Product Review Column from *QST* Magazine

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Trio-Kenwood TS-440S HF Transceiver

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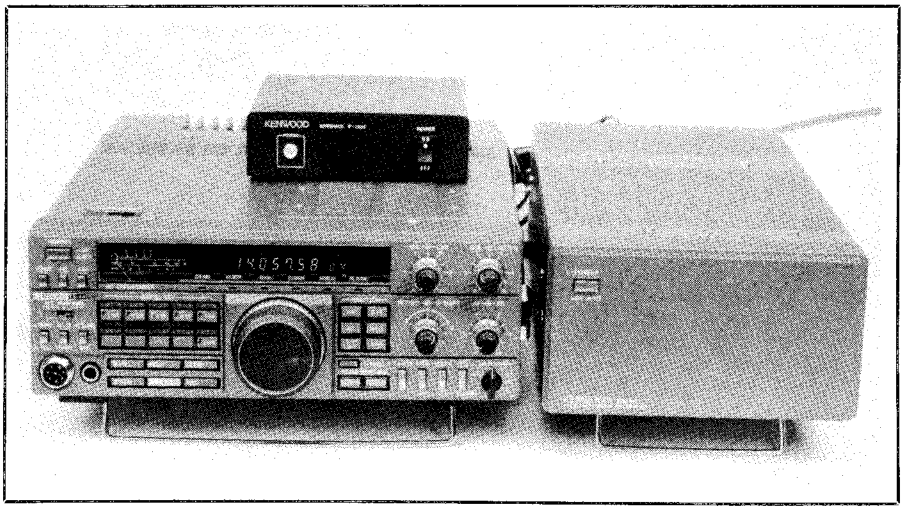
Trio-Kenwood's latest entry into the full-featured, compact HF transceiver market is here—the TS-440S. Comparable with ICOM's IC-735 (see Product Review, *QST*, Jan 1986), the '440 is the next step in the development of the TS-430S transceiver. Feature for feature, the '440 falls somewhere in between the '430 and the '940 (Product Review, *QST*, Dec 1985), incorporating traits of both rigs.



Receiver Features

The TS-440S receiver uses a state-of-the-art triple-conversion scheme with IFs of 45.05 MHz, 8.83 MHz and 455 kHz. Its wide dynamic range can be attributed to the use of 3SK73 dual-gate MOSFETs, 2SK125 JFETs and a number of multipole band-pass filters (selected by the microprocessor) for maximum rejection of unwanted signals without sacrificing performance. There are two VFOs using a common shaft encoder and a PLL containing five loops. Either VFO covers the frequency range of 100 kHz through 30 MHz.

Transmitter Features

Because I've used rigs with vacuum tube finals most of the time I've been a ham, I found the user friendliness of solid-state finals a pleasant change. The only transmitter adjustments are the MIC (microphone gain) and CAR (carrier level) controls.

The transmitter also uses the triple-conversion scheme. The double-sideband first IF is generated at 455 kHz, then mixed with a local oscillator (8.375 MHz) to produce the second IF at 8.83 MHz. This signal is filtered and then fed to the RF unit where it is mixed with a heterodyne oscillator output to result in a 45.05-MHz third IF that is mixed again with the VFO output to develop the desired output frequency. This output is fed to the power amplifier, the low-pass filter, and then to the antenna connector on the rear panel, or to the (optional) internal automatic antenna tuner.

In the TUNE mode, the transmitter output is limited to approximately 10 W to protect the final transistors from any high SWR conditions. In the event that the antenna tuner cannot match the antenna impedance, a current foldback circuit protects the finals. Kenwood specifies that a range of 20 to 150 ohms can be matched. I used it to match both a tribander antenna and an 80/40-meter dipole to work all bands, 10 through 80 meters. I then tried matching a 40-meter antenna on 80 meters and was successful except at the very low end of the 80-meter band. The antenna tuner's threshold is an SWR of about 1.5:1, and it is satisfied if it sees that, or less. I am rather impressed with the antenna tuner, as it apparently will match about anything you present it with. The one drawback is that it does not function on 160 meters.

