

Heathkit of the Month #34:
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Heathkit GC-1A "Mohican"
Solid-State Communications Receiver

Introduction:

In late 1959 Heathkit introduced its first all solid-state communications receiver, the GC-1. This small radio, one of the last "Indian" named radios, is compact (around 7" x 12" x 10") yet heavy at 17 lbs. It can run on batteries or use the XP-2, an optional internal AC power supply.

Transistor development was advancing fast when the Mohican was in design. Getting transistors to operate over a few megacycles per second (mc) had been a challenge that was finally being overcome. The GC-1 uses 10 germanium PNP transistors including the 2N1225 and 2N1396 RF transistors allowing operation of the receiver up to 32 mc. Neither silicon nor NPN transistors were yet readily available to the industry at competitive prices.

The GC-1 and the later GC-1A each originally cost \$109.95 in kit form. An optional XP-2 AC power supply cost an additional \$9.95 but was not available initially. The radio was also available factory wired as the GCW-1A for \$193.50. By 1964 the prices dropped to \$95.00 and \$165.00. In 1966 the GC-1A price further dropped to \$89.50. The price of the XP-2 remained unchanged.

The GC-1A remained in production until 1968.

The GC-1 Mohican:

I could not find a copy of the manual or even a schematic of the early GC-1. I did find a schematic of the GC-1U which is the European version of the GC-1.



Fig 1: Beautifully Restored GC-1A Mohican.
 Photo courtesy of WD4EUI

The GC-1 is an all solid-state, ten transistor, single conversion superheterodyne receiver covering 550 kc to 32 mc in five bands. Bandspread tuning is included with calibrated scales covering 80/75 meters, 40 meters, 20 and 15 meters, and 11/10 meters. There is also a linear 0-100 logging scale. (Ironically, 11 meters was an amateur radio band until September 11th, 1958).

The single conversion radio uses an IF of 455 kc. It also uses a diode tuned BFO to allow reception of CW and SSB. Audio output is up to four-tenths of a watt at 10% audio distortion. The radio draws a mere 35 ma of current from the batteries when listening at an audio level of 50 mW.

The Mohican runs on batteries. The later GC-1A uses eight "C" cells, but there is more than one source that specifies six "C" cells for the original GC-1. I haven't found whether this is correct or not, but lean towards eight cells.

The optional XP-2 AC power supply was not available initially when the GC-1 was released. It does not work with the early GC-1 receivers without a modification to the receiver circuit. Fortunately this modification is a simple com-

ponent relocation on the circuit board, and instructions are included on a sheet that came with the XP-2 manual. The modification was added to the GC-1 during its model run.

Though a “compact portable” communications receiver, the Mohican weighs 17 pounds. This is mostly the weight from the steel cabinet and chassis. The unit is built with ruggedness in mind and to reduce frequency instability due to chassis flexing. Individual compartments are shielded from one another adding to the amount of chassis material used.

In late 1961 the GC-1 was updated to the GC-1A. Some of the original GC-1 receivers suffered from audio distortion after the batteries were partially consumed or when hot, as well as unstable operation at higher frequencies. Heathkit made numerous circuit modifications and introduced the GC-1A. they didn't forget their patrons though and provided a kit of parts for GC-1 owners to fix those radios that suffered from the known problems. A big change to the radio was the introduction of temperature and voltage compensating diodes in the audio bias circuit to prevent distortion due to low voltage or high temperature.

The GC-1A Mohican:

The GC-1A Mohican (See Figure 1) that replaced the GC-1 became quite popular. It is rugged and works well. Numerous reports I read commented on good sensitivity, the radios generally being classified as “hot”. Frequency stability is not near today's standards but acceptable for such a radio in the sixties. Some amateurs used the GC-1 as a backup receiver, and a few even used it as their main receiver on the lower HF ham bands.

Selectivity is 3 kc at 6 dB down. No specification is given at -60 dB. However selectivity is by the use of two sets of ceramic “Transfilters” in the IF section which should result in sharp skirts. Heathkit later used Transfilters in some of their stereo Hi-Fi receivers.

The front panel of the Heathkit GC-1A is divided into three sections.

