CQ REVIEWS:

The Heath SS-9000
H.F. Synthesized Transceiver

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The Heath SS-9000 h.f. all-band transceiver has been a fairly long time in coming on the market. However, it is now available as Heath's top-of-the-line transceiver. It is only available as a completely assembled unit, and the only accessories available for it are a matching power supply and a service manual. No other accessories are available simply because a full range of filters is standard with the SS-9000.

By now everyone who has followed the Heath line of amateur radio products knows that there is something very new and different about the SS-9000. It is not simply a transceiver one can manually tune and operate, but rather it can be *completely* remote controlled via a terminal.

However, as tempting as it is to race on to describe the computer controlled possibilities of the SS-9000, we'll first describe it as a manually operated transceiver. This should give the reader a feel for the capabilities of the unit as a radio, and then we'll go on to the terminal control possibilities for the unit. After that, if one basically can understand what the radio can do and how it can be controlled, one will easily be able to appreciate some of the new possibilities it opens up for all sorts of innovative ideas regarding h.f. transceiver usage.

The SS-9000 on the operating table with the PS-9000 power supply below it.

Specifications

Table I lists the general specifications for the SS-9000. Basically, the transceiver is an amateur-band-only unit designed for s.s.b., c.w., and RTTY service. All control frequencies within the unit are frequency synthesized. Two six-digit frequency displays are provided for what are essentially the v.f.o. A/B frequencies. There is also one frequency memory per band. Tuning of the transceiver is done by a main tuning control which has a fixed tuning rate of 5 kHz/revolution. Table II shows the transmitter specifications. The transceiver is rated to deliver 100 watts PEP and 100 watts carrier on c.w./RTTY into a 50 ohm load. The automatic cutback in power output when the load v.s.w.r. reaches 2:1 is only to 80 watts. As shown in the table, a combination time/temperature factor also determines the power output. The rest of the specifications regarding carrier suppression, unwanted sideband suppression, harmonic radiation, etc., are all quite good, being in the 50 + dB range. Table III shows the receiver specifications. The sensitivity is very respectable for a modern-day transceiver. The s.s.b. shape factor is 2.38 (6/60 dB), which, on the other hand, is not exceptional for a modern-day transceiver. Image rejection and i.f. rejection are specified at a very good −70 to −90 dB. RIT is provided with a specified range of ±250 Hz.

Circuitry

Fig. 1 shows a block diagram of the SS-9000's circuitry. If one concentrates on the Preamp, PA, Transmit/Receive, and Audio circuit boards, it is fairly easy to follow the receive/transmit signal flow paths.

Received signals first pass through separate low-pass and high-pass filter assemblies on the PA circuit board. They are then applied to a receive preamplifier which is followed by a PIN diode attenuator (which acts as the r.f. gain control) and an assembly of nine electronically switched bandpass filters. The signal goes on to the first mixer stage where it is mixed with the h.f.o. signal and translated to a 9 MHz i.f. This is followed by an amplifier and bandpass filter stage, and then the signal goes on to a second mixer. In the second mixer the signal is mixed with an approximately 12.4 MHz i.f.o. frequency and translated to its final i.f. of 3.395 MHz. This signal then passes through the main s.s.b. filter, further amplification, either of the two c.w. filters when desired, more amplification, and then on to a product detector. Final audio amplification of the audio output of the product detector is preceded by a low-pass filter stage.

For transmit, microphone input signals are amplified and applied to a balanced modulator stage which produces a d.s.b. signal at the 3.395 MHz i.f. This signal passes through a first s.s.b. filter and then, if it is activated, through the r.f. speech processor circuit. After that circuitry, it passes through a second s.s.b. filter and then is translated to the 9 MHz i.f. The signal is then further translated to its final output frequency and amplified through an amplifier chain to its final output level.

A basic frequency standard and three synthesizer loops for the voltage-controlled oscillator sections are on the Transmit/Receive board (h.f.o., i.f.o., and b.f.o. signals) form the synthesizer.

A simply labeled block "controller" is, however, the "intelligent" heart of the SS-9000. As can be seen from fig. 1, this element performs an interface function between external commands (via front-panel controls or from a terminal interface) and the internal circuits on all

*c/o CQ Magazine

GENERAL	
Frequency Readout	Two 6-digit electronic displays
Readout Accuracy	To the nearest 100 Hz
Frequency Control	Synthesized VFO, HFO, and BFO for stability and easy tuning.
Tuning	100 Hz per step, 5 kHz per knob rotation. Push-buttons provided for up/down tuning (rate is internally adjustable).
Operation	Split transmit/receive or transceive from either readout.
Synthesized Lock Indicator	Visual indication when the synthesizer is un-locked. Transmitter is disabled when the synthesizer is un-locked.
Frequency Coverage (megahertz)	1.8 to 2.0*. 3.5 to 4.0*. 7.0 to 7.3*. 10.1 to 10.15. 14.0 to 14.350*. 18.068 to 18.168*. 21.0 to 21.450*. 24.890 to 24.990. 28.0 to 29.7. WWV @ 15.0
*Extended receiver coverage (above and below these bands).	
Frequency Stability	Less than 3 ppm drift from turn-on for first 15 minutes. Less than 3 ppm/hour drift after 15 minutes warm-up. Less than 20 ppm drift from 0° C to +40° C. (Single crystal-controlled 10 MHz frequency standard.)
Modes of Operation	LSB. USB. CW-Wide. CW-Medium (400 Hz filter). CW-Narrow (200 Hz filter). RTTY (LSB, 400 Hz filter).
Operating Temperature Range	0° C to +40° C.
Speech Processing	Adjustable RF speech compressor.
IF Shift	Incremental plus and minus passband shift (−600, −400, −200, −100, 0, +100, +200, and +400 Hz) in the SSB modes.
Power Requirements*	11 to 16 VDC with a nominal current maximum of 25 amperes at 100 watts CW output. Receiver current is 2 amperes nominal.
Front Panel Connectors	Microphone, headphones.
Rear Panel Connectors & Control	Antenna (SO-239). Linear ALC In. Linear ALC Adjust. Low Power Enable. Spares (5). DC Power Input. CW Key Jack. External Transmit Audio In (2). Speaker Out. External Receiver Audio. T/R In. T/R Out. Mute. Mute (inverted). External Relay (linear). RS-232 Computer interface.
*All specifications are referenced to 13.8 VDC at 25°C ambient.	

