Refurbishing the Heathkit SB-610

and

"The 610C-2 Makeover"

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Collins Radio Association

http://collinsra.com/index.html

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Introduction

The Heathkit SB-610 Monitor Scope, although not as popular today as it was 20 years ago, is relatively inexpensive and available through Hamfests and Web-based auction sites. Not only can it check transmitter signal characteristics but also monitor signals from other stations when used in conjunction with a receiver.[i] With its built-in two-tone test generator [a hard to find accessory of late], the SB-610 is one of the best-suited piece of test equipment to analyze a transmitted signal that may look good on a meter but sound terrible to the receiving station. You see what you are actually transmitting. It was for these reasons I embarked on a project to extend its life and better integrate it with my Collins gear. Although documented in 2007, I offer it now to those wishing to duplicate it.

Refurbishing

I began by refurbishing my '610 based on its current condition rather than attempt a complete rebuild. With instruction manual in hand, a list of currently available components matched to the original Heathkit part numbers was compiled. You will find that list below along with a revised schematic diagram free of errors noted in the initial and subsequent Heathkit manuals. Also included within the schematic is a modification by K6SDE that will prevent additional CRT phosphor damage. And finally, since the SB-610 does not present itself well next to my KWM-2, I have included a procedure to customize the front panel to match your Collins KWM-2 or S-Line equipment.

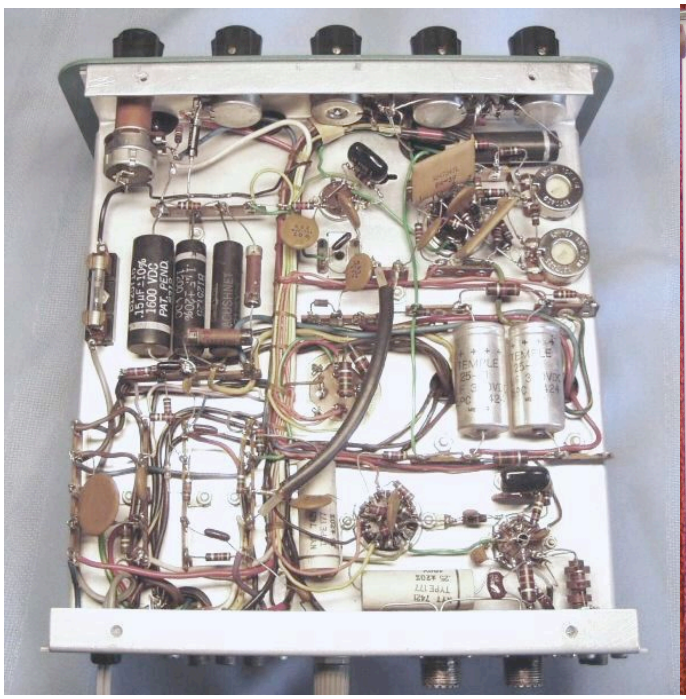


Figure 1, Original Condition

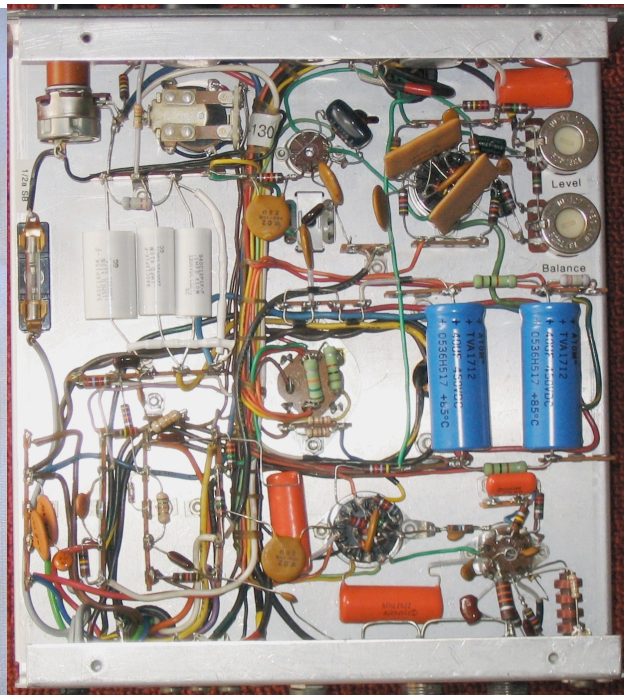


Figure 2, Refurbished Condition

Figure 3, C602 Replacement

This particular SB-610 was evidently built by a real craftsman. The unit is well laid-out and neatly soldered; a text book example of how a kit should be assembled. Still, I inventoried, measured and inspected for damage all capacitors and resistors.[ii] Two resistors were replaced with higher wattage values as their color bands had disintegrated from overheating. Although leakage measurements showed that none of the mica capacitors were defective, four capacitors were leaking during the initial voltage checks and subsequently replaced. None of the front panel controls or switches required replacing but was in need of a thorough cleaning with DeOxit. All control shafts and detents were lubricated with WD-40.