The upper third of the front panel (L to R):

S-meter	0-1 ma meter. (arbitrary vertical scale)
Main Tuning	slide dial. (scales for bands A, B, C, D, E)

The middle third of the front panel (L to R):

AVC:	slide switch.
OFF/ON	(below S-meter)
Bandspread	slide dial. (scales for 80, 40, 20 & 15, 11 & 10M , Log)

The lower third of the front panel (L to R):

MAIN TUNING:	variable capacitor. (operates upper slide dial)
VOLUME:	potentiometer.
Power OFF	(ccw - no scaling)
ANL:	slide switch.
OFF/ON	
BFO off/on and tune:	pot with pull sw. (3 dots signifying LSB, center, USB)
BANDSWITCH:	5 pos. rotary sw.
A, B, C, D, E	
RF GAIN:	potentiometer.
(no scaling)	
DIAL LIGHT	slide switch.
OFF/ON	
ANT. TUNING:	variable capacitor.
(no scaling)	
BANDSPREAD:	variable capacitor. (operates lower slide dial)

(Panel nomenclature is shown in **bold**.)

Table 1: GC-1A Front Controls

Antenna (high Z):	two screw terminal.
EXT. ANT, GND	
MUTING:	two screw terminal. (normally connected - open to mute)
PHONES:	1/4" phone jack. (35Ω impedance)

Table 2: GC-1A Rear Chassis Connections

Table 1 lists the front panel controls. The upper rear of the GC-1A cabinet has an open area where either the included battery pack or XP-2 snap in. The rear panel connections along the lower chassis are listed in table 2.

Heathkit recommends that when using the Mohican with a transmitter that an external relay short the receive antenna connections to ground during transmit to protect the transistor in the RF amplifier from damage. This should be done in addition to opening the **MUTING** connections on the rear chassis.

Styling-wise the Mohican uses the same paint scheme as their ham equipment of the time. The green and green-gray colors match the style of the Apache and Mohawk, as do the knobs. The GC-1A however has chrome knobs found on the later ham equipment of that time. The radio also has a handle on the top for carrying and a whip antenna for true portable operation. The handle may be moved to the side.

Heathkit GC-1A Circuit Description:

The GC-1A uses ten transistors and seven diodes as listed in Table 3. The transistors all mount in sockets, something rarely done today.

RF Circuits:

The RF amplifier uses a 2N1396, which is a selected version of the 2N1225 used in the mixer and local oscillator. These transistors are drift type germanium transistors where the doping of the base varies exponentially from heavy at the emitter to light at the collector. This results in low base resistance and low base-collector capacitance - features that are needed for high frequency response. The circuit is a standard tuned input, tuned output, common-base amplifier offering a large current gain. It provides a sensitivity of 2 μV except on the AM broadcast band (Band A) where it is 10 μV. AVC voltage adjusts the bias voltage of the stage to reduce gain on strong signals. The RF gain further controls the AVC voltage, or when the AVC is turned off, controls the stage bias directly.

The mixer stage is a common emitter circuit with the signal injected into the base and the oscillator injected into the emitter. A series of tuned circuits, one for each band, between the RF stage and the mixer are tapped to provide proper impedance matching.

The local oscillator section consists of an RF transistor in common base mode. The oscillator runs 455 kc higher than the received signal on bands A through D and 455 kc lower on band E. Different oscillator coils are switched in for the various bands as are networks to control feedback and injection levels.

The main tuning capacitor is three sections: one tunes the RF input coils, one tunes the mixer input coils and one tunes the local oscillator frequency. The **ANT. TUNE** capacitor is across the section that tunes to RF input to allow adjustment for antenna mismatching, and the **BANDSPREAD** capacitor is across the section that tunes the local oscillator allowing electrical bandspread tuning.

Germanium PNP Transistors:

2N1396	RF Amplifier
2N1225	Mixer
2N1225	Master Oscillator
2N373	1st IF Amplifier
2N373	2nd IF Amplifier
2N373	3rd IF Amplifier
2N407	Audio Driver
2x 2N407	Push-Pull Audio Output
2N409	BFO

Diodes:

2x 1N2326	Stabilizing Diodes*
1N754	Voltage Regulator 6.8V
not given	Detector Diode**
HD2257	AVC Crystal Diode
HD2257	ANL Crystal Diode
HD2257	BFO Varactor Diode

* Used to thermally stabilize the 2N407 audio output diodes.

