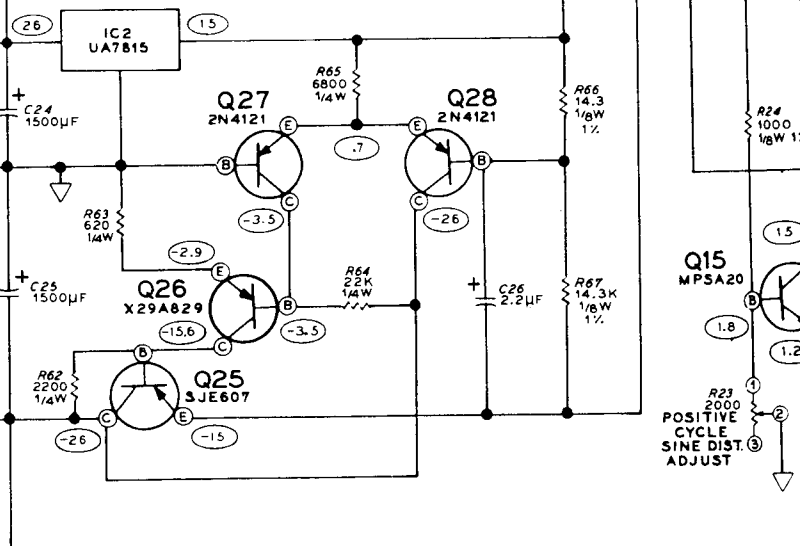
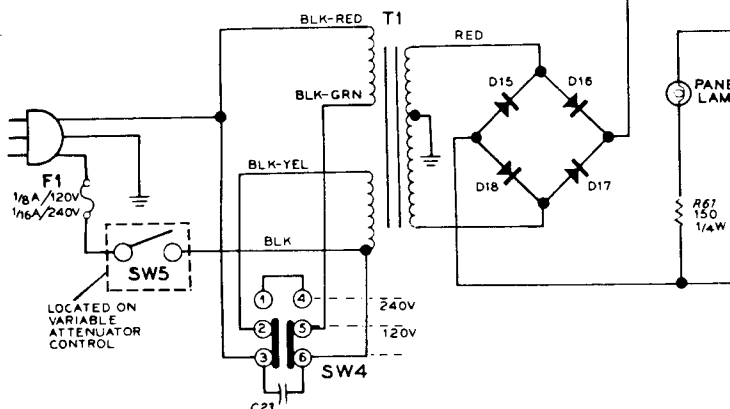
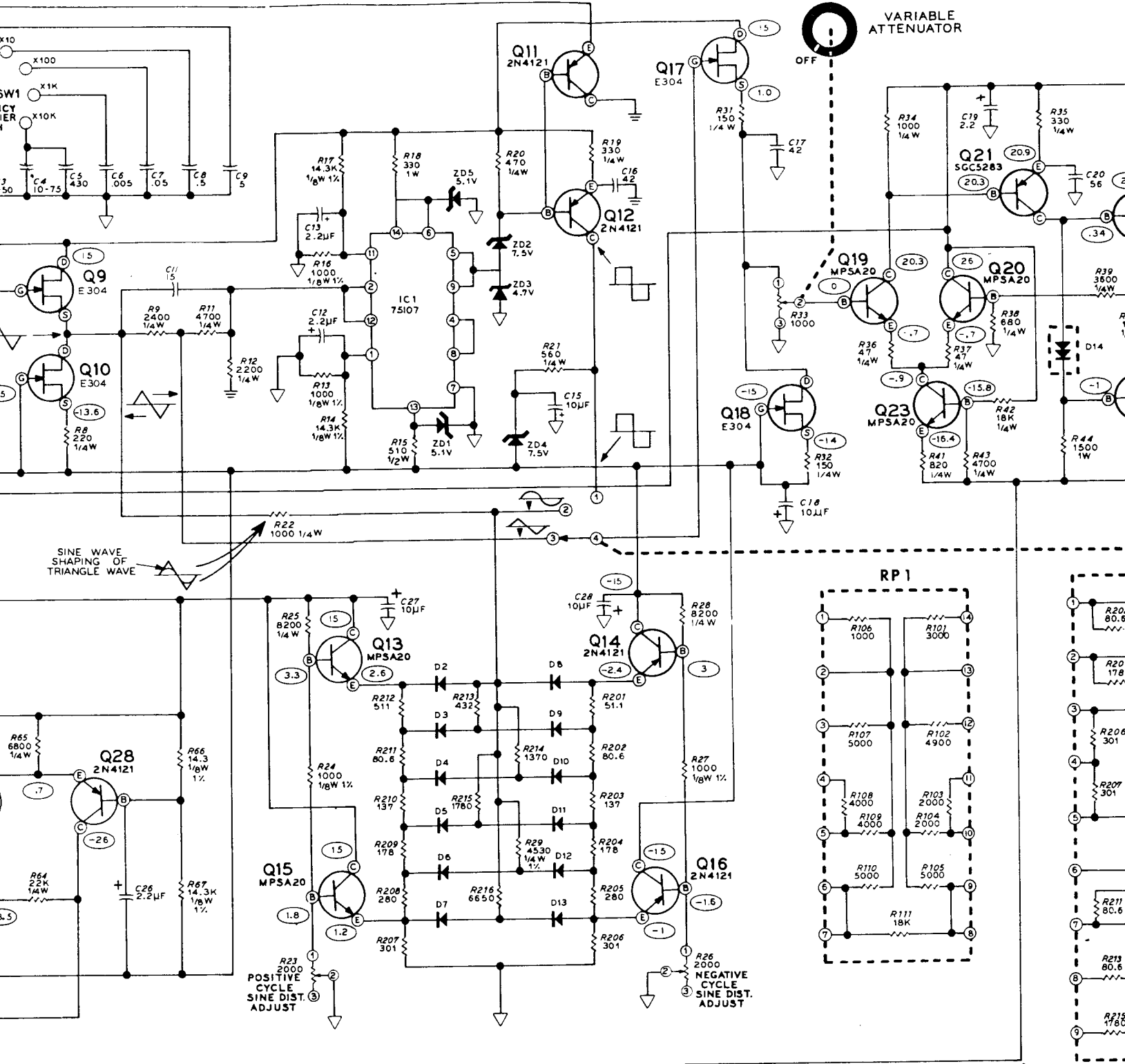


