

The Hallicrafters SX-115 Receiver

HAVE you ever felt you wanted a receiver with just about everything in it? Well, if you have, the Hallicrafters SX-115 is an answer. This is a triple-conversion superheterodyne receiver for use on s.s.b., c.w., or a.m. featuring linear tuning with highly accurate frequency readout and stability together with five degrees of i.f. selectivity. It also is a top-class piece of equipment both as to quality and performance which measures up to or exceeds the manufacturer's specifications, so rather than just enumerating these, as well as the many other features, they will be discussed one at a time along with comments pertaining to the actual or measured performance of the unit checked for evaluation.

For those interested in the circuit arrangement, a brief description with a block diagram is given in fig. 1.

Frequency Coverage

First of all, the SX-115 is an amateur-band only type of receiver. No diddling around with a critical bandsetting dial is required. Each range is bandswitched, covering the following 500 kc segments: 3.5-4.0 mc, 7.0-7.5 mc, 14.0-14.5 mc, 21.0-21.5 mc, 28.0-28.5 mc, 28.5-29.0 mc, 29.0-29.5 mc and 29.5-30.0 mc. A separate range is also included for receiving WWV on 10 mc.

The main dial, which is semi-circular, is calibrated in 25 kc increments, while a vernier dial covers 25 kc per revolution and is linearly calibrated in 1 kc increments spaced $5/16"$ apart on the dial! This provides an exceptionally high degree of frequency readout and resettability

which may be made to within 100 c.p.s. The drive ratio also is high, making it easy to tune in s.s.b. signals. The frequency is determined directly by adding the reading of the vernier dial to those of the main dial.

Crystal Calibrator

A 100 kc crystal calibrator is included and the vernier dial may be indexed to coincide with any of the 100 kc reference beats. This is done by means of CALIBRATION-SET control which locks the dial in position while the receiver is tuned to frequency. Then, after the dial is unlocked, it will rotate with the tuning knob and may be used for accurate reference. Unlike other arrangements sometimes used, this allows the hairline fiducial to always be set at the center of the dial window.

Calibration Accuracy

The linear calibration accuracy of the vernier dial is specified as better than 1000 cycles between 100 kc calibration points after indexing, but it was found to be greater than this. Checks at every 10 kc point over the entire 500 kc range of the v.f.o., after indexing at only one point (3700 kc), indicated the readout to be well within 200 c.p.s. (three points were out 300 c.p.s.). It was still better for readings obtained between adjacent calibrated 100 kc points. Besides this, thanks to an excellent gear-driven tuning mechanism, absolutely no backlash could be detected, the frequency readout being the same regardless of which direction the dial was rotated toward the reference point.

