

Heathkit of the Month #32:
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Heathkit

The Heathkit LG-1 Laboratory RF Signal Generator (and its Early Family - Through 1956)

Introduction:

The radio frequency (RF) signal generator is a tool needed by any serious radio amateur who builds radio equipment, tinkers or services his or her own equipment. Thus Heathkit has offered over the years numerous models of RF signal generators offering improving capabilities with each new model, while keeping the cost reasonable.

This month's article will cover the early RF signal generators produced by Heathkit from the start of the company through 1956 (around the time when Daystrom bought Heathkit), focusing on the Heathkit LG-1 Laboratory RF signal generator - See Figure 1. Information is hard to obtain on some of these old units so they will be discussed only briefly. Perhaps a reader can fill in some missing details.

Model:	From:	To:
G-1	1/48	9/49
G-4	no information	
G-5	9/49	9/50
SG-6	9/50	9/52
SG-7	9/52	9/53
SG-8	9/53	(1961)
LG-1	9/53	(1962)

Table 1: Production Years

The RF signal generators produced over this period and their dates are given in table 1.

As one can deduce from the table, Heathkit, in the late forties and early fifties, often introduced their new and updated kits in time for their fall flier, and the Holiday shopping season.

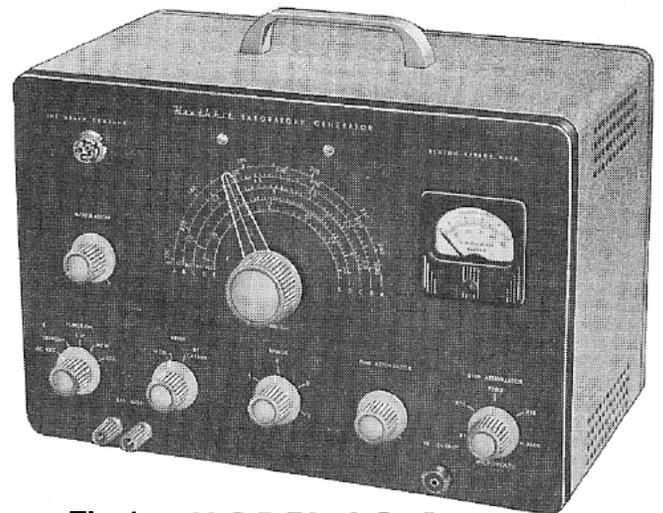


Fig 1: MODEL LG-1

Heath G-1 RF Signal Generator:

Heathkit introduced their first unit, the G-1, in early 1948 for \$19.50 - See Figure 2. It covers 150 Kc to 34 Mc (See note 1) in five bands. A built in relaxation oscillator provides modulation when selected. The G-1 was modified a couple of times during its manufacturing run; these were mostly cosmetic changes including a new handle and front panel paint. The G1 uses just two tubes, a 6X5 rectifier in the power supply and a 6SN7 dual-triode. One section of the dual-triode is the RF oscillator and the other section is a 400 cps audio oscillator providing modulation; this audio is also available at the front panel. The audio oscillator uses an

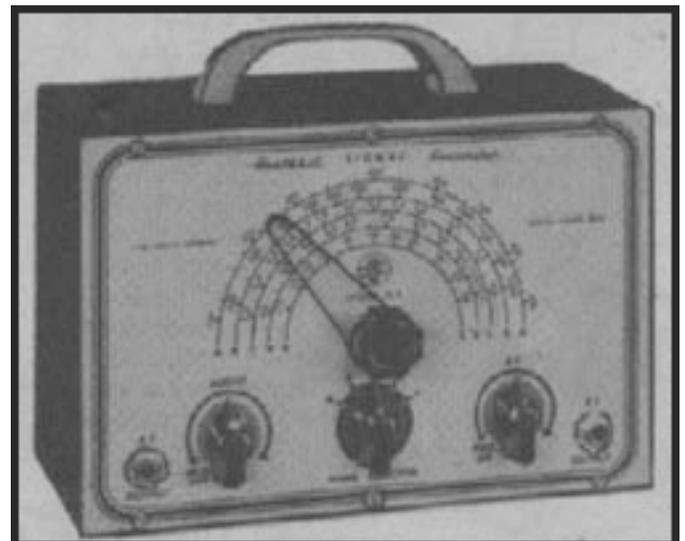


Fig 2: G-1 Signal Generator

NEW 1951
Heathkit **SIGNAL GENERATOR KIT**

Features

- Sine wave audio modulation.
- Extended range 160 Kc. to 50 megacycles fundamentals.
- New step attenuator output.
- New miniature HF tubes.
- Transformer operated for safety.
- Calibrated harmonics to 150 megacycles.
- New external modulation switch.
- 5 to 1 vernier tuning for accurate settings.

A completely new Heathkit Signal Generator Kit. Dozens of improvements. The range on fundamentals has been extended to over 50 megacycles; makes this Heathkit ideal as a marker oscillator for T.V. New step attenuator gives controlled outputs from very low values to high output. A continuously variable control is used with each step. New miniature HF tubes are required for the high frequencies covered.

Uses 6C4 master oscillator and 6C4 sine wave audio oscillator. The set is transformer operated and a husky selenium rectifier is used in the power supply. The coils are precision wound and checked for calibration making only one adjustment necessary for all bands.

New sine wave audio oscillator provides internal modulation and is also available for external audio testing. Switch provided allows the oscillator to be modulated by an external audio oscillator for fidelity testing of receivers.

A best buy — think of all the features for less than \$20.00. The entire coil and tuning assembly are assembled on a separate turret for quick assembly — comes complete — all tubes — cabinet — test leads — every part. The instruction manual has step-by-step, instructions and pictorials. It's easy and fun to build a Heathkit Model SG-6 Signal Generator. Shipping Wt., 7 lbs.



\$19.50

Fig 3: Fall 1950 Ad for the New SG-6 RF Signal Generator

NE-51 neon bulb in a relaxation type circuit. Front panel controls are simple. A 5-band switch (see table-two for the frequency ranges), a tuning control with a plastic graticule over a front panel 5-band scale, an RF level control with power switch, an audio level control with modulation switch, and 1/4" phone jacks for RF and audio output. The G-1 tuning knob is direct drive so adjustment is a bit challenging.

Band	Lower:	Upper:
A	150 Kc	450 Kc
B	450 Kc	1300 Kc
C	1.3 Mc	4.0 Mc
D	4 Mc	12 Mc
E	12 Mc	34 Mc
E ₃ *	34 Mc	102 Mc

(* G-5 only)

Table 2: G-1 & G5 Band Ranges

Heath G-4 HF-AM Signal Generator:

Here is a mystery kit. I found some references to this kit, but no schematic or description other than the title. I even found one place selling a photo copy of the manual, which I'd buy if I actually had the unit. Heathkit made a G-2 Audio Oscillator and a G-3 Sweep Generator, so the existence of a G-4 is a given.

Heath G-5 RF Signal Generator:

Electrically, the G-5 is similar to the G-1 with just a few component refinements. It features 5:1 vernier tuning and a new scale that now includes the third harmonic of band E (36 Mc to 102 Mc). The G-5's audio circuit was altered to allow external modulation, making the audio-out phone jack also the audio-in connector. The AF IN - OUT control is marked INT. MOD. at its fully counterclockwise position and EXT. MOD. at its fully clockwise position. When turned fully CCW the switch controlling modulation type is switched to the internal position, where it remains until the control is moved fully CW where it switches to the external position. There it remains until again moved fully CCW. Thus the control acts as both audio output level, audio input level and audio in / out selector.

Heath SG-6 RF Signal Generator:

In time for the 1951 updates, Heathkit changed their nomenclature; the G line became the more distinguishable SG line. Heath entered this decade with the SG-6 signal generator (Figure 3) that still sold for the \$19.50 price of the G-1. It is a completely redesigned RF signal generator.

The power supply in the SG-6 uses a selenium rectifier; gone is the 6X4 tube rectifier. It also uses two miniature seven-pin 6C4 triodes, one

for the RF oscillator and one for the audio oscillator and modulator. A jeweled green pilot lamp holding a #47 miniature bulb, missing on earlier units (and often an added modification), now adorns the front panel.

The RF oscillator, using the higher frequency 6C4 tube, covers new fundamental frequency ranges up to 50 Mc (see Table 3), and the RF output includes a 3-position step attenuator as well as a variable control. Coils come pre-calibrated to simplify final adjustment.

Band	Lower:	Upper:
A	160 Kc	510 Kc
B	500 Kc	1650 Kc
C	1.65 Mc	5.7 Mc
D	5.4 Mc	19 Mc
E	17 Mc	50 Mc
E ₃ *	51 Mc	150 Mc

* Calibrated 3rd Harmonic of Band E

Table 3: SG-6 & SG-7 RF Ranges

The audio section is no longer a relaxation (neon bulb) oscillator, but instead it is a Colpitts oscillator using the second 6C4 tube. This circuit produces a much cleaner 400 cps sine wave signal than the sawtooth wave of the earlier generators. Separate connectors are used for AF Out and AF In, which are selected by the Modulation switch. Table 4 shows the full complement of controls.

Heath SG-7 RF Signal Generator:

The SG-7 replaced the SG-6 in the usual September timeframe in time for 1952. It continued at the \$19.50 price. The SG-7 is identical to the SG-6 except for a change in the value of the resistors in the RF oscillator's cathode circuit. Cosmetically the front panel is almost identical, the main difference being the logo in the upper left of the SG-6 was removed.

Heath SG-8 RF Signal Generator:

Heathkit released a major update to their signal generator line in time for the 1954 holiday season. The SG-8 features a new style with a

The Heathkit SG-6 front panel controls along the bottom from left to right are:

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

MODULATION: 2 pos. rotary sw.
INT., EXT.

AF IN - OUT: Potentiometer
(no scaling)

(band): 5 pos. rotary sw.
A, B, C, D, E

RF OUTPUT: Potentiometer.
AC OFF (ccw - no scaling)

RF STEPS: 3 pos. rotary sw.
(Dot), (Dot), **HI**

Above the Modulation sw. (top to bottom):

AF: 1/4" phone jack
OUT

AF: 1/4" phone jack
IN

Above the band switch:

(main tuning): Variable capacitor.
(the 6 frequency scales - Table 3)

Above the RF Steps switch (top to bottom):

(No Nomenclature) Jeweled pilot lamp

RF: 1/4" phone jack
OUT

Table 4: SG-6 Controls

formed light grey cabinet and formed dark grey front panel, (both aluminum) with white nomenclature. Gone also are the 1/4" phone jacks; Instead Amphenol 75 series connectors are used. While the audio oscillator / modulator circuit remains the same as the SG-6 and SG-7, the RF oscillator has been updated replacing the 6C4 single triode with a 12AU7 dual triode and extending the fundamental frequency up to 110 Mc. (see Table 5). The tuning vernier was increased to 6:1. The additional triode stage acts as a cathode follower circuit to isolate the oscillator from the load and help frequency stability and ease of setting. With all these added features the price amazingly remained at \$19.50!

Band	Lower:	Upper:
A	160 Kc	500 Kc
B	500 Kc	1650 Kc
C	1.65 Mc	6.5 Mc
D	6.5 Mc	25 Mc
E	25 Mc	110 Mc
E ₂ *	110 Mc	220 Mc

* Calibrated 2nd Harmonic of Band E

Table 5: SG-8 RF Ranges

All the generators covered thus far provide RF output at a level in excess of 100,000 μ V and an audio output around 400 cps at a level of 2 to 3 volts. They all feature transformer operated power supplies. These units are designed for experimenters and radio-TV shops for troubleshooting and calibration. They all leak RF and the control over output and modulation levels is not very precise. These problems are addressed in higher priced laboratory grade RF signal generators such as the Heathkit LG-1.

Heath LG-1 Laboratory RF Signal Generator:

In 1953, at the same time as the SG-8 was introduced, Heathkit introduced its laboratory RF signal generator, the LG-1 with the same new paint scheme as the SG-8. This generator, while more limited in frequency range, offers calibrated output levels and modulation percentage measured on a front panel meter. Being more advanced the LG-1 commanded a higher price, \$39.50; about twice the price of the other models discussed.

Heath LG-1 Features:

The LG-1 covers 100 Kc to 30 Mc in five bands. The RF output level can be controlled accurately by a calibrated step attenuator as well as a fine attenuation control, and the value read out on a front panel meter. The user can set the signal level accurately down to less than one microvolt. Extensive shielding virtually eliminates undesired RF leakage. RF output impedance is 50 Ω and a terminated output cable with a built-in termination resistor is provided.

Modulation is either from an internal 400 cps Colpitts oscillator or an external audio signal. Modulation depth can be adjusted between 0% and 50% and read on the front panel meter. There is no external output for the internal 400 cps audio oscillator. The 100 Kc to 30 Mc output is divided into five ranges as shown in table 6

Band	Lower:	Upper:
A	100 Kc	290 Kc
B	280 Kc	1000 Kc
C	0.95 Mc	3.1 Mc
D	2.9 Mc	9.5 Mc
E	9.0 Mc	30 Mc

Table 6: LG-1 RF Ranges

Heath LG-1 Circuit Description:

Figure 4 shows the circuit of the four-tube LG-1. The transformer power supply provides about 160 volts DC that is divided down for the various circuits. The selenium rectifier power supply includes a filter choke to provide a higher degree of 60 cps ripple removal than found in the less expensive signal generators. An 0B2 gas voltage regulator tube produces a stable 105 VDC for the oscillator and buffer screen grid. Filament and pilot lamp voltage is provided by a separate winding on the transformer. There is a Standby position on the Function switch that allows filament voltage to be supplied without high voltage. An RF filter in the AC power leads prevents RF from entering or exiting the signal generator by the power cord.

The oscillator section is mounted within its own shielded compartment. The frequency determining coils and band switch are mounted in a separate shielded can within the shielded oscillator section. The RF oscillator consists of two tubes, a miniature 6AF4 tube wired as a Colpitts RF oscillator and an octal 6AV5 tetrode that buffers the oscillator and provides a low impedance 50 Ω output through the Fine Attenuator control. A sample of the RF level is

measured at the output of this control for the meter circuit.

RF output from the buffer is connected by coaxial cable to a separately shielded five-position step attenuator and then to an Amphenol type 75 RF output connector. Each position of the step attenuator reduces the RF signal voltage by a factor of 10 (20 dB) while keeping the circuit impedance at 50Ω.

The modulator circuit consists of a dual triode 12AU7 tube. The first triode section is a 400 cps Colpitts oscillator similar to the one used in the SG-6 RF generator. The second section is a cathode follower that grid modulates the RF buffer stage. The Function switch allows the choice of no modulation, internal oscillator modulation or external modulation. A pair of banana jacks on the front panel provide input for an external modulation signal. External modulation bandwidth is 60 cps to 10 Kc.

LG-1 Specifications:

Frequency	100 kc - 30 mc in 5 calibrated bands.
Output.....	up to 100,000 microvolts.
Attenuation	10:1 ratio in 5 steps, 10:1 ratio continuous, metered.
Modulation	0-50% metered, 400 cps internal, or 60-10,000 cps external.
Termination	50 ohms.
Tubes	1-6AF4, 1-6AV5, 1-12AU7, 1-0B2.
Power	105-125 volts AC, 50-60 cps.
Dimensions	13" wide, 8" high, 7" deep.

Table 7: LG-1 Specifications

The meter circuit has a two-position Meter rotary switch to select either Modulation or RF Carrier; the meter itself has a sensitive 50μA movement. In the Modulation position a half bridge circuit consisting of two crystal diodes rectifies a sample of the AF voltage presented to the buffer. This voltage is read on the meter on a 0 - 50% marked scale. Note that in many tests a requirement for 30% modulation is standard; this can easily be set. When the meter switch is in the RF Carrier position a separate crystal diode rectifies a sample of the RF after the variable attenuator control, and this is read on the meter. Both meter circuits have a calibration potentiometer. The crystals diodes used are the Hughes HD-2257.

All of these sections are further shielded by the outer cabinet. And the chassis and shields are copper plated to further improve shielding.

The row of front panel controls near the bottom from left to right are:

- FUNCTION:** 5 pos. rotary sw.
AC OFF, STANDBY, CW, MCW, EXT
- METER:** 2 pos. rotary sw.
MOD, RF CARRIER
- RANGE:** 5 pos. rotary sw.
A, B, C, D, E
- FINE ATTENUATOR:** Potentiometer.
(no scaling - read on meter)
- STEP ATTENUATOR:** 5 pos. rotary sw.
X1, X10, X100, X1K, X10K

Below and between the Function and Meter switches:

- EXT. MOD.:** Dual Banana Jacks

Below and between the Fine and Step attenuator controls:

- RF OUTPUT:** Amphenol 75 conn.

Above the Function switch (top to bottom):

- (No Nomenclature) Jeweled pilot lamp

- MODULATION:** Potentiometer.
(unmarked scale)

Above the band switch:

- (main tuning knob): Variable capacitor.
(the 5 frequency scales - Table 6)

Meter above the Step Attenuator switch:

- CARRIER LEVEL (μV)**
0 - 10 in 50 divisions

- % MODULATION**
0 - 50 in 25 divisions

Table 8: LG-1 Controls

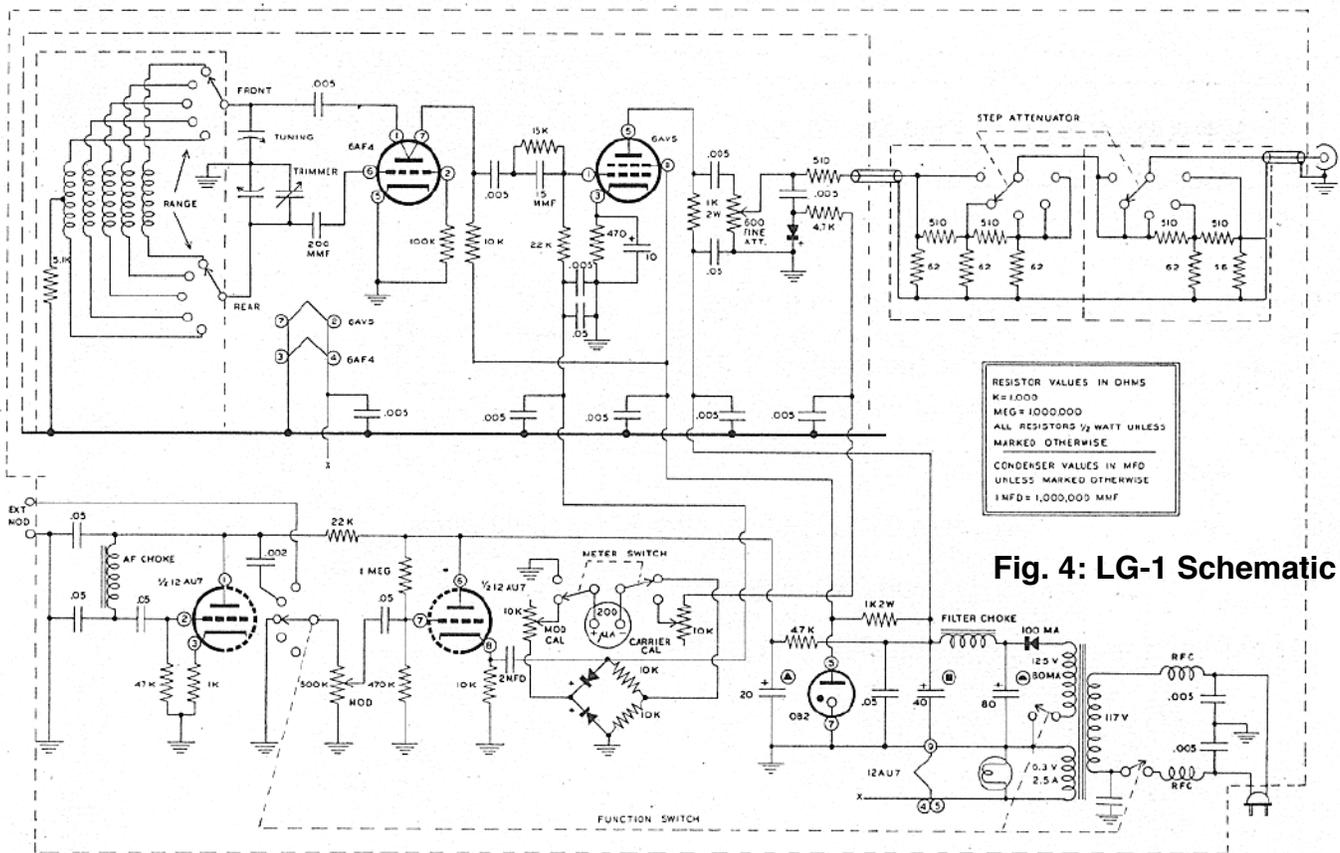


Figure 5: AF6C's Restored Heathkit LG-1 on the club 10 Meter 28.375 net Frequency

Heath LG-1 Operation:

Operation of the LG-1 is quite simple. Set the Range switch to the range covering the desired test signal and the dial to the desired frequency. Next set the desired level: Assume, say, you want a level of 500 μ V; set the Fine Attenuator until the meter reads 5.0; then turn the Step Attenuator to the X100 position.

Setting the modulation, is as simple. On the Function switch select CW if no modulation is needed, MCW if you'd like internal 400 modulation or EXT if you want modulation from an external source. External modulation requires a few volts of audio be applied to the front panel EXT. MOD. banana jacks. Finally, if modulation is selected adjust the Modulation control until the meter reads the desired modulation percent.

Figure 5 shows a recently restored Heathkit LP-1, previously owned by Ray Davis - W6NT, connected to an HP frequency counter and set on the club 10 meter net frequency of 28.375 Mc. Notice the RF output cable that ends in a small black plastic case holding a 50 Ω terminating resistor and dual binding posts.

Cleaning and lubricating switches and potentiometers is a big part of restoration. Restoring the LP-1 was a challenge due mainly to the extensive shielding. To get access to certain components requires removing shields which in turn requires unsoldering components. It is important to take good notes or have the full manual. Many of the manuals that once frequented places on the web like BAMA (Boat Anchor Manual Archive) were only partial manuals and didn't cover the step-by-step assembly with its component and wiring layout. Most of these are gone now that a company is said to have bought the copyright to all the old Heathkit manuals and has worked successfully to remove copies of the free manuals that used to be available in many places on the Internet.

Another challenge restoring this kit involved the vernier dial. The lubricant had dried out

and the vernier action was frozen causing the knob to operate the tuning capacitor directly. The vernier was removed and carefully cleaned. Unfreezing the vernier mechanism took a lot of patience and soakings in solvents and penetrating oils. Finally when it freed up, the mechanism was carefully re-lubricated using a Lubri-Plate like white lithium grease. It has since worked smoothly and flawlessly.

Final Comments:

Heathkit continued to build RF Generator kits. The RF-1 and later IG-102 are updated versions of the SG-8; the is IG-42, is a cosmetically updated version of the LP-1. These RF generators continued to be sold into the late seventies. Heathkit also make a low-end IG-5280 RF generator as part of their low-cost 5280 series test bench up to the time they began phasing out kits.

Finally I'd like to thank John - W6JOR who passed some old Heathkit manuals along, including the GC-1A Mohican communications receiver and OL-1 3" Oscilloscope. We'll be covering some of those kits in future articles.

Notes:

1. I've used the old frequency nomenclature of Mc and Kc and cps instead of MHz, KHz and Hz, since they were the nomenclature of the time period covered.

73, from AF6C



Remember if you come across any old Heathkit Manuals or Catalogs that you do not need, please pass them along to me.

Thanks - AF6C

This article originally appeared in the August 2011 issue of RF, the newsletter of the Orange County Amateur Radio Club - W6ZE.