

## Kenwood TS-950SDX MF/HF Transceiver

Reviewed by Rus Healy, NJ2L

It's natural to wonder how Kenwood revised the TS-950S platform to build their new top-of-the-line TS-950SDX. "It had better be something *really* special," you're thinking, "otherwise Kenwood would have a lot of explaining to do as to why they released this rig less than two years after its predecessor!" Well, the new '950 is really special. It retains all the basic radio performance of the TS-950SD, and Kenwood's digital signal processing has finally come of age in this product.

In developing the TS-950SDX, Kenwood substantially revised the TS-950S's front panel and operating software. Unfortunately for TS-950S/SD owners, Kenwood has no plans to offer an upgrade to the TS-950SDX. A physical upgrade is practically impossible; the new '950 is a completely different radio in most respects. It's so different, in fact, that after reviewing it, I'm surprised they didn't call it the TS-960S.

To get a better idea how the new radio differs from the old, and to see how their lab-measured performance compares, read the January 1991 *QST* TS-950SD review. Except where they differ, I won't discuss most of the features and controls the TS-950SDX shares with the TS-950S/SD.

### What's New?

Here's a rundown of the more substantial changes and improvements:

#### Now Standard:

- The TS-850S's wonderfully quiet, nearly spur-free direct digital synthesizer, which can tune in 1-Hz steps.
- CW operation on either sideband and a **FINE** button, which gives 1-kHz-per-revolution tuning in CW mode, like the '850.
- The AGC control has an **AUTO** position in which the radio chooses AGC constants by mode. You select the default for each mode in a setup menu.
- Memory keyer with remote control. We've entered a new era in transceivers with the TS-950SDX: Its supplied wired remote is your *sole* access to the radio's standard three-memory keyer (and the optional DRU-2 digital voice recorder/player, if installed).
- A refined, useful second receiver.
- New DSP effectiveness and versatility.

#### No Longer Standard:

- 270-Hz and 1.8-kHz filters for the 8.83-MHz IF.
- No longer is there a "base" TS-950S; the



digital signal processing (DSP) unit is now so completely integrated into the radio that Kenwood decided to offer only one package.

#### Still Standard:

Excellent basic radio performance; 150 W output; fast, quiet automatic antenna tuner; simple VFO manipulation and split operation; 100 memories; RF-derived SSB monitor circuit; lots more.

#### Other Highlights

- The radio's improved software results in fewer front-panel controls and less clutter. The reworked panel is easier to navigate than the old one.
- The TS-850S-like Quick Memo function allows easy storage and recall of five frequency/mode/filter combinations. You can tune these memories in Recall mode.
- A widely variable display dimmer that lets you vary the intensity of every front-panel indicator.
- Menu-configurable IF-filter choices by mode. Why should you have to pass over a 500- or 270-Hz filter in SSB mode—or a 6-kHz filter in CW? Now you can deselect them to make filter selection more convenient.

#### The Bottom Line

Rich in features, this transceiver rewards top-dollar-radio buyers with top-shelf performance. It does a lot, but is somewhat complicated to use—as reflected by its manual, which is not up to the task.

Data-mode operation is quite straightforward with the TS-950SDX. In FSK, the radio ignores front-panel microphone input and works quite smoothly. Three DSP filter bandwidths are available in FSK, in addition to the CW IF filters and **VBT** controls. On the rear-panel data in/out jack (**ACC 2**), a pin can also be used to disable the microphone input for other modes (packet radio, AMTOR, etc).

You can connect an external keying source *and* a paddle to the radio at the same time, using the rig's internal keyer and external keying source with relatively little hassle. To do so, however, you have to wire an external adapter cable for the remote control, because both it and the external keyer connect via the **REMOTE** jack (see "Documentation").

In the different-but-not-better category: The traditional Kenwood 10/20/30 dB attenuator settings are gone. Now your choices are 6, 12 and 18 dB. I consider this a drawback. This radio is *so* sensitive that I often operate on 160, 80 and 40 meters using 18 dB of attenuation *and* the AIP circuit to keep signals to a reasonable level.

Kenwood has left behind the TS-950SD's bipolar output transistors in favor of FETs in the '950SDX. The new radio puts out just as much power as the old one, but its SSB IMD characteristics, although still very good, are actually slightly worse than the TS-950S—at least in the samples we've tested in the ARRL Lab. Kenwood says that the new FET final offers enhanced reliability.

