

Heathkit of the Month #133:
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AMATEUR RADIO - SWL

**Heathkit HRA-10-1
 100 KC Crystal Calibrator**

Introduction:

Before synthesized tuning and digital frequency displays, amateur radio operators had to rely on an analog dial to readout his or her frequency on the receiver. Frequency readout could be tricky and took some practice. This is one reason the FCC, when they announced the Novice class license back in 1951, required transmitters used by novices to be crystal controlled.

If the crystal, or its desired harmonic, was within the novice band, then the novice would be on a known legal frequency. Transmitters, in those days, often had a spotting function that would only let the oscillator and multiplier stages operate, outputting milliwatts of power. The operator could then zero beat the receiver to the transmitter frequency. And since the crystal frequency was known, the receiver band-spread could be set to that frequency. On a ham-band only receiver, like the HR-10(B), that is accomplished with the CAL. RESET control; on some receivers, like the SB-301 or Drake 2B, you could adjust the scale or hairline indicator to the known frequency. On general



Figure 1: The Heathkit HRA-10-1 Crystal calibrator that may be plugged into the HR-10(B) receiver or one of the Single-Bander transceivers.

coverage receivers the band-spread dial was set to the known frequency, and then zero beat was accomplished with the main tuning dial.

Once the novice graduated to a general or higher class license, and switched to a VFO for the transmitting frequency, another standard was needed to check the frequency. The most common was using a crystal controlled marker oscillator. This oscillator is designed to emit strong harmonics. A 100 kc¹ marker oscillator can produce strong harmonics every 100 kc across the HF range.

While 100 kc is the most common marker frequency, other frequencies are sometimes used such as 500 kc² and 1 mc. These will more likely be found on general coverage receivers. With the development of RTL and TTL logic IC's in the late 1960s multiple marker frequen-

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 6.

cies such as 1 mc, 500 kc, 100, kc, 50 kc and 25 kc could be selected from a single 1 or 4 mc crystal³. Such a calibration unit could be purchased, or be home-brewed from articles in many ham magazines.

The HRA-10-1 100 KC Crystal Calibrator:

When Heathkit released HR-10 Basic Amateur Band Receiver it also offered the new HRA-10-1 calibrator as an accessory (**Figure 1**). This accessory plugs into an octal socket on the HR-10 series chassis, though it could easily be used with other receivers by making some simple receiver modifications. The HRA-10-1 gets its filament and B+ power from the host receiver, and supplies a harmonic rich 100 kc signal to the receiver antenna terminals through the octal socket. It is surprising how many HR-10(B) receivers on today's market do not have the HRA-10-1 installed. Either it wasn't a popular accessory or

people held on to the calibrator when disposing of their receiver.

When Heathkit released the Single-Bander series of SSB transceivers in 1963, they provided an octal socket that would accept the HRA-10-1 crystal calibrator. Unfortunately, when the HRA-10-1 was originally designed no one had the foresight to design it so it could easily be used with equipment designed for 12V mobile operation. Thus one has to be careful when using it with the HW-12/22/32(A) Single-Banders. More about this in a later section.

Earlier, in 1960, Heathkit had released a stand-alone 100 kc crystal calibrator, the HD-20 (HotM #99). It sold for fifteen years until mid-1975 for, \$14.95. This crystal calibrator is transistorized and uses an "unobtainium" NEDA 1600D 9-volt battery. Luckily, it is a simple modification to switch to today's standard NEDA 1604 9-volt battery.

HRA-10-1 100 KC Xtal Calibrator Specifications

Frequency Coverage100 kc to at least 30 mc, in harmonics of 100 kc.

Crystal –

Type:.....Quartz, fundamental Frequency

Heath Part #:.....404 - 43

Frequency:.....100 kc $\pm$ 0.005%

Holder:.....HC6/U (tall)

Pin Spacing:0.486"

Pin Diameter:.....0.050"

Vacuum Tube.....6BA6 pentode

Power Requirements –

B+ Voltage:.....150 volts, 1.7 milliamperes (mA)

Filament Voltage:6.3 volts, 0.3 amperes

Dimensions:2-1/8" x 2-1/8" x 3-1/8" from chassis

Net weight:.....5 oz.

