Heathkit of the Month #132:
by Bob Eckweiler, AF6C

AMATEUR RADIO - SWL

Heathkit HR-10(B)
Basic Amateur Band Receiver.

Introduction: By the time Heath had announced the HR-10 (**Figure 1**) in the Fall - Winter (1961 - 1962) catalog (**Figure 2**), it had also released 52 other significant amateur products. The first ham product was the GD-1 Grid Dip Meter released in September of 1952. **Table I**[1] lists those kits. Interestingly, one of the five kits released in that catalog was a replacement for the GD-1B, an updated version of the first ham kit, the GD-1. The replacement was the solid state HM-10 “Tunnel Dipper” meter which uses a tunnel diode oscillator, making it battery powered and very portable.

The HR-10 is an HF ham-band only receiver. It covers the full 80/75, 40, 20, 15[2] and 10 meter bands. It was designed to be a companion receiver for the recently released DX-60 transmitter, which replaced the DX-40, and it matches the DX-60 style. The HR-10 originally sold for $82.95 (the same price the DX-60 sold for at the time). By the time it was replaced with the HR-10B in early summer of 1967, its price had been reduced to $75.00.

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

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FIGURE 1: Heathkit HR-10 Basic Amateur Band Receiver (B model shown)

The HR-10 filled a receiver gap for Heathkit. At that point the choice of a Heathkit receiver came down to the aged AR-3, the expensive ($300) advanced RX-1 Mohawk, or the MR-1 mobile receiver ($130), which needed either a home-built power supply or the HP-20 Utility Power Supply, which brought the cost up to $160. While the HR-10 is styled for the DX-60, it works with all the low-cost Heathkit HF transmitters (DX-20, HX-11, DX-35 and DX-40).

The HR-10 Receiver:

This receiver is basic, yet it has some features not found in similar class receivers. Though it is single conversion, it has a rather high intermediate frequency (IF) of 1,681 kHz. This offers superior image rejection (See **Sidebar**) over single conversion receivers with a 455 kHz IF frequency, at the cost of poorer selectivity. However, Heath over came the selectivity issue by adding a half crystal-lattice filter at the input to the IF. This filter results in a selectivity of 3 kHz @ 6 dB down, and 9 kHz at 40 dB down.

The HR-10 uses seven vacuum tubes, and while that seems minimal, the use of multi-section vacuum tubes makes it effectively a twelve tube receiver. **Table II** lists the tube types and their functions, and **Figure 3** is a block diagram of the receiver.

The radio has an octal tube socket on the top of the chassis for the optional HRA-10-1 100 kHz crystal

FIGURE 2: Fall-1961 - Winter 1962 Catalog Ad introducing the Heathkit HR10 Basic Amateur Band Receiver.

calibrator. It's surprising this option is often not found with second-hand HR-10s. The crystal calibrator is almost mandatory for day-to-day operations. The receiver **CAL. RESET** control allows the user to easily calibrate the radio dial to the neatest 100 kHz mark for better accuracy.

Controls on the HR-10(B)[3] are easily accessible and give the user the options needed during a QSO. The main tuning control is flywheel weighted for a smooth feel. **TABLE III** lists the controls and indicators. As usual, text printed in bold caps in the table are as they appear on the front panel.

The rear panel, from left to right as viewed from the rear, has the **ANT**enna jack (RCA-type, though many have been changed to an SO-239 UHF connector), the "Blue & White" series label, the S-**METER ZERO ADJ**. control (10 KΩ, screwdriver slot), octal accessory socket which utilizes two of its eight pins - pin-6 **MUTING**, and pin-1 **GND**, line cord with strain relief and **SP**ea**K**e**R. 8Ω** jack (RCA-type).

Table IV gives the specifications from manual [595-500-1] for the HR-10. They are identical to the specifications for the HR-10B.

GD-1	Grid Dip Meter	Fall	1952
AT-1	Amateur HF CW Transmitter	Spr	1953
GD-1A	Grid Dip Meter	Spe	1953
AR-2	Communications Receiver	Sum	1953
AC-1	Antenna Coupler	Sum	1953
AM-1	Impedance Meter	Fall	1953
VF-1	HF VFO	Fall	1954
GD-1B	Grid Dip Meter	Win	1954
DX-100	Phone & CW HF Transmitter	Win	1955
AR-3	Communications Receiver	Fall	1955
QF-1	'Q'-Multiplier	Fall	1955
DX-35	Phone & CW HF Transmitter	Win	1956
DX-20	Amateur HF CW Transmitter	Fall	1956
PM-1	RF Power Meter	Spr	1957
CA-1	Conelrad Alarm	Fall	1957
B-1	Balun Coil	Fall	1957
DX-40	Phone & CW HF Transmitter	Fall	1957
AM-2	Reflected Power Meter	Fall	1957
VX-1	Voice Control Unit	Fall	1957
RX-1	Amateur Band Receiver	Spr	1958
TX-1	Phone & CW HF Transmitter	Spr	1958
AK-5	Matching Speaker for RX-1	Sum	1958
SB-10	SSB Adapter for TX-1	Sum	1958
DX-100B	Amateur HF Transmitter	Sum	1958
VHF-1	Amateur VHF Transmitter	Fall	1958
MT-1	Mobile Ham Transmitter	Spr	1959
MR-1	Mobile Ham Receiver	Spr	1959
MP-1	Mobile Power Supply	Spr	1959
AK-6	Mobile Base Mount	Spr	1959
AK-7	Mobile Speaker	Spr	1959
PM-2	Power Meter Kit	Spr	1959
XC-6	6-Meter Converter for RX-1	Spr	1959
CO-1	Code Practice Oscillator	Spr	1959
KS-1	Kilowatt Power Supply	Sum	1959
KL-1	Kilowatt Linear Amplifier	Fall	1959
XC-2	2-Meter Converter	Fall	1959
UT-1	Utility Power Supply	Fall	1959
HW-19	10-Meter Transceiver	Fall	1960
HW-29	6-Meter Transceiver	Fall	1960
HW-30	2-Meter Transceiver	Fall	1960
HD-20	100 KC Crystal Calibrator	Fall	1960
HP-10	Transistor Mobile Power Supply	Fall	1960
DX-60	Phone & CW HF Transmitter	May	1961
HW-10	6-Meter Transmitter - Receiver	May	1961
HW-20	2-Meter Transmitter - Receiver	May	1961
HA-10	HF Linear Amplifier	May	1961
HD-19	Hybrid Phone Patch	May	1961
GP-11	Vibrator Power Supply	July	1961
HX-11	Amateur HF CW Transmitter	Fall	1961
HG-10	HF VFO	Fall	1961
HD-11	'Q'-Multiplier	Fall	1961
HM-10	Tunnel "Dipper" Meter	Fall	1961
HR-10	**Basic Amateur HF Receiver**	**Fall**	**1961**

