the attention of the manufacturer, who has assured me that they will be corrected. However, none of them is sufficient to cause any problem with understanding the operation of the VS 1500A, or in preventing one from placing the unit in use.

Lab Tests

As measured in the ARRL Lab, the insertion loss of the Transmatch was only 0.5 dB. It handled the rated input power into a 50-ohm dummy load with no difficulty.

The VS 1500A Transmatch has been in use in my station for several months, and has done a thorough job of helping to match to a variety of antennas from 160 to 10 meters. Operation is simple, straightforward and effective in that it combines all antenna switching and feed-line matching into one compact unit. As with any device of this type, it is desirable to obtain a matched condition at low power, prior to the application of high power.

The VS 1500A measures 5-3/4 × 11-1/4 × 13-1/2 inches (HWD) and weighs 6-1/4 lb.[1] It is distributed by Unadilla/Reyco Division, Microwave Filter Co., 6743 Kinne St., East Syracuse, NY 13057. Price class: $490. — *Lee Aurick, W1SE*

MORSE CODE TRAINER II

☐ Written by Joe Morris, N4EU, this product is a versatile Morse training program for users of the Radio Shack TRS-80® Models I or III microcomputer. This software package, available for 16K cassette or 32K disk systems, tutors and drills you in the 26 letters, 10 numerals and five common punctuation marks (. , ? / —), and helps you increase your code speed, at your own pace, to 31 words per minute (wpm). The 16K cassette version was reviewed on a TRS-80 Model III.

The manufacturer has intentionally omitted a detailed instruction manual to keep the cost down, knowing that even novice TRS-80 users will use the CLOAD command in the absence of other directions. The instructions can be called easily, and the program will automatically lead you in the right direction with clear-cut menus, self prompting and effective error trapping.

Not until you've unwrapped the package, loaded the program and begun running the Morse Code Trainer II will you realize that additional equipment is needed. Early in your first encounter with the program, you'll read on the video screen: "Requirements: In addition to the computer and software you will need a code oscillator or an audio amplifier similar to those available at your local Radio Shack." You'll also need wire, clip leads and possibly a speaker or batteries, depending on whether the oscillator or amplifier comes equipped with them.

The code-practice oscillator and speaker are attached to the computer by running a clip lead between the oscillator and the smallest cassette cable plug. This cable is normally used to turn the cassette player on and off remotely; here it is used by the computer to key the oscillator. Alternatively, you can take advantage of the keying tone generated by the computer at the large auxiliary (AUX) plug by using an audio

[1]mm = in. × 25.4; kg = lb × 0.454.

amplifier. Suitable oscillators and amplifiers are available from Radio Shack under part numbers listed in the program.

Program operation is straightforward, self-explanatory and effective. On starting up, you're presented with a choice of creating or loading from a cassette (previously created and saved) word/phrase data file that will be used under later menu options. The beginner can bypass this simply by pressing C, * and ENTER. Once this has been completed, you are given the main menu options: (W) random words, (M) mixed groups, (L) letter groups, (N) number groups, (B) Beginner's Club and (E) end cw practice. You simply respond with the letter of your choice.

If you're a newcomer, you'll select (B) to enter the Beginner's Club, and will be asked to respond to several questions. First, you'll be asked to list those characters (if any) already known and then to list a few characters you'd like to learn during the session. The program initializes at 5 wpm (characters are formed at 13 wpm, spaced to yield 5 wpm overall) and begins the instruction sequence.

The first of the new characters to be learned is sent 10 times at 5 wpm in perfectly formed code, and the character is displayed on the screen. The beginner is then asked if "You got it . . . (Y/N)?" Responding with a "no" causes the sequence to be repeated; responding with a "yes" causes the computer to offer congratulations and gives the option of reviewing the characters one more time. Then, the sequence recycles for the next new character to be learned. When all new characters are learned to the *user's* satisfaction, you'll move from the instruction sequence to the drill sequence.

Under program control, you're drilled on both the characters just learned and the ones listed earlier as already known; a character is sent and you're asked to type the appropriate response. If the response is correct, another character is sent. If the response is incorrect, the phrase "No, I sent . . ." (followed by the character) is displayed as the character is sent three more times; then, the incorrect response is displayed and sent three times. If you don't respond at all, the character being sent is eventually displayed on the screen.

When you have had enough drill, or if you already know the code at 5 wpm, you can get to the other options through the main menu. Typing W, M, L or N will bring up the speed-setting routine for subsequent practice. Code speed is adjusted from 5 to 31 wpm by holding down the F key to increase, or the S key to decrease the speed; the speed, which changes in 2-wpm increments, is displayed on the screen. At code speeds of less than 13 wpm, each character is sent at 13 wpm with between-character spacing adjusted for the proper overall speed; at 13 wpm and above, the code is formed and spaced in "real time." You also have the option of changing the within-character dot/dash/space ratios, that is, the character weighting. Ratios are initialized at the proper relative values.

The remaining options provide a variety of specialized practice routines to get you up to your desired code speed quickly. Selecting L results in five-character groups of random numerals; M mixes letters and numerals in five-character random groups; W yields randomly selected words and phrases from the user-generated text files; and E ends the code practice session. Under all of these options (except E), the characters being sent are displayed on the screen so you can check your accuracy.