TABLE I

The HRA-10-1 Specifications:

Table 1 lists the specifications given in the specification sheet. Note that the 100 kc crystal (part # 404-43)⁴ has a tolerance of 0.005%. That means that if the crystal is in a circuit offering the proper parallel capacitance, the 300th harmonic of the crystal will be within 1.5 kc of 30 mc. By slightly adjusting the load capacitance across the crystal the frequency can be changed slightly and brought closer than the 0.005% specified accuracy. This is done by zero beating the HRA-10-1 with a known standard. The practical way is to use WWV on one of its transmitted frequencies of (2.5 mc, 5.0, mc 10.0 mc, 15 mc, 20 mc and 25 mc⁵.) The HRA-10-1 has a trimmer capacitor specifically for making minor corrections to the crystal frequency. Unfortunately, the HR-10(B) does not receive any of the WWV frequencies, so an external receiver must be used⁶.

The HRA-10-1 Circuit:

While the stand-alone HD-20 100 kc crystal calibrator is transistorized, the HRA-10-1 uses a single vacuum tube since the needed voltages are readily available in the host receiver. The current draw for the filament is 300 mA at 6.3 VAC. It is less than 2 mA for the 150V B+.

Figure 2 shows the schematic of the crystal calibrator. The crystal is operating at its serial resonant frequency. Feedback is provided off the screen grid, while output is from the plate. This helps isolate the crystal from the output load. This circuit is commonly called an “electron-coupled crystal oscillator”. C2 allows adjustment of the crystal series capacitance load for frequency correction. C4 reduces the feedback to keep the crystal dissipation at a safe level. Capacitor C5 couples the signal to the host receiver’s antenna terminal. It is kept small for isolation and also to attenuate the stronger lower frequency harmonics, while letting the weaker higher harmonics pass with less attenuation.

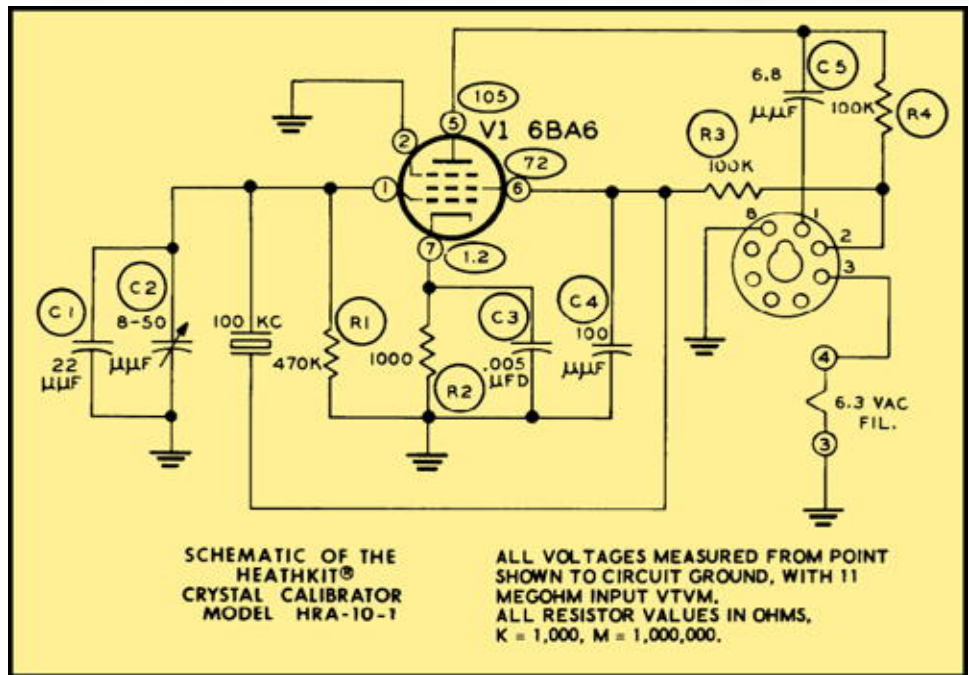


FIGURE 2: Schematic of the HRA-10-1 100 KC Crystal Calibrator

Power is obtained by an octal plug on the bottom of the calibrator chassis. It mates with a standard octal tube socket. **Table II** shows the pin out of the octal plug. While filament voltage is applied to the tube as long as the HR-10 or the Single-Bander is powered on, B+ is only provided when the OFF - CAL. slide-switch on the HR-10(B) is in the CAL. position, or the rotary FUNCTION switch on the Single-Bander is in the CAL. position.

