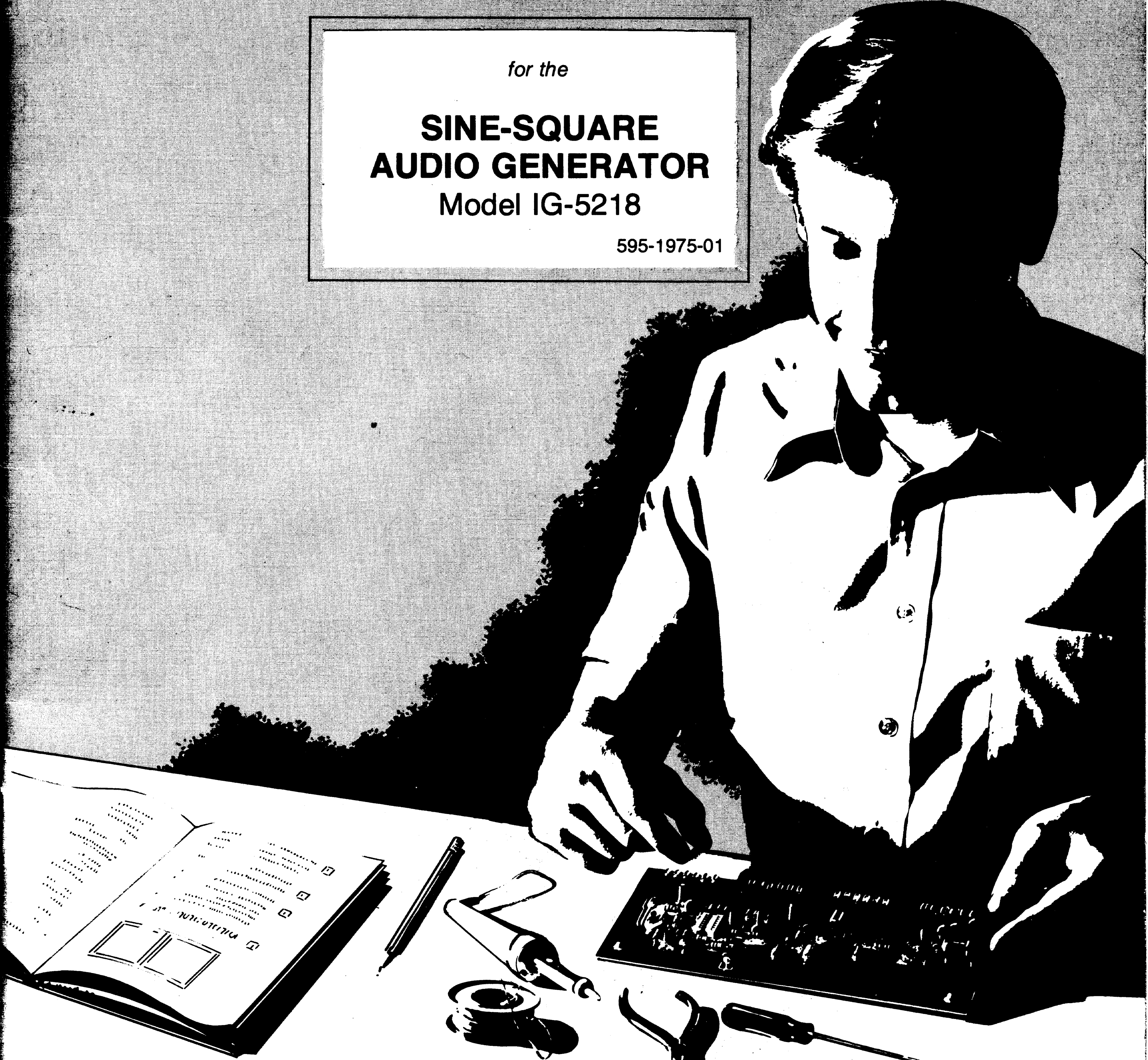
HEATHKIT® MANUAL

for the

SINE-SQUARE AUDIO GENERATOR
Model IG-5218

595-1975-01



HEATH COMPANY • BENTON HARBOR, MICHIGAN

INTRODUCTION

The Heathkit Model IG-5218 Sine-Square Audio Generator has been designed for laboratory use as well as for service and testing. Sine wave signals are available between 1 Hz and 100 kHz. Low distortion (less than .1%) sine wave signals are available between 1 Hz and 100 kHz. Low distortion (less than .1%) sine wave signals are available from 10 Hz to 100 kHz. The output is stepped from .003 volt to 10 volts. These high quality sine wave signals make it ideal for such applications as testing audio amplifiers for gain and frequency response, as a signal source for harmonic distortion measurements, or as an external modulator for an RF signal generator.

Square wave signals with a rise time of 50 nanoseconds are available from 5 Hz to 100 kHz at output levels up to 10 volts. These clean square wave signals can be used for checking frequency response in audio equipment, or as a trigger for testing digital instruments.

The sine and square wave frequencies are identical and the level of each is independently adjustable. Both signals may be used either simultaneously or independently.

The sine wave output will operate into high impedance loads (10 kΩ or higher) in all output ranges, or it will operate into 600 ohm loads in ranges up to 1 volt. The square wave output is designed to operate into loads of 2000 ohms or greater.

Other features include: A panel meter for monitoring the sine wave output; repeatable selection of any frequency; switch-selected 600 ohm internal load; and all solid-state circuitry for maximum reliability. All of these features combine to provide you with a versatile, accurate, and attractive signal source. It will be a valuable and useful addition to your laboratory or workbench.

DIFFICULTY	POSSIBLE CAUSE
Measured voltage less than 43 VDC but more than zero.	1. Diode D5 or D6 installed backwards. 2. Poor solder connections. 3. Capacitors C1, C2, C3, or C4 installed backwards.
No voltage.	1. Transistor improperly installed. 2. Open circuit or short circuit on power supply circuit board.
Measured voltage about 50 volts.	1. Zener diode D7.

(✓) Turn the POWER switch off.

This concludes the tests. Proceed to the Adjustments.

ADJUSTMENTS

Two methods for adjusting the Audio Generator are provided below. The first method uses only an AC voltmeter, and the second method (on Page 42) uses an AC voltmeter and an oscilloscope. Use the second method if you intend to use the Audio Generator with an oscilloscope. This will enable you to adjust the square wave Symmetry control, which cannot be done effectively with only a voltmeter.

ADJUSTMENTS WITH AC VOLTMETER ONLY

Set the switches and controls as follows:

( ) POWER SWITCH: OFF.

( ) MULTIPLIER: X10.

( ) TENS FREQUENCY: 10.

( ) UNITS FREQUENCY: 0.

( ) FREQUENCY control: 0.