#### Options

Filtering options for the TS-950SDX's

main receiver include 1.8-kHz and 270-Hz units for the 8.83-MHz IF, and a 250-Hz unit for the 455-kHz IF. For all but the most demanding contesting on crowded bands, the radio's stock 500-Hz CW IF filters, DSP low-pass filter and VBT controls do the job well. If you have a 40-meter beam, live on the East Coast (or in Europe) and spend a lot of your operating time in DX contests, you'll probably benefit from one or both of the narrower (sub-300-Hz) filters. For SSB contesting and DXing, the 1.8-kHz filter is valuable, but not absolutely necessary, thanks to the radio's other filtering functions.

### User Interface Improvements

The TS-950SDX implements most user-definable functions via setup menus. In fact, there's now only one configuration switch on the radio: the external-amplifier control switch on the back panel. Most commonly changed functions (29 of them) are configurable at any time via the **MENU** key and sub display. Thirty other functions, covering everything from FSK shift to frequency- and channel-step sizes, can be reconfigured only at power-up.

Here's how the menu system works. Let's say you want to change the display brightness (when the display **DIM** switch is pressed). You push the **MENU** button and use the **M.CH/WFO.CH** knob to select the appropriate menu item—in this case number 02. As you turn the knob, you'll see the item numbers, brief descriptions of each function, and the current settings roll by. When you reach number 02, you'll see *Bright* on the sub display, followed by its relative setting. You can then choose any of eight display-brightness settings using the up- and down-arrow keys on the keypad. The brightness changes as you push these keys. Push **MENU** again and you're back to normal operation. While in **MENU** mode, the radio's main functions—tuning, AF gain, and so forth—remain usable.

The TS-950S/SD's top hatch is gone in the TS-950SDX, and the controls that were under it moved to the front panel. Bravo, Kenwood!

### The New DSP System

Kenwood's first-generation TS-950SD DSP unit was rather unimpressive, mainly offering limited transmitted-signal processing functions. Its only receive function was a variable-bandwidth audio filter that didn't exactly revolutionize audio-filter performance.

One of the TS-950SDX's biggest improvements over the '950SD lies in its sophisticated, effective DSP receive functions. On transmit, the DSP unit still sets the high and low cutoff frequencies of transmitted AM and SSB audio, shapes the CW waveform and generates the FM carrier, but it's now also used for a variety of receive functions, such as SSB and CW *detection*, band-pass filtering on CW, FSK and SSB, and noise filtering on SSB.

In SSB and CW operation, the TS-950SDX's DSP detection makes for incredible elimination of the audio image ("opposite sideband")—even with low CW offsets and loud signals! The acid test was setting the radio's offset to 400 Hz and tuning in W1AW's S9 + 60-dB signal on CW. Using a 500-Hz filter and almost any other radio, you can tune such a signal on both sides of zero beat (the desired sideband and the audio image); in the '950SDX, *the audio image isn't there*—even with a 2.7-kHz filter in line! Of course, this works equally effectively on SSB. Kenwood has made quite a leap with digital signal processing in this area.

Another feather in Kenwood's engineering cap is its much-touted DSP *comb filter*, which you can toggle on and off via a menu item. Except on the quietest bands, the comb filter makes for a sometimes dramatic improvement in signal-to-noise ratio, though it does noticeably limit the receiver's audio response. The comb filter vastly reduces band noise—and operator fatigue—particularly in 40, 75 and 160-meter SSB operation.

Used in combination with the IF filters, SSB **SLOPE TUNE** controls and the variable-cutoff DSP low-pass filter (which also works very well on CW), the comb filter makes the TS-950SDX an exceptionally selective SSB radio—Kenwood's best ever. Between that, the radio's obliteration of the undesired sideband on receive, and Kenwood's traditional interference-reduction controls, the TS-950SDX is certainly one of the most capable SSB DXing and contesting radios ever made.

### Enhanced Sub Receiver

The TS-950S's sub receiver was perhaps its least fully developed feature. It stuck you with an SSB-bandwidth filter, a small tuning knob and limited range ( $\pm 500$  kHz with respect to the main-receiver frequency). You had no choice but mixed audio, with the audio-output ratio and levels set by separate **AF GAIN** controls. In these limitations, the TS-950S's sub receiver significantly lagged its competition.

