KENWOOD

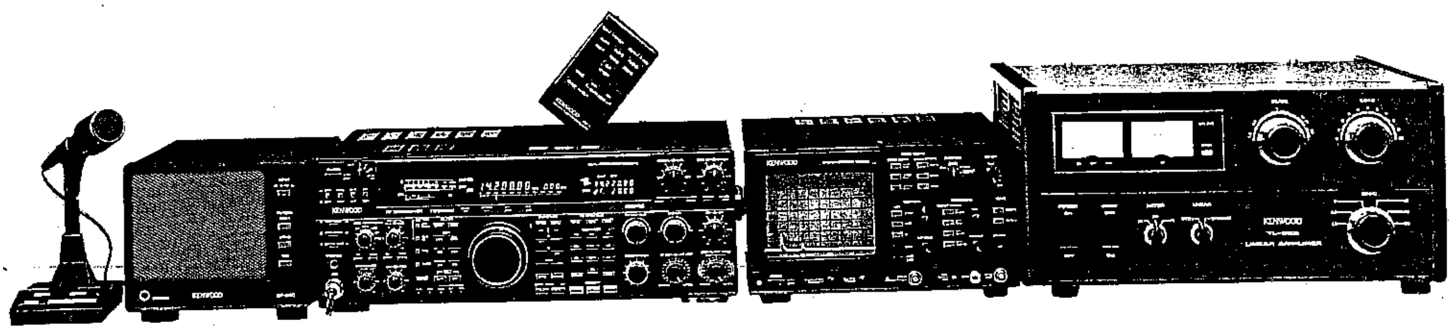
# IN-DEPTH MANUAL

# TS-950SDX

HF TRANSCEIVER

# C•O•N•T•E•N•T•S

The TS-950SDX ranks foremost among HF transceivers. Derived from the TS-950SD, the first Amateur Radio transceiver offering a built-in DSP (digital signal processor) and dual-frequency receive on the same band, it advances HF performance a step ahead. The refined design adds DSP-based digital detection capability and an FET final section, plus completely new RX and TX features. Furthermore, as regards performance and operability, it exhibits a quantum leap improvement with such features as the M/S function and TF-WATCH function, designed to make maximum use of the sub receiver with its separate crystal filter for CW operation. It also features a menu system to adjust the DSP digital filters' cutoff frequencies, even while in use. A message keyer is incorporated, and with a remote function keypad for convenient keyer operation, the TS-950SDX is perhaps the most powerful HF rig ever available for contests and DX-peditions.



# HF TRANSCEIVER

# TS-950SDX

Designed especially for DX-peditions, DXing, and contests, the TS-950SDX exploits the latest advances in electronics and microprocessor engineering, fields in which progress has become increasingly rapid over the last few years. It incorporates such new technology as an FET final RF power section and DSP, providing levels of performance and functionality never before seen in an Amateur Radio transceiver.

This In-Depth Manual provides detailed explanations of the various aspects of the TS-950SDX, focusing on the latest features and functions. There are six main sections: Features & Functions, DSP, Reception, Transmission, Other Features, and Options.

# 1. Features & Functions
## — Winning techniques —

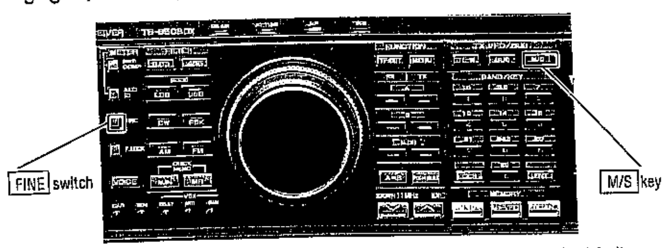
### 1. Dual-frequency receive
DX-peditions provide a grueling test of man and machine: a split-second decision can make the difference between success or failure. To give you the edge, Kenwood engineers have paid careful attention to feedback from the users of previous models when developing the new TS-950SDX. Both performance and operating ease of the sub-receiver have been upgraded by adding a crystal filter for CW operation, and it is now possible to change the sub-receive frequency using the main tuning knob. Consequently, simultaneous dual-frequency receive on the same band is easier and more efficient for the operator. Furthermore, keeping in mind the reality of DX operations, a menu system has been added to allow setting and changing DSP digital filter characteristics on the fly. Supplied as standard equipment are a message keyer and remote function keypad, which are extremely useful for DXing and contesting. Enjoy the self-confidence of knowing that you have at your fingertips the features and functions of a truly first-class HF transceiver.

#### (1) Technically sophisticated dual-frequency receive on the same band
In order to achieve success in contests, DXing and DX-peditions—In which numerous veteran DX stations jostle for position—the ability to receive two frequencies simultaneously is an indispensable advantage. In fact, in some form this capability has recently become a commonplace feature on top-rank HF transceivers.
Kenwood's TS-950S and SD HF transceivers provided the ability to receive two frequencies simultaneously on the same band. But this has been further refined for the new TS-950SDX, with improvements made especially to the features and functions of the sub receiver. As a result, not only performance but also operating ease is enhanced.

#### (2) CW crystal filter in the sub-receiver section
In the sub-receiver section of the previous TS-950S and SD, when operating in CW mode the narrow bandwidth required for proper reception was provided by the AF-VBT audio filtering. That is why, when compared to the main receiver with its crystal filter, operational versatility in the CW mode was somewhat hampered and CW DX'ers voiced a desire for improvement.
Now, in the TS-950SDX, a 500Hz CW crystal filter has been provided for the sub receiver, ensuring almost identical performance from both main and sub receivers in the CW mode. It is thus possible to enjoy smooth dual-frequency receive without giving much thought to whether you are using the main, or the sub receiver.

#### (3) M/S key
The TS-950SDX features a new M/S (main/sub) select key function that enables you to change the sub-receiver frequency using the main tuning encoder.
When operating split frequencies for DXing, it is usual to receive the signal from the DX station on the main band. Once found, there is then little need to operate the encoder for the main receiver. Instead, by changing the frequency of the sub receiver you can check on competing stations crowding around the DX station, affording increased opportunities to change your calling frequency to the most favorable spot. Thus, a reliable encoder for the sub receiver becomes very important.
On the TS-950S and SD, the sub-receiver frequency was controlled by a dedicated encoder, reserved for that purpose. The performance of this encoder did not compare favorably with that of the functionally superior main encoder, and as a result there may have been those occasions when the frequency could not be adjusted as quickly or as easily as with the main tuning.
The solution to this is the M/S select key. By pressing the M/S key, you can switch the main encoder between the main and the sub receiver in response to changing situations. This ensures complete flexibility when selecting frequencies, irrespective of whether the main or sub receiver is being used. Another advantage is that, if the
M/S key is used to switch the main encoder to the sub receiver, the frequency of the main receiver is locked, so there is no fear of losing a DX station's signal once captured. Of course, the TS-950SDX is also equipped with a separate encoder for the sub receiver, as on the previous model, should this be needed in combination with the main encoder.

#### (4) FINE switch
The TS-950SDX features the same ultra-fine tuning that has proven so popular on the TS-850S. This makes best use of the characteristics of the Direct Digital Synthesizer (DDS). Normally one rotation of the main encoder is equivalent to approximately 10kHz. However, with the FINE switch engaged, this drops to just 1kHz per rotation. With a step of 1Hz,




Using a power-on menu (item #63) on the TS-950SDX, it is also possible to set the default for the main encoder to approximately 5kHz per revolution.

this offers you the facility to tune with the highest achievable precision.
The FINE switch is ideal for controlling the frequency accurately in SSB and CW modes. It can also be used together with the M/S select key, thus allowing precision control of the sub-receiver frequency.

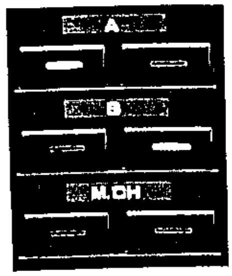
**(5) Separate & semi-separate modes**
Thanks to independent audio output circuits for the main and sub receivers, the TS-950SDX can provide separate and simultaneous audio outputs.
If the menu system is used to select separate mode during simultaneous dual-frequency receive, the main signal can be heard on an external speaker while the sub receiver is monitored on the built-in speaker. When using stereo headphones, the signals are divided between left (sub) and right (main); this is separate mode.
An alternative is semi-separate mode. This way, it is possible to listen to the main signal mixed with a background sub signal (20dB lower), and the sub signal mixed with a background main signal (20dB lower). By mixing signals in this way, the stereo effect allows you to easily identify each receiver by natural sound.

**(6) VFO/M channel switching with 6 function keys**

| Menu setting | Mode | Internal speaker | External speaker |
|---|---|---|---|
| OFF | Mixed | Main & sub | Main & sub |
| 1 | Semi-separate | Sub (+ main) | Main (+ sub) |
| 2 | Separate | Sub | Main |

Split-frequency operation has become commonplace for DXing.
To provide optimum versatility and convenience for split-frequency operation, the TS-950SDX features a bank of six keys for switching between VFOs (A and B) and the memory channels, for either RX (receive) or TX (transmit). When pressed, a green LED backlights the active keys. Ease of operation is enhanced, since the current selection can be seen at a glance.
In addition to these six convenient function keys, the TS-950SDX offers such features as TF-SET, TF-WATCH and the ΔF display. These enable split-frequency operation which makes full use of the TS-950SDX's ability to receive two frequencies simultaneously. Thus, as the operator, you can employ sophisticated techniques— such as tracking the other stations that have been picked up, while you simultaneously receive the DX-pedition's signal—so as to ensure the perfect choice of frequency and timing.

**(7) Simplex operation**
As with the previous model, the TS-950SDX is designed so that if the VFO used for RX is operated or if the MR key is pressed, the TX VFO automatically follows suit, putting the transceiver into simplex mode. Under normal operating conditions this mode is convenient; however, with a power-on menu it is possible to disengage RX and TX operations so that one does not affect the other.



Split-frequency funcction keys

TS-950SDX Display

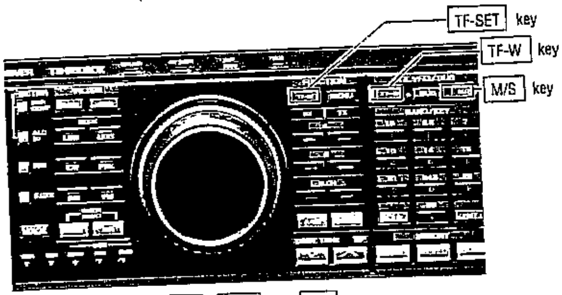
**(8) Split-frequency operation**
Three modes—VFO A, VFO B and MR—can be chosen independently for RX and TX, so various split-frequency operations are possible with the TS-950SDX.
TF-SET, TF-WATCH and the ΔF feature further enhance split-frequency operation.

**(a) TF-SET**
This feature enables you to temporarily receive on your own transmit frequency during split-frequency operation. It is only available while the TF-SET key is being depressed. and you can be sure that it has no effect on the actual split-frequency settings. A TF-SET key is also provided on the remote function keypad supplied with the TS-950SDX. so you can easily check the TX frequency whenever you wish. Note that while the TF-SET button is depressed. the transmit frequency can be changed with the main encoder.

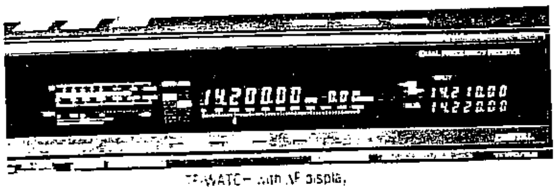
**(b) TF-WATCH**
This sets the TS-950SDX's transmit frequency to the sub-receiver frequency during split-frequency operation. All that is required is to press the TF-W key. This means that once the pickup frequency of a DX station is determined. you are in a position to immediately call. And, if the M/S select key is used to switch the main encoder to sub-receiver use, precise tuning is instantly available, thus making full use of the TF-WATCH feature. Since the main-receiver frequency. is locked, you won't have to think about losing the DX station's transmitted signal.

**(c) ΔF display**
The ΔF feature, which has proven very popular on the TS-450S, can be selected using the menu system. This directly displays the difference (ΔF) between RX and TX frequencies. instead of the sub-receiver frequency.
The TS-950SDX automatically makes calculations that the operator previously had to perform in his head. So,

even if a DX station suddenly announces a change in frequency, you can respond quickly and accurately. In addition to enabling quick QSY, this feature—once mastered—makes it relatively easy to recognize the habits of another operator. One simply notes those stations that have been picked up, and uses the ΔF display to check the exact frequency separation from the DX station.



TF-SET, TFW and M/S keys


TF-WATCH with ΔF display

## 2. Memory functions

### (1) 100 memory channels

More and more operators are making skillful use of memory functions for DX applications and contests. For example, the A and B VFOs can be used instead of 2 memory channels for each band: VFO A is dedicated to SSB use and VFO B to CW use. Another development is the abundance of good DX information now available in a variety of media. Since fresh information can be readily obtained, an operator often knows beforehand how a DX-pedition is organized, what communications equipment is involved, and which frequencies are likely to be used. As a result, there are fewer frequencies that need to be watched, and the operator can prepare by storing the expected frequencies in memory. The 100 memory channels provided in the TS-950SDX are more than sufficient for this purpose.

Recently, however, it is not just the number of memory channels that determines the usefulness of a high-performance HF rig. For instance, operators are now also interested in how easy it is to recall data stored in memory, or how convenient it is to transfer that data to a VFO.

Simply by pressing the M.CH key, you can instantly recall data from memory for both the receiver and transmitter. And since the memory channel selector "clicks" for confirmation, changing channels is accomplished very smoothly and quickly. Also, the data recalled from memory can be immediately transferred to a VFO with the M➤VFO key. With 100 memory channels at your disposal, you can afford to use some of them for testing conditions on each band. The frequencies of selected short-wave broadcasting stations can be stored in memory to serve as beacons for this purpose.

### (2) Electronic memo pad: 5-channel Quick Memory

While some DX'ers pride themselves on making the best use of memory, there are others who find the very process of entering data into memory too complex to bother with. The perfect solution for such operators is the Quick Memory feature which has proven so popular on the TS-850S. On the TS-950SDX, 5 channels are reserved for this purpose. Operation is simplicity itself. Once an interesting DX station is discovered, you just press the QUICK MEMO M.IN key to stack that frequency in memory. Recall is equally convenient: pressing the QUICK MEMO MR key recalls the most recently stored data. Frequencies stored prior to that can be accessed, in order, by turning the memory selector—just as if one were paging through a memo pad. This Quick Memory feature plays a major role in making the TS-950SDX as user-friendly as it is powerful.

## 3. Message keyer and remote function keypad

The TS-950SDX is supplied with a message keyer and a remote function keypad. It is also compatible with the DRU-2 digital recording unit, which is available as an option. These are particularly useful for sophisticated CW and SSB operations, and once an operator has used them for DX-peditions or DX contests, he may well find them indispensable.

### (1) Message keyer

The electronic keyer circuit, which features dynamic dot and dash memories, includes a weighting control to correct the dot/dash balance and thus automatically compensate for changes in keying speed. This ensures a clean, natural sounding signal. Three memory channels are provided for storing messages. With the message keyer, you can transmit error-free messages repeatedly, making it extremely convenient for both regular CQs, schedules, or DX contests that lend themselves to a fixed message for transmission. And of course the weighting ratio can be tailored via the menu system. Also, by incorporating the DRU-2 digital recording unit, continuous recording of the received signal is possible.

### (2) Remote function keypad

The supplied remote function keypad is equally handy for DXing and contests since it provides you with the same sort of convenience that a mouse offers the computer user: one-hand control over important functions. Specifically, it can control message keyer recording and playback, and the TF-SET feature. Opening the keypad cover provides access to Quick Memory input and recall, and also voice functions. If you choose to control the keyer via this remote function keypad, you can transmit messages without physically touching the CW keyer. This can really reduce operator fatigue during contests, which demand the same message be transmitted over and over again.

### (3) DRU-2 digital recording unit (option)

Equipping the TS-950SDX with the DRU-2 unit makes possible the recording and playback of SSB messages transmitted by the operator, and also the recording and playback of signals received in both the CW and SSB modes.

## 4. Interface for computer control

While it is true that computer control of the transceiver is by no means essential for DX operators, recently a great deal of software for Amateur Radio applications has begun to appear. No longer can one say that computers have no part to play in the hobbyist's world of HF communications. In fact, it has even become common for operators to make use of computers for contests. This is because frequency and mode data can be input to the transceiver from a computer via an interface, and software can then automatically run duplicate checks or print out contact lists. With these kinds of duties delegated to the computer, the operator is free to concentrate on operating. One might even say that in order to achieve top scores in DX contests, today's operators must learn to make good use of computers.

And computers can help with more than contests. For example, they are invaluable for managing a log or distributing QSL cards. Some old timers may say that they are computer-phobic or just uninterested in computers, but they may well change their minds once they have seen what can be done nowadays.

The TS-950SDX is compatible with the IF-232C interface for RS-232C use, so many computer control configurations are possible.

## 5. Improvements to operating ease

In terms of hardware, the TS-950SDX represents the most advanced Amateur Radio transceiver in the world. But to realize its full potential, advanced software is also needed. Here too the TS-950SDX shines.

Every detail of the panel layout, displays and controls has been meticulously planned to make the superior features of the TS-950SDX easy to access. What's more, each individual operator is able to configure his transceiver to taste. First, in organizing the panel layout it was decided to provide special switches, keys and controls for those features and functions that are used most frequently or that require instant selection or cancellation. And for those functions that might be needed on-the-fly, panel-mounted controls offer real-time access via the versatile menu system. Finally, there are some settings that an operator may choose to implement semi-permanently, so these can now be set automatically using a power-on menu (they become the default settings every time power is switched on). All in all, "user-friendly" is a concept that has received top priority during field research, planning and design.

### (1) Dedicated switches, keys, and controls (main)

| | |
|---|---|
| [AIP] switch | Engages AIP (Advanced Intercept Point). AIP switch |
| [FINE] switch | Sets frequency step to 1Hz, so one rotation of the encoder represents approximately 1kHz. |
| QUICK MEMO [MIN] key | Instantly stores operating status in Quick Memory. |
| QUICK MEMO [MR] key | Instantly recalls data stored in Quick Memory. Data from each of the channels can be recalled sequentially by turning the M.CH/VFO CH control. |
| [8.83] key | Selects the 8.83MHz crystal filter. |
| [455] key | Selects the 455kHz crystal filter. |
| [TF-SET] key | Enables reception (while the key is depressed) on the TX frequency during split-frequency operation. |
| [MENU] key | Activates or deactivates the menu system. |
| [A = B] key | Equalizes the frequency of the VFO A to that of VFO B. If this key is depressed during power-on, all user selectable functions are reset to initial factory settings. |
| [RX↔SUB] key | Press this key during simultaneous dual-frequency receive to exchange the main- and sub-receiver frequencies. Also, press this key while the CLR key is depressed to transfer the main-receiver frequency to the sub receiver, making them identical. |
| [TF-W] key | Activates or deactivates the TF-WATCH function. |
| [SUB] key | Turns the sub receiver on or off. |
| [M/S] key | Determines whether the main encoder controls the main or the sub receiver. |
| [M.IN] key | Stores data in a memory channel. |
| [M➤VFO] key | Transfers the content of a memory channel to the VFO. |
| [SCAN] key | Initiates scan operation. |
| [M.CH/VFO CH] control | During memory channel operation, selects the desired channel. During VFO operation, |

changes the frequency in 10 kHz steps. "Clicks" for confirmation.