Table I– General specifications of the SS-9000.

of the previously mentioned circuit boards. The controller consists of a CPU, a peripheral interface adapter, a static memory interface, a read-only memory, 256 bytes of CMOS RAM, and various latches and gates.

The block marked "Terminal Interface" contains an asynchronous communications element (**ACE**). This device performs the functions of the conventional **UART** and has an internal software programmable baud rate generator, modem control, and self-test functions.

Physical Construction

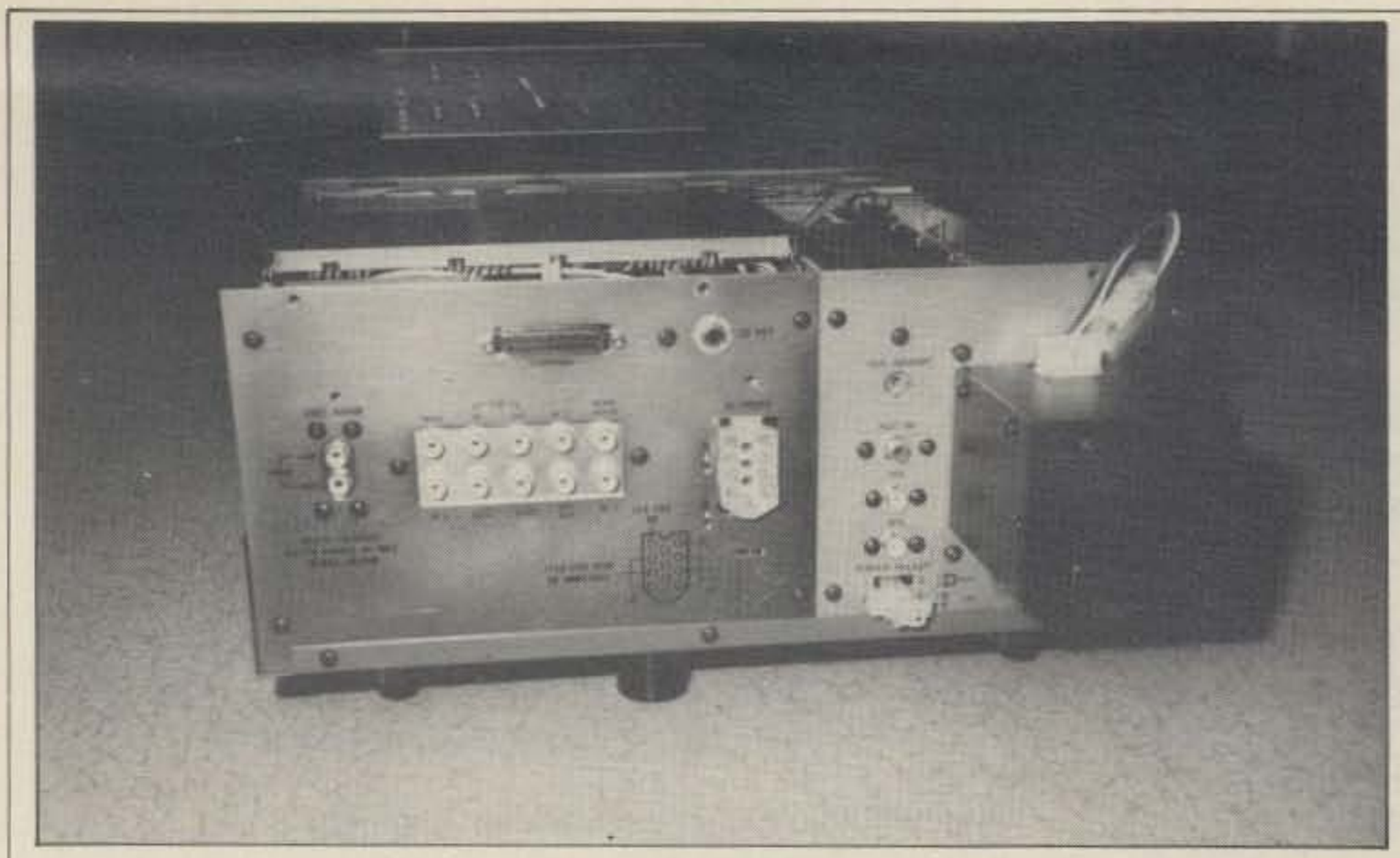
The specification tables give the size and weight data for the SS-9000. The front panel is

TRANSMITTER	
RF Power Output	SSB: 100 watts PEP. CW & RTTY: 100 watts.
Duty Cycle	100% with appropriate automatic power output reduction by an internal thermal sensor. This reduction is determined by the time factor and the ambient temperature. The nominal parameters are as follows: Ambient Temperature: +25° C. Supply Voltage: +13.8 VDC. Frequency: 14.1 MHz. Mode: CW key down, 100% duty cycle. Example: Power Output / Time 100 watts / 0 min. 80 watts / 3 min. 60 watts / 10 min. 40 watts / Infinite
Load Impedance	50 ohms.
VSWR	This Transceiver is stable at any VSWR and load impedance. The VSWR cutback circuitry guarantees at least 80% of rated power at any VSWR less than 2:1 and a minimum of 15 watts at any VSWR.
Transmitter Protection	Thermally protected. High VSWR cut-back. Overcurrent protection.
Carrier Suppression	50 dB down from a 100 watt, single-tone (1000 Hz) output.
Unwanted Sideband Suppression	55 dB down from a 100 watt, single-tone (1000 Hz) output.
Harmonic Radiation	50 dB down below 50 MHz; 65 dB down above 50 MHz.
Spurious Radiation	50 dB down, except at 17 meters (40 dB down).
Third Order Distortion	30 dB down from a 100-watt, PEP, two-tone output.
T/R Operation	SSB: PTT or VOX. CW: Semi break-in.
CW Sidetone	To speaker or headphones (800 Hz tone, adjustable level).
Microphone Input	High impedance (25 k ohm) with a rating of −55 dBm.
Front Panel Meter	Receive: S units. Transmit (selectable: ALC, relative RF power, or speech compression).
Phone Patch Impedance	4 ohm output to speaker, high impedance input to transmitter.
Available Accessories	AC power supply/speaker with built-in dual time 12/24-hour clock. Customer Service Manual.
Cabinet Dimensions	6-1/8" high × 14" wide × 13-3/4" deep (15.6 × 35.6 × 34.9 cm).
Weight	35 lbs (15.9 kg).