All component changes are reflected in my parts list below.[iii] For example, a few ½ watt resistors were changed to 1-watt ratings and old diodes were replaced to improved reliability. This was done to increase the PIV rating due to the elevated line voltage [127 VAC] common at my Long Island location, and to replaced the poor quality selenium rectifiers originally supplied. For example, diodes D5 and D6 were replaced using two, series connected 1N4007 diodes and redesigned D5A-D5B and D6A-D6B, as noted on the schematic. A few components were replaced for reasons such as nicked wire leads and other physical damage.

As far as the electrolytic capacitors, all were removed and replaced. I didn't test them. I consider all electrolytic caps bad. As noted on the parts list below, a replacement for the four-section, 30-20-20-20uf electrolytic C602, was available from DK Distributors as a made-to-order part identical to the original.[iv] Since his vendor does not assign part numbers one must describe the values, the pin layout, and the physical proportions when ordering. Better yet, send along your old cap as I did. All internal components supplied within the new steel case were fresh; no "NOS" parts were used. Also, be sure to request a new mounting plate with your order. At the time of my purchase [2006], DK Distributors accepted telephone, U.S Mail, and FAX orders only. They did not accept email or Internet orders.

As a backup to the above, C602 could be rebuilt. Try cutting the original container to reuse the base terminals. I've seen this on the Internet. All it takes is a little improvising and the desire to succeed. Consider the caps above the chassis; terminals below (I don't recommend wiring all new caps below due to space limitations). But I did consider using a small, aluminum, mini-box early in the project. The end result is it's not necessary to rebuild this device to what is should look like, but to rebuild it to how it should perform; hopefully, better.

Are the original tubes in good condition? Unsure, two complete sets were purchased just to have on hand. In the end, every tube in my working SB-610 had to be replaced when voltage checks confirmed the need. The complete set consists of a 6BN8, 6EW6, 6C10, 6J11, and a 3RP1 CRT if necessary. My 3RP1 CRT had to be replaced due to considerable phosphor damage across the center of the display. A brand new 3RP1A was located. Either type is usable in the SB-610.[v]

Schematic Diagram

Both the schematic diagram and parts listed below include all component changes.[vi] This schematic is formatted to print in landscape on any paper size including the larger 11 x 14 stock, assuming your printer supports that capability. The 11 x 14 inch paper matches the original size schematic found in the Heathkit manual. Otherwise, the schematic will default to standard 8.5 by 11 inch paper. With all this being said, understand that this document is directed towards Collins and other receivers requiring a 455 kHz receiver IF. The SB-610 included optional components for different IF frequency ranges up to 6 MHz. All but the 455 kHz IF components have been removed. Refer to the Heathkit manual for the additional IF components. Receivers using 9 MHz IF circuits may also be used.[vii]

With the 455 kHz IF option installed, the vertical input impedance is 100K which equates to 70mv/inch deflection. A 12pf capacitor coupled to the plate of the last IF worked well in my KWM-2 without noticeable signal loading. In order to view far more accurate signals additional bandwidth is necessary. Try a voltage divider consisting of a series 0.001uf and a 47k ohm resistor to ground at the plate of the receiver's first mixer.[viii]

Front Panel, Bezel and Cabinet

I was inspired to restyle the front panel on my SB-610 in order to complement my KWM-2 and matching accessories. I began work on the front panel after purchasing a set of nine pointer knobs and a logo.[ix] Aluminum primer, Collins front-panel paint, trim-ring paint and cabinet gray paint was ordered from *Surplus Sales of Nebraska*,[x] J-B Weld, a readily available cement from a local auto-parts store was used to fill in two Heathkit medallion holes in the front panel. The panel was then sanded and primed.