Front-Panel Controls

I was intimidated when I first saw the transceiver's front panel, but after spending a few minutes with the operating manual, it all came together. In the extreme-upper-left corner of the panel is the push-button ON/OFF switch (see Fig 1). Immediately beneath the ON/OFF switch are three additional push buttons. The VOICE push button causes the optional voice synthesizer to announce the operating frequency (in English or Japanese). The noise blanker, NB, can reduce a pulsating noise signal by as much as 40 dB. The ATTenuator introduces 20 dB of attenuation to incoming signals. The ATTenuator is useful if operating under extremely strong signal conditions, as it reduces front-end overload.

The front-panel meter functions as an S meter in all receive modes. A three-position slide switch allows selection of three different meter functions in transmit mode; PWR (power output), ALC level, or SWR. In the PWR position, the meter indicates the output power. It is a peak-reading meter, not an average-reading meter. In the ALC position, the meter monitors the drive level in USB, LSB and AFSK modes. The SWR meter shows the condition of the antenna only when the AUTO/THRU switch is in THRU position. Immediately below the meter switch are the SEND/RECeive push button, and the AUTO/THRU and AT TUNE/OFF switches to control the antenna tuner.

Using the automatic antenna tuner is easy—first push the AUTO button to enable the system. Then (if the frequency is clear) press the AT TUNE to put the rig in the transmit mode and cause the tuner to look for

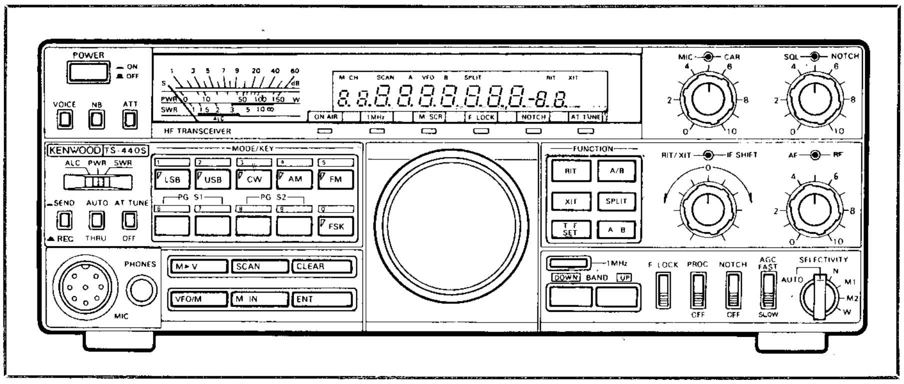


Fig 1—Front panel layout of the Trio-Kenwood TS-440S HF transceiver.

the best match. When you press AT TUNE, an LED indicator to the right of the status display at the top of the panel illuminates to indicate that the tuner is operating. When the tuner has found an acceptable match, which it accomplishes through microprocessor control, the LED goes off. This is the *only* indication that the tuner has found the optimum match. If the tuner is unable to obtain a satisfactory match (about 1.5:1 SWR), it continues to run until the AT TUNE is pressed to OFF. The operating manual notes that the tuner should not be allowed to operate more than 30 seconds. If it does, then press AT TUNE to OFF, and then back to on again. If the tuner fails to stop after several tries, the antenna impedance is unmatchable. It is also necessary, after completion of the tuning process, to again press (release) the AT TUNE push button before operating the transmitter. The MIC connector, an 8-pin male type, is located in the lower left of the front panel, next to the ¼-in, single-circuit PHONES jack.

The operating mode is selected by six buttons on a membrane MODE/KEY numeric keypad located in the middle left of the front panel. When one of the mode switches (LSB, USB, CW, AM, FM or FSK) is pressed, a green LED lights in the key pressed, and an audible Morse code indication of the selected mode is heard from the speaker (L for LSB, U for USB, C for CW, A for AM, F for FM and R for FSK). The mode-selection switches also double as part of the 10-key numeric keypad used for direct entry of VFO frequency. This feature allows rapid frequency changes without the delays encountered in other tuning methods. Below this keypad are six push buttons used for selection of the memory mode and direct frequency entry.

The '440 contains 100 (numbered 00 through 99) memories that contain frequency, VFO mode (VFO A, VFO B, Split VFO and so on) and XIT/RIT information. Memory entry and recall can be accomplished in several different ways. Selection of the memory to be used can be made through the VFO dial, the numeric keypad, or the UP/DOWN switches on the panel or microphone. Memory information can be transferred from one memory channel to another or from memory channel to VFO. Split-frequency information can be stored in memory channels 90 through 99.

