Heathkit of the Month #91:

by Bob Eckweiler, AF6C
AMATEUR RADIO - SWL

Heathkit SBA-300-3 and SBA-300-4 Six and Two Meter Converters

Introduction:

Late in 1963 Heathkit introduced the SB-300 ham band receiver and companion SB-400 transmitter. These are 5-band (pre-WARC) HF SSB/CW radios.

The SB-300 includes provisions for selecting a six-meter or two-meter converter on the front panel. Around late summer of 1964 Heath released the two converters designed to work with the SB-300 as well as other HF receivers with 10 meter coverage. These converters were given the model numbers of SBA-300-3 for six-meters (**Figure 1A**) and SBA-300-4 for two-meters (**Figure 1B**). The SBA-300-1 and -2 designations were already in use for the optional SB-300 AM and CW crystal filters. The converters also work with the later SB-301 receiver, released in 1966. The converters remained in production

Figure 1A: Heathkit SBA-300-3 Six-Meter Converter. Figures: 1A, 1B, 4 and 5 are courtesy of Chuck Penson, WA7ZZE

Figure 1B: Heathkit SBA-300-4 Two-Meter Converter

Here is a link to the index of Heathkit of the Month (HotM) articles:

http://www.w6ze.org/Heathkit/Heathkit_Index.html

6 & 2 Meter Plug-In Converters For SB-300

EXTEND OPERATION OF SB-300 TO VHF! 6-meter model extends coverage of SB-300 from 48 to 54 mc (50 to 52 mc with crystal supplied); 2-meter extends coverage from 142 to 150 mc (144 to 146 mc using crystal supplied). Uses 6DJ8 cascode amplifier for low noise factor & high sensitivity. Applied AGC provision allows strong signal handling capability. Easy to build and install. Use with any receiver providing appropriate voltages and 10-meter coverage.

SBA-300-3 (6 meter), 2 lbs. **$19.95**
SBA-300-4 (2 meter), 2 lbs. **$19.95**

SBA-300-3 SPECIFICATIONS—Sensitivity (signal plus noise-to-noise in db): AM, less than 0.1 uv for 6 db @ 3750 cps bandwidth; SSB, less than 0.1 uv for 10 db @ 2100 cps bandwidth; CW, less than 0.1 uv for 15 db @ 400 cps bandwidth. **Noise figure:** 5 db or less. **Frequency:** Input, 48 to 54 mc (50 to 52 mc with crystal supplied). Output, 28 to 30 mc. **Bandpass:** Essentially flat over any 2 mc segment from 48 to 54 mc. **Image rejection:** 50 db or better @ 6 mc. **IF rejection:** 40 db or better @ 28 mc. **Crystal:** 22 mc ±0.005%, 3rd overtone. **Tube complement:** 6DJ8 cascode RF amplifier, 6EA8 oscillator-mixer. **Power requirements:** 120 v. @ 12.5 milliamperes, 6.3 v. AC @ 815 milliamperes. **Dimensions:** Overall, 2⅛" W x 5¾" L x 3¾" H.

SBA-300-4 SPECIFICATIONS—Sensitivity: (signal plus noise-to-noise in db) AM, less than 0.2 uv for 6 db @ 3750 cps bandwidth; SSB, less than 0.2 uv for 12 db @ 2100 cps bandwidth; CW, less than 0.2 uv for 20 db @ 400 cps bandwidth. **Noise figure:** 7 db or less. **Frequency:** Input, 142 to 150 mc (144 to 146 mc with crystal supplied); output, 28 to 30 mc. **Bandpass:** Essentially flat over any 2 mc segment from 142 to 150 mc. **Image rejection:** 80 db or better at 88 mc. **IF rejection:** 50 db or better at 29 mc. **Crystal:** 38.67 mc ±.003%, 3rd overtone. **Tube complement:** 6DJ8 cascade RF amplifier, 6EA8 oscillator-tripler-mixer. **Power requirements:** 130 V. DC @ 12.5 milliamperes, 6.3 V. AC @ 815 milliamperes. **Dimensions:** Overall; 2⅛" W x 5¾" L x 3¾" H.

Figure 2: An early ad for the SB-300-3 and SB-300-4 converters (1966 Catalog 810/60A)

until shortly after the SB-301 receiver was replaced with the SB-303 solid-state receiver in 1970. The SBA-300-3 and SBA-300-4 each sold for $19.95 from the factory throughout their lifetime. The price at a retail Heathkit store was $4.00 higher. **Figure 2** is an ad from a 1966 Heathkit catalog.