The HRA-10-1 and the Single-Banders:

In Chuck Penson’s excellent 3rd edition of *Heathkit - A Guide to the Amateur Radio Products* he comments :

Note: The [HRA-10-1] calibrator filament circuit is grounded internally to the calibrator chassis. For this reason, the calibrator chassis must not be grounded to the chassis of the radio with which it is used.

This comment seemed odd until realizing that two-years after the HR-10 and HRA-10-1 were

HRA-10-1 100 KC CRYSTAL CALIBRATOR

Pin 1	Oscillator Signal	Output	
Pin 2	150 VDC, 2 mA	Input	B+ power
Pin 3	6.3 VAC 300 mA	Input	Fil. power
Pin 4	Not used		
Pin 5	Not used		
Pin 6	Not used		
Pin 7	Not used		
Pin 8	Ground		Power and chassis

Table II

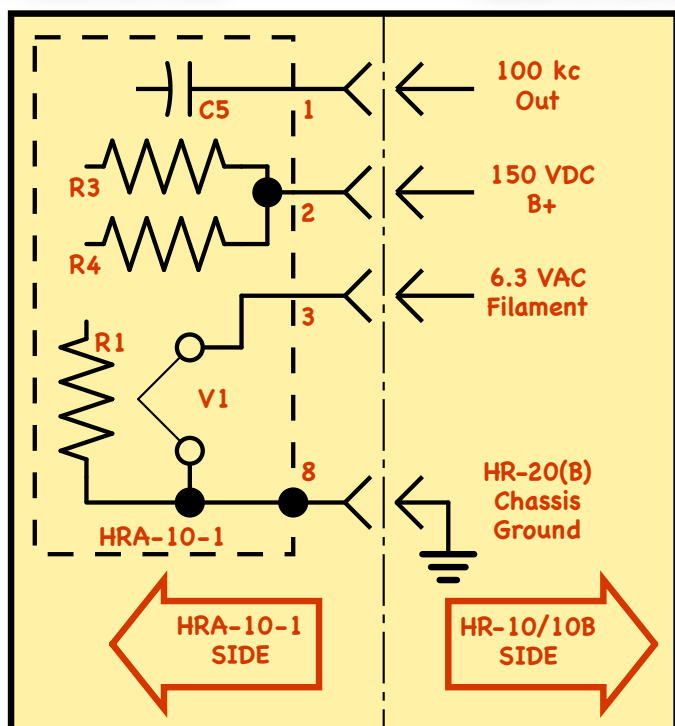


Figure 3: Partial schematic of the current Heath interface between the HR-10 and HRA-10-1.

designed, Heath decided to use it in the Single-Bander transceivers. These radios were designed for both mobile and at home, using an external power supply (HP-13 series for mobile use and HP-23 series for home use). A problem suddenly appeared because now the filaments were running off of 12 volts. There is no problem, and the note doesn't apply to the combination of the HR-10(B) and HRA-10-1. But it does create a dilemma with the 12 volt filament chain of a Single-Bander.

When Heath designed the HRA-10-1 they used pin-8 as a common ground return line for the 150 V power as well as the 6.3 V filament (**Figure 3**). At the time they didn't consider it ever being used with a radio with a 12 volt filament chain. If they had, they would have isolated the filament return line, and grounded it on the receiver side (**Figure 4**). In this figure, pin-5 was chosen for the isolated filament lead. The reason will be obvious shortly.

