Heathkit of the Month #115:
by Bob Eckweiler, AF6C

AMATEUR RADIO - SWL

Heathkit SB-620 “Scanalyzer” (Panoramic adapter)

Introduction:

Over the years HotM has covered many of the accessories that went with the SB-300/301/400/401 HF twins. Some years back an SB-620 “Scanalyzer” article was started, but shelved because the author’s SB-620 power transformer had developed an intermittent short between ground and the CRT filament winding. Discouraged, effort was directed to a different accessory. A recent email request from Jon – KB7BTO, got me thinking again about covering this kit.

The SB-620 (**Figure 1**) is a “panoramic adapter” (See sidebar) designed to work with receivers with intermediate frequencies (IFs) between 1000 kHz and 6000 kHz as well as the common 455 kHz IF[1]. The desired IF has to be decided prior to wiring as a coupling circuit between the RF amplifier and mixer, and components in the sweep oscillator, are different depending on the IF frequency desired. Components for three different coupling circuits are provided; one each for 455 kHz, 3395 kHz and all the other IFs. Since the SB-300 series receivers use an IF of 3395 kHz, it and the very common 455 kHz IF received heavier attention during the SB-620 design.

Figure 1: SB-620 “Scanalyzer”

Here is a link to the index of Heathkit of the Month (HotM) articles:
http://www.w6ze.org/Heathkit/Heathkit_Index.html

1. Notes begin on page 14.

The SB-620 “Scanalyzer”:

The SB-620 is similar to the earlier HO-13 “Ham Scan” panoramic adapter (circa 1964 – 1966) with styling and significant circuit updates. It also covers more IF frequencies. The HO-13 design was focused on the 1682 kHz IF of the RX-1 Mohawk receiver. It also covers 455 kHz and 3395 kHz and other less common IFs between 1600 kHz and 3055 kHz.

The SB-620 was first introduced in the 1967 810/67A Heathkit catalog[2] as *“coming soon”* and *“Watch For Full Details in the Christmas Flier”,* (**See Figure 2**). An interesting note is a change in the device name. The early ad calls the SB-620 “Hamscan”, but by the 1968 main catalog the name appears as “Scanalyzer”. The SB-620 initially sold for $119.95. In comparison the, then soon to be discontinued, HO-13 sold for $79.50 in the 1966 810/60A catalog. The SB-620 remained in production until early 1976. The last catalog available to the author showing the SB-620 is winter 1976 (#807). At that time the SB-620 was selling for $149.95. Specifications for the SB-620 are shown in **Table I**.

Specifications for the Heathkit SB-620 "Scanalyzer" Panoramic Adapter
From Heath Manual 595-827 (10-17-69)

RF AMPLIFIER

Input Frequencies: (Receiver IF) One of the following: 455 kHz, 1000 kHz, 1600 to 1680 kHz, 2075 kHz, 2215 kHz, 2445 kHz, 3000 kHz, 3055 kHz, 3395 kHz, 5200 to 6000 kHz.

Frequency Response: 0.5 dB at ±50 kHz from receiver IF.

IF Frequency: 350 kHz.

Sensitivity: Approx. 10µV input signal provides a visible signal (40 dB mark) at full pip gain setting.

Spectrum Analyzer: Test signal input frequencies up to 50 MHz;

HORIZONTAL DEFLECTION

Horizontal. Sweep Generator: Sawtooth sweep produced by neon lamp relaxation oscillator.

Sweep rate: (Approx. Frequencies) 10 kHz preset: 0.5 Hz.
50 kHz preset: 2 Hz to 2.5 Hz.
Variable:5 Hz to 15 Hz.

Preset Sweep Width: 10 kHz preset: 10 kHz.
50 kHz preset: 50 kHz.

Variable Sweep Widths*:

455 kHz	10 kHz to 100 kHz
1000	50 kHz to 500 kHz
1600	50 kHz to 500 kHz
1680	50 kHz to 500 kHz
2075	50 kHz to 500 kHz
2215	50 kHz to 500 kHz
2445	50 kHz to 500 kHz
3000	100 kHz to 500 kHz
3055	100 kHz to 500 kHz
3395	100 kHz to 500 kHz
5200	100 kHz to 500 kHz
6000	100 kHz to 500 kHz

* These sweep widths are minimum values. Actual sweep width ranges will be greater than those listed depending on the receiver IF frequency for which it is wired.

Resolution: 1 kHz.
NOTE: Resolution is defined as the frequency separation between two equal adjacent signals such that the intersection between their respective pip indications is 30% below the apex amplitude.

Amplitude Scales: Linear: 20 dB (10:1) range
Log: 40 dB (100:1) range.
-20 dB Log: (extends calibrated range to 60 dB.

TABLE I *Continued…*

Specifications for the Heathkit SB-620
…Table I** Continued.

POWER SUPPLY

Type: Transformer operated; fused at ½ amp.

Low Voltage: Full-wave voltage doubler circuit, using four silicon diodes.

High Voltage: Full-wave voltage doubler circuit, using two selenium diodes.

Bias Voltage: Full-wave bridge circuit, using four silicon diodes.

Power Requirements: 120 or 240 volts AC, 50/60 Hz 40 watts.

GENERAL

Tube Complement:
V1 6EW6, RF Amplifier.
V2A - ½ 6EA8 Mixer.
V2B - ½ 6EA8 Sweep Oscillator.
V3 6EW6, IF amplifier.
V4 6AU6, IF log amplifier.
V5A ½ 6AT6, detector.
V5B ½ 6AT6, vertical amplifier.
V6 12AU7, horizontal push - pull amplifier).
V7 3RP7, high persistence CRT

Diode complement:
D1 MV1638 Varicap diode 29.7 - 36.3pF, 400mW.
D2 - D3 P33-40HQ selenium diode 1750 PIV, 2mA,.
D4 - D11 1N2071 silicon diode 600 PIV 750 mA

Cabinet Dimensions:
6⅝" high x 10" wide x 10-½ deep.

Weight: 10 lbs. net, 15 lbs. shipping..

TABLE I

SB-620 Front Panel:

The front panel of the SB-620 has a pilot lamp (neon) centered near the top, and the 3" CRT, with a yellow filter containing a scale, is mounted in a bezel in the upper left. Below the CRT is a Heathkit medallion identifying the model number. The front panel contains nine controls; four are to the right of the CRT in two rows of two. the remaining five are along the lower panel. The two top controls are rotary switches, while the rest are potentiometers. **Table II** shows

SB-620 Front Panel Controls

Top Row (right of the CRT and below the pilot lamp).

