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Assistant Technical Editor

Trio-Kenwood Communications TS-940S HF Transceiver

What a radio! This feature-packed box is Kenwood's newest state-of-the-art transceiver and their showpiece. Here, in one package, you will find a high-performance, general-coverage receiver; a 250-W input, solid-state, broadband transmitter; a sturdy power supply; lots of "bells and whistles" and even an optional all-band, automatic antenna-matching network.

There is more to say about the TS-940S than available space will allow. For that reason, this review will highlight some of the unique features of this radio and compare it to the TS-930S (see January 1984 *QST*).

Trio-Kenwood TS-940S Transceiver, Serial No. 51110330

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: 150 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 and LCD dot-matrix 16-digit sub-display.	As specified.
Frequency resolution: 10 Hz	As specified.
Frequency stability: 10 PPM	Not measured.
Transmitter:	*Transmitter Dynamic Testing*
Power input: 250-W PEP (160-10 m bands, SSB, CW, FSK, FM); 140-W (AM).	Power output (CW): 160 m, 118 W; 80 m, 120 W; 40 m, 120 W; 30 m, 116 W; 20 m, 120 W; 17 m, 118 W; 15 m, 117 W; 12 m, 115 W; 10 m, 118 W.
Spurious signal and harmonic suppression: −40 dB or less (in CW).	−54 dB. See Fig 1.
Third-order intermodulation distortion: −37 dB or less (single-tone input).	−37 dB. See Fig 2.
CW keying waveform: Not specified.	See Fig 3.
Receiver:	*Receiver Dynamic Testing*
Receiver sensitivity: 10-dB S/N −14 dBμ (0.2 μV) or less in SSB, CW and FSK; 10-dB S/N 6 dBμ (2 μV) AM; 12 dB signal + noise + distortion/signal + noise, −6 dBμ (0.5 μV) or less in FM.	Minimum discernible signal (noise floor) (dBm): *80 m* −140, *20 m* −139
Receiver dynamic range: Not specified.	Blocking dynamic range (dB): *80 m* 141, *20 m* 138
	Two-tone, third-order intermodulation distortion dynamic range (dB): *80 m* 93, *20 m* 97
	Third-order input intercept (dBm): *80 m* −0.5, *20 m* +6.5
Receiver recovery time:	Receiver quieting (μV for 12-dB signal + noise + distortion/signal + distortion): 0.3 μV at 29.6 MHz.
Squelch sensitivity: −10 dBμ (0.32 μV) or less.	See Fig 4.
Receiver audio output at 10% total harmonic distortion: 1.5 W.	Min 0.13 μV, max 1.1 μV.
Color: Brown.	As specified.
Size (HWD): 7.5 × 15.4 × 16.0 in.	
Weight: 68 lb.	

Frequency Control

Like the '930, the '940 employs a push-button band switch. There is a button for each ham band from 160 to 10 meters, including the WARC bands. A pair of buttons, located immediately below these, allow UP/DOWN tuning in 1-MHz frequency steps. The 10 band switches in the '940 serve a second purpose. They can also be used to enter a frequency directly into the selected VFO. This is a handy feature indeed.

The A/B push button is used to select between the two VFOs that control the frequency synthesizer. The SPLIT push button allows split operation. The T-F SET button allows selection of transmit frequency during split operation. The A=B switch brings the unused VFO to the frequency in use. Rotating the weighted VFO knob at normal tuning speeds shifts the frequency in 10-Hz steps, or 10 kHz per VFO knob revolution. Turning the knob faster (over 5.5 to 6 rev/s), increases the frequency step rate proportionally.

If you like memories, you'll love the '940. Here you will find four switch-selected banks of 10 memories each. That's right—40 of your favorite frequencies ready for rapid recall. (A big increase over the 8 memories—16 if you make a modification—of the '930.) The bank switch is located inside a door in the top cover, so you'll want to organize memory contents into the four banks in a logical manner, like favorite nets in one bank, shortwave and standard BC stations in another, and so forth.

