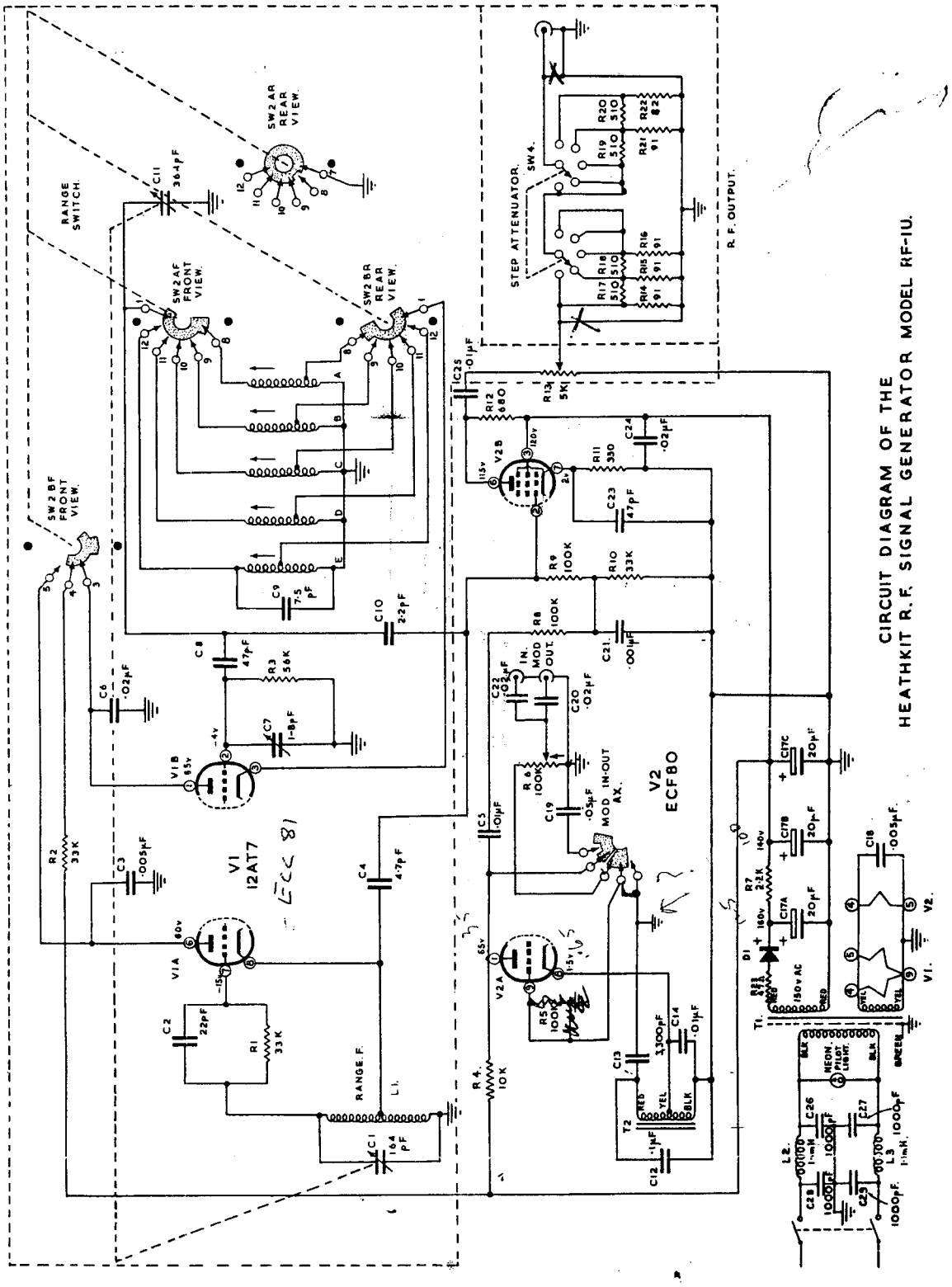
Assembly and Operation of the HEATHKIT SIGNAL GENERATOR

MODEL RF-1U

SPECIFICATIONS

Frequency Range:	
Range A	100 Kc/s to 300 Kc/s
Range B	300 Kc/s to 1 Mc/s
Range C	1 Mc/s to 3 Mc/s
Range D	3 Mc/s to 10 Mc/s
Range E	10 Mc/s to 30 Mc/s
Range F	30 Mc/s to 100 Mc/s
Calibrated Harmonics	100 Mc/s to 200 Mc/s
Accuracy:	± 2% of dial calibration
Output:	
Impedance	75Ω
Voltage	Up to 100 mV on all ranges
Modulation:	
Internal	Approximately 400 cycles, 30% depth (nominal)
External	Approximately 3 volts across 50 KΩ for 30%
Audio Output	Approximately 9 volts across 1 megohm
Valve Complement:	V1 - 12AT7 - RF oscillator V2 - ECF80 - modulator and RF output
Power Requirements:	230-250 volts 50/60 cycles AC 15 watts
Cabinet Dimensions:	9½" wide x 6½" high x 5" deep
Net Weight:	8 lbs.
Shipping Weight:	10 lbs.


CIRCUIT DIAGRAM OF THE
HEATHKIT R.F. SIGNAL GENERATOR MODEL RF-1U.
V1 12AT7
V2 ECF80
RANGE SWITCH
SW2AR REAR VIEW
SW2AF FRONT VIEW
SW2BR REAR VIEW
SW2BF FRONT VIEW
STEP ATTENUATOR. SW4.
R.F. OUTPUT.
MOD IN-OUT AX.
RANGE F.
L1.
T1.
T2
L2.
L3
D1
NEON PILOT LIGHT.

INTRODUCTION

The Heathkit RF (radio frequency) Signal Generator Model RF-1U has been designed to provide the service technician, ham and experimenter, with an accurate and stable source of RF signals. A pre-assembled range switch and coil assembly, aligned to factory precision standards, eliminates the necessity of having costly equipment to calibrate the finished kit. To ensure that the maximum performance that is available in this kit be realised, it is suggested that the builder take a few minutes now to read the CIRCUIT DESCRIPTION and PRELIMINARY NOTES AND INSTRUCTIONS.

CIRCUIT DESCRIPTION

The RF oscillator for ranges A, B, C, D and E consists of one-half of a 12AT7 valve (V1B), and the tuning capacitor C11 and the five adjustable Hartley oscillator coils. These coils are supplied as a pre-aligned range switch assembly (SW2). The cathode of the valve is connected to the tap of the coils through switch SW2-BR. Because one end of each coil is earthed, the current from the cathode will excite the coil at resonance. The feedback necessary to maintain oscillation is coupled from the "hot" end of the coil through switch SW2-AF and then through capacitor C8 to the valve grid. Switch SW2-AR shorts out the unused coils to prevent any undesirable suckouts.

The coil for range F is mounted directly on the tuning capacitor and is permanently connected to the other half of the 12AT7 oscillator valve (V1A). This arrangement eliminates the stray capacities that would be involved in switching and thus provides a more desirable LC ratio. Range switching is accomplished by switching the HT to the anode of V1A through switch SW2-BF.

The triode section of an ECF80 (V2A) is used for the audio oscillator. A Hartley oscillator is also used in this circuit but, of course, the coil is of the iron core type because of the low frequency involved. The modulation in-out switch AX connects either the anode or the grid through R6 to the modulation socket. This arrangement enables the audio output to be amplitude controlled, and also controls the level of external modulation applied to the grid of V2A.

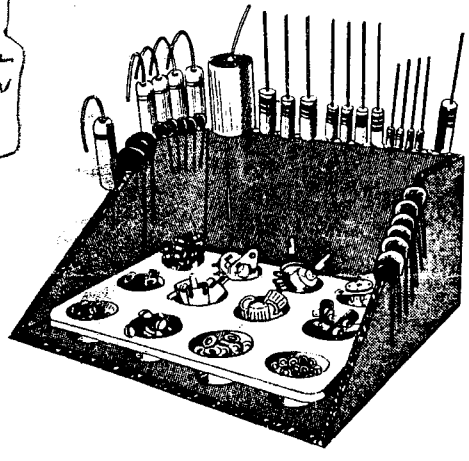
RF signals are coupled to the grid of the ECF80 output valve (V2B) through capacitors C4 and C10. Modulation is coupled to the grid through capacitor C5, resistors R8 and R9. These components, along with resistor R10, establish the modulation level. The modulated RF signal is then coupled from the anode of V2B through capacitor C25, fine attenuator R13 and the step attenuator SW4 to the RF output socket.

The power for the RF-1U is supplied through transformer T1. A conservatively rated selenium diode (D1) is used in a half-wave rectifier circuit to supply HT for the generator. C17 is a 20 µF + 20 µF + 20 µF electrolytic capacitor, two sections of which are parallel connected to provide extra smoothing.

A 130 MV
B 60 ✓
C 80 ✓
D 50 ✓
E 40 ✓
F 190 ✓
Measured 25/6/98
Audio out varies from Zero to 1.5V using vol control

	MV	
F	190	50
E	90	70
D	100	80
C	115	110
B	90	95
A	165	150

Varies with frequency thro' the band.



This illustration shows how resistors and capacitors may be placed in the cut edge of a corrugated cardboard carton until they are needed. Their values can be written on the cardboard next to each component.

( ) Mount the five skirted knobs and ensure that each knob lines up with the panel printing.

( ) Fit the four rubber feet to the cabinet referring to Figure 4.

( ) Prepare the coaxial cable as shown in Figure 5.

This completes the assembly of your RF-1U. Before switching on however, turn the instrument upside down and vigorously shake it to remove any wire clippings or solder splashes which may be loose inside. Also make a check for any solder "bridges" or wiring errors which may be apparent. A few minutes spent checking for errors of this kind may save component damage when switching on.

Connect to an AC outlet of 230-250v, 50-60 cycles. DO NOT under any circumstances connect to a DC outlet as serious component damage will occur.

When switching on, the valve heaters should glow RED. If they do not glow, a check of the heater wiring is suggested. If possible, with a suitable meter, make a check of voltages existing at the various valve tags referring to the voltages given in the circuit diagram. Any discrepancy should be investigated before proceeding with alignment checks.

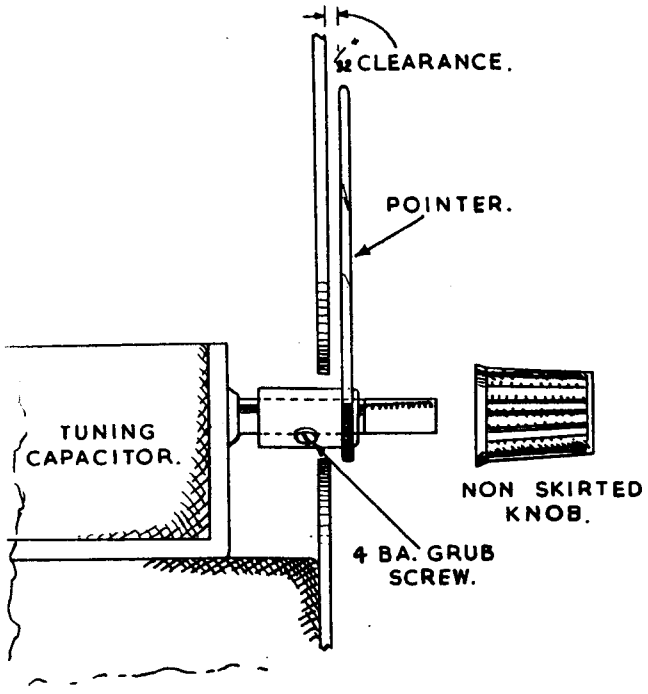


FIGURE - 3

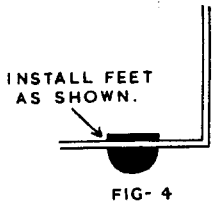


FIG- 4

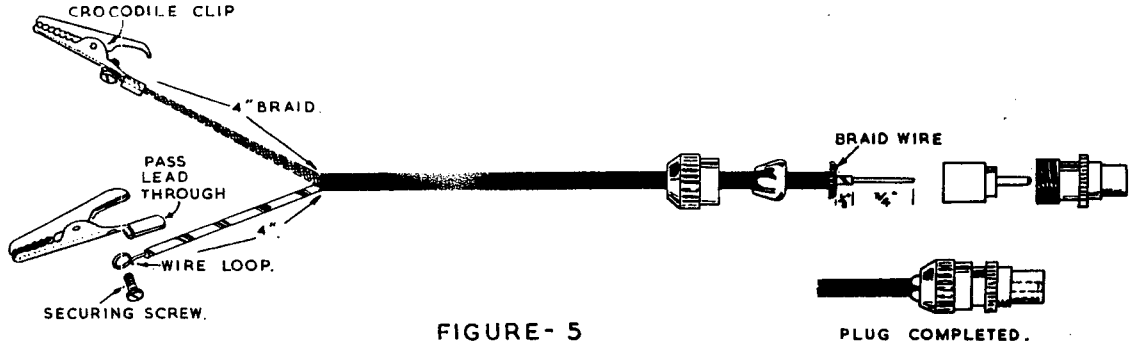


FIGURE- 5

CALIBRATING THE RF-1U

The only equipment needed for calibration is an AM and an FM radio. Before proceeding with the following steps, turn on both the RF-1U and the radios and allow approximately ten minutes warm-up time.

1. ( ) Carefully tune the AM radio to a station of known frequency in the medium wave band. The frequency of the chosen station should preferably be one that falls on a range B dial calibration point, such as 800 Kc/s or 1000 Kc/s. If no station is available, the Light programme at 200 Kc/s (range A) will be suitable.

2. ( ) Adjust the trimmer capacitor TR so that the top of the threaded portion is approximately 3/8" above the chassis, it has been found that this setting gives optimum accuracy.

3. ( ) Set the range switch of the generator to range B, the modulation switch to EXT. MOD., and the coarse and fine attenuators to their maximum clockwise rotation.

4. ( ) Connect the output cable to the RF output socket. Place the end of the cable in close proximity to the loop or aerial lead of the radio, but not directly connected to the radio.

5. ( ) Turn the tuning control of the RF-1U until a squeal is heard in the radio receiver. Adjust the tuning for the lowest pitched squeal, or preferably a point where there is a slow popping, with an increasing squeal on either side of this setting. The slow popping, or its complete cessation is known as "zero beat". The pointer should now indicate a frequency very close to the frequency of the station to which the receiver is tuned.

6. ( ) Reset the tuning of the generator so that the pointer indicates the same frequency as that of the broadcasting station. Now adjust the trimmer capacitor TR to re-establish the zero beat.

7. ( ) Tune the FM radio to a station around 90 Mc/s.

8. ( ) Connect the output cable to the FM aerial terminals.

9. ( ) Turn the generator to range F and turn the modulation switch to INT. MOD./AF OUT.

10. ( ) Adjust the tuning of the RF-1U to the frequency to which the receiver is tuned. It will be noted that as the generator is tuned through the frequency, that the audio modulation will be louder on both sides of the centre frequency. This is normal and is due to the fact that the generator is amplitude modulated and has very little frequency modulation. The point where the audio tone is at a minimum is the correct position.

11. ( ) If, in Step 10, the RF-1U dial indicated a frequency higher than the station frequency, gently squeeze the turns of the range F coil together until the dial indicates the correct frequency. If the dial indicates a lower frequency, the coil turns should be spread apart slightly.

This concludes the general calibration of the instrument. IMPORTANT: The cores of the coils for ranges A, B, C, D and E have been individually adjusted before despatch from the factory to precision standards. We strongly recommend that these cores are not touched unless there is definite evidence of misalignment.

If it is desired to check the accuracy of each range and the operator has the necessary equipment and is familiar with alignment procedures, we would suggest the following equipment:-

1. A laboratory generator with an accuracy of at least 1% or, as an alternative, a communications type receiver fitted with a crystal calibrator.

2. An oscilloscope to indicate zero beat.

Before alignment it will be necessary to slacken the mounting nuts of the range switch and re-position the switch so that the cores are accessible.

After adjustment, restore the switch to its correct position.

ACCURACY.

Any signal generator is designed as a convenient and controlled source of modulated or unmodulated signals. No ordinary signal generator is designed as a frequency standard, the accuracy of more expensive generators is generally 1%, however, the accuracy of the Heathkit RF-1U is ± 2% of the dial calibration which is quite satisfactory for service work and alignment. In receiver alignment the frequency at which a particular adjustment is made is not very critical, but the adjustment itself for maximum receiver output is frequently critical. For calibration of home built receivers or equipment, various B.B.C. stations on the long or medium waveband or V.H.F. bands may be selected to provide calibration points on the dial.

However, when checking the accuracy of your RF-1U, always select stations of known frequency (frequencies of B.B.C. stations can be found in a copy of the Radio Times or the programme section of some daily papers). Do not use the dial calibration of the receiver as an indication of the generator frequency, unless it is a communications type receiver equipped with crystal calibration facilities.

After checking that the generator functions correctly and that its calibration is satisfactory, fit the RF screen as shown in Figure 6. The screen covers valveholder B, the coil pack and the attenuator circuits. Ensure that no lead or components are trapped between the chassis and the screen. Use 6BA x 5/16" screws, lockwashers and nuts and tighten all the screws securely.

Having fitted the RF screen, fit the RF-1U in its cabinet using two 3/8" sheet metal screws.

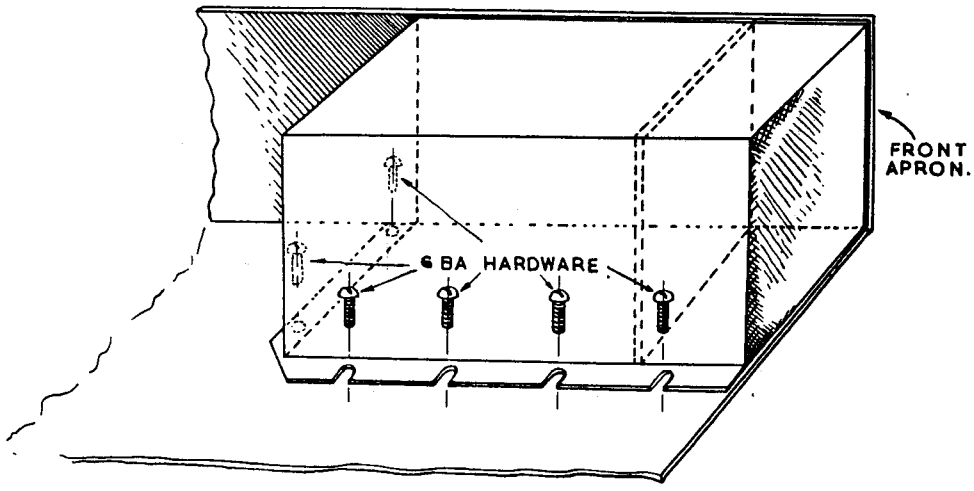


FIGURE - 6

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in coloured pencil on the pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. It is interesting to note that about 90% of the kits that are returned for repair are defective due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as illustrated in the Figures found in the PROPER SOLDERING PROCEDURE section of this manual.

3. Check to be sure that all valves are in their proper locations. Make sure that all valves light up properly.

4. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the Pictorial diagram and as called out in the wiring instructions.

5. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring, valve sockets or tagstrips.

6. If possible, check the valves with a valve tester or by substituting a known good valve of the same type.

7. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those found on the Schematic Diagram. NOTE: All voltage readings were taken with a Heathkit Valve Voltmeter. Voltages may vary 10% due to mains voltage variations.

8. A review of the circuit description will prove helpful in indicating where to look for trouble.

9. If the RF-1U fails to function on any one particular range, the coil for the range may be open circuited.

USING THE RF-1U

In order to realise the maximum usefulness of this instrument, the operator should thoroughly familiarise himself with the following information on operating procedures and alignment, etc.

The RF fine attenuator, coarse attenuator and RF output are self explanatory. An audio frequency is available at the AF OUT socket when the modulation switch is in the internal modulation position. When the switch is in the external modulation position, the internal modulation is turned off and the RF signal may be modulated by feeding an audio frequency signal into the AF IN socket. Approximately 3 volts is required for 30% modulation. The EXT/ LEVEL control enables the user to control the level of external modulation and also the level of the audio output. This control turns the instrument off and on.

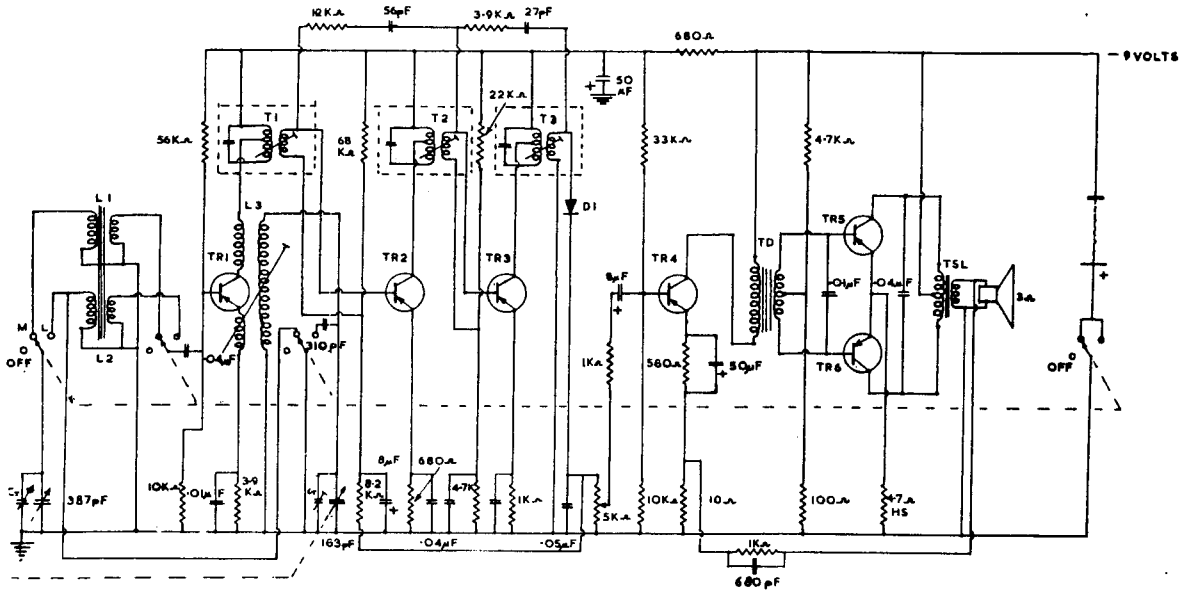


FIGURE-7

ALIGNMENT OF AM TUNERS AND RECEIVERS

Modern AM receivers have in general become quite standard in intermediate frequency and the broadcast bands covered. An IF of 470 Kc/s is now used by most manufacturers although there are probably still some variations. However, the relevant manufacturers data will soon supply the required information for the complete IF and RF alignment of the receiver.

The RF-1U can be used to completely test and align a receiver. Always remember, however, to completely isolate the generator by including a capacitor in each lead of the output cable. The audio tone available at the AF OUT socket can be used to check the AF output circuits of the receiver for correct functioning.

Outlined below is an approximate guide for receiver alignment. It should be remembered, however, that the manufacturers service sheets should always be referred to.

Figure 7 shows the circuit diagram of a typical transistorised superhet. receiver, in this case the Heathkit UXR-1.

1. Turn the signal generator on and allow it to warm up for about a quarter of an hour to reach operating temperature.

2. While the speaker may be used as an indication of output it is much more desirable to use some other type of output indicator. This may be an AC meter connected directly across the speaker terminals or perhaps a valve voltmeter connected to measure AVC voltage.

3. Turn the tuning dial so that the tuning capacitors are completely open (this is the high frequency end of the dial).

4. Before connecting your RF-1U to any part of the circuit always include an isolating capacitor in each lead of the output cable.

5. For alignment of the IF transformers connect the 'hot' lead of the generator to the base of TR1.

6. With the generator set to 470 Kc/s and the MOD switch to INT. MOD. adjust generator output until the receiver output is below 50 milliwatts because at this low level the AVC is inoperative (of course this is irrelevant if you are using the AVC voltage as an indication).

7. Adjust the IF cores for maximum output, reducing the receiver output as alignment progresses to keep it below 50 milliwatts.

N.B. During RF alignment, it will be sufficient to couple the generator to the set by means of a loose coil wound around the ferrite.

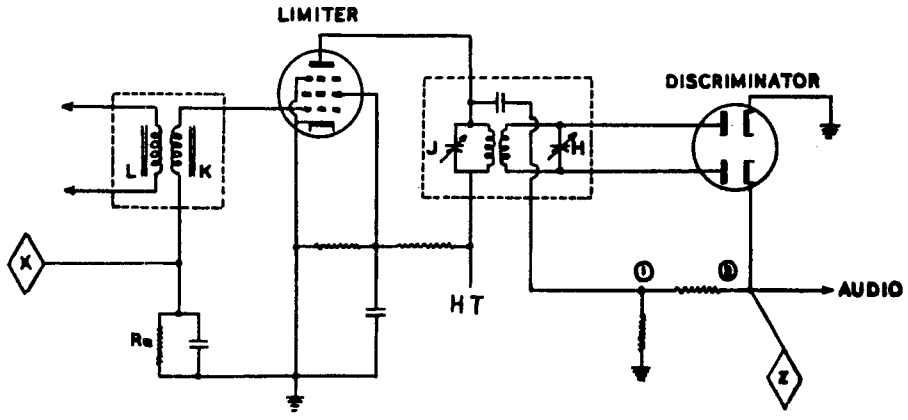


FIGURE-8

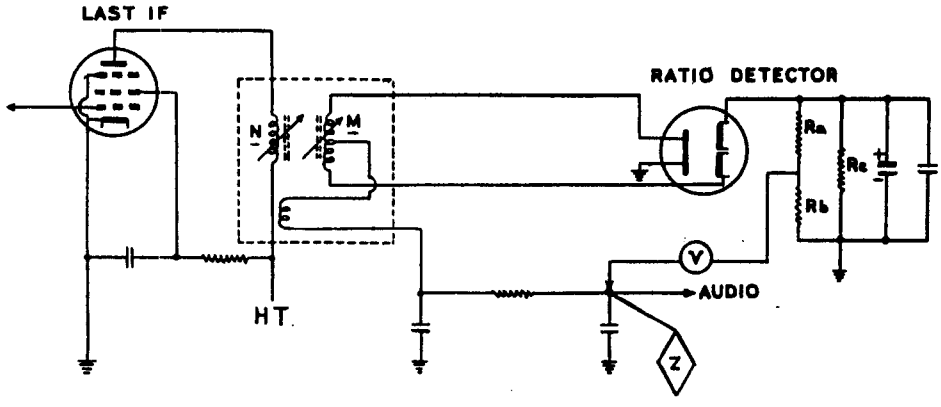
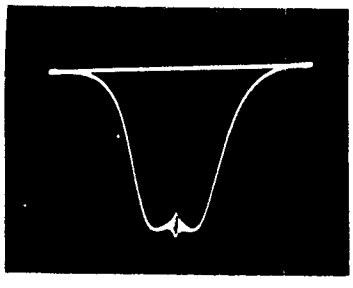
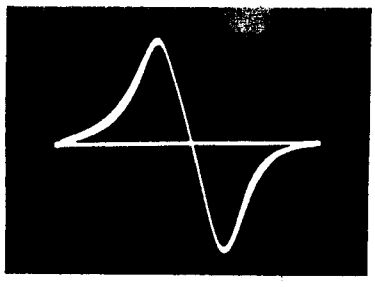


FIGURE-9



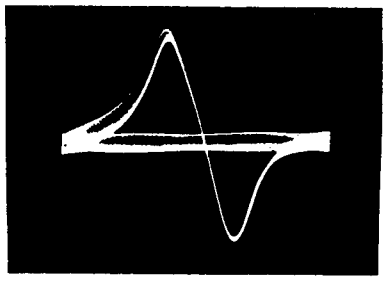
FIGURES-10A.

FM IF response with 10.7 Mc/s marker.



10B.

Ratio detector or discriminator response with 10.7 Mc/s marker at 0.



10C.

Ratio detector or discriminator response with 10.7 Mc/s marker not at 0. Note 400 cycle modulation.

( ) Set the generator to 1500 Kc/s and tune the receiver on the medium waveband until the generator signal can be heard or read on the output indicator. Adjust the oscillator trimmer and alternatively retune the capacitor until the signal appears at 1500 Kc/s on the receiver tuning scale.

( ) Retune the generator and receiver to 1400 Kc/s and tune the aerial trimmers for maximum output.

( ) Now tune both the receiver and generator to 600 Kc/s and adjust L3 core for maximum, alternately tune the capacitor with one hand and the oscillator core with the other until no further improvement can be made. On this receiver there is no 'padding' or 'tracking' capacitor in the aerial circuit but a certain degree of adjustment can be made by sliding the medium wave coil along the ferrite rod.

( ) In cases where adjustment is made at the low frequency end of the dial, it will be necessary to repeat the adjustments at the low frequency end and the high frequency end of the dial until no further adjustment is required.

The RF alignment procedure for multiband AM receivers is essentially the same as outlined above for a single band set. Each band is aligned separately, starting with the highest frequency and working toward the lowest. The technique outlined above should be used but with appropriate high and low frequency settings for each band.

ALIGNMENT OF FM TUNERS AND RECEIVERS

While the procedure of aligning the IF and then the ~~oscillator and~~ RF of an FM receiver is similar to that of an AM receiver, there are several important differences, the greatest one being that the ratio detector or discriminator must be aligned after the IF alignment. Due to the many varied IF bandwidths and types of IF transformer coupling that are used, it is imperative that the unskilled operator consult the receiver manufacturer's alignment notes before attempting FM alignment. While many FM receivers may be aligned with a standard AM generator by peaking the IF's to the required frequency (usually 10.7 Mc/s), as many others will have to be aligned using a sweep generator. Therefore, only a general procedure will be outlined here. The RF-1U may be used, no matter which procedure is recommended by the manufacturer, either as as AM generator or as an accurate marker generator during sweep alignment.

Most procedures call for the use of either a valve voltmeter or oscilloscope as an output indicator. The specified indicator is generally connected in series with an approximately 100 KΩ resistor to the grid return of the last limiter (point X in Figure 8). Output indications for both RF and IF alignment are obtained from this point. Oscilloscope connections for both a ratio detector and a discriminator are shown as point Z in accompanying Figures 8 and 9 respectively. When aligning the secondary of a ratio detector or discriminator, it is sometimes very difficult to see the 10.7 marker on the S curve because the 10.7 Mc/s point is at 0, or the crossover point. To facilitate alignment of the secondary, it is helpful to turn the modulation from the RF generator on and adjust the secondary for a minimum amount of 400 cycle signal on the S curve (see Figures 10B and 10C). A ratio detector or discriminator inherently has a certain amount of AM suppression. Therefore, when the 400 cycle AM modulation is at a minimum, the operator can be sure that the 10.7 marker is at 0 even though it may not be visible. This procedure is only effective when an AM signal generator such as the RF-1U, which has very little incidental FM, is used.

Siganl generator connections to the receiver vary with different procedures. Some procedures align each stage successively, starting with the last limiter stage and proceeding toward the mixer; in other procedures, the generator is connected directly to the mixer. A convenient method that can be used to connect the generator to the mixer stage without upsetting alignment is to connect the 'hot' lead of the generator to a loose coil wound around the mixer valve. For RF alignment, the generator is usually connected to the aerial terminals through a suitable matching pad.

SERVICING BY SIGNAL INJECTION

Another use of the generator is a method of servicing called signal injection. This procedure may prove very helpful in isolating defective stages in a receiver when other fault finding methods fail. The method involves the application of first, an audio signal to the grid of the audio output valve and then moving forward to the first audio amplifier. From there an audio modulated intermediate frequency signal should be fed into the grid of the last IF valve. Continue to move the signal injection point toward the aerial terminals (using the appropriate frequency) until the defective stage is located; this of course would be where there is no signal heard through the receiver. For example, if a clear tone is heard when the 'hot' generator lead is touched to point E in Figure 11, but not when it is touched to point F, we are reasonably sure that capacitor C1 is open. The accompanying Block Diagram may also help to illustrate this procedure. See Figure 12.

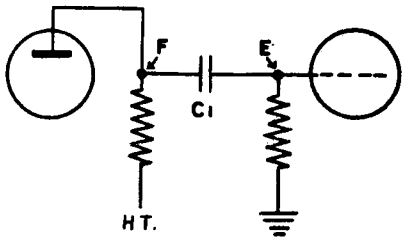


FIGURE-11.

PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors (¼ watt)		
Q-820C5	1	82Ω (Grey, Red, Black)
Q-910C5	4	91Ω (White, Brown, Black)
Q-511C5	4	510Ω (Green, Brown, Brown)
Resistors (½ watt)		
H-470C10	1	47Ω (Yellow, Violet, Black)
H-331C10	1	330Ω (Orange, Orange, Brown)
H-681C10	1	680Ω (Blue, Grey, Brown)
H-333C10	3	33 KΩ (Orange, Orange, Orange)
H-563C10	1	56 KΩ (Green, Blue, Orange)
H-104C10	3	100 KΩ (Brown, Black, Yellow)
Resistors (1 watt)		
1-222C10	1	2.2 KΩ (Red, Red, Red)
1-103C10	1	10 KΩ (Brown, Black, Orange)
Capacitors (all types)		
20-514	1	22 pF, silver mica
21-536	1	2.2 pF, ceramic
21-524	1	4.7 pF, N750 (Violet, Yellow, Violet White, Brown) tubular, ceramic
21-501	2	47 pF, tubular, ceramic
21-543	1	3,300 pF (Orange, Orange, Red) tubular, ceramic
21-509	5	1,000 pF (.001 μF) disc, ceramic
21-522	2	5,000 pF (.005 μF) disc, ceramic
21-511	3	10,000 pF (.01 μF) disc, ceramic
21-512	4	20,000 pF (.02 μF) disc, ceramic
23-504	1	.05 μF, 250 volt, tubular, paper
23-505	1	.1 μF, 250 volt, tubular, paper
25-519	1	20+20+20 μF, 350 volt, electrolytic
26-512	1	364-164 pF, variable
31-503	1	1-8 pF trimmer, variable
Controls, Switches, Transformers, Coils		
19-[illegible]	1	100 KΩ lin with D/P switch
19-[illegible]	1	5 KΩ lin, moulded track
63-524	1	Mod IN-OUT switch
63-525	1	Attenuator 2-wafer switch
51-44	1	Modulation transformer
54-522	1	Mains transformer
45-506	2	1.1 mH RF choke
40-542	1	Range F coil
100-518	1	Range switch and coil assembly comprising:-
20-52	1	7.5 pF silver mica capacitor
40-537	1	Range A coil
40-538	1	Range B coil
40-539	1	Range C coil
40-540	1	Range D coil
40-541	1	Range E coil
63-212	1	6-position range switch
Tagstrips, Coaxial Plugs, Sockets		
431-501	1	1-way tagstrip
431-16	1	2-way tagstrip with earth
431-10	1	3-way tagstrip
Tagstrips, Coaxial Plugs, Sockets		
431-12	2	4-way tagstrip (with earth tag)
431-502	1	4-way tagstrip (without earth tag)
431-509	2	5-way tagstrip (with earth tag)
438-504	1	Coaxial plug
432-505	3	Coaxial socket
Valves, Rectifiers, Indicating Lamp		
411-502	1	ECF80 valve
411-24	1	12AT7 (ECC81) valve
412-518	1	Neon indicating lamp, red
57-503	1	Selenium rectifier
Sheet Metal Parts		
200-524	1	Chassis, copper plated
206-517	1	RF screen, copper plated
206-518	1	Attenuator screen, copper plated
203-523	1	Front panel
90-508	1	Cabinet
204-507	2	L bracket, cadmium plated
Wire, Mains Lead, Sleeving, Solder		
340-501	1 length	22 swg. bare wire
343-503	1 length	Coaxial cable
344-506	1 length	Connecting wire
346-501	1 length	Sleeving
331-501	1 length	18 swg. solder
89-1	1 length	Mains lead
Hardware		
250-527	2	6BA x ¼" countersunk head screw
250-525	8	6BA x 5/16" instrument head chrome plated screw
250-502	14	6BA x 5/16" binderhead screw
250-530	4	4BA x 1/8" cheesehead screw
250-513	15	4BA x ¼" binderhead screw
254-501	16	6BA lockwasher
254-1	13	4BA lockwasher
252-501	16	6BA nut
252-3	13	4BA nut
259-504	2	4BA solder tag
259-505	3	6BA solder tag
250-8	2	3/8" sheet metal screw
Miscellaneous		
73-501	4	3/8" rubber grommet
73-504	6	¼" rubber grommet
211-4U	1	Handle
463-504	1	Dial pointer
462-18	1	Knob without skirt
462-19	5	Knob with skirt
481-501	1	Mounting wafer
261-502	4	Rubber feet
260-1	2	Crocodile clip
434-501	1	9-pin valveholder with skirt
434-502	1	9-pin valveholder without skirt
258-507	1	Valve retaining clip
206-501	1	Screening can
595-572	1	Manual