AMPLITUDE SCALE:	Rotary switch: 3P3T **LIN, LOG, -–20 DB LOG**
SWEEP WIDTH:	Rotary switch: 4P3T **10 kHz, 50 kHz, VARIABLE**

Second Row (right of the CRT).

VARIABLE SPEED RATE:	Potentiometer, 7.5 Meg Ω
HORIZ. POS.: Fast Scan:	Potentiometer , 500 KΩ with N.O. SPST momentary push on switch

Third Row (Below CRT; full panel width).

OFF - INTENSITY:	Potentiometer (High Voltage) 500 KΩ with CCW N.O. SPST switch
FOCUS:	Potentiometer, 1 Meg Ω, (H.V.)
VARIABLE SWEEP WIDTH:	Potentiometer, 7.5 Meg Ω Scale: 9 radial dash marks 30º apart from 8 o'clock to 4 o'clock
PIP CENTER:	Potentiometer, 5000 Ω
PIP GAIN:	Potentiometer, 5000 Ω

NOTES: All front panel potentiometers are linear taper. N.O. means normally open switch contacts. BOLD CAPITALIZED letters are as they appear on the instrument.

TABLE II

SB-620 REAR Panel Controls & Connections (As viewed from the rear)

Atop Chassis Left side (accessible from rear).

–20 dB log adjust**:**	Trim potentiometer 100 KΩ LIN.

Along Chassis Skirt (left to right)

RF INPUT: (Spec. Analyzer)	RCA female connector.
20 DB ATTEN:	DPDT slide switch **IN** (up) **OUT** (down) for RF input.
Function :	SPDT slide switch: **HAM SCAN”** (up) (up), **SPECTRUM ANALYZER** (down)
Multi Input:	RCA female connector. **IF INPUT** for Ham Scan; **SIG. GEN. INPUT** for Spec. Analyzer
HORIZ.WIDTH	Potentiometer 7.5 Meg Ω, tab mount
VERT. POS.	Potentiometer 1 Meg Ω, tab mount
LOG ADJ.:	Potentiometer 100 KΩ, tab mount
ASTIG.(matism):	Potentiometer 1 Meg Ω, tab mount
Power cord exit:	**120 V 60 Hz 40 WATTS.** with Heyco strain relief. (two wire line cord).

NOTES: All rear panel potentiometers are linear taper. BOLD CAPITALIZED letters are as they appear on the instrument.

TABLE III

the markings and function of these controls. Less used controls are located on the rear chassis skirt. as is the necessary switching and connectors to use the SB-620 as an RF spectrum analyzer. **Table III** lists the controls and connections accessible from the rear chassis.

Connecting the SB-620 to a Receiver:

Proper connection to the receiver is needed to

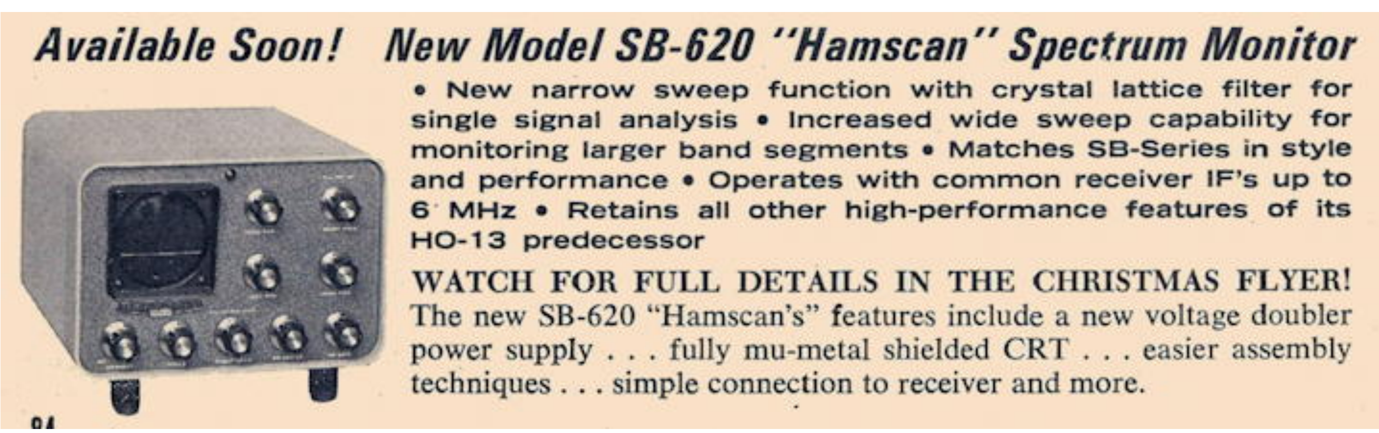

Figure 2: Announcement in the Heathkit 810/67A catalog (p84), introducing the SB-620 Spectrum Monitor.