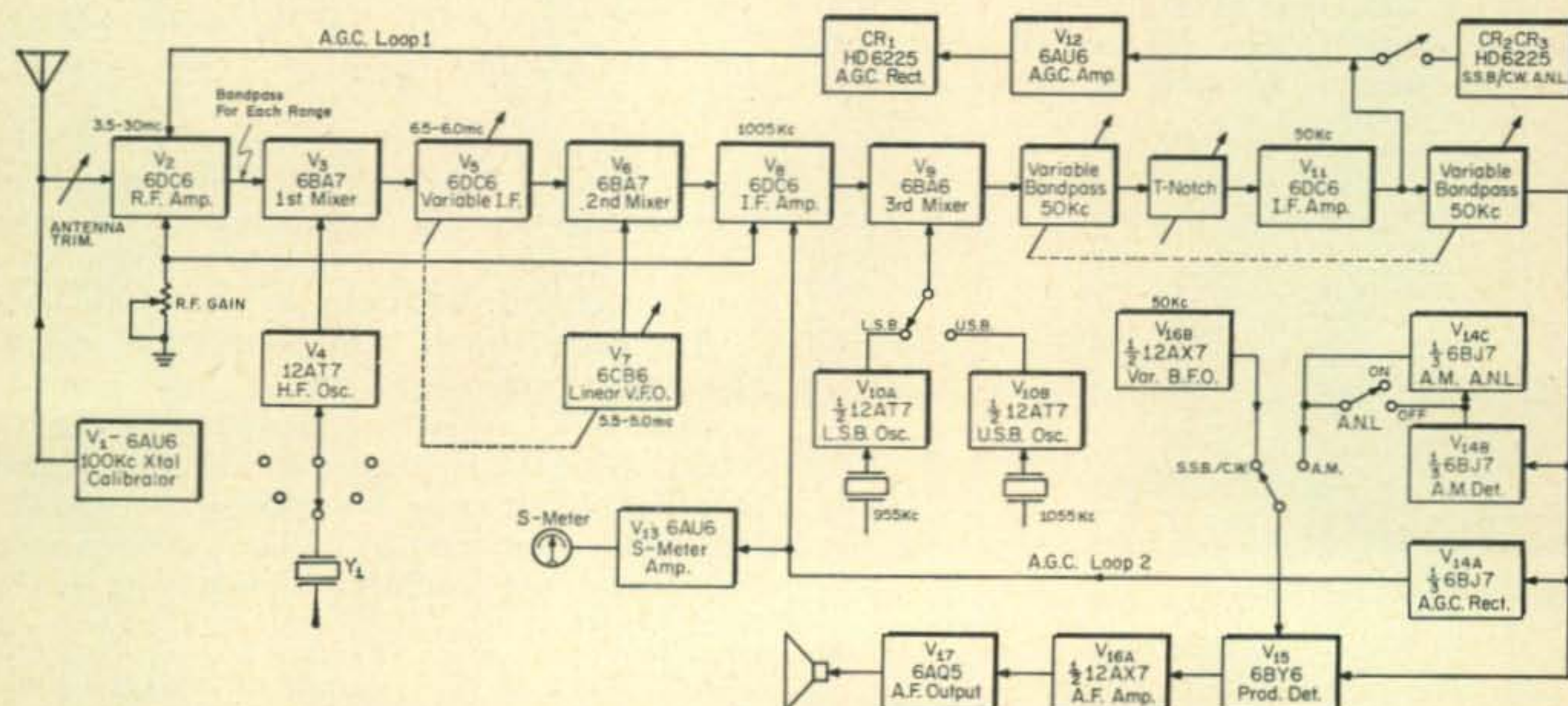


Fig. 1—Block diagram of the SX-115. Note that the control potential for a.g.c. loop 1 is obtained from a point prior to the selective circuit at the output of V₁₁, while that for a.g.c. loop 2 is obtained from the output side of the selective circuit. The selectivity of the two a.g.c. loops thus is different, increasing the selectivity when a.g.c. is used, as explained in the text. When a.m. is used, the b.f.o. potential is removed from the product detector, V₁₅, and the output of the a.m. detector, V_{14B}, is applied to V₁₅ instead. The latter then becomes an a.f. amplifier. Frequency of Y₁ is 6.505 mc higher than the bottom end of each band range.

The Hallicrafters SX-115 Receiver. It is smartly styled with a symmetrical layout. The large knobs, each side of center at the bottom, are the BAND SELECTOR (left) and TUNING with the 1 kc incremental frequency dial (right). Other controls are conveniently located.



Stability

A transmitter-type v.f.o., with Hallicrafter's system of differential temperature compensation, is used. Stability is specified as better than 300 cycles after a 15 minute warmup period. It was found that, starting cold from a normal room ambient temperature, the frequency dropped 400 cycles after 10 minutes. Eight hours thereafter it had moved 600 cycles, equivalent to 75 c.p.s. per hour. Line potential variations of 10% affected the frequency only a few cycles.

A standby heating element (damp-chaser) is employed in the SX-115 which maintains a moderate amount of heat and a uniform degree of low humidity as long as the set is plugged into a 117 volt a.c. outlet. The power switch need not be turned on. This arrangement is designed mainly to cut down warm-up drift which was then found to be only 200 c.p.s.

Rugged construction also assures a high order of mechanical stability. Vibration and drop tests indicated no frequency shift, quivver, microphonics or other adverse effects.

Selectivity

The SX-115 is provided with five degrees of i.f. selectivity, namely: 0.5, 1, 2, 3 and 5 kc bandwidth at 6 db down. A special front-end a.v.c. loop is employed to improve the selectivity characteristics when the a.v.c. is in operation, so the instruction book contains two charts showing the i.f. response, one with the a.v.c. off, the other with the a.v.c. on. This is explained further during the description of the a.v.c. system.