**TX VFO/SUB control** Serves as a tuning control for the TX frequency during split-frequency operation, and for the sub-receiver frequency during simultaneous dual-frequency receive.

**AGC switch** Sets the AGC (automatic gain control) to one of five possible positions: OFF, AUTO, FAST, MID, or SLOW. If set to AUTO, the control speed is automatically set for the selected mode. Settings are determined by a power-on menu (item #59).

**KEY SPEED control** Continuously varies the speed of the electronic keyer.

(2) Menu system

As a rule, every time a new transceiver appears on the market, the number of features and functions increases. No doubt there are some operators who do not welcome this trend since they feel they already have enough features. More knobs would lead to greater confusion. And yet Amateurs continue to make suggestions for new useful features that they would like to see. The manufacturer, for his part, would naturally like to develop new, products equipped with every conceivable feature. But clearly a balance must be found.

On previous Kenwood's HF transceivers this problem was resolved by incorporating power-on function settings, allowing the operator to select his desired defaults. Unfortunately, there was a limit to the number of keys available for this purpose, and this in turn limited the number of possible settings. Another disadvantage was that in order to change a setting the power had to be switched off and back on. Mid-QSO changes were out of the question.

The solution has been found in the TS-950SDX's versatile menu system. Even during communications, you can press the MENU key and activate or deactivate several major functions. While the menu system is active, the display panel is used to indicate the various selections, so even without the instruction manual an operator can easily choose the proper setting.

An extremely handy feature of this menu system is that the operator can select a desired filter cutoff frequency—using the DSP's digital filters—while monitoring actual TX and RX audio quality.

Below are the menu items and applications that help to bring out the full potential of the TS-950SDX.

**00 "P Hold"** Switches the meter's peak hold function on or off.

**01 "Pitch"** Displays the CW pitch frequency. On the TS-950SDX it is possible to change pitch frequency from 400Hz to 1000Hz in 20 Hz steps using the pitch control. Many operators seem to give little thought to the CW pitch frequency they are listening to; for example, someone may think he is hearing 800Hz when in actuality it is 500 Hz. That is why it is a good idea to use this menu to check on pitch frequency at least once.

**02 "Bright"** Adjusts the display dimmer level between 30 and 70. On this scale a value of 100 represents the intensity of the display when the dimmer is switched off.

**03 "Delta f"** Displays the difference (ΔF) between the TX frequency and the RX frequency. Previously, when a DX station stipulated separate frequencies, you had to rely on mental calculations to set your own TX frequency in relation to the frequency of the other station's signal. As a TS-950SDX operator, however, you can check visually on the separation between your own TX frequency and that of the DX station during split-frequency operation.

**04 "Convert"** Switches the frequency display to the transverter output frequency when using the TS-950SDX as a transverter master unit. The operator has a choice of 3 frequencies: 50MHz, 144MHz and 430 MHz. For instance, if the input and output frequency of a 50MHz transverter is 28 MHz, with 50.000 MHz converted to 28.000 MHz, the TS-950SDX's frequency would be set to 28.000MHz and 50MHz would be selected from the menu. Note that it is only the frequency display that changes, not the actual TX or RX frequencies of the TS-950SDX.

**05 "Cross"** Enables setting the sub-receiver mode independently of the main-receiver mode. The default is OFF, so main and sub modes are identical.

**06 "Stereo"** Sets main- and sub-receiver audio output to mixed, semi-separate, or separate mode. In separate mode, the main AF output can be heard on an external speaker while the sub-receiver output is monitored on the built-in speaker. Using headphones, the signals are divided between left and right. If semi-separate mode is selected, each signal is mixed with the other, the secondary signal at a level 20 dB lower than the primary signal for that audio channel. This results in audio separation that is easy to listen to.

**07 "Spot"** Switches the built-in marker oscillator on and off. Used for confirming or recalibrating the transceiver's frequency base against the reference time stations WWV or JJY. Since the TS-950SDX features a TCXO with an accuracy of ±0.5 ppm, this should typically be needed only for confirmation, not adjustment.

**08 "At Auto"** Selects automatic or manual control of the built-in antenna tuner. Automatic is the normal choice, but manual tuning is possible by using the main tuning control and the TX VFO/SUB tuning control to adjust the two variable capacitors in the antenna tuner. This is the suggested method if automatic tuning is not successful, or if the operator just wants to do it himself.

**09 "Transfr"** Allows transfer of all operational data (frequencies, etc.) between two TS-950SDXs or between a TS-950SDX and a TS-850S linked with a close cable (available at Kenwood authorized service centers). Transfers are initiated by pressing the QUICK MEMO M.IN key on the sending side.

**10 "Direct"** Determines whether the frequency data received by the transceiver (with menu #09 ON), is written directly to the VFO or is stored in Quick Memory.

**11 "T inh"** When using the split-frequency transfer function (menu #09 ON), this inhibits transmit on the master transceiver to avoid overloading the receiver, which would cause unwanted acoustic feedback. If this function is ON and the receiver's standby terminal is controlled by a relay, itself controlled by the transmitter, transmit will be inhibited and the transceiver will be in mute mode. However, since only IF and AF circuits are muted, other steps—such as disconnecting the ANT terminal—should be taken to ensure against high-power receiver front-end overload.

**12 "Paddle"** Activates or deactivates the TS-950SDX's built-in electronic keyer.

**13 "Auto"** Activates or deactivates the automatic weighting control for the electronic keyer. When enabled, the dot/dash ratio is automatically adjusted—between 1:2.8, 1:3 and 1:3.2—depending on keying speed.

**14 "Auto Rev"** Available when automatic weighting control is ON, auto reverse will swap the 1:2.8 and 1:3.2 dot/dash ratios.

**15 "Ratio"** This enables the operator to manually set the dot/dash ratio for the built-in electronic keyer in a range of from 1:2.5 to 1:4.

**16 "Bug"** This allows bug-type operation from the electronic keyer.

**17 "Play.int"** Enables paddle interruption during message keyer playback.

**18 "Dsp.c.fil"** Activates or deactivates the DSP's comb filter for SSB reception. This comb filter has two notches—one at the carrier point and another in the vicinity of 1.6kHz—so as well as serving as a low-cut filter it reduces noise in the 1.6kHz region, thus offering potential improvements in the S/N (signal-to-noise) ratio.
With conventional analog notch filters, there are sudden phase changes close to the notch and if the notch enters the pass band of the received signal the latter will usually sound peculiar. On the TS-950SDX, however, since the comb filter is comprised of DSP digital filters with uniform group delay characteristics, there is virtually no chance of audio quality being distorted or sounding unusual.

**19 "Dsp.r.Lpf"** Selects the cutoff frequency of the DSP's AF #LPF and BF #BPF for reception. There are 15 LPFs to choose from, ranging from 600Hz to 6kHz, and 3 BPFs for FSK use with a 2.2kHz central frequency.

**20 "Dsp.t.Hpf"** Sets the cutoff frequency of the HPF used during SSB transmit. There are 5 low-cut settings: OFF, 100Hz, 200Hz, 300Hz, and 400Hz.

21 "Dsp.t.Lpf" Sets the cutoff frequency of the LPF used during SSB transmit. There are 4 high-cut settings: 2600Hz, 2750Hz, 2900Hz, and 31000Hz.

22 "C rise" Selects the rise and decay time of CW wave forms. Thanks to signal processing performed by the DSP, it is possible to produce an ideal CW wave form, devoid of clicks. The operator can choose from 4 settings: 2 msec., 4 msec., 6 msec., and 8 msec. To get through pile-ups, a CW signal with a 2 msec. rise time may well prove to be more successful. At the other end, however, a decay time of 8 msec. takes so much time that full break-in cannot be used.

23 "Rec t" If the optional DRU-2 digital recording unit is installed, the recording times of the 3 audio memories can be set to either 8 sec.. 8 sec., and 16 sec. or 16 sec., 16 sec., and 32 sec. At the shorter recording times, the sampling frequency is higher, so that audio quality on playback is better.

24 "Con rec" Activates the 3rd audio memory of the DRU-2 unit for continuous recording of the received signal. This is an advantage when, for example, the operator misses a call sign: he can replay the last heard segment for confirmation.

25 "Con rec.t Selects a time frame of 8 seconds or 16 seconds for continuous recording of the received signal (menu #24). The 8 sec. setting provides better sound quality on playback.

26 "Repeat" Activates repeated transmission of CW or SSB messages with a set interval. This is extremely useful for contests.

27 "Rep t" Sets the repeat playback interval (see menu #26) to a value between 0 and 60 seconds.

28 "Rtty.rev" Reverses TX and RX polarity for RTTY communications. Using the initial setting, a key closure transmits a mark, and the BFO is on LSB. In reverse mode, transmit is reverse shift, and the receive BFO is on USB.

### (3)Power-on menus

For those functions of the TS-950SDX that need be set only once and thereafter hardly ever modified, a series of power-on menus are provided. These is accessed by turning on the power while depressing the MENU key. By allowing you the ability to tailor the transceiver to your own needs and preferences, they enhance the practicality and user-friendly nature of your TS-950SDX.

### (4) List of menu functions

**● Built-in electronic keyer settings**

| Menu No. | Function | Default |
|---|---|---|
| 12 | selects whether the electronic keyer will be used (ON) or not (OFF) | OFF |
| 13 | activates or deactivates automatic weighting control for the electronic keyer [if menu #12 is ON]. | ON |
| 14 | activates or deactivates reverse mode for the automatic weighting control [if menus #12 and #13 are ON]. | OFF |
| 15 | sets the manual weighting value for the electronic keyer [if menu #12 is ON and #13 is OFF]. | 3.0 |
| 16 | selects whether the electronic keyer will be used as a "bug" (ON) or not (OFF). [if menu #12 is ON]. | OFF |
| 17 | selects whether paddle input during message keyer playback is possible (ON) or not (OFF) [if menu #12 is ON]. | OFF |

**● DSP settings**

| Menu No. | Function | Default |
|---|---|---|
| 18 | activates or deactivates the DSP's low-cut comb filters for SSB reception. | OFF |
| 19 | sets the cutoff frequency for the DSP's digital filters (LPF and BPF) for reception. BPF1 to BPF3 (with a central frequency of 2200 Hz) are for FSK use. | 2800Hz |
| 20 | sets the cutoff frequency of the DSP's analog HPF (high-pass filter) for transmission. | 200Hz |
| 21 | sets the cutoff frequency of the DSP's LPF (low-pass filter) for transmission. | 2750Hz |
| 22 | selects the rise and decay time of CW wave forms generated by the DSP for transmission. | 4msec. |

● **Audio recording settings**

| Menu No. | Function | Default |
|---|---|---|
| 23 | switches the 3 audio memories— REC-1, REC-2 and REC-3—between 8sec. & 16sec. mode (8sec., 8sec., and 16sec.) and 16sec. & 32sec. mode (16sec., 16sec., and 32sec.). With the 16-32sec. mode, sound quality decreases since the sampling frequency is half that for the 8-16sec. mode. | 8-16 |
| 24 | selects whether the 3rd audio memory (REC-3) will be used for continuous recording (ON) or not (OFF). When switching off power to the TS-950SDX, make sure that this function is OFF, since recorded messages might be erased. | OFF |
| 25 | sets the time frame of REC-3 continuous recording to either 8sec. or 16sec. [if menu #24 is ON]. | 8sec. |
| 26 | sets repeat playback to ON or OFF. | OFF |
| 27 | sets the repeat playback interval to between 0 and 60 sec. | 10sec. |

● **Transfer settings**

(These require that the TS-950SDX be connected to another transceiver that supports transfer functions.)

| Menu No. | Function | Default |
|---|---|---|
| 09 | activates and deactivates the split-frequency transfer function. | OFF |
| 10 | selects whether data will be written directly to the VFO of the other transceiver (ON) or not (OFF). | OFF |
| 11 | selects whether to inhibit transmit on the master transceiver (ON) or not (OFF). | OFF |

**Warning:**
Selecting ON for menu #11 only mutes the IF and AF circuits. Since the RF circuits are still operating, they can suffer damage if the ANT terminal is subjected to high power in mute mode. Therefore, please ensure that the muted transceiver is not directly subjected to high power at these times

● **Other settings**

| Menu No. | Function | Default |
|---|---|---|
| 00 | switches the meter peak hold function ON or OFF. | OFF |
| 01 | displays the CW pitch frequency. To adjust the frequency, use the pitch control. | — |
| 02 | adjusts the display's dimmer level (brightness) between 30 and 70. | 50 |
| 03 | switches the ΔF display for the sub receiver ON and OFF. | ON |
| 04 | Switches the 50MHz/144MHz/430MHz converter display ON or OFF. | OFF |
| 05 | links the main-receiver mode with the sub-receiver mode (ON) or makes them independent (OFF). | OFF |
| 06 | selects mixed, semi-separate, or separate mode.<br>OFF = mixed mode: both main- and sub-receiver audio output can be heard on the internal and external speakers.<br>1 = semi-separate mode: main and sub signals are mixed so that the main band audio is emphasized on the external speaker, while the sub band audio is emphasized on the internal speaker.<br>2 = separate mode: the sub-receiver signal is heard exclusively on the internal speaker, while the main-receiver signal is output entirely via the external speaker. | OFF |
| 07 | switches the built-in 500kHz marker ON or OFF. When this is activated, marker signals can be detected at 500Hz intervals. | OFF |
| 08 | selects automatic (ON) or manual (OFF) control of the antenna tuner. | ON |

**(5)List of power-on menu functions**

● **Beep settings**

| Menu No. | Function | Default |
|---|---|---|
| 50 | switches the electronic beep—which confirms operation of any switch or key—on or off (volume can be adjusted using an internal potentiometer). | ON |
| 51 | selects either Morse (ON) or beep (OFF) mode announcements [if menu #50 is ON]. | ON |

| | | |
|---|---|---|
| 52 | selects either Morse error messages (ON) or a warning beep (OFF) [if menu #50 is ON].<br>**Morse error messages**<br>The following warnings can be issued in Morse code:<br>CHECK – the scan key has been pressed when memory scanning is not possible.<br>OVER–the frequency entered using the keypad is outside the operational range of the transceiver. | ON |

● **FSK settings**

| Menu No. | Function | Default |
|---|---|---|
| 53 | switches FSK reverse mode on and off. | OFF |
| 54 | selects whether a space (ON) or a mark (OFF) is transmitted when the FSK key is closed. | OFF |
| 55 | selects the shift range in FSK mode (170Hz, 200Hz, 425Hz, 850Hz). | 170Hz |
| 56 | selects either high (2125Hz) or low (1275Hz) receive tone pairs in FSK mode. | 2125Hz |

● **FM sub-tone settings**

| Menu No. | Function | Default |
|---|---|---|
| 57 | sets the repeater sub-tone frequency. | 88.5Hz |
| 58 | selects either burst (b) or continuous (c) mode for the repeater access tone. | C |

● **Frequency display settings**

| Menu No. | Function | Default |
|---|---|---|
| 74 | switches 10Hz frequency display resolution ON or OFF. | ON |
| 75 | sets the full-scale deflection of the analog scale to 1000kHz or 100kHz | 1000kHz |

● **Frequency display settings**

| Menu No. | Function | Default |
|---|---|---|
| 63 | selects the frequency step size for the main tuning knob: 5kHz or 10kHz per revolution. Note that this is overridden when the FINE switch is ON, or when operating in SSB, CW or FSK modes. In FM mode, the choice is 25 kHz or 50kHz. | 10kHz |
| 64 | adjusts the frequency step size for the M.CH/VFO CH control in 1kHz increments within a range of 1 kHz to 10kHz. | 10kHz |
| 65 | when operating in the AM mode (Broadcast band only), this selects a frequency step size of either 10kHz or 9 kHz for the M.CH/VFO CH control. | 9kHz |
| 66 | adjusts the UP and DOWN key frequency step size in 1kHz increments within a range of 1kHz to 10kHz, 500 kHz or 1MHz. | 1MHz |

● **Memory settings**

| Menu No. | Function | Default |
|---|---|---|
| 60 | during memory channel recall, this selects whether the main tuning knob can be used for temporary frequency adjustment (ON) or not (OFF). | OFF |
| 62 | selects whether the M.IN key will automatically increase the memory channel number (ON) or not (OFF). | OFF |
| 72 | switches program scan hold ON and OFF. | OFF |

● **RIT/XIT settings**

| Menu No. | Function | Default |
|---|---|---|
| 67 | selects whether the RIT/XIT frequency will be displayed (OFF) or not (ON) when the RIT/XIT switch is off. | OFF |
| 68 | selects whether the CLEAR key will copy RIT/XIT frequency change data to the main display (ON) or not (OFF). | OFF |

● **Other settings**

| Menu No. | Function | Default |
|---|---|---|
| 59 | sets the AGC speed in the AUTO position (1 = SLOW, 2 = MID, 3 = FAST). This is set independently for SSB, CW and FSK modes.<br>In the FSK mode it is locked at FAST, and when "..." is displayed this function is not available. | 1 for SSB<br>3 for CW<br>3 for FSK |
| 61 | selects what data is stored in band memory: HALF (1) frequency only; ALL (2) frequency, mode, filter; or OFF. | ALL |
| 69 | activates or deactivates chattering suppression for the electronic keyer [if menu #12 is ON]. | ON |

| | | |
|---|---|---|
| 70 | selects whether the FULL/SEMI switch is locked to SEMI (ON) or not (OFF) during CW message playback. | OFF |
| 71 | switches SSB auto mode ON and OFF. | ON |
| 73 | selects whether the filter selection will be determined by the operating mode (ON) or not (OFF). | ON |
| 76 | switches the TX frequency main/sub swap ON and OFF during split-frequency operation (the main receiver frequency display and the TX frequency display are exchanged). | OFF |
| 77 | switches the sub-marker ON or OFF when using optional SM-230 with either a 100 kHz or a 250kHz span. (If ON, the SM-230's marker may drift). | OFF |

# 2. DSP

–Digital processing complete with digital detection–

The DSP-10 was the world's first digital signal processor for Amateur Radio transceivers that successfully employed digital technology for SSB, CW and FSK modulation. This was followed by the DSP-100, which represented significant progress in the digital detection of signals. And now, the DSP featured in the TS-950SDX optimizes these capabilities, while providing a wide range of features to ensure user-friendly operation in a highly practical package.
Designed to enable digital detection during reception, the DSP installed in the TS-950SDX offers extremely low distortion and a high S/N ratio. Among the ways in which this is accomplished is an anti-aliasing filter that prevents the generation of distortion during analog-to-digital conversion of the received signal. It also employs an FDNR filter for smoothing—that is, removing unwanted signal components that arise during digital-to-analog conversion. Other improvements include enhanced technology for digital modulation during transmission, a reduced sampling frequency and an increased instruction set for the DSP. These improve the processing capabilities of the DSP, making available digital filters covering a broad bandwidth, and generating a digitally modulated signal of greater purity. To make the DSP even more convenient to use, the TS-950SDX has been equipped with a menu system that enables adjustments to the cutoff frequencies of these digital filters. Settings can even be changed in real-time—during actual transmission or reception— from the front panel.
These and other enhancements—not all of which are reflected in the published specifications—raise the performance of the TS-950SDX's digital signal processor to a level higher than that of the DSP-10 and DSP-100 on which it is based.