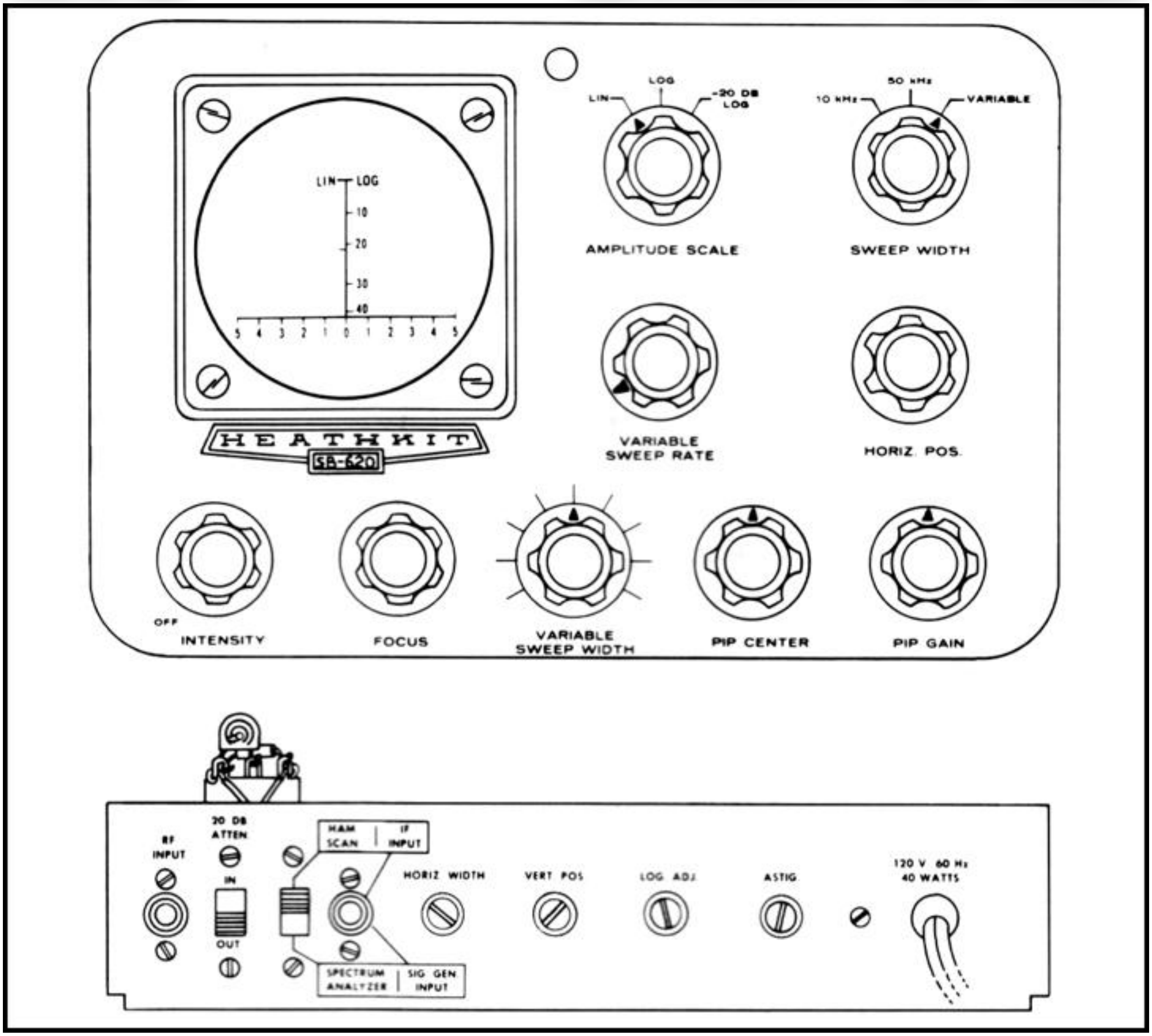

Figure 3: Illustration showing the front and rear controls and connections (From the Heathkit Manual).

get the best performance from the SB-620. Heathkit dedicates three pages in the manual to this connection. It also includes a table of 29 popular receivers from 8 different manufacturers (including 12 Heathkit receivers), giving coupling capacitance (7.5 or 12 pF) and where to make the connection. The two coupling capacitors are supplied with the kit.

The connection is usually made to the plate of the first mixer tube. In a dual conversion receiver with a wide-band first IF, such as the SB-300/301, the connection is made to the second mixer. Once installed, the mixer may need to have its alignment re-peaked.

Operating the SB-620:

If you own an SB-620 it is strongly recommended you have a manual[3] to refer too. Operation is covered over eleven full pages including two foldout pages, and shows 18 sketches of scope patterns, each with an explanation, and five photos, similarly explained. The manual also covers using the SB-620 as a basic test instrument. A good quality stable RF signal generator is required and allows you to test for *"such things as oscillator stages for harmonic levels, parasitics, etc.; mixer stages for signal and oscillator feed-through; and linear amplifiers for distortion products."*

To monitor for signals ±50 kHz from your operating frequency, the unit is turned on, and the INTENSITY and FOCUS controls are adjusted for medium brightness and a sharp trace. The VARIABLE SWEEP WIDTH control is adjusted for a sweep of 100 kHz using the receiver crystal calibrator[4]. A signal is then tuned in and the PIP CENTER control is adjusted to align the center of the signal with the vertical graticule on the screen. The PIP GAIN can be adjusted as desired. The AMPLITUDE SCALE can be switched from LINear to LOG should the amplitudes vary by more that about 10:1.

The sweep width can be reduce to 10 or 50 kHz for a scan over a narrower range. 10 kHz provides a good analysis of the sidebands of a received AM or SSB signal. At 10 kHz the sweep rate is ½ Hz and the 50 kHz is around 2 Hz.

The SB-620 Circuit Description:

Figure 4 shows a block diagram of the SB-620. A full schematic is available online[5]. The circuit basics, digested a block or block group at a time follows. It is always good to start with the power supply:

SB-620 Power Supplies:

The power supply is mostly conventional. All voltages are developed by one power transformer (part # 54-182). The transformer has a dual primary for operation on both 120 and 240 VAC 50/60 Hz and four secondary windings: Two 6.3 VAC filament windings, 3A for all the tubes but the CRT, and 0.6A heavily insulated winding for the CRT; 225V 25mA winding for B+ voltages and a 600V 1 mA winding for the CRT HV. this is the same transformer used in the SB-610 and SB-614 monitor scopes.

The Filament Power Supply produces three separate low voltages:

PANORAMIC ADAPTER

A "panadapter" shows on a CRT screen the signals below and above the received frequency. as vertical pips. The horizontal position represents the relative frequency from where the receiver is tuned with the actual received frequency at the center of the horizontal trace. The sweep width can be set to calibrated values or varied by a variable sweep control. A narrow sweep, often ±5 kHz, allows analysis of the received signal. Higher sweep widths show signals ±250 kHz, around the tuned in frequency. The sweep moves left to right starting below the center frequency, sweeping up through the center frequency to the high frequency, where it then moves quickly back to the left to start another sweep. The sweep rate is fixed for the calibrated sweep rates but can be adjusted when using variable sweep. The sweep rate is slow, on the order of ½ Hz up to about 15 Hz. Due to the slow sweep rates many panoramic adapters have a high persistence CRT (the trace that fades slowly).

The panoramic adapter is actually a receiver whose local oscillator frequency varies in a sawtooth manner around the receiver IF frequency. Instead of producing audio, the level of a signal at the current frequency is displayed as a vert pip whose height is relative to the signal's instantaneous level. A sawtooth oscillator drives the CRT horizontal trace and also varies the local oscillator frequency via a "Varicap" diode. The panadapter itself has a low frequency IF and usually a sharp filter (on the order of a few hundred hertz). to give reasonable frequency resolution on the CRT. The vertical pip amplifier is adjustable, and in many panadapters its gain can be made linear or logarithmic when monitoring large signals alongside weak signals.