In order to obtain a more exact Collins finish, black wrinkle paint for the first and second base coat was used followed quickly by evenly heating the panel over the kitchen stove. This technique emphasizes and hardens the wrinkle texture. Two coats of dark panel-gray spray completed the job. The CRT bezel received two coats of RustOleum Satin-Black spray, #7777-830. Since wrinkle paint on an aluminum surface can be one of trial and error, check the Internet for some helpful hints.[xi]

When preparing the cabinet for painting I found it unnecessary to completely strip the original paint. A light sanding followed by a quick dishwasher cycle removed leftover dust and surface grease. The heat cycle provided an ideal primed surface for fresh paint. Two coats of cabinet gray, and eight hours baking in the hot August Sun, completed the process. The following weekend I repeated the process for the trim-ring. The final result was a perfectly dried and hard finish. But the cabinet seemed to need a bit more luster, so my XYL suggested a moderate dry polishing with a house-hold cleaner such as 'Soft-Scrub;' followed by a rinse in the kitchen sink. Polishing it dry with an old bath towel was all it needed to produce a factory fresh; gloss finish.

Since the project was completed, I read that paint matching Collins paints could be found at local hardware/paint stores. Bring along a cabinet and to match the colors required. Surplus Sales supply Collins paints and are numbered as (COL)PAINT-250 Front Panel Gray, (COL)PAINT-180 Cabinet Gray and (COL)PAINT-126 Trim-Ring Gray.

With the panel fully dry apply the press-on lettering. If this is your first attempt at lettering a wrinkle finish you may want to practice on a test panel. Rather than rub the transfers as instructed, finger pressure is the ideal way to transfer the lettering on this finish. Rubbing is not recommended or tearing will result!

The panel was lettered with press-on lettering transfer kits from Ocean State Electronics.[xii] I'll address the 'detent lettering' next. Two sets of K61W lettering and one set of K62 for the detent lines were ordered. While you apply the transfers, protect the previously areas using one of the backing sheets supplied with the lettering. The backing sheets will prevent "lifting" from skin contact.

Detent Guides

I've been asked about this more than any other task. "How do I match the switch detent lettering to the detent positions?" Here's how: Create a "transfer-template" represented by Figure 4A, below. To correctly align the detent positions two detent guides was created. These guides transfer the correct angle and position for the two rotary switches used. After the panel is primed and painted, the guide is re-positioned it as illustrated in Figure, 4B. One guide goes under the SWEEP switch and a taller guide for the TONE GENERATOR switch. Detent lettering is applied before apply the switch nomenclature. Lettering must be protected to prevent lifting or pealing.

Unsolder and remove the three-position SWEEP switch. With the front panel in hand, insert the switch through the panel with a 3/8" hole punched the card stock. See Figure 4A. The hole size should be identical to the hole in the panel. Insure card is square and the switch is secure. A vertical draw a line drawn through the center of the guide will help with alignment. Install the pointer knob and confirm the center detent is perfectly vertical. The Collins knobs I used were the ¼", round shaft used with a setscrew.[xiii]

With certainty that the dots and the vertical reference are correct, secure the guide by bending them around and over the top of the front panel. Secure with blue painters-tape to insure the detent guide remains stationary. Do one card at a time. At the center detent position, place a dot on the card at the tip of the knob's pointer. Rotate the switch and repeat this for each of the other detent positions.

Detent Guide

Figure 4A

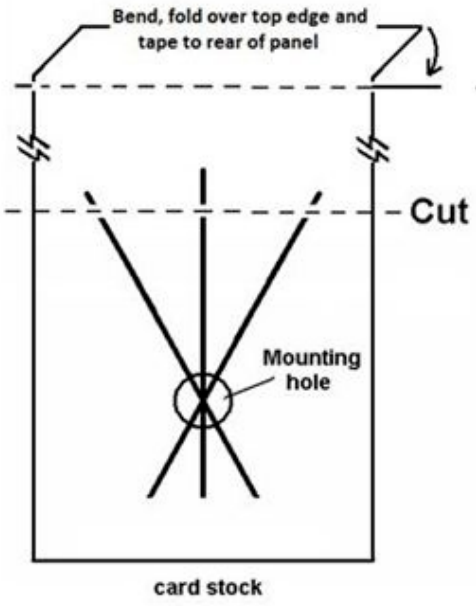
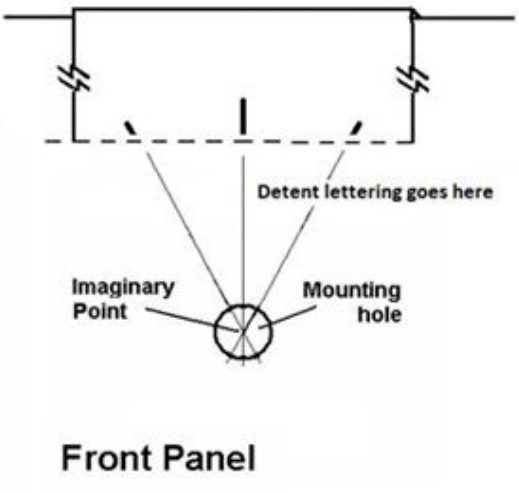