Two screws mount each SBA-300 series converter to the outside rear cabinet of an SB-300 or SB-301 receiver in existing holes[1]. Each converter has an octal plug at one end and an octal socket at the other end. If two converters are used, they can be plugged directly together before mounting. A short jumper cable from the octal socket on the rear of the receiver to the exposed octal plug provides power and AGC voltage. The output connections are short RCA to RCA coax jumpers that go to the VHF-1 or VHF-2 inputs on the rear of the receiver. Parts for the power cable and antenna jumper cable are included in each kit along with a spare RCA plug for the VHF antenna input connection.

SBA-300-3 (-4) Converter Overview

The two SBA-300 converters each measure 2-5/8" W x 5-3/4" L x 3-3/4" H. They are an open frame design with two tubes in shields as well as alignment adjustments mounting outside the enclosed chassis. When mounted to the SB-300 or SB-301 the tubes are horizontal and the depth of the receiver increases by 3-3/4". Rubber feet are also included with each kit so it may sit on a table or shelf when used with a third party receiver. Two RCA connectors on each converter are for RF input and output. The input connects to the VHF antenna (through a user supplied antenna relay if the receiver is used with a VHF transmitter).

While designed for the SB-300/301 receivers, the SBA-300 converters work with any receiver that covers 28 - 30 MHz. It is convenient if the receiver can also supply 130 VDC at 12.5 ma and 6.3VAC at 815 ma. If not, a simple power supply can be built to supply the power externally. On the front of the SB-300 and SB-301 a **CONVERTER** switch selects either **VHF 1**, **VHF 2** or **HF**. It routes DC and filament power to the selected converter as well as connecting the correct converter to the receiver's antenna input.

The converters cover any two megahertz segment of their band, depending on the crystal installed in the converter. The factory supplied crystal covers the lowest two-megahertz of the six or two meter ham band. With the proper crystal, the converters can cover more than the ham band. SBA-300-3 covers 48 - 54 MHz[2] and the SBA-300-4 covers 142 - 150 MHz.

Let's take look at each converter separately. The common circuitry will be pointed out.

SBA-300-4 2-Meter Converter Overview

The two-meter converter will be covered first. **Table I** presents both converter's specs. Both converters use two dual-section vacuum tubes: a 6DJ8 dual triode provides RF amplification, and a 6EA8 pentode/triode provides mixing and the crystal controlled oscillator, and includes a frequency tripler for 2-meters.

Power for the both converters is provided through the octal plug. The pinout is shown in **Table II**. All the pins, except pin-5, which is not used, are directly connected to the octal socket on the other end of the chassis to allow daisy-chaining with either converter connected first. The 2-meter SBA-300-4 takes its B+ from pin-6 and its filament power from pin-8. If the converter is connected to the SB-300 or SB-301 receiver it will only receive power when the receiver's front panel CONVERTER switch is in the VHF-1 position. Note that when moving the switch to the VHF

PARAMETER	SBA-400-3	SBA-400-4
Sensitivity (S+N/N):		
AM @ 3.75 KHz BW	<0.1µV/6 db	<0.2µV/6 db
SSB @ 2.1 KHz BW	<0.1µV/10 db	<0.2µV/12db
CW @ 0.4 KHz BW	<0.1µV/15 db	<0.2µV/15 db
Noise Figure:	< 5 db	< 7 db
Input Frequency:	48 - 54 MHz	142 - 150 MHz
(With supplied Xtal):	50 - 52 MHz	144 - 146 MHz
Output Frequency:	28 - 30 MHz	28 - 30 MHz
Supplied Crystal:	22.000 MHz	38.66666 MHz
Xtal. Tolerance:	±0.005%	±0.003%
(Third Overtone type)		
Image Rejection (db):	>50 @ 6 MHz	>80 @ 88 MHz
IF Rejection (db):	>40 @ 28 MHz	>50 @ 29 MHz
PARAMETER	**FOR BOTH UNITS**	
Bandpass:	Essentially flat over any 2 MHz segment of input range.	
Tube Complement:	6DJ8 Cascode RF Amplifier 6EA8 OSC[A] - Mixer	
Power Requirements:	130 VDC 12.5 ma. 6.3 VAC 815 ma.	
Dimensions:	2-5/8" W x 5-3/4" L x 3-3/4" H	
Net Weight:	10-1/2 ounces	

Note A: Oscillator - Tripler for SBA-400-4

TABLE I :SBA-300-3 / -4 SPECIFICATIONS

1 or VHF 2 position that converter's filaments need to come up to temperature before reception will begin. All power is disconnected from a converter unless it is selected.

