

Trio-Kenwood Communications TS-930S HF Transceiver

Every major manufacturer of HF equipment has a feature-packed, state-of-the-art transceiver these days. Kenwood is no exception. The TS-930S is their show piece. This electronic marvel contains a 250-W input, solid-state, broadband transmitter, a high-performance receiver (including general coverage), synthesized frequency control, a hefty power supply, a bevy of bells and whistles, and even an optional automatic antenna-matching network all in one box.

Describing each and every feature of the '930 would fill considerably more space than available here. Table 1 lists the front- and rear-panel controls and connectors. This review will highlight some of the unique features of the radio.

Frequency Control

The TS-930S employs a push-button band-switch instead of the conventional rotary-type selector. There is a button for each band from 160 to 10 meters, including the WARC bands. Two push buttons located at the bottom of the bandswitch panel allow tuning up or down in 1-MHz steps to access the nonham frequencies covered by the general-coverage receiver.

Two VFOs are built into the '930. Both share a common synthesizer and are controlled by the main tuning knob. The VFO function switch has settings for transceive on VFO A or VFO B. Using one VFO for transmit and the other for receive is easily possible for split operation. The A-B switch brings the unused VFO to the frequency in use. The VFOs tune in 10-Hz steps, providing frequency transition almost as smooth as in radios with a crystal-controlled LO. The main tuning knob is weighted to give a smooth, high-quality feel.



One feature not standard on most HF rigs (not yet, anyway) is a memory. Up to eight frequencies on any combination of bands may be stored in the '930 memory. Storing a frequency in memory is as easy as tuning to the desired spot and pressing the **MRN** switch. The **MR** switch may be used to recall a frequency. The **VFO/MEMO** switch transfers frequency control from the VFO to the memory switch for selection among the preset channels. Three AA-size batteries in a compartment under the top cover back up the memory when power is disconnected. These memories may be used in a variety of ways. A traffic handler might store chosen net frequencies, while a DXer could program in several pileup frequencies and switch among them.

Contest operators may plug in their favorite frequency for each band before the fray begins

so they can bandswitch directly to the active part of the band with a minimum of dial twirling.

Another unusual feature of the '930 is the digital display. Years ago, any digital display attracted attention. Now, they come in all shapes and sizes, and the '930's is white! A red pointer dial underneath the display digits tracks the progress up and down the band in 20-kHz increments. This display is wonderful to look at.

The two digits to the right of the main frequency display show the **RIT** offset in 100-Hz increments. The **RIT** range is an amazing ± 9.9 kHz, and there is no conventional center off position. Instead, the **RIT-CLEAR** switch returns the offset to zero.

Receiver

The '930 uses a quadruple-conversion receiver

*Assistant Technical Editor

Table 1
TS-930S Controls and Connections

Front Panel

General

METER switch
POWER switch
DIMMER switch
SEND/REC switch
MODE switch
VOX switch

Frequency Control

BAND switch
1 MHz STEP switch
DIAL LOCK switch
VFO FUNCTION switch
VFO A=B switch
F-SET switch
VFO/MEMO switch
MEMORY CH switch
MIN memory write switch
MR memory recall switch

Transmitter

MICROPHONE gain control
CARRIER level control
FULLSEMI CW break-in switch
PROCESSOR switch
PROCESSOR IN-OUT control
MONITOR switch
AUTO/THRU antenna tuner switch
MIC jack (8 pin)

Receiver

NB1 noise blanker 1 switch
NB LEVEL control
NB2 noise blanker 2 switch
RIT switch and control
RIT-CLEAR switch
NOTCH switch and control
AF TUNE switch and control

NARROW CW filter switch
AGC switch
PHONES jack (1/4-in phone)[†]
RF ATTENUATOR switch
AF gain control
RF gain control
CW VBT control
SSB SLOPE TUNE control
PITCH control

Top Panel

VOX GAIN control
ANTI VOX control
VOX DELAY control
CALIBRATOR switch

Rear Panel

ANTENNA connector (SO)-239)
GND ground terminal
RX. ANT output switch
TX. ANT jack (phono)
RX. VERTER connector (7-pin DIN)
REMOTE connector (7-pin DIN)
IF OUT jack (phono)
PHONE PATCH jacks (phono)
RITY KEY jack (phono)
Power connector
EXT. SPEAKER jack (1/8-in phone)
CW. KEY jack (1/4-in phone)
FUSE 6A holder

[†]mm = in \times 25.4.