Each memory location contains both a frequency and a mode. This is possible because the mode is selected electronically by means of push buttons located to the left of the VFO knob. An annunciator indicates the mode selected by an audio signal—the international Morse code for the first letter of the mode (C for CW, A for AM, etc). Under the top cover is a switch that selects either 100- or 10-Hz resolution on the white digital frequency display. Beneath the digital display is an analog display with a red pointer to track tuning up and down the band. Another switch selects a pointer range of 1000 or 100 kHz.

The two digits to the right of the main frequency display show the RIT/XIT offset in 10-Hz increments. That's right—XIT has been added in the '940. The RIT/XIT range is a full ±9.9 kHz, and there is no conventional "center off" position. Instead, the

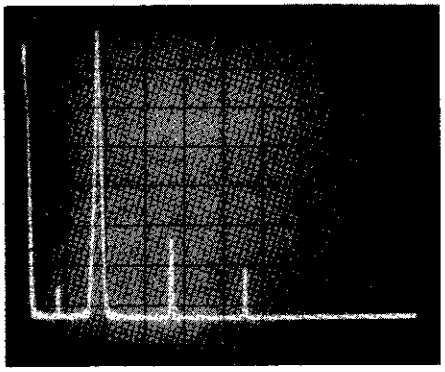


Fig 1—Worst-case spectral display of the TS-940S operating on the 160-m band. Vertical divisions are each 10 dB; horizontal divisions are each 1 MHz. Output power is approximately 100 W at a frequency of 1.85 MHz. All spurious emissions are at least 54 dB below peak fundamental output. The TS-940S complies with current FCC specifications for spectral purity.

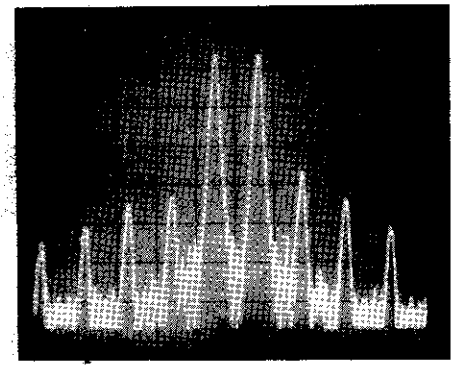


Fig 2—Spectral display of the TS-940S output during transmitter two-tone intermodulation distortion (IMD) test. Third-order products are 37 dB below PEP, and fifth-order products are 43 dB down. Vertical divisions are each 10 dB; horizontal divisions are each 1 kHz. The TS-940S was being operated at rated input power on the 20-m band.

CLEAR switch returns the offset to zero.

A unique green multipurpose subdisplay located to the right of the main display shows a clock, a graphical representation of the receiver bandpass characteristics, or frequencies contained in the VFOs or the selected memory bank. The clock function in the '940 includes a timer that can be used to turn the transceiver on and off at predetermined times.

Kenwood has even thought of the vision-impaired ham. An optional voice-synthesizer unit can be mounted inside the cabinet. The synthesizer announces the main display frequency on demand (pressing the VOICE push button). The review unit did not include this feature.

Receiver

The '940 features a quadruple-conversion receiver in SSB, CW, AM and FSK modes, and triple conversion in the FM mode. The first IF is at 45.05 MHz, the second at 8.83 MHz, the third at 455 kHz and the fourth at 100 kHz. An FM discriminator is fed from the 455-kHz IF output of the third mixer. The receiver lives up to Kenwood's fine reputation for producing high-dynamic-range receivers.

As with the '930, two noise blankers are included. The first, with a threshold control, is effective against pulse-type noise. The second is for pulses of a longer duration, such as those annoying woodpecker (over-the-horizon radar) pulses. Both blankers work effectively, but blankers can degrade receiver performance under high-level signal conditions. Judicious use of the NB LEVEL and RF ATTenuator controls will get rid of the noise while keeping overload problems to a minimum.