## 1. Sampling frequency

For a DSP that employs the discrete-time system, an extremely important factor in determining performance is sampling frequency.
If a high sampling frequency is chosen, one advantage is that the filters required for analog and digital conversion can cover a broad bandwidth. However, the higher the sampling frequency, the shorter each sampling cycle, and all signal processing must be completed within a single cycle. Thus, if the DSP itself is not capable of sufficiently fast processing, performance actually deteriorates rather than improves. As with computers, very fast processors are very highly priced, so at present such high-speed processing is not a practical proposition for Amateur Radio transceivers.
The TS-950SDX's sampling frequency has been chosen to ensure optimum performance for the processing speed of the DSP. This represents a significant departure from the design of the previous DSP-10 and DSP-100, for which sampling speed was set as high as possible to enable broad-bandwidth digital filtering.
Specifically, the DSP-10 and DSP-100 were equipped with the minimum instruction set required for digital signal processing and—in order to expand the digital filter bandwidth as much as possible— the sampling frequency was set at 49.189kHz. The opposite approach was used to design the DSP in the TS-950SDX: while ensuring the sort of digital filter bandwidth required for a first-class transceiver, the sampling frequency was calculated to make maximum use of the processing capabilities of the DSP. In fact, two sampling frequencies were chosen: 44.39024kHz (transmit) and 44.4kHz (receive). This allows the DSP some excess processing capacity, which is used to raise the PSN order for SSB modulation and otherwise improve performance.

**Table 1: HPF cutoff frequencies and frequency bandwidth (theoretical)**

| HPF | Frequency bandwidth (theoretical)/ sideband suppression |
|---|---|
| OFF | 38.2Hz-4584Hz / 70dB |
| 100Hz | 45Hz-4500Hz / 75dB |
| 200Hz | 67Hz-6700Hz / 75dB |
| 300Hz, 400Hz | 140Hz-8400Hz / 80dB |

## 2. PSN-SSB modulation performed by DSP

The TS-950SDX features the same PSN (phase shift network) approach to modulation as the TS-950SD. However, the number of instructions that can be carried out in one sampling cycle has increased, and this has led to improvements in the DSP's signal processing performance and hence in PSN modulation characteristics.

SSB modulation technology based on analog PSN and filters is demonstratively incapable of ever outperforming the PSN-SSB modulation method used by the TS-950SDX's DSP.

During transmission, the TS-950SDX's DSP employs IIR filters for digital HPF and digital LPF. Since these IIR filters perform well even with the relatively small instruction set of the DSP, they can make use of the unused processing capacity of the DSP to expand PSN bandwidth and enhance transmission performance.

Despite having this advantage of requiring a relatively small instruction set, IIR filters do have one drawback: the so-called zero input limit cycle phenomenon. This means that when there is no signal, they generate digital noise. On the DSP-100 this problem was avoided by constantly feeding the IIR filters with a signal taken from the DDS (Direct Digital Synthesizer), thus ensuring that a zero-signal situation did not arise. The TS-950SDX prevents the zero input limit cycle phenomenon in a similar way, although the IIR filters are fed with divided-frequency output from the TCXO. Note that, since this additional signal is attenuated by the notch filter used for carrier suppression, it does not appear in the modulated output.

The MIC input low-cut HPF on the TS-950SDX offers a choice of 5 settings: OFF, 100Hz, 200Hz, 300Hz, and 400Hz. The low-cut frequency is the cutoff frequency when combined with the carrier-suppression notch filter. If the notch filter is set to OFF, ideally filter characteristics should be good down to DC; however, in practice one observes a deterioration in carrier suppression performance resulting from A/D converter characteristics and the DSP's numeric processing errors.

It is unlikely that the operator will in fact be using a microphone with good performance characteristics down to DC, but if the HPF is set to OFF, low-range performance is more than acceptable, even without the notch filter switched off.

## 3. PSN-SSB digital detection performed by the DSP

During reception too, the TS-950SDX makes use of the DSP's signal processing capabilities to perform PSN-SSB detection. When an SSB signal is detected, FIR filters with superior S/N characteristics are used to exploit the DSP's full potential. No recourse is made to the IIR filtering that is used during PSN-SSB modulation to expand PSN bandwidth. Using FIR filters in this way, the TS-950SDX is able to offer reception performance of a level sufficient to rank it among the world's foremost HF transceivers.

The reason IIR filters are not used for detection during reception is that priority has been given to S/N. By using FIRfilters that produce little digital noise through numeric processing errors, it is possible to make optimum use of the TS-950SDX's DSP, raising reception performance overall.

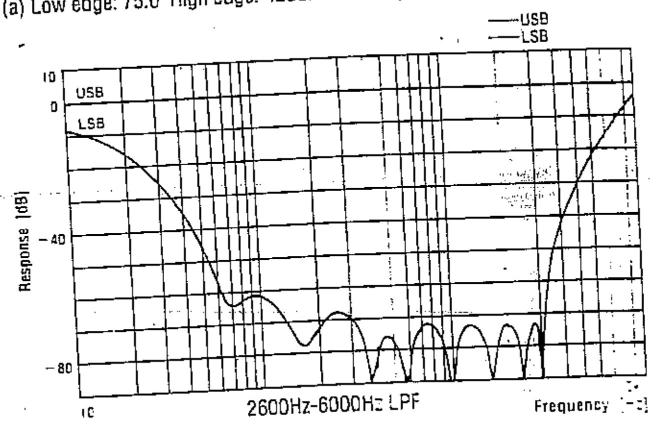
The TS-950SDX's FIR filters consist of 15 LPFs (low-pass filters) and 3 BPFs (band-pass filters). Since these can be selected during transceiver operation using the menu system, the operator can tailor performance to particular conditions and adjust audio quality to taste, thus assuring SSB reception with superb S/N characteristics.

**Table 2: FIR filter cutoff frequencies and frequency bandwidth (theoretical)**

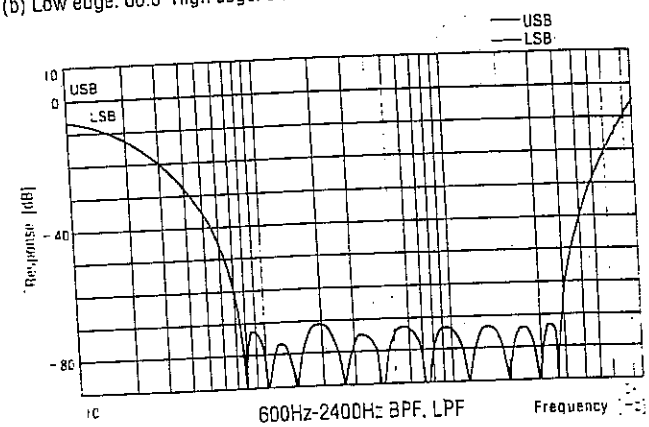
| FIR | Frequency bandwidth (theoretical)/ sideband suppression |
|---|---|
| LPF: 2600Hz-6000Hz | 75Hz-4296.3Hz / 70dB |
| BPF: LPF: 600Hz-2400Hz | 60Hz-3437Hz / 70dB |

**Figure 1: Receive PSN characteristics**

(a) Low edge: 75.0 High edge: 4296.3 16-bit quantization




(b) Low edge: 60.0 High edge: 3437.0 16-bit quantization




The order of the TS-950SDX's FIR filters used for PSN-SSB detection during reception is low and the bandwidth ratio is 57.28 (maximum), representing about half of the bandwidth provided by the IIR filters used for PSN-SSB modulation during transmission. This is because the TS-950SDX is designed to make maximum use of the limited processing capabilities of the DSP to realize ideal SSB operations. For TX, IIR filters provide a broad bandwidth capability, enabling the generation of a complete SSB modulated signal: and for

RX, FIR filters assure a high signal-to-noise ratio, enabling extremely quiet (zero-signal state) SSB reception.
An additional feature of the TS-950SDX's SSB detector worthy of note is the use of comb filters. These have become quite familiar owing to their extensive use in TV and video applications. Since comb filters are linear phase filters, they can attenuate noise (unwanted signals) on either side of the voice formant frequency without reducing intelligibility, although tone may change. They thus contribute to improved S/N. While analog notch filters can be used for the same amplitude characteristics as comb filters, the former give rise to group delay distortion that can impair audio clarity. And as well as improving S/N, comb filters have another use: if low frequencies seem to be overemphasized, switching them on can greatly improve sound quality.
To summarize, thanks to two types of digital filter—FIR and comb— he TS-950SDX offers exceptionally good reception characterized by unparalleled S/N.

## 4. CW modulation performed by the DSP

A ROM filter is used to obtain shaped CW output from key input. As with the DSP-100, Gaussian characteristics are employed, providing a choice of 4 settings—2msec., 4msec., 6msec. or 8msec.—for the leading and trailing edges (0 to 100%).

## 5. CW digital detection performed by the DSP

PSN detection is also used for CW mode. This ensures a clear signal with no leakage on the opposite sideband. The DSP functions in the same way as for SSB detection.
However, one difference between SSB and CW reception is that in the CW mode the comb filters are always enabled (in SSB mode, they can be switched in and out using the menu system). If a signal is received at a pitch that does not correspond to the comb filter peak, it will suffer slight attenuation. But since comb filter characteristics are broad, it is possible to obtain good audio quality with the lower frequencies removed to ensure a natural balance. The DSP's comb filters make an enormous difference to CW reception.

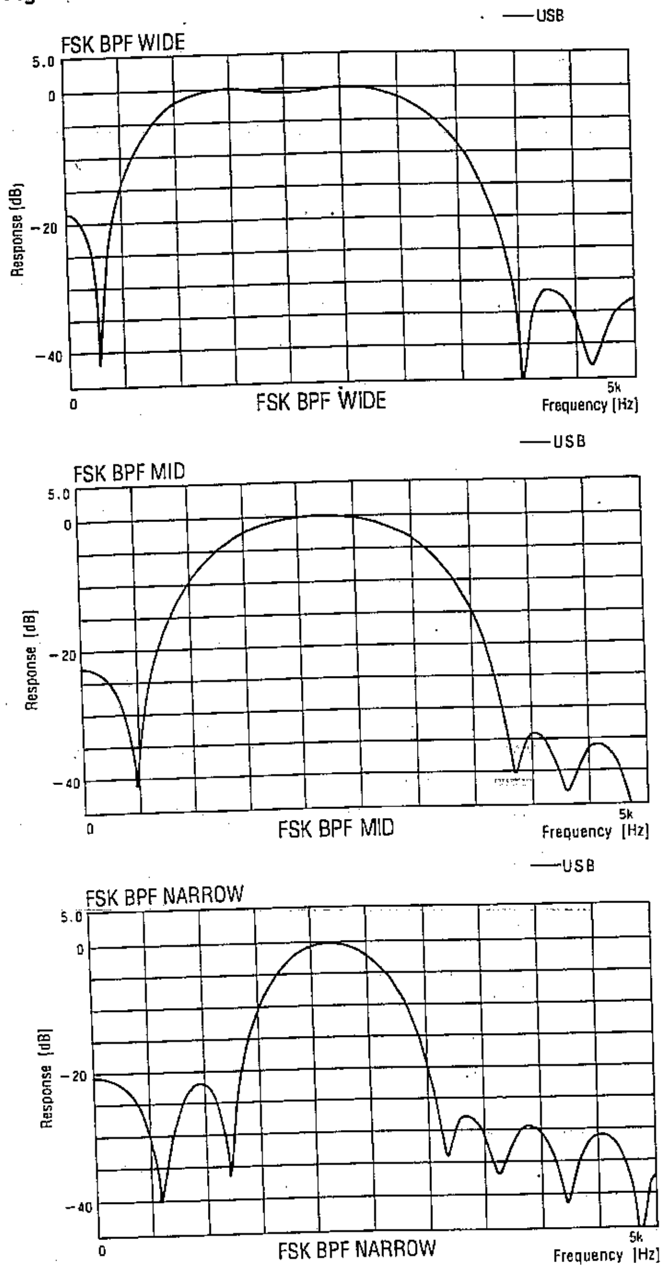
## 6. FSK modulation performed by the DSP

As with the DSP-100, ideal FSK modulation is afforded by shaping and modulating the input of FIR filters with excellent S/N characteristics.

## 7. FSK digital detection performed by the DSP

PSN technology is also used for FSK detection. As regards FIR filter characteristics, the operator can obtain good results by making selective use of the 3 BPFs (with a central frequency of 2.2kHz) to match current operating conditions.

**Figure 2: BPF characteristics (for FSK reception)**




## 8. AM modulation performed by the DSP

For AM modulation, the DSP uses FIR filters to limit bandwidth and a high-performance digital multiplier.

## 9. The future of DSP-based digital processing

In developing the TS-950SDX's DSP it has not, unfortunately, been possible to harness the power of digital signal processing for AM or FM detection. With current DSP technology there are still significant limitations as regards processing power, and it is believed that analog detection still affords the best overall performance for AM and FM detection.

## 10. Digital filter selection via the menu system

The TS-950SDX has been equipped with a menu system that allows control over the DSP's various settings during operation. And since this is accessible from the front panel, the DSP is very practical and very easy to operate.

# 3.Reception

– DSP-enhanced reception plus simultaneous dual-frequency receive on the same band –

The TS-950SDX features DSP-based digital detection and digital filters that minimize distortion, resulting in high-quality reception. Also, the redesigned sub-receiver section enables simultaneous dual-frequency receive on the same band with no distinction between main and sub receivers. Other significant improvements in performance have resulted from detailed refinements to the operational level of the various components of the received signal. Progress can be appreciated in such areas as inter-modulation characteristics, which affect audio quality; notch selectivity; and reduced noise floor level.

Equipped with its DSP and the capability to receive two frequencies on the same band simultaneously, the TS-950SDX provides receiver performance of the highest level achieved by any HF transceiver.

The TS-950SDX employs a quadruple conversion approach to reception (triple conversion for FM mode). Let's trace the path followed by a received signal to see how each part of the circuitry operates.

### 1. RF section

#### (1) RF ATT (RF attenuator)

The TS-950SDX features a variable 4-position RF attenuator with 6dB steps (OFF, 6, 12, or 18dB). The steps have been made smaller than on the TS-950S, ensuring greater control and effectiveness. Note that if more than 18dB of attenuation is required, a further 10dB is available by pressing the AIP switch.

#### (2) HPF (high-pass filter)

This high-pass filter is provided to shut out the signals of commercial stations broadcasting in the BC band. It is useful when operating in proximity to a radio station, or for combating interference caused by a powerful medium-wave signal at night.

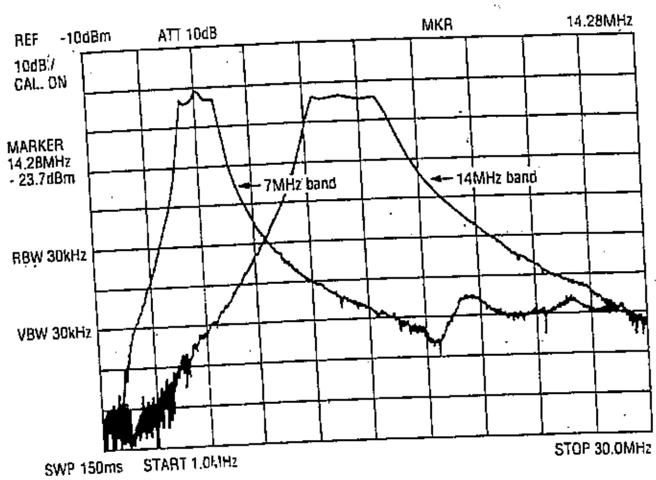
#### (3) RF BPFs (band-pass filters)

The TS-950SDX has a narrow-bandwidth BPF for each of the Amateur Radio bands. If those for general coverage use are included, this makes a total of 15 divided BPFs. By providing a specific BPF for each Amateur band, the operator can be protected from the sort of powerful signal that originates from a short-wave radio station broadcasting on a nearby frequency. In effect, these BPFs improve the dynamic range of the receiver.

**Table 3: RX band-pass filters**

| Frequency range | Amateur band |
|---|---|
| 10kHz - 490 kHz | |
| 490kHz - 1.62MHz | BC band |
| 1.62MHz - 2.99MHz | 1.9MHz band |
| 2.99MHz - 3.99MHz | 3.5MHz & 3.8MHz bands |
| 3.99MHz - 6.99MHz | |
| 6.99MHz - 7.49MHz | 7MHz band |
| 7.49MHz - 9.99MHz | |
| 9.99MHz - 10.49MHz | 10MHz band |
| 10.49MHz - 13.99MHz | |
| 13.99MHz - 14.49MHz | 14MHz band |
| 14.49MHz - 17.99MHz | |
| 17.99MHz - 20.99MHz | 18MHz band |
| 20.99MHz - 21.49MHz | 21MHz band |
| 21.49MHz - 24.49MHz | |
| 24.49MHz - 30.00MHz | 24.5 & 28MHz bands |

**Figure 3: TS-950SDX RF BPF characteristics**




#### (4) RF AGC

RF automatic gain control operates in the same way as does AGC for the IF section. In the event that a powerful signal is input via the antenna terminal, this prevents signal saturation in or after the RF amplifier and mixer sections. The RF AGC circuit features a continuously variable attenuator employing PIN diodes.