Trio-Kenwood Communications TS-930S HF Transceiver, Serial No. 3070685

Manufacturer's Claimed Specifications

Frequency Coverage: Receive — 150 kHz to 29.9999 MHz; transmit — 1.8-2.0, 3.5-4.0, 7.0-7.3, 10.1-10.15, 14.0-14.35, 18.068-18.168, 21.0-21.45, 24.89-24.99, 28.0-29.7 MHz.

Modes of operation: CW, SSB, AM, FSK.
kHz/turn of knob: Not specified.
Frequency display: 6-digit fluorescent.
Frequency resolution: 100 Hz.
Backlash: Not specified.
S-meter sensitivity (μV for S9 reading): Not specified.

Transmitter power input: 250-W SSB/CW/FSK; 80 W AM.

Harmonic suppression: Better than 40 dB.
Third-order IMD: Less than -31 dB.
Spurious suppression: Better than 50 dB.
Receiver sensitivity: (1.8-30 MHz) less than 0.25 μV for 10 dB S+N/N.

Measured in ARRL Lab

Receive — as specified;
Transmit — 1.5-1.9999;
3.5-4.0; 7.0-7.4999; 10.0-10.4999; 14.0-14.4999;
18.0-18.4999; 21.0-21.4999;
24.5-25.0; 28.0-29.9999 MHz.

As specified.
10.
5/16-in high, white digits.
As specified.

Nil.
160 m, 155; 80 m, 160;
40 m, 160; 20 m, 160;
15 m, 190; 10 m, 165.

Power output (measurements without AT-930 tuner in line/with AT-930 in line):
160 m, 110 W, 80 m, 115/105;
40 m, 120/105; 30 m, 120/107;
20 m, 120/110; 15 m, 120/105;
10 m, 115/100.

50 dB (see Fig. 1).
-35 dB (see Fig. 2).
50 dB (see Fig. 1).

Receiver dynamics measured with optional 500-Hz CW filters installed:

	80 m	20 m
Noise floor (MDS) dBm:	-139	-139
Blocking DR (dB):	Noise limited.	Noise limited.
Two-tone 3rd-order IMD DR (dB):	87.5† (99.5)††	86.5 † (96.5)††
Third-order intercept (dBm):	-9.25† (5.75)††	-7.75† (10.25)††

Color: Two-tone gray.

Size (HWD): 5.6 × 14.75 × 13.8 in (141 × 374 × 350 mm).

Weight: 40.8 lb (18.5 kg).

†at 20-kHz spacing

††at 50-kHz spacing

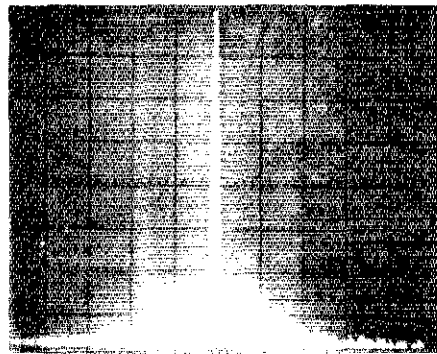


Fig. 3 — Spectral display of synthesizer noise about the carrier. Vertical divisions are each 10 dB; horizontal divisions are each 20 kHz. The TS-930S was being operated at rated input power on the 20-meter band.

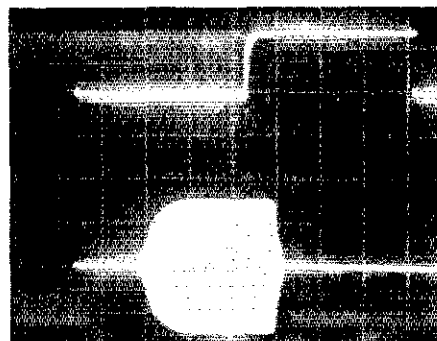


Fig. 4 — CW keying waveform of the TS-930S. Upper trace is the actual key closure; lower trace is the RF envelope. Each horizontal division is 5 ms.

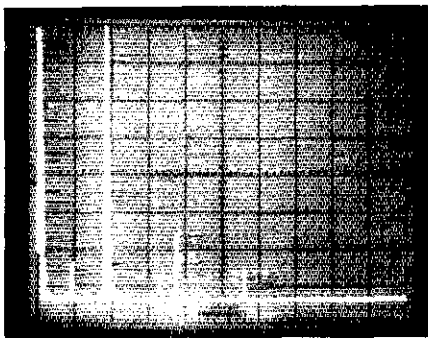


Fig. 1 — Worst-case spectral display of the Kenwood TS-930S. Vertical divisions are each 10 dB; horizontal divisions are each 1 MHz. Output power is approximately 100 W at a frequency of 1.8 MHz. All spurious emissions and harmonics are at least 50 dB below peak fundamental output. The TS-930S complies with current FCC specifications for spectral purity.