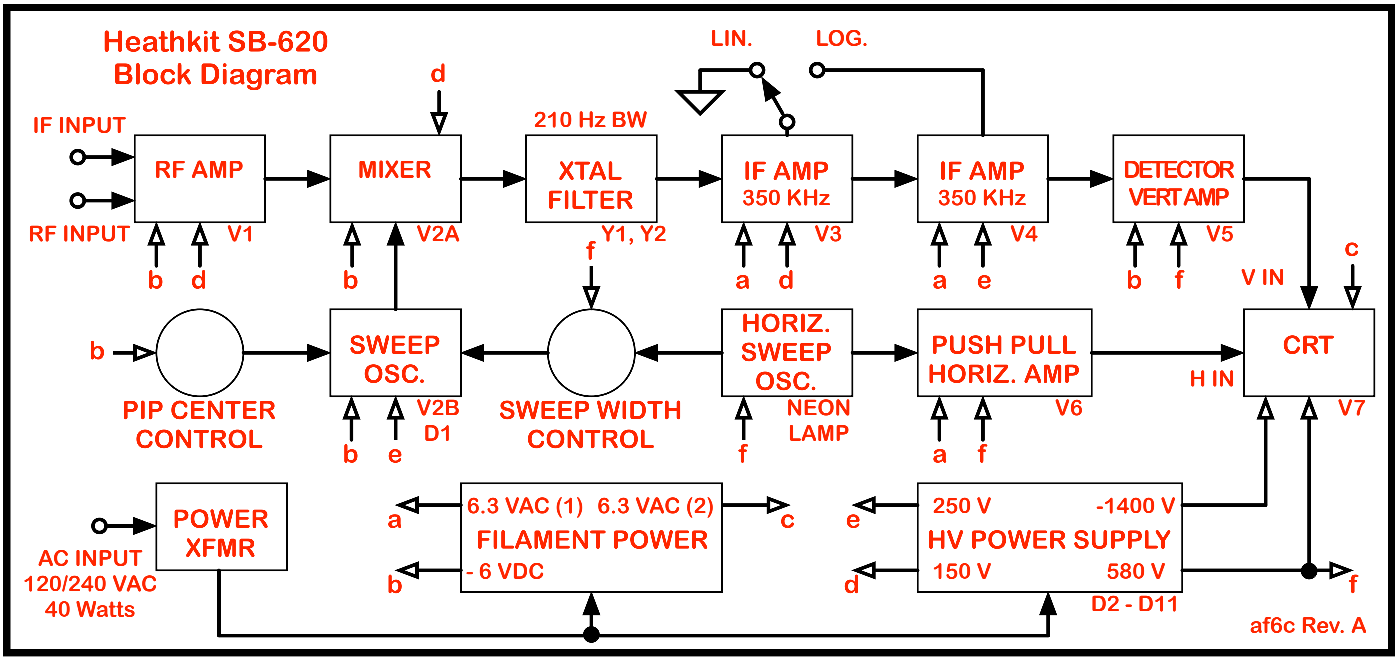

Figure 4: SB-620 expanded block diagram. Lower case letters track back to the Power supplies.

a. A 6.3 VAC @ 3A winding, isolated from ground, that powers the filaments of V3, V4 and V6.

b. Approximately –6 VDC (bridge rectified and well-filtered), from the same 6.3 volt winding as (a), that powers the filaments of V1, V2 and V5. The positive side of this supply is grounded. The use of DC for these filaments reduces hum from being introduced into the signal from the receiver. The –6 VDC also provides negative DC bias for the **PIP CENTER CONTROL**.

c. A second 6.3 VAC 0.6A winding, well insulated and isolated, that powers the filament of the CRT.

The High Voltage (HV) Power Supply provides four DC voltages:, +150 V, +250 V and +580 V from a voltage doubler circuit using the 225 V winding, and –1400 V from a voltage doubler circuit from the 600 V winding.

d. +150 VDC dropped and filtered from the 250 VDC supply (e). that powers the RF amplifier, mixer and first IF circuits.

e. 250 VDC developed from lower half of the 580V voltage doubler that powers the sweep oscillator and the second IF amplifier.

f. 580 VDC output of the full voltage doubler that powers the horizontal sweep oscillator and the horizontal amplifier.

g. –1400 VDC for the CRT.

SB-620 RF Amplifier (V1):

The 6EW6 RF amplifier has two inputs. The **RF INPUT** only comes into play when the SB-620 is being used as a spectrum analyzer with an external signal generator. It is coupled to the cathode of V1. A 20 dB attenuator can be switched in if needed to reduce the input signal. The **IF – SIG**nal **GEN**erator **INPUT**, when using the SB-620 as a scanner, connects to the receiver IF. This signal is coupled through the PIP GAIN control to the grid of the RF amplifier. A 350 kHz trap composed of L1 and a 470 pF capacitor keep the SB-620 IF from being fed back into the receiver. The output of the RF amplifier is coupled to the mixer via one of three circuits depending on the receiver’s IF frequency. The three circuits are shown on the schematic. Circuit #1 is for receivers with a 455 KC IF. Circuit #2 is for receivers (such as the Heathkit SB-300, 301, 303 and 310) with a 3395 kHz IF. And circuit #3, a generic circuit for receivers with other IFs listed in the specifications.

IF CHART FOR SB-620 SWEEP OSCILLATOR

RECEIVER IF (kHz)	OSCILLATOR COIL L3	R1 10 KHZ SWEEP	R2 50 KHZ SWEEP	C3 (pF)	C4 (pF)
455	40-775* (123 µH)	820 KΩ	100 KΩ	260	75
1000	40-775* (123 µH)	10 MΩ	100 KΩ	260	(none)
1600 1680 2075 2215	40-808 (44 µH)	10 MΩ	1.5 MΩ	470	56
2445	40-808 (44 µH)	18 MΩ	1.5 MΩ	470	56
3000 3055	40-776 (23.6 µH)	22 MΩ	3.3 MΩ	470	56
3395	40-776 (23.6 µH)	22 MΩ	5.6 MΩ	470	56
5200 6000	40-807 (4.8 µH)	22 MΩ	3.3 MΩ	470	56

***A value of 260 pF (two 130 pF capacitors in parallel is used at C3 with coli 40-775.**

TABLE IV

SB-620 Sweep Oscillator (V2B, D1):

The sweep oscillator (the triode section of a 6EA8) operates at a nominal frequency 350 kHz above the receiver’s IF frequency. It is a simple Hartley oscillator. The components (including L3) used in this circuit vary, depending on the IF frequency of the receiver it is to be used with. **TABLE IV** lists these components. All components for the listed IF frequencies are supplied with the kit.