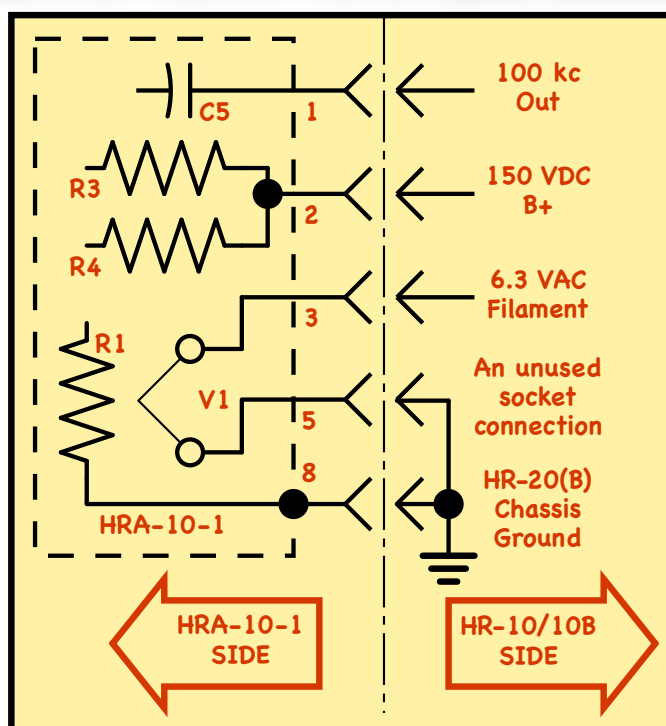


Figure 4: Partial schematic of a more robust interface between the HR-10 and HRA-10-1.

For the HR-10 this mod is trivial, but that isn't the case if the HRA-10-1 is used with an HW Single-Bander.

The following is a discussion on how Heath could have simplified the problem. Unfortunately, since the calibrator socket mounts on the circuit board and pins 4, 6, and 7, while not used by the calibrator, are connected to various parts of the circuit to

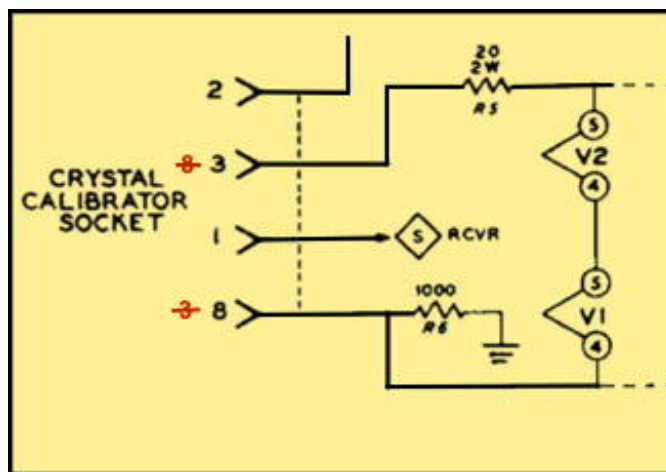


Figure 5: Correct numbering of calibrator socket pins 3 and 8 (from the HW-22A Manual).

expedite the board layout⁷, only pin-5 is isolated. This exercise is more a theoretical solution than a practical modification.

Please note that there is a common error in the early HW-12, HW-22 and HW-32 manual schematics. This relates to pins 3 and 8 on the calibrator octal socket. From top to bottom, they should be marked 2, 3, 1, 8 as shown in black in **Figure 5**. The numbers on pins 3 and 8 should be swapped on early manuals. This error has been corrected in the 'A series' Single-Banders.

Figure 6 shows the unmodified HRA-10-1 connected to an HW Single-Bander. Since pin-8 cannot be grounded at the radio, the B+ return has to go through R6 to ground. Meanwhile the calibrator filament is run directly from the 12 V filament power through R5, a 20 Ω , 2W series resistor to drop the calibrator filament voltage to 6 V. Since pin-8 is connected to the chassis of the calibrator the calibrator is not at ground potential and must be isolated from the chassis of the