Several optional filters are available for the '940. There is a 6-kHz (AM) second IF filter, and 500-Hz, CW filters for the second and third IFs, and a 250-Hz filter for the third IF. The CW VBT control is a continuously variable bandwidth tuning control that may be used to tighten up CW selectivity. Used with the wide (SSB) filters, the VBT varies the bandwidth from 2.7 kHz down to 600 Hz. With either or both 500-Hz CW filters installed, the VBT range is 500 to 150 Hz. VBT is especially handy for those times when the narrow filter is too much and the wide filter is not enough. In fact, the casual CW operator may never need the selectivity afforded by the optional CW filters.

In addition to IF filtering, the '940 incorporates an effective audio filter. The AF TUNE circuit controls a peak-type audio filter with an 800-Hz center frequency, adjustable ±400 Hz. This filter is useful for reducing unwanted signals and noise.

Perhaps the most important feature for the CW operator is the PITCH control. The normal CW offset is 800 Hz. For those operators who prefer to listen to a different note, the PITCH control simultaneously shifts the IF passband, the received beat frequency *and* the sidetone pitch.

For the SSB operator, the SSB SLOPE TUNE controls (HIGH CUT and LOW CUT) allow independent adjustment of the high and/or low frequency slopes of the IF passband. These controls help cut interference from stations higher or lower in frequency. In addition, the NOTCH filter (also useful on CW) helps cut carriers or SSB QRM.

Transmitter

Kenwood chose a pair of rugged Motorola MRF-422 transistors, each capable of dissipating 290 W, for the final amplifiers. The finals operate at 28-V dc, and the net result is a clean, cool-running transmitter. Output power is at least 100 W on all bands. The transmitter is broadbanded, and no tuning is required. Internal protection circuitry reduces transmitter output if the load SWR is greater than about 2:1. Two quiet cooling fans, one for the final amplifier heat sink and one for the power supply, automatically activate when heat sink temperatures rise and shut off after the temperatures fall below set levels.

The review '940 contained the optional AT-940 automatic antenna-matching network. This T-network uses relay-switched inductors as well as two motor-driven variable capacitors. According to the manual, it is capable of matching antenna impedances from 20 to 150 ohms. The AT-940 works on all amateur bands—and that includes 160 meters!

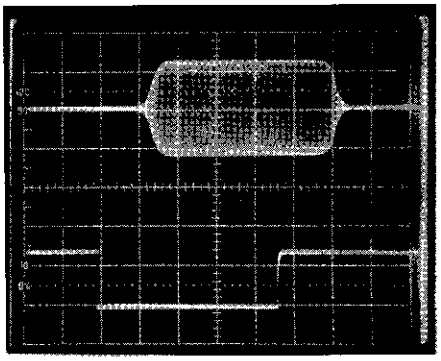


Fig 3—CW keying waveform of the TS-940S. The lower trace is the actual key closure; the upper trace is the RF envelope. Each horizontal division is 5 ms.

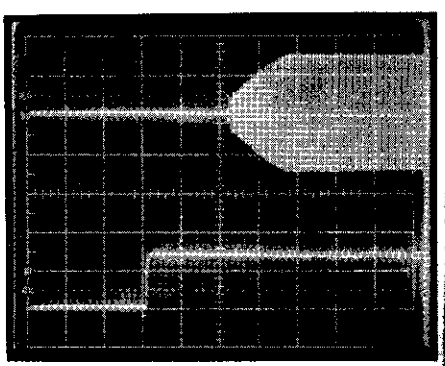


Fig 4—Receiver recovery (turnaround) time. The lower trace shows the key opening; the upper trace shows receiver audio output. Horizontal divisions are each 10 ms. There is an approximate 20-ms delay before receiver recovery.

Full-break-in CW, that is real QSK, is another feature of the '940. Proper sequencing is assured by CMOS logic circuitry, and reed relays provide nearly silent operation. Receiver AGC action is smooth with no annoying pops or thumps.

The built-in speech processor gives punch to the transmitted voice signal. I particularly appreciate the facilities for properly adjusting the processor. Use headphones and operate the MONI switch so that you can hear the audio signal as it will be transmitted. With the METER switch in the COMP position, adjust the PROCESSOR IN control for about midscale deflection as you speak into the microphone. Next, place the switch in the ALC position and adjust the PROCESSOR OUT control for mid-scale deflection as before.