NOTE: The word FINE on the front panel refers to the small knob on each of the AMPLITUDE controls. COARSE refers to the large knob on each of the AMPLITUDE switches.

( ) SINE WAVE AMPLITUDE switch (coarse): 10 volts.

( ) SINE WAVE AMPLITUDE control (fine): Fully clockwise.

( ) SQUARE WAVE AMPLITUDE switch (coarse): 10 volts.

( ) SQUARE WAVE AMPLITUDE control (fine): Fully clockwise.

( ) 600 Ω LOAD SWITCH: EXT.

NOTE: The following controls are located on the wave generator circuit board. Refer to Figure 1 for their location. Position each control at its center of rotation.

( ) BIAS.

( ) FEEDBACK.

( ) SYMMETRY.

( ) METER CAL.

( ) Plug the line cord into an AC outlet.

( ) Turn the POWER switch ON.

( ) Adjust the FEEDBACK control until the panel meter reads between 6 and 8 on the 0-10 scale.

( ) Set the external voltmeter to read 10 volts AC.

( ) Connect the external voltmeter common lead to the black sine wave output binding post. Connect the other voltmeter lead to the red sine wave output binding post.

( ) Rotate the METER CAL control clockwise until the panel meter reads the same, on the 0-10 scale, as the voltmeter.

( ) Disconnect the external voltmeter.

NOTE: During the following adjustments the panel meter pointer may seem to vary erratically. This is normal. If you encounter difficulties, make the control adjustments in small increments and allow the instrument time to stabilize after each adjustment.

( ) Turn the SINE WAVE AMPLITUDE control (fine) to approximately the 3 o'clock position.

( ) Adjust the BIAS control until you obtain a maximum panel meter reading.

( ) Turn the SINE WAVE AMPLITUDE (fine) control fully clockwise.

( ) Adjust the FEEDBACK control until the panel meter reads 10 volts.

NOTE: In the following two steps, if no change can be detected in the panel meter reading, it will not be necessary to readjust the feedback control.

( ) Turn the TENS FREQUENCY switch to each position, 10 through 100. Leave the switch in the position where the panel meter indicates the lowest voltage.

( ) Turn the MULTIPLIER switch to each position, X1 through X1000. Leave the switch in the position where the panel meter indicates the lowest voltage.

( ) Readjust the FEEDBACK control until the panel meter indicates 10 volts.

This completes the adjustments of the Audio Generator. Turn off the power and remove the AC plug from the socket. Proceed with the Final Assembly on Page 45.

ADJUSTMENTS WITH AC VOLTMETER AND OSCILLOSCOPE

Set the controls and switches as follows:

(✓) POWER SWITCH: OFF.

(✓) MULTIPLIER: X100.

(✓) TENS FREQUENCY: 10.

( ) UNITS FREQUENCY: 0.

( ) FREQUENCY control: 0.

NOTE: The word FINE on the front panel refers to the small knob on each of the AMPLITUDE controls. COARSE refers to the large knob on each of the AMPLITUDE switches.

(✓) SINE WAVE AMPLITUDE switch (coarse): 10 volts.

(✓) SINE WAVE AMPLITUDE control (fine): Fully clockwise.

(✓) SQUARE WAVE AMPLITUDE switch (coarse): 10 volts.

(✓) SQUARE WAVE AMPLITUDE control (fine): Fully clockwise.

(✓) 600 Ω LOAD: EXT.

NOTE: The following controls are located on the wave generator circuit board. Refer to Figure 1 (fold-out from Page 36) for their location. Position each control at its center of rotation.

(✓) BIAS.

(✓) FEEDBACK.

(✓) SYMMETRY.

(✓) METER CAL.

( ) Plug the line cord into an AC outlet.

( ) Turn the POWER switch ON.

( ) Adjust the FEEDBACK control until the panel meter reads between 6 and 8 on the 0-10 scale.

( ) Set the external voltmeter to read 10 volts AC.

( ) Connect the external voltmeter common lead to the black sine wave output binding post. Connect the other voltmeter lead to the red sine wave output binding post.

( ) Adjust the METER CAL control until the panel meter reads the same, on the 0-10 scale, as the voltmeter.

( ) Disconnect the external voltmeter.

( ) Set the oscilloscope to display a 1000 Hz waveform at an amplitude of 10 volts.

( ) Connect the oscilloscope to the sine wave output binding posts.

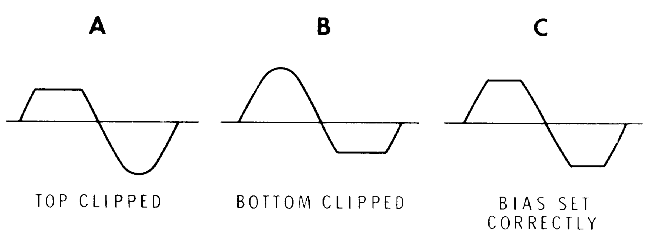


Figure 2

( ) Rotate the FEEDBACK control fully clockwise. Note that the positive or negative half of the waveform is clipped as shown in part A or B of Figure 2.

( ) Adjust the BIAS control so both halves of the waveform are clipped equally, as shown in Part C of Figure 2.

( ) Adjust the FEEDBACK control until the panel meter indicates 10 volts.

( ) Disconnect the oscilloscope.

NOTE: In the following two steps, if no change can be detected in the panel meter reading, it will not be necessary to readjust the feedback control.

( ) Turn the TENS FREQUENCY switch to each position, 10 through 100. Leave the switch in the position where the panel meter indicates the lowest voltage.

( ) Turn the MULTIPLIER switch to each position, X1 through X1000. Leave the switch in the position where the panel meter indicates the lowest voltage.

( ) Readjust the FEEDBACK control so that the panel meter indicates 10 volts.

( ) Reset the FREQUENCY and MULTIPLIER switches for a 1000 Hz output at 10 volts (MULTIPLIER at X100, TENS FREQUENCY at 10).

( ) Connect the oscilloscope to the square wave output binding posts. Set the oscilloscope input switch to AC.

NOTE: The very fast rise time (leading edge) of the square wave signal is very rich in harmonics, extending into the megahertz range. Low frequency oscilloscopes may respond in various ways to this signal. The leading edge may be "rounded off" through the roll-off characteristics of the oscilloscope, or frequency compensation (with peaking coil, for instance) may lead to "ringing" or "overshoot". Even the leads between the generator and oscilloscope may affect the pattern displayed.

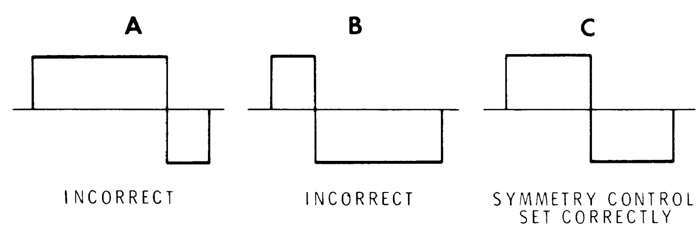


Figure 3

( ) Rotate the SYMMETRY control until the positive and negative halves of the square waveform are equal, as shown in part C of Figure 3.