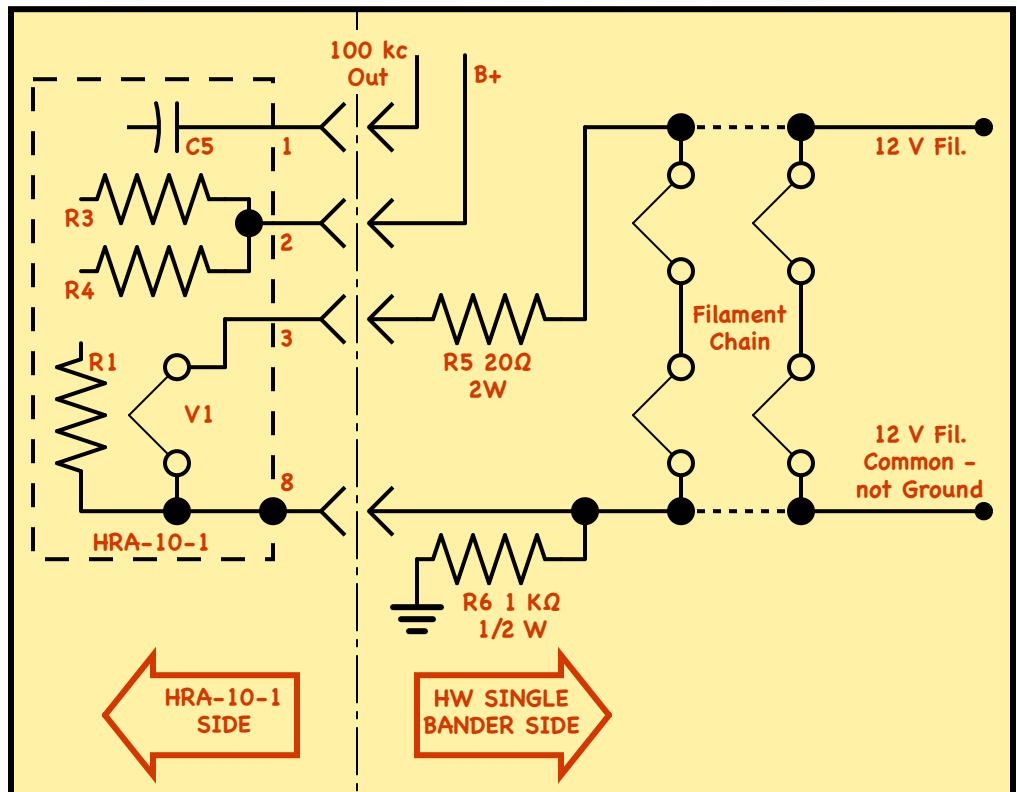


Figure 6: Partial schematic of the stock connections between the calibrator and an HW Single-Bander. Note that the calibrator chassis is floating.