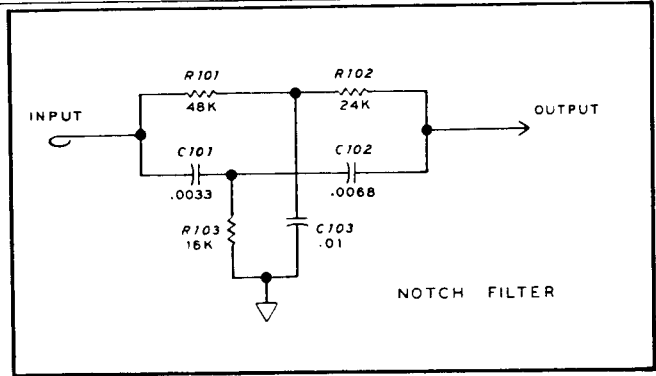
- NOTES:
1. RESISTORS NUMBERED 101-112 ARE CONTAINED IN RESISTOR PACK RP-1.
 2. RESISTORS NUMBERED 201-216 ARE CONTAINED IN RESISTOR PACK RP-2.
 3. CAPACITOR VALUES LESS THAN 1 ARE IN μF , VALUES OF 1 OR GREATER ARE IN pF UNLESS OTHERWISE STATED.
 4. ∇ THIS SYMBOL INDICATES A CIRCUIT BOARD GROUND.
 5. \equiv THIS SYMBOL INDICATES A CHASSIS GROUND.
 6. \bigcirc THIS SYMBOL INDICATES A DC VOLTAGE MEASUREMENT TAKEN FROM THE INDICATED POINT TO GROUND WITH A HIGH INPUT IMPEDANCE VOLTMETER.
 7. * FREQUENCY DIAL SET FOR 10. VARIABLE ATTENUATION SET FOR MINIMUM OUTPUT.