D1 is a varactor diode. This diode acts as a variable capacitor. It never conducts, as it is back biased. Its capacitance depends upon the amount of reverse bias voltage applied. The diode is a MV1638 and is specified to have a capacitance of 33 pF when the bias is –4 volts. As the bias increases the capacitance decreases until, around –20 volts the capacitance is about 13 pF. The bias is supplied by the sawtooth horizontal sweep oscillator that drives the horizontal trace on the CRT. The sawtooth voltage is summed with a negative DC voltage set by the **PIP CENTER** control. This control aligns the center of the IF frequency to the horizontal center of the CRT screen. The width of sweep may be set by the **SWEEP WIDTH** switch and **VARIABLE SWEEP WIDTH** control. Two fixed sweep widths are provided 10 kHz (±5 kHz) and 50 kHz (±25 kHz). The VARIABLE SWEEP WIDTH control is still active in the fixed sweep switch positions to allow making small calibration corrections. The nominal position of this control is determined during calibration.

SB-620 Mixer (V2A):

The Mixer circuit combines the sweep oscillator output with the RF amplifier output in the pentode section of a 6EA8. One of the mixer outputs is the difference between these two signals and is around 350 kHz.

As an example, say your receiver has an IF of 3395 kHz and you have the bandwidth set at 50 kHz (±25 kHz). Thus you will be displaying signals between 3370 kHz and 3420 kHz around the receiver IF. The output of sweep oscillator then must sweep between 3720 kHz and 3770 KHz and then return quickly back to 3720 kHz. As it sweeps the 350 kHz output samples a small piece of the waveform the IF is seeing. **Figure 5a** shows a typical waveform within the passband of the receiver with signals at 3377.5, 3388.7, 3395, 3408.7 (with sidebands) and 3416.2 kHz. Due to the selectivity in the actual receiver, only the signal at 3395 is heard in the receiver. **5b** shows the sweep oscillator at at 3725 kHz. The 350 kHz difference (shown in the narrow unshaded area) appears at the output of the mixer. As the narrow area sweeps up in frequency (**5c** and **5d**), the mixer output is filtered, amplified, detected and fed to the vertical plates of the CRT. Meanwhile the same signal that drives the sweep oscillator is fed to the horizontal plates, moving the CRT beam, drawing the trace on the CRT screen (**Figure 5e**).

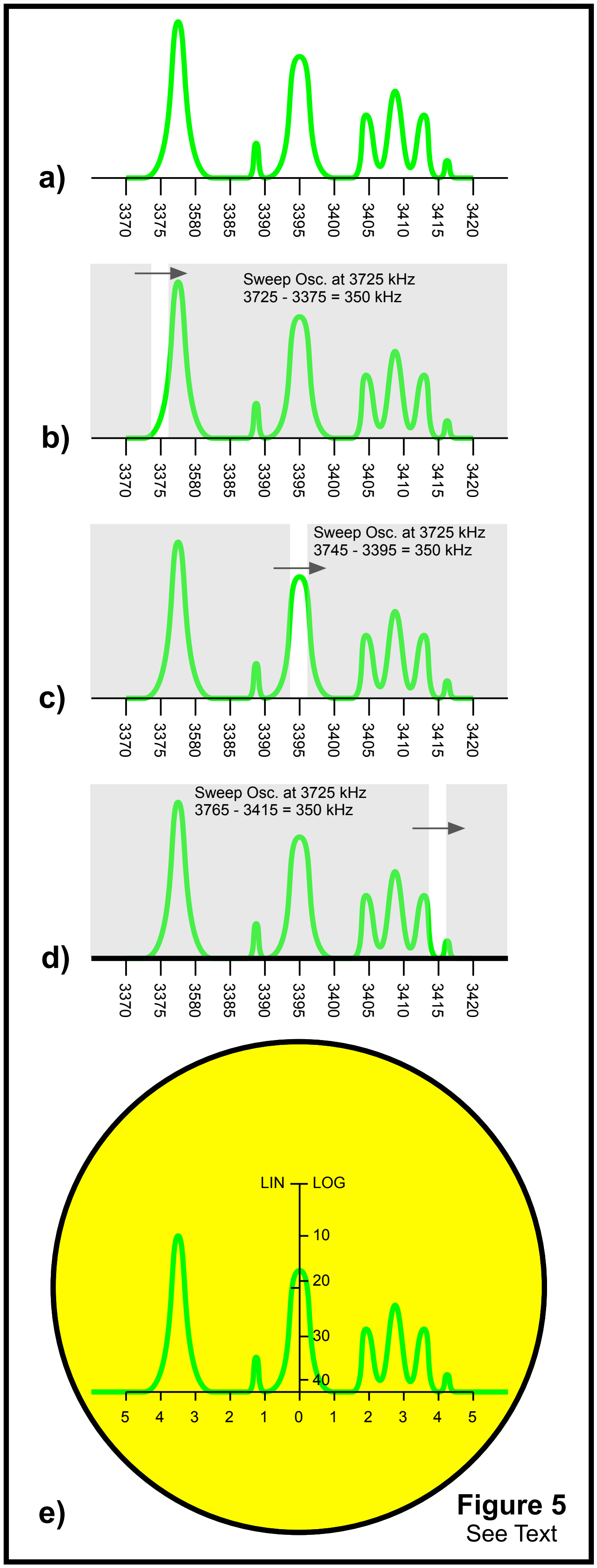

Figure 5
See Text

SB-620 Xtal Filter (Y1, Y2):

The output of the mixer is fed to a very sharp crystal filter with a bandwidth of about 200 Hz which makes the gap shown in **Figure 5b, c** and **d** about 12 times narrower than depicted in the drawing, significantly increasing the resolution of the trace on the CRT. T1, along with crystals Y1 (350.000 kHz and Y2 348.850 kHz create this narrow filter. This filter also removes the unwanted sum product as well as the two mixing signals that are also present at the mixer output.

SB-620 350 kHz IF Stages (V3, V4):

The filtered signal is amplified by two stages of IF amplification prior to detection. The first stage uses V3 a 6EW6 pentode and has three

SB-620 “Scanalyzer”
Tube, Lamp Line-up

No.	Tube	Type	Function
V1	6EW6	Pentode	RF Amplifier
V2A	½-6EA8	Pentode	Mixer
V2B	½-6EA8	Triode	Sweep Oscillator
V3	6EW6	Pentode	1st IF Amplifier
V4	6AU6	Pentode	2nd IF Amplifier
V5A	⅓-6AT6	Triode	Vertical Amplifier
V5B	⅓-6AT6	Triode	Detector
V5C	⅓-6AT6	Diode	not used
V6A	½-12AU7	Triode	½ Horizontal Amplifier
V6B	½-12AU7	Triode	½ Horizontal Amplifier
V7	3RP7(A)	CRT	Cathode Ray Tube
none	NE-83B	Neon Lamp Voltage Regulator / Pilot lamp	
none	NE-83B	Neon Lamp Horizontal sweep oscillator	