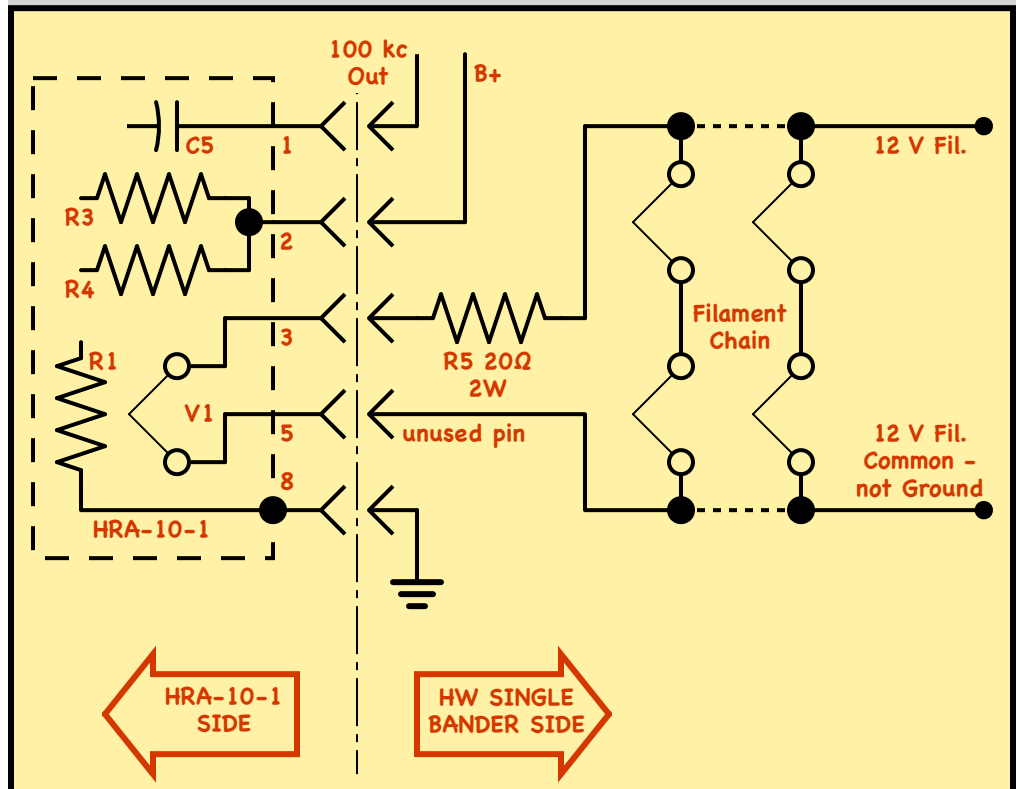


Figure 7: Partial schematic of a hypothetical correction to allow the calibrator chassis to be at ground potential. R6 is no longer needed.



Figure 8 - The Hammarlund FS-135 100 KC Crystal Calibrator circa late 1940 to early 1950s. Note Bliley KV3 Crystal.

Single-Bander. When operating mobile using the HP-13 power supply the filament common is grounded at the car battery, but when running from the home HP-23 the filament is isolated from ground.

Figure 7 is a hypothetical connection between the calibrator modified with the separate isolated filament return line and an HW Single-Bander, that solves the dilemma, and allows the calibrator chassis to be at ground potential.

Why Heath didn't put out an HRA-10-2 with the modification shown is a good question. It could still be used with the HR-10(B) by adding a simple jumper between pins 5 and 8 on the HR-10(B) calibrator socket. Likely the three circuit boards for the HW Single-Banders had finished layout and Heath didn't want to pay the cost to redo them. A clever Heath engi-

neer had figured a work-around that was sufficient to get the HRA-10-1 working, as is, with just the added cost of one resistor (R6), a metal bracket and fiber insulating washers. The exact reason is lost to history.

I've got an eye out for an HRA-10-1 calibrator as none was included with the HR-10B that was recently acquired. I've been toying with using an old Hammarlund FS-135 100 kc frequency standard (**Figure 8**) that I have ready to be rebuilt. It is about the same size, and adding an octal plug to the bottom wouldn't be too difficult.

73, from AF6C



Notes:

1. While today kHz is the approved abbreviation for 'kilocycles per second', the author is using kc, which was the abbreviation at the time the HRA-10-1 was introduced. The same is true for mc instead of MHz.
2. The portable Heathkit GR-78 Solid-State General Coverage Receiver uses a 500 kc calibrator (HotM #62).
3. Square waves from logic ICs produce strong odd harmonics but weak or nonexistent even harmonics, so the circuit output should be designed to enhance even harmonics.
4. Part # 404-43 - This is the same 100 kc crystal used in the HD-20, the The HW-100 series transceivers, SB-100 series transceivers (except the SB-104), the SB-300 series receivers and possibly others. The RX-1 Mohawk receiver uses a different crystal.
5. NIST WWV has resumed broadcasting on 25 MHz on an experimental basis. It may be interrupted or suspended without notice. The broadcast consists of the normal WWV signal heard on all other WWV frequencies, at the same level of accuracy.
6. The HR-10A manual offers another calibration method using an AM broadcast receiver.
7. Pin 4 and Pin 7 both connect to junction of R76, R77 and R79 (and other components). Pin 6 connects to the the side of R5 that is not connected to Pin 3.

Notes: HotM #133 HRA-10-1

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

This article is copyright 2026, and originally appeared in the July issue of 'RF', the newsletter of the Orange County Amateur Radio Club - W6ZE.

Thanks - AF6C