This completes the adjustments. Turn off the power and remove the AC plug from the socket. Proceed to Final Assembly.

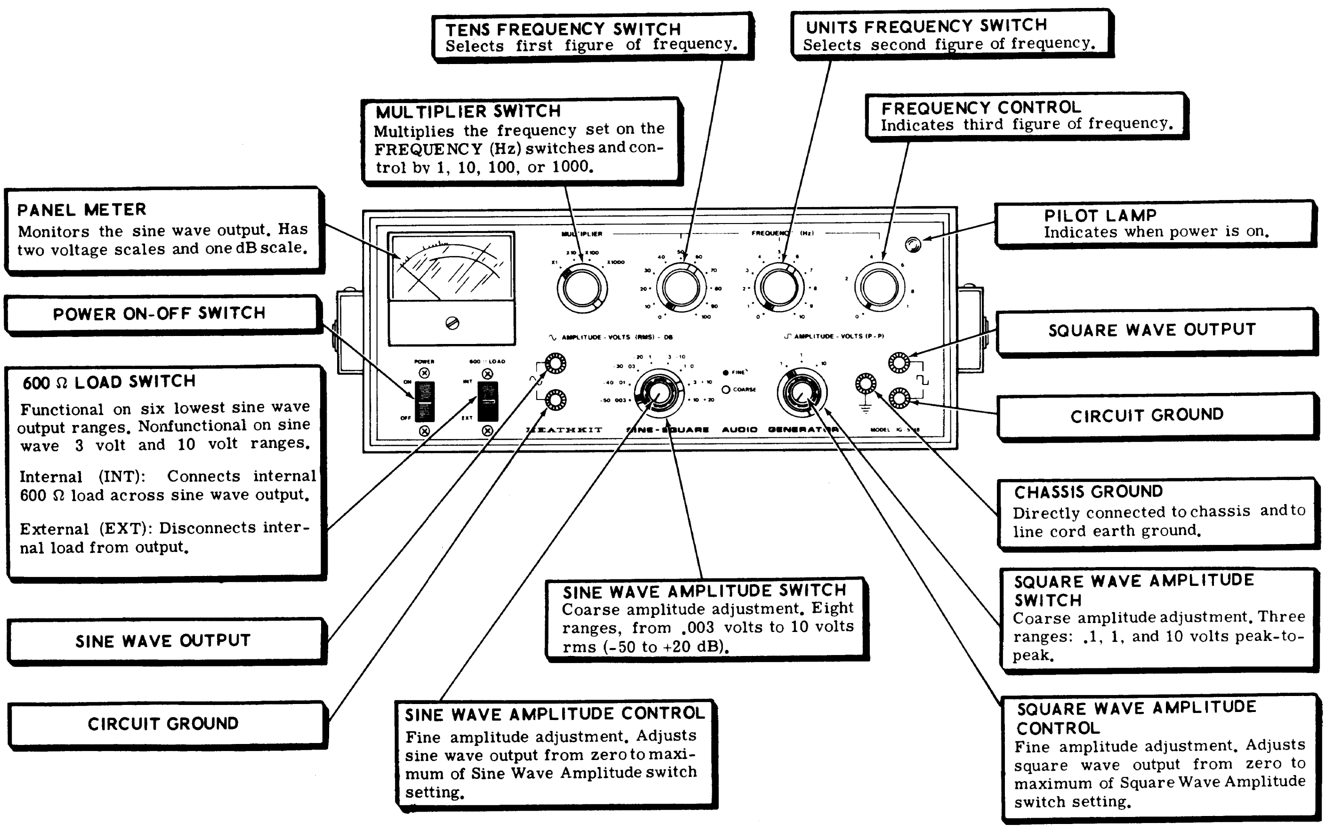

TENS FREQUENCY SWITCH
Selects first figure of frequency.
UNITS FREQUENCY SWITCH
Selects second figure of frequency.
MULTIPLIER SWITCH
Multiplies the frequency set on the FREQUENCY (Hz) switches and control by 1, 10, 100, or 1000.
FREQUENCY CONTROL
Indicates third figure of frequency.
PANEL METER
Monitors the sine wave output. Has two voltage scales and one dB scale.
PILOT LAMP
Indicates when power is on.
POWER ON-OFF SWITCH
SQUARE WAVE OUTPUT
600 Ω LOAD SWITCH
Functional on six lowest sine wave output ranges. Nonfunctional on sine wave 3 volt and 10 volt ranges.
Internal (INT): Connects internal 600 Ω load across sine wave output.
External (EXT): Disconnects internal load from output.
CIRCUIT GROUND
CHASSIS GROUND
Directly connected to chassis and to line cord earth ground.
SQUARE WAVE AMPLITUDE SWITCH
Coarse amplitude adjustment. Three ranges: .1, 1, and 10 volts peak-to-peak.
SINE WAVE AMPLITUDE SWITCH
Coarse amplitude adjustment. Eight ranges, from .003 volts to 10 volts rms (-50 to +20 dB).
SINE WAVE OUTPUT
CIRCUIT GROUND
SINE WAVE AMPLITUDE CONTROL
Fine amplitude adjustment. Adjusts sine wave output from zero to maximum of Sine Wave Amplitude switch setting.
SQUARE WAVE AMPLITUDE CONTROL
Fine amplitude adjustment. Adjusts square wave output from zero to maximum of Square Wave Amplitude switch setting.

Figure 4

OPERATION

Refer to Figure 4, which describes each of the front panel controls and terminals, before you read the remaining material in this section.

FREQUENCY SELECTION

To select a given frequency, set the TENS and UNITS FREQUENCY switches to correspond with the first two figures of the frequency. If a third figure is required, set the FREQUENCY control to the correct number. Then set the MULTIPLIER switch to the appropriate position to multiply the switch and control settings by the required multiplying factor.

EXAMPLES:

SWITCH AND CONTROL SETTINGS

SELECTED FREQUENCY	MULTIPLIER	TENS FREQUENCY	UNITS FREQUENCY	FREQUENCY CONTROL
60 Hz	X1	60	0	0
60 Hz	X10	0	6	0
400 Hz	X10	40	0	0
1520 Hz	X100	10	5	.2
15.2 kHz	X1000	10	5	.2

SINE WAVE AMPLITUDE

The output of the Audio Generator must be properly terminated to obtain accurate meter indications.