TABLE I - Amateur Radio Heathkits (1952 Thru 1961)

HR-10 VACUUM TUBE LINE-UP

ID	TUBE	TUBE TYPE	FUNCTION
V1	6BZ6	Pentode	RF Amplifier
V2A	½ 6EA8	Pentode	Mixer
V2B	½ 6EA8	Triode	Heterodyne Oscillator
V3	6BA6	Pentode	1st IF Amplifier
V4A	½ 6EA8	Pentode	2nd IF Amplifier
V4B	½ 6EA8	Triode	BFO (Oscillator)
V5A	⅓ 6BJ7	Diode	AM Detector
V5B	⅓ 6BJ7	Diode	AVC Rectifier
V5C	⅓ 6BJ7	Diode	ANL Clipper
V6A	½ 6EB8	Triode	1st Audio Amplifier
V6B	½ 6EB6	Pentode	Audio Output
V7	6X4	Dual Diode	Full-Wave Rectifier

TABLE II

The HR-10B Receiver:

The HR-10 was sold as a companion to the DX-60 and DX-60A transmitters. When Heathkit released the DX-60B with its crinkle green finish, it released the HR-10B receiver update, skipping any 'A' version. Other than paint there is only one circuit modification. This change is minor and might even have been done prior to HR-10B. It involves R20 a 47 KΩ resistor which is across the output of the second IF transformer (T2 terminals 2 and 4). This resistor was removed. The purpose of this resistor was to broaden slightly the bandwidth of T2 by lowering its 'Q'. Evidently, Heath found this was not necessary.

Over the lifetime of the HR-10B one other manufacturing change was made. The power

HR-10/HR-10B Front Panel Controls & Indicators

Upper Row (L to R):	
S-Meter:	2 mA f.s. 850 Ω S: **0**, **3**, **6**, **9**, dB over 9: **20**, **40**, **60**
Ruler Freq.Dial:	
80Meters:	**3.5**, **3.6**, **3.7**, **3.8**, **3.9**, **4.0**
40Meters:	**7.0**, **7.1**, **7.2**, **7.3**
20Meters:	**14.0**, **14.1**, **14.2**, **14.3**, (14.35)
15Meters:	**21.0**, **21.1**, **21.2**, **21.3**, **21.4**, **21.5**
Tic marks for above:	Medium 50 kHz, minor 10 kHz
10Meters:	**28.0**, **28.5**, **29.0**, **29.5**, (29,7)
Tic marks for above:	Medium 100 kHz, minor 20 kHz
CAL.RESET:	Variable capacitor 21 µµf
OFF - CAL.:	Slide switch (red) SPST (below)
ANT. TRIM:	Variable capacitor 21 µµf
STBY. - REC.:	Slide switch (red) SPST (below)
Lower Row (L to R):	
PHONES:	¼" phone jack (500Ω)
OFF -AF GAIN:	500 KΩ control w/ SPST switch
OFF - ANL:	Slide switch (red) SPST
RF GAIN:	10 KΩ control
OFF - AVC:	Slide switch (red) DPDT
BFO TUNE:	Variable capacitor 21 µµf Markings each 30º from 9 o'clock CW: • • • ▲ • • •
OFF - BFO:	Slide switch (red) SPST
BAND:	Rotary Switch 5P5T
MAIN TUNING:	Variable capacitor, 3-gang 15 µµ*f*, 15 µµ*f*, 15 µµ*f*

TABLE III

transformer (T6) was upgraded for 120/240 volt operation. (Part # 54-122 was replaced with part #54-122-24). This required replacing the 3-lug terminal strip (#431-10) at location BC with a 4-lug terminal strip (#431-40). The extra lug is needed to wire the transformer primary for 240 VAC.

The HR-10(B) Circuit Description:

Schematics of the HR-10 and HR-10B are available online[4]. The basic single conversion superheterodyne circuit has been covered in earlier articles. A very basic description is given here:

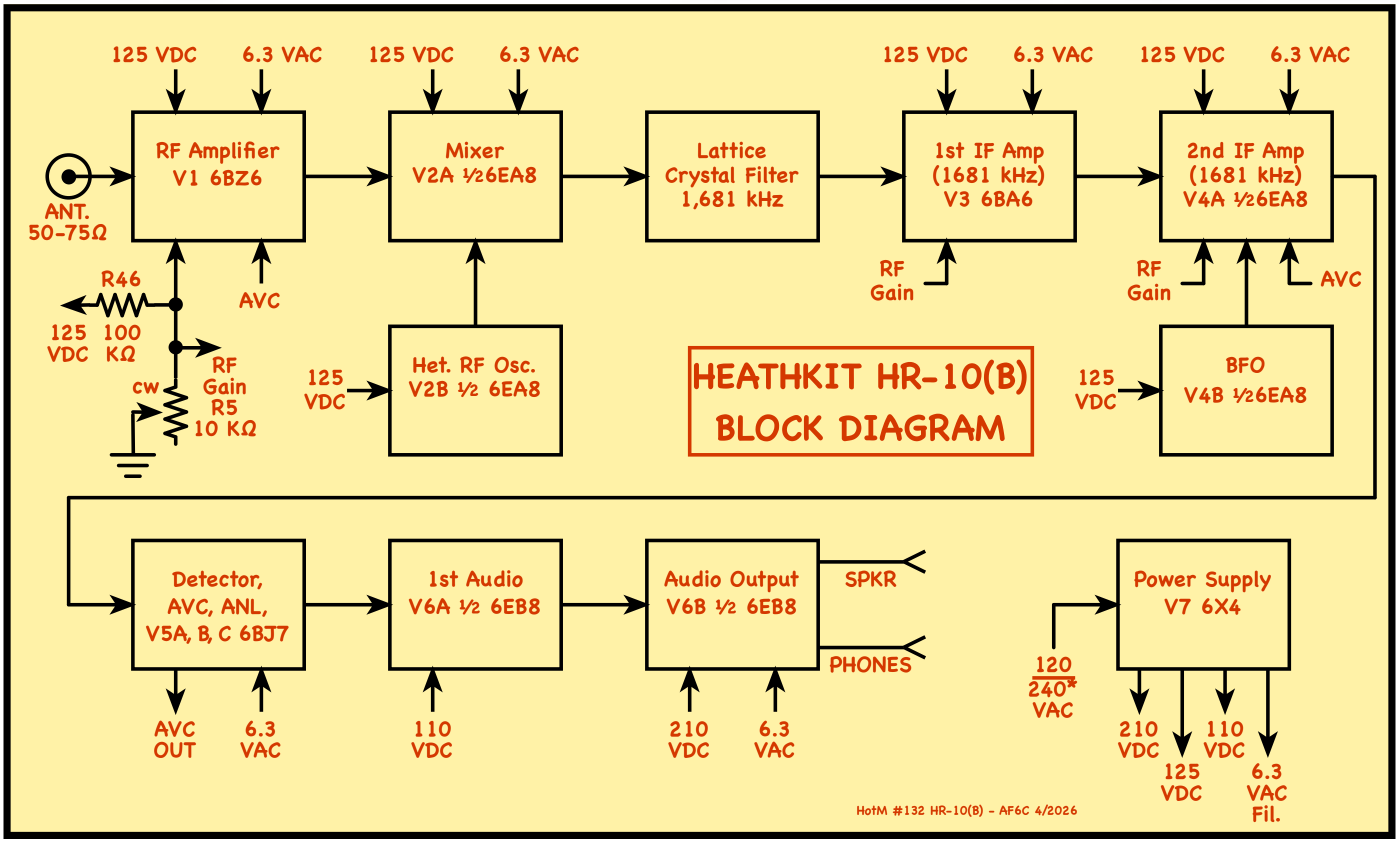
A basic superheterodyne communications receiver is made up of ten sections, some are optional: RF amplifier (optional); (HO) heterodyne oscillator; mixer; (IF) intermediate frequency amplifiers; (BFO) beat frequency oscillator (optional); detector; (AVC) automatic volume control; (ANL) automatic noise limiter (optional); audio amplifiers and power supply.

The optional RF amplifier is tuned to the desired frequency and helps increase image rejection. The heterodyne oscillator produces a signal that is a given frequency above or below the received frequency; when tuning the receiver the HO tracks the received frequency keeping their difference in frequency constant. The mixer, whose input is also tuned to track the received frequency, mixes the HO signal and the received signal; the result is an IF sig-

HR-10 / HR-10B SPECIFICATIONS

Frequency Coverage –			
80/75 Meters:	3.5 MHz	to	4.0 MHz
40 Meters:	7.0 MHz	to	7.3 MHz
20 Meters:	14.0 MHz	to	14.35 MHz
15 Meters:	21.0 MHz	to	21.5 MHz
10 Meters:	28.0 MHz	to	29.7 MHz
Intermediate Freq. (IF):......	1681.0 kHz		
Sensitivity:	1 µV for 10 dB (S+N) / N.		
Selectivity:	3 kHz @ -6dB, 9 kHz @ -40dB		
Image Rejection:	40 dB or better		
Input Impedance:	50 to 75 Ω, coaxial		
Audio Out Impedance:	8 Ω spkr. or 500 Ω phones		
Panel Controls:	See **Table III**		
Tube Complement:	See **Table II**		
Power Requirements:	117 VAC, 50/60 Hz, 30 watts		
Cabinet Size:	13-¾" W x 11-½" D x 6-½" H		
Net Weight:	18 lbs.		
Shipping Weight:	21 lbs (HR-10 only)		

TABLE IV



nal that is the difference between the HO and received signal. The IF frequency is usually quite low to improve selectivity; since it is a fixed frequency it can be amplified and coupled with fixed tuned circuits. If the receiver is designed to receive CW or SSB it has the optional BFO that can usually be tuned across the IF frequency; a beat note between the BFO and IF signal, when properly tuned will make the CW signal intelligible as a tone heard as CW. The BFO can also be tuned to replace the missing SSB carrier and makes the SSB signal intelligible. The AVC adjusts the gain of some earlier stages to tend to keep signals of different strengths appear to be near the same level. Finally, the audio section amplifies the audio to drive earphones or a speaker. The power supply section provides power to the other sections.

The HR-10(B) RF Amplifier (V1)

An RF amplifier stage (V1) provides decent sensitivity of 1.0 μV for 10 dB signal-plus-noise to noise ratio. An **ANT**enna **TRIM**mer control allows peaking the signal for different impedance antennas. The RF amplifier input is tuned, as is the input to the mixer. Both tuned circuits track each other as the **MAIN TUNING** knob is turned. The RF amplifier gain is controlled by an AVC voltage, and also by the manual **RF GAIN** control (R5).

The HR-10(B) Heterodyne Oscillator (V2B)

The HR-10(B) has an IF of 1,681 kHz. The Heterodyne Oscillator (HO) produces a CW signal that tracks the received signal with the MAIN TUNING knob, but is 1,681 kHz higher in frequency. On 15 and 10 meters the HO produces a signal whose second harmonic is used. **TABLE V** lists the band and HO frequencies.

The HR-10(B) Mixer (V2A)

Both the output of the RF amplifier and the

	RECEIVE FREQ. MHz		HET. OSC. MHz	
BAND	LOW	HIGH	LOW	HIGH
80/75M	3.5	4.00	5.1810	5.6810
40M	7.0	7.30	8.6810	8.9810
20M	14.0	14.35	15.6810	16.0310
15M	21.0	21.50	11.3405*	11.5655*
10M	28.0	29.70	14.8405*	15.6905*

Table V: Receive Frequencies & Associated Heterodyne Oscillator Frequencies
* The second harmonic of this freq. is used.

heterodyne oscillator are coupled to the control grid of the mixer via C18 and C19 respectively. This stage is biased to produce non-linear amplification. The result is four significant signals appear at the plate[5] - the two original signals, the sum of the two signals and the difference between the two signals. Only the difference frequency makes it through the crystal filter, which is set to the frequency of the IF.