Pin #	Function	Wire Color
1.	VHF-2 6.3 VAC Filament	YEL
2.	Power Common	BLK
3.	VHF-2 130 VDC B+	BRN
4.	AGC voltage	WHI
5.	Not Used	ORG
6.	VHF-1 130 VDC B+	RED
7.	Power Common	GRN
8.	VHF-1 6.3 VAC Filament	BLU

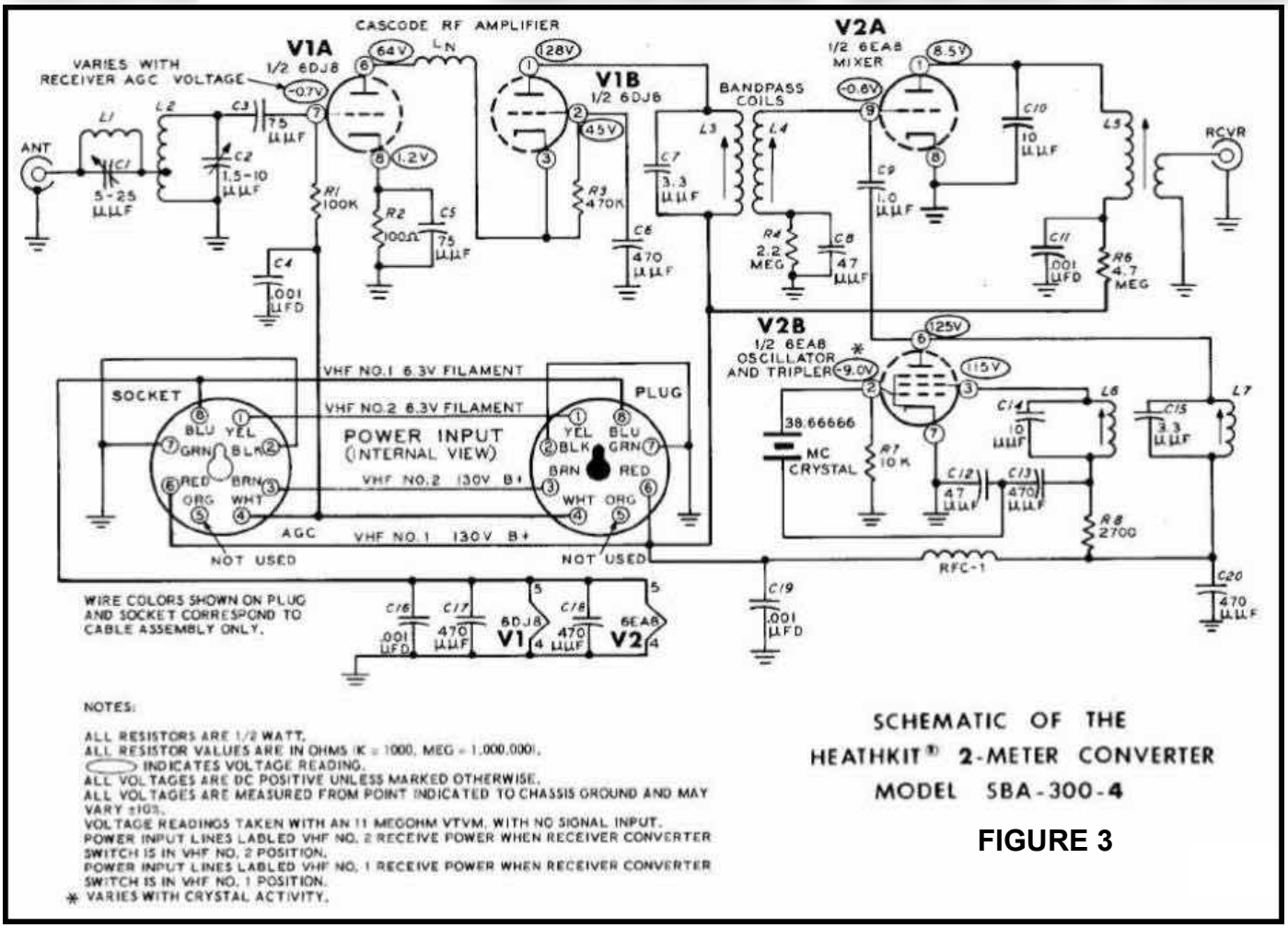
TABLE II :SBA-300-3 / -4 Power Connector

Figure 3 is a schematic of the SBA-300-4 two-meter converter, **Figure 4** is an internal photo and **Figure 5** is a block diagram. With the converter powered up and connected to an appropriate antenna, signals are amplified by V1 which is wired as a 'cascode'[3] amplifier. The cascode amplifier consists of V1A, a common cathode amplifier and V1B a common grid amplifier with their B+ chain in series. Between the two is a small inductor L_N (actually a small inductive 0.9Ω resistor) that is all that is needed for neutralization. The cascode amplifier offers high gain (without the noise of a pentode amplifier), a low noise factor, high bandwidth (due to a reduction in input capacitance caused by the Miller effect[3]), and simple neutralization (if needed). These traits make the cascode amplifier common for VHF/UHF front-end amplifiers.