The '950SDX provides much more sub-receiver versatility. Thanks to the **M/S** (main/sub swap) key, no longer must we suffer by tuning the sub receiver with that little **RIT/XIT**-size knob! And the **RX  $\leftrightarrow$  SUB** key lets you swap the two entirely, rather than just their controls, which is very useful in contest operation. The second receiver now has its own signal-strength meter: During sub-receiver operation, the transmitter's yellow ALC scale doubles as the sub-receiver S meter.

The **SUB** key also gives direct-frequency-entry capability and shows the selected IF filter (500 Hz or 2.7 kHz). Yes, the radio now comes with a selectable 500-Hz CW filter in the sub receiver! That's a big improvement. CW DXers may consider this feature the sub receiver's most significant improvement: It allows using the sub

receiver on crowded bands—something very difficult to do with the '950S.

Stereo/mixed audio selections, invoked from the **MENU** key, are useful. You can select which receiver's audio goes to which ear in a stereo headset, or to internal and external speakers. But the radio still has two **AF GAIN** controls, making adjustment less quick and easy than a master AF gain and separate balance control.

### Sub-Receiver Tidbits

- Its AGC is fixed at something close to the main receiver's **MID** constant.
- It's tunable  $\pm 1$  MHz from the main receiver.
- It works only on CW, SSB and FSK, and you can't enable the sub receiver if the main receiver is in AM or FM.
- It's still restricted to the main receiver's mode.

### On the Air

The TS-950SDX hits the mark in the most important ways: receiver dynamic range, transmitter cleanliness, CW wave shaping, and low phase noise.

On CW, the TS-950S was hard to improve on—except for its QSK transmission. If you wanted to use the TS-950S in QSK mode, you had to trade off optimum performance in semi-break-in mode. Not so in the 'SDX. As the keying photos and on-the-air use show, this radio does both very well, with external or internal keying sources. If you're using either radio in QSK mode, you'll definitely want to turn off the external amplifier key line, however; the relay used to switch this line is rather noisy.

The radio's low-pass DSP audio filter is always active; you set its cutoff frequency in the range of 400 Hz to 6 kHz in a menu. This filter lets you shape receiver audio response optimally for any mode. With this filter wide open, the receiver's AM-audio response is wonderfully wide. It's quite useful on CW, SSB and FSK, also.

Kenwood has kept its basic, proven IF-filter scheme, improving it with each radio generation. With variable-bandwidth tuning in the radio's audio and IF sections and wonderfully smooth AGC on all modes, the TS-950SDX is at least the TS-950S's equal. But with its cleaner synthesizer, DSP low-pass filter and improved user interface, the 'SDX is more effective and enjoyable to use.

### Documentation

The 63-page TS-950SDX manual covers a lot of ground; it documents a very complex radio. It isn't up to the standards set by Yaesu, Ten-Tec and ICOM, however. I had trouble finding information I needed on numerous occasions. Although the manual does a pretty good job of describing what happens when you press a button or turn a knob, it gives very little *practical* information on how to use the radio's many functions, so it takes a lot longer to

learn to use this radio than you might otherwise require.

In some cases the manual is vague. For instance, it strongly implies that the DSP low-pass filter is only available in FSK; it's not—it works on FSK, CW and SSB. Only the band-pass selections are solely for FSK. I found only one error in the manual: A box on page 31, the section on SSB transmitting, contains this note: "The transmitter will not operate unless the **FULL/SEMI** switch is in the **FULL** position." This is not true.

The manual is also somewhat disorganized. The section on connecting accessories is near the beginning, just past the rear-panel jack descriptions. I wanted to connect a separate keying source (my computer) and a paddle for use with the radio's internal keyer. This is possible, as mentioned earlier, but the section on how to do it is buried in the option-installation section near the back of the manual, with no pointers from elsewhere. Descriptions of the radio's DSP functions are also widely scattered throughout the manual.

On the good side, the manual's sections on basic receiving and transmitting functions, accessory connections and option installation are concise and easy to follow. Three manuals are shipped with the radio: the instruction manual, the external control manual (which details computer-control operation), and a booklet of fold-out schematic diagrams—a nice touch. The radio also comes with a handy quick-reference card showing the functions accessible via the **MENU** key, their default settings, and summaries of what they do.

