Heathkit of the Month #099:
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AMATEUR RADIO - SWL

Heathkit HD-20
100 KC Crystal Calibrator

Introduction:

Hams have it so good today. It's easy to know your operating frequency, often to within a few cps [Hz]. It wasn't always that way. Operating within a band required skill and some form of standard. When the FCC introduced the Novice license in 1951, they wanted to be sure the new inexperienced hams stayed within their sub-bands, so they required novices to use crystal control for their transmissions.

Many general coverage communications receivers of the time have main tuning and bandspread tuning knobs. **Figure 2** shows the bandspread dial of a typical 1950s receiver. To use the bandspread scales the main tuning has to be accurately set for proper bandspread calibration. Higher priced radios often included, or offered as an accessory, a crystal calibrator. Less expensive 50's, 60's and later receivers did not have any internal means of calibration, and novices relied on their crystal controlled transmitter to spot their frequency,

The Crystal Calibrator:

A crystal calibrator is a frequency standard that produces strong harmonics. The most

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

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

Figure 1: Heathkit HD-20 100 kc Crystal Calibrator. Photo courtesy of Richard Post - KB8TAD

common standard frequency is 100 kc. The crystal may be easily calibrated by zero-beating it to one of the WWV HF transmission frequencies. When it is turned on and its output is coupled loosely to the antenna input of a radio, an accurate marker carrier appears every 100 kc, The markers are useable across the HF band and often up into the VHF region. Ones built into a radio are coupled to the antenna input through a small capacitor. External ones can be coupled similarly to the antenna terminals or by placing a wire near the antenna lead.

The Heathkit HD-20 Crystal Calibrator:

Heathkit saw a stand-alone crystal calibrator as a likely strong market, and developed the Heathkit HD-20. (**Figure 1**). It was first

Figure 2: Typical 50's bandspread dial. This one is from a National Radio NC-88 / NC-98.

introduced in 1960 for $14.95, and sold well over its 16 year production run. The HD-20 finally disappeared from the catalog in mid 1975. At the end of its run the HD-20 still sold at the initial $14.95 price in the U.S.

The HD-20 features a simple circuit. It uses one transistor and runs on a 9-V battery. Its overall measurements are 2½" wide x 4½" high x 2⅝" deep and it weighs 9 oz. It has just one control, the power switch. Early HD-20s came with a chrome knob similar to the ones used on the "Indian Tribe"[1] series of amateur radio gear such as the MT-1 and RX-1. Output is via a Heathkit 5-way[2] red binding post atop the unit.

The HD-20 uses a 9V battery, (see **Figure 3)**, common at the time, that is no longer easily obtainable, NEDA # 1600. Heath supplied a Burgess battery[3] (Heath P/N 418-6) as part of the early kits. **Table I** lists equivalent batteries from various companies of the period. By late 1962 the battery was no longer included with the kit; but a note at the bottom of the parts list read:

Figure 3: The NEDA 1600D (Burgess P6M) battery believed to be supplied with the early HD-20 kits. A round NEDA 1600 (Burgess P6) fits as well.

Mfr.	Part #	NEDA #
Burgess *	P6M	1600D **
Burgess	P6	1600
Eveready	226	1600
Mallory	M1600	1600
Ray-O-Vac	1600	1600
RCA	VS300	1600

* This battery was supplied with early HD-20 kits.

** Same size as NEDA 1600 but with a squarish sides along the circumference.

Table I: Compatible Batteries for the HD-20

A 9-volt (NEDA type No. 1600) battery should be purchased at this time for use in the completed kit.

Later in the production of the HD-20 the chrome metal knob (462-60) was replaced with the common gray plastic knob (462-19). Both of these changes were likely done to keep the price at the initial $14.95. **Table II** shows the HD-20 specifications.

HD-20 Crystal Calibrator Ckt. & Adjustment:
The schematic printed in the original manual dated 3/18/60 had an error as shown in **Figure 4A**. The correct schematic, from a later manual is shown in **Figure 4B**.

Frequency Coverage:	100 kc to >54 mc, in harmonics of 100kc.
Crystal:	
Type	Quartz, fundamental frequency.
Frequency	100 kc ± 0.005%.
Pin Spacing	0.486".
Pin Size	0.050".
Transistor:	2N409 GePNP.
Battery:	9-volts (NEMA1600/1600D).
Battery Life:	6 mo. normal intermittent service
Switch:	OFF-ON
Dimensions (overall):	2½" wide x 4½" high x 2⅝" deep
Net / Shipping Weight:	9 oz / 1 lb.