Figure 4B



Remove the switch and with a straight-edge, draw a line through each dot and the center of the mounting hole as accurately as possible forming an imaginary point of reference for the switch's pivot. The lines should extend across each side of the mounting hole as in Figure 4A. Replace the switch and knob to confirm the detent and vertical reference is correct. Remove the components and place the detent guide aside until the front panel is ready for lettering.

Assuming the panel is ready for lettering, reinstall the guide and secure with tape behind the front panel. Cut the guide where indicated and secure above that cut as shown in Figure, 4B. Apply the lettering to intersect the lines on the guide through the imaginary point within the 3/8" hole. I recommend a blank piece of "backing sheet" just placed over each line. When completed, remove the guide and carefully reinstall the switch. Secure the switch

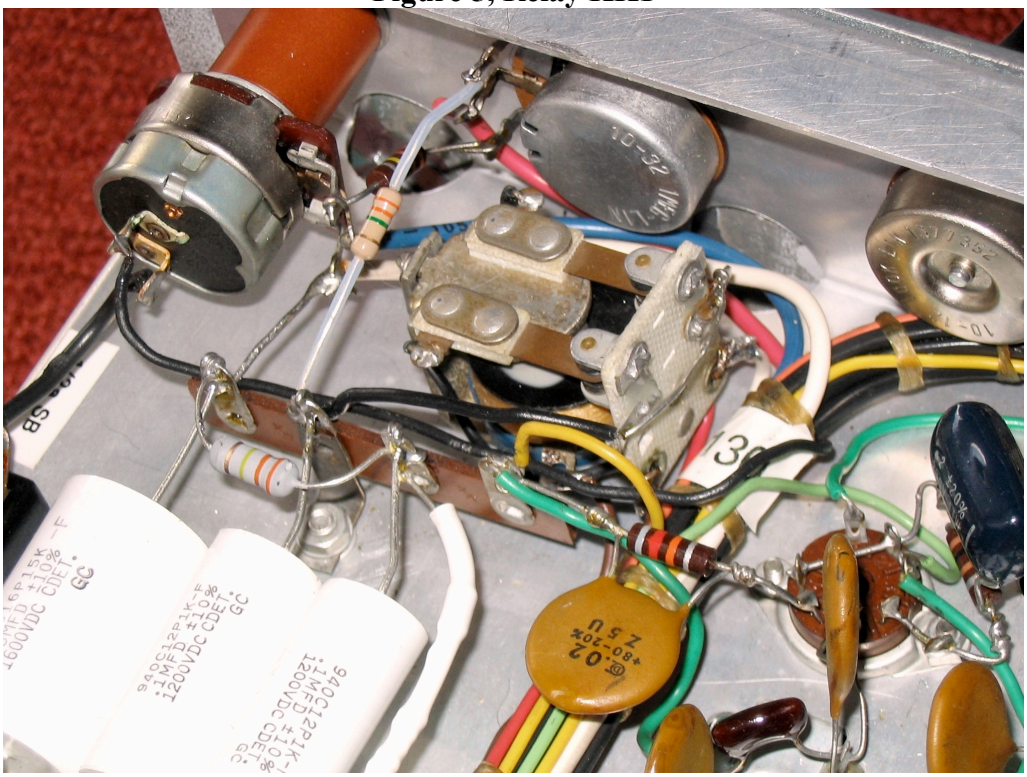
lock nut so not to disturb the lettering and then replace the knob. Refer to the cover photo and note the length a detent line extends above the knob pointer. With a sharp knife, pick-off any excess you feel necessary. When this is completed a horizontal piece at the edge of the detent may be applied. You may disregard that edge if you wish. Repeat this entire procedure for the TONE switch using longer piece of card stock.

When all lettering has been completed, spray the panel with two or three very light coats of Krylon Clear Matte Finish, #1311. Blow away any residual dust that may have settled. And when spraying, always spray in circular fashion at least two or three feet away to prevent the lettering from "running," while too much spray will cause the transfers to disintegrate. Practice on test material.