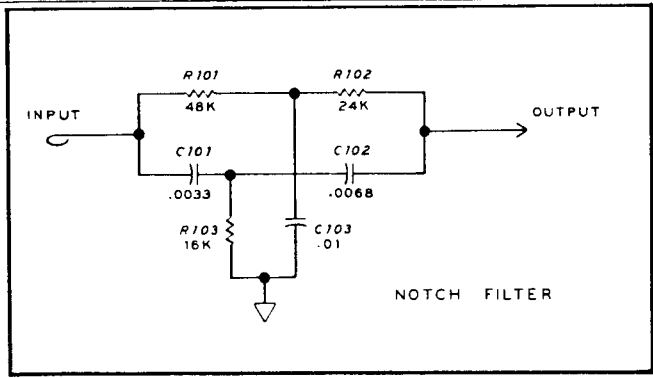
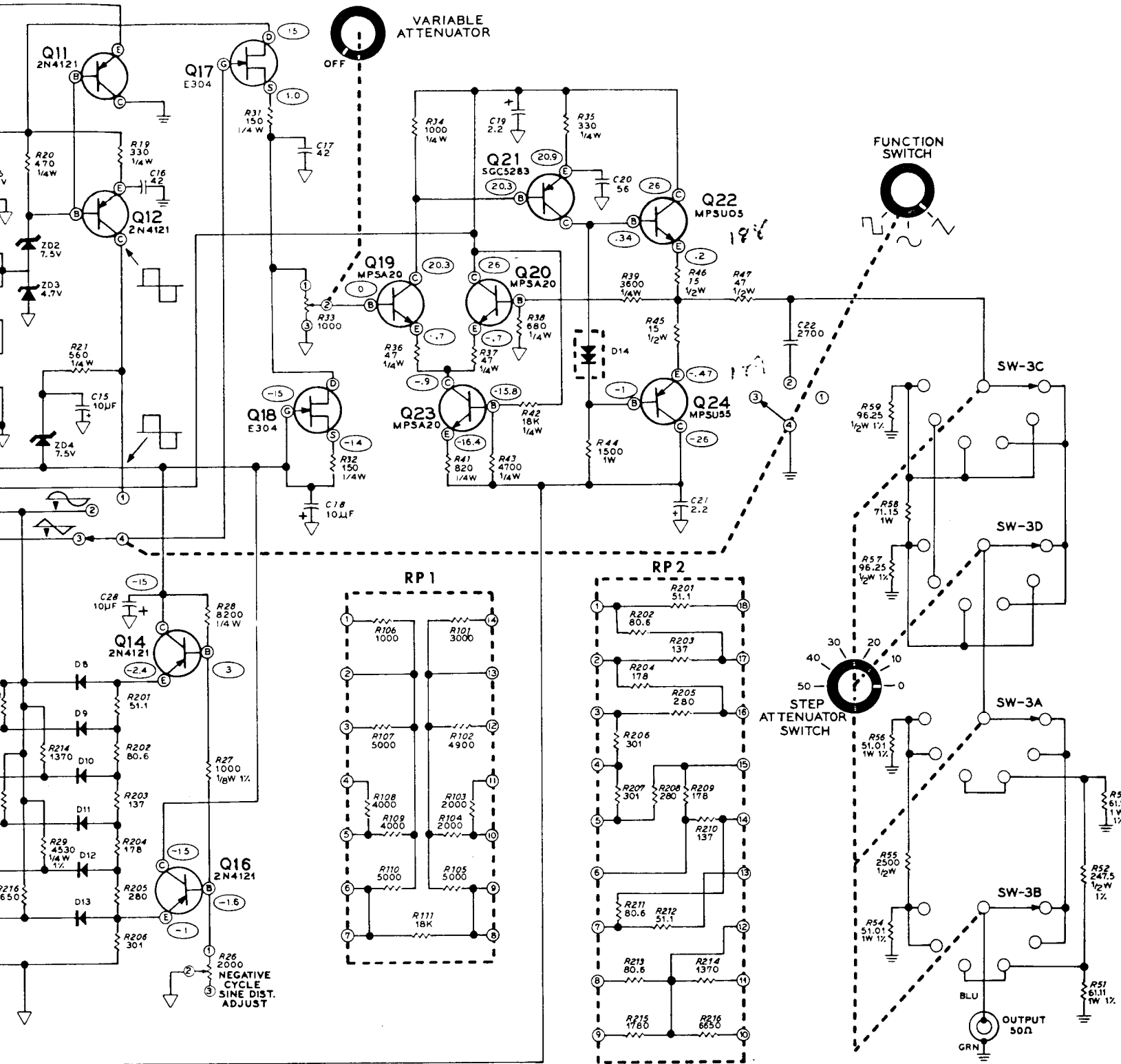