The VFO tuning knob incorporates adjustable drag control, and frequency rate of change is faster if the knob is turned faster. VFO mode is controlled through a FUNCTION pad with six push buttons, just to the right of the knob. This pad allows VFO A/B selection, VFO A=B, SPLIT VFO operation, T-F SET (allows you to check or set the transmitter frequency during SPLIT operation) and RIT/XIT. BAND selection is accomplished through three switches; DOWN, UP and 1 MHz. The 1 MHz switch toggles on and off. When on, it lights up an LED on the top front panel display, and allows frequency changes in 1-MHz steps with the DOWN/UP buttons (for general coverage). If it is off, DOWN and UP select the next higher or lower amateur band.

There are four dual-function potentiometer controls on the upper right panel: MIC gain/CARrier level; SQueLch gain/NOTCH frequency; RIT/XIT offset/IF SHIFT and AF/RF gain. Below these controls, at the bottom right of the panel are: Frequency LOCK (locks all VFO functions); PROC/OFF (enables or disables the speech processor); NOTCH/OFF (controls the notch filter); AGC FAST/SLOW (the AGC cannot be turned off) and SELECTIVITY. The '440 will select the appropriate filter AUTOmatically, if desired, or the operator can choose Narrow, M1, M2 or Wide. The radio comes equipped with an SSB filter installed (2.2 kHz at −6 dB), and optional SSB, FSK and CW filters are available (250 Hz and 500 Hz for CW, and 1.8 kHz for SSB).

Rear and Top Panel Controls and Connectors

Three DIN connectors on the rear panel provide most of the necessary interfacing to the '440. ACC 1 provides an RS-232-C interface (more on this later). ACC 2 provides user access to TR relay control and RX/TX lines. REMOTE accesses the TR relay contacts, ALC input, PTT control, speaker output and 12 V dc at 10 mA during transmit. Other connections include a ¼-in phone jack for the key (short to ground for transmit, open voltage approximately 5.5 V dc), a 1/8-in external speaker jack, a 6-pin Molex-type connector for the external 12 V dc power supply, an SO-239 antenna connector, a stud with a wing nut for grounding, and three phono jacks for FSK audio in, FSK audio out, and a spare. Three recessed potentiometers provide VOX GAIN, VOX DELAY and ANTI VOX gain.

The TS-440S is capable of full or semi break-in, or manual PTT control. The control switch is recessed in the front left top cover. This switch also functions as the VOX enable.

Operation

As mentioned previously, the '440's 100 memory channels provide tremendous flexibility. Memory entry and recall are two-step processes. This enables you to save the present frequency, hop to another frequency for a quick QSO, and come back to the original frequency without having to write anything down or even remember anything except the channel number. To enter a frequency and VFO mode into memory, first select the frequency on the VFO and the mode. Press the M.IN switch to enter the memory scroll mode (the M.SCR LED lights on the top display panel) and current memory channel number (M.CH)—frequency and mode will be displayed. Then find a memory channel that is free (no information) or that can be reprogrammed, by turning the VFO dial, with the numeric keypad or with the UP/DOWN buttons. When M.IN is pressed again, the frequency and mode is saved into the selected memory channel. You can check the frequencies in memory by pressing the VFO/M key and tuning across the memory channels. Recalling a frequency from memory is even easier—press VFO/M, find the memory location with the VFO dial and press M>V. Presto! All the information is recalled to the VFO. However, all information in that memory channel is erased—it must be reentered.

The scan function allows you to scan between two frequencies entered into memory. Memory scan operates from channel 00 to channel 99, with stops at each channel where data is stored at approximately 3-4 second intervals. Program scan is provided in two programmable scan ranges. PG.S-1 utilizes