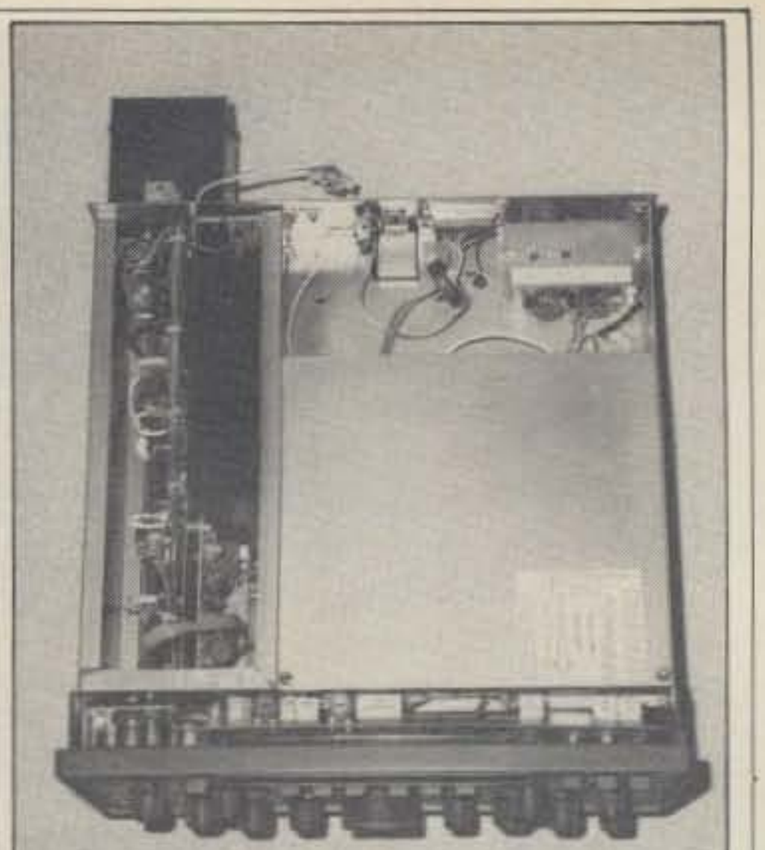
Table II– Transmitter specifications of the SS-9000.

of die-cast zinc construction with a brushed metal rim around the entire front panel and again around the frequency display area. The panel has a two-tone light/dark gray finish, and the control markings, which are all cast and raised from the panel, are painted white. Various LED's indicate the setting of functions such as RIT on/off, Noise Blanker on/off, etc. The two frequency readouts use green LED displays. The transceiver is enclosed by a two-part rolled steel enclosure such that one can access either the top or bottom half of the interior. Overall, the external appearance of the SS-9000 is very impressive. The knobs all have a very smooth operating feel, and they are well spaced and logical in their arrangement.

The photographs illustrate what one sees if one starts to take the top and bottom covers off of the SS-9000. Although the preceding circuitry description may have sounded a bit simple, the SS-9000 is a very complicated "machine" inside. However, it is extremely well constructed. All of the components are very neatly mounted, the PC boards are absolutely "clean," and there is a generous amount of individual copper shields around sensitive circuit areas. The front panel hinges forward for service accessibility, and all of the main circuit boards fan out for easy access without having to use extenders. For service access, should it ever be required, the construction of the SS-9000 has to be rated as outstanding.



Rear panel of the SS-9000. The box on the right contains the bandswitch motor. External connections are provided for just about any purpose: linear amplifier, ALC, audio connections, PTT, etc.

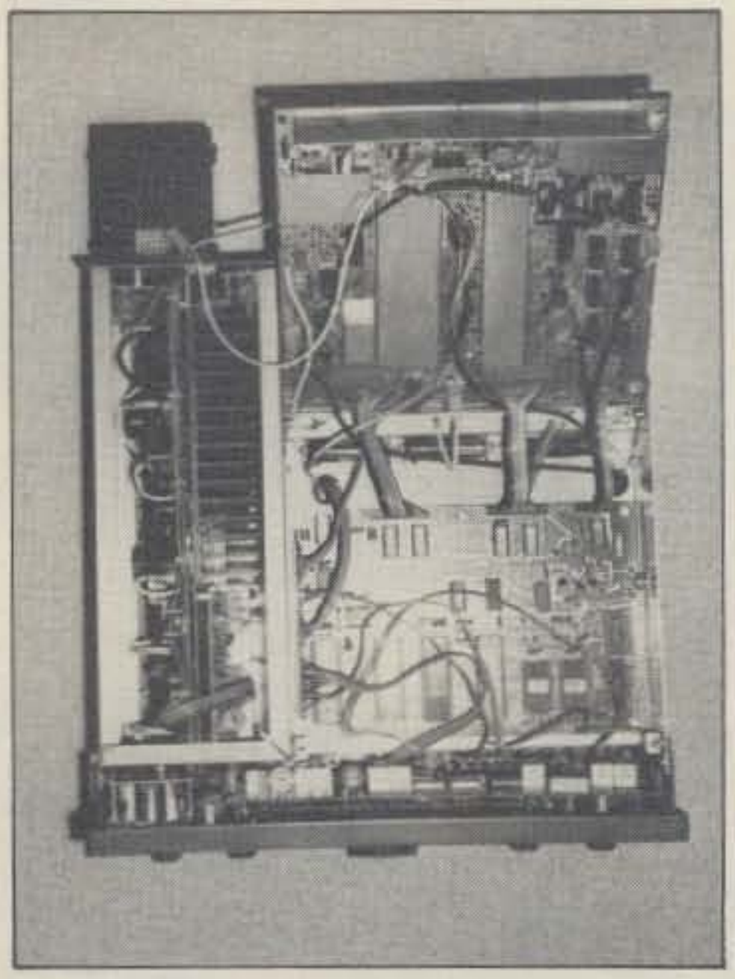


Just taking the top cover off the unit, one notes the very clean, well-shielded construction.