The following table indicates the unwanted sideband suppression measured at 1 kc for three selectivity positions as determined from the a.f. output with the a.v.c. disabled.

Selectivity Position	Sideband Suppression At 1 kc
1 kc	-40 db
2 kc	-30 db
3 kc	-26 db

Suppression figures are not given for 5 kc, since this position is for use with a.m.

The 0.5 kc position is for use with c.w. In this

case the response was down 20 db at 500 c.p.s. each side of the peak and down 40 db at 1 kc on each side. The nose of the peak was ± 250 c.p.s. at 6 db down. Narrow band i.f. systems often ring from shock excitation due to strong adjacent-channel c.w. signals, but no such effect was experienced with the 500 cycle position in this receiver.

T-Notch Filter

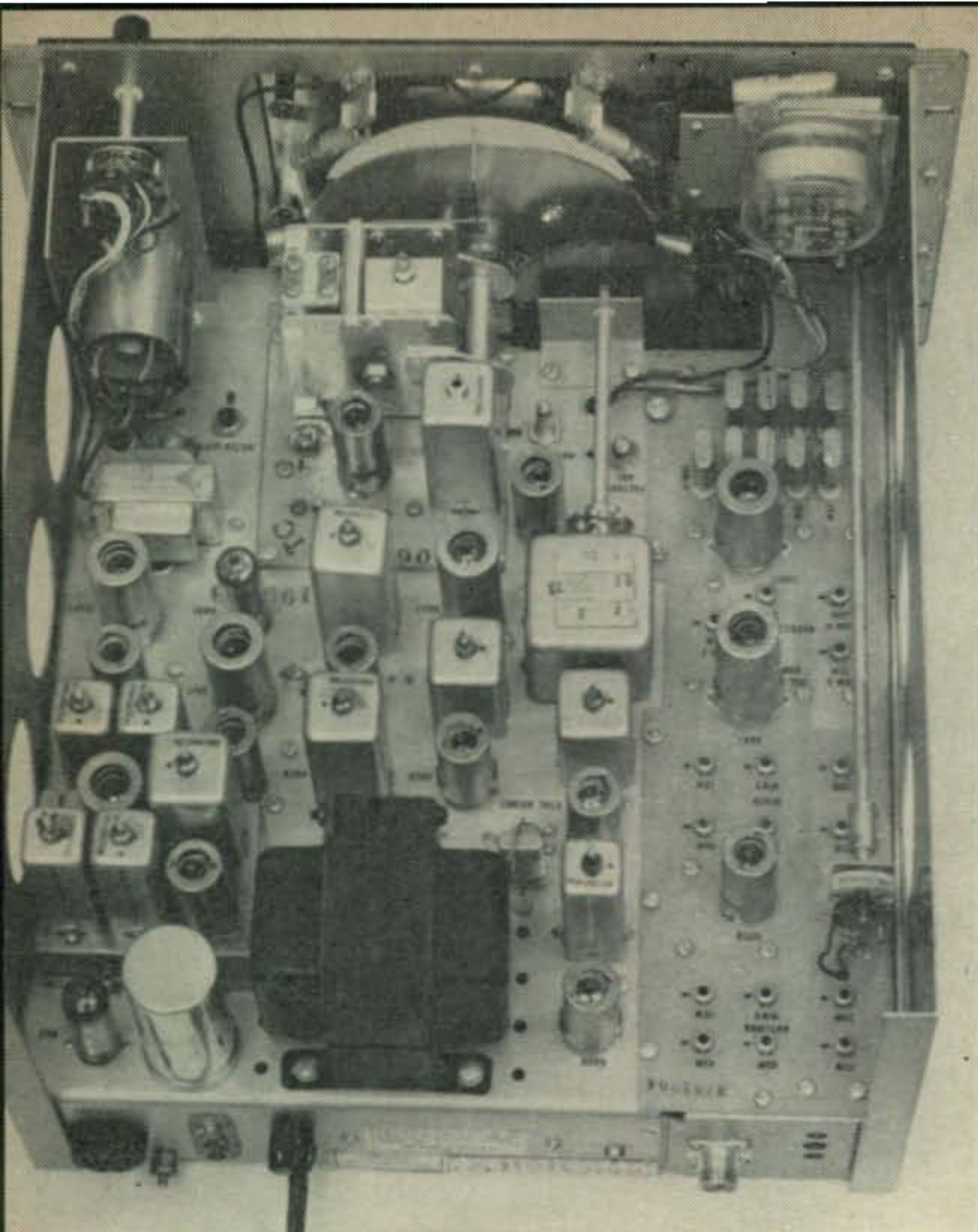
An excellent T-Notch filter very effectively rejects interference from a heterodyne or an adjacent carrier beat. Its performance checked with the given specifications of 400 c.p.s. bandwidth at 6 db down with a notch depth control of at least 50 db; however, the latter is dependent on the frequency at which the internal depth control was initially adjusted for maximum attenuation. Some deterioration will occur at other points in the passband. In this respect, it was found best to set the depth control for maximum rejection when the notch filter is tuned to reject a 1 kc beat, after which the attenuation at other points tuned in the passband will be fairly uniform.