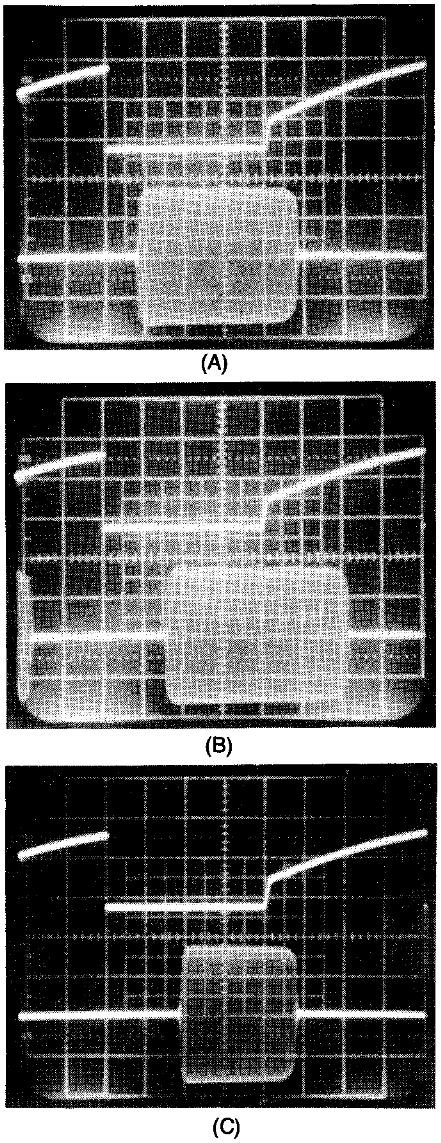
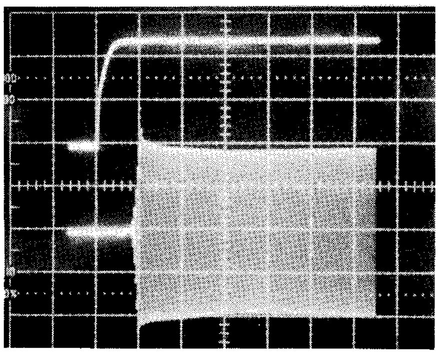


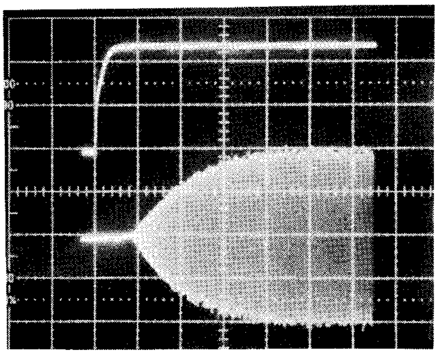
Fig 2—Keying waveforms for the '440. The transmitter was operating at a power output of 123 W on 14.100 MHz. Each horizontal division is 5 ms. The top trace is the input key closure; the bottom trace is the RF output. At A, a normal manually keyed signal is shown. B shows a semi-QSK signal—some delay is evident in the keying waveform. Additional delay as well as shortening of the signal is evident in the full-QSK signal at C. At speeds above about 30 WPM, this signal could sound choppy.

memory channels 06 and 07 to specify the upper and lower scan limits. PG.S-2 uses memory channels 08 and 09 to define upper and lower scan limits. Once programmed (similar to memory channel entry), scanning is initiated by pressing the SCAN button. This function can also be used in any segment of the general coverage receiver.

Remote computer control capability is another impressive feature of the '440. (There were rumors floating around after Field Day that one entrant was a CW robot consisting of a computer with exchange and duping capabilities and automatic control of a TS-440S. He, she or it supposedly did very well!) Installation of the IC-10 and IF-232



(A)



(B)

Fig 3—Receiver turnaround-time waveforms for the TS-440S transceiver. Each horizontal division is 20 ms. The top trace shows the key closure. The lower trace shows audio output. Upon key opening, the delay from opening to 90% audio output is measured. Receiver turnaround time with an S9 signal input is shown at A. The turnaround time is 20 ms, suitable for AMTOR. At B, receiver turnaround time with an S1 signal is shown. The turnaround time is approximately 45 ms, which may be marginal for weak-signal AMTOR operation.