RECEIVER

Sensitivity	0.3 μV for 10 dB (S+N)/N SSB on the 40 thru 10 meter bands; 0.5 μV on the 160 and 80 meter bands.
Selectivity	2.1 kHz at 6 dB down; 5 kHz at 60 dB down.
	CW filters:
	CWM: 400 Hz at 6 dB down; 1.5 kHz at 60 dB down.
	CWN: 200 Hz at 6 dB down; 1 kHz at 60 dB down.
Overall Gain	Less than 1 microvolt for a .25 watt audio output.
Audio Output	1.5 watts into 4 ohms at less than 10% THD.
AGC	Fast-attack with switch selectable Off, Fast, and Slow decay.
Intermodulation Distortion 20 kHz spacing	−70 dB.
Image Rejection	−80 dB (except −65 dB on the 17 and 12 meter bands).
Second IF Rejection	−90 dB.
First IF Rejection	−80 dB (except −60 dB on the 40 and 30 meter bands).
Internally Generated Spurious Signals	Generally below the noise level; all below 1 μV equivalent.
RIT	± 250 Hz.

Table III– Receiver specifications of the SS-9000.



One shielded cover hinges upward to reveal still more PC boards and individually shielded assemblies. Note the heatsink on the left for the internally mounted PA stage.

The arrangement of the PA stages within the transceiver is particularly interesting. As can be seen from the photographs, the PA stage is mounted internally with its heat sink and does not need any fan!

Controls and Operation

Fig. 2 shows the front-panel controls on the SS-9000 in detail. Many of the controls are self-explanatory, and obviously Heath laborec quite a bit on the subject of which functions should be assigned front-panel controls in order to achieve operating ease and clarity, versus having the front panel look like the cockpit of a commercial airliner.

Separate a.f. and r.f. gain controls are available as well as a.g.c. selection which includes an "off" position. The RIT knob is conveniently located next to the main tuning knob. The Passband Shift Control will slide the fixed i.f. filter bandwidth above or below the i.f. center frequency. The Main Tuning is noted as adjusting the receive frequency in 100 Hz steps and that is true, but the coverage per revolution is 5 kHz. The meter indicates S units in receive and a.l.c., power output or compression level in transmit. The Meter Select pushbutton changes the meter function, and as it is alternatively depressed, the LED's for **ALC**, **PWR**, or **COMP** will be illuminated. In a similar manner, if the pushbuttons for **TUNE**, **RIT**, or **NB** are depressed, the LED's above them will illuminate to indicate an "on" status. The Power Output control allows one to adjust the power output from a few watts to the nominal, full 100 watts output. Although the power output scale on the panel meter is supposed to be only a relative indicator, it does, in fact, indicate almost the exact power output over the 20–100 watt range. The Speech Compression control, although it is not indicated in fig. 2, does have a click-stop "off" position at its extreme CCW rotation point. The two pushbuttons below the main tuning knob provide for a frequency scan function. If either the **up** or **down** button is depressed, the receive frequency will be scanned accordingly. The operation is completely a manual start/stop one. The rate of scanning can be set internally to be from 2.5 to 270 kHz/sec.

Any user should find most of the controls to be extremely easy to understand. The pushbuttons under the dual frequency display are