To obtain correct meter readings with a high impedance load (10 kΩ or more); set the 600 Ω LOAD switch to INT, and set the SINE WAVE AMPLITUDE switch to the nearest full scale value above the desired output level. Then adjust the SINE WAVE AMPLITUDE control to give the desired output on the proper meter scale. EXAMPLE: For an output voltage of 7.3 volts, set the SINE WAVE AMPLITUDE switch to 10 volts. Then turn the SINE WAVE AMPLITUDE control to give a 7.3 reading on the 0-10 scale of the meter. EXAMPLE: For an output of .025 volt, set the SINE WAVE AMPLITUDE switch to .03 volt. Then turn the SINE WAVE AMPLITUDE control to give a 2.5 reading on the 0-3 meter scale.

To obtain correct meter readings with an external 600 Ω load (1 volt maximum output signal level): set the LOAD switch to EXT and proceed as before.

SQUARE WAVE AMPLITUDE

To select a square wave output level, set the COARSE SQUARE WAVE AMPLITUDE switch to the lowest range that includes the desired voltage. Then adjust the FINE SQUARE WAVE AMPLITUDE control until the required voltage is produced. The front panel voltage ranges (.1v, 1v, and 10v) are for loads of 2000 Ω impedance or more. Output level may be measured with a high impedance AC voltmeter or with an oscilloscope. Remember that a square wave is measured in peak-to-peak volts and that most AC voltmeters indicate rms volts.

CAUTION: The square wave generator output is DC-coupled to avoid poor low frequency response (see "Square Wave Testing" on Page 52). The output is a DC signal that varies from zero to some positive value when measured at the output terminals. Do not connect this generator output into DC circuitry without using capacitive coupling. (Observe proper capacitor polarity.) Do not short the output terminals at maximum (10.0v) output.

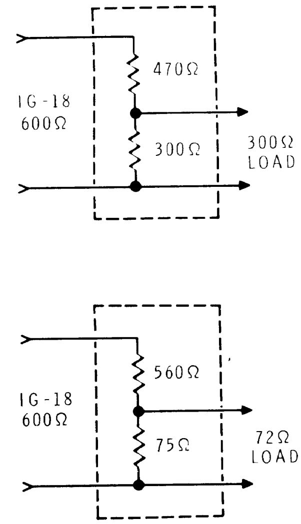


Figure 5

IMPEDANCE MATCHING

In general, impedance matching is not critical in test work. However, if close matching is required, matching pads may be constructed using composition resistors as shown in Figure 5. This Figure shows two examples for matching the 600 Ω output to different input leads. Since these pads also act as voltage divider networks, the input voltage will be less than the voltage indicated by the panel meter.

dB MEASUREMENT

The red scale on the panel meter is used for decibel (dB) comparisons. The decibel is a ratio, or comparison, of power levels. It is defined by the equation:

$$dB = 10 \log \frac{P_1}{P_2}$$

Since $P = EI$ and $I = \frac{E}{R}$, the above equation may be restated as:

$$dB = 10 \log \frac{\frac{E_1^2}{R_1}}{\frac{E_2^2}{R_2}}$$

While the decibel is basically a relative expression between two power levels, it can be used as a quantitative expression if one of the levels is defined as a standard level.

After various levels in several industries were partly accepted as "standard levels", the audio industry settled on a standard level of 1 milliwatt of power into a 600 ohm load. This standard level may be used in 600 ohm circuits only. In these circuits R^1 and R^2 in the above equation are equal and cancel out, simplifying the expression to:

$$dB = 10 \log \frac{E_1^2}{E_2^2}, \text{ or}$$

$$dB = 10 \log \left(\frac{E_1}{E_2}\right)^2, \text{ or}$$

$$dB = 20 \log \frac{E_1}{E_2}.$$

Accordingly, with the standard 600 Ω load across the signal output, you can read relative power on a voltmeter, such as the front panel meter on the Generator or any other voltmeter with the appropriate calibration (dB scale).

As zero dB is defined as 1 milliwatt in a 600 Ω load, and $P = \frac{E^2}{R}$, then $.001 = \frac{E^2}{600}$, or $E = \sqrt{.6}$, or E = .775 V. It is for this reason that the zero dB mark is in line with the 7.75 mark on the 0-10 meter scale.

TROUBLESHOOTING CHART

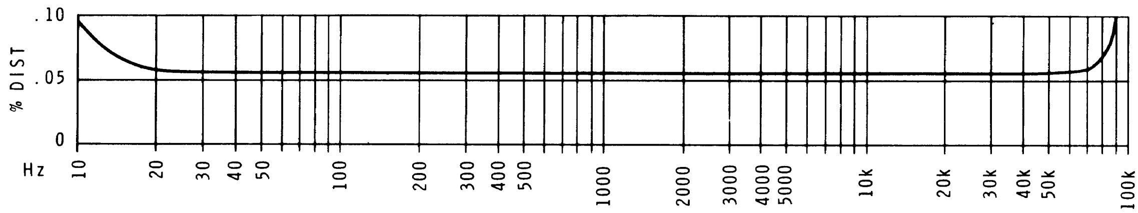
DIFFICULTY	POSSIBLE CAUSE AND SUGGESTED CURE
Pilot lamp lights. No sine or square wave output.	1. All controls set at zero. 2. Measure the B+ voltage at point A on the generator circuit board. If the voltage is low or there is no voltage, refer to the next Difficulty on this Chart. 3. Feedback control not set properly. (Refer to Adjustments section on Page 41.) 4. Check transistors Q1, Q2, Q5, Q4, and Q3 in that order. 5. Open filament in lamp L1. 6. Wrong part value, improper connection, or faulty part in notch filter circuits (units and tens switches). (Make checks at other frequency settings to test this possibility.)
B+ voltage low or no B+ voltage.	Measure the resistance of the generator circuit board at TP1 as described in the step under "Tests" on Page 39. If this resistance is less than 1500 Ω, apply the checks on the previous page to the generator circuit board. If the resistance is 1500 Ω or greater, check the following: 1. Transistor Q10. 2. Diodes D5 and D6. 3. Zener diode D7. 4. Capacitors C1, C2, C3, and C4. 5. Transformer primary windings.
No sine wave output. Square wave output ok.	1. Short circuit or excessive load at sine wave output terminals. 2. Check control R106. 3. Check capacitor C6.
No square wave output. Sine wave output ok.	1. Short circuit or excessive load at square wave output terminals. 2. Symmetry trimmer not adjusted properly. 3. Check transistors Q6, Q7, and Q8. 4. Check control R101. 5. Check capacitor C8. 6. Frequency set too low.
Bottom of square wave goes below zero.	1. D8 open.

DIFFICULTY	POSSIBLE CAUSE AND SUGGESTED CURE
Meter inoperative. Sine wave output ok.	1. Check diodes D3 and D4. 2. Check control R21. 3. Meter pointer stuck. 4. Meter coil open. WARNING: When testing the meter for continuity, use only the highest resistance range of the ohmmeter.
Sine wave distorted.	1. Feedback control set too high. 2. Bias control not set correctly. 3. Check Q10. 4. Check Q5, Q4, Q1, Q2, and Q3. 5. Improper ground connections between Generator and associated equipment. 6. Low line voltage.

SPECIFICATIONS

SINE WAVE OUTPUT

Frequency Range.	1 Hz to 100 kHz.
Output Voltage Ranges.	0 - .003 0 - .01 0 - .03 0 - .1 0 - .3 0 - 1 0 - 3 0 - 10
Internal Load.	Internal 600 Ω load available on .003, .01, .03, .1, .3, and 1 volt ranges.
dB Ranges.	-62 to +22 dB. -12 to +2 dB on meter; -50 to +20 dB in eight 10 dB switch positions. +2 dB maximum into 600 Ω load.
Output Variation.	±1 dB from 10 Hz to 100 kHz.
Output Indication.	Two voltage scales and one dB scale on front panel meter.
Output Impedance.	10 volt range: 0-1000 Ω. 3 volt range: 800-1000 Ω. 1 volt range and lower: 600 Ω.
Meter Accuracy.	±10% of full scale with proper load termination.



PERCENT DISTORTION-TYPICAL

Distortion. . . . . Less than .1% from 10 Hz to 20 kHz.

Type Of Circuit. . . . . Differential amplifier with complementary pair output. Notch filter frequency determination.

SQUARE WAVE OUTPUT

Frequency Ranges. . . . . 5 Hz to 100 kHz.

Output Voltage Ranges. . . . . 0-.1 V, 0-1 V, and 0-10 V zero-to-peak into 2000 Ω or higher load.

Output Impedance. . . . . 52 Ω on .1 V and 1 V ranges;
Up to 220 Ω on 10 V range.

Rise Time. . . . . Less than 50 nanoseconds.

GENERAL

Frequency Selection. . . . . First two significant figures on 0-100 and 0-10 switches each in ten steps.
Third figure on 0-1 control.
Multiplier switch: X1, X10, X100, X1000.

Frequency Error . . . . Within ± 5% of first and second digit.

Power Requirements. . . . . 105-125 VAC or 210-250 VAC, 50/60 Hz, 6 Watts.

Dimensions. . . . . 5-1/8" high x 13-1/4" wide x 7" deep.

Net Weight. . . . . 7 lbs.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

Refer to the Block Diagram on Page 65 and to the Schematic Diagram (fold-out from Page 75) while reading this Circuit Description.

The circuit of the Sine-Square Audio Generator includes three principal sections: The Sine Wave Generator (including the meter and output attenuator circuits), the Square Wave Generator and the Power Supply. Each of these Sections will be described separately.

SINE WAVE GENERATOR

The sine wave oscillator circuits consists of differential amplifier transistors Q1 and Q2; voltage amplifier transistor Q3; power amplifier transistors Q4 and Q5; and the positive and negative feedback loops. Positive (regenerative) feedback comes from the common emitter output of transistors Q4 and Q5, and is coupled to the base of transistor Q2 through the lamp L1, the arm of feedback control R7, and resistor R6. Negative (degenerative) feedback comes through the notch filter and is directly coupled to the base of transistor Q1.

Oscillation occurs due to the positive feedback. Without negative feedback, the circuit would oscillate at some indeterminate frequency; however, the notch filter, which passes all frequencies except the one to which it is tuned, provides the negative feedback to the base of transistor Q1. This negative feedback prevents oscillation at all frequencies except the one that is not passed, permitting the system to oscillate at only the selected frequency.

The tuned frequency of the RC notch filter circuit may be calculated by the general formula:

$$F = \frac{1}{2\pi RC}$$

where F is frequency in hertz, R is resistance in ohms, and C is capacitance in farads. However, since this notch filter is a specialized RC network in which there are two resistances and two capacitances, the formula for this network then becomes:

$$F = \frac{1}{2\pi\sqrt{R_1 R_2}\sqrt{C_1 C_2}}.$$

Since R_1 and R_2 will always be equal, the formula simplifies to:

$$F = \frac{1}{2\pi R\sqrt{C_1 C_2}}.$$

In the notch filter in the Sine-Square Audio Generator R may consist of one or several resistors in parallel; or

$$R = \frac{1}{\frac{1}{R_x} + \frac{1}{R_y} + \frac{1}{R_z}}; \quad C_1 = C_x; \quad \text{and } C_2 = C_y.$$

R_x represents the resistance value selected by the Tens Frequency switch for a particular frequency. This resistance may consist of one resistor, or a parallel combination of several resistors. For example; for 20 Hz the two 5000 Ω resistors are selected and R_x = 5000 Ω, for 40 Hz the two 2500 Ω resistors are selected and R_x = 2500 Ω, for 60 Hz both the 5000 Ω and the 2500 Ω resistors are selected in parallel and R_x = 1670 Ω.

R_y represents the resistance value selected by the Units Frequency switch for a particular frequency. The operation of this switch is identical to that of the Tens Frequency switch, except that the resistance values are ten times those of the Tens Frequency switch.

R_z represents the resistance value of the Frequency Control when adjusted for a particular frequency.

C_x and C_y represent the capacitors on the Multiplier switch. The value of C_y will always be 10 times larger than the value of C_x for all positions of the Multiplier switch.

As shown in the general formula $F = \frac{1}{2\pi RC}$, the tuned frequency of a notch filter is inversely proportional to the value of its resistances and capacitances. Therefore, to achieve an increase in frequency the resistance must decrease. Likewise, for a tenfold increase in frequency, by using the Multiplier switch, the capacitance must decrease tenfold.

Any tendency of the oscillator to produce signals of increasing amplitude is controlled by lamp L1. If the oscillator output increases, more current is fed through the feedback circuit and through lamp L1. This increased current causes the filament of the lamp to heat slightly, which causes its resistance to increase. This increase in resistance attenuates the feedback signal to the base of transistor Q2. The result is a regulated output from transistor Q2.

DC base bias is provided to Q1 and Q2 through a voltage divider that consists of resistors R5 and R6, and control R7. (Resistor R3 decreases the gain of the differential amplifier to make it more stable.) The voltage at the lower end of this divider, and therefore at the bases of Q1 and Q2, is made adjustable by being connected to the arm of Bias control R9, which is connected in a DC voltage divider with R8 and R10.

The signal from the differential amplifier is direct coupled from the collector of Q2 to the base of voltage amplifier transistor Q3. From the collector of Q3, the signal is direct coupled to the base of Q4, and through diodes D1 and D2 to the base of Q5. These diodes maintain a 1.2 volt difference between the bases of transistors Q4 and Q5.

Q4 and Q5 form an emitter follower complementary-pair amplifier with no voltage gain and a low impedance output. The output signal from this stage is coupled to the square wave circuits as a trigger signal and to the sine wave output attenuator.

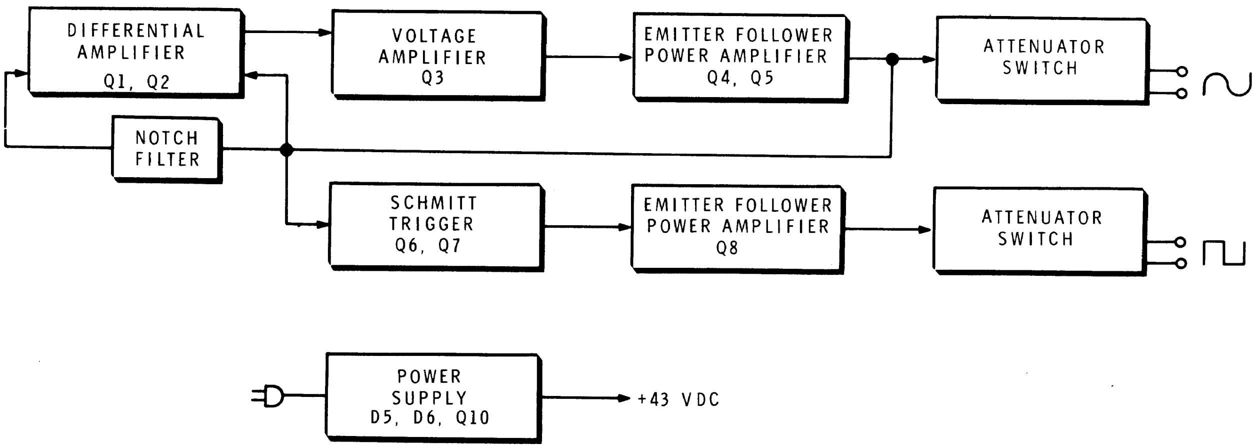
SINE WAVE OUTPUT ATTENUATOR

The sine wave signal from Q4 and Q5 is coupled through capacitor C6 to Sine Wave Amplitude control R106. From R106, the signal is coupled through isolating resistor R107 to the meter circuit and to the Sine Wave Amplitude switch.

The resistor network on two sections of this switch comprise an eight-step voltage divider (R109 to R121) which proportionately divides the signal into steps of 10 dB each. The selected voltage level is applied to the sine wave output terminals. The remaining section of the switch permits internal load resistor R122 to be connected across the output terminals in the six lowest output ranges.

METER CIRCUIT

Resistor R108 and meter calibration control R21 comprise a voltage divider through which some of the signal from resistor R107 is bypassed for monitoring by the panel meter. Diodes D3 and D4, and load resistors R24 and R25 form a half-wave bridge rectifier circuit for the output meter.



BLOCK DIAGRAM

SQUARE WAVE GENERATOR

The square wave section consists of a Schmitt trigger circuit Q6 and Q7, a power amplifier Q8, and the square wave attenuator. The square wave is produced by the Schmitt trigger circuit, which is triggered by a sine wave signal that is coupled through resistor R15 and Symmetry control R16 to the base of Q6.

The Schmitt trigger circuit has two stable states: one in which Q7 is conducting and Q6 is cut off, and the other in which Q6 is conducting and Q7 is cut off. The switching time between these two states is extremely short, which permits the circuit to produce a square wave with a very fast rise time.

The switching is controlled by the voltage on the base of Q6. This voltage varies with the rising and falling voltage of the sine wave input. Symmetry control R16 is adjusted to produce time intervals between switching on and switching off that are of equal length; therefore, producing a symmetrical square wave.

The Schmitt trigger output from the collector of transistor Q7 is coupled through capacitor C8 to the base of emitter follower transistor Q8, which provides a low impedance output with no voltage gain. D8 protects the base of Q8 from excessive negative voltage. The output from Q8 passes directly to Square Wave Amplitude control R101. From R101, the square wave is applied through the attenuator network on the Square Wave Amplitude switch to the square wave output terminals.

POWER SUPPLY

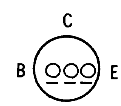
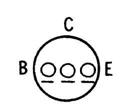
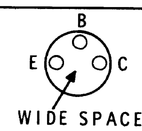
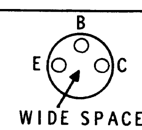
Dual-primary power transformer T1 can be wired to operate from either 120 VAC or 240 VAC. The output from the secondary of T1 is rectified by diodes D5 and D6 in a full wave rectifier circuit, and filtered by the pi filter consisting of capacitors C1 and C2 and resistor R27.

Zener diode D7 provides a regulated reference voltage for the base of voltage regulator transistor Q10, which regulates the DC output at 43 volts. Capacitor C4 grounds AC feedback from the sine wave generator at high frequencies.

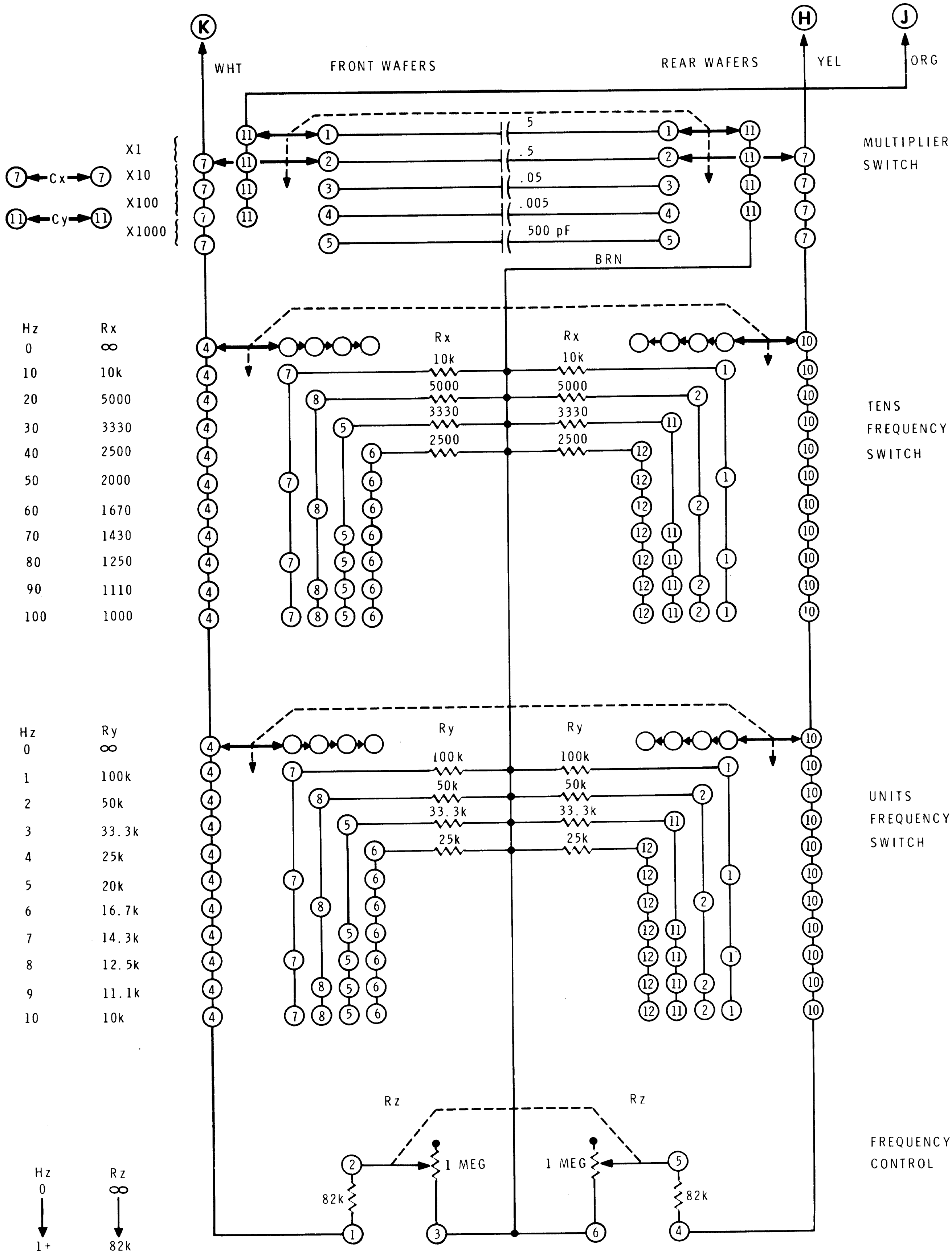
SCHEMATIC OF THE HEATHKIT®
SINE-SQUARE AUDIO GENERATOR
MODEL IG-5218

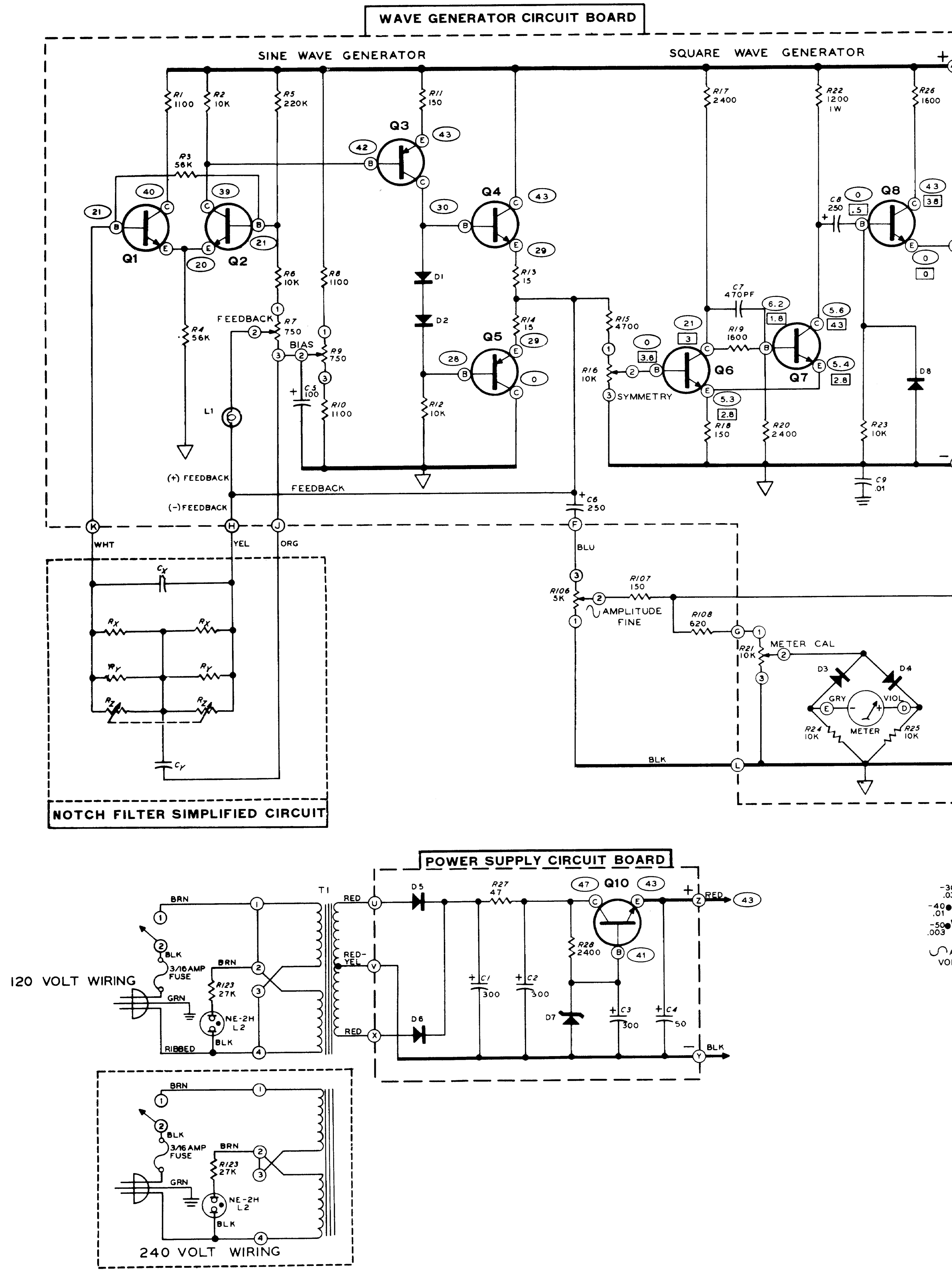
NOTES:

1. RESISTORS AND CAPACITORS, EXCEPT THOSE IN THE NOTCH FILTER CIRCUIT, ARE NUMBERED IN THE FOLLOWING GROUPS:
   0-99 PARTS MOUNTED ON CIRCUIT BOARDS.
   100-199 PARTS MOUNTED ON CHASSIS.
2. ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (k=1000).
3. ALL CAPACITORS ARE IN µF UNLESS MARKED OTHERWISE (pF=PICOFARAD).
4. ALL SWITCHES SHOWN IN FULL COUNTERCLOCKWISE POSITION WHEN VIEWED FROM THE KNOB END.
5. ▽ INDICATES COMMON CIRCUIT GROUND.
6. ⏚ INDICATES CHASSIS GROUND.
7. REFER TO THE CHASSIS PHOTOGRAPHS AND CIRCUIT BOARD X-RAY VIEWS FOR THE PHYSICAL LOCATION OF PARTS.
8. ⬭ +DC VOLTAGES TO EITHER COMMON OUTPUT TERMINAL. ALL CIRCUIT BOARD CONTROLS FULLY CCW, ALL FREQUENCY SWITCHES AND CONTROL CCW, ALL AMPLITUDE SWITCHES AND CONTROLS FULLY CW. VOLTAGES ±10%.
9. □ +DC VOLTAGES, THE SAME AS ABOVE, EXCEPT SYMMETRY CONTROL FULLY CW.

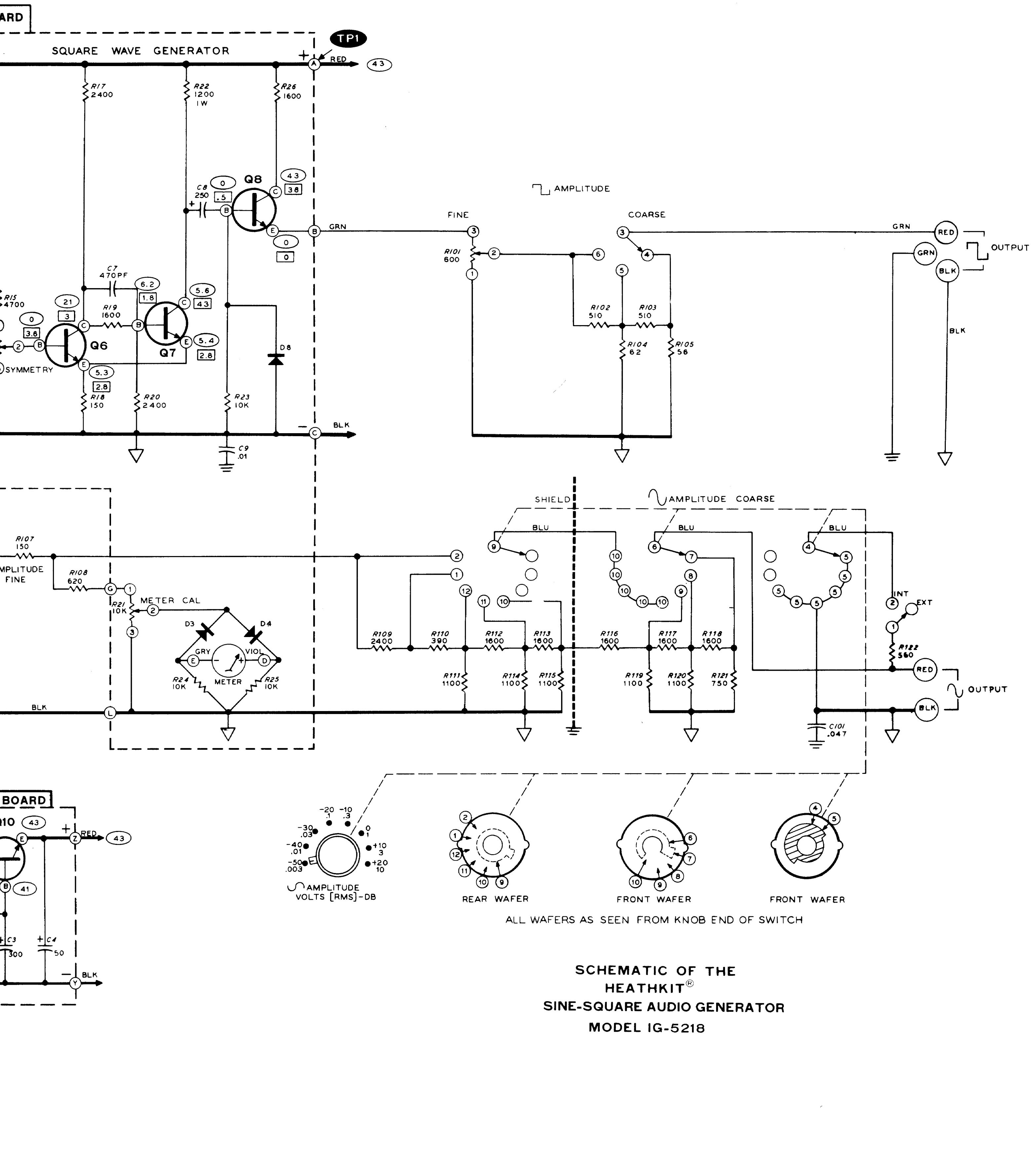
TRANSISTOR, DIODE	PART NUMBER	MAY BE REPLACED WITH	BASING DIAGRAM (BOTTOM VIEW)
Q1, Q2, Q4	417-94	2N3416	
Q3, Q5	417-201	2N2306	
Q6, Q7, Q8	417-154	2N2369	
Q10	417-178	40389	
D1, D2, D5, D6	57-65	1N4002 SILICON 100 PIV, 100 mA	
D3, D4	56-26	1N191	
D7	56-66	ZENER 1N3035 1 WATT	
D8	56-56	1N4149	

NOTCH FILTER — COMPLETE CIRCUIT





WAVE GENERATOR CIRCUIT BOARD
SINE WAVE GENERATOR
SQUARE WAVE GENERATOR
R1 1100
R2 10K
R5 220K
R3 56K
R11 150
Q3
Q4
Q5
Q1
Q2
R4 56K
R6 10K
R8 1100
FEEDBACK
R7 750
BIAS
R9 750
C5 100
R10 1100
L1
D1
D2
R13 15
R14 15
R12 10K
(+) FEEDBACK
(−) FEEDBACK
FEEDBACK
C6 250
R17 2400
R22 1200 1W
R26 1600
C8 250
Q8
C7 470PF
R19 1600
R15 4700
R16 10K
SYMMETRY
Q6
Q7
R18 150
R20 2400
R23 10K
D8
C9 .01
WHT
YEL
ORG
BLU
NOTCH FILTER SIMPLIFIED CIRCUIT
R106 5K
R107 150
AMPLITUDE FINE
R108 620
R21 10K
METER CAL
D3
D4
GRY
VIOL
METER
R24 10K
R25 10K
BLK
POWER SUPPLY CIRCUIT BOARD
T1
D5
R27 47
Q10
D6
R28 2400
C1 300
C2 300
D7
C3 300
C4 50
RED
RED-YEL
BRN
BLK
3/16 AMP FUSE
R123 27K
NE-2H L2
GRN
RIBBED
120 VOLT WIRING
240 VOLT WIRING



SCHEMATIC OF THE HEATHKIT® SINE-SQUARE AUDIO GENERATOR MODEL IG-5218