How effective is the Morse Code Trainer II? Its approach, from aural-only drill, immediate feedback and user-specified drill sequences to the slow-code-speed 13-wpm character generation, is an adaptation of many successful techniques. These, with the operating flexibility, make the Morse Code Trainer II attractive. Micro 80, Inc., claims that a newcomer who spends 1/2 hour daily using the program will reach the 13-wpm level in 120 days, and within 60 more days, 20 wpm. For most people, this estimate is likely conservative, especially if they also *use* their newly learned skill *on the air*. Though many other techniques that don't require a computer are also effective in teaching the code and increasing one's speed, if you have a TRS-80 Model I or III microcomputer, Morse Code Trainer II is certainly an effective and enjoyable way to go. Morse Code Trainer II is available from Micro 80, Inc., 2665 North Busby Rd., Oak Harbor, WA 98277. Price class: $17 (plus $2 shipping). — *Steve Place, WB1EYI*

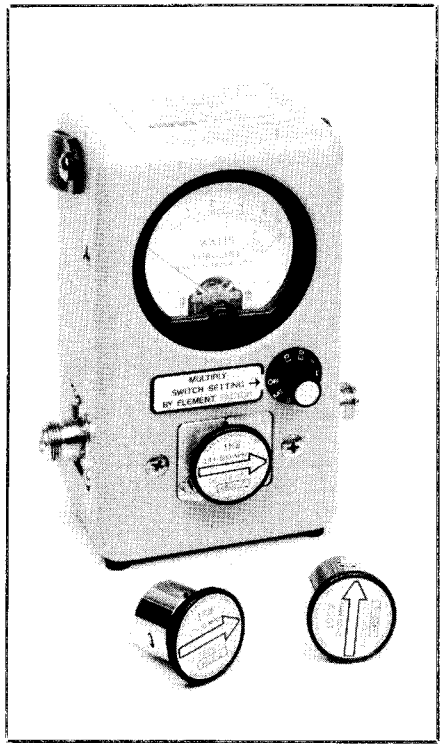
BIRD MODEL 4410 THRULINE® WATTMETER

☐ Bird wattmeters have long enjoyed a reputation for accuracy and reliability. The model 4410, designed for use in 50-ohm transmission lines, upholds the tradition.

The 4410 is housed in a sturdy grey 6-7/8 × 4 × 3-3/8 inch (HWD) aluminum enclosure, complete with leather carrying strap and rubber feet on both the bottom and rear panels.[2] It weighs three pounds. In size and appearance, the 4410 is very similar to the venerable Bird 43. The unit is normally supplied with female type N connectors, but a wide variety of male and female Bird quick-change fittings is available.

Depending on the plug-in element selected, this instrument will measure 0 to 10 kW from 200 kHz to 30 MHz, and 0 to 1 kW from 30 to 1000 MHz. Like the Bird 43, the 4410 samples rf flowing in the precisely machined Thruline, a short section of air-type line with a characteristic impedance of 50 ohms. The coupling circuit, which samples the traveling waves, is in the plug-in element. The element may be rotated to measure either forward or reflected power.

[2]m = ft × 0.3048.



Unlike the Bird 43, the 4410 incorporates circuitry to allow each plug-in element to measure a wide range of full-scale power values. The 4410 meter face has two scales: zero to one, and zero to three. A switch above the slug socket allows the user to select the full-scale power range needed for the job at hand. The switch has the following settings: 100, 30, 10, 3, 1, 0.3 and 0.1. Each element has a "factor" (100 for the 10-kW slugs, and 10 for the 1-kW slugs). The power-range-switch setting multiplied by the element-factor number gives the full-scale-power value. For example, with the 1-kW, 144-520 MHz slug installed (factor = 10) and the switch set on 1, the full-scale power reading is 10 W. Move the switch to 30, and the full-scale value becomes 300 W. Depending on the switch setting, each 1-kW slug will measure 0 to 1000, 300, 100, 30, 10, 3 or 1 W. For the 10-kW slugs, the full-scale values are 10,000, 3000, 1000, 300, 100, 30 and 10 W.

A 9-V alkaline battery powers the 4410. With the range selector in any position but OFF, there is a slight battery drain. Battery life is rated at 24 hours of continuous use. Among the settings on the range switch is a battery test position, which should be used before making any measurements. A weak battery will affect accuracy.

To find out if the same slug could really measure 0 to 1 and 0 to 1000 W with accuracy, we compared readings made with the 4410 to some made with the ARRL laboratory unit, a recently factory-calibrated Bird 43. We tried various powers at different frequencies, from 1 kW on 3.5 MHz, to 120 W on 14 MHz, to 10 W on 144 MHz, to 500 W on 432 MHz. Although the 4410 and the 43 did not always exactly agree, the readings were always within Bird's claimed specifications of ± 5% of reading above 20% of full scale. Readings on the 4410 were consistent from setting to setting (i.e. 100 W on the 100 W setting was also 100 W on the 300- and 1000-W settings).

The only complaint I have with the 4410 is that the meter movement is slower in responding to power changes than most other wattmeters I've used. It's so slow that I sometimes found it difficult to tune up a transmitter with "touchy" controls when using the 4410 to monitor output power. I would tune through the output power peak before the meter responded. Other than that, the 4410 is a dandy little unit, able to measure QRP or QRO accurately at the flick of a switch.

The instruction manual is exceptionally comprehensive for a device as simple as a wattmeter. Included are such goodies as nomographs for determining VSWR based on forward vs. reflected power readings, and complete calibration information. Slugs of interest available to amateurs include 1 or 10 kW 2-30 MHz, and 1 kW 25-80, 50-200, 144-520 and 200-1000 MHz units.

Price class of the Bird 4410: $495; plug-in elements: $150 each for the 2-30 MHz units, $125 for the 144-520 MHz unit. The manufacturer is Bird Electronics Corp., 30303 Aurora Rd., Solon, OH 44139. — *Mark Wilson, AA2Z*