### (5) RF amplifier (high-frequency amp)

The TS-950SDX has two RF amplifiers: an FET 2-stage (2SK125-2SK520) amp with high sensitivity, and a 1-stage (2SK125) amp with a high intercept point. The operator can choose one or the other using the AIP switch.

**(a) High-sensitivity RF amp (AIP OFF)**

Operated as an FET 2-stage high-gain amplifier. For the 1.62MHz-30MHz Amateur bands, it provides sensitivity equivalent to -14dB (0.25μV) or less in SSB, CW, and FSK modes.

**(b) High intercept point RF amp (AIP ON)**

Operated as a 1-stage (2SK125) low-gain amplifier. It is used when you want to put priority on dynamic range, for it provides sufficient sensitivity for reception together with a high intercept point. For the 3.5MHz and 7MHz low bands, it is particularly useful, as it can be used to provide approximately 10dB of attenuation with good inter modulation characteristics.

## 2. Main receiver section

### (1) Mixer

This is a quad mixer circuit with 4 FET 2SK520s. A double-balanced approach has been adopted to ensure a high intercept point. The function of this circuit is to mix the received signal with M.Lo1 (1st local oscillator injection signal for the main receiver), converting it into the 1st IF signal (73.05MHz).

### (2) 1st IF amp and onwards

Upon entering the IF unit, the 1st IF signal is divided into two paths. The first of these passes through a buffer and is mixed with the 64.22MHz M.Lo2 (2nd local oscillator signal for the main receiver) to become the 8.83MHz wide-bandwidth signal that is output from the IF OUT-1 terminal on the rear panel. This can be fed into the optional SM-230 station monitor band scope.

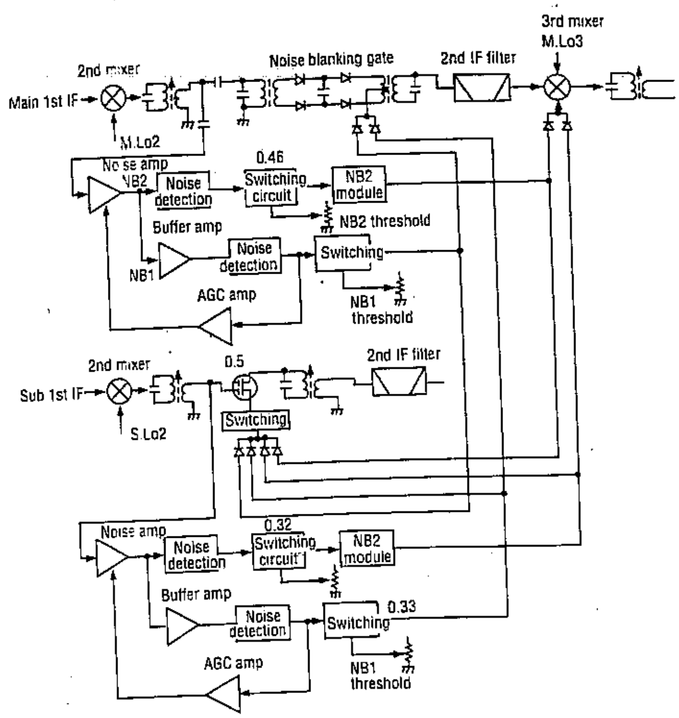
Meanwhile, the other of the two signals passes via a buffer to a 15kHz MCF that filters out unwanted signals. It then goes to the 2nd mixer where it is combined with M.Lo2 to become the 2nd IF signal (8.83MHz).

### (3) Noise blanker

The 2nd IF signal is also divided into two paths: one goes to the noise blanker circuit, and the other passes through a noise blanking gate consisting of 4 diodes and then enters the 2nd IF filter circuit.

The blanking pulse, generated by the main receiver, is supplied to the noise blanking gates of both main and sub receivers. In fact, the two blanking pulses act in reciprocal fashion, since that generated by the sub receiver is also supplied to the noise blanking gate of the main receiver. This means that the sub receiver can be dedicated to noise detection to enable the main receiver to operate with a minimum of noise; this is referred to as the noise-select function.

**Figure 4: Noise blanker circuit**




### (4) 2nd IF filter

The 8.83MHz IF filter circuit is equipped with a 500Hz crystal filter for CW applications. If an even narrower filter is desired, the 270 Hz YK-88CN-1 CW narrow filter is available as an option.

Should an SSB narrow filter be required, there is also the 1.8kHz YK-88SN-1 (option).

### (5) 3rd IF filter

After passing through the 2nd IF filter, the IF signal is converted into the 3rd IF signal (455kHz) in the 3rd mixer. What happens to this 3rd IF signal depends on whether the TS-950SDX is operating in FM mode or not. If not in the FM mode, the 3rd IF signal is amplified and passed on to the 3rd IF filter (455kHz) circuit, which features crystal filters for AM (6kHz), SSB (2.4kHz), and CW (500Hz).

Optionally available is the 270Hz YG-455CN-1 CW filter for a narrower bandwidth.

### (6) Notch filter circuit

After passing through the 3rd IF filter, the signal is amplified and then converted by the 4th mixer into a 100kHz IF signal. A notch filter can be introduced at this stage. The TS-950SDX's notch filter is a T-type bridge circuit employing a voltage variable-capacitance diode and covering a range of 100kHz ±3kHz.

## Figure 5: Block diagram of TS-950SDX receiver section

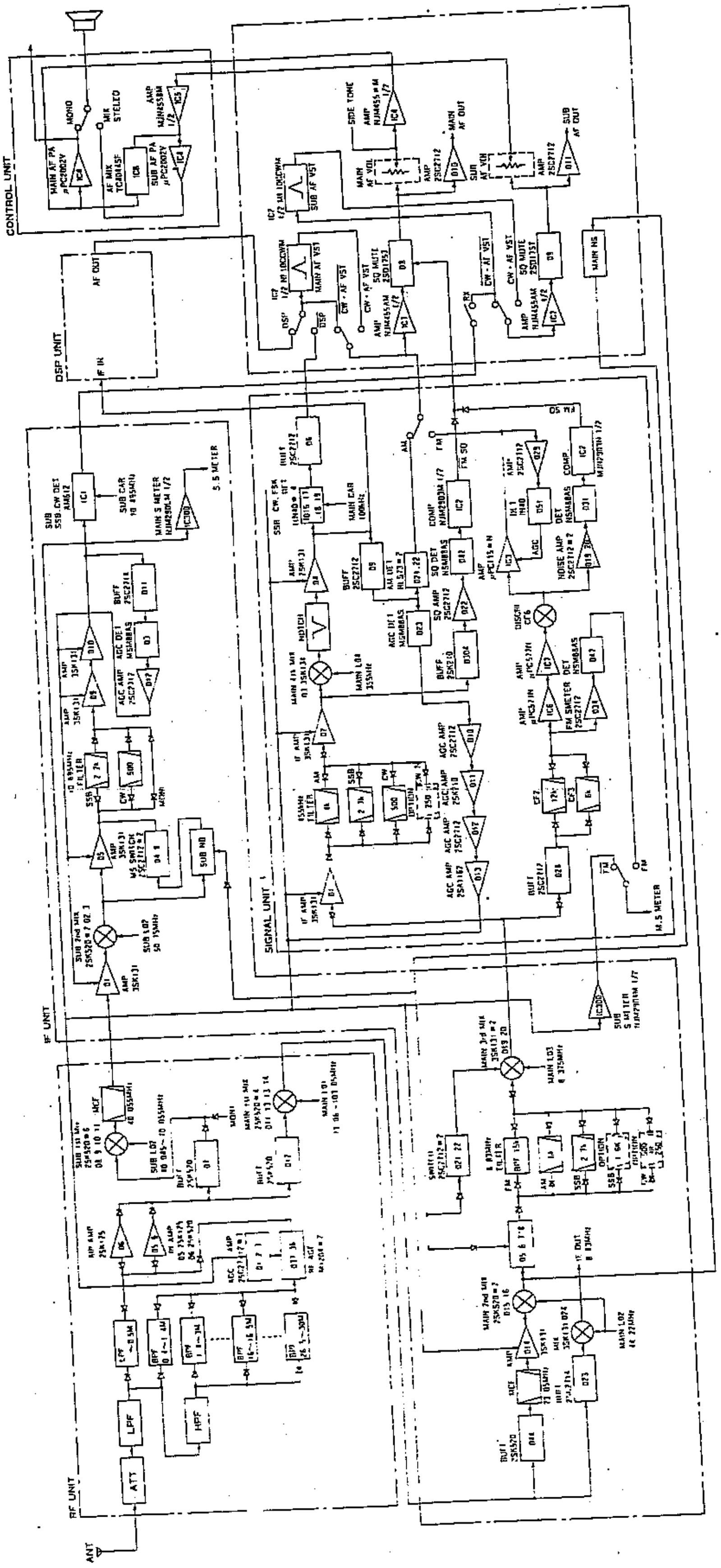
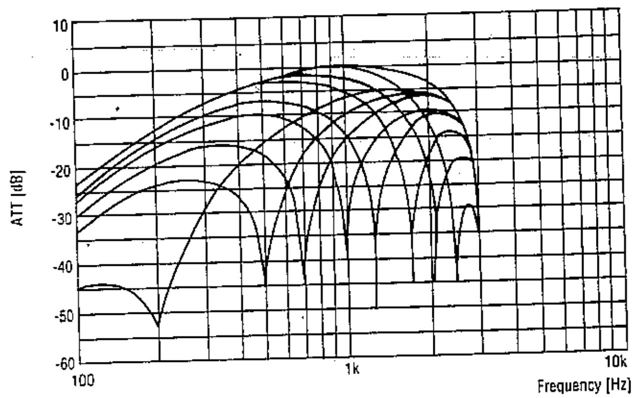


Figure 6: Notch filter characteristics(AF)




(7) DSP-PSN detection circuit

The 100kHz IF signal is amplified, filtered through an LPF, converted from analog to digital, and then input to the DSP. Here the various digital signal processing operations are performed—including digital detection and FIR digital filtering—before conversion back to analog and output as an AF signal.

(8) AM and FM detection circuit

AM detection is performed by an envelope detector using a Shottky barrier diode.
The FM signal for detection is first converted into the 3rd IF signal (455kHz), passed through the FM filter circuit (12kHz or 6kHz selectable), given sufficient amplification, and then fed into a discriminator. Since audio output power is limited, even a signal that has been processed by a compressor amplifier and heavily modulated can be made to sound clear and natural.

## 3. Sub-receiver section

(1) Mixer

As is the case with the main receiver, the signal output by the RF amplifier passes via a buffer to a quad mixer circuit. In the sub receiver's 1st mixer, it is combined with S.Lo1 (1st local oscillator injection signal for the sub receiver), converting it to the 1st IF signal (40.055MHz). This is then filtered through a 15kHz MCF to remove unwanted signals, and processed by the 2nd mixer to become the 2nd IF signal (10.695MHz).
This 2nd IF signal is divided into two paths: one is supplied to the noise blanker circuits of the main and sub receivers, while the other is amplified by the IF amp.

(2) Sub-receiver IF filter

The sub receiver's 2nd IF filter circuit features crystal filters for SSB (2.2kHz) and CW (500Hz). If it is desired to use the sub-receiver section as a TX monitor circuit, the filter must be bypassed for SSB transmission.

(3) IF, AGC & detection circuits

The sub receiver's AGC is applied to the 10.695MHz 2nd IF signal, its time constant being set to about the same as the MID position on the main receiver AGC selector.
The IC-based analog detection circuit has been refined to ensure audio quality little different from that of the main receiver. The AF signal detected here is sent on to the sub-receiver AF and monitor circuits.

## 4. AF amplifier (low-frequency amp)

The AF signals produced by the main and sub receivers are amplified by independent AF amplifiers.

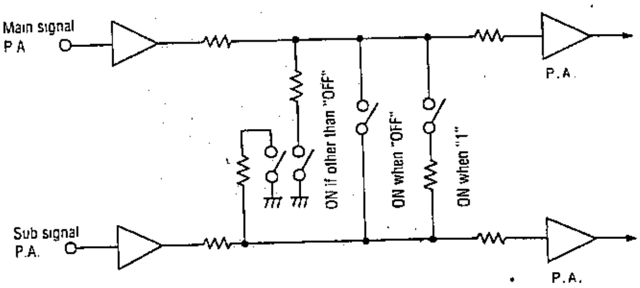
(1) AF-VBT circuits

The main and sub AF signals are input to their respective AF-VBT circuits. If these AF-VBT circuits are switched on while operating in CW mode, it is possible to adjust the pass band width using the AF-VBT control on the front panel (for the main signal) or the internal trim potentio-meter (for the sub signal).
After passing through these AF-VBT circuits, the signals are amplified by OP amps and passed though potentio—meters (separate for main and sub receivers). They can then be combined with a monitor signal, a sidetone signal, or the audio output of the DRU-2 digital recording unit, and finally sent to the main and sub mix circuit.

(2) Main and sub mix circuit

Both AF signals are passed to the main and sub mix circuit, and from there to the speaker(s), as dictated by the speaker mode selected via the menu system. You have a choice of three speaker modes: Mixed (OFF), semi-separate (1), and separate (2).

Figure 7: Audio mixing circuit




## 5. Interference reduction measures

(1) IF filter selection

You are free to choose or combine the TS-950SDX's independent IF filters— for 8.83 MHz, 455 kHz, and the sub RX— to suit the particular mode.

**(a)8.83MHz crystal filters**

With each press of the 8.83 key on the front panel, the filters are selected in rotation. There are five filters (some optional) that can be selected: [1] 6kHz AM, [2] 2.7kHz SSB, [3] 1.8kHz SSB (optional), [4] 500Hz CW, and [5] 270Hz CW (optional).

**(b)455kHz crystal filters**

With each press of the 455 key on the front panel, the filters are selected in rotation. There are five filters (some optional) that can be selected: [1] 12kHz FM and AM, [2] 6kHz AM, [3] 2.4kHz SSB, [4] 500Hz CW, and [5] 250Hz CW (optional).

**(c)Sub RX crystal filters**

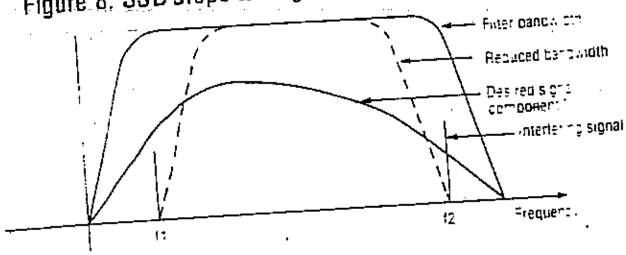
Once the M/S key has been used to switch the main encoder to sub-receiver use, pressing the 455 key will select one or the other of the sub RX filters. There are two filters to choose from: [1] 2.2kHz SSB, and [2] 500Hz CW.

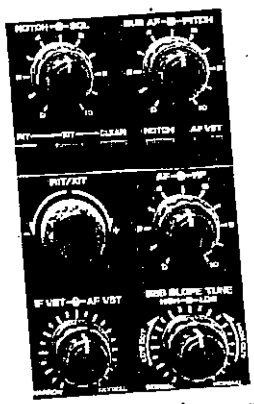
**(2) SSB slope tuning**

The slope tuning circuit uses paired IF filters and by giving each a different IF shift you can adjust the apparent pass band width to reduce or eliminate interference.

The following illustration shows how SSB slope tuning can be of use when interfering signals are received in the upper and lower regions of the normal communications bandwidth.

**Figure 8: SSB slope tuning**



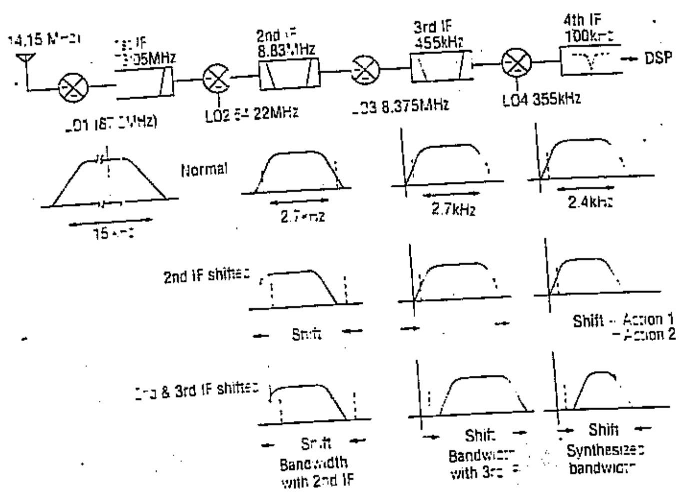



**SSB slope tuning control**

To avoid the interfering signals labeled $f_1$ and $f_2$, it would clearly seem advantageous to adjust bandwidth to a new, synthesized pass band width—marked by the dotted line. But since the bandwidth of crystal filters cannot actually be changed, it becomes necessary to shift the heterodyne frequency slightly. This is in practice equivalent to adjusting the filter bandwidth.

Figure 9 illustrates the layout of the TS-950SDX's receiver section and also the pass band width characteristics of the successive IF filters.

**Figure 9: Receiver section frequency profile & pass band width characteristics for IF filters (single and combined)**




Without engaging SSB slope tuning, and without making any changes to the standard settings, the synthesized pass band width is 2.4kHz—the widest possible.

Next, if the SSB slope tuning high-cut control is applied to the 2nd IF filter, bandwidth shifts lower and the synthesized pass band width narrows, cutting out the upper interfering signal $f_2$ (action 1).

Similarly, if the SSB slope tuning low-cut control is applied to the 3rd IF filter, bandwidth shifts higher and the synthesized pass band width narrows, cutting out the lower interfering signal $f_1$ (action 2, opposite of action 1).

Executing actions 1 and 2 simultaneously neatly removes both interfering signals, $f_1$ and $f_2$.