The antenna input is coupled to the cascode amplifier by a broadly tuned circuit consisting of L2 and C2. The antenna signal is fed to a tap on L2 to match the 50Ω antenna impedance. L1 and C1 form a trap in the 88 MHz region. This trap is adjusted to reduce any interference that may occur from a nearby FM broadcast station, as discussed later.

On the SBA-400-4 the output of the cascode amplifier is fed to V2A, a triode mixer through a bandpass transformer consisting of L3, L4, C7 and C8. This transformer passes 143 - 149 MHz signals while rejecting other frequencies amplified by the cascode amplifier, effectively bypassing them to ground.

On the SBA-400-4 V2B, the pentode section of the 6EA8 is a crystal oscillator. It also acts as a frequency tripler. The screen grid acts as the plate for the crystal oscillator circuit and its associated tuned circuit (L6 and C14) is at the crystal frequency. However, the



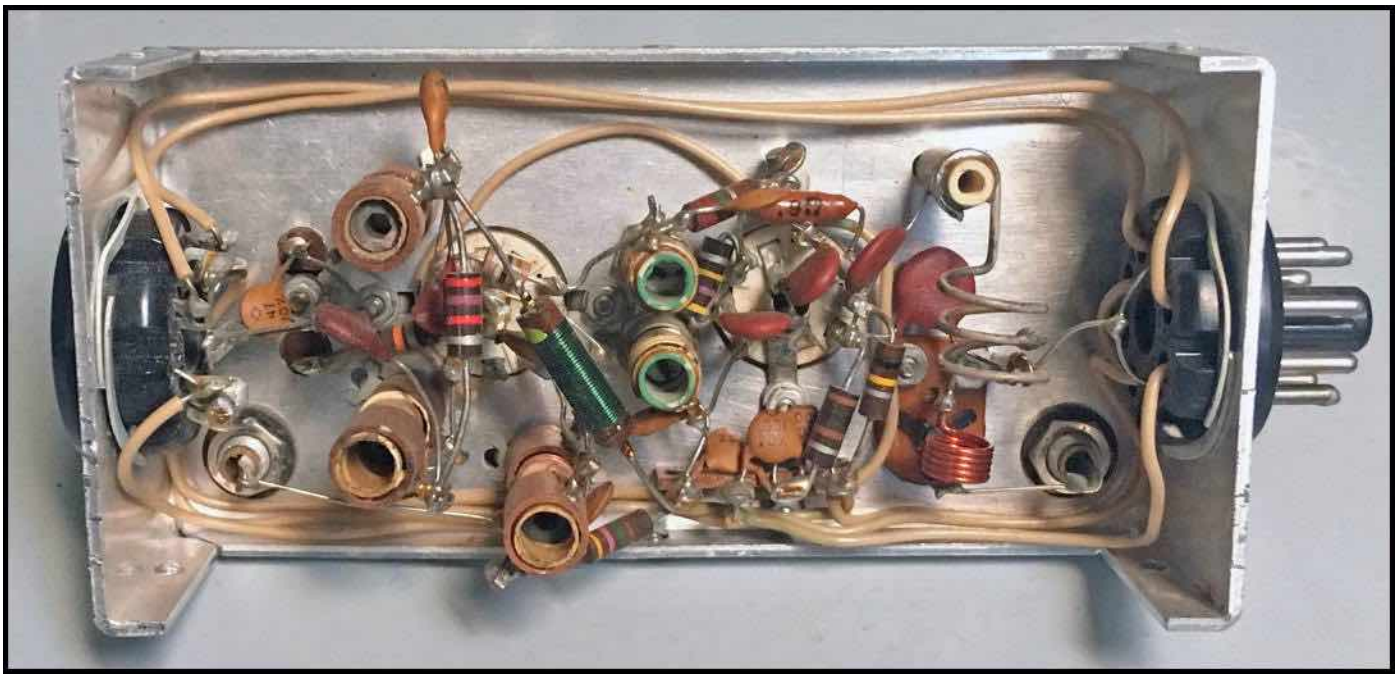
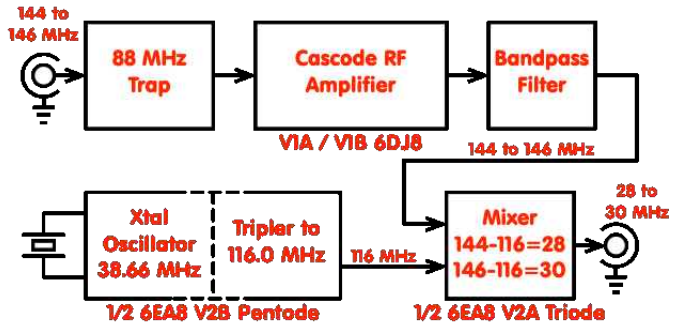