SCHEM
MODE
FUNCTION

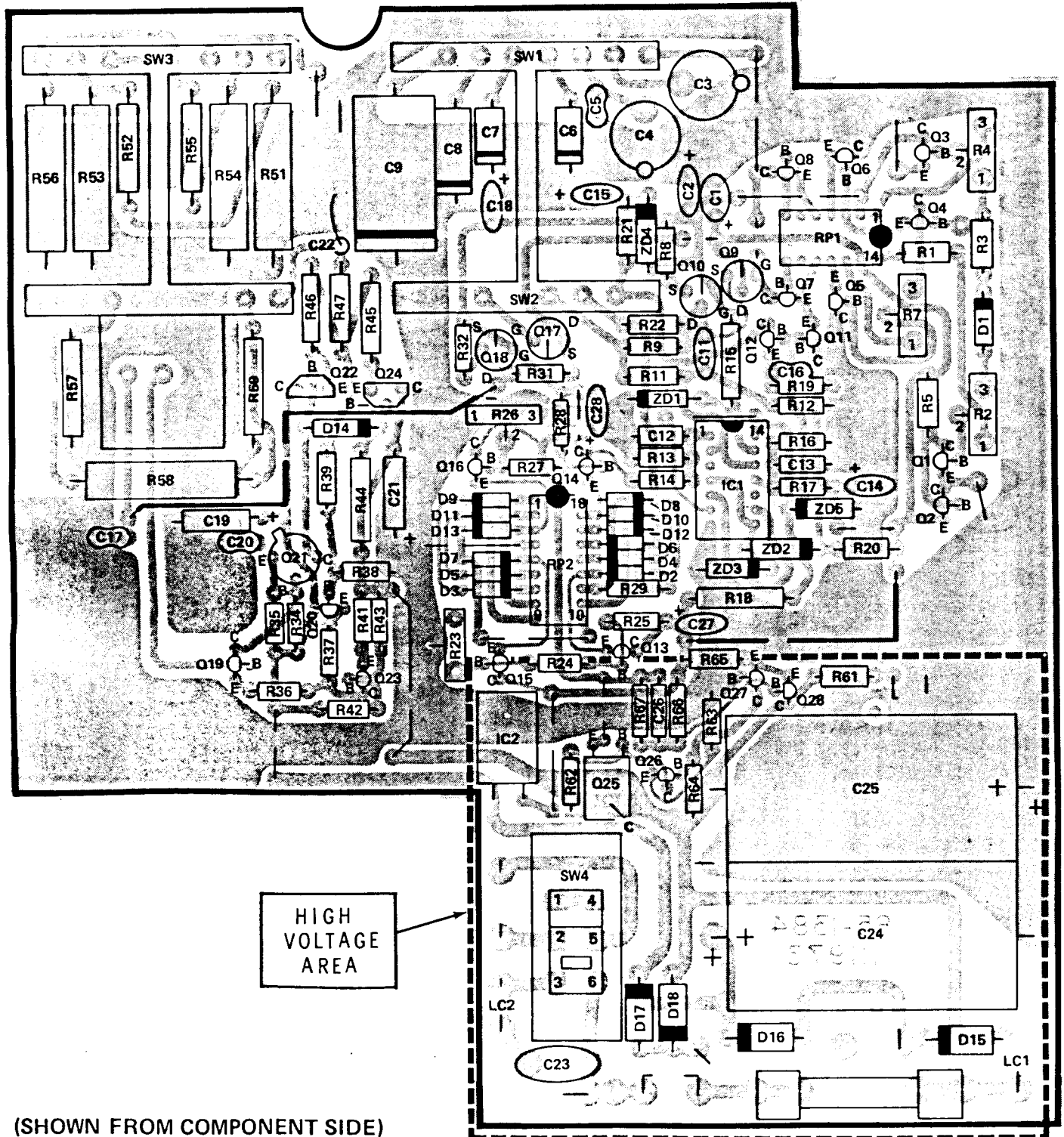


SCHEMATIC OF THE
MODEL SG-1271
FUNCTION GENERATOR





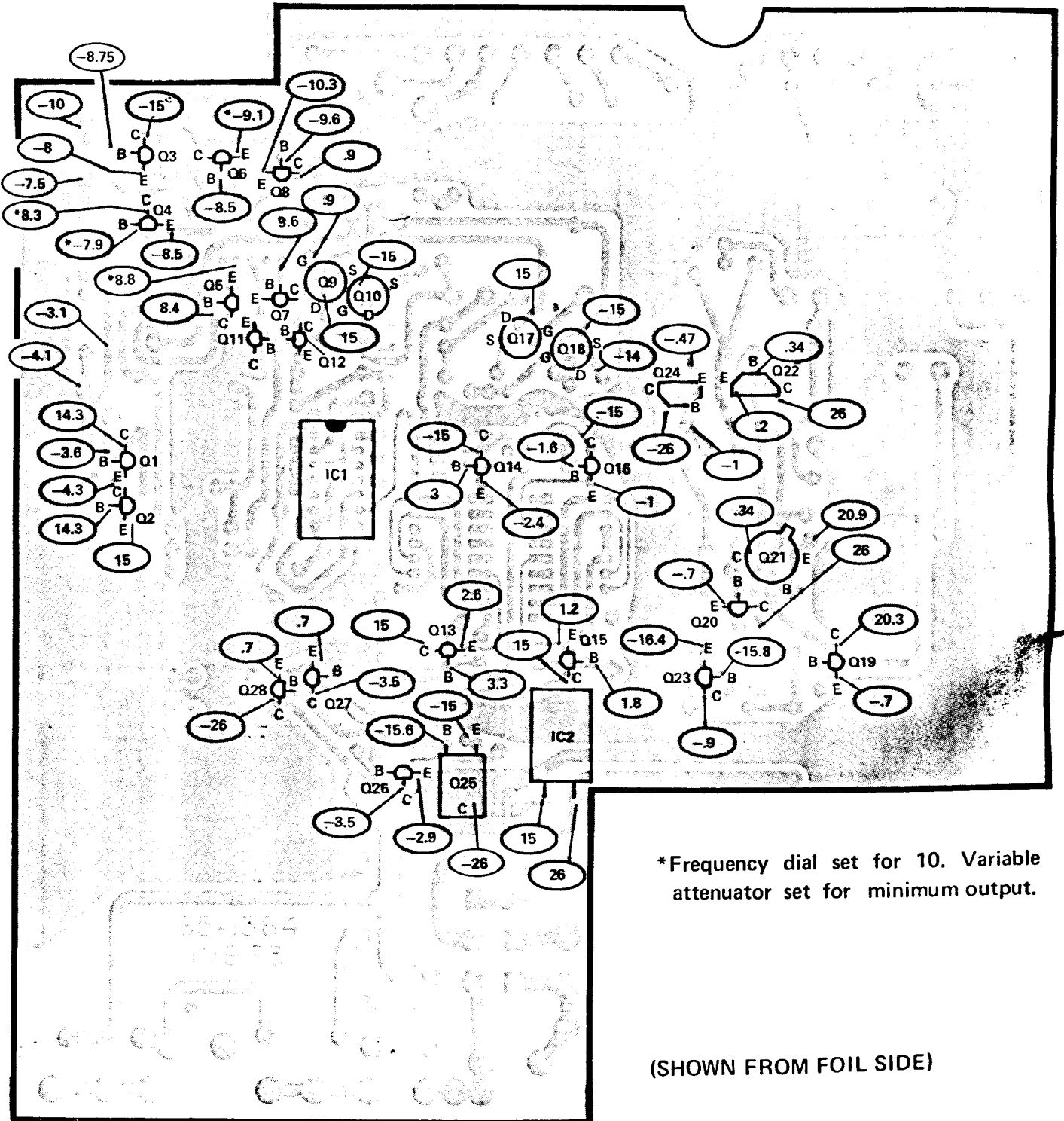
CIRCUIT BOARD X-RAY VIEW



HIGH VOLTAGE AREA

(SHOWN FROM COMPONENT SIDE)

CIRCUIT BOARD VOLTAGE CHART



*Frequency dial set for 10. Variable attenuator set for minimum output.

(SHOWN FROM FOIL SIDE)

CIRCUIT DESCRIPTION

The Function Generator first generates a triangle waveform of the selected frequency. Then the triangle wave is shaped to produce a sine wave or used to trigger other circuitry to produce a square wave if this function is selected.

TRIANGLE WAVEFORM

The triangle waveform is generated by transistors Q7, Q8, Q9, Q10, Q11; multiplier capacitor C3, C4, C5, C6, C7, C8, or C9; and IC1.

Transistor Q7 conducts only on the positive going ramp of each waveform. Transistor Q8, however, conducts all the time. The current that is supplied by transistor Q7 is divided exactly in half by transistor Q8. Half of this current is directed through Q8 and the remaining half is coupled to the multiplier capacitor to charge it. This is shown in Figure 6.