<u>The K6SDE Modification</u> – (Applies to all SB-610's)

As good as the SB-610 is the design lacks one critical function: A blanking circuit necessary to inhibit horizontal sweep when no vertical input signal is applied. This deficiency is responsible for the various degrees of phosphor damage observed across the face of almost all SB-610 displays. In the most severe cases a trace will not be visible across the horizontal center of the display. With less severe damage part of the waveform could be visible just above and just below the center of the graticule. Although phosphor burn is permanent it could be prevented.

Figure 5, Relay KK1



Realize this damage has nothing to do with monitoring a received signal; in fact it's just the opposite. With the SB-610, damage occurs from not monitoring a receiver. What was necessary is a means to remove the trace when the transceiver, or transmitter, switches to receive. I searched through years of old radio magazines for a clue to this problem and found a solution buried deep in a long-past issue of *73 Magazine*. Ian Webb, K6SDE, not only described the problem, but also engineered a simple solution using nothing more than a small DPDT relay, a couple of resistors, a capacitor and a wire jumper.

Simply put, K6SDE's modification used a relay to control the horizontal sweep circuit only when enabled by the push-pull CLAMP switch so the relay operation can be switched on or off when necessary. With the addition of a jumper wired across the SWEEP mode switch, the clamp circuit will enable the relay to blank the sweep when no signal is present in the INTERNAL, or LINE input position. The interesting part of this modification is that the RF TRAP and RTTY mode displays are totally unaffected by this modification. I'm including K6SDE's description here for completeness. For the complete procedure I highly recommend Ian's article. [xiv]

> With the CLAMP switched off [in position], the relay will remain de-energized and the sweep runs continuously. This is the normal, non-modified operation which at moderate to high intensity will burn the face of the CRT. When the CLAMP switch is on [out position], and with no vertical [or receiver] input signal applied, the relay energizes and the sweep is blanked. If a vertical input signal from a receiver is detected, the relay drops out and the incoming signal is displayed. Key the transmitter and the relay will remain de-energized, or will de-energize by the RF ANTENNA input signal as it overrides the clamp; thus allowing the return of the transmitted RF display. - K6SDE

Ian's relay of choice is a DPDT, DC operated, 5000-ohm "plate relay." Since the relay called for was impossible to find, I settled on a spare KWM-2 "antenna relay" found lying around in a box of parts.[xv] It's a Potter and Brumfield/Diletrod, KR-2565, which just fit behind the Vertical Position control. Also as noted on the original Heathkit schematic and parts list is C102. The K6SDE modification calls for a, 0.05uf, 50-vdc cap in place of the original value. This new cap is noted CK1 on the enclosed, updated schematic.

Testing

Since the resistance readings were recorded prior the refurbishing process, the actual voltage readings were now confirmed. Voltage irregularities measured were resolved with a tube replacement. I had acquired two complete sets of spare tubes at the start of this project and every tube had to be replaced at lease once. The 3RP1A, 1.4 kV high voltage supply was confirmed only because a HV probe was available. That measurement was not necessary since all power supply components were replaced.

Front panel controls and rotary switches were checked during the refurbishing and then again after the relay modification was installed. Vertical and horizontal gain and positioning controls were checked for limit and balance by referencing the trace within the center of the graticule area. Other than the INTENSITY control, all controls correctly positioned the sweep at the center of their rotations.

The relay modification should be tested to insure it energizes reliably. The plate resistor, RK1A/B, and the internal resistance of the coil set the maximum plate dissipation allowed. Should any delay be observed or intermittent failure of the relay to energize, just bend the normally-closed contacts to reduce the gap between the armature and the solenoid. A final pull-in test should be made with the SB-610 positioned upside-down. Should the relay still fail to energize, consider reducing the gap even further, or replace the relay.

Conclusion

Whether the original Heathkit color scheme is maintained or the unit is styled to match a particular brand of equipment, the SB-610 monitor scope still makes a handy addition to any ham shack no matter what make of equipment is in use. This self-designated "610C-2" Collins look-alike blends in perfectly at my operating position and has become the center of attention whenever visitors stop by. Refurbished with updated components, a revised clamp circuit to protect the CRT, the ability to instantly test and monitor your transmitted or any type of incoming signal, a refurbished SB-610 is the ideal monitoring device for the next 20 years.