Figure 4: Inside view of the SBA-300-4 - 2-Meter Converter.
Photo courtesy of Chuck Penson, WA7ZZE

tuned circuit connected to the plate (L7 and C15) is tuned to the third harmonic of the crystal - 116 MHz with the supplied crystal (38.66666 MHz.) The 116 MHz frequency is coupled through C9 to the grid of the mixer V2A alongside the signal from the bandpass transformer. In the mixer one of the products produced is the difference between the signals in the 144 to 146 range and 116 MHz. converting those signals into the range of 28 to 30 MHz. Other crystals may be used for different coverage as shown in **Table III**. Unwanted products from the mixer are rejected by the tuned circuit L5 and C10. The link coil of L5 provides the correct impedance for the receiver input.

An additional product of the mixer is the another difference frequency; thus frequencies in the 88 - 86 MHz range will also mix with 116 MHz and provide output in the 28 - 30 MHz range with the supplied crystal[4]. This "image" range borders the FM broadcast band (88 - 108 MHz). Worse yet, if you are using a custom 39.4 or 40.0 MHz crystal the image frequency range will be inside the FM broadcast band. A strong local FM station or two can create interference to a desired receive frequency. The trap of C1 and L1 can be tuned to the interfering signal to reduce it significantly, if not altogether. The trap is broad enough that it can be effective on two



Heathkit SBA-300-4 Block Diagram (2M)

Figure 5

reasonably close signals by tuning it between them. For the provided crystal the manual recommends the trap be tuned to 88 MHz unless warranted by a specific interfering signal. The manual discusses how to adjust the trap.

Alignment of the SBA-300-4 two-meter converter can be accomplished without equipment other than a compatible receiver. Heath claims these preliminary adjustments should provide performance equal to or better than the specifications. However, instructions are included for a full instrument alignment requiring an RF signal generator that covers 142 - 150 MHz and a VTVM. This alignment will assure optimum performance.

SBA-300-3 6-Meter Converter Overview

The six-meter converter is physically very similar to the two-meter converter both me-

Input Range	Crystal Freq.	Tripler Freq.	Output Range
142 - 144	38.00000	114	28 - 30
144 - 146	38.66666*	116	28 - 30
146 - 148	39.33333	118	28 - 30
148 - 150	40.00000	120	28 - 30

All frequencies are in MHz.
* Crystal supplied with kit

TABLE III :SBA-300-4 Crystal Options

Input Range	Crystal Freq.	Tripler Freq.	Output Range
48 - 50	20.0	114	28 - 30
49 - 51	21.0	116	28 - 30
50 - 52	22.0*	118	28 - 30
51 - 53	23.0	120	28 - 30
52 - 54	24.0	120	28 - 30