TRANSCEIVER BLOCK DIAGRAM

RX SHOWS THE RECEIVE PATH

TX SHOWS THE TRANSMIT PATH

Part of 595-2303

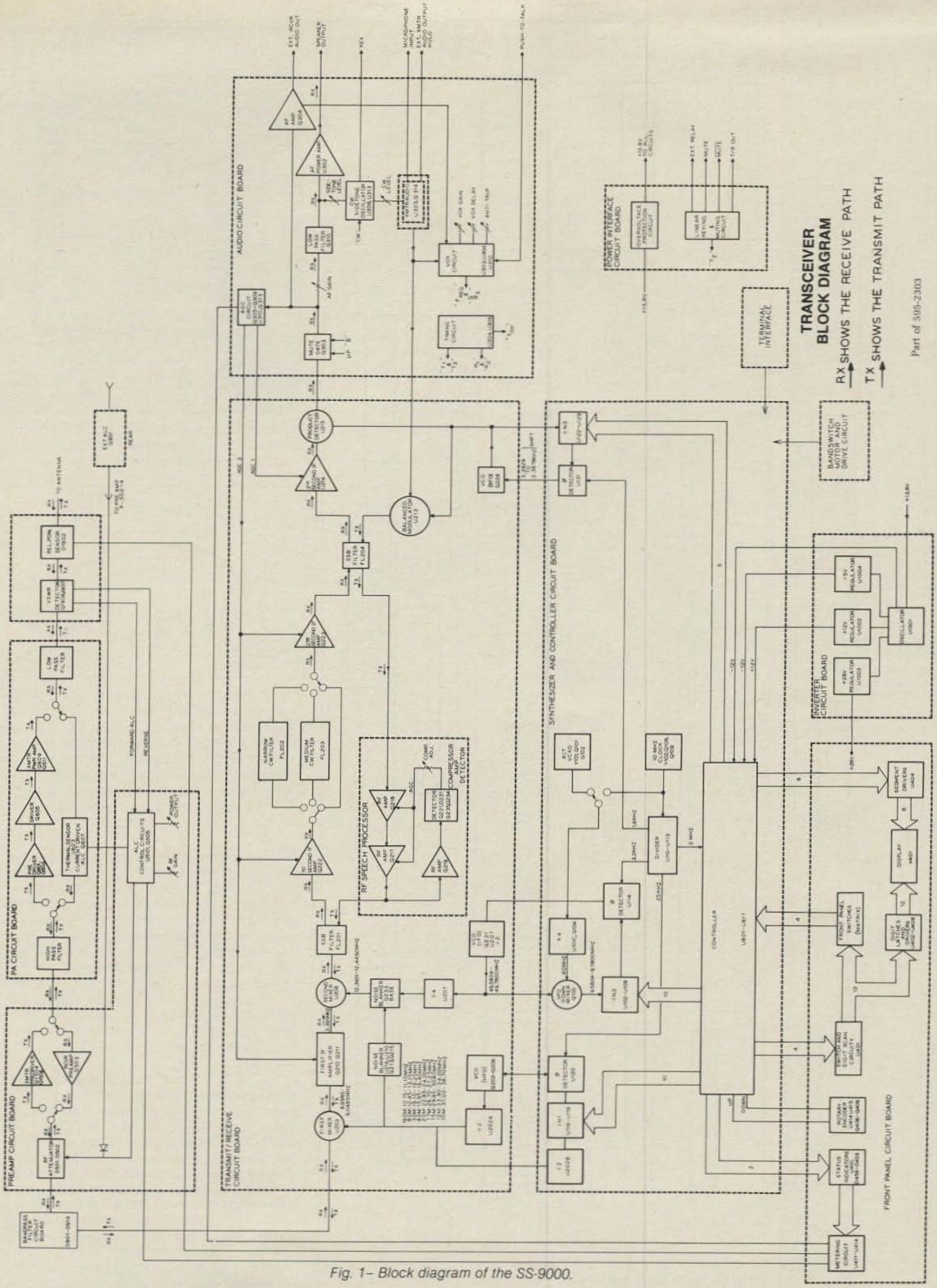


Fig. 1– Block diagram of the SS-9000.

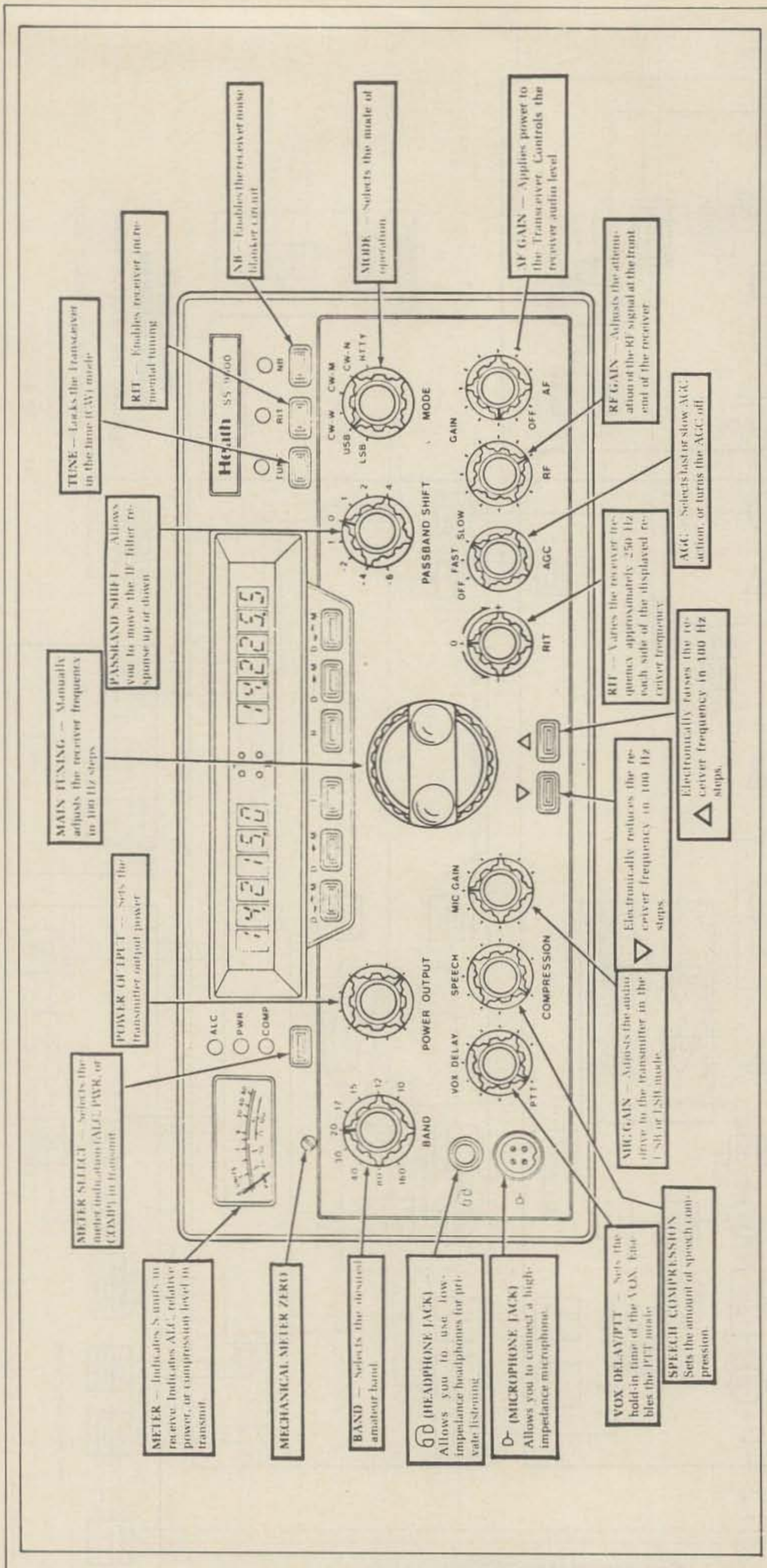
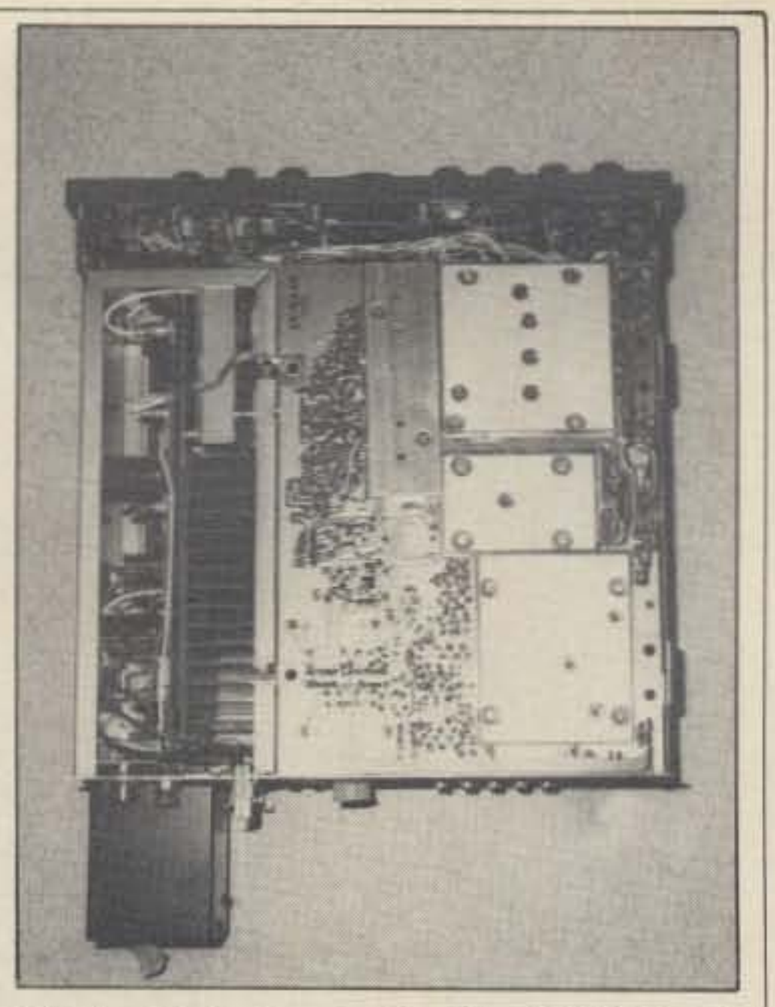