Table II: HD-20 Crystal Calibrator Specifications

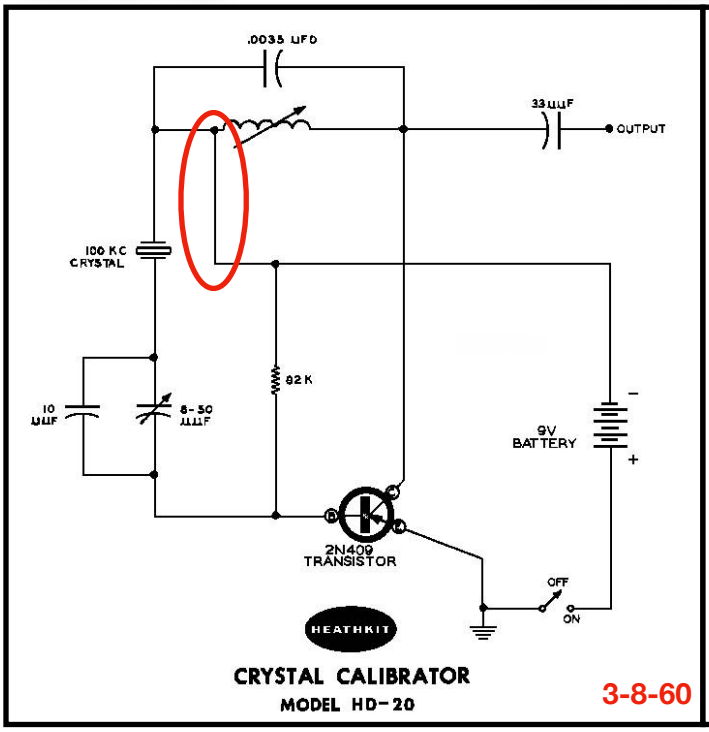

Figure 4A: Incorrect schematic in the early manual. (March 8, 1960) The wire shown connected to the crystal end of the coil should go to a tap on the coil.

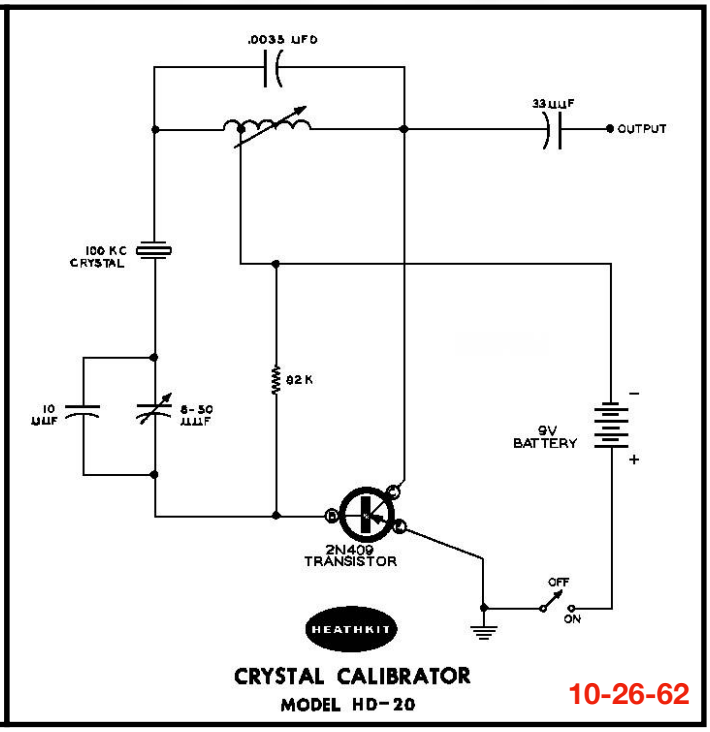

Figure 4B: Corrected schematic on a later manual (October 26, 1962) showing coil tap and the correct connection.