** Not in parts list. Part of IF transformer T2.

Table 3: GC-1A Semiconductors

IF Circuits:

Three stages of IF amplification follow the mixer. All utilize a 2N373 transistor. Only the gain of the first IF stage is controlled by the AVC circuit. IF transformers are used only for the input to the first stage and output from the third stage. Between stages ceramic “transfilters” provide a fixed selectivity of 3 kc at 6 dB down. Skirt response is not specified but the ceramic filters should provide superior performance than transformers. The second and third IF stages also have a series resonant “transfilter” in their emitter leads instead of bypass capacitors to further increase selectivity. There is an option, shown on the schematic, to replace one series filter with a capacitor to reduce selectivity for wider frequency response.

AVC voltage is developed from the collector of the third IF transistor and coupled through a capacitor to the AVC diode where it is converted to DC, filtered and fed back to the RF and first IF stages.

BFO Circuit:

The Beat Frequency Oscillator uses a 2N409 transistor. The frequency is determined by a coil and a fixed capacitor. Instead of a variable capacitor adjusting the frequency a crystal diode is back-biased across the coil. When back biased the diode acts as a small capacitor and by adjusting the bias the capacitance changes and the BFO can be tuned. As the semiconductor industry grew some diodes were designed just for this purpose. They are called varactor diodes. Heathkit used a simple crystal diode for the purpose and it works well. The BFO oscillator tunes across the IF passband allowing for tuning of CW and SSB/DSB signals.

Detector and Audio Circuits:

A simple diode detector is built into the second IF transformer can, providing signal detection. (Heathkit doesn't include this diode in their “ten transistors and six diodes” description for some reason.) The resulting audio is passed through the **VOLUME** control to the first audio amplifier. A simple diode **ANL** circuit may be

switched in to clip large noise spikes. This function is controlled by the **ANL** (automatic noise limiter) switch.

The first audio amplifier uses a 2N407 and runs in class A driving a coupling transformer. The coupling transformer has dual 750Ω secondaries; each driving one transistor of a modified class B push-pull amplifier. The two 2N407 audio output transistors receive their voltage in series.

The bias circuit of the two output transistors evidently changed from the GC-1 to the GC-1A. It is rumored that Heathkit put out a modification kit for the GC-1 to improve stability at higher frequencies and improve audio which became distorted in some radios at high temperatures and when the batteries were not fresh. The biasing of the two audio output transistors were modified and a diode was added in each output transistor's bias circuit. The 1N2326 germanium diode in the bias circuit compensated for changes in temperature and battery voltage and helped keep the audio output stage stabilized at its proper operating condition.

Power Supply:

The power for the GC-1A comes from a 12 volt battery pack or an optional XP-2 AC supply that provides 12 volts. In either case the voltage is positive ground, eliminating the use from the cigarette lighter of a negative ground automobile or the 12 volt source running most of today's ham gear - at least without some form of power converter.

The Audio output stage runs at 12 volts while dividers drop the voltage to 10.6 volts and 9.3 volts to power the first audio stage and IF stages respectively. A zener diode is used to provide a stable regulated voltage to the local oscillator and BFO stages as well as the RF and mixer stages. Typical current drain is 35 mA. The maximum current drain is around 120 mA with full volume and the dial lights on. When using the AC supply the dial lamps are on con-

tinuously at a slightly dimmed state. Operating the dial light switch will bring them to full brightness. The GC-1A uses two #49 miniature lamps (2.0 V 60 ma rated).

Summary:

Heathkit's entry into the solid state communications receiver market was a big success. The GC-1A is still regarded as a great portable receiver. Obtaining replacement transistors should not be difficult; currently they all have listed NTE replacements. Whether the replacements will work well is not known. However since the transistors are socketed replacement and experimentation is easy.

Acknowledgements:

I'd like to thank three people for helping me put together this article. They are:

Allen Wooten - WD4EUI for allowing me to use some pictures from his GC-1A Mohican webpage:

http://wd4eui.com/Heathkit_GC_1A_Mohican.html

Be sure to visit his site to see more pictures of this nicely restored Heathkit GC-1A Mohican.