The HR-10(B) Half-Lattice Crystal Filter

The output of the mixer is coupled to a simple two-crystal half-lattice filter. This filter provides better selectivity than could be established only with a standard IF of 1,681 kHz.

The HR-10(B) 1st IF Amplifier V3

A pentode 6BA6 provides initial IF gain. R15 sets the load impedance needed for the output of the lattice filter. This stage runs without any AVC action, but its gain can be reduced by decreasing the RF GAIN control. This stage is coupled through T2 to the second IF stage.

The HR-10(B) 2nd IF Amplifier V4A

The pentode section of a 6EA8 provides additional IF amplification. In the early HR-10 receivers a 47 KΩ is used across the secondary of T2. This resistor reduces the 'Q' of the secondary increasing bandwidth. This resistor, shown on the HR-10 schematic was no longer used on the HR-10B. Whether this change occurred when the model changed or before, has not been discovered. It appears in manual 595-500 (HR-10), but not in manual 595-885, which is the early HR-10B manual dated 4-21-67. The gain of the second IF is controlled by the AVC, as well as the manual RF GAIN control. Output of the second RF stage is coupled through T3 to the detector.

Figure 4: A larger view of the HR-10B front panel. Note that the 15 meter scale goes to 21.50 MHz though the band ends at 21.45. The AM/SSB frequencies are marked by a thickened white bottom line.

The HR-10(B) BFO - V4B

The triode stage of V4 is a simple Hartley beat frequency oscillator (BFO) that tunes across the IF bandwidth centered on 1,681 kHz. The BFO can be turned on by the **OFF - BFO** slide switch and tuned by the **BFO TUNE** control. When on, the oscillator will beat with a CW signal in the IF producing an audio tone. The tone frequency is the difference between the IF frequency of the CW signal and the BFO signal. The tone may be changed by adjusting the BFO TUNE control. SSB reception is achieved by tuning for maximum signal and then adjusting the BFO to where it replaces the missing carrier of the received SSB signal. This is either to the left or right of center depending on the sideband in use.

The HR-10(B) Detector- V5A

The HR-10(B) receiver does not have a more advanced "product detector" that is superior for CW and SSB reception. Instead the IF amplifier output is coupled to the plate (lug 2) of V5A, one section of a 6BJ7 triple diode. The cathode (lug 1) of this diode section has a load resistance composed of R28, R29 and R30, across which the audio voltage is developed. Any IF frequency components remaining are removed by C32. The audio then is filtered by a low-pass filter composed of R31 and C33, which has a cutoff around 4 kHz, passing normal voice communications frequencies. The audio is coupled through C35 to the volume control and on to the 1st audio amplifier.

The HR-10(B) AVC- V5B

A small amount of the IF is coupled via C34 and rectified by V5B (lugs 8 and 9). the resulting negative voltage is developed across R27. R26 and C29 set the AVC delay time which is fixed on this receiver. When the **OFF - AVC** slide switch is in the AVC position this negative DC voltage is applied to the control grids of the RF amplifier, V1 and the 2nd IF amplifier, V4A, causing their gain to automatically be reduced when a strong signal is being received. When the OFF - AVC switch is in the OFF position the AVC line is grounded and the S-Meter, which relies on the AVC voltage being connected, is disabled.

The HR-10(B) ANL- V5C

Diode section V5C and associated circuitry make up a simple self-adjusting shunt-type automatic noise limiter (ANL). This type circuit is useful only for noise reduction during AM reception. The DX-35, DX-40 and DX-60 series all transmitted on AM as well as CW. The ANL is activated by the **OFF- ANL** slide switch.

The HR-10(B) RF Gain & Standby/Muting

(Refer to **FIGURE 5**) In the full CW position, the wiper of the RF GAIN control R5 is at ground potential when the **STBY - REC** switch is in REC and the external contacts pin-6 (MUTING) and pin-1 (GND) on the octal accessory socket are connected together. With the

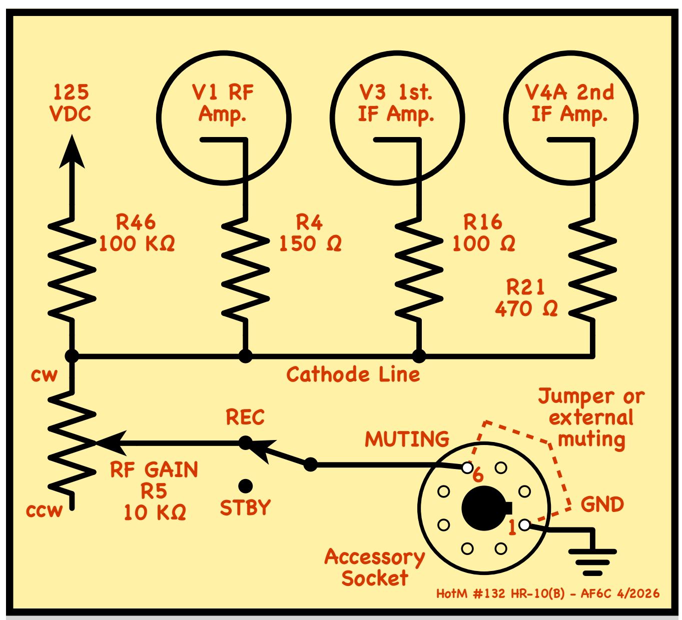


Figure 5: HR-10(B) RF Gain and Muting circuit.

wiper at ground potential the cathode of the RF amplifier and the 1st and 2nd IF amplifiers are effectively grounded through their cathode resistors R4, R16 and R21 respectively, and the gain of those stages are at maximum as currently set by the AVC circuit, if enabled.

As the RF GAIN is turned counter-clockwise R46 and R5 make a voltage divider, and the voltage on the cathode line of the three controlled stages increases from zero to about +11 volts. This voltage raises the voltage of the cathodes, making the control grids more negative and reducing the gain of those stages, manually controlling the gain of the receiver.