Trio-Kenwood TS-440S Transceiver, Serial No. 7050095

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Transmitter frequency range: 160 m 1.8- 2.0 MHz 80 m 3.5- 4.0 MHz 40 m 7.0- 7.3 MHz 30 m 10.1-10.15 MHz 17 m 18.068-18.168 MHz 15 m 21.0-21.45 MHz 12 m 24.89-24.99 MHz 10 m 28.0-29.7 MHz	As specified.
Receiver frequency range: 100 kHz-30.0 MHz.	As specified.
Modes of operation: A3J (USB, LSB), A1 (CW), F1 (FSK), A3 (AM), F3 (FM).	As specified.
Frequency display: Large fluorescent-tube digital main display.	As specified.
Frequency resolution: $\pm 1 \times 10^{-5}$.	As specified.
Frequency stability: $\pm 1 \times 10^{-5}$.	As specified.
Transmitter	*Transmitter Dynamic Testing*
Power input: 200 W PEP (160-10 m bands, SSB, CW, FSK, FM) 110 W (AM).	Power output (CW): 160 m, 118 W; 80 m, 123 W; 40 m, 123 W; 30 m, 125 W; 20 m; 127 W; 17 m, 126 W; 15 m, 126 W; 12 m, 124 W; 10 m, 123 W.
Spurious signal and harmonic suppression: Less than −40 dB (in CW).	−43 dB. See Fig 4.
Third-order intermodulation distortion: More than 26 dB below one of two tones.	−28 dB. See Fig 5.
CW keying waveform: Not specified.	See Fig 2.
Receiver	*Receiver Dynamic Testing*
Receiver sensitivity: LSB, USB, CW, FSK (at 10 dB S/N) 100-150 kHz: less than 2.5 μV. 150-500 kHz: less than 1.0 μV. 500-1600 kHz: less than 4.0 μV. 1.6-30 MHz: less than 0.25 μV. AM (at 10 dB S/N) 100-150 kHz: less than 25 μV. 150-500 kHz: less than 13 μV. 500-1600 kHz: less 40 μV. 1.6-30 MHz: less than 2.5 μV. FM (at 12-dB SINAD) 1.6-30 MHz: less than 0.7 μV.	Minimum discernible signal (Noise floor) (dBm) *80 m* *20 m* −140 −139
Receiver dynamic range: Not specified.	Blocking dynamic range (dB): *80 m* *20 m* 112 111 Two-tone, 3rd-order intermodulation distortion dynamic range (dB): *80 m* *20 m* 89 89 Third-order input intercept (dBm): *80 m* *20 m* −6.5 −5.5 Receiver quieting (μV for 12 dB signal + noise + distortion/signal + distortion): 0.65 μV at 29.0 MHz.
Receiver recovery time: Not specified.	See Fig 3.
Squelch sensitivity: FM, 1.6-30 MHz.	Min 0.12 μV, max 0.33 μV.
Receiver audio output at 10% total harmonic distortion: 1.5 W.	2.0 W
RIT/XIT variable range: more than ±1 kHz.	±1.3 kHz.
Color: Gray.	
Size (height × width × depth): 4.5 × 12.0 × 13.0 in.	
Weight: 13.9 lb (16.1 lb with AT-440).	

interface units requires about half an hour. With these options and a suitable computer, the following functions can be remotely controlled: frequency, RIT/XIT mode, VFO selection, memory usage and scanning. This requires a computer with a communications program capable of sending and receiving 4800-baud ASCII with eight data bits, one stop bit and no parity. I used a Radio Shack® TRS-80 microcomputer, Model 4P, with a terminal program to test this capability. I then wrote a BASIC program to control the '440 through the RS-232-C port. It is possible to control the transceiver completely from the computer during normal QSOs.

The TS-440S QSK feature has two speed options, fast and slow. Slow QSK works something like VOX keying (the delay is internally fixed), and the fast mode allows break-in between each dot and dash. There are some problems, however, with how this is accomplished. Fig 2 shows the '440's keying waveshape in manual, semi-QSK and full-QSK modes. In all three cases, the input keying waveform is the same—about 20 ms. The upper trace shows the key closure; the lower trace is the RF output. Fig 2A shows a normal manually keyed output waveform. In Fig 2B, the semi-QSK keying causes some additional delay in the transmitted signal, while in full-QSK, Fig 2C, it is evident that considerable shortening of the waveform occurs. At speeds above about 30 WPM, this signal may sound choppy, but additional keying weight may improve the signal.

Although Kenwood states that FSK data transmission is possible with the '440, the rig requires an external source of audio with the desired tones. The '440 has no built-in tone generator. The rig can be driven to full output with less than 100 mV of audio. With the SELECTIVITY switch in AUTO position, and the optional YK-88C filter installed, the receiver exhibits a 500-Hz bandwidth.

We measured the receiver turnaround time, (the time it takes for the receiver to reach 90% audio output after the TR relay opens) to determine if the '440 is suitable for AMTOR. For an S9 signal, the delay was 20 ms (Fig 3), and for an S1 signal it was approximately 45 ms. Although the transceiver is capable of good performance on medium-to-strong signals, it may be marginal for weak-signal AMTOR, depending on the type of modem used. AMTOR normally requires receiver turnaround in about 30 ms, or less.