SB-620 “Scanalyzer”
Solid State Line-up

D1	MV1638	Sweep Oscillator Varactor.
D2	P3340HQ	Selenium HV Voltage doubler
D3	P3340HQ	Selenium HV Voltage doubler
D4	1N2071	¼ B+ Silicon Voltage Doubler
D5	1N2071	¼ B+ Silicon Voltage Doubler
D6	1N2071	¼ B+ Silicon Voltage Doubler
D7	1N2071	¼ B+ Silicon Voltage Doubler
D8	1N2071	¼ Filament Silicon FW rectifier
D9	1N2071	¼ Filament Silicon FW rectifier
D10	1N2071	¼ Filament Silicon FW rectifier
D11	1N2071	¼ Filament Silicon FW rectifier

Table IV: HO-10 & SB-610 Tube Line-up

gain settings depending upon the selected sweep width. The gain is controlled by switching in different cathode resistances. When the **AMPLITUDE SCALE** switch is in the **–20 DB LOG** position a negative voltage is applied to the control grid of V3 reducing its gain. This voltage is set by the **–20 DB LOG ADJ.** trimpot located in the back of the chassis just above the **20 DB ATTEN.** slide switch.

The second IF stage uses V4, a 6AU6 pentode. The tube’s gain can either be linear or logarithmic depending on the position of the AMPLITUDE SCALE switch. In the **LIN** (linear) position the control grid is grounded through a 220 KΩ resistor (R43) and the bias is set by a positive DC voltage applied to cathode across R45. When the AMPLITUDE SCALE switch is in either the **LOG** or the −20 DB LOG position two things occur. The positive voltage to the cathode is changed by an adjustable amount by the rear panel **LOG. ADJ**. potentiometer (R47). At the same time the detected IF signal is fed back to the grid of V4 through R43, reducing the gain on strong signals and causing the response of V4 amplification to become logarithmic. (R47 is set during calibration.)

SB-620 Detector & Vertical Amplifier (V5):
V5 is a three section tube consisting of two diodes and a triode. One diode is not used and its anode (pin 5) is grounded. the IF signal is coupled through IF transformer T3 to the other diode anode (pin 6). The cathode is grounded, thus a negative voltage which is an image of the waveform, in the form set by the AMPLITUDE SCALE switch, appears on pin 1 of T3. This negative voltage signal is fed back to V4 when a log scale is selected, as discussed in the previous section. It is also fed to the grid of the triode section of V5. Depending on the SWEEP WIDTH switch different capacitors are switched in to correct the gain for the different sweep widths. The inverted (positive going) waveform goes to pin 10 of the CRT. This is deflection plate D1. A positive voltage on D1, with respect to D2 results is the beam moving upward on the CRT screen. D2 is at a fixed voltage set by the **VERT. POS.** adjustment pot located on the rear panel.

SB-620 Horizontal Sweep Oscillator (NE-83):
To create the sawtooth signal used to move the CRT trace from left to right and quickly back to the left Heathkit utilized a simple neon lamp relaxation oscillator. A basic schematic of the circuit is shown in **Figure 6**. It is basically a voltage source charging a capacitor (C43) through a resistance. The resistor and capacitor form an RC circuit. A neon bulb is across the capacitor but will not conduct until its firing voltage is reached (nominally about 80V.) When the neon bulb conducts, it quickly discharges the capacitor to the voltage that can no longer keep the gas ionized (nominally 60V.) The bulb then stops conducting and the capacitor starts charging again. This continues to cycle and produce a semi-sawtooth wave. An RC circuit such as this does not produce a linear ramp. To counter this problem a significantly higher voltage than required is used for the source. In the case of the SB-620 it is nearly 600 V so only a small portion (20V) of the curved ramp is used and the linearity is thus quite close to linear, yet the circuit is cost effective.

The resistance controls the actual sweep rate. Three sweep settings may be selected by the SWEEP WIDTH switch. The VARIABLE SWEEP RATE control is active in all three positions allowing correction of the 10 kHz and 50 kHz positions for more precise monitoring. This correction may be done using the receiver's crystal calibrator.

SB-620 Horizontal Amplifier (V6):
V6 is a 12AU7 twin triode tube. The two sections in a push-pull configuration coupled by R66, a common cathode resistor. The grid of triode V6A is directly coupled to the horizontal sweep oscillator through the rear mounted **HOR. WIDTH** control. This adjustment determines the length of the horizontal trace and is set to just cover the full width of the CRT screen. The grid of triode V6B is connected to a DC voltage through R62, the HOR. POS. control that sets the horizontal position of the trace on the CRT. The plates of these two triodes are each connected to the +560V supply through a 220 KΩ load resistor and to the CRT horizontal deflection plates of D3 and D4

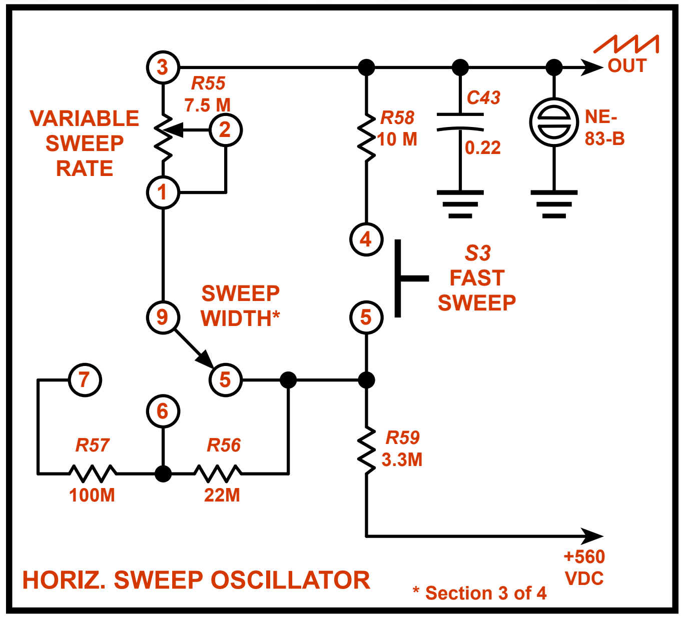

Figure 6: Horizontal Sweep Oscillator Circuit.

SB-620 CRT Circuit (V7):
V7 is a 3RP7 CRT. Some of the SB-620s may have come with the later 3RP7A with a flat face CRT. What makes this tube special is that it has a high persistence P7 phosphor coating on its screen. Most people are familiar with the green P1 phosphor of many early CRTs or the white P4 phosphor used in black and white TVs. The P7 phosphor was used in many radar systems. It is noted for the trace it creates on the screen. When seen through a blue filter it is a short persistence trace. However, when viewed through a yellow filter the high persistence trace remains on the screen for a longer time. Since the sweep of the "Scanalyzer" can be quite slow (up to 2 seconds to sweep across the face of the CRT with some sweep settings) the long persistence makes the trace remain visible for seconds.