All frequencies are in MHz.
* Crystal supplied with kit

TABLE IV :SBA-300-3 Crystal Options

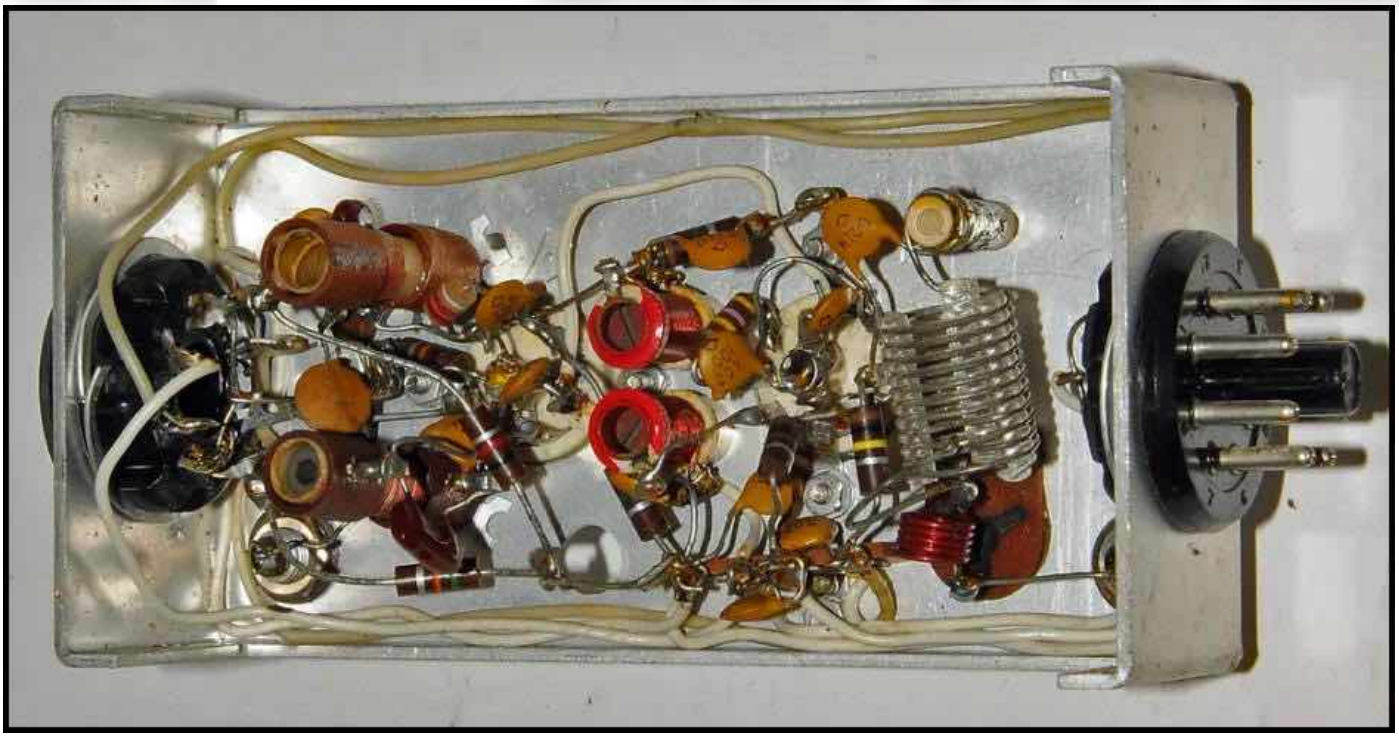


Figure 6: Inside view of the SBA-300-3 Six-Meter Converter (WA7ZZE - credit)