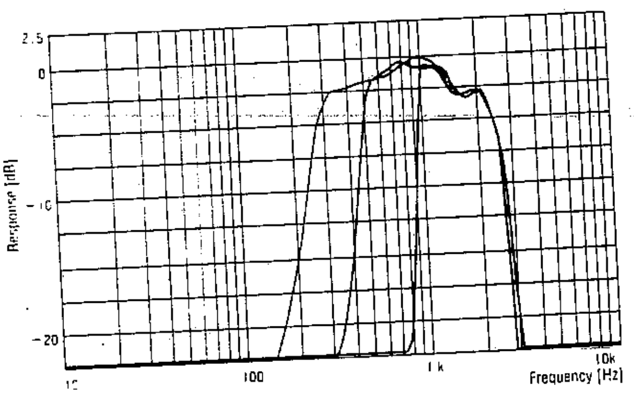
The actual heterodyne operations that make slope tuning possible are as follows. Taking 7MHz LSB reception as an example, the 1st IF filter converts the signal to a 73.05MHz USB signal. This then passes through the 8.83MHz, 455kHz and 100kHz finally entering the DSP unit still as a USB signal. In order to implement high-cut control for SSB slope tuning, it is simply necessary to shift the central frequency of a filter downwards. Since this reduces the filter's high-range cutoff frequency, its pass band width is effectively narrowed by the amount of the shift, removing the interfering signal $f_2$ shown in Figure 8. To shift the filter's central frequency downwards, the frequencies of Lo1 and Lo3 are raised. If the amount of the shift is $\Delta f$, the signal input to the 2nd IF filter becomes Lo1+$\Delta f$, and the 2nd IF frequency rises by $\Delta f$. This

$\Delta f$ rise is compensated for by making the signal input of the 3rd IF filter Lo3+$\Delta f$. Thus, high-cut control consists of increasing the 2nd and 3rd local oscillator frequencies by $\Delta f$, decreasing the cutoff frequency by $\Delta f$, and thus narrowing what is in effect a synthesized pass band width on the filter's upper frequency.

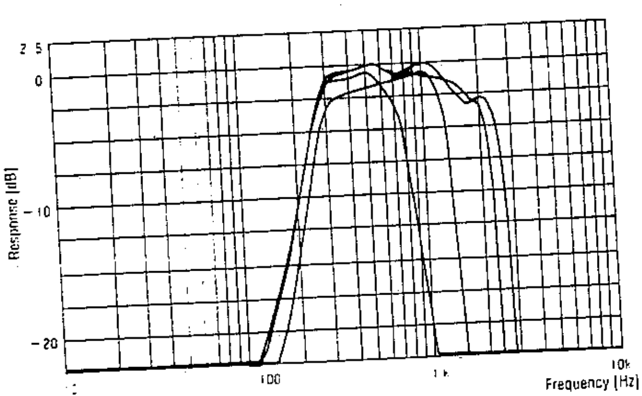
Low-cut control is implemented in a similar fashion. The central frequency of a filter not used for high-cut control is shifted upwards, raising the filter's low-range cutoff frequency. On the TS-950SDX the local oscillator signal input to the 3rd mixer is raised to Lo3+$\Delta f'$, and this is compensated for by making the local oscillator injection signal input for the 4th IF filter Lo4-$\Delta f'$. This effectively narrows the synthesized pass band width on the filter's lower frequency, enabling low-cut control.

Since high-cut control and low-cut control can be executed independently, you can tailor SSB slope tuning to cleanly remove interfering signals $f_1$ and $f_2$—interference reduction at its best.

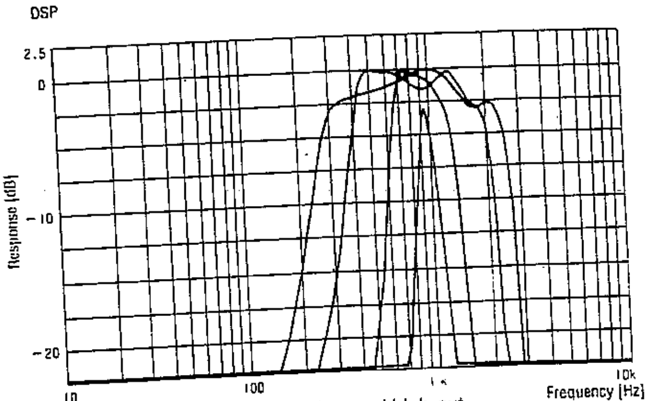
**Figure 10: Bandwidth changes resulting from IF interference reduction measures**




(a) Slope tune low-cut




(b) Slope tune high-cut




(c) Slope tune low-and high-cut

**(3) IF VBT**

This circuit enables you to vary bandwidth in the CW, FSK and AM modes. It works on the same principle as SSB slope tuning, operating simultaneously on both the 8.83MHz and 455kHz filters for continuous control over pass band width.

**(4) IF notch filter**

When an interfering signal comes not to one side but in the middle of your target signal— as illustrated in Figure 11—it does no good to adjust filter cutoff frequencies. This is because slope tuning aimed at narrowing IF pass band width will attenuate the target signal, making it very difficult to hear.

The solution to such problems is a notch filter. This surgically removes the interfering signal through severe attenuation at a single, specific frequency. The notch filter is comprised of a T-type bridge circuit, as illustrated in Figure 12. By adjusting the voltage impressed on the voltage variable-capacitance diode, it is possible to change the resonance frequency, thus sharply attenuating only the interfering signal. Since the notch filter is situated inside the 4th IF filter circuit (100kHz), it can operate independently of both SSB slope tuning and IF VBT. Moreover, it provides good results for all modes excluding FM, where it is not required.

**Figure 11: Notch filter**

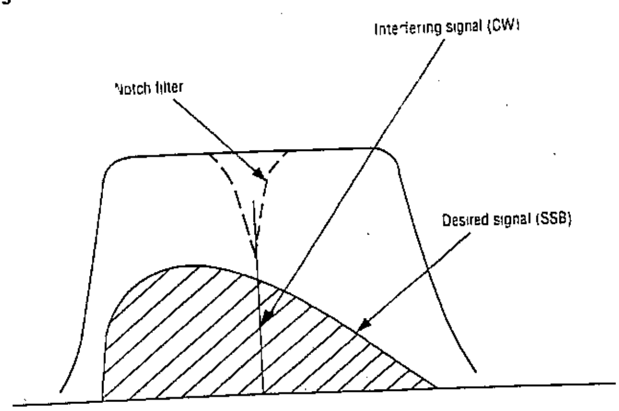
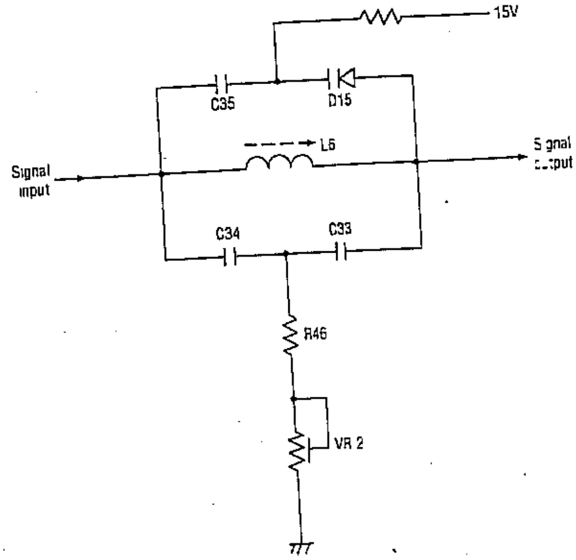
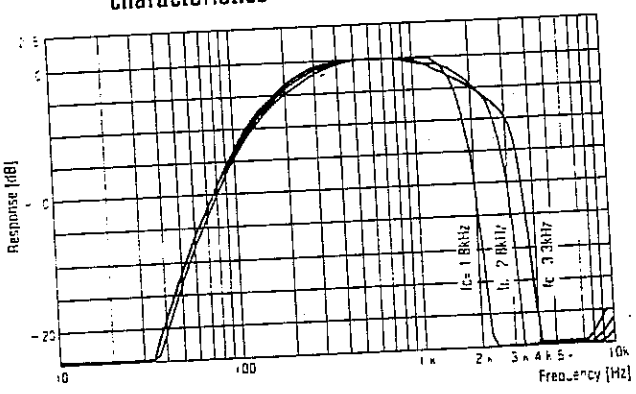


Figure 12: Notch circuit (signal unit)




(5) DSP audio filter
On the TS-950SDX, audio filtering following detection is also performed by digital processing. The DSP's FIR digital filters—offering excellent S/N characteristics— cleanly cut away unwanted audio bandwidth.
The menu system provides you with a choice of 15 LPFs (with cutoff frequencies ranging from 600Hz to 6kHz), and 3 BPFs for FSK use (with a center frequency of 2.2kHz). Figure 13 shows the audio frequency characteristics of the entire receiver section, with typical cutoff frequencies indicated.

Figure 13: Receiver section's audio frequency characteristics




(6) AF VBT (in CW mode)
There is a VBT circuit in the AF stage, separate from that in the IF stage, which can also be used to adjust pass band width. This is effective against adjacent beat interference and noise, improving the clarity of reception. It employs a switched capacitor filter whose center frequency can be set using a clock signal.
Pass band width can be reduced to less than 100Hz. Adjustments are made using the AF-VBT control on the front panel for the main receiver, or an internal trim potentiometer for the sub signal. The default setting is approximately 200Hz. The center frequency does not require adjustment since it is linked to the pitch control.

(7) Pitch control
In the CW mode, after the operator has tuned in a signal, he can adjust the BFO pitch to suit his own preference.
When the pitch is altered, however, neither the TX frequency nor the filters' center frequencies change, so the operator can adjust the pitch without concern for either receiver or transmitter frequency shift. The sidetone and center frequency of the AF VBT are linked to the BFO pitch. Whatever position the pitch control is in, as long as the operator tunes so that the sidetone corresponds to the frequency of the received CW signal, he can zero-beat the incoming signal with absolute accuracy.

(8) CW reverse mode
Once in CW mode, pressing the CW key again enables CW-R (CW reverse) mode, in which the BFO switches from USB to the LSB. Frequency spectrums are reversed in this mode, so the beat frequency of interference outside the target signal is also reversed. This means that interference with a pitch higher than the target signal is changed so that the pitch is lower and the intelligibility of the target signal is improved.
When setting CW reverse mode and turning the main tuning knob from lower to higher frequencies, the pitch of the received CW signal also changes from low to high. The direction in which the tuning knob is being turned thus matches the change in pitch. CW reverse mode also enables the operator to zero-beat a signal. Operation is simple: if RX frequency is adjusted so that the pitch is the same in both CW mode and CW reverse mode, that will be the target frequency.
CW reverse mode thus provides opportunities for you to reduce interference and to rapidly zero-beat a target signal.

# 4. Transmission

— FET final section: a world first for Amateur Radio —

The TS-950SDX ranks as the world's first Amateur Radio transceiver to feature power MOS-type FETs (MRF150MP). Nowadays transistor final sections have become the norm, yet there remains a persistent demand for vacuum tube technology. Interestingly, the operational characteristics of an FET device are more like those of a pentode than of a transistor. The TS-950SDX is thus equipped with an ideal final amp, capable of delivering a TX signal of the superior quality associated with tube technology, while at the same time assuring the convenience, reliability and efficiency of transistor technology.

### 1.FET final section (MRF150MP)

For its final amp, the TS-950SDX is equipped with power MOS FETs (MRF150MP) manufactured by Motorola.

In many of today's electronic appliances FETs are replacing bipolar junction transistors (BJTs)—clear evidence that the former are superior. In particular, three reasons can be identified for choosing an FET device over a BJT device as the final amp of a transceiver: (1) unlike a BJT, the FET is not susceptible to thermal runaway (2) the Negative Feedback required is lower than that for a BJT; and (3) higher order IMD characteristics are excellent.

The first advantage of an FET concerns heat. When the temperature around a BJT rises its collector current rises, since they are related. This can lead to thermal runaway, in which the BJT no longer operates in a linear fashion. An FET's drain current, however, is in inverse relationship to ambient temperature, and thus a runaway situation can not develop.

Secondly, Negative Feedback is lower with an FET. Whereas a BJT has a PN base-emitter junction, which generates considerable noise, no such union is incorporated within an FET. Consequently, the Negative Feedback level for an FET is about one third that of a BJT.

The third advantage of an FET—its excellent high-order IMD characteristics—derives from the fact that its design ensures good linearity between outputs. Some people may feel it strange that the FET should be described as having an advantage over the BJT in this regard, but there is a reason for this. Motorola's own references explain that, while it is generally believed that an FET has better linearity than a BJT, this is only true for small outputs with a bias equivalent to that of a class A amplifier. According to Motorola's data, regarding the 3rd to 7th IMD characteristics the BJT has an advantage over the FET of 6-7dB. The reason why high-level IMD characteristics are important for transceivers is that they can prevent your own transmitted signal from disturbing other stations—especially those operating close to your TX frequency—and this in itself is sufficient to make the FET attractive.

In actual fact, even split from 10kHz, the TS-950SDX will not cause interference problems for local stations (excepting cases of unavoidable linear distortion). Nevertheless, the advantage typically enjoyed by the BJT regarding the 3rd and 5th IMD characteristics has been motivation enough to work on improving the low-order IMD characteristics of the TS-950SDX's FET final section.

First, FET characteristics were matched. The MRF150MP ("MP" stands for "matched pair") features FETs with identical gfs (mutual conductance). However, even with equal gfs, there is a discrepancy in Vgs (th)—the gate source voltage at which drain current starts flowing—and this makes inappropriate the conventional use of a single bias circuit to apply bias to both FETs, since it would result in an unbalanced relationship between bias current and gain for each FET. The solution was to provide each FET with its own bias circuit so bias current and gain can be balanced.

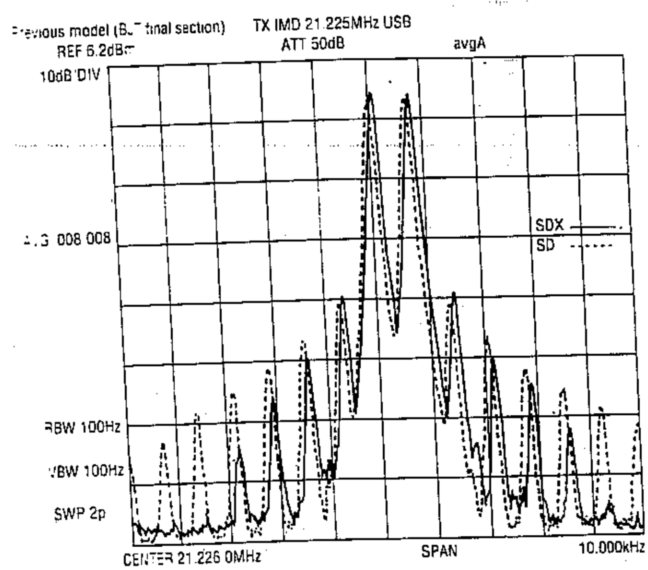
Additionally, matching transformers were developed using Teflon coaxial cable to assure a matching balance on output. The shield of the coaxial cable is used for the primary winding, with the center conductor becoming the secondary winding. Whereas the behavior of a conventional coil-type transformer is governed by the way in which it was wound, with this coaxial-cable design the relationship between primary and secondary windings is constant, making it easier to balance the two FETs.

These refinements mean that, at 150W PEP, the 3rd IMD figure is approximately below −37dB and the 11th IMD product is approximately below −70dB. Thus, even regarding low-level IMD characteristics, the TS-950SDX offers performance worthy of the finest transceivers. In addition, high-level IMD characteristics are even better than published in the specifications. The excellent performance of the TS-950SDX's FET final section can best be ascertained by having local stations act a monitors.

### 2. Final amplifier

The TS-950SDX's MRF150MP power MOS-type FETs (total device dissipation = 300W x 2) are designed so that TX characteristics are optimum when nominal output is 150W (SSB, CW, FSK & FM modes).

**Figure14:TS-950SDX's IMD characteristics**




# 5.Other Features

### 1.Automatic antenna tuner

Like its predecessor, the TS-950SDX is equipped with an automatic antenna tuner. This is of the preset type, meaning that once it has been tuned the data is retained in memory; thereafter, tuning is instantaneous. In all, there are 3 antenna tuner modes: auto, preset, and manual.

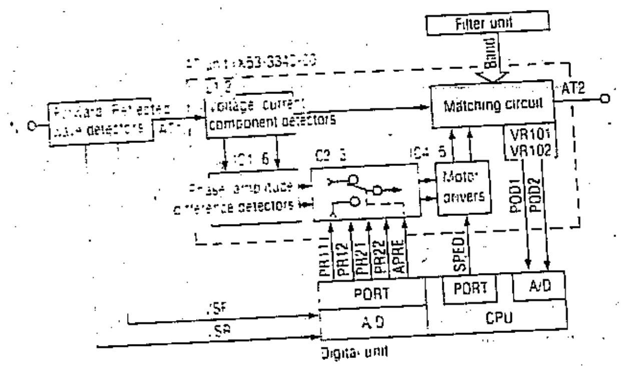
**(1) Auto mode**

In this mode the transceiver outputs a CW signal of about 10W, enabling the tuner to match the transceiver and antenna automatically. It is useful when connecting an antenna to the TS-950SDX for the first time. Once tuning is complete, the tuner automatically switches to the preset mode.

When you wish to use this mode, you first connect the antenna and then set the THRU/AUTO switch to AUTO. After the frequency is adjusted and the AT TUNE switch pressed, both the ON AIR and AT TUNE indicators light. These signal that antenna tuning has started: SWR is lowered, and when it reaches a value of about 1.2 tuning is completed. Transmission is then enabled. This is repeated for each antenna and each band—the position of the variable tuning capacitors being stored in memory— so that in the future it is only necessary to set the frequency for a particular band to ensure instant antenna tuning (preset mode).

During automatic tuning, adjusting of the variable tuning capacitor is entirely under the control of the CPU, and the TS-950SDX is automatically set to CW mode with a power output of 10W in order to protect both transceiver and antenna from possible damage.

**Figure 15: Block diagram of the automatic antenna tuner**




The operation of the automatic antenna tuner is illustrated in Figure 15. After passing through the filter unit, the TX output goes to transformers L1 and L2 (which have toroidal cores) to detect current and voltage. The current and voltage components are then processed by the wave form generation circuit—consisting of D4, Q1 and D7, Q2—and compared by IC1 (SN74S74N) to detect the SWR. The two motors that rotate the variable tuning capacitors respond to the duty ratios of the pulses input to the No. 8 control input pins of IC4 and IC5. Depending on the VSWR value calculated by the digital unit's CPU, and on whether the tuner is in preset mode or manual mode, the motors are then operated at optimum speed to rotate variable tuning capacitors VC1 and VC2.

The SPEED pulse signal output by the digital unit is processed by Q5 (DTC114EK), amplified by Q4 (2SA1204), and is input to IC4 and IC5 to produce the control pulses.

**(2) Preset mode**

Once the tuning data has been stored in the CPU, it can be recalled automatically when an Amateur band is selected to set the variable tuning capacitors to their appropriate preset positions. This time-saving feature assures that matching is completed almost instantaneously. The TS-950SDX is capable of storing preset data for 11 Amateur bands.