The notch filter also may be used to make more pleasant-sounding reception of some of the strident-quality s.s.b. signals. This is done by varying the notch frequency control accordingly. It can also be used to advantage for exalted-carrier reception of a.m. signals. When used for taking out an unwanted beat, it should be noted that rejection is obtainable only throughout the normal passband of the i.f. system and therefore a signal on the unwanted sideband cannot be rejected.

Also, maximum rejection will be obtained only when the a.v.c. is turned off or when the r.f. gain is turned down. (Maximum sideband suppression also will be obtained under the same conditions).

Sensitivity

Sensitivity on a.m. is specified as less than 1 μ v for a 10 db signal-to-noise ratio and less than 0.5 μ v for s.s.b. and c.w. Measurements indicated this to be mostly on the "less" side except on 10 meters. The input impedance is 50-70 ohms.



Top chassis view of the SX-115. Some of the gear-drive mechanism may be seen at the center of the panel. The v.f.o. tuning capacitor is left of center. Heavy supporting brackets at the sides of the chassis enhance sturdiness and serve as convenient supports when the chassis is turned over in the event servicing is required.

Detectors and Noise Limiters

Separate detectors and noise limiters are provided for a.m. and s.s.b./c.w. operation. For a.m. a conventional diode detector and an automatic-threshold series-type noise limiter arrangement is used. For s.s.b. and c.w. a product detector is employed. The noise limiter for this mode is an i.f. type which is one of the most effective and simple ones yet devised for s.s.b. and c.w.¹ Key clicks and hard ac. action are also thereby minimized. The detectors and noise limiters may be switched individually.

S-Meter

The S-meter is calibrated in the usual fashion. Accuracy of calibration was found to be within 15% for 6 db per S-unit with the a.v.c. in operation and the r.f. gain set fully on. A 1 μ v signal produced an average meter reading of S-4, and the average reading for a 50 μ v signal was S-9. A band-gain equalization arrangement is used, so the indicated readings for each band were almost identical. The S-meter still functions when the r.f. gain is turned down or when the a.v.c. is disabled; however, the calibration does not hold and the indications are then only relative.

A.G.C.

A dual-loop a.g.c. system is used which improves selectivity when a.g.c. is used. The first a.g.c. loop derives an amplified control potential from the 50.75 kc i.f. amplifier at a point which is not as selective as the circuit to which the

second a.g.c. loop is connected. The first loop controls the front-end r.f. stage, the second controls an i.f. stage and the S-meter.

When an adjacent-channel signal, stronger than the desired signal, is present, it will reduce the front-end gain, but as this drops, the r.f. potential at the second a.g.c. rectifier will also drop, thereby tending to increase the receiver gain. (Due to the higher selectivity involving the second loop, the adjacent signal will have little effect on its a.g.c. potential). The net result is a compensating action between the two a.g.c. loops which minimizes desensitization of the receiver and holds up the weaker signal. This effectively increases the dynamic selectivity (which actually can be measured) and lessens a.g.c. pumping and monkey-chatter by the strong adjacent signal. The action holds up to about a 50 μ v signal input at which point a further increase in signal level (the desired one) brings the a.g.c. into play. It is a two-step action which is dependent on the ratio of the gain in the two a.g.c. loops and which contributes to smoothness of operation and minimizes desired-signal pumping and popping of a.g.c. In addition, the a.g.c. attack is fast, release is slow, making the overall action pleasant sounding.