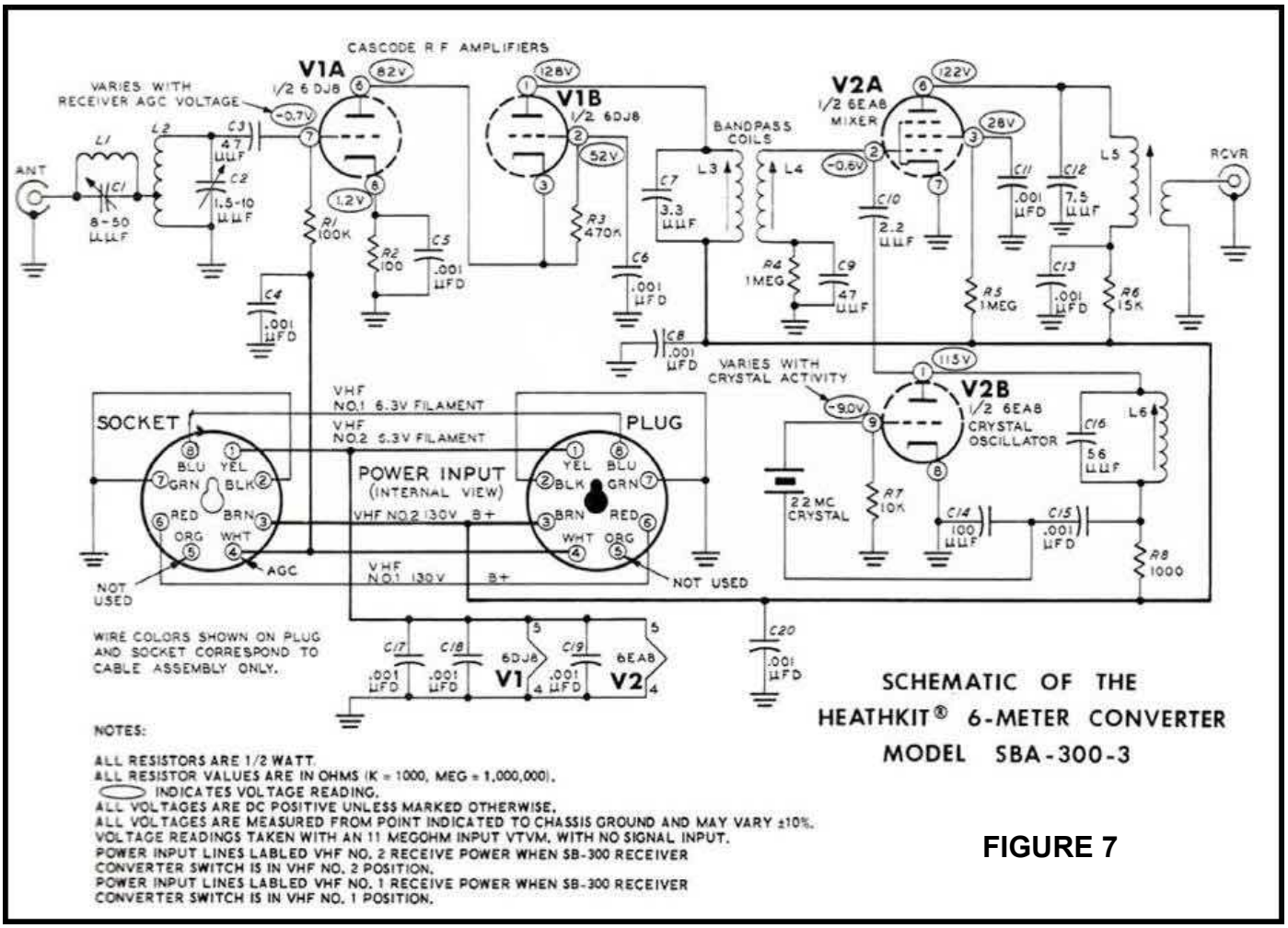
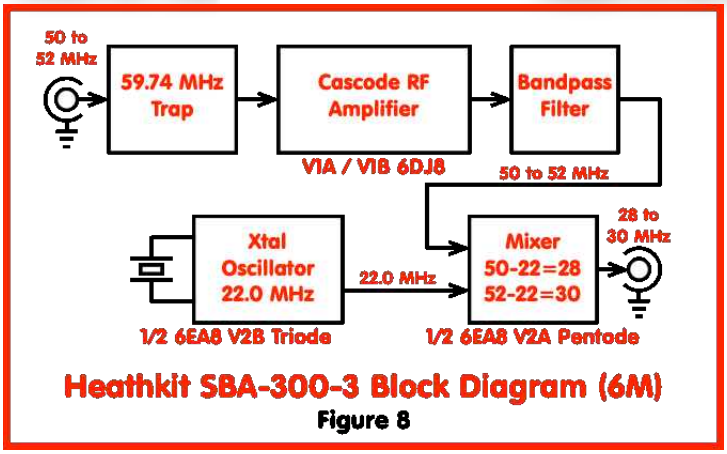


FIGURE 7



Heathkit SBA-300-3 Block Diagram (6M)

Figure 8

chanically and physically. **Figure 5** is an inside photo of the 6-meter converter and **Figure 7** is the schematic and **Figure 8** is a block diagram. The major differences, besides those involving tuned circuits, are the input trap and the lack of a tripler as part of the crystal oscillator. This allowed the designer to swap sections of the 6EA8 tube (V2). In the six-meter converter the oscillator now uses the triode section and the mixer uses the pentode section. The trap is tuned to the 59.75 MHz (Old CH-2 sound carrier), which if strong will create a spurious signal at 28.025 MHz.

The SBA-300-3 cascode amplifier lacks L_N as neutralization isn't needed at the lower frequency. Otherwise the circuit is similar, with only the capacitors being larger due to the lower frequency.

The crystal oscillator circuit (V2B) operates at 22 MHz and its output is directly injected into the mixer. Thus the triode section is used, allowing the pentode section to be used for the mixer. Output of the crystal oscillator is tuned by L6 and C16 and coupled to the grid of V6A through C10 (2.2 pf).

The mixer uses the pentode section of V2A. The amplified 6-meter signal, after passing through the bandpass filter similar to that used in the 2-meter converter, is coupled to the grid of the mixer (V2A) along with the crystal oscillator signal. One output from the mixer is the difference between the desired signal range of 50 - 52 MHz and the 22 MHz oscillator, or 28 - 30 MHz. The broadband output tuned circuit allows 28 - 30 MHz to pass while attenuating others out side that range.