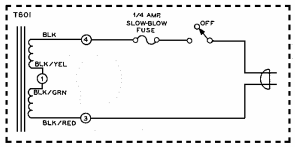
K2QDE

SB-610/610C-2 Revised Parts List - 05-08-07

Heath#	Quan	Component	Value	Mouser.com
1-3	1	R201	100 ohm, 1/2 Watt, 5%	293-100-RC
1-4	1	R300	330 ohm, 1/2 Watt, 5%	293-330-RC
1-13	6	R1, 100,307,511,107,108	2700 ohm, 1/2 Watt, 5%	293-2.7K-RC
1-16	1	R309	4700 ohm, 1/2 Watt, 5%	293-4.7K-RC
1-19	5	R105,302,303,402,408	6800 ohm, 1/2 Watt, 5%	293-6.8K-RC
1-25	5	R101,512,410,413,515	47 K, 1/2 Watt, 5%	293-47K-RC
1-102	2	R202,604	82 K, 1/2 Watt, 5%	293-82K-RC
1-26	2	R103,505	100 K, 1/2 Watt, 5%	293-100K-RC
1-126	2	R411,412	180 K, 1/2 Watt, 5%	293-180K-RC
1-29	3	R401,403,409	220 K, 1/2 Watt, 5%	293-220K-RC
1-31	4	R304,501,506,508	330 K, 1/2 Watt, 5%	293-330K-RC
1-35	4	R301,503,405,406	1 Meg, 1/2 Watt, 5%	293-1M-RC
1-37	1	R102	2.2 Meg, 1/2 Watt, 5%	293-2.2K-RC
1-38	2	R504,510	3.3 Meg, 1/2 Watt, 5%	293-3.3M-RC
1-40	1	R104	10 Meg, 1/2 Watt, 5%	293-10M-RC
1-A-26	1	R513	15 K, 1 Watt, 5%	294-15K-RC
1-A-31	2	R308,605	330 K, 1 Watt, 5%	294-33K-RC
1-2-1	3	R600,601,603	1000 ohm, 1 Watt, 5%	261-1.0K-RC
1-26-1	2	R2,602	15 K, 1 Watt, 5%	261-15K-RC
1-27-1	2	R106,516	33 K, 1 Watt, 5%	294-33K-RC
20-52	2	C104,509	7.5 pf Mica/tube	
20-99	2	C501,508	22 pf Mica	
20-102	1	C100	100 pf Mica	See Manual
20-108	3	C2,505,506	200 pf Mica	See Manual
21-14	9	C3,101,103,405,406,500,503,507,603	0.001uF 500V 10%	75-5TSD10
21-90	1	C513	0.001uF 3000V DISC	539-HT102M
21-31	7	C202,203,300,305,402,403,512	0.02uF 500V 20%	75-5GASS20
21-38	1	C504	0.02uF 1.6 KV	
28-1	1	C510	2.2 pf Tubular	
23-11	1	C511	0.10uf 600V OR DROP	75-715P600V0.1
23-63	2	C301,304	0.22uf 400V OR DROP	75-715P400V0.22
23-29	2	C604,605	0.10uF 1200V	5984-940C12P1K-F
23-94	1	C606	0.15uF 1600V	5984-940C16P15K-F
23-15	1	C303	0.47uf 400V O-DROP	75-715P400V0.47
27-34	2	C102,201	0.22 ufd Resin	75-225P200V0.22
27-52	1	C102A	0.047uF 200V O-DROP	75-225P200V0.047
25-54	2	C401,C404	10.0 uF 25V	75-TVA1204
25-41	2	C600 C601	40uF 450V	75-TVA1712
25-63	1	C602A,602B,602C,602D	30-20-20-20 uf	DK Distrubuters
481-1	1	Capacitor Mtg. wafer	For C206, above	DK Distrubuters
40-746	1	L2	455KHz IF Transformer	
45-4	1	RF choke	1.1 mh	
412-15	1	Neon Lamp	NE101	
413-10	1	Red Plastic Lens	Radio Shack	
421-20	1	Fuse	1/2 Amp, SB, 250V	
56-26	1	D7	Ge 75PRV .005A	526-1N34A
57-27	4	D1 D2 D3 D4	1.0a Diode Rectifier	512-1N4005
57-44	4	D5A, D5B, D6A, D6B	1A, 1000VPV	512-1N4007
KK1	1	Relay, KWM2 (K04) P&B/Deltrol @surplussales.com/Collins		(COL)KR2565-1
Knob	9	Pointer, ¼" Round re-mfg Collins www.advanced-optics.com/collins.htm		