Fig. 2– Front-panel controls on the SS-9000.



A look at the bottom inside of the SS-9000 with more shielded assemblies and the PA heat-sink again on the left side.

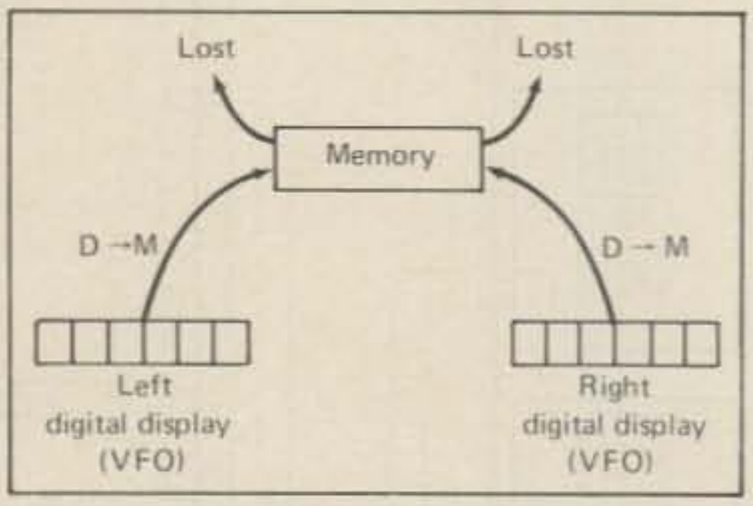


Fig. 3– Basic memory system in the SS-9000. If the D→M pushbutton under either display is depressed, the frequency from that display goes into memory. Whatever frequency was in memory is lost. A separate D⇄M pushbutton under each display allows one to toggle the displayed and memory frequency without changing the memory frequency.

also extremely easy to use, but they do require just a small bit of explanation. Between the two frequency displays there are four LED's. The upper set has red LED's and is associated with the **T** (transmit) pushbutton. The lower set has green LED's and is associated with the **R** (receive) pushbutton. By using the pushbuttons, one can set the right or left digitally displayed frequency to be both the receive and transmit frequency, or one to be the receive frequency and the other the transmit frequency, or vice versa. So, split frequency operation is possible over the complete extent of any one band.

The pushbuttons marked **D** and **M** with the arrows control the memory function on each band. The memory operates as shown in fig. 3. There is one memory per band, and if the **D→M** pushbutton under either display is pressed, the displayed frequency will go into memory, erasing whatever frequency was in memory. The displayed frequency does not change, so one can go on tuning. The **D⇄M** pushbuttons under each display simply exchange the displayed frequency and the frequency in memory. One push on the switch will call up the memory frequency on the display, and another push will restore the originally displayed fre-

Band	Low Freq. (MHz)	High Freq. (MHz)
10	28.000.0	29.700.0
12	24.890.0	24.990.0
15	20.925.0	21.760.0
17	17.699.0	18.200.0
20	13.925.0	15.000.8
30	10.100.0	10.150.0
40	6.925.0	7.375.0
80	3.425.0	4.075.0
160	1.745.0	2.055.0

Table IV– Actual SS-9000 frequency coverage.

quency. The frequency written in memory is not affected by use of the **D⇄M** pushbutton. The transceiver will also remember which v.f.o. was set up for receive and transmit on each band. The dual v.f.o./memory system is not the most elaborate one found in a manual transceiver, but it is very straightforward and easy to use.

Performance

Table I indicated that the actual frequency coverage extended beyond some band edges. The actual frequency coverage of the SS-9000 unit tested is shown in Table IV. As can be seen, there is quite generous extended coverage on some bands. It's only too bad that the 30 meter coverage couldn't be extended down to 10.0 MHz.

As was mentioned before, the arrangement of the various controls is nicely done and the transceiver is very easy to use in practice. The 5 kHz tuning rate is a nice compromise for s.s.b. and c.w. tuning, especially when using the narrow c.w. filter. Unfortunately, one has to take the top cover off to set the scan tuning rate and once it's set, that's it. The front-panel selection of two tuning or scan rates would have been a helpful feature. The manual tuning "feel" is excellent—smooth without being too loose. The simple pushbutton marked **Tune** is a very great convenience feature, and it's hard to understand why more transceivers don't have such a feature. When the pushbutton is depressed, the transceiver is keyed in the c.w. mode. Since the PA is automatically s.w.r. protected, to adjust an antenna tuner, for instance, one simply presses the **Tune** button and adjusts the tuner. The power output automatically comes up as the tuner is adjusted to present a 50 ohm load to the SS-9000.