The multiplier capacitor charges to +5 volts which is coupled through transistor Q9 to the voltage divider network made up of resistors R9, R11, and R12. This voltage divider supplies 1 volt of the +5 volts from the multiplier capacitor to pins 2 and 12 of IC1. Therefore, if we were to view this at point A in Figure 6 we would see a symmetrical voltage rise (positive ramp) from -5 volts to +5 volts.

IC1 is a dual comparator IC. During the positive going ramp, the voltages at pins 5 and 9 are approximately +5 volts and transistor Q11 is not conducting. As the multiplier capacitor charges, and the voltage at pins 2 and 12 approaches +1 volt, IC1 switches and the voltage at pins 5 and 9 becomes low (+.4 volt). This causes transistor Q11 to conduct which cuts off transistor Q7.

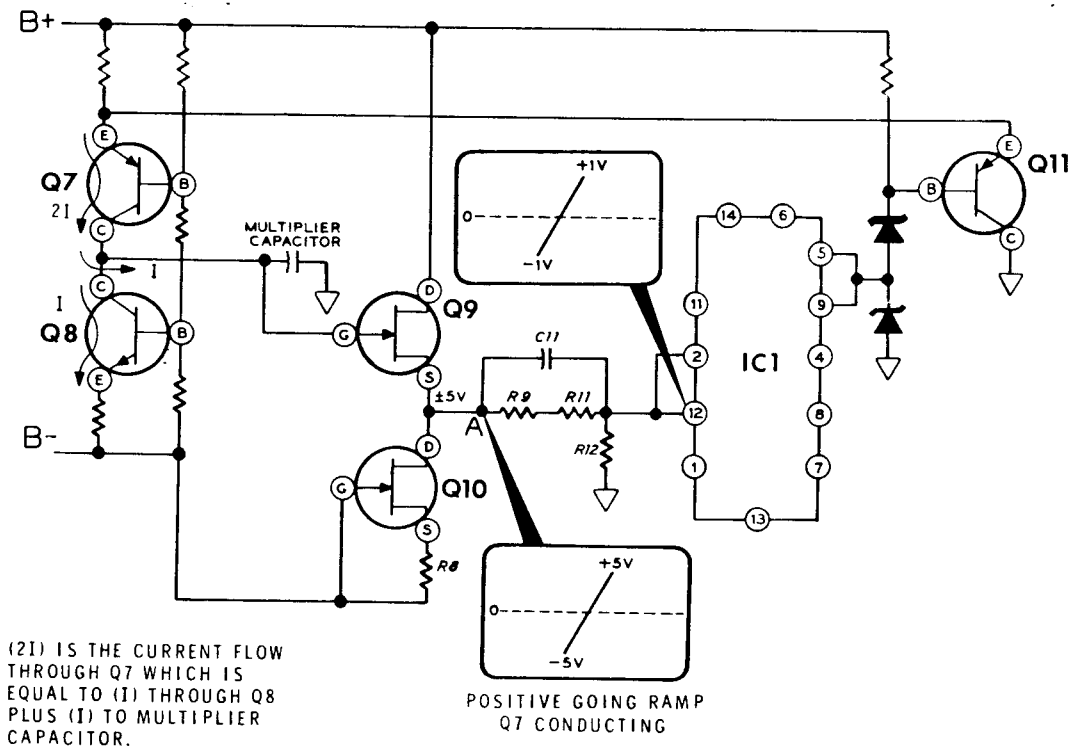


Figure 6

At this time, transistor Q8, which is always conducting, will begin to charge the multiplier capacitor from +5 volts to -5 volts. This causes a linear voltage change in the negative direction (negative going ramp). It is important to note at this time that the current required to charge the multiplier capacitor to -5 volts is exactly equal to the current that charged it to +5 volts. Thus a symmetrical triangle wave is produced. See Figure 7.

During the negative going ramp, the voltage at pins 5 and 9 of IC1 is approximately .4 volt. As the multiplier capacitor charges to -5 volts, the voltage divider network supplies -1 volt of the -5 volts to pins 2 and 12 of IC1. When the voltage at pins 2 and 12 of IC1 approaches -1 volt, IC1 switches again and the voltage at pins 5 and 9 becomes high (approximately +5 volts). This allows transistor Q7 to conduct again and another positive going ramp starts.