**Amateur bands (11) for preset mode**

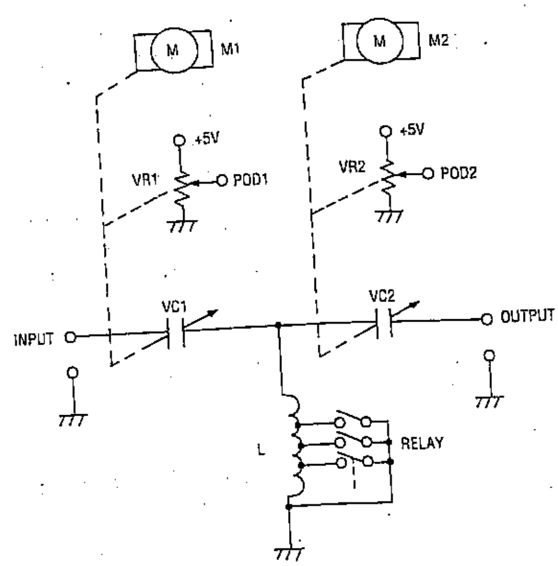
- 1.8MHz
- 3.5MHz
- 3.8MHz
- 7MHz
- 10MHz
- 14MHz
- 18.5MHz
- 21MHz
- 24.5MHz
- 28MHz
- 29MHz

**(3) Manual mode**

Manual tuning is available if automatic tuning is unsuccessful or otherwise undesirable. When manual mode is desired, the operator first presses the MENU key and selects menu #08, turning it off. If the AT TUNE switch is then pressed, manual tuning can proceed. The operator slowly turns the main encoder and the M.CH/VFO CH control while looking at the built-in SWR meter to find the optimum (minimum SWR) position.

During manual tuning, the antenna tuner's variable capacitor VC1 is controlled by the main encoder, while VC2 is adjusted using the M.CH/VFO CH control. Approximately 8 revolutions of the control is equivalent to 1/2 revolution of the variable capacitor (from lowest capacity to highest). When tuning is completed (SWR is less than 1.2, or manual tuning is deselected), the data is stored.

**Figure 16: Matching circuit**




## 2. Large fluorescent display

The design of the TS-950SDX is based on human engineering principles to ensure that the operator has quick access to a wide variety of information presented clearly. To this end it employs the same large fluorescent display featured on the previous model.

### (1) Digital bar meter
During simultaneous dual-frequency receive, the bar meter now functions as an S meter for the sub receiver.
The 30-dot multi-function meter is arranged horizontally on three levels, enabling the simultaneous display of three different types of information—something that puts it in a different league to analog S meter designs.
The top level acts as an S meter during receive, and as a power meter during transmission. The middle level can be either an SWR meter or a compression level meter during transmission (selectable). The third level functions as an S meter for the sub receiver during reception, and either as an ALC (automatic level control) meter or as an IC (input current) meter during transmission (selectable). Both the second and third levels can be blanked if no display is required.
The ability to display three types of information via the digital bar meter is very convenient, providing you with a fuller picture of the TS-950SDX's operational status. For instance, during transmission one can monitor power, SWR and ALC at the same time, without having to switch between display modes. There is also a peak hold function, making it easier to gauge a signal's peak level.

### (2) IF filter display
As with the previous model, the TS-950SDX displays the bandwidth of the selected 8.83MHz and 455kHz filters. To simplify operation, the choice of IF crystal filters has been made dependent on the mode: Thru↔1.8kHz for SSB mode, 2.7kHz↔500Hz for CW mode. (Note that this feature can be deactivated via the menu system, allowing free selection of filters.) Also, when the TS-950SDX's M/S select key is used to control the sub receiver via the main encoder, sub-receiver filter information is displayed.

### (3) Frequency display
The TS-950SDX provides three separate frequency displays: main-receiver frequency in the center, split TX frequency to right, and sub RX frequency or ΔF below that. This arrangement is extremely useful when operating split frequencies.

### (4) Memory channel & RIT display
In addition to the operating frequency, the center of the display can provide information on memory channels (number) and RIT/XIT operation (offset). RIT offset is displayed in 10Hz steps. During program scan, hold and wait data are also displayed automatically.

### (5) Analog scale
Continuing in the tradition of the TS-930S, TS-940S and TS-950S/SD, the TS-950SDX has been equipped with an analog scale for displaying frequency data. Full scale range is either 1MHz or 100kHz (selectable).

### (6) M.CH/VFO CH display
Following the example of the very popular VFO-230 , the TS-950SDX features 6 keys to facilitate VFO and M.CH operations. Each key top has a green LED to indicate it is active, and the fluorescent display also provides VFO/MR information at a glance—this is particularly useful when operating split frequencies.

### (7) Display colors
To make the large multi-function fluorescent display as smart and clear as possible, careful thought has been given not only to positioning but also to color choice. In all, three colors are used: light-blue for the main items, such as operating frequency; red for function settings and meter zone emphasis; and yellow for the sub receiver's frequency and S meter. Each individual piece of information can thus be distinguished clearly.

### (8) Dimmer
With the introduction of the digital bar meter it has been possible to do away with incandescent lamp illumination and the heat associated with it. Instead, the level of illumination can now be freely adjusted, thanks to the property of fluorescent display devices to respond to changes in the pulse duty cycle. Using the menu system, you can adjust the dimmer level between 30% and 70% (100% represents display intensity with the dimmer switched off) in 5% steps.

## 3. Construction of the TS-950SDX
The TS-950SDX has been designed to take maximum advantage of recent progress in microprocessor and display technology to give you the information you need at a glance, and to allow you to access a wide range of functions with unprecedented ease. The large fluorescent display, the illuminated tactile keys, and the positioning of the main controls all contribute to this, reflecting the high priority given to human engineering research.
The panel is of a quiet, dark gray color. Inside, the meticulously arranged layout positions the power supply, antenna tuner and other components to maximize space efficiency. Moreover, the construction of the chassis supporting the heavier parts—such as the power transformer and heat sink—offers unparalleled durability and resistance to shock and vibration.
The dimensions of the unit are (W x H x D) 402 x 141 x 400mm (15-13/16 x 5-9/16 x 15-3/4in), not including projections.

### (1) Front panel
To ensure ample strength, the front panel has been molded from reinforced ABS plastic with an average thickness of 4mm (2-3mm is common). The rotating controls, such as the main VFO dial, have been given a smart metallic finish. The AGC control is now a dual concentric potentiometer; the inner control adjusts key speed. This is handy for matching your own speed with that of another station when operating in CW mode. New keys that provide instant access to other convenient features include FINE, MENU, RX↔SUB, and M/S.

**(2) Display**
The multi-function fluorescent display enables you to view a wide variety of information simultaneously and thus quickly grasp operational status. A smoked acrylic dial glass improves visibility. Also, durability is improved as there is no longer any need to replace dial or meter lamps.

**(3) VFOs**
For the main and sub VFOs, a magnetic encoder design has been adopted. First used on the TS-950S and SD, this replaces the digital VFO—featured on the TS-940S series —which used a light-emitting diode and photo transistor to count pulses optically.
The magnetic encoder consists of a magnetized drum and a magnetic sensor arranged in close proximity. The outer surface of the drum has a multi-pole magnetic pattern. The sensor contains a corresponding pattern forming an electrical circuit whose output is dependent on the rotation of the drum. This works on the principle that the application of a magnetic field can reduce electrical resistance in a circuit.
This magnetic encoder has three features that make it superior to the previous optical encoder design. First, operation is more stable since the detector does not include delicate optical elements. Second, a fast response time makes it more suitable for high drum rotation speeds. And third, the encoder is small and lightweight.
Also, the torque of the main encoder dial can be adjusted to suit your individual preference.

Figure 17: Magnetic encoder

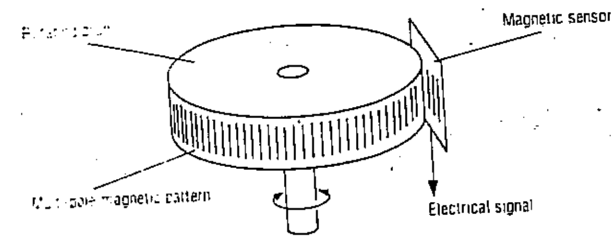
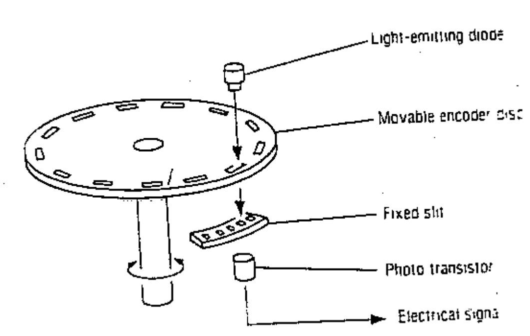



Figure 18 : Optical encoder




**(4) Controls**
To enhance operating ease, the TS-950SDX is equipped with illuminated tactile switches. LEDs inside the mode, function and other keys enable instant verification of current status. For example, the BAND/KEY arrangement of ten keys is illuminated when the ENT key is pressed, showing that the 0-9 key identifications are active and a frequency can be input directly; when not illuminated, these keys are used for Amateur band selection.

**(5) Internal construction**
The positioning of the TS-950SDX's heavier components—such as the power supply transformer, the final section, and the antenna tuner—has been arranged so that the overall layout is as balanced as possible. This spreads the load supported by the chassis.
The construction of the chassis itself is unchanged from the previous model; it has been reinforced with angle brackets at strategic points to ensure ample strength. To the left, one third of the upper part of the chassis is taken up by the power supply, with the final section in the center and the antenna tuner to the right. The partition between the power supply and final section is used to strengthen the chassis from front to back. The lower part of the chassis houses 4 PCBs with a bracket placed to provide sideways reinforcement. This arrangement results in an ideal cross-shape pattern of reinforcement. The chassis is then firmly attached to the lower case to protect it from shock and vibration.
To protect the power supply from shock, its transformer features a tough EI core (the shapes of the laminations are like the letters E and I). Both it and the other main units have been positioned to maximize safety during operation.

**(6) FET final section & cooling**
To cool the final section and power supply, the TS-950SDX is equipped with the same high-capacity cooling fan as the TS-950S and SD. Featuring a brushless DC motor, this offers quiet, trouble-free operation. Durability is further enhanced by anticipating cooling requirements: the fan is engaged as soon as the transceiver commences transmission.

## 4. DDS and 1Hz-step tuning
The TS-950SDX employs a DDS (Direct Digital Synthesizer) to enable ultra-fine tuning in 1Hz steps.
The previously employed PLL system offered coarser tuning in steps of 10Hz, which was a little inconvenient for CW and FSK operations. With steps of just 1Hz, however, tuning is so smooth you might think the TS-950SDX has an analog VFO.
Exploiting the full potential of the DDS is the new FINE switch. When this is pressed, one revolution of the main encoder is equivalent to approximately 1kHz—ideal for precision tuning in CW, SSB, and FSK modes. The combination of this feature with a narrow filter is handy for CW contests, making it relatively simple for you to tailor the tone you hear for easy listening.
Using only a PLL system to adjust frequency requires multiple loops, but noise is generated when switching between upper

loops (every 10kHz or so). The TS-950SDX, however, can change frequency smoothly over a continuous range of 500kHz. And the DDS has no "lockup time"—the interval required for a PLL to settle (stabilize) after changing frequency—meaning that response is immediate, and quiet. This difference is appreciable for CW break-in and AMTOR applications.

**5. General coverage receiver (100 kHz-30 MHz)**

The TS-950SDX can receive over a continuous range stretching from 100 kHz to 30 MHz. This general coverage allows you to check on band conditions and keep up with world news.

# 6. Options

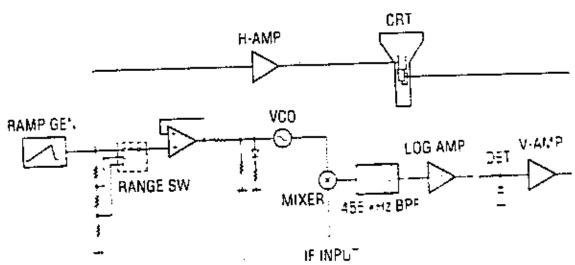
## 1. SM-230

The SM-230 is a high-performance station monitor—with a simultaneous dual-frequency receive display function— capable of further extending the potential and operating ease of the TS-950SDX. Its band scope (panoramic display) is very convenient for checking on band conditions and seeing how various stations are dispersed during pile-ups. The 10MHz bandwidth, synchronized oscilloscope and bright 6-inch CRT also contribute to making the SM-230 not only an invaluable asset for communications support, but also for general use around your station.

**(1) Band scope (panoramic display)**

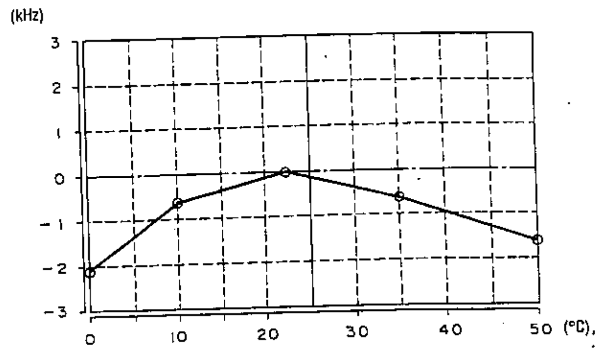
The SM-230's band scope (panoramic display) can monitor received signals over a maximum bandwidth of ±250kHz. Two other scan widths are available for closer observation: ±25kHz and 100kHz. And for all 3 ranges you can choose either automatic or manual control of sweep speed.
Band scope operation is illustrated in Figure 19.

**Figure 19: Block diagram of band scope**

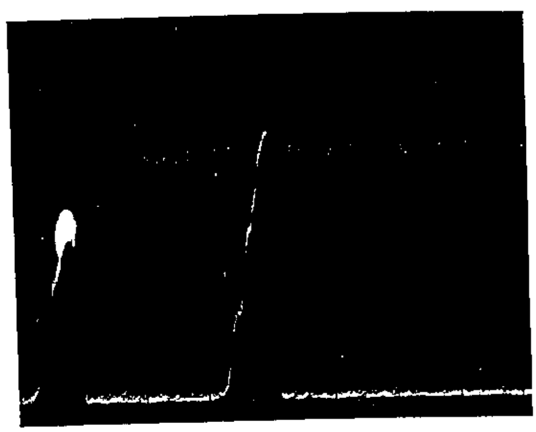



The ramp generator outputs both the CRT horizontal sweep signal and the sawtooth wave for sweep oscillation. After adjusting for scan width, the latter signal is input to a diode attenuator (to compensate for non-linearity) and from there applies bias to the variable-capacity diode of the sweep oscillator VCO. The VCO features a Colpitts oscillator and operates from 8.125MHz to 8.625MHz. with a central frequency of 8.375MHz and a maximum bandwidth of ±250kHz. High-precision components ensure exceptional stability and resistance to temperature drift, as illustrated by Figure 20.

**Figure 20: Band scope (panoramic display) center frequency drift**




The frequency sweep signal produced by the VCO is sent together with the TS-950SDX's IF signal (fo=8.830MHz), which it frequency converts in a dual-gate FET mixer. The output is then processed by a band-pass filter – (a) 455kHz, 1kHz BW— extracting just the 455kHz component of the signal. Since the VCO sweeps at 8.125MHz to 8.625MHz, the range for the IF signal is shifted by 455kHz to 8.580MHz to 9.080MHz—or in other words, 8.830MHz ±250kHz.
The IF signal is converted back to 455kHz and is then passed to an 80dB log amp for logarithmic amplification. The output then goes to a diode detector, a vertical amp, and finally the CRT's deflector plate.



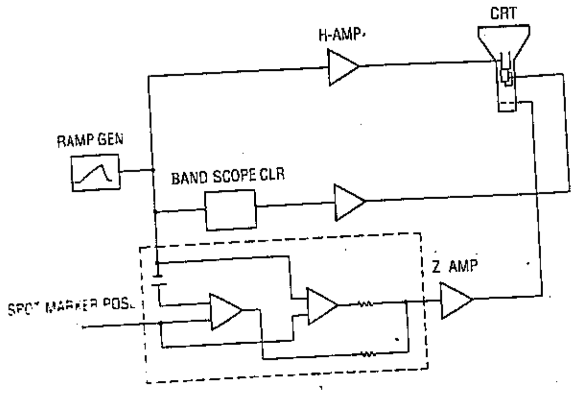
**Simultaneos dual-frequency receive display function**

**(2) Simultaneous dual-frequency receive display function**

This function facilitates use of the TS-950SDX's marker for simultaneous dual-frequency receive.
When the SM-230 is operating in band scope mode, the main-receiver frequency is always displayed in the center of the screen. If dual-frequency receive is activated, the sub-receiver frequency is also displayed on screen, as a bright marker. This makes it easy to verify both frequencies simultaneously on the same display.
As illustrated in Figure 21, the sawtooth wave supplied by the VCO as a sweep signal is also used as the input for a wind

comparator, which compares it with the positional information of the TS-950SDX's marker. By piling up this output with the unblanking signal sent to the CRT, it is possible to display the relative position of the sub-receiver frequency on screen. And since the sawtooth wave is also used as the CRT's horizontal sweep signal, the sub-receiver frequency is always displayed very accurately.

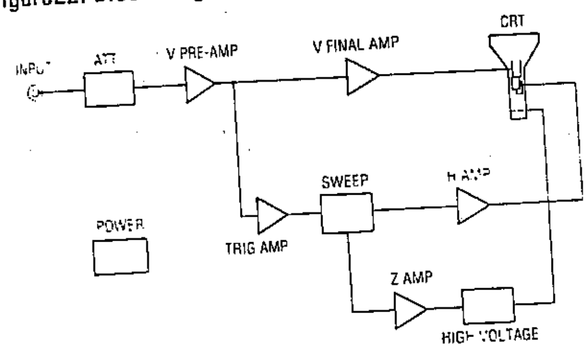
**Figure21: Block diagram of the sub-receiver maker**




### (3)Oscilloscope

Figure 22 illustrates the operation of the SM-230's oscilloscope. The signal input via the vertical input BNC passes through an attenuator to adjust level and from there goes to a vertical pre-amp.
After the impedance is adjusted with an FET source follower, the signal is passed from a variable gain circuit to a feed-forward amp for approximately 28dB of amplification. The high-frequency component is amplified using an emitter ground return amp while the DC component is amplified with an OP amp. The result is a broad bandwidth with minimal drift: frequency response is DC-25MHz (-3dB), drift is approximately 50μ2V/°C, and drift is less than 1% at 50°C.