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this voltage source; only a few milliamperes of current are required.

The value of Q1's base resistor, R1, is chosen to produce a nominal 100-mA grid-current limit, and can be selected as required for any particular amplifier. This selection need be made only once during the design of the amplifier; it is not an adjustment (this is still a "no adjustment" circuit). The advantage of this approach to that of RF voltage-detector ALC circuits is that the latter needs adjustment to compensate for the different RF drive voltages required on different bands, caused by differing tube and circuit losses. If the low value base resistor is inconvenient, a somewhat larger value may be used, followed by a voltage divider —perhaps a "set and forget" trimmer potentiometer. Any method that produces 0.6 V at the base of Q1 will do. The usual RF filtering, as shown in the July article, should be applied to all circuit leads.—*Mark Mandelkern, KN5S, Department of Mathematics, New Mexico State University, Las Cruces, NM 88003*

Feedback

☐ Author Stephen Stuntz reports a good response to his article, "A CW Program Cartridge for the Atari Computer," *QST*, Aug 1986, p 34. Some who have modified the cartridge PC board, however, couldn't remember how to orient the board when reinstalling it in the cartridge. Author Stuntz advises that the circuit board should be oriented so the top of the EPROM faces the back of the cartridge.

☐ From author Clay Abrams, we've received corrections to Figs 1 and 3 of "In Search of the Perfect Picture," *QST*, Jan 1986, pp 18-24. In Fig 1, p 20, there should be a connection between U5 pin 1 (not shown) and the common point of U8B, pin 4 and U9B, pin 3. In Fig 3, p 22, insert a 0.01-μF capacitor in the line between the arm of S1 and U3, pin 6. At U8, change the Q10 output pin number (labeled 14 on the diagram) to 12.

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41Ø DATA &hØØ,&hCD,&h16,&h3C,&h67,&h74,&hØ6,&h3C
42Ø DATA &h47,&h74,&hØ2,&h75,&hF2,&hB9,&hFF,&hØØ
43Ø DATA &hBA,&hØ1,&hØ2,&hEC,&h3C,&h8Ø,&h73,&hF8
44Ø DATA &hE2,&hF6,&hBØ,&hØØ,&hA2,&hØØ,&hØØ,&hB9
45Ø DATA &hCØ,&hØ3,&h8B,&h3E,&hØ1,&hØØ,&hBA,&hØ1
46Ø DATA &hØ2,&hEC,&hDØ,&hDØ,&hDØ,&h95,&hØB,&hØØ
47Ø DATA &h47,&h51,&hB9,&h63,&hØØ,&h9Ø,&hE2,&hFD
48Ø '
49Ø DATA &h59,&hE2,&hEB,&hB9,&hBC,&hØ1,&h51,&hB9
5ØØ DATA &hAØ,&hØ1,&h9Ø,&hE2,&hFD,&h59,&h9Ø,&hE2
51Ø DATA &hF5,&h8B,&hØE,&hØ5,&hØØ,&h9Ø,&hE2,&hFD
52Ø DATA &hB9,&hCØ,&hØ3,&h8B,&h3E,&hØ1,&hØØ,&hBA
53Ø DATA &hØ1,&hØ2,&hEC,&hDØ,&hDØ,&hDØ,&h95,&hØB
54Ø DATA &hØØ,&h47,&h51,&hB9,&h63,&hØØ,&h9Ø,&hE2
55Ø DATA &hFD,&h59,&hE2,&hEB,&hB8,&hØØ,&hØØ,&h8B
56Ø DATA &h3E,&hØ3,&hØØ,&hAØ,&hØØ,&hØØ,&hB2,&hFØ
57Ø DATA &hF6,&hE2,&hØ3,&hF8,&hBA,&hØØ,&hØØ,&hB9
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59Ø DATA &hB4,&hØØ,&hBØ,&h4C,&hCD,&h17,&hB4,&hØØ
6ØØ DATA &hBØ,&hFØ,&hCD,&h17,&hB4,&hØØ,&hBØ,&hØ8
61Ø DATA &hCD,&h17,&hB4,&hØØ,&h8A,&h85,&hØB,&hØØ
62Ø DATA &hCD,&h17,&h47,&hE2,&hF5,&hFE,&hØ6,&hØØ
63Ø DATA &hØØ,&h8Ø,&h3E,&hØØ,&hØØ,&hØ4,&h74,&h18
64Ø DATA &hB9,&hB2,&hØ1,&h51,&hB9,&hA6,&hØ1,&h9Ø
65Ø '
66Ø DATA &hE2,&hFD,&h59,&h9Ø,&hE2,&hF5,&h8B,&hØE
67Ø DATA &hØ7,&hØØ,&h9Ø,&hE2,&hFD,&hE9,&h57,&hFF
68Ø DATA &hB4,&hØØ,&hBØ,&hØD,&hCD,&h17,&hB4,&hØØ
69Ø DATA &hBØ,&hØA,&hCD,&h17,&hA1,&hØ1,&hØØ,&h8B
7ØØ DATA &hØE,&hØ3,&hØØ,&hA3,&hØ3,&hØØ,&h89,&hØE
71Ø DATA &hØ1,&hØØ,&hB4,&hØ1,&hCD,&h16,&h74,&hØF
72Ø DATA &hB4,&hØØ,&hBØ,&hØD,&hCD,&h17,&hB4,&hØØ
73Ø DATA &hBØ,&hØA,&hCD,&h17,&hEB,&h19,&h9Ø,&hB9
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77Ø DATA &hDØ,&h8E,&hD8,&h5D,&hCA,&hØ6,&hØØ,&hØØ
78Ø DATA &hØØ,&hØØ,&hØØ,&hE8,&hØ3,&hØØ,&hØØ,&hØØ
79Ø DATA &hØØ,&hØØ,&hØØ
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Product Review