Should the STBY - REC switch be placed in STBY, or the external mute connection between pins 6 (MUTING) and 1 GND of the octal accessory socket be opened, it will cause R46 to raise the voltage on the cathode line to over 100 volts fully cutting off the RF amplifier and both IF amplifiers, muting the receiver.

The HR-10(B) Main Tuning (C6)

A three-section MAIN TUNING variable capacitor performs the tuning. One section (C6A), in conjunction with the ANT. TRIM control tunes the input to the RF stage. The second section (C6B) tunes the mixer input, and the third section (C6C), in conjunction with the CAL RESET control tunes the heterodyne oscillator. Each section of C6 (#26-84) is 15 $\mu\mu f$. When the receiver is properly aligned, these three sections track one another with minor adjustments available via the ANT. TRIM and CAL RESET controls. On 80 - 20 meters the HO tracks 1,681 kHz high, and on 15 - 10 meters the second harmonic tracks 1,681 kHz high.

Figure 6 shows the main tuning scale of the HR-10B. Markings are each 10 kHz except on 10 meters they are each 20 kHz. The HR-10 is similar.

The HR-10(B) Audio Circuits (V6)

The 1st audio stage uses the triode section (V6B) of a 6EB8 dual section vacuum tube. It is a simple audio circuit lacking cathode bypass to improve linearity. V6B drives the control grid of V6A through C38. V6A runs class A drawing about 20 mA of plate current. Its screen grid is powered directly by the 125 volt power source. T4 converts the 7.5 KΩ plate load of V6B to 8Ω to drive a speaker and 500 Ω to drive earphones. R34, a 1500 Ω 2-watt resistor is across the 500 Ω transformer output to protect the output stage in case there is no phone or speaker load. The speaker output is automatically disconnected when phones are plugged into the PHONE jack on the front of the receiver.

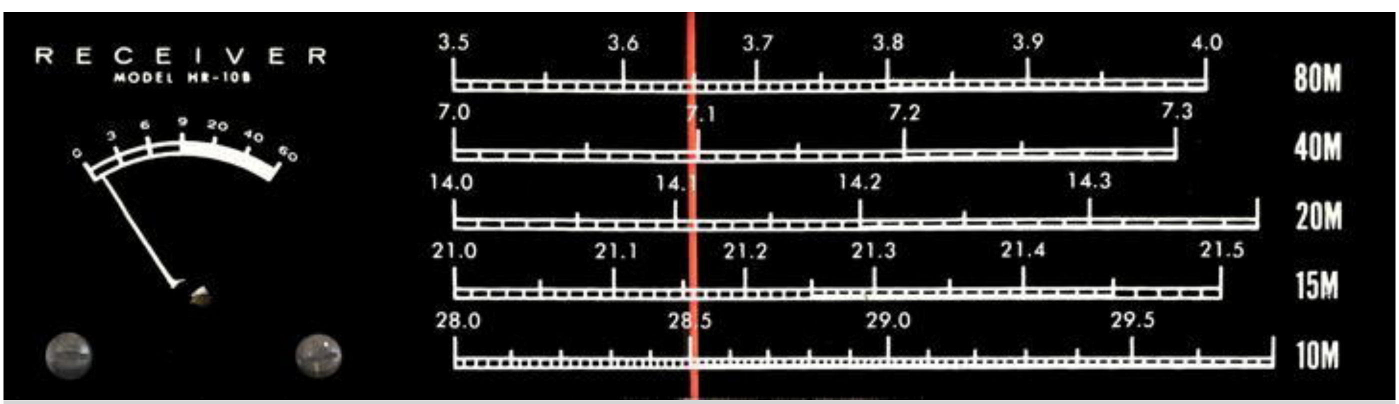


Figure 6: HR-10B S-Meter and Tuning Scale. note that 15 M extends an extra 50 kHz to 21.5 MHz.

The HR-10(B) Power Supply (V7)

The HR-10(B) is totally void of any solid-state devices. Heath decided to use a 6X4 vacuum tube rectifier (V7) in lieu of rectifier diodes. Whether this was for cost-savings or because Heath had a large inventory of 6X4 tubes, is unknown. The companion DX-60 uses silicon rectifier diodes in its power supply. Power is provided by T6 (54-122 - 410 VCT @ 63 mA, 6.3 VAC @ 4 A). Output from the full-wave rectifier tube is filtered by C57 producing about 210 volts which runs the audio output tube V6B. The 210 VDC is further filtered by R44 and C56 producing about 125 VDC that powers most of the radio's circuits. The 125 volts is again filtered to produce 110 VDC at a small current to power the 1st audio amplifier (V6A). The extra filtering provides highly filtered power to the stage most susceptible to power supply hum.

Sometime before 1970 Heath replaced the power transformer with one that had a dual 120 volt primary so it could run on 120 VAC with the primary winding in parallel and on 240 VAC with the primaries is series. Filament and pilot lamps draw is under 3.5 A leaving a good safety margin over 10%[6]. The power supply is internally fused with a ½ amp 3AG slow-blow fuse.

The HR-10(B) Operation:

Operation of the receiver is fairly simple. The **BAND** switch is set to the desired band; the STBY - REC switch is set to REC; the CAL switch is set to OFF.

To receive AM signals set the BFO switch to OFF, the RF GAIN fully clockwise, the **AF GAIN** to a comfortable level, and tune in the signal, using the MAIN TUNING knob, for maximum S-meter reading, peaking the ANT. TRIM as needed. Should the signal be so strong it is

RECEIVER IMAGE REJECTION

Imagine a receiver with a very common 455 kHz IF. When receiving a signal on 14,010 kHz. The heterodyne oscillator (HO) can either be 455 kHz above or below the received frequency. Let's assume the HO is above the received frequency which means it is at 14,465 kHz. The desired signal out of the mixer is the difference between the two frequencies or 455 kHz.

However, assume there is also a strong signal at 15,000 kHz (WWV). If it reaches the input to the mixer it will mix with the 14,465 kHz, (HO) and also appear at 455 kHz. This unwanted signal is called the image. If there is no RF amplifier stage the image can only be rejected by the mixer tuning circuit. If there is an RF amplifier, its tuned input circuit also helps attenuate the image signal. The difference between the two signals is 910 kHz so the RF amplifier and mixer must have a high 'Q' which can cause other problems.