**Figure22: Block diagram of oscilloscope**

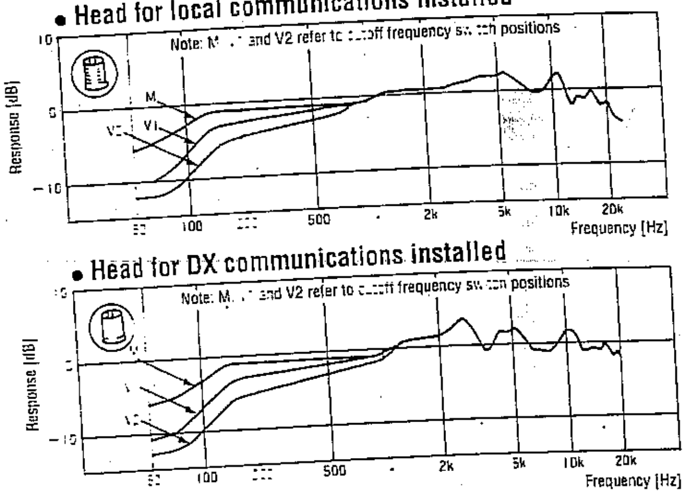



The pre-amp output passes to a vertical final amp and also to a trigger amp.
The vertical final amp is of a differential push-pull design operating on +100V and providing a deflection sensitivity of approximately 10V/div. Since the CRT uses static electricity for beam deflection, final amp load determines capacity. Thus, the design focus of this amp is its high-frequency current drive. And to drive a high-frequency current that is up to 2 times that of the DC bias current, the emitter of the transistor on the current source side is capacity-grounded driving the base side.

## 2.MC-90 DSP-compatible desktop microphone

The TS-950SDX is equipped to provide very high audio quality during transmission, thanks to the built-in DSP. However, the wrong choice of microphone can mean that the full potential of the rig is not realized. That is why a DSP-compatible desktop microphone—the MC-90—has been developed for use with the TS-950SDX.
The MC-90 features high-quality components. Supplied with it are two interchangeable heads: one has a flat frequency response for good overall performance, while the other offers exceptional clarity and an output level characteristic that peaks at around 3kHz, making it ideal for DX applications. There is also a 3-position switch on the base to tailor low-range cutoff frequency to suit the operator.

**Figure23:MC-90 DSP-compatible microphone (opt.) frequency response**



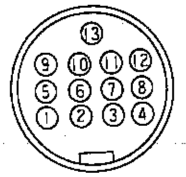

The Canon plug with which the MC-90 is supplied means that it may also be used for a wide range of applications besides communications.

# 7. APPENDIX

## 1. ACC2 Terminal Specifications

The ACC2 connector on the rear panel is an input/ output terminal for data communications. It is used for RTTY and packet communications.

**Pin assignments of ACC2 terminal seen from the rear panel**



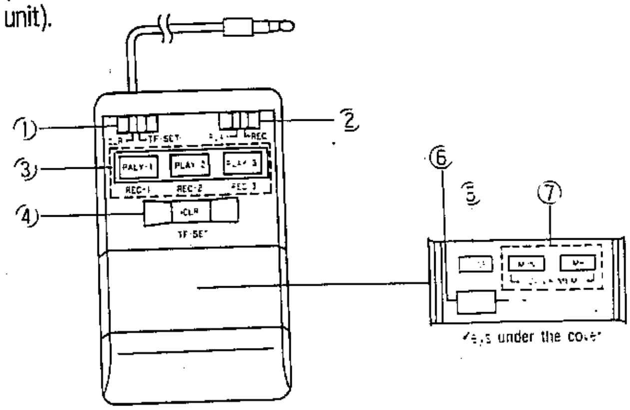

**● Table of ACC2 pin assignments**

| Number | Name | Use |
|---|---|---|
| 1 | SANO (sub-receiver audio output) | Audio output during receive is set at a fixed level, irrespective of the SUB AF volume control. Output voltage: over 300mV with terminal impedance of 4.7kΩ large signal input reception. |
| 2 | NC | (no connection) |
| 3 | MANO (main-receiver audio output) | Audio output during receive is set at a fixed level, irrespective of the AF volume control. Output voltage: over 300mV with terminal impedance of 4.7kΩ, large signal input reception. |
| 4 | GND | Ground (connect to audio output shield GND) |
| 5 | PSQ | TNC squelch control for packet communications use. If connected, packets cannot be transmitted while the squelch is open. |
| 6 | Voltage output for analog S meter | Approximately 2V DC with S9 input. If a meter with low input impedance is connected, the digital S meter readings may be affected. |
| 7 | NC | (no connection) |
| 8 | GND | Ground |
| 9 | PKS | Standby for exclusive terminal use. If standby is used, microphone input is automatically switched off and transmission begins. |
| 10 | NC | (no connection) |
| 11 | PKD | Audio signal input from a terminal. Operates with 20mV (1 kHz) signal. |
| 12 | GND | Ground (connect to audio input shield GND). |
| 13 | SS | Normal standby. If grounded, transmission begins. |

The optional ACC2 plug (part no. E07-1351-05) can be obtained through authorized Kenwood Amateur Radio dealers.

## 2. Remote Function Keypad

The keypad is connected to the terminal on the rear panel and allows remote operation of some of the keys on the front panel. Functions that are accessible in this way are: REC-1, REC-2, REC-3, PLAY-1, PLAY-2, PLAY-3, CLR, TF-SET, QUICK MEMO (M. IN, MR), VOICE (requires optional VS-2 voice synthesizer unit).




① CLR/TF-SET switch
The position of this switch determines which key designations are in effect: those on the key tops, or those at the bottom of each key.

② REC/PLAY switch
When the switch is in the REC position, the key bottom designations (REC-1, REC-2, REC-3) are in effect; when in the PLAY position, the key top designations (PLAY-1, PLAY-2, PLAY-3) are in effect.

③ PLAY-1/REC-1, PLAY-2/ REC-2, PLAY-3/ REC-3 keys
These keys are used for recording either CW keying or audio from the microphone, or alternatively for playing back recorded material. Whether these keys control recording or playback is determined by the REC/PLAY switch. In the former case, recording is active as long as a key is pressed; the channel is determined by key selection.

④ CLR/TF-SET key
The position of this slide switch determines whether it functions as a CLR (key top) or TF-SET (key bottom) key.

⑤ VOICE
This functions in the same way as the TS-950SDX's VOICE switch. If the optional VS-2 voice synthesizer unit is connected, voice frequency identification is enabled. This can also be used for playing back recordings of received audio.

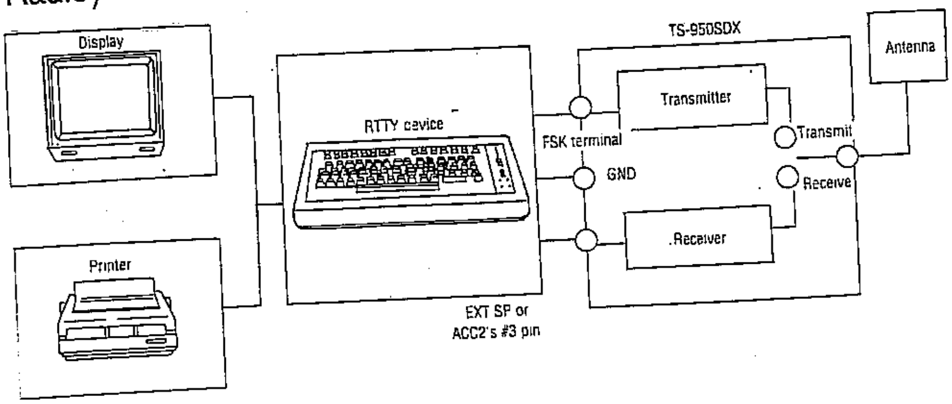
⑥ TF-SET key
This functions in the same way as the TS-950SDX's TF-SET key. It operates as TF-SET when the CLR/TF-SET switch is on CLR; and operates as CLR when the switch is set to TF-SET.

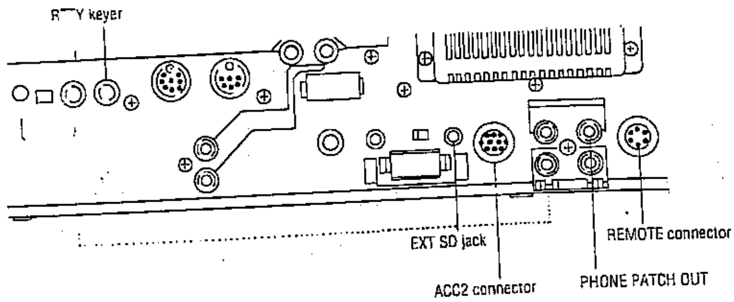
⑦ QUICK MEMO keys
These function in the same way as the TS-950SDX's QUICK MEMO keys:

● M.IN key
Stores current operating status in one of 5 channels.

● MR key
Recalls data stored in Quick Memory. Channels can be selected using the M.CH/VFO CH control.

# 3. RTTY (Radio Teletype) & AMTOR (Amateur Microprocessor Teleprinter Over Radio)

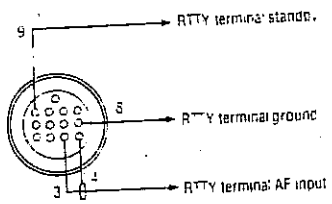


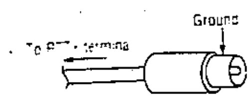

## RECEIVE

First, the RTTY device is connected to the ACC2 connector on the rear panel.

**Connection to ACC2 connector on rear panel**




**Connection to RTTY terminal on rear panel**




1 Turn the transceiver's power switch on. Frequency etc. will be displayed on the front panel.

2 Adjust volume with the AF volume control.

> **Note:** When using the ACC2 connector, volume is fixed irrespective of the position of the AF control.

3 Select the desired band using the band keys.

4 Press the FSK key to match mode.
Data mode is active when the DATA indicator lights. Note that when the FSK key is pressed, the letter "R" (first letter of "RTTY") is heard over the speaker in Morse code; this is the Morse announcement function.

5 Turn the tuning control to select the frequency. In FSK mode, the tuning knob can be turned slowly in steps of 10Hz (one revolution is approximately 10kHz). Ultra-fine tuning is possible if the FINE switch is turned on: each step is then 1Hz and one revolution is approximately 1kHz.
The M.CH/ VFO CH control can be used to change the frequency in steps of 1kHz to 10kHz (in 1kHz units). Other controls that can be used to select a frequency are the 1MHz UP/DOWN switch, the ENT key and the 0 through 9keys (for direct input).

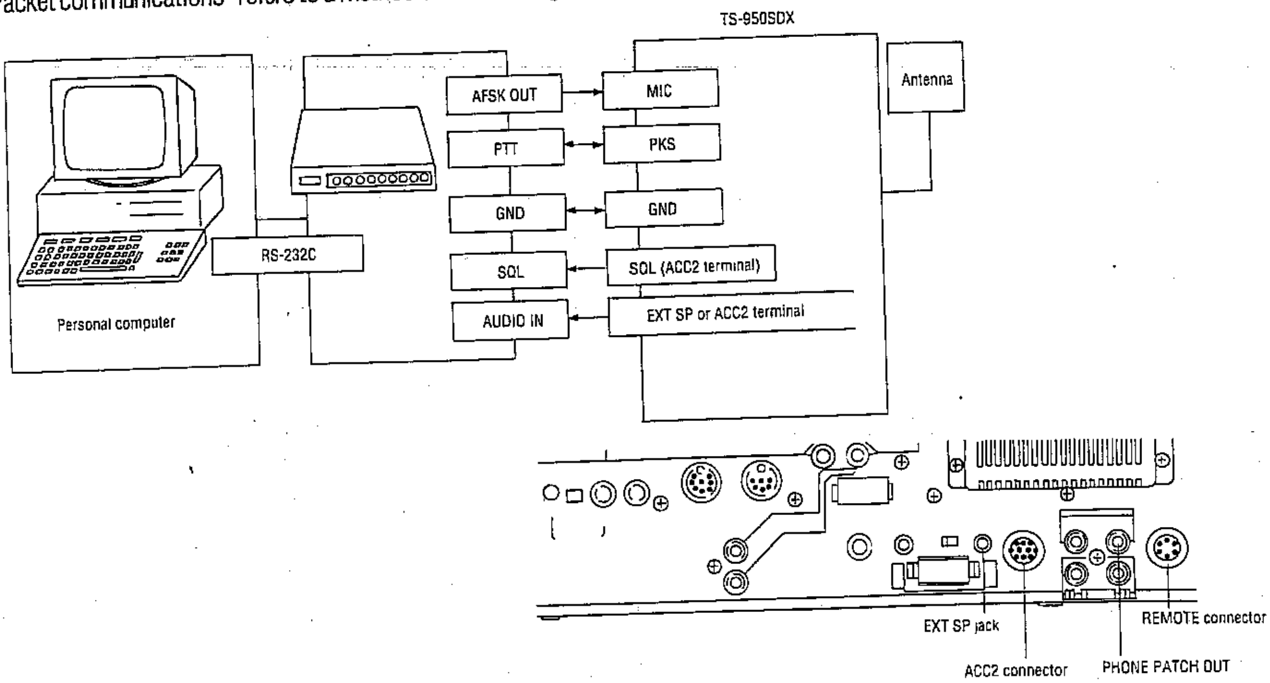
## CHANGING RECEIVE TONE

The FSK receive tone is set at 2125Hz (HIGH). However, it can be changed to 1275Hz (LOW).

> Use the MENU key to change the FSK receive tone:
> 1. Turn the power on while pressing the MENU key.
> 2. Select menu #56 using the M.CH/ VFO CH control. The FSK receive tone can be checked in the sub-receiver frequency display.
> 3. Use the UP/ DOWN switch to select either 2125 (HIGH) or 1275 (LOW).
> 4. Press the MENU key again to complete the selection.

# 4. Packet Communications (AFSK)

"Packet communications" refers to a method of transferring data using the keyboard of a computer instead of a microphone or keyer.




● Equipment

Besides the transceiver, a TNC (terminal node controller) and a personal computer (with communications software) are required.

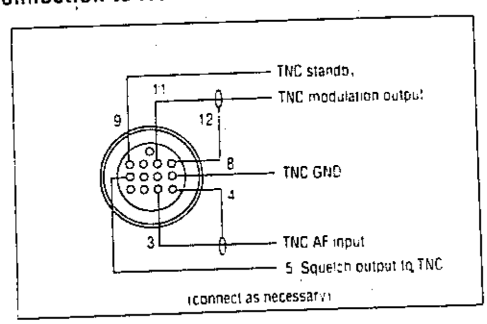
● Modulation frequency

Since a variety of frequencies are used by different TNCs, attention must be paid to the AFSK frequency of the particular TNC in use; otherwise, the correct operating frequency may prove elusive. Follow the terminal's instruction manual to ensure that the correct settings are made before commencing transmission.

● ACC2 connector

The packet communications equipment should first be connected to the ACC2 connector on the rear panel.

**Connection to ACC2 connector on rear panel**




# 5. Computer Control

By connecting the optional IF-232C interface to the ACC1 connector, a personal computer can be used to control the TS-950SDX as outlined below. For further details, refer to the optional Command Reference booklet, available through authorized Kenwood dealers.

● **Table of ACC1 pin assignments**

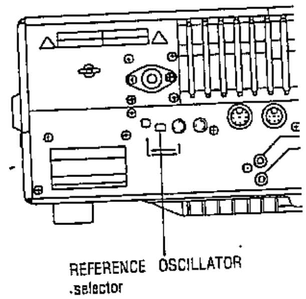
| Number | Name | Use |
|---|---|---|
| 1 | GND | Ground (connect to signal line GND). |
| 2 | TXD | Serial data output from the transceiver to the computer. Negative logic. |
| 3 | RXD | Serial data input from the computer to the transceiver. Negative logic. |
| 4 | CTS | Flow control signal from the computer to the transceiver stopping transmission when the computer is not ready to receive TX data. Positive logic. |
| 5 | RTS | Flow control signal from the transceiver to the computer stopping transmission when the transceiver is not ready to receive RX data. Positive logic. |
| 6 | NC | (no connection) |

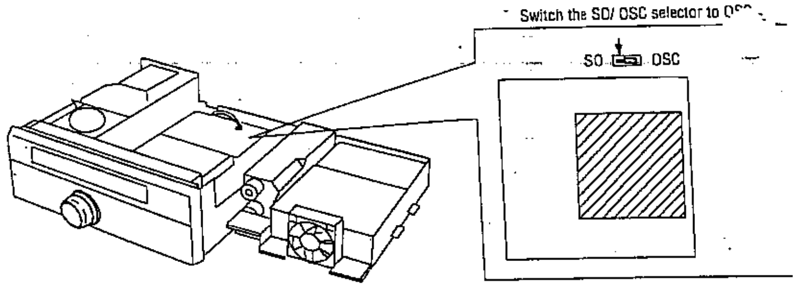
| Functions & features accessible via computer control |
|---|
| TX/RX selection |
| Model number check |
| Mode selection |
| Memory input |
| Memory channel readout |
| Memory channel selection |
| Meter signal output |
| Meter selection, meter value readout |
| Switching microphone's UP/DOWN on or off |
| Filter selection |
| Transceiver status readout |
| Sub-tone frequency selection |
| Switching XIT on or off |
| Switching VOICE on |
| VFO A, VFO B, memory TX/ RX selection |
| VFO A, VFO B or sub-receiver frequency selection and readout |
| Slope tuning bandwidth selection and readout |
| Switching SCAN on or off |
| Switching RIT on or off |
| RIT / XIT frequency UP and DOWN |
| RIT / XIT clear |
| Pitch selection |
| Switching IF command on or off |
| Switching F.LOCK on and off or readout |
| Switching AIP on and off |
| VBT bandwidth selection and readout |
| Switching data mode on or off |
| Switching SUB on or off and TF-W on or off |
| DRS CW message playback |

# 6. Connection to an External Reference Oscillator

Frequency accuracy and stability can be enhanced with a high-precision reference signal (1Vp-p, 10kHz).

Notes:
1. When using the EXT INPUT terminal, switch the REFERENCE OSCILLATOR selector to EXT.
2. Do not use the F. ADJ trimmer.
3. Switch the SO-2 temperature-compensated crystal oscillator's SO/OSC selector to OSC.

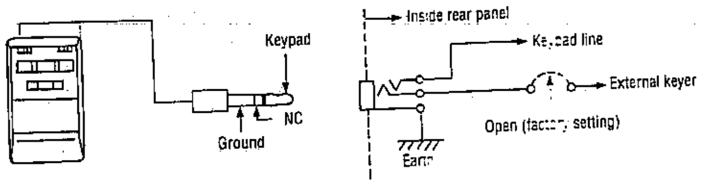


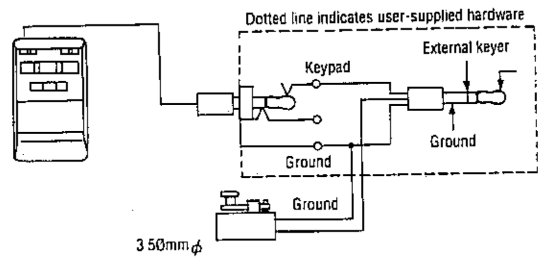

Switch the SO/ OSC selector to OSC

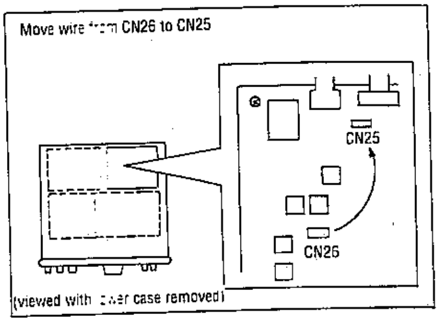
# 7. Simultaneous Use of Internal & External Keyers

A stereo jack is used to connect the remote function keypad and external keyer to the rear panel connector, as illustrated.