The symmetry adjust control, R7, balances the circuit so the current supplied by transistor Q7 is exactly twice the current coupled through transistor Q8. This control compensates for the unbalance in the circuit that is caused by resistor tolerances and variations in transistor leakage currents.

FREQUENCY CONTROL

For a given frequency, the time that is required for the multiplier capacitor to charge and discharge remains constant because the current flow through transistors Q7

and Q8 remains constant. However, as Frequency control R5 is turned counterclockwise and selects a more negative voltage, the voltage on the base of transistor Q4 becomes more negative. This causes the voltage on the collector of Q4, and also the base of Q5 to become more positive. At the same time, the voltage on the emitter of Q4 and the base of Q6 becomes more negative. This reduces the amount of current that is flowing in these transistors. Since the emitters of these transistors are connected to the emitters of Q7 and Q8 the amount of current that flows in Q5 and Q6 must be drawn away from the emitters of Q7 and Q8. Therefore as the current flow in transistors Q5 and Q6 decreases, the current flow in transistors Q7 and Q8 increases.

Note that resistor R103 is one half of the value of R108. This is to insure that as the current flow in transistors Q7 and Q8 changes with frequency, the current flow change in transistor Q7 will always be exactly twice the current change in transistor Q8.

As the current flow in transistors Q7 and Q8 increases, the multiplier capacitor will charge more quickly and the output frequency is increased.

Transistors Q1 and Q2 provide a constant negative voltage to one end of R301. Transistor Q3 provides a constant negative voltage to the other end of R301. Controls R2 and R4 provide biasing for these transistors.

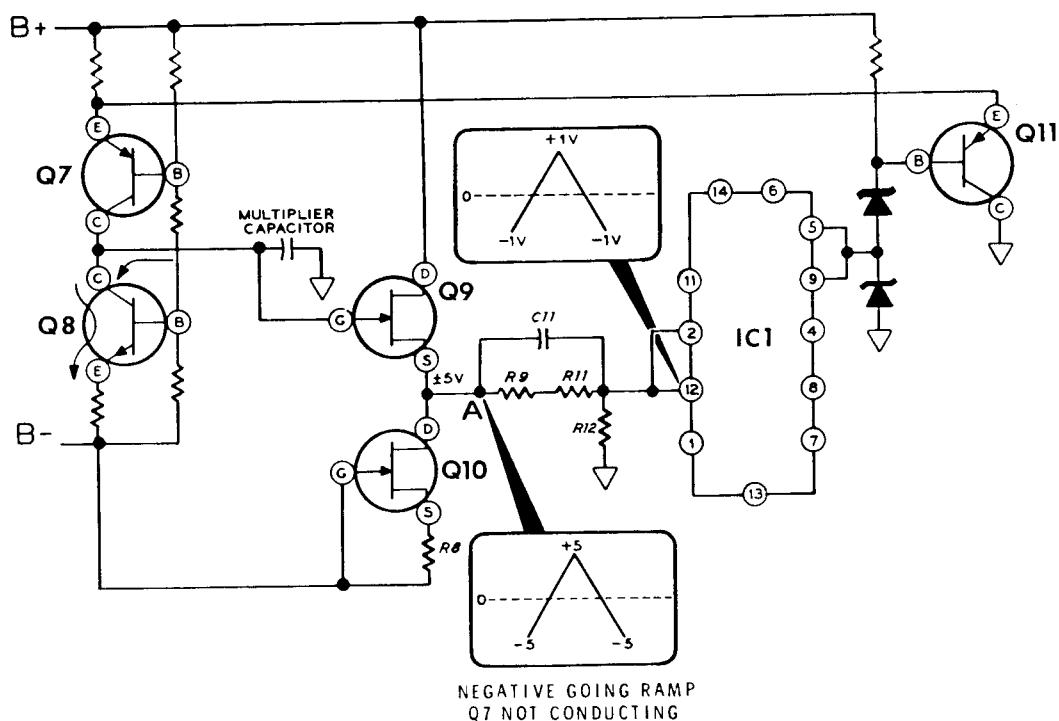


Figure 7

SQUARE WAVE GENERATION

Each time IC1 switches, the voltage at pins 5 and 9 of IC1 goes from .4 volt to 5 volts or from 5 volts to .4 volt. This sudden voltage change is a square wave of the same frequency as the triangle wave. The square wave is coupled to transistor Q12 which amplifies the signal and level translates the signal so its negative and positive excursions are of equal amplitude from the zero reference.