Another way to improve image rejection is to raise the frequency of the IF. The HR-10(B) uses 1,681 kHz which increases the difference between the desired signal and a possible unwanted image signal to 3,362 kHz increasing the effectiveness of the RF and mixer tuned circuits.

However, increasing the IF creates a new problem. The lower the IF the more effective tuned LC circuits are at improving selectivity between adjacent signals. Heathkit solved this problem by adding a half-lattice crystal filter to the IF. It surely raised the cost of the receiver, but provided a significant improvement for that cost.

More expensive receivers often use two or even three IF frequencies. The first a high one for good image rejection and then (a) lower one(s) for good selectivity. Image rejection is less of a problem on the lower bands; some use single conversion (1 IF) on the bands below 10,000 kHz and double conversion (2 IFs) above that.

More expensive receivers also can use mechanical or crystal filters that might cost ⅓ to ¾ of the price of the HR-10(B) to improve selectivity. The SB-300 series uses a wide-band (8,395 to 8,895 kHz) first IF and a 3,395 kHz second IF with selectable crystal filters.

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overloading the receiver turn the RF GAIN control counter-clockwise until the overload is eliminated. Readjust the AF GAIN control as needed.

To receive CW signals set the BFO switch to BFO, and the AVC switch to OFF, set the AF GAIN control to the 3-o'clock position and use the RF GAIN control to adjust the audio level. Use the BFO TUNE control to adjust the pitch of the received CW signal.

To receive single-sideband (SSB) signals set the BFO switch to BFO, the AVC switch to ON, the AF GAIN control to the 3-o'clock position and use the RF GAIN control to adjust the audio level. Set the BFO TUNE control to 10 o'clock to receive upper side band (USB) or to 2 o'clock to receive lower sideband (LSB). Adjust the MAIN TUNING control and BFO TUNE slightly for the most intelligible audio. If you cannot tune the signal in, try tuning for the other sideband by repositioning the BFO TUNE control to the other side.

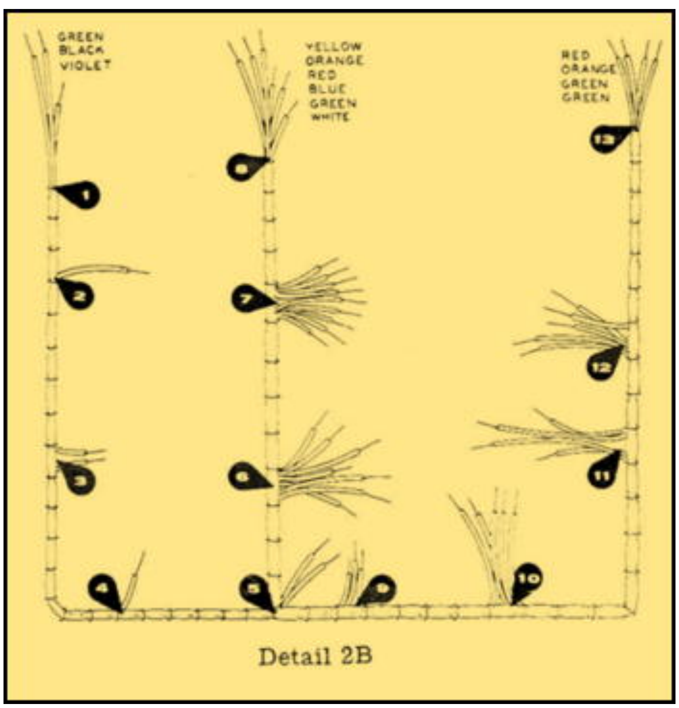

Figure 7: Factory provided wiring harness #134-40

If your HR-10(B) receiver is equipped with the HRA-10-1 Crystal Calibrator, you can determine the frequency of the received signal more accurately. First, tune to the nearest 100 kHz marking on the dial face. If the BFO switch is OFF turn it to BFO. Set the BFO TUNE to 12 o'clock. You should hear a tone from the receiver. Adjust the CAL RESET control for zero beat with the calibrator signal. Now tune back to the station you were receiving and read the frequency from the dial.

The HR-10(B) Assembly:

Assembly and alignment is simplified by the receiver being shipped with a "preassembled front end" (Part # 110-8) that includes the band-switch, 3 resistors, 17 silver mica capacitors, five ceramic temperature compensating capacitors, a bypass capacitor, an RF choke and three coils for each of the five bands (15 coils total), but not the main tuning capacitor, tubes, tube socket or most of the tube socket wiring. The coils in this assembly are factory adjusted to be close to their adjusted position. Since the circuitry and components added in assembly and wiring differences are unknown, there is still need for alignment - but you'll be starting close to the final adjustments. **Table VI** lists the components that are part of the preassembled front end.

Be aware that the coils are mislabeled on the *Replacement Parts Price List for the Preassembled Front End* on page 39 of manual [595-945-01] and possibly other early manuals. The list in manual [595-945-03] is correct.

The HR-10(B) uses no printed circuit boards, it is all point-to-point wiring. The layout is mostly spacious making assembly easy. A wiring harness keeps connections neat and helps prevent errors.