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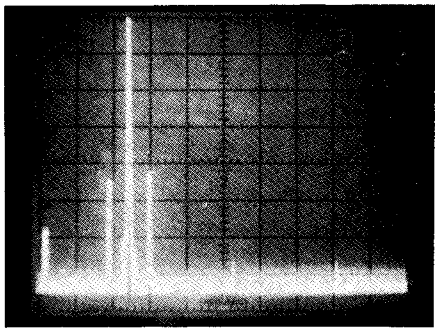

Fig 4—Worst-case spectral display of the TS-440S operating on the 20-m band. Vertical divisions are each 10 dB; horizontal divisions are each 10 MHz. Output power is approximately 123 W at a frequency of 14.1 MHz. All spurious emissions are at least 43 dB below peak fundamental output. The two taller pips on each side of the fundamental are mixing products, but are below the maximum level allowable under FCC regulations. The TS-440S complies with current FCC specifications for spectral purity.

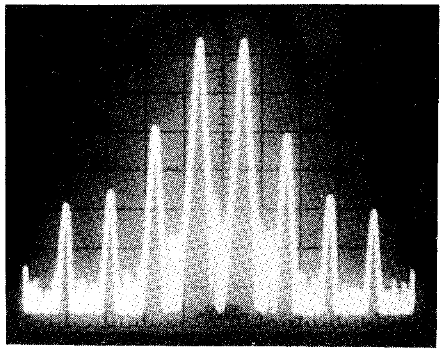

Fig 5—Spectral display of the TS-440S output during transmitter two-tone intermodulation distortion (IMD) testing. The transmitter was being operated at rated input power on the 20-m band. Third-order products are 28 dB below PEP, and fifth-order products are 46 dB down. Vertical divisions are each 10 dB; horizontal divisions are each 1 kHz.

Conclusion

The TS-440S is truly a pleasure to use, and I must say that I am impressed with its many features. It performed flawlessly through the review period. Because I tend not to operate from one location all of the time, its light weight and compact design enhanced my operations. Even though the controls are compactly arranged, I did not find them difficult to use. The only complaint I have is that the RIT and XIT controls are not separate—this caused some problems during contests because I use these two controls a lot in contesting. All things considered, however, I give Trio-Kenwood's TS-440S a "10."

Manufacturer: Trio-Kenwood Communications, 1111 West Walnut St, Compton, CA 90220. Price class: TS-440S with AT-440 antenna tuner, $1200; YK-88C 500-Hz CW filter, $65; YK-88CN 270-Hz CW filter, $65; VS-1 voice synthesizer, $45; PS-50 heavy-duty power supply, $210 ; IF-232C level translator, $55; IC-10 modem IC kit, $23.—*Thomas Miller, KA1JQW*