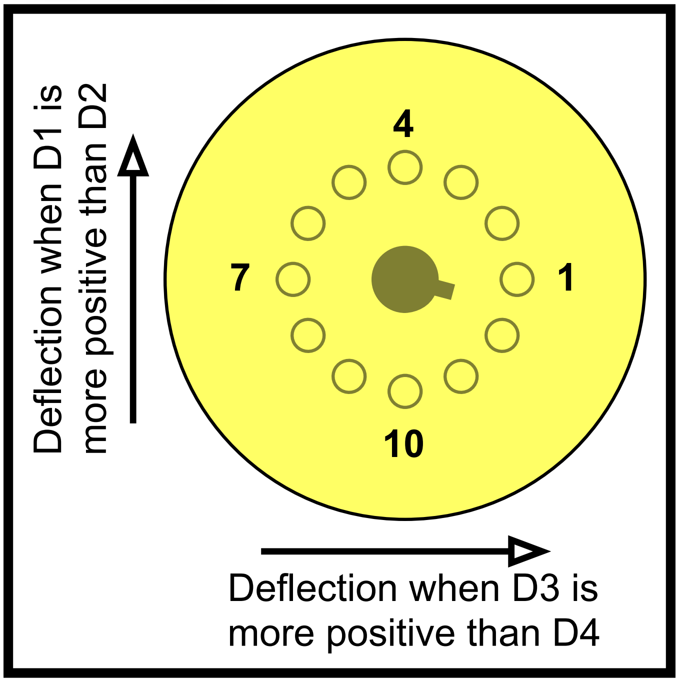

Figure 7: Orientation of the CRT in the SB-620. Pin 4 is at the top and directions are shown. View is looking at the front face of the tube; The two deflection angles are specified to be within 3° of each other, but the deflection angles can be up to 10° from their pin orientation. A simple rotation of the tube will correct this during calibration. D1 - D4 are the deflection plates of the CRT.

In past HotM articles scopes and the circuit for the CRT have been discussed numerous times. There is also a May 2018 TechTalk article #51[6] that discussed the basics of CRTs so little else needs to be said. However, one point that isn't mentioned in the Heathkit documentation is the deflection of the beam in relation to the voltages applied. **Figure 7** defines this. In the SB-620 the 12-pin CRT is mounted with pin 4 at the top. As oriented, deflection plates D1 and D2 control the vertical position of the beam and that direction is up (towards pin 4) when the voltage on D1 is more positive than D2. The typical vertical deflection is about 120V/in. Likewise deflection plates D3 and D4 control the horizontal position of the beam and that direction is to the right (towards pin 1) when D3 is more positive than D4. The typical horizontal deflection is about 87V/in.

Assembling the SB-620:

The SB-620 was a surprise in that it used only point-to-point wiring and no printed circuit boards. The same is true of the SB-610 Monitor Scope. Construction begins by installing all the major components on the chassis. This is followed by installation of the components on the front panel. The panel is next secured to the chassis by five potentiometers that mount through both panel and chassis. The **INTENSITY** control with its plastic shaft mounts using a threaded phenolic spacer due to the high voltage on the control. This control also has the off – on power switch.

Initial wiring involves connecting the transformer leads and connecting lengths of hookup wire from one point to another. It also involves preparing the CRT socket and wiring its leads to the chassis. The factory assembled wiring harness is installed next and wired to its correct points on the chassis. Up to this point no leaded components have been installed.

Wiring of the front panel occurs next with leaded components connected to the AMPLITUDE SCALE and SWEEP WIDTH rotary switches, and the VARIABLE SWEEP RATE and HORIZ. POS. potentiometers. Depending on IF frequency selected, the correct values of R1 and R2 are selected and installed on the SWEEP WIDTH switch. The sections of the wiring harness that come up through a hole in the chassis are connected to the top front panel controls next. With the unit positioned on its top, under chassis components are wired in place, including components that attach to the rear panel; the line cord is attached.

At this point in time there is one area still open on the bottom of the chassis. This section is now wired in one of three ways depending on the selected IF frequency:

- 455 kHz.

- 1000 kHz, 1600 kHz, 1680 kHz, 2075 kHz, 2215 kHz, 2445 kHz, 3000 kHz, 3055 kHz, 5200 kHz, or 6000 kHz.
- 3395 kHz.

Each way has its own wiring section in the manual, and each takes up two full manual pages.

Finally the CRT in installed with lots of WARNING about the dangers of handling the CRT with its high internal vacuum and the chance of implosion. The CRT mounts in a mu-metal shield to prevent magnetic interference from distorting the CRT trace. Knobs are then installed as well as the blue and white identification label that gives the model and series information needed for parts ordering or technical help from Heath Co. SB-620 checkout then starts.

SB-620: Checkout:
The controls are first preset per a list in the manual. Then resistance checks are made to make sure there are no errors that might cause damage. Those checks are shown in **Table V** which also correlates the un-descriptive terminal designations given in the manual to the corresponding point on the circuit diagram.

With the proper resistances confirmed, the remaining tubes, fuse and filter crystals are installed, and with the control presets confirmed, the power cord is plugged in and the INTENSITY control is turned clockwise to about the 2 o’clock position. The pilot lamp should light and a horizontal trace should appear. If not, the HORIZ POS and VERT POS controls should be adjusted until it does. The manual discusses a procedure to rotate the CRT so the trace is horizontal with screen graticule. If everything appears to be functioning properly the unit is left on and the neon lamps are aged for an hour before alignment begins.

INITIAL RESISTANCE CHECKS:

Terminal strip C, lug 1: (Junction of R79 and C47: –1400 V)	8 MΩ
Terminal strip M, lug 2: (Junction of C51– and C53C: 250V)	40 KΩ
Terminal strip N, lug 2: (Junction of C51+ and R81: 560V)	300 KΩ
Capacitor S, lug 1: (Junction of C53B and R82: 150V)	40 KΩ
Terminal strip R, lug 4: (Junction of D8 and D10: -6V)	8 KΩ

NOTES: that these checks are taken prior to the tubes (excluding the CRT) being installed.

Table V

SB-620 Alignment:
The Alignment of the SB-620 is a long procedure and won’t be covered in this article. The manual offers two different alignment procedures. The recommended procedure requires a ***“calibrated RF signal generator with adjustable output control”***. The second procedure, if an RF generator is not available, requires the SB-620 to be connected to its receiver. The two procedures combined cover about 10½ pages in the manual. They are not difficult to perform, but are lengthy.