Electronic Parts List for the Preassembled HR-10(B) Front End (#110-8)

ID	Part #	Description	Band	Section	ID	Part #	Description	Band	Section
R1	1-41	10 Ω 1/2W Resistor	N/A	Ant.	C54	21-65	25 μμf Tubular Ceramic N750 Cap	10 M	H.O.
R9	1-44	2.2 KΩ 1/2W Resistor	N/A	Mix.	C61	21-66	50 μμf Tubular Ceramic N750 Cap	15 M	H.O.
R45	1-44	2.2 KΩ 1/2W Resistor	80 M	Mix.	C66	21-65	25 μμf Tubular Ceramic N750 Cap	80 M	H.O.
C1	20-100	30 μμf Silver Mica Capacitor	80 M	Ant.	C67	21-7	33 μμf Disc Ceramic N750 Capacitor	40 M	H.O.
C2	20-102	100 μμf Silver Mica Capacitor	40 M	Ant.	C68	21-66	50 μμf Tubular Ceramic N750 Cap	20 M	H.O.
C3	20-105	180 μμf Silver Mica Capacitor	20 M	Ant.	L1	40-414	Antenna Coil - 0.385 μH	10 M	Ant.
C4	20-111	230 μμf Silver Mica Capacitor	15 M	Ant.	L2	40-415	Antenna Coil - 0.270 μH	15 M	Ant.
C5	20-78	56 μμf Silver Mica Capacitor	10 M	Ant.	L3	40-416	Antenna Coil - 0.635 μH	20 M	Ant.
C7	20-100	30 μμf Silver Mica Capacitor	N/A	Ant.	L4	40-417	Antenna Coil - 3.20 μH	40 M	Ant.
C11	20-102	100 μμf Silver Mica Capacitor	10 M	Mix.	L5	40-418	Antenna Coil - 25.0 μH	80 M	Ant.
C12	20-114	270 μμf Silver Mica Capacitor	15 M	Mix.	L6	40-419	Mixer Coil - 0.287 μH	10 M	Mix.
C13	20-111	230 μμf Silver Mica Capacitor	20 M	Mix.	L7	40-420	Mixer Coil - 0.245 μH	15 M	Mix.
C14	21-27	0.005 Disc Ceramic Bypass Cap	N/A	Mix.	L8	40-421	Mixer Coil - 0.523 μH	20 M	Mix.
C15	20-102	100 μμf Silver Mica Capacitor	40 M	Mix.	L9	40-422	Mixer Coil - 3.70 μH	40 M	Mix.
C16	20-99	22 μμf Silver Mica Capacitor	80 M	Mix.	L10	40-423	Mixer Coil - 28.1 μH	80 M	Mix.
C44	20-100	30 μμf Silver Mica Capacitor	N/A	H.O.	L11	40-424	Heterodyne Oscillator Coil -0.900 μH	10 M	H.O.
C46	20-117	90 μμf Silver Mica Capacitor	10 M	H.O.	L12	40-425	Heterodyne Oscillator Coil - 0.640 μH	15 M	H.O.
C47	20-126	255 μμf Silver Mica Capacitor	15 M	H.O.	L13	40-426	Heterodyne Oscillator Coil - 0.374 μH	20 M	H.O.
C48	20-126	255 μμf Silver Mica Capacitor	20 M	H.O.	L14	40-427	Heterodyne Oscillator Coil - 1.52 μH	40 M	H.O.
C49	20-103	150 μμf Silver Mica Capacitor	40 M	H.O.	L15	40-428	Heterodyne Oscillator Coil - 11.3 μH	80 M	H.O.
C50	20-77	24 μμf Silver Mica Capacitor	80 M	H.O.	PC-2	45-43	RF Choke - 6 Turns on 470 Ω Resistor	N/A	H.O.

TABLE VI ∑

Assembly begins with a lot of parts, tube sockets, terminal strips, variable capacitors, the three-section electrolytic capacitor being mounted on the chassis. Focus then turns to assembling the front panel. Switches, dial plate, dial pointer, S-meter, and pulleys for the dial string, are added; and the front panel is attached to the chassis and held in place by installing the front controls.

Next, the audio and power transformers are mounted and their leads connected to the proper location. The wiring harness **(Figure 7)**, which comes manufactured, is then laid out inside the chassis and its leads are attached per the manual. various wires are run from point to point and a few special cables are prepared and installed. In the process, V7 is wired completely. These steps begin the soldering.

Components are then installed and soldered under the chassis starting around V5, then V6, V4, V3, the rear panel, V2 and finally V1.

At this point the preassembled front end is installed under the chassis, along with the main tuning shaft and its inertia weight. Connections are made between the preassembled front end and: V1 lugs 1 and 5; terminal strip R lug 4 (125 volt point); V2 lugs 8 and 9; the antenna connector on the rear panel (coaxial cable) and each of the three sections of the MAIN TUNING variable capacitor (C6A, B, C).

Once the "preassembled front end" is installed, the space around V1 and V2 gets quite tight. So any major servicing in that area probably involves removing the assembly. Luckily that doesn't appear to be too hard, but it might require restringing the dreaded dial-cord?

The two-wire line cord is wired in. The chassis top wiring is completed. The dial cord is strung, and shaft extensions, knobs, the fuse, the pilot lamps, the filter crystals and the tubes are installed.

The HR-10(B) Checkout:

An initial resistance check between the filter C55 (the 110 VDC buss) and ground is measured. It should be greater than 30 KΩ after approximately 30 seconds; this assures there are no major shorts in the B+ wiring. The controls are then set (TABLE VII), a speaker is connected, and the radio is plugged in. The AF GAIN should then be turned from OFF to the 12 o'clock position. Observe that the pilot lights come on, as do the tube filaments. After the filaments warm up, a rushing noise should be heard from the speaker. If these tests are met, alignment is next.

Checkout Control Settings:

AF GAIN	OFF
RF GAIN	Maximun clockwise
BFO TUNE	12 o'clock
BAND Switch	80 meters
MAIN TUNING	3.5 mc.
ANL	OFF
AVC	OFF
BFO	OFF
CAL	OFF
STBY - REC	REC

TABLE VII

The HR-10(B) Alignment:

Alignment requires a VTVM that measures AC voltage and an amplitude modulated RF signal generator. Step-by-step alignment instructions from the manual are available on the W6ZE website[7].

First the IF stages are aligned. The HO is temporally disabled with a jumper. The signal generator is set to around 1,681 kHz and peaked to the pass-band of the crystal filter. The slugs in T1, T2 and T3 are then adjusted in a special order. After each set of adjustments to the transformers the signal generator is repeaked, and the transformers are readjusted. This is repeated until no improvement is noticed.

Next, the BFO is switched to ON, the BFO TUNE is set to 12 o'clock and the BFO aligned to zero-beat with the peaked signal generator.

Finally the RF front-end circuits are aligned, starting at 80 meters and proceeding to 10 meters. First the signal generator is set to the low end of the band, and the 80 meter oscillator coil (L11) is adjusted for maximum signal. Then the signal generator is reset to approximately the middle of the band and the dial is set to correspond. Now the CAL RESET control, antenna (L6) and mixer (L7) coils are peaked. This is repeated for each band.