Operation

To operate the controls of the '940 is to realize that this is a quality piece of equipment. All controls have the firm but smooth feeling that you expect from Kenwood. Panel layout is well done, making the rig very easy to use.

The features of this radio make sense—they work and they perform useful functions. Especially useful are all the QRM fighters. Accessories are easily added if desired, be they transverters or a Beverage antenna for receiving.

The manual covers what you need to know in plain, easy-to-understand language, and it is profusely illustrated. It is very well done, and especially useful for the beginner. The only shortcoming I found is a lack of connection details for the ACC1 jack.

In normal operation, I found the XIT to be particularly useful and easier to use than operating split with two VFOs. Variable-speed tuning makes rapid QSYs within a band faster. These and many other features make this a significant improvement over the '930. As in the '930, synthesizer switching transients can be heard when tuning the band at a moderate-to-fast rate. These "pops" are particularly annoying when tuning across a nearly dead band.

In my opinion, Kenwood has come up with another winner in the '940. If you are thinking about buying a state-of-the-art transceiver, you should check this one out. Manufacturer: Trio-Kenwood Communications, 1111 West Walnut St, Compton, CA 90220. Price class: TS-940S with AT-940 antenna tuner, $2000; YK-88A-1 6-kHz AM filter, $60; YK-88C-1 500-Hz filter for 8.8-kHz IF, $70; YG-455-1 500-Hz CW filter for 455-kHz IF, $100; YG-455CN-1 250-Hz CW filter for 455-kHz IF, $120; VS-1 voice-synthesizer unit, $40. —*Joseph Hutchinson, K8CH*

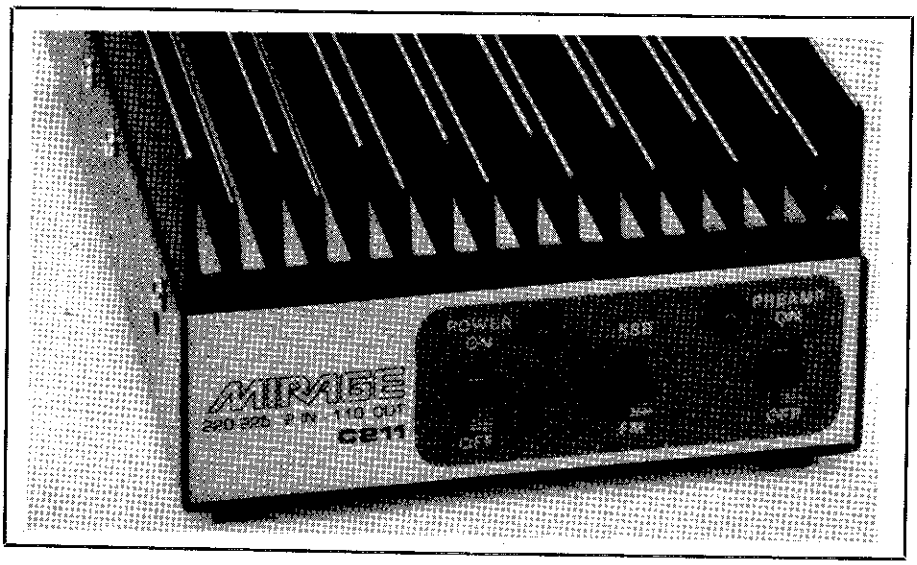
MIRAGE COMMUNICATIONS C211 220-MHz AMPLIFIER

With all the concern these days about the Amateur Radio Service keeping the allocation at 220 MHz, it's only right that we get on the band and use it. From an operator's viewpoint, it's a great band—the DX-communications possibilities are approximately the same as on 2 meters, and in many areas, the repeater segment is much less crowded. Several persistent amateurs have earned WAS and VUCC on the band. Commercial equipment for 220 MHz is not nearly as plentiful as for other bands because the market is much smaller; only North American amateurs are blessed with an allocation here. The lack of commercial equipment, especially for SSB and CW, is part of our 220-MHz population problem.