The circuit is a simple crystal oscillator using a germanium PNP (GePNP) transistor, the 2N409. Negative 9-V power is supplied from the battery. The only control on the device is the **OFF-ON** switch which connects battery power to the circuit. Once ON, 9 volts is applied to the collector thru the coil tap and to the base through the 82 KΩ resistor. The transistor begins to conduct causing a pulse to appear between the coil tap and the crystal, exciting the crystal. Output from the crystal is coupled to the base and amplified. A portion of the amplified signal is coupled via the coil to the crystal causing the circuit to oscillate. Since the crystal acts as a very high 'Q' tuned circuit the oscillations occur at the crystal frequency (100 kc). The coil is resonant at the crystal frequency due to the parallel 0.0035 μf capacitor. The coil is adjustable and is set for maximum output and proper starting. A capacitance in series with the crystal, consisting of a 10 μμf capacitor in parallel with an 8 - 50 μμf trimmer, allows the crystal to be netted precisely to 100 kc. This is usually done by zero-beating with one of the WWV standard frequencies using a communications receiver.

A crystal oscillator can produce a very nice sine wave; however, in this device you want strong harmonics and a pure sine wave lacks harmonics. Thus the 82 KΩ bias resistor was chosen to make the transistor operate in a non-linear fashion creating strong harmonics well into the low VHF range.

To preserve battery life and unwanted 'birdies' in the receiver, the HD-20 should be turned on only when being used and turned off immediately after use. The device draws 3.5 mA typically when in use.

HD-20 Comments:

Heathkit had a winner with this accessory. Everyone with a shortwave receiver lacking a calibrator could use this device, and due to its portability one HD-20 could suffice for a

Material:	Germanium
Polarity:	PNP
Max. Collector Power Diss.:	0.08 watts
Max. Collector Base V [Vcb]:	13 volts
Max. Collector Current:	15 mA
Max. Operating Junction Temp:	85 °C
Transition Frequency [ft]:	3 MHz
Collector Capacitance::	20 pF
Gain [hFE]:	50
Case:	TO-40

Table III: 2N409 Specifications

group of receivers. Many HD-20 calibrators are still in use today; some a lot have been modified to take today's standard 9-volt battery. Some have been modified to run off of external power. Be careful using the shack's 12VDC power as the the 9V cannot share the same ground[4].

While the 2N409 transistor, which is socketed, may be hard to find today, many other general purpose GeNPN transistors can be substituted[4]. The socket lets you try them easily. The basic specifications for the 2N409 are shown in **Table III**. You may even try a silicon PNP transistor, though you will have to play with the base bias resistor to restore the rich harmonics.

The crystal (404-43), crystal socket (434-74), crystal clip (260-29), and trimmer capacitor (31-27) parts are common with the Heathkit HRA-10-1 crystal calibrator.

General:

I'd like to thank Richard Post - KB8TAD for allowing me use his photo of the HD-20. You can find this photo and many others, along with lots of radio related links on his website: https://people.ohio.edu/postr/bapix/.

This is the 99th HOM article. Next month is April and also HOM #100. In keeping tradition with the "Fool's" month of April I try to find an unusual kit to write on. There was the HeathCraft F2587K/M candlestick (my favorite), the GU-1800 garbage compactor, the GT-18/GT-101 motorbikes, the GDP-5457 flashlight, the very expensive HS-3860 laptop, and the GU-1810 log splitter. Once I even made up a kit. This April will be no exception. I have an idea, and, if I can collect enough information to make the article worthwhile, I will proceed. Otherwise the 100th HOM might not appear until May.

73, from AF6C

Notes:

1. Over about a two-year period from 1958 to 1960 Heath named much of its amateur equipment after native American tribes, nine in all, starting with the Apache TX-1 transmitter and Mohawk RX-1 receiver and ending with the GC-1 Mohican.
2. The Heath 5-way binding post works with a wire, spade lug, pin plug banana plug or alligator clip. A set of five red and five black sold for $4 in the 1953/54 winter flyer. These began appearing on new Heathkits in late 1952.
3. The battery shown in the HD-20 manual (Pictorial 4) is definitely a Burgess P6M which is not round but rectangular with rounded corners and measures the same from rounded corner to rounded corner as the totally round P6 diameter. Both batteries fit the same holders but NEDA gave the P6M the variant NEDA number of 1600D instead of 1600. There is also a 1600M which is a mercury 8.4 volt 1600 size battery.
4. The NTE equivalent is NTE126. The ECG equivalent is ECG126.

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Thanks - AF6C