Once alignment is complete, final assembly is performed. The feet, bottom plate and cabinet are attached and the blue series sticker is attached to the rear panel.

Comments:

Recently an HR-10B was obtained from a club member; it had been passed on to him from someone who had had it passed on to them. The original builder is unknown. Receiving the radio was motivation for this article. Plans were to fix it up and pass it along to a friend. The article had been started before the radio was fully examined. The radio externally looked in reasonable shape with the cabinet needing painting and the S-meter needle needing straightening.

When the bottom plate was removed to take some photos, (it was held on using only two of the six screw holes – always a bad sign) the first thing noticed was the fuse was incorrect. Instead of the specified 3AG ½-amp 250 V slow-blow fuse[8], there was an SFE 20-amp 32 V fuse[9]. It had been powered up earlier, the pilot lamps lit and, after warming up, a hiss was heard from an external speaker. Looking over the underside, a number of cold-soldered joints were found. The wiring harness was not down along the chassis, but floating in most places. What really stood out were the disk ceramic coupling and bypass capacitors. The leads of most of these were almost their full uncut length, and many stuck up an inch or two above the tube socket. (Figure 8).

Figure 8: Above is the first IF's socket (V3) showing the installation of the bypass capacitors standing up with very long leads. Just about all the other bypass capacitors are installed likewise throughout the radio. Even at the critical mixer and RF Amplifier stages.

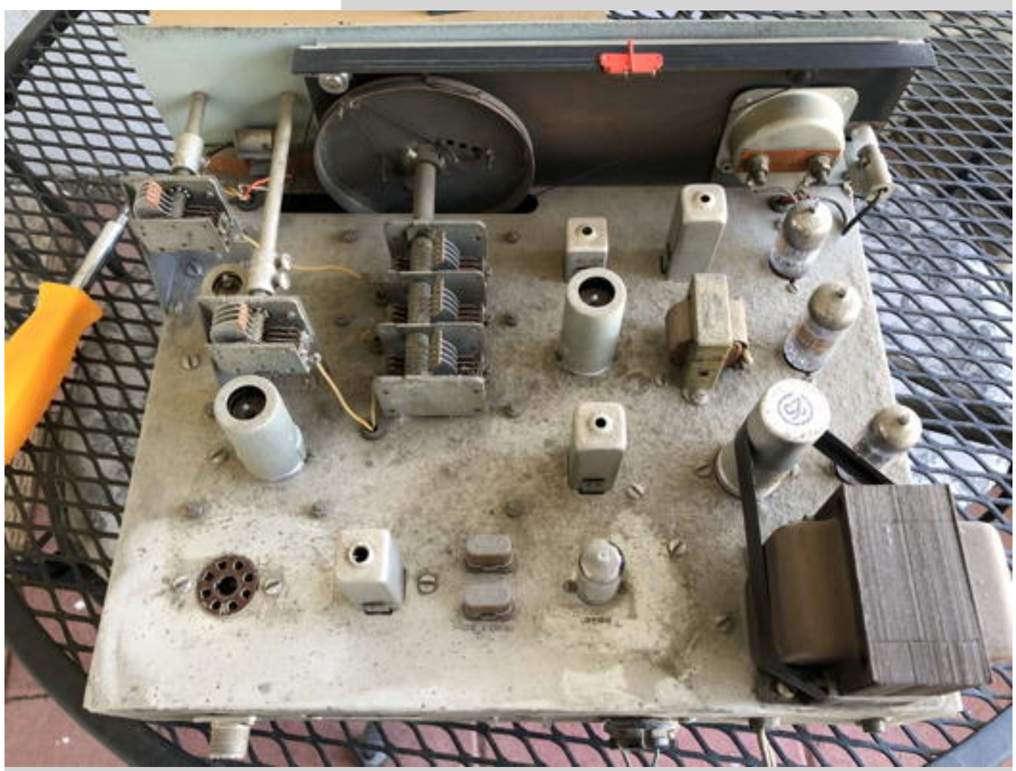

Figure 9: Removing the cabinet revealed a lot of dust that needed to be removed. The reason for the tape around the filter capacitor and transformer is, as yet, unknown.

This can easily cause instability in the RF and IF stages.

Next the cabinet was removed. Someone had taped a piece of cardboard across the back opening and that should have helped keep some dust out. It didn't! (See **Figure 9**). Most of the dust was removed easily with a brush, which is promising.

This looks like a *'down to the bare chassis'* restoration job. At least, most of the 0.005 μf ceramic bypass capacitors can be saved with adequate lead length remaining. The front panel is in reasonable shape, the chassis bottom is quite clean, the chassis top should be able to be cleaned reasonably and the difficult to replace parts seem all intact and appear to be working, so it should be a doable project. Free time will be the biggest constraint.

Notes:

1. These dates are compiled from the author's incomplete catalog file and may have some small discrepancies.
2. The 15 meter ham band is 21.00 to 21.45 MHz. The HR-10(B) covers an additional 50 kHz, 21.00 to 21.50 MHz.
3. When the 'B' is in parentheses it refers to both the HR-10 and HR-10B receivers.
4. The schematic for the HR-10 and HR-10B, as well as the alignment instructions can be found here: https://www.w6ze.org/Heathkit/HR-10/HR10.html
5. Many other mixer products also appear at lower strengths. These may show up as "birdies" when tuning. Proper selection of the IF frequency reduces the problem.
6. 5% when the optional HRA-10-1 Crystal Calibrator is installed
7. Refer to note 4 above.
8. Proper fuses are Buss MDL-½ or Littelfuse 313.500.
9. Fuse type SFE are automotive fuses.They are only good for 32 volts. At 120/240 VAC they can continue arcing after they blow. A FIRE HAZARD!

Notes: HotM #132 HR-10B

There are a few Heathkits on the agenda to write on: An IO-4550 Dual trace oscilloscope that is mostly restored and beautiful, but needed some "unobtainium" parts, which I finally have a break-thru on; and an IM-5238 AC VTVM. that is in great shape. I do have a few other obligations, so there may not be an article next month.

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