On receive, one gets the impression that received signals sound very "clean." This was confirmed by bench measurements which showed the SS-9000 to easily meet its claimed specifications. A few very minor spurious signals (equivalent to less than 0.5 μV) were found on the upper end of 10 meters, but they would never be noted in actual operation. The s.s.b. selectivity is adequate except for extreme conditions when a bit better shape factor would be helpful. The passband shift is moderately helpful under bad QRM conditions. The RIT control actually had a range of $\pm$400 Hz and was perfectly adequate for s.s.b. or c.w. use, but the received frequency display does not indicate the offset set by the control. The display itself is perfectly stable and flicker-free. It is also easy on the eyes with its green color. Heath does not give overload specifications and overload measurements were not made, due to a lack of time before changing QTH's, but the impression one gets when operating the lower end of 40 meters at night is that the SS-9000 can easily hold its own. The noise blanker is very effective against almost any impulse (e.g., ignition) type noise. Overall, on receive the SS-9000 demonstrates excellent performance, although some operators might like to have more QRM fighting aids (e.g., variable bandwidth tuning and a notch filter).

On transmit, the SS-9000 also easily meets its specifications. The power output ranged from 105 to 110 watts over the entire range of the transceiver. The PA was absolutely stable with any type of mismatched load. With a proper load, it easily maintained full power output for repeated full 5 minute periods before the automatic circuitry started to reduce the output to prevent overheating. There is no fan, so operation is perfectly quiet. On s.s.b. the third-order IMD products measured a respectable -32 dB. Keying is smooth and semi-break-in is possible since the VOX delay time can be used to adjust the transmit hold-in time on c.w. Sidetone monitoring is provided with adjustable level at a fixed 800 Hz frequency. The r.f. speech processor is very effective, and numerous on-the-air reports of "very, very good" audio were received (a common, medium-impedance dynamic microphone was used). The only awkward thing about the processor is that one must note the meter scale reading when the meter is set to **Comp** with the tune switch activated and then adjust the compression-level control to that same meter reading while transmitting. There is no separate "compression" scale on the meter.

Terminal Interface

The 25-pin "D" connector on the rear panel of the SS-9000 is the key to unleashing the real capabilities of the transceiver. It is the RS-232C signal-level standard in/out terminal which allows the transceiver to interface with an ASCII terminal, modem, or computer. If you have a Heath H-19 or Zenith Z-19 video terminal, you just plug the extension cable that comes with the terminal into the SS-9000. If you do not have that equipment, instructions are given for general interconnection.

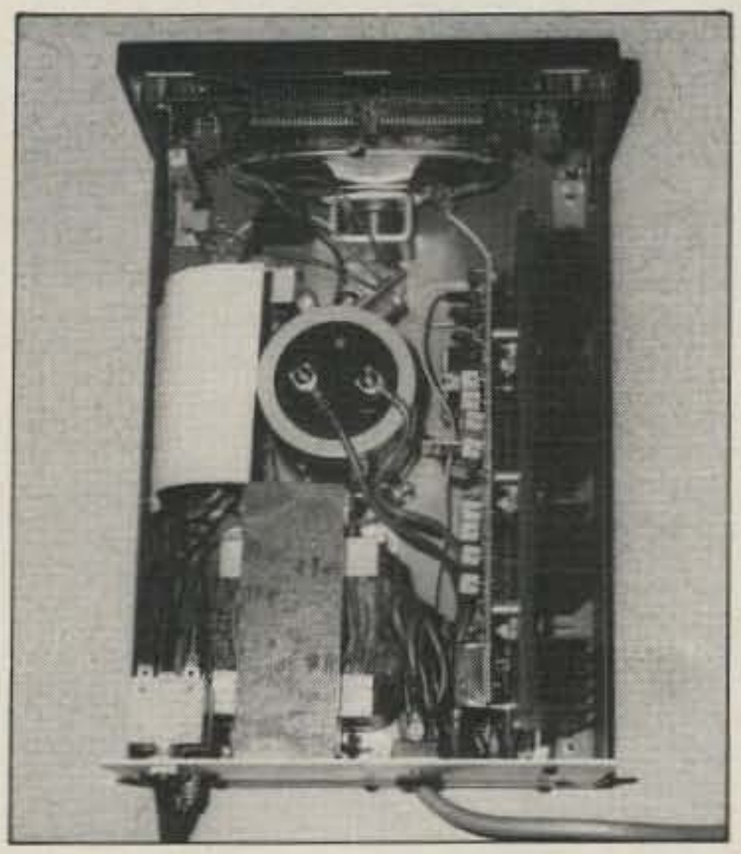
Commands will be accepted by the transceiver to control and monitor all functions that are under the control of the microprocessor in the order received, and if they are not in the proper syntex, the transceiver will generate one of 12 error codes (e.g., numbers which will indicate attempted out-of-band operation, improper switch command, etc.). The same command that can be used to set a parameter to a particular value also allows one to examine the currently set value of that parameter. Table V shows the commands accepted by the transceiver. One can, for instance, note that one command will print the current setting of the bandswitch, and then the same command can be used, if desired, to change bands. Expressions are used to specify frequencies for either the display or memory. The transceiver can do numerous things under terminal control which it cannot do under manual control. The scan rate can be set as desired, frequencies can be added to or subtracted from the left or right displays or memory on different bands, memory frequencies may be combined for use on one band instead of having just one memory per band, etc. Basically, the SS-9000 can be commanded by a terminal to do anything except turn itself on.

In practice, this means that one can sit at a terminal and completely control the transceiver. For example, one might ask for a listing of frequencies and various control settings. Then by keystroke, one can change bands, put different frequencies in the v.f.o.'s, tune or scan up and down from a set frequency, adjust the passband shift, etc. On s.s.b. one still