Power to the SBA-300-3 comes in on pins 1 (6.3 VAC filament power) and 3 (130 VDC B+ power) of the octal connector, allowing the six-meter converter to be powered separately from a daisy-chained two-meter converter.

Like the two-meter converter, the SBA-300-3 can use different crystals to cover other segments of the six-meter band as shown in **Table IV.**

Purchasing Crystals for the SBA-300-3/-4:

Vendors who manufacture custom crystals have become a rare commodity. The specifications for the crystals required for the two converters is given in **Table V**. Information on the three known vendors are given in the notes at the end of this article. Often a minimum purchase is required, and the price may be substantial. Two sources are Bomar Crystals[5] in Middlesex, New Jersey. and

Crystal Specifications from the Heathkit Manuals

Specification	SBA300-3	SBA300-4
Manual P/N:	595-706	595-712
Manual Date:	7/18/1969	1/19/1968
Holder:	HC-6/U	HC-6/U*
Load Capacitance (C1)	12.8 pF	19.1 pF
Internal Capacity (Co)	6 pf max.	7 pf max.
Series Resistance (Rs)	30Ω max.	
Drive Level:	8 mW	10 mW*
Tolerance:	±0.005%	±0.003%
Mode of Operation:	3rd Overtone	

* Not stated, or incorrect in manual

Table V

QuartSLab[6] in England. AF4K[7] also sells common crystals, though he doesn't manufacture them, he does stock many common frequencies and crystals for Heathkit, Collins and Drake.

Operating the SBA-300-3/-4:

My history with the SBA-300-4 two meter converter began back on the 1st of February in 1969 when I purchased a kit from the local Heathkit store on Ball road in Anaheim. The kit cost $23.95, about 20% above the mail-order price. The kit assembled easily in an evening or two and was aligned using just the simple instructions in the manual.

For a short period I operated my SB-301, to which the SBA-300-4 was mounted on 2-meter CW and AM. The transmitter was an old Ameco TX-62. I didn't have a VFO, and so I was crystal bound with just two crystals, one for CW and one for AM phone. The receiver with the converter worked well and seemed very sensitive. I spent some time listening to hams ragchewing on two-meter SSB. My impression of the converter with the SB-301 is that signals were easy to tune in and seemed stable, though some of the stations, especially on CW and AM tended to drift (I attribute that to their transmitter); on my receiver most 2-meter SSB signals, with their more stable VFOs, seemed rock solid on frequency.

The converters only cover a two MHz portion of their band, and the factory supplied crystals result in coverage of the low end of each band. This typically works out fine, since it is in that band section that most CW, SSB and AM operations take place. Since the SB-300 / 301 receiver is not designed to receive FM there is little value receiving in the upper portion of the band since most of the activity there is FM.

I never made a measurement of the sensitivity, but it seemed to be very high. I did realign the converter using my old PACO G-30 signal generator (that covered the two-meter band) and my Heathkit V-7A VTVM. Little difference if any was noticed afterwards.

Credits:

The schematics were taken from the Heath manuals. Many photos were supplied by Chuck Penson - WA7ZZE, and a couple are from eBay or other unknown sources. The block diagrams were rendered in *Graphic* for the Mac by the author.

Final Comments:

I've been tied up with life and not able to spend too much time thinking about Heathkits for the past three-and-a-half months. Now I can get back to writing articles and completing the restoration of an S-40B and an SX-71 (Run-4 model with 15 meters). I hope to be back to nearly monthly articles soon.

73, from AF6C

Notes:

1. Some very early SB-300 cabinets last mounting holes for the converters. HA detail in both of the manuals may br used for locating and drilling the four mounting 5/32" holes in the rear of the cabinet.
2. The pre-digital channel 2 covered 54 to 60 MHz no reception over 54 MHz would be practical.
3. A short discussion of the Cascode amplifier and the Miller Effect is included in this month's TechTalk column.
4. When the 116 MHz signal mixes with an 88 MHz FM station the result is 116 - 88 or 28 MHz; similarity: 116 - 86 = 30 MHz.
5. Bomar Crystals::http://bomarcrystal.com/crystals.html
6. QuartSLab: http://www.quartslab.com
7. AF4K: http://af4k.com/crystals.htm

This article originally appeared in the May 2019 issue of RF, the newsletter of the Orange County Amateur Radio Club - W6ZE.

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

Thanks - AF6C