The dual loop a.g.c. also cuts down desensitization of the receiver by short noise pulses, as also does the s.s.b./c.w. i.f. noise limiter which operates ahead of the a.g.c. system.

The a.g.c. figure of merit is given as 60 db. Tests showed that the a.f. output level increased with r.f. input level as follows:

		A.F.		
		Input Level Change (μ v)	Output Level Change (db)	Cumulative Total (db)
From	To	Level Increase (db)	Level Change (db)	
1	10	20	9	9
10	100	20	3	12
100	1000	20	2	14
1000	10000	20	2	16

The total output level change was 16 db for an input signal increase of 80 db from 1 μ v to 10000 μ v, and 7 db for an input increase of 60 db from 10 μ v to 10000 μ v.

Image and Spurious Responses

I.f. image rejection is given as better than 60 db and i.f. signal rejection as better than 70 db. These specifications were confirmed with signal rejection running as high as 80 db on some

[Continued on page 104]

¹Scherer, 20 Kc Filter Adapter and S.S.B. I.F. Noise Limiter for the Collins 75A-4 CQ, April, 1960, p. 32; "IFNL", An S.S.B. I.F. Noise Limiter, CQ, June, 1960, p. 42; "More on the IFNL," CQ, November, 1960, p. 62; Raguse "Variable I.F. Noise Limiter," CQ, November, 1960, p. 70.

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Comments

If you have been reading this column consistently you will remember the heartaches associated with Project Despair, the project of obtaining printed circuit boards at a reasonable cost for the W2JAV transistorized wide band TU and a.f.s.k. oscillator. (They are all gone, now.) Well, maybe we are a sucker for punishment, but we are going to *try* to get boards for the narrow shift TU described in the September '63 RTTY Column. Don't write, don't call; just watch here for reports on our progress, if any.

73, Byron, W2JTP

SX-115 Receiver [from page 50]

ranges. In-band tweets (spurious receiver responses) are given as equivalent to less than 1 μ v. One such response was found on each range. They were well within tolerance, (the strongest one being experienced at 21.2 mc).

Cross Modulation

Strong-signal handling capabilities, in respect to overload and cross modulation, were found to be excellent after following simple modification instructions, requiring less than 10 minutes time, as given in the Engineering Bulletin for the SX-115. (This bulletin may be obtained by writing to the Hallicrafters Co.). Input signals of between 10,000 and 20,000 μ v could be tolerated without deteriorating effects. 14 mc reception was possible using the receiver in the same room with several 50 kw transmitters one of which was operating on 15 mc; something which was not possible with many other receivers.

A. F. Output

Inverse feedback is used in the audio system. The a.f. output power is specified as 1.5 watts at less than 10% distortion with a power gain of less than 1 μ v (30% modulation) for 0.5 watts output. Full output was obtainable with 1 μ v of signal input.

B. F. O. Control

The b.f.o. is tunable from the front panel and is usually set so that zero beat is maintained with a signal when the selection of either sideband is made; however, the b.f.o. may be tuned for the operator's taste to alter the pitch or the unwanted sideband suppression of a signal and thereby obtain passband tuning, but when this is done, the receiver must also be retuned accordingly.

Mode and Sideband Selection

A function switch provides the following: receiver on and off, lower or upper sideband for s.s.b./c.w. (b.f.o. and product detector in use) and lower or upper sideband for a.m. (envelope detector in use). A.m. is not restricted to one sideband however. When the 5 kc i.f. selectivity is used, normal double-sideband a.m. may be had by tuning the receiver to the center of the i.f. passband. Lower or upper sideband a.m. reception is best used as needed to get out of adjacent-

channel QRM. Also, the s.s.b./c.w. function for either sideband will be found useful for a.m. exalted-carrier reception.

A.V.C.-A.N.L. Switch

This is a four-position switch which provides A.V.C. OFF, A.V.C. ON, S.S.B. NOISE LIMITER ON with A.V.C. on and A.M. NOISE LIMITER ON with A.V.C. on.

Other Controls

Other controls are: R.F. GAIN, A.F. GAIN, ANTENNA TRIM, BAND SELECTOR, SELECTIVITY, T-NOTCH FILTER, CRYSTAL CALIBRATE SWITCH, CALIBRATE SET and DIAL LOCK, RECEIVE-STANDBY switch and TUNING. All controls are individual; no dual concentric types are used. A phone jack is also located on the front panel. 50-2000 ohm impedance headphones may be used.