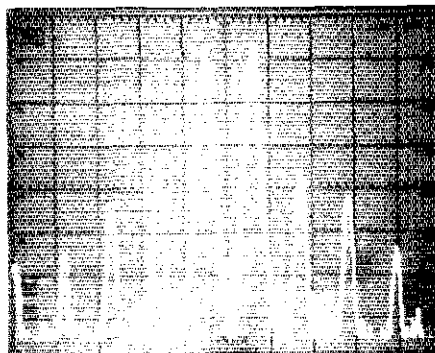


Fig. 2 — Spectral display of the TS-930S output during transmitter two-tone IMD test. Third-order products are 35 dB below PEP, and fifth-order products are 42 dB down. Vertical divisions are each 10 dB; horizontal divisions are each 1 kHz. The transceiver was being operated at rated input power on the 20-meter band.

with the first IF at 44.93 MHz, the second at 8.83 MHz, the third at 455 kHz, and the fourth at 100 kHz. Signals enter the receiver through switched band-pass filters and are sent to paralleled JFET RF amplifiers. The first and second mixers are balanced, employing two more JFETs each. The third and fourth mixers use dual-gate MOSFETs. There are as many different approaches to the state-of-the-art high-

dynamic-range receiver as there are rigs, and Kenwood has a winner here.

Not one but two noise blankers are included in the '930. 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. The woodpecker blanker really helps. Use of the noise blankers noticeably degrades 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.

An entire arsenal of QRM-fighting weaponry is available to the '930 operator. For CW operation, several optional filter combinations are available. The review '930 came with the YK-88C-1 500-Hz second IF filter and the YG-455C-1 500-Hz third IF filter installed. A front-panel NAR/WIDE switch offers selection of the narrow CW filters or the normal 2.7-kHz SSB filters.

The CW VBT control is a continuously variable bandwidth tuning control, which 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 CW filters installed, the VBT range is 500-150 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 VBT works so well that a casual CW operator may never need the selectivity afforded by the optional filters.

In addition to IF filtering, the TS-930S 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.

Yet another feature for the CW op is the PITCH control. The normal CW offset is 800 Hz. For those operators who prefer to listen to a higher (heaven forbid!) or lower note, the PITCH

control simultaneously shifts the IF passband, the received beat frequency *and* the sidetone pitch. This rig is a far cry from the days when CW was added as an afterthought!

Kenwood has not forgotten the SSB operator, either. 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 SSB QRM.

Even the REATTENUATOR is worth mentioning. Instead of the usual fixed 20 dB or so value, the '930's attenuator is switchable — 10, 20 or 30 dB. This feature allows the operator to choose the right amount for conditions and is especially useful on the low bands.

Transmitter

Kenwood chose a pair of rugged Motorola MRF-422 transistors, each capable of dissipating 290 W, for the final amplifiers. The MRF-422s 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 broadband, and no tuning is required. SWR-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 a safe level.

The review TS-930S came with the optional AT-930 automatic antenna-matching network installed. This pi-network uses coils and two motor-driven variable capacitors. According to the manual, it is capable of matching antenna impedances from 20 to 150 ohms. The AT-930 works on all amateur bands except 160 meters. To use the tuner, simply place the AUTO/THRU switch in AUTO, set the mode switch to TUNE, and hit the SEND switch. After some motor whirring and buzzing as the tuner searches for the best match, the transceiver is ready for operation. Tuning ranges are preset for each band, so the automatic operation takes only a few seconds when using a resonant antenna. Just for fun, I tried matching my coax-fed full-size 160-meter inverted V on various bands. The AT-930 matched that antenna for use on each of the 80-10 meter amateur bands!

As mentioned in the receiver portion of this review, CW operation was a primary design consideration rather than an afterthought. The full break-in CW operation is just that — real QSK. The circuit uses CMOS logic to ensure proper sequencing and reed relays for silent operation. The receiver AGC recovers instantly, as it should, making QSK a joy to use.

For the RTTY operator, the '930 has FSK. On transmit, the modem output keying line may be connected directly to the RTTY KEY jack if the voltage on the line is 3-V dc or less. A keying relay must be used with older high-voltage equipment. For receive, the modem input signal may be derived from the PHONE PATCH OUT jack.