SINE WAVE SHAPING

A sine wave is generated by feeding a triangle wave through resistor R22 to a nonlinear voltage controlled resistance network. That is, as the triangle wave increases in amplitude (negative or positive), the resistance in the network decreases. Conversely, as the amplitude of the triangle wave decreases, the resistance of the network increases. This results in a triangle wave that is rounded off on each extreme, and rounding off more and more as the amplitude increases. This shapes the triangle wave into a sine wave.

The positive side of this voltage-controlled resistance network is made up of transistors Q13 and Q15; resistors R207, R208, R209, R210, R211, R212; and diodes D2, D3, D4, D5, D6, and D7. The negative side of the network is made up of transistors Q14 and Q16; resistors R201, R202, R203, R204, R205, and R206; and diodes D8, D9, D10, D11, D12, and D13.

Since the negative side of the shaper works the same as the positive side, except in a negative direction, only the positive side will be discussed.

Transistors Q13 and Q15 set the positive bias levels to the resistance network. Resistors R207, R208, R209, R210, R211, and R212 form a voltage divider. This voltage divider reverse biases diodes D7, D6, D5, D4, D3, and D2 with different amounts of reverse bias on each diode.

As the positive half of the triangle waveform begins to rise in amplitude, the reverse bias on diode D7 is overcome and the diode begins to conduct. This changes the total resistance of the network and the triangle wave shape is changed slightly. As the amplitude of the triangle wave continues to increase in amplitude, each diode in turn begins to conduct and change the total resistance of the network and to round off more at the top.

As the amplitude decreases, each diode now stops conducting as its reverse bias point is reached and the trailing edge of the positive half of the sine wave is formed.

OUTPUT AMPLIFIER

Transistor Q17 reduces the loading on the sine wave shaper and the triangle generator circuit. Transistor Q18 provides temperature compensation for Q17 and capacitor C17 eliminates high frequency switching transients from the waveforms.

Transistors Q19 and Q20 form a differential amplifier. This amplifier drives voltage amplifier Q21. From transistor Q21 the generator signal is coupled to transistor Q22 and through diode D14 to transistor Q24. This complementary emitter follower circuit provides the low output impedance necessary for driving a 50-ohm load.

Resistors R39 and R47 provide negative feedback from the output to the base of transistor Q20. This further reduces the output impedance and increases the input impedance to a point where the loading on Variable Attenuator R33 is insignificant.

Transistor Q23 acts as a constant current source in order to improve both the common mode rejection and power supply rejection of the amplifier. Resistor R47 in conjunction with the output impedance of the amplifier provides the 50-ohm impedance necessary to properly match the 50-ohm load.

The output attenuator is made up of three 50-ohm resistance networks. Switch SW3 connects these networks in varying combinations to provide discrete 10 dB steps from 0 dB to 50 dB.

POWER SUPPLY

Transformer T1 has two primary windings which are connected through switch SW4 to provide operation on either 120 VAC or 240 VAC supplies. The reduced AC voltage is rectified by diodes D15, D16, D17, and D18 and filtered by capacitors C24 and C25. This produces a negative and a positive 25 volt supply which is used to power the output amplifier and voltage regulator circuits.

Integrated circuit IC2 is a voltage regulator which supplies +15V to the generator circuits. The -15V volts for the generator circuits is derived from the -25 volts by a discrete voltage regulator. Transistor Q25 is the series pass element with the -15 volts taken from its emitter.

Transistors Q27 and Q28 form a difference amplifier which compares the difference between the +15 volts and ground, and the -15 volts and ground. Any detected difference is amplified by transistor Q26 and coupled back to transistor Q25. Thus the -15 volt supply will stay exactly equal in potential but opposite in polarity to the +15 volt supply.

Resistors R15, R18, and zener diodes ZD1, ZD5, supply the positive and negative 5 volts needed to operate IC1.

INTRODUCTION

The SG-1271 Function Generator is a high quality test instrument that will produce sine, square, and triangle waveforms over a frequency range of .1 Hz to 1 MHz. This wide range of frequencies is divided into six ranges, and each range is variably controlled over a 100 to 1 frequency ratio.

The output supplies a 10-volt peak-to-peak signal into a 50 ohm load and features a calibrated attenuator that is

adjustable in 10 dB steps, from 0 to 50 dB. Also included is a continually variable attenuator that provides up to 20 dB additional attenuation.

The compact size and light weight make the Generