

Heathkit® of the Month #61:
by Bob Eckweiler, AF6C



Heathkit® SG-8
Low-Cost RF Signal Generator.
TEST EQUIPMENT

Update to HOM #32:

Back in August of 2011 I covered the Heathkit® LG-1 Laboratory RF Signal Generator and one of its successors, the IG-42. I failed to mention an even later laboratory generator, the IG-5242 which is electrically identical to the IG-42 and LG-1 except in the primary AC wiring circuitry. The LG-1 can be wired only for 120V operation. The IG-42 began as just a styling change to the LG-1; (though an export model was available for 240V 50 Hz). Sometime between May of 1969 and 1972 the export model was dropped and 120/240 volt 50/60 Hz operation became standard; this was done without a change in the model number. The later IG-5242 was another styling change and again the primary wiring was changed, adding a three-wire grounded plug and a fuse. I could not find a manual, a schematic, nor even a catalog listing that includes the IG-5242. It was not yet introduced in my Spring 1977 catalog and no longer listed in my Fall 1980 catalog, yet it existed between those dates.

In HOM #32 I also briefly mentioned the G-4 HF AM Signal Generator that seemed to be a mystery. According to Chuck Penson's *Heathkit Test Equipment Products* book* the G-4 was short lived and advertised only in one 1949 Heathkit flyer. It covers 32 to 110 Mc and includes a calibrated 64 to 220 Mc harmonic scale. It was designed to continue upward in frequency coverage from where the G-1 stops.



Figure 1: Heathkit® SG-8 RF Signal Generator

Table I shows the complete Heathkit RF signal generator line. Dates and prices are as best I could determine reviewing my catalogs and on-line catalogs I have found.

Introduction:

An RF signal generator is a must for anyone doing repair or alignment of old of receivers or even just tinkering around with amateur radio. Heathkit recognized this, and produced over the years a series of RF signal generators in four distinct categories (shown in Table I), as well as numerous other RF sweep oscillators for general and specific purposes.

The Laboratory RF generators were covered in the earlier HOM article, and the IG-5280 is part of the 5280 "Starter Test Bench" series and will be discussed if and when the series is covered. We'll briefly touch on the "2% accurate" RF general purpose generator group later. The focus of HOM #61 will be on the low-cost general purpose SG-8, the last of the low-cost general purpose line. The members of this family were briefly discussed in the earlier article, but since so many SG-8s are still in use and easily available it should be covered in a bit more detail.

Heathkit General Purpose RF Signal Generators:

All the low-cost general purpose series RF signal generators use two tubes. In the early G1 and G5 one of those tubes is a 6X5 rectifier tube; the

other is a 6SN7 dual triode. In the later SG-6, SG-7 and SG-8 a selenium rectifier replaces the rectifier tube. The SG-6 and SG-7 use two separate 6C4 triodes instead of the 6SN7 dual triode. The SG-8 (Figure 1) uses one 6C4 and one 12AU7 dual triode, thus adding a third triode section. The tube lineups are listed in Table II. The smaller 6C4 and 12AU7 tubes allow the later generators to operate up over 100 mc instead of below 50 mc. All these generators have built-in modulation. The G1 and G5 use a neon bulb relaxation oscillator driving one of the triodes and modulating the second RF oscillator triode. The SG-6 through 8 use a 6C4 as a audio Colpitts oscillator for the modulator; this produces a more sinusoidal tone than the high harmonic audio tone of the relaxation oscillator. The SG-6 through SG-8 use the same circuit for the audio section, with the exception of the input and output connectors, which were changed from 1/4" phone jacks to the, now hard to find, Amphenol 75 series connectors.

Heathkit© RF SIGNAL GENERATORS					
General Purpose - Tube					
Model	Range Mc	Intro.	Price	Last	Price
G-1	0.15 - 32 ⁵	Jan. 48	\$19.50	Aug. 49	\$19.50
G-4	32 - 110 ^{1,4}	Apr. 49	\$19.50	< Jun. 49	\$19.50
G-5	0.15 - 34 ^{2,5}	Sep. 49	\$19.50	Aug. 50	\$19.50
SG-6	0.16 - 50 ^{3,5}	Sep. 50	\$19.50	Aug. 52	\$19.50
SG-7	0.16 - 50 ^{3,5}	Sep. 52	\$19.50	Aug. 53	\$19.50
SG-8	0.16 - 110 ^{1,5}	Sep. 53	\$19.50	< May 61	\$19.50?
"2% Accurate" General Purpose - Tube					
Model	Range MHz	Intro.	Price	Last	Price
RF-1	0.10 - 110 ^{1,6}	59	\$27.95	63	\$27.95?
IG-102	0.10 - 110 ^{1,6}	62	\$29.95	77	\$56.95
Starter Test Bench - Solid-State					
IG-5280	0.31 - 110 ^{1,5}	77	\$37.95	Sep. 90	\$119.95
Laboratory Grade - Tube					
LG-1	0.10 - 30 ⁵	Sep. 53	\$39.50	62	??
IG-42	0.10 - 30 ⁵	63	\$59.00	78	\$109.95
IG-5242	0.10 - 30 ⁵	78	\$119.95	80	\$119.95
Notes:					
1 Calibrated harmonics to 220 Mc.					
2 Calibrated harmonics to 102 Mc.					
3 Calibrated harmonics to 150 Mc.					
4 A single fundamental band.					
5 Five fundamental bands.					
6 Six fundamental bands.					

Table I

The SG-8 RF Signal Generator:

The SG-8 was sold between the Fall of 1953 and early 1961. In the May 1961 catalog the only RF generator shown was the later RF-1. It overlapped the SG-8 for a period of time.

The SG-8 is a simple RF signal generator. For its low cost I was surprised at how accurately and stably it performs. This signal generator covers 160 kc to 110 mc in five bands. A sixth scale covers 110 to 220 mc on the harmonic of the fifth band. The band coverage is given in table III.

The front panel includes five controls plus the main tuning knob, which is a 6:1 vernier drive; also on the front panel are three Amphenol receptacles and a big green pilot lamp. The front panel controls are listed in table IV. The rear of the SG-8 contains only a grommet for the exiting AC power cable.

Operation amounts to letting the signal generator warm up for a reasonable period. The RF tuning is then set to the desired frequency. Use of an external calibrated receiver or frequency

**Heathkit® Low Cost General Purpose
Signal Generator Tube Lineup**

#*	Type	Function
G-1 and G-5		
V1	6X5	Power Supply Rectifier
V2a	1/2-6SN7	Amp / Modulator
V2b	1/2-6SN7	RF Oscillator
SG-6** and SG-7**		
V1	6C4	AF Oscillator / Amp
V2	6C4	RF Oscillator
SG-8**		
V1	6C4	AF Oscillator
V2a	1/2-12AU7	RF Oscillator
V2b	1/2-12AU7	Buffer Follower

Notes:

- * No 'V' designations given in manual on these models.
- ** Selenium rectifier used in place of a vacuum tube rectifier.

Table II

counter can enhance accuracy. If you want the RF carrier modulated, place the **MODULATION** switch to **INT**ernal and adjust the **AF IN-OUT** control for the desired level of modulation. You may instead apply an external audio signal to the **AF IN** receptacle with the **MODULATION** switch in the **EXT**ernal position. The RF level output is coarsely adjusted by the **RF STEPS** switch and finely adjusted with the **RF OUTPUT** potentiometer. Maximum RF output is specified as more than 100,000 µV.

The internal modulator audio (approximately 400 Hz) is available at the **AF OUT** receptacle with the **MODULATION** switch set to **INT**ernal. The audio output level is specified at 2 to 3 volts

Heathkit® SG-8 Frequency Range

Band A	160 kc	500 kc
Band B	500 kc	1650 kc
Band C	1.65 mc	6.5 mc
Band D	6.5 mc	25 mc
Band E	25 mc	110 mc
Band E (Harm.)	110 mc	220 mc

Table III

Heathkit® SG-8 Front Panel Controls

Top Row - (Left to Right)

(AF) OUT Microphone type receptacle (M)
Amphenol 75-PC1M*

Pilot Light Green with #47 bulb

Middle Row (Left to Right)

(AF) IN Microphone type receptacle (M)
Amphenol 75-PC1M*

(Tuning) Dual split variable capacitor
(6:1 vernier drive)

Large six-scale frequency dial
RF OUT Microphone type receptacle (M)
Amphenol 75-PC1M*

Bottom Row (Left to Right)

MODULATION Rotary Switch (2-position)

EXT. – INT.

AF IN-OUT Potentiometer

Arc line with arrows at ends

(Band) Rotary Switch (5-position)

A, B, C, D, E

RF OUTPUT Potentiometer with CCW AC switch
(w/ AC Power) **AC OFF**, Arc line with arrows at ends

RF STEPS Rotary switch (3-position 60°)
Just a line for pos.1 & 2; **HI** for pos. 3

Table IV

maximum and is adjustable downward by the **AF IN-OUT** control.

Heathkit® SG-8 Circuit Description

The circuit of the SG-8 is quite straight forward and may be separated into four sections: the power supply, the audio oscillator, the RF oscillator and the cathode-follower and attenuator circuits. The schematic is shown in Figure 5.

The Power Supply:

There is not much to say here. B+ is obtained from a transformer fed half-wave power supply that utilizes a selenium rectifier and an RC filter composed of two 20 µF electrolytic capacitors separated by a 3.3KΩ resistance. The transformer also has a second winding that supplies filament current to the two tubes and the pilot lamp. Both sides of the AC line are bypassed with 0.01 µF capacitors to help decou-

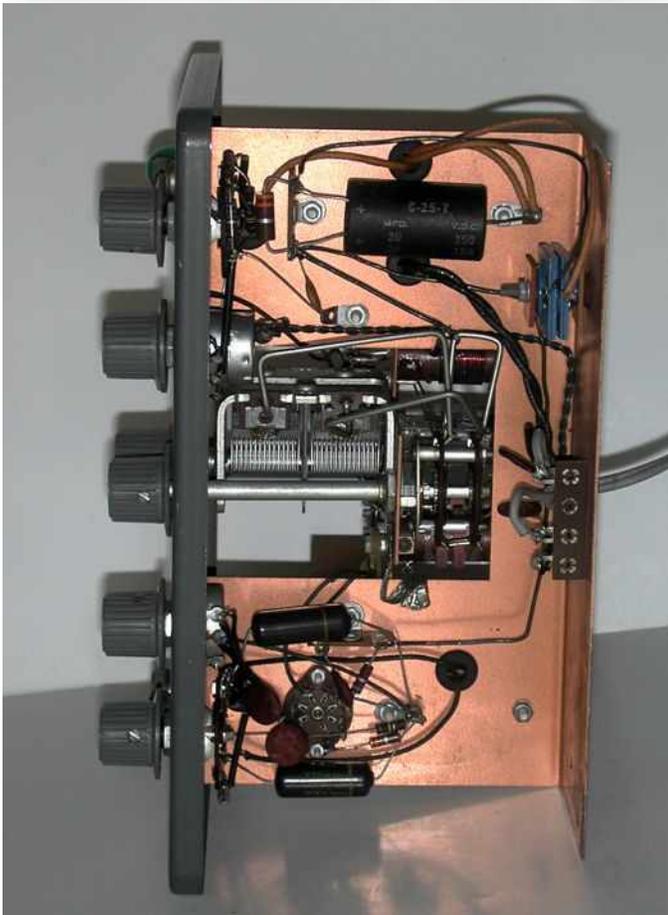


Figure 2: SG-8 RF Generator Bottom View. The dual tubular electrolytic capacitor is the large black cylinder near at the top, with the blue selenium rectifier to its lower right. The dual tuning capacitor is in the center, and near the bottom is the socket for the 6C4 tube. The two black cylinders above and below the tube socket are the two molded paper capacitors.

ple the power cord and prevent it from leaking RF energy. The higher cost Heathkit© signal generators use pi-filters for the same purpose.

The Audio Oscillator:

The 400 cycle per second (nominal) oscillator is a simple audio Colpitts oscillator that uses a transformer style 1 Henry AF choke shunted by two series capacitors. The connection between the two capacitors is grounded. Feedback to sustain oscillation is developed across one of the capacitors while the other provides energy from the plate circuit of the 6C4 triode. The transformer and capacitors are only switched

in when INTERNAL MODULATION is selected. In this position the 400 cps is also available at the AF OUTPUT receptacle. The level is controlled by the AF IN-OUT control and can provide a high impedance sine wave up to 2 to 3 volts.

In the EXTERNAL position the 6C4 acts as an audio amplifier connected to the AF INPUT connector, again through the same AF IN-OUT control. About 5 volts of audio across the 1 MΩ external input will give about the same level of modulation as when using the internal 400 cps oscillator. The maximum modulation level is not mentioned in the manual. Figure 2 shows the under-chassis with the 6C4 at the bottom.

The RF Oscillator:

The RF oscillator is also a Colpitts oscillator using one-half of a 12AU7 triode; 450 pF/450 pF dual variable capacitors in series with their common lead grounded and a switched inductor make up the tuned circuit. The inductors on the lower four bands (A through D) are factory calibrated coils that are switched in by the band switch. The dual variable capacitor, the RF coils, the band switch and the 12AU7 RF oscillator tube all mount on a vertical sub-chassis which greatly reduces lead length (Fig. 3).

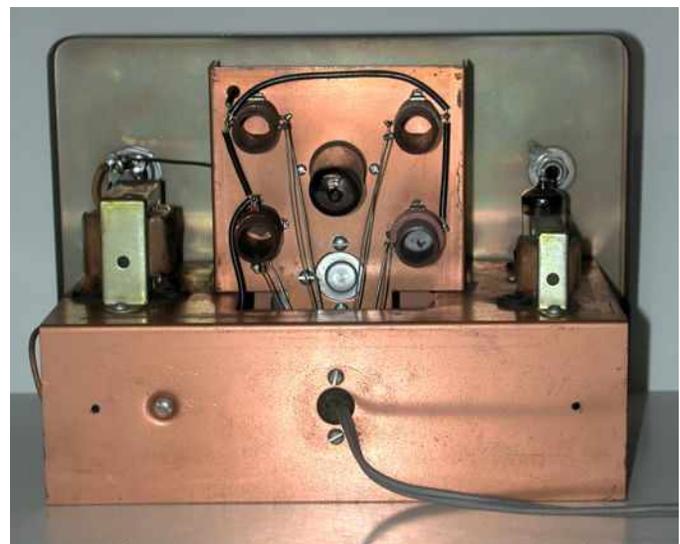


Figure 3: SG-8 RF Vertical Sub-chassis showing the 12AU7 tube surrounded by the band A through D coils. On the left is the power transformer and on the right is the audio choke.

A very clever part of the SG-8 is the way Band E is implemented. Whoever thought this idea up hopefully got a big raise! The four lower-band coils are all wired normally to the band switch as are the coil center-taps where the RF oscillator voltage is applied. However the wiring from the switch to the dual variable capacitor consists of three heavy-gauge uninsulated, plated and formed wires. These heavy wires connect the band switch to the variable capacitors and the center-tap connections on the band switch together. When using the bands A through D these wires are just conductors, but on band E these heavy wires actually make up the band-E coil (Not to be confused with E Coli or Ebola!) Figure 4 shows the band-E coil wires.



Figure 4: Close-up bottom view showing the three (gray) heavy formed wires that make up the band-E coil.

There are no tuning slugs in the band coils nor are there any trimmer capacitors. The accuracy relies on the factory wound coils and the kit-builder's prowess.

The Follower and Attenuator Circuit:

The second triode section of the 12AU7 tube mounted horizontally on the sub-chassis is wired as a cathode follower. This provides high impedance to the oscillator so that changing loads will have little effect on the oscillator frequency, and low output impedance so that 50Ω cable can be driven without a lot of loss.

The follower triode is capacitively coupled to the output of the RF oscillator. It is also capaci-

tively coupled to the output of the 6C4 audio oscillator/modulator. If audio is present the result is audio modulated RF at a low impedance at the cathode of the follower triode. This RF is developed across a 1KΩ resistor in series with the 1KΩ **RF OUTPUT** potentiometer. Output from the potentiometer goes to the three position **RF STEPS** switch which has two 24 dB attenuators that are switched out as the switch is rotated from left to right. At the full right position no additional attenuation, other than the RF OUTPUT potentiometer is in the circuit.

The “2% Accurate” General Purpose Series:

In late 1959, while the SG-8 was still in production, Heathkit® introduced the RF-1. Up to that time none of the signal generators advertised a specified accuracy, not even the laboratory generators. The frequency accuracy of the SG-8 was never specified in any ads that I could find, but is mentioned on page 15 of the SG-8 manual: *“The [SG-8] may be expected to fall within 2 to 3% of the frequency calibration...”*. The RF-1 accuracy was advertised as 2%. It features six overlapping bands in a “1 - 3.2, 3.1 - 11” sequence. It also includes a 100 - 220 mc harmonic scale. In 1961 the SG-8 was dropped, leaving the RF-1 as the “low-cost” RF signal generator product.

Both the RF-1 and the later IG-102 came with a factory wired and adjusted coil-band-switch assembly. The manual gives instructions for basic alignment using a simple AM/FM broadcast radio.

The RF-1 underwent a styling change in 1962 and became the IG-102 which remained in production into 1977. By that time it had more than doubled in price over the original cost of the RF-1. There were no changes I could detect in the circuits of these two units. The IG-102 did receive an updated transformer to allow 120/240 volt operation around the time the IG-42 received the same update. In Chuck Penson's book, he shows a photo of an IG-102 updated in style to the cream color scheme.

Conclusion:

The SG-8 used in this article came into my collection fairly recently. My main RF signal generator for many years was a PACO S-50 signal generator that was similar to the SG-8 but had a much more precision tuning dial. During college I used the SG-8 in some lab classes. Some years back I picked up an old Heathkit© LG-1 lab generator that was restored to working condition and used in place of the S-50.

The fact that the SG-8 has no calibration adjustments, other than aligning the vernier pointer on the scale, worried me at first. But I soon found that even after 52 or more years the calibration was still within the 2 to 3% frequency specification of a new kit. Of course, today that is a large error, up to 0.9 mc at 30 mc. This problem is easily overcome by using the generator at a higher level output that can drive a frequency counter and then also using an external attenuator to reduce the signal to the device under test. I also happily found that, once the generator is warmed up, the frequency drift is small and easily manageable, a lot better than my PACO S-50 signal generator of the same era.

My current SG-8 appears well built and is in good condition. The kit appears original with no modifications, nor component replacements. The only non-disc or mica capacitors in the SG-8 are the two-section axial electrolytic power supply capacitor that mounts under the chassis (2 x 20 µF at 150V) and the two molded paper capacitors (0.1 and 0.02 µF) that are part of the audio oscillator. After bringing up the voltage slowly on a variable transformer, a quick check of the AC ripple on the B+ showed the 50+ year old electrolytic capacitors are still performing. The two molded paper capacitors were not even checked as their weakness would result in no audio oscillation or one way off the 400 cps specification. I may replace these capacitors in the future. The two capacitors I am replacing are the 0.01 µF line filter capacitors that go between the AC power and ground. These will be replaced with modern capacitors designed just for this purpose. Perhaps a three-

wire AC cord with a ground and the installation of an internal fuse in the hot lead are also reasonable future modifications?

None of the non-laboratory Heathkit signal generators tell you the RF voltage. The Lab generators have a voltmeter before the attenuator so you can get an accurate idea of the signal being applied to the device under test. However, that accuracy depends on proper termination.

Final Comments:

I'd like to thank two hams who have added to my catalog files to help me look up prices and dates of Heathkit products. Club president Nicholas - AF6CF passed along a Summer 1991 catalog that I had never even seen before and Eugene Colton - AF9O sent a spare 1969 catalog from lovely Santa Fe, NM. The 1969 catalog fills an important hole for me as it was probably from that same catalog that I ordered my SB-301/401 station shortly after starting my first job out of college. Many of my earlier Heathkit catalogs disappeared during a move at work that occurred while I was on a test across the county. Blame a pointy-haired boss!

73, from AF6C



This article originally appeared in the November 2014 issue of RF, the newsletter of the Orange County Amateur Radio Club - W6ZE.

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

Thanks - AF6C

*** Heathkit Test Equipment Products** by Chuck Penson - WA7ZZE is available through Amazon and other book sources. If you are interested in Heathkit, it is worth having in your library. I recommend it highly! See my review in the July 2014 issue of RF (page 8).