Operation

The TS-930S is a quality piece of equipment. All of the controls have a good feel — the variable controls are firm but smooth, and the switches are solid. The front panel is well thought out, making the rig exceptionally easy to use.

There must be active amateurs on Kenwood's design staff because the transceiver has so many subtle useful touches. Most of the receiver bells

and whistles really do work in reducing QRM when pulling out weak signals. Rear-panel jacks make connecting an outboard receiver, an external preamp or a different receive antenna (e.g., a Beverage for the low bands) a snap. The speech processor is easy to set up and, properly adjusted, sounds good. Unlike some other solid-state rigs, the transmitter has enough power to drive almost any amplifier to its limit, even on 10 meters. The panel meter even functions as an accurate wattmeter and direct-reading SWR meter. Accessory connectors on the rear panel allow attachment of an array of transverters, phone patches, monitor scopes and other accessory items. This rig has just about everything an active ham could want.

Although receiver dynamics testing in the ARRL lab was somewhat limited by reciprocal mixing noise, at no time during my on-the-air evaluation did I experience phase-noise problems. Even during high-signal-level conditions on the low end of 40 meters, I could not detect any phase noise. I used the transceiver during several contests, on CW and SSB, and the receiver delivered outstanding performance.

I do have two complaints about the '930. Synthesizer switching transients can be heard when tuning the band at a moderate-to-fast rate. These "pops" seem like built-in QRN and are especially annoying when tuning a dying band during a contest looking for very weak signals. The other complaint only comes into play when using the '930 as an IF for VHF and UHF transverters. The advent of transceivers found manufacturers generating CW by injecting a tone into the microphone amplifier circuit, normally in the USB mode. During CW reception, a narrow band-pass filter is usually added to reduce the IF bandwidth. For some reason, Kenwood has chosen LSB for CW generation in the '930S after years of using USB. While this does not affect CW-to-CW QSOs, this presents some problems on the bands above 144 MHz, where CW-to-USB QSOs are common.

All things considered, Kenwood has done an outstanding job with the TS-930S, and anyone considering the purchase of a state-of-the-art rig should audition one. Manufacturer: Trio-Kenwood Communications, 1111 West Walnut St., Compton, CA 90220. Price class: TS-930S with AT-930 antenna tuner, \$1800, YK-88C-1 filter, \$70; YG-455C-1 filter, \$100. — Mark Wilson, AA2Z

MIRAGE COMMUNICATIONS D1010 430-450-MHz AMPLIFIER

□ This solid-state amplifier is designed to operate with as little as 300-mW input to a maximum of 15 W. Such a wide range of input levels provides flexibility so that most any hand-held transceiver, homemade exciter or multimode rig can be used as a driver.

The D1010 operates as a linear amplifier in the CW, SSB, FM and ATV modes. Two front panel switches control all operation: One is the POWER ON/OFF switch, while the FM/SSB switch selects the T-R relay time delay. A hole on the side of the amplifier allows access to a control whose adjustment sets the delay time required when operating SSB. The built-in antenna relay is RF actuated so the amplifier can be used with a transceiver. A rear-panel jack is provided for separate amplifier keying to eliminate relay noise when VOX operation is not used. Grounding this point will key the antenna relay.

The only other front-panel items are two LEDs. One indicates the antenna relay is energized during transmit; the other LED lights when power is applied. If this light should go out during operation, it indicates an overheating condition, and the amplifier will be disabled until

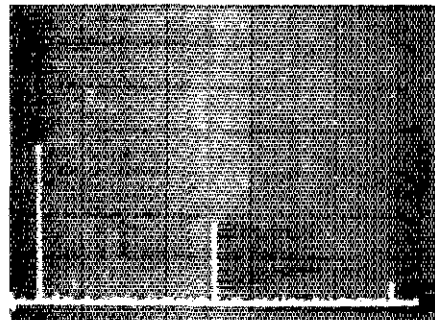


Fig. 5 — Worst-case spectral display of the Mirage D1010 amplifier. Vertical divisions are each 10 dB; horizontal divisions are each 100 MHz. Output power is approximately 100 W at a frequency of 432 MHz. The fundamental (pip at the left of the photo) has been reduced in amplitude approximately 32 dB by means of notch cavities; this prevents analyzer overload. All harmonics and spurious emissions are at least 50 dB below peak fundamental output.