Rear Apron

Speaker output terminals for 3.2 or 500 ohm impedances are located on the rear apron with an SO-239 coax antenna connector, a line fuse and an auxiliary octal socket with plug which may be used for remote control connections to operate receive-standby or transmitter relays. The 50.75 kc i.f. output is also available from this socket.

Construction

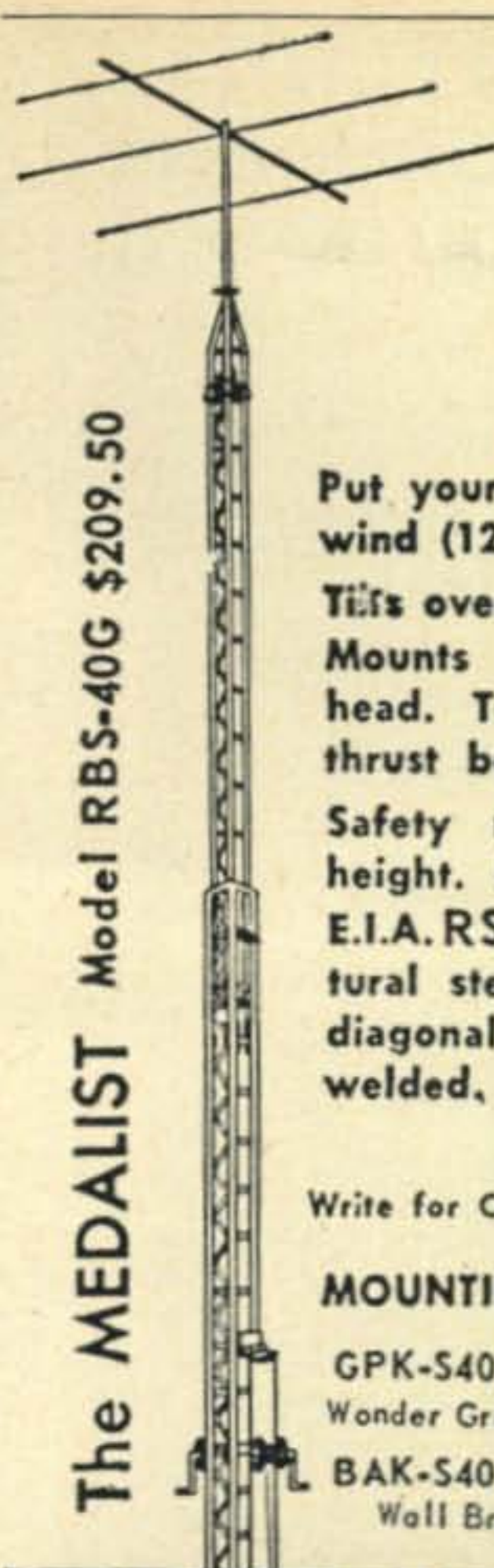
Besides being solidly constructed, the SX-115 is exceptionally well ventilated. The use of silicon rectifiers in the power supply also minimizes heat build-up. Continuous operation over long periods of time did not show up any overheating or deterioration of components.

The front panel is symmetrically laid out and is gray colored with a cast-metal escutcheon plate finished in black crackle. Knobs are black with polished-aluminum inserts and skirts. The S-meter, main-dial, band-selector-dial and vernier-dial windows are illuminated, while the background for the meter scale and the dials is black. Glare is eliminated, making observations easy on the eyes. The tuning knob has a solid feel to it which makes operation comfortable.

The cabinet is black with a hinged silver-colored perforated cover for ready access to the inside of the unit. The overall dimensions are 16" side, 10½" high and 16" deep. Weight is 44 pounds.

The instruction manual provides the most needed information regarding specifications, operation and servicing of the receiver, including detailed alignment procedures.

Use of the SX-115 over a period of many months, in all modes of operation, has provided much pleasure, especially in respect to its stability, frequency readout, handling capabilities and its convenient features with smooth performance. It also really digs out the very weak signals. It is a Class "A" receiver priced at \$599.50. The Manufacturer is The Hallicrafters Company, 5th and Kostner Avenues, Chicago 24, Illinois.—W2AEF



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