Club member John Roberts - W6JOR for passing along the GC-1A and XP-2 manuals (and several others) making this article possible.

Mark Bender - KD6NOT for dusting off his GC-1A Mohican so he could answer some questions I had on the details of the receiver.

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

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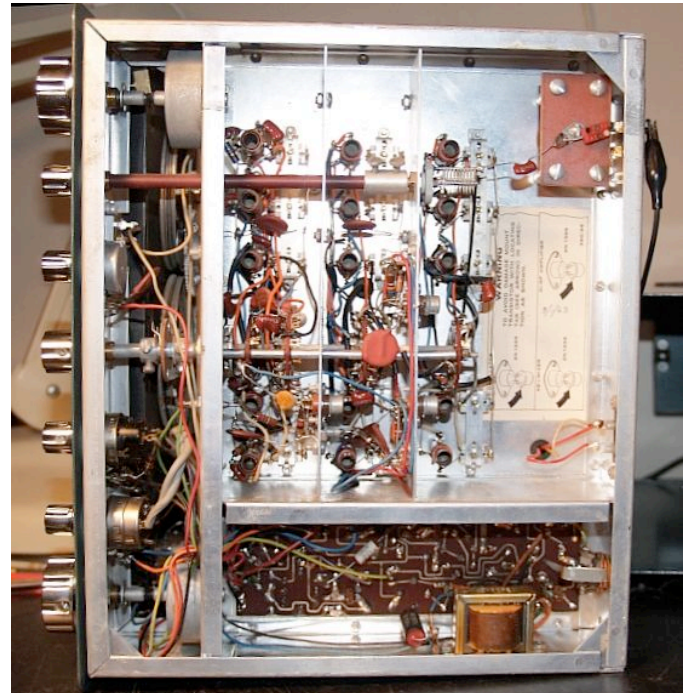
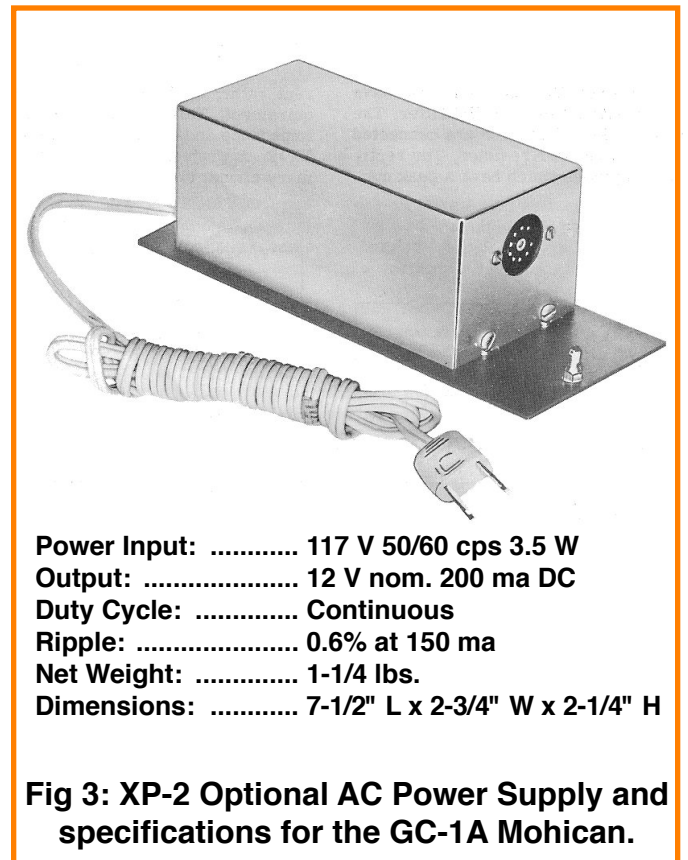


Fig 2: GC-1A Mohican under chassis view. Photo courtesy of WD4EUI



Power Input: 117 V 50/60 cps 3.5 W
 Output: 12 V nom. 200 ma DC
 Duty Cycle: Continuous
 Ripple: 0.6% at 150 ma
 Net Weight: 1-1/4 lbs.
 Dimensions: 7-1/2" L x 2-3/4" W x 2-1/4" H

Fig 3: XP-2 Optional AC Power Supply and specifications for the GC-1A Mohican.