COMMANDS

BR[ate]=	Prints the current Baud Rate setting.
BR[ate]=n	Sets the Baud Rate setting.
	where: n = 50, 75, 110, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, or 9600.
BA[nd]=	Prints the current Band switch setting.
BA[nd]=n	Rotates the Band switch to the n meter band.
	where: n = 16[0], 8[0], 4[0], 3[0], 2[0], 17, 15, 12, or 1[0].
MO[de]=	Prints the current Mode switch setting.
MO[de]=n	Sets the Mode to n.
	where: n = LO[wer], UP[per], W[ide], M[edium], N[arrow], or R[TTY].
SH[ift]=	Prints the current PASSBAND SHIFT switch setting.
SH[ift]=n	Sets the Passband Shift to n.
	where: n = −6[00], −4[00], −2[00], −1[00], 0, 1[00], 2[00], 4[00].
S[can]=	Prints the current SCAN switch setting.
S[can]=n	Sets the Scan rate to n.
	where: n = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16. NOTE: 1 = approximately 2.5 kHz per second; 16 = approximately 300 kHz per second.
SW[itch]=	Releases all switches to their physical settings. NOTE: This includes the BAUD RATE switches.
L[ock]	Locks all switches to their current state.
PS[witch]	Prints the switch settings. NOTE: An "L" (locked) appears after any switch setting that was set from the terminal.
PF[req]	Prints the frequencies in memory for all bands.
PF[req]<band>	Prints the frequencies in memory for <band>, where <band> is one of the values for n listed in the BA[nd] command (see above). NOTE: The frequencies that are selected for receive and transmit are indicated by R and T, respectively.
RI[ndicator]	Toggles the receive indicator for the current band
RI[ndicator] <band>	Toggles the receive indicator for <band>.
TI[ndicator]	Toggles the transmit indicator for the current band
TI[ndicator] <band>	Toggles the transmit indicator for <band>.
RE[ceive]	Sets the Receive mode.
TR[ansmit]	Sets the Transmit mode.

Table V– Terminal commands for the SS-9000.



A look inside the PS-9000 power supply. Note the hefty heatsink on the right side for the regulator pass transistors.

needs audio in/out connections to the transceiver. However, with a suitably equipped terminal, c.w. and RTTY can be automated for all practical purposes.

Since the SS-9000 can be terminal-controlled, it can, of course, be operated by a computer program. What sort of program one might want to devise is left up to the imagination. One could write a program for the transceiver to check certain frequencies on certain bands at specific times, to scan specific band segments at certain times, to set up itself for a certain mode of operation on a specific frequency at given times, etc. If a signal-recognition device could also be integrated into the system, a computer program could be written such that the transceiver would search various segments of various bands and sound an alarm when a specific signal is found. It probably will not be too long, for instance, before stations who like to keep DX schedules will be using computer-controlled transceivers to automatically search out the best band, including crossband possibilities, and frequencies with the least QRM for their schedules immediately before the schedule time starts and to set up the transceiver at each end for operation.

The software demonstration package (5¼ inch diskette) which comes with the SS-9000 doesn't suggest anything like the foregoing idea. However, it does introduce one to terminal control of the SS-9000 in a very practical manner by asking the operator to perform various control functions from a keyboard and then performing various control functions on its own for illustrative purposes. Although it has a "teaching" function, it also illustrates how the SS-9000 can be controlled by a computer program.

Antenna Switch Interface

The bandswitch on the SS-9000 is controlled for non-manual operation by a motor assembly on the rear of the transceiver. The motor assembly has some external connections such that it can be interfaced with the Heath SA-1480 Remote Coax Switch. When this is done, any one of up to five antennas can be automatically selected when the bandswitch on the SS-9000 changes.

Accessories

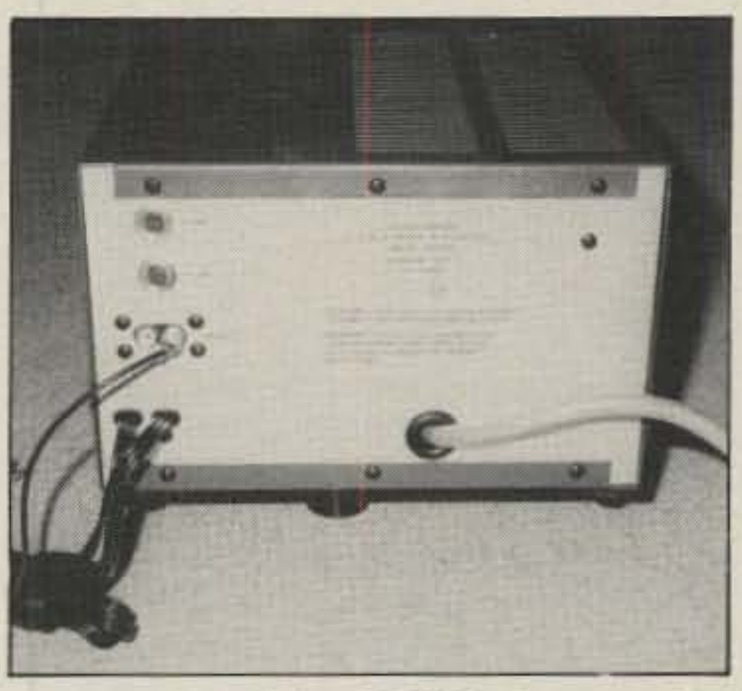
The main accessory for the SS-9000 is the PS-9000 power supply. It is styled to match the SS-9000 and basically supplies a regulated 13.8 v.d.c. output with a 25 ampere intermittent or 15 ampere continuous rating. It has current limiting and thermal protection but no apparent over-voltage crowbar circuitry. Filtering in the unit is mainly provided by a hefty 39,000 mF capacitor. Construction is quite rugged, and it can be set up to operate on 110/220 volt, 50/60 Hz.

The unit also contains two independent 2400-hour format clocks and a good-quality speaker. Two separate line cords are provided so the clocks can remain on an unswitched line and the power supply itself can be connected to a station's "big switch" a.c. line. The clocks can be set by front-panel pushbuttons, and an internal adjustment is provided to set the brightness of each clock. The clocks use the line frequency for timing purposes and must be reset if an a.c. power interruption should occur.

The only other accessory for the SS-9000 is a service manual costing $35.00. The owner's manual which comes with the SS-9000 gives very complete and clear installation and operating instructions. However, the SS-9000 is a complex unit, and it makes good sense for detailed service information to be contained in a separate manual. The manual itself was not examined, but considering the clarity of the owner's manual and all other Heath manuals, it undoubtedly is of the same high quality.

Summary

The SS-9000 is a very high quality transceiver in every respect—construction, performance, and control. It is also an expensive transceiver. In considering purchase of the unit, one primarily would have to balance the cost of the unit against one's anticipation of making use of its extraordinary terminal control possibilities. CQ



A rear view of the PS-9000. Separate line cords are provided for the power supply/clock circuits and there are two circuit breaker resets (one for each of the two 110 V primary windings on the power transformer).