### Odds and Ends

Kenwood has addressed a number of TS-950S owners' concerns in the TS-950SDX. For example, some users of the TS-950S (and other radios) have experienced high-SWR power reduction when

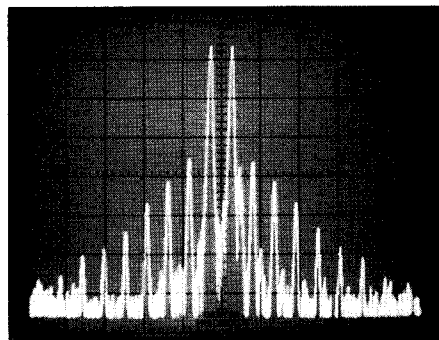


Fig 1—Worst-case spectral display of the TS-950SDX transmitter during two-tone intermodulation distortion (IMD) testing. Third-order products are approximately 35 dB below PEP output, and fifth-order products are approximately 41 dB down. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The transceiver was being operated at 150 W PEP output at 3.9 MHz.

Table 1

## Kenwood TS-950SDX MF/HF Transceiver, Serial no. 31200011

### Manufacturer's Claimed Specifications

Frequency coverage: Receive, 0.1-30 MHz, transmit, 1.8-2, 3.5-4, 7-7.3, 10.1-10.15, 14-14.35, 18.068-18.168, 21-21.45, 24.89-24.99, and 28-29.7 MHz.

Modes of operation: AM, CW, FM, FSK, LSB, USB.

Power requirement: 120 V ac  $\pm$  10% at 110 W on receive and 700 W max on transmit.

### Receiver

Receiver sensitivity (10 dB [S+N/N], bandwidth not specified, AIP off): SSB and CW: 0.1-0.15 MHz, 2.5  $\mu$ V (-99 dBm); 0.15-0.49 MHz, 1  $\mu$ V (-107 dBm); 0.49-1.7 MHz, 4  $\mu$ V (-95 dBm); 1.7-30 MHz, 0.2  $\mu$ V (-121 dBm).

AM (10 dB S+N/N, bandwidth not specified, AIP off): 0.1-0.15 MHz, 25  $\mu$ V (-79 dBm); 0.15-0.49 MHz, 10  $\mu$ V (-87 dBm); 0.49-1.7 MHz, 32  $\mu$ V (-77 dBm); 1.7-30 MHz, 2  $\mu$ V (-101 dBm)

FM (12 dB SINAD, AIP off): 28-30 MHz, 0.5  $\mu$ V. (-113 dBm).

Blocking dynamic range: Not specified.

Two-tone, third-order IMD dynamic range: 108 dB (signal spacing and IF bandwidth not specified).

Third-order input intercept:<sup>†</sup> Not specified.

S-meter sensitivity (for S9 reading): Not specified.

CW/SSB squelch sensitivity (1.7-30 MHz): Less than 0.5  $\mu$ V.

FM squelch sensitivity (28-30 MHz): Less than 0.32  $\mu$ V

IF notch filter attenuation: More than 45 dB.

Receiver audio output: 1.5 W into 8  $\Omega$  at 10% distortion.

Receiver IF/audio response: Not specified.

### Transmitter

Transmitter power output: Adjustable from 20-150 W on CW, FM, FSK and SSB; 10-40 W on AM.

Spurious-signal suppression: > 40 dB.

Third-order intermodulation distortion products: Not specified.

CW keying characteristics: Not specified.

Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.

Composite transmitted noise: Not specified.

Size (height, width, depth): 6 x 16.1 x 17.6 inches; weight, 51 pounds.

### Measured in the ARRL Lab

Receive, as specified; transmit, 1.7-2, 3-4, 6.5-7.5, 10-11, 13.5-14.5, 18-19, 20.5-21.5, 24-25, and 27.5-30 MHz.

As specified

Not measured.