SCHEMATIC of the
HEATHKIT - COLLINS MONITOR SCOPE
SB-610 - 610C-2

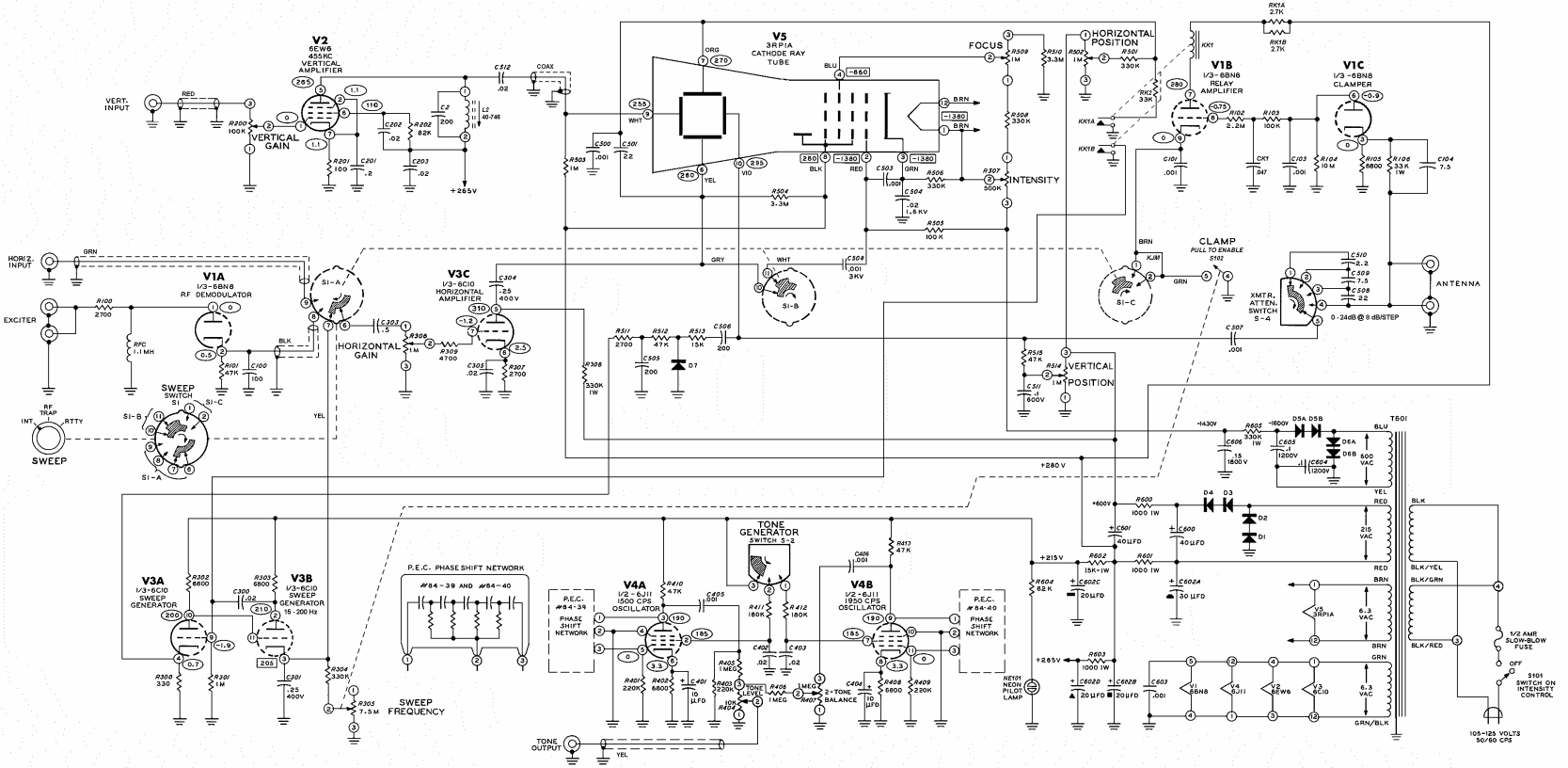
K2QDE 12/2006



210 — 250 VOLT WIRING

NOTES:

1. MOST RESISTORS AND CAPACITORS ARE NUMBERED ACCORDING TO THE TUBE THEY ARE ASSOCIATED WITH.
   EXAMPLE:
   R 4 1 3
   - R = RESISTOR
   - 4 = PART OF TUBE CIRCUIT V4
   - 13 = THE NUMBER FOR THIS RESISTOR
2. PARTS IN THE POWER SUPPLY ARE NUMBERED IN THE '600 SERIES.
3. ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS: K = 1000, M = 1,000,000.
4. CAPACITOR VALUES LESS THAN 1 ARE IN uF. VALUES OF 1 AND ABOVE ARE IN uuF (pF), UNLESS MARKED OTHERWISE.
5. ⬭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT TAKEN WITH AN 11 MEGOHM VTVM FROM THE POINT INDICATED TO CHASSIS GROUND. VOLTAGE MAY VARY +/- 10%.
6. ▭ THIS SYMBOL INDICATES A VOLTAGE THAT MAY VARY WITH THE ASSOCIATED CONTROL SETTING.
7. VOLTAGE READINGS TAKEN WITH THE CONTROLS AND SWITCHES IN THE FOLLOWING POSITIONS:
   - HORIZONTAL GAIN - FULL CLOCKWISE
   - SWEEP FREQUENCY - FULL CLOCKWISE
   - INTENSITY - SET FOR NORMAL TRACE
   - FOCUS - SET FOR NORMAL TRACE
   - VERTICAL POSITION - SET FOR NORMAL TRACE
   - HORIZONTAL POSITION - SET FOR NORMAL TRACE
   - VERTICAL GAIN - FULL COUNTERCLOCKWISE
   - SWEEP - FULL COUNTERCLOCKWISE
   - TONE GENERATOR - FULL COUNTERCLOCKWISE EXCEPT FOR MEASUREMENTS AT V4, VOLTAGE READINGS AT V4 ARE TAKEN WITH TONE SWITCH IN 2-TONE POSITION.
   - CLAMP - OFF, PUSHED IN.
8. SWITCH WAFERS SHOWN IN FULL COUNTERCLOCKWISE POSITION, AS VIEWED FROM THE KNOB END OF THE SHAFT.
9. DIODES D5 AND D6 ARE COMPRISED OF TWO 1N4007'S EACH. D5A-D5B, AND D6A-D6B.
10. RELAY KK1, RK1, RK2, CK1, AND JUMPER KJM, REMOVES SWEEP DURING RECEIVE WHEN NOT MONITORING A RECEIVER, AND THE CLAMP SWITCH IS ENABLED. SEE 73 MAGAZINE, APRIL 1989, PAGE 44, BY K6SDE



NOTES

[i] R. Clark, K9HVW, "The HO-10 & SB-610 as an RTTY monitor scope" *Ham Radio*, Sept '74, pg 70.

[ii] M.V. Johnson, VE3DJU/VE3DDI, "Vintage Radio Equipment Repair Basics: Thoughts from a Backyard Mechanic" *The Collins Journal*, Vol. 14, No.1 Jan-Feb, '07.

[iii] To speed-up locating and replacing components within the SB-610, take time to transpose all component identifications, such as R12, C34, etc., from the schematic to the applicable pictorial diagrams located in your Heathkit manual.

[iv] DK Distributors, (317-684-0050), PO Box 48623, Wichita, KS 67201

[v] The flat-faced 3RP1A shows a more astigmatic sweep, but presents a more natural visual presentation. The earlier round-face CRT showed less astigmatism at the ends of the sweep, but more visual distortion when viewed through the plastic graticule screen. Note: An experiment using the astigmatic circuitry pulled from an SB-620 proved problematic. Because of additional focus and intensity issues it was removed.

[vi] The schematic diagram is a reproduction of the revised original drawing scanned by a Canon i5570 printer at 11 x 14, 660 DPI; saved as a TIF file. The scanned diagram was cleaned, edited, and in many areas redrawn using Microsoft Paint. When saved in .PNG format, MS Paint's native file format, the file size is reduced to less than 500KB.

[vii] "Mosfet Converter for Receiver Instrumentation," by WA9ZMT, *Ham Radio*, January 1971, PG 62.

[viii] H.M. Goosier, W6VFR, "Monitoring SSB Signals," *Ham Radio Magazine* March 1972, pg 36.

[ix] Advanced Optics products are available in the U.S., from the Collins Radio Association, Post Office Box 34, Sidman, PA 15955, or internationally via, http://www.advancedoptics/Collins.htm/

[x] http://www.surplussales.com/.

[xi] http://www.arrl.org/tis/info/wrinkle.html.

[xii] http://www.oselectronics.com/.

[xiii] Advanced Optics, http://www.advancedoptics/Collins.htm/

[xiv] I. Webb, K6SDE, "Modifying the SB-610" 73 Magazine, April 1969, pg 44.

[xv] Relay, K2, KWM-2 Antenna, Deltrol, KR2565, DPDT, @ 115vdc 14K coils (http://www.surplusssales.com)