Using a 3.5mm stereo plug and jack, it is possible to hook up both the internal electronic keyer and an external keyer for simultaneous use, as illustrated.



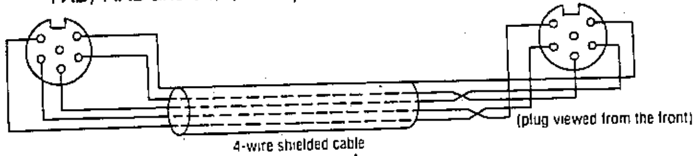




**Caution:**
When the 3.5mm stereo plug connecting both internal and external keyers is inserted into the remote function keypad jack, the transceiver will enter TX mode for an instant. Because of this, either switch off break-in, or select a mode other than CW when inserting the plug.

# 8. Split-Frequency Transfer Function

If the TS-950SDX is connected to another transceiver compatible with Kenwood's transfer function—such as a second TS-950SDX or a TS-850S, TS-690S, or TS-450S— it is possible to transfer frequency and mode data from one (the master) to the other (the slave). This is useful if the operator wishes to receive simultaneously with two rigs; it also ensures accurate operation for two-man contest teams.

The connection is made between the transceivers' ACC1 connectors using a cable with 6-pin DIN plugs. As illustrated, the TXD/ RXD and CTS/ RTS pairs are both crossed inside the cable.

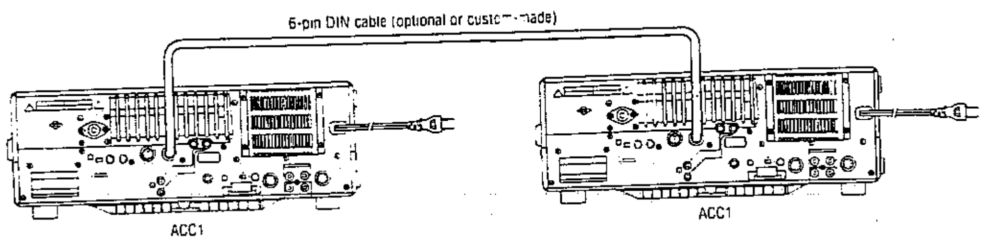



Cable .................. 6-pin DIN cable
Connectors .......... ACC1 on both master and slave
An optional 1m transfer cable with 6-pin DIN plugs can be obtained through Authorized Kenwood Amateur Radio dealers. 6-pin DIN plugs are also available separately as a spare part.
6-pin DIN cable ... Part no. E30-3047-05
6-pin DIN plug...... Part no. E07-0654-05

**Pin assignments**

| | Terminal 1 | Use | Terminal 2 |
|---|---|---|---|
| 1 | GND | Signal ground | GND |
| 2 | TXD | TX data | RXD |
| 3 | RXD | RX data | TXD |
| 4 | CTS | TX enable | RTS |
| 5 | RTS | TX request | CTS |
| 6 | NC | (no connection) | NC |

**Example: TS-950SDX to TS-950SDX transfer**



# 9. Options

## TL-922/TL-922A HF Linear Amplifier*

The TL-922/TL-922A covers all Amateur bands, 160m through 10m* (except for the three WARC bands), in SSB, CW and RTTY modes. This class $AB_2$ grounded-grid linear amplifier employs twin EIMAC 3-500Z power tubes to assure reliable and economical performance. Note that it operates with semi break-in but not full break-in.

*Model TL-922A, available only in the USA, does not cover the 10m band.

**FEATURES**

- Twin EIMAC 3-500Z high-performance transmitting tubes
- Class $AB_2$ grounded-grid circuit
- Excellent IMD (intermodulation products distortion) characteristics
- Blower turn-off delay circuit
- Adjustable threshold level ALC circuit
- Two large, easy-to-read meters

**SPECIFICATIONS**

**Frequency range:** 1.8–2.0MHz, 3.5–4.0MHz, 7.0–7.3MHz, 14.0–14.35MHz, 21.0–21.45MHz, 28.0–29.7MHz (not TL-922A)
**Modes:** SSB, CW, RTTY
**Drive power:** 80W or more for full output
**RF input power:** SSB= 2,000W PEP, CW, RTTY= 1,000W DC
**Circuitry:** Class $AB_2$ grounded-grid linear amplifier
**Input impedance:** 50Ω
**Output impedance:** 50– 75Ω
**Cooling:** Forced air
**Fan motor delay stop time:** 140 ±30 seconds
**ALC:** Negative going adjustable threshold -8V DC max. output (typical)
**Tubes:** 2 x 3-500Z (optional)
**Power requirements:** 120/220V, 28A, 50/60Hz; also, 220/240V, 14A, 50/60Hz
**Dimensions (W x H x D):** 390 x 190 x 407mm (15-3/8 x 7-1/2 x 16in)
**Weight:** 31kg (68lb. 6oz)

## SP-950 External Speaker

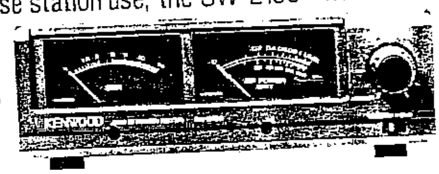
Like the SM-230 station monitor, the SP-950 is designed to match the TS-950SDX in size, color and appearance. This high-quality speaker features a panel made of reinforced ABS plastic and an expanded metal speaker grill to improve tone quality.

**SPECIFICATIONS**

**Speaker diameter:** 100mm (4 in)
**Input power (max.):** 1.5W (3.0W)
**Impedance:** 8Ω **Frequency response:** 160Hz–7kHz
**Filter cut-off frequency:** LOW 400Hz (-3dB); HIGH1 3kHz (- 3dB); HIGH2 1.2kHz (-3dB); HIGH1 + HIGH2 900Hz (-3dB)
**Filter attenuation:** -6dB/ OCT
**Dimensions (W x H x D):** 180 x 141 x 300mm (7-1/16 x 5-9/16 x 11-3/16in) [Projections not included]
**Weight:** 2kg (4lb. 7oz) approx.

## SW-2100 SWR/ POWER Meter

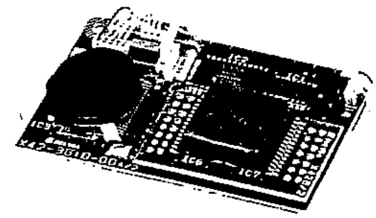
Convenient for base station use, the SW-2100—with built-in coupler—has selectable RMS and SWR/POWER meters.



**SPECIFICATIONS**

**Dimensions (W x H x D):** 208 x 66 x 85mm (8-3/16 x 2-5/8 x 3-3/8in)
**Weight:** 850g (1lb. 14oz)
**Connector:** M type (SO-239)
**Impedance:** 50– 52Ω
**Frequency range:** 1.8–30MHz
**Maximum through power:** 2000W/PEP
**Insertion loss:** Less than 0.3dB
**Residual SWR:** Within 1.2
**Power measurement range:** 0– 200W, 0– 2000 W
**Power measurement accuracy:** 1.8–30 MHz, 10% (full scale)
**Minimum power for SWR measurement:** 30W approx.

## DRU-2 Digital Recording Unit



The DRU-2 allows transmission voice recording using 3 audio memories—2 of 8 seconds, one of 16 seconds—for SSB, FM and AM calling. You can operate it from the remote function keypad (RM-1). It can also be programmed, using the menu system, for continuous recording of the received signal; thus allowing the operator to replay the last 8-or 16-second segment should confirmation be needed.

## MC-60A Deluxe Desktop Microphone (50kΩ/500Ω)

Featuring a built-in pre-amplifier, this high-quality communications microphone has a zinc die-cast base to provide extra stability. The MC-60A is also equipped with PTT and LOCK switches, UP/DOWN switches, an impedance selector switch, and an 8-pin connector.

## MC-80 Desktop Microphone (700Ω)

The MC-80 is an omnidirectional electret condenser microphone using an 8-pin connector. Featured are an UP/DOWN frequency switch, volume adjustment for output level, PTT and LOCK switches, and a built-in pre-amplifier.

## MC-85 Multi-Function Desktop Microphone (700Ω)

Built-in audio level compensation distinguishes the MC-85, a undirectional electret condenser microphone with three output selections, audio level compensation circuit, low-cut filter, level meter, 8-pin connector, PTT and LOCK switches.

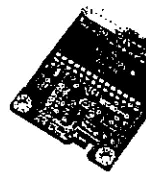
## MC-43S Hand Microphone (500Ω)

The MC-43S is a dynamic hand microphone with both PTT and UP/DOWN switches. (8-pin)

**PC-1A Phone Patch Controller**
(Available only where phone patch operation is legal)
FCC Part 68 registered

**IF-232C Interface Unit**

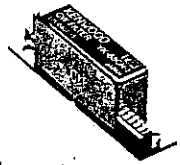

**VS-2 Voice Synthesizer Unit**



**HS-5 Deluxe Headphones (8Ω)**
(Monaural)

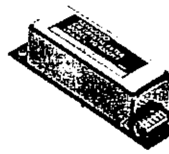
**HS-6 Small Headphones (12.5Ω)**
(Monaural)

**YK-88CN-1 270Hz CW Filter for 8.83MHz IF**

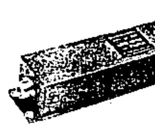


**YK-88SN-1 1.8kHz SSB Narrow Filter for 8.83MHz IF**

**YG-455CN-1 250Hz CW Narrow Filter for 455kHz IF**



**LF-30A Low-Pass Filter**



## 10. Specifications

| | | | | TS-950SDX |
|---|---|---|---|---|
| General | Mode | | | J3E (SSB), A1A (CW), A3E (AM), F3E (FM), F1D (FSK) |
| General | Memory channels | | | 100 |
| General | Antenna impedance | | | 50Ω, With Antenna Tuner 20 – 150Ω (1.9 – 28MHz band) |
| General | Power requirement | USA, CANADA type | | 120V AC ± 10% |
| General | Power requirement | GENERAL type | | 120/220V AC ± 10% |
| General | Power requirement | EUROPE type | | 230V AC ± 10% |
| General | Power requirement | UK, AUSTRALIA type | | 120/240V AC ± 10% |
| General | Power consumption | Receive (no signal) | | 110W |
| General | Power consumption | Transmit (Max.) | | 850W |
| General | Temperature range | | | –10 to +50°C (+14 to +122°F) |
| General | Frequency stability | | | ±0.5 × 10⁻⁶ (–10°C ~ +50°C) |
| General | Dimensions (W × H × D) (Projections not included) | | | 402 × 141 × 400mm (15.83 × 5.55 × 15.75 inches) |
| General | Weight | | | 23kg (50.71 lbs) |
| Transmitter | Frequency range | 160m band | | 1.8/1.81*/1.83** to 1.85**/2.0MHz |
| Transmitter | Frequency range | 80m band | | 3.5 to 3.8*/4.0MHz |
| Transmitter | Frequency range | 40m band | | 7.0 to 7.1*/7.3MHz |
| Transmitter | Frequency range | 30m band | | 10.1 to 10.15MHz |
| Transmitter | Frequency range | 20m band | | 14.0 to 14.35MHz |
| Transmitter | Frequency range | 17m band | | 18.068 to 18.168MHz |
| Transmitter | Frequency range | 15m band | | 21.0 to 21.45MHz |
| Transmitter | Frequency range | 12m band | | 24.89 to 24.99MHz |
| Transmitter | Frequency range | 10m band | | 28.0 to 29.7MHz |
| Transmitter | Output power (with auto antenna tuner in "THRU") | SSB, CW, FSK, FM | | 150W PEP |
| Transmitter | Output power (with auto antenna tuner in "THRU") | AM | | 40W |
| Transmitter | Modulation | SSB | | Balanced modulation |
| Transmitter | Modulation | FM | | Reactance modulation |
| Transmitter | Modulation | AM | | Low level modulation |
| Transmitter | Spurious radiation | | | Less than –40dB |
| Transmitter | Carrier suppression | | | More than 50dB |
| Transmitter | Unwanted sideband suppression (Modulation frequency: 1kHz) | | | More than 50dB |
| Transmitter | Maximum frequency deviation (FM) | | | Wide: Less than ±5kHz, Narrow: Less than ±2.5kHz |
| Transmitter | Frequency response (SSB) | | | 100 to 3100Hz (variable) |
| Transmitter | XIT variable range | | | ±9.99kHz |
| Transmitter | Microphone impedance | | | 250Ω to 600Ω |
| Receiver | Circuitry | Main | SSB, CW, FSK, AM | Quadruple conversion system |
| Receiver | Circuitry | Main | FM | Triple conversion system |
| Receiver | Circuitry | Sub | SSB, CW, FSK | Double conversion system |
| Receiver | Frequency range | | | 100kHz to 30MHz |
| Receiver | Intermediate frequency | Main | | 1st: 73.05MHz, 2nd: 8.83MHz, 3rd: 455kHz, 4th: 100kHz |
| Receiver | Intermediate frequency | Sub | | 1st: 40.055MHz, 2nd: 10.695MHz |
| Receiver | Sensitivity | (Main/Sub) SSB, CW, FSK, (at 10dB S+N/N) | 100kHz – 150kHz | Less than 2.5µV |
| Receiver | Sensitivity | (Main/Sub) SSB, CW, FSK, (at 10dB S+N/N) | 150kHz – 490kHz | Less than 1µV |
| Receiver | Sensitivity | (Main/Sub) SSB, CW, FSK, (at 10dB S+N/N) | 490kHz – 1.62/1.705***MHz | Less than 4µV |
| Receiver | Sensitivity | (Main/Sub) SSB, CW, FSK, (at 10dB S+N/N) | 1.62/1.705*** ~ 30MHz | Less than 0.2µV |
| Receiver | Sensitivity | (Main) AM (at 10dB S+N/N) | 100kHz ~ 150kHz | Less than 25µV |
| Receiver | Sensitivity | (Main) AM (at 10dB S+N/N) | 150kHz – 490kHz | Less than 10µV |
| Receiver | Sensitivity | (Main) AM (at 10dB S+N/N) | 490kHz – 1.62/1.705***MHz | Less than 32µV |
| Receiver | Sensitivity | (Main) AM (at 10dB S+N/N) | 1.62/1.705*** ~ 30MHz | Less than 2.0µV |
| Receiver | Sensitivity | (Main) FM (at 12dB SINAD) | 28MHz – 30MHz | Less than 0.5µV |
| Receiver | Selectivity | Main | SSB, CW-W, FSK | More than 2.4kHz (–6dB), Less than 3.4kHz (–60dB) |
| Receiver | Selectivity | Main | CW-N | More than 500Hz (–6dB), Less than 900Hz (–60dB) |
| Receiver | Selectivity | Main | AM | More than 6kHz (–6dB), Less than 15kHz (–50dB) |
| Receiver | Selectivity | Main | FM | More than 12kHz (–6dB), Less than 24kHz (–50dB) |
| Receiver | Selectivity | Sub | SSB, CW-W, FSK | More than 2.2kHz (–6dB), Less than 4.8kHz (–50dB) |
| Receiver | Selectivity | Sub | CW-N | More than 500Hz (–6dB), Less than 2kHz (–50dB) |
| Receiver | Image ratio | | | More than 80dB (1.8 – 30MHz) |
| Receiver | IF rejection | | | More than 70dB (1.8 – 30MHz) |
| Receiver | Notch filter attenuation | | | More than 45dB |
| Receiver | RIT variable range | | | ±9.99kHz |
| Receiver | Squelch sensitivity (Main/Sub) | SSB, CW, FSK, AM | 100kHz – 150kHz | Less than 6.3µV |
| Receiver | Squelch sensitivity (Main/Sub) | SSB, CW, FSK, AM | 150kHz – 490kHz | Less than 2.5µV |
| Receiver | Squelch sensitivity (Main/Sub) | SSB, CW, FSK, AM | 490kHz – 1.62/1.705***MHz | Less than 10µV |
| Receiver | Squelch sensitivity (Main/Sub) | SSB, CW, FSK, AM | 1.62/1.705*** ~ 30MHz | Less than 0.5µV |
| Receiver | Squelch sensitivity (Main/Sub) | FM | 28MHz – 30MHz | Less than 0.32µV |
| Receiver | Audio output power | | | 1.5W (8Ω at 10% distortion) |
| Receiver | Audio output impedance | | | 8Ω |

| | | SM-230 |
|---|---|---|
| General | Power requirement | 120/220/240V AC ± 10%, 50/60Hz (120V for USA and Canada) |
| General | Power consumption | 29W |
| General | Dimensions (W × H × D) | 260 × 141 × 400mm (10-1/4 × 5-9/16 × 15-3/4in) |
| General | Weight | 7.5kg (16lb 9oz) |
| Monitor | Frequency range | 1.8 – 150MHz |
| Monitor | Sensitivity | Better than 37dBm/div (1.8 – 30MHz), 41dBm/div (30 – 150MHz) |
| Monitor | Maximum power | 2kW PEP (1.8 – 30MHz), 100W PEP (30 – 150MHz) |
| Band scope | Input center frequency | 8.83MHz |
| Band scope | Input sensitivity | Better than 10µVrms/div |
| Band scope | Scan width | ±25kHz, ±100kHz, ±250kHz, swichable ±10% |
| Two-tone generator | Osillator frequency | 1000Hz and 1575Hz (±10%) |
| Two-tone generator | Output voltage | 5mVrms ±20% |
| Two-tone generator | Output impedance | 600Ω |
| Vertical amplifier | Deflection sensitivity | 10mV – 10V/div (3 ranges, with fine adjustment) |
| Vertical amplifier | Input impedance | 1MΩ50pF or less |
| Vertical amplifier | Frequency response | DC – 10MHz |
| Vertical amplifier | Max. input voltage | 500Vp-p or 250V (DC+AC peak) |
| Sweep circuit | Sweep frequency | 10Hz – 100kHz (4 ranges, with fine adjustment) |
| Sweep circuit | Sync. system | Syncronized sweep |

*Europe Type **Belgium Type ***USA Type

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