Enter Mirage Communications, a major manufacturer of VHF and UHF accessory equipment. Mirage markets several power amplifiers that are of interest to amateurs active on 220 MHz; the newest is the C211. This amplifier features 110-W output for just over 1-W drive and a preamp for the receiver. TR switching with a variable delay for SSB is standard. Like most other Mirage power amplifiers, the C211 may be used with the optional remote-control head (model RC-1), which duplicates the front-panel controls.

Circuit Highlights

There are three switches and two LED pilot lights on the front panel. The POWER ON/OFF switch controls the power amplifier. The PREAMP ON/OFF switch controls the preamplifier. The power amplifier and preamplifier may be used simultaneously or separately, as operating conditions dictate, and the two LEDs indicate the POWER ON condition of each. The SSB/FM switch controls the TR time delay. The rear panel is equally straightforward. There are two SO-239 connectors for input and



Mirage Communications C211 220-MHz Amplifier, Serial No. 018-384

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 220 to 225 MHz.	As specified.
Modes of operation: FM, SSB and CW.	As specified.
Power output: 110 W or more for 2-W input. Input power 0.2 to 4 W.	94 W for 0.8-W drive; 110 W for 1.2-W drive.
Spurious signal and harmonic suppression: Not specified.	See Fig 5.
Receive preamplifier: 10-dB gain with 2.5-dB (±0.5 dB) noise figure.	9-dB gain. NF not measured.
Power requirements: 13.6-V dc at 18-20 A, nominal.	13.6-V dc at 19.5 A at 110-W output.
Size (height, width, depth): 3 × 5.5 × 12 in.	
Weight: 5 lb.	

output, a phono jack for TR control, a six-pin Molex connector for the RC-1 and two heavy wires for dc power. A 35-A fuse is provided in the dc power line. The cover must be removed to replace this fuse.

The C211 is always biased for linear operation, even when the front-panel switch is set for FM. The only difference between the SSB and FM mode settings is the TR relay drop-out time delay. The relay drops out instantly in FM, but drop-out time may be set for anywhere between a few milliseconds and about 1.5 seconds for VOX SSB operation. This delay adjustment is made through a hole in the left side of the cover, behind the front panel.

Two stages of power amplification are used to get from the 2-W level up to the 110-W output. The first stage uses an MRF240A, while the second stage uses a pair of SRF2838 transistors. The preamp uses a U309 FET. All components are mounted on a PC board that is bolted to the hefty heat sink that forms the top of the amplifier. A built-in thermostat shuts off the C211 if the heat-sink temperature reaches 170 °F; it will not come back on until the heat-sink temperature drops below 140 °F.

It is important to note that the C211 manual cautions that input power must not exceed 4 W. Higher power may damage the driver transistor and will void the warranty. If your rig has more than 4-W output and no reliable means of controlling the power output, you should choose another power amplifier with higher drive requirements. The manual also states that the antenna should be matched to an SWR of 1.5:1 or better. Higher SWR will not damage the amplifier, but it will degrade performance.

RF-sensed switching is standard. Whenever approximately 0.2 W, or more, of RF drive is applied to the RADIO (input) jack on the

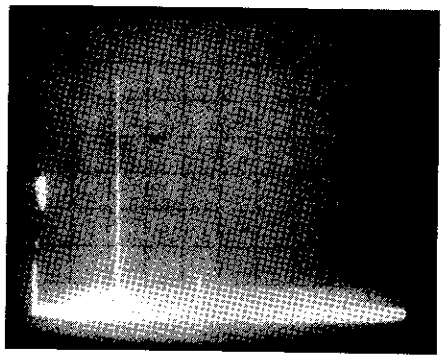


Fig 5—Worst-case spectral display of the Mirage C211 amplifier. Vertical divisions are each 10 dB; horizontal divisions are each 100 MHz. Output power is approximately 110 W at 220 MHz. The fundamental (pip at the left of the photo) has been reduced in amplitude approximately 14 dB by means of a notch filter to prevent spectrum-analyzer overload. All harmonics and spurious emissions are at least 68 dB below peak fundamental output. The C211 complies with current FCC specifications for spectral purity.