### Receiver Dynamic Testing

Minimum discernible signal (noise floor) with 500-Hz IF filters:

	AIP Off	AIP On
1.0 MHz	-121 dBm	-111 dBm
3.5 MHz	-139 dBm	-127 dBm
14.0 MHz	-138 dBm	-126 dBm
28.0 MHz	-137 dBm	-127 dBm

Signal 30% modulated with a 1-kHz tone:

	AIP Off	AIP On
1.0 MHz	-105 dBm	-96 dBm
3.8 MHz	-122 dBm	-111 dBm

29 MHz with 6-kHz filter: -118 dBm (AIP off); -110 dBm (AIP on).

Blocking dynamic range with 500-Hz IF filters:<sup>\*</sup>

	AIP Off	AIP On
1.0 MHz	128.5 dB	129.3 dB
3.5 MHz	131.5 dB	133.5 dB
14.0 MHz	131.8 dB	133.9 dB
28.0 MHz	135.4 dB	138.4 dB

Two-tone, third-order IMD dynamic range with 500-Hz IF filters:<sup>\*</sup>

	AIP Off	AIP On
1.0 MHz	83 dB	87 dB
3.5 MHz	93 dB	94 dB
14.0 MHz	94 dB	95 dB
28.0 MHz	97 dB	100 dB

At 14 MHz: AIP off, 59.5  $\mu$ V; AIP on, 282  $\mu$ V.

As specified.

As specified.

29 dB.

2.3 W into 8  $\Omega$  at 10% total harmonic distortion.

At -6 dB, with audio low-pass filter at 2.8 kHz: SSB (2.7-kHz IF filters), 282-2534 Hz (2252 Hz); CW (500-Hz IF filters, 500-Hz offset), 247-646 Hz (399 Hz).

### Transmitter Dynamic Testing

Adjustable from 10 to 150 W (CW, SSB, FM—output varies slightly from band to band). AM as specified.

As specified. Meets FCC specifications for equipment in its power-output class and frequency range.

See Fig 1.

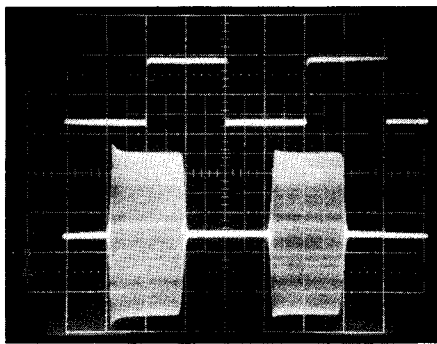
See Fig 2.

AGC fast: S1 signal, 25 ms; S9 signal, 23 ms.

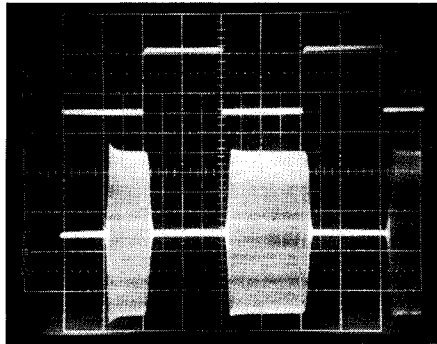
See Fig 3.

<sup>\*</sup>Blocking dynamic range and third-order IMD dynamic range measurements were made at the ARRL Lab standard signal spacing of 20 kHz. Also see Table 2.

<sup>†</sup>Third-order input intercept (dBm) = MDS (dBm) + 1.5 x third-order IMD dynamic range (dB).



(A)



(B)

Fig 2—CW-keying waveforms for the Kenwood TS-950SDX in the semi-break-in (VOX) mode (A) and the full-QSK mode (B). The upper traces are the actual key closures; the lower traces are the RF envelopes. Horizontal divisions are 10 ms. The transceiver was being operated at 143 W output at 14 MHz. In VOX mode, the first keyed element is shortened by about 5 ms; in QSK mode, no perceptible element shortening occurs. In both modes, the first element after key closure is slightly harder than the rest.

using them with external power amplifiers. When first keyed, some amplifier TR-relay contacts take long enough to settle that the radio sees a very high SWR for a few milliseconds and cuts back power accordingly to protect the final-amplifier transistors. When things have settled, the radio's output slowly rises. To alleviate this problem with amplifiers that use slow-settling relays, the TS-950SDX has a jumper you can cut that delays the radio's RF output by 30 milliseconds (instead of the default 15 ms) in semi-break-in mode. (QSK operation isn't affected.)

One rather annoying characteristic of the TS-950S/SD was display flicker. Whenever any part of the display changed, the entire display flickered. In the TS-950SDX, this problem is better, but not completely fixed. Now only when very loud signals "move the S meter" (illuminate its bars) over about S9 is flicker perceptible.

### Decisions, Decisions

The TS-950SDX is a strong and worthy contender for your high-performance-radio dollars. With the TS-950SDX, it's more important than ever that you obtain a copy of the manual before making your buying

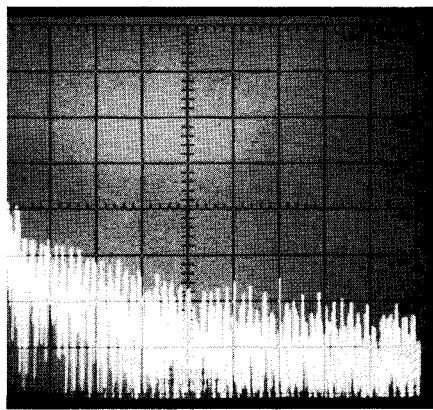


Fig 3—Spectral display of the TS-950SDX transmitter output during composite-noise testing. Power output is 144 W at 14 MHz. Vertical divisions are 10 dB; horizontal divisions are 2 kHz. The scale on the spectrum analyzer on which these photos were taken is calibrated so that the log reference level (the top horizontal line on the scale) represents -60 dBc/Hz and the baseline is -140 dBc/Hz. Composite-noise levels between -60 and -140 dBc/Hz may be read directly from the photographs. The carrier, off the left edge of the photographs, is not shown. These photographs show composite transmitted noise at frequencies 2 to 20 kHz offset from the carrier.

**Table 2**  
**TS-950SDX Sub Receiver Performance at 14 MHz**

Category	Measured in the ARRL Lab	
	AIP Off	AIP On
CW Sensitivity*	-139 dBm	-130 dBm
Blocking Dynamic Range†	126 dBm	134 dB
Third-Order IMD Dynamic Range†	94 dB	96 dB
IF/audio response at -6 dB*	With 2.7-kHz filter, 158-2661 Hz (2503 Hz); with 500-Hz filter, 341-1035 Hz (694 Hz).	
S-meter sensitivity for S9 reading	AIP off, 28.2 μV; AIP on, 129 μV.	

Note: Sub-receiver AGC cannot be disabled.

\*500-Hz IF bandwidth.

†20-kHz signal spacing.

decision. Because this radio is so complex and capable, a few evenings of studying the manual will reveal a great deal of useful information that will help you determine if this is the high-performance radio for you. While you're at it, study the competitors' manuals and *QST* Product Reviews of their radios to see how things compare. Above all, make a concerted effort to spend some time with every radio you're considering, even if it's only at a convention or dealer.

More than \$3700 (a typical TS-950SDX street price) is a lot of money to spend on a radio. Do everything you can to make sure you pick one that's right for you.

Thanks to Dave Newkirk, WJ1Z, and Steve Powlisken, K1FO, for their contributions to this review.

Manufacturer's suggested list prices: TS-950SDX, \$4500; YK-88SN-1 1.8-kHz IF filter, \$85; YK-88CN-1 270-Hz IF filter, \$84.95; YG-455CN-1 250-Hz CW filter, \$160; MC-90 microphone, \$220; VS-2 voice synthesizer, \$63; IF-232C computer interface, \$99; DRU-2 digital voice recorder/player, \$122; SP-950 filtered speaker, \$110; SM-230 monitor scope, \$1000. Manufacturer: Kenwood USA Corp, 2201 E Dominguez St, Long Beach, CA 90801, tel 310-639-4200.

## Maldol 28HS2HB 2-Element 10-Meter Beam

Reviewed by Bart J. Jahnke, KB9NM

The 28HS2HB caught my eye as I thumbed through *QST* ads. (I saw it in a spread for EasyTech, one of Maldol's US distributors.) For my station, the antenna's price, size (two elements on a 4-foot, 5-inch boom), and nondemanding installation (it can be rotated using a light-duty TV-antenna rotator) were highly attractive. Furthermore, with the influx of new hams who have 10-meter privileges and the resultant popularity of 10 meters, a mono-bander—however small—for that band was

something I wanted to try.<sup>1</sup> The 28HS2HB looked as if it would give me the opportunity.

### Specifications and Construction

The Maldol 28HS2HB's two elements are driven out of phase. One element is made shorter than the other to give the antenna directivity. For an SWR of 1.5:1 or less, the antenna's specified bandwidth is

<sup>1</sup>A 6-meter version, the 50HS2HB, is also available.