SB-620 In Action:
The common use of the SB-620 is to scan the band above and below your frequency. Usually it is set to scan ±250 kHz so you have a good idea of other signals on the band. It can tell you if there is a “pileup” in that range; handy if you are chasing DX. It’s also good when the band seems dead and you are looking for signals. When you are receiving splatter from a station, it is often possible to detect which signal is causing the problem, when it is in the 500 kHz bandwidth, by seeing which blip appears and disappears along with the interfer-

ence. It's also great to detect when one of your local friends are on the air. If there is a strong blip you can switch the AMPLITUDE SWITCH to the LOG position to make it look less imposing along with the other signal blips; actually this is where I normally used to keep it set.

Restoring an SB-620:

Scanalyzers often appear on eBay. If you are looking for one there are a few things you need to be careful about. First, be sure the unit you are buying is wired for the IF you need. Unless you are experienced at winding coils you will find it very difficult to obtain the needed coils to rewire to a different IF. Especially difficult is the part # 52-101 bandpass transformer used for the 3.395 MHz IF. Even though the kit came with a full set of coils, by now the unused coils have been misplaced or used somewhere else. Also, since a majority of the kits were probably wired for the 3.395 MHz IF frequency, if you end up with an SB-620 wired to a different IF and want to rewire it to 3.395 MHz, finding the needed coils (40-776 and 52-101) will be next to impossible 40-776 is nominally 23.6 µH so you may be able to rewind one of the coils. The bandpass transformer, 52-101 is really just two toroid wound coils, each 18.3 µH, cemented to an empty coil form (no slug). Since they are wound on toroids there is no mutual coupling between the windings (assuming they are spaced a bit). Coupling occurs due to the common capacitor C21 (1800 pF) Also since the capacitance across each coil is 130 pF in series with 1800 pF (121 pF), each 18.3 uH coil resonates very near 3.395 MHz. Winding two 18.3 µH toroid coils on cores efficient at 3.4 MHz and gluing them onto a spare coil form (See **Figure 8**) would probably make a good starting point for a replacement.

Other things to lookout for are the crystals, the transformer and the CRT. The two crystals used in the SB-620 are part of the narrow crystal filter and would be expensive to purchase. Heathkit sold the crystals as a matched set (Part # 404-304). They should probably still be good, so just make sure they are there and marked with the correct frequencies (350.000 and 349.850 kHz).

The transformer is known to be a weak link; I can confirm that. The 600V winding has been known to open up and the CRT filament winding insulation has been known to breakdown. Some success was achieved repairing the transformer by dissolving varnish and transformer tar in 91% alcohol and squirting it in the filament lead hole. The breakdown evidently occurred near the opening. This fix only worked for a year or so.

The 3RP7(A) CRT is also hard to find, so check the face of the CRT for burns and, if possible be sure it is in good condition. If your 3RP7 CRT does test bad, you can replace it with the more common (yet still rare) 3RP1. You'll lose the high persistence trace, but it will still be useable. the earlier HO-13 uses the 3RP1.

It is a good idea to replace the can filter capacitors and other electrolytic and tubular capacitors; especially the three high voltage capacitors (2 ea. 0.1µF @ 1200V - C48, C49 and 1 ea. 0.15µf @1600V, - C47). Unless they are bad, don't replace the two HV selenium rectifiers. They add some protection to the transformer that a HV silicon diode doesn't. A kit for replacing the old capacitors in the SB-620 including the can capacitor is available from Hayseed Hamfest[7].

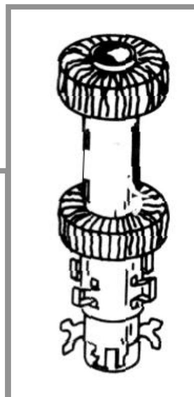

Figure 8: Part #52-101 bandpass transformer showing the two toroids mounted on a coil form. Image is of the factory supplied part from the Heathkit SB-620 manual.

An SB-620 Weakness:

While it does the job it is supposed to do, the SB-620 has a few quirks. When hooked up to the SB-300/301 the pickup point is the plate of the second mixer. This is just before the SB-301 crystal filter. At the filter's center frequency its impedance is low. Off of the center frequency the impedances is higher. Thus signals at the center frequency appear attenuated on the screen to some extent. It is most noticeable tuning across the crystal calibrator marker. To add to this problem the receiver's RF stage is reduced on strong signals due to the ALC action of the receiver, further reducing the size of the pip. People have tried installing a simple transistor amplifier in the line from the receiver, and while this helps provide a bigger pip height, it doesn't solve the actual problem.

Conclusion:

Until the power transformer gave out, the SB-620 was a nice addition to the shack. Late at night I'd often turn the receiver on with the audio down and have the scope scanning the band as I read or studied. Many times I picked up a pip and tuning to that frequency pick up a station out in the pacific or down under. Our club net used to meet on 21.375 MHz [± QRM] in the evening. As net control back then the scope also let me find a nearby quiet spot on occasions when the band remained open and active. in the evening.

Things have been busy here.I actually started this article in October of last year, scheduled for the November issue of RF. Other things kept me away from completing it until now. Hopefully I'll have another (smaller) article in a month or two.

My ham shack was disassembled so new windows could be installed in the house. The process of getting the shack back together has been slow. It just seemed like a good time to recap and realign the SB-301 and SB-401, and to replace resistors that have changed value with new metal film resistors. Also the SB-220 linear amplifier has been sitting unused for a few years and needs a good cleaning to remove any dust that might cause arcing.

73, from AF6C

Remember if you are getting rid of any old Heathkit Manuals or Catalogs, please pass them along to me for my research.

Thanks - AF6C

Notes:

1. Maximum sweep width at 455 kHz is limited to 100 kHz (±50 kHz).
2. The 1967 810/67A catalog was mailed in early September of 1966.
3. A Quality copy of the SB-620 manual (80 pages) is available for $20 plus shipping at: https://shop.heathkit.com/page/vintage-replacement-manuals
4. A procedure is presented in the manual during calibration to find this settings of the sweep width control so it can be set when needed without recalibrating.
5. The full SB-620 schematic is available at: https://www.w6ze.org/Heathkit/Sch/SB620_Sch.pdf
6. The TeckTalk article on CRTs is available online at: https://www.w6ze.org/btt/BTT051A.pdf
7. A capacitor kit for the SB-620, as well as many other ham receivers and transmitters is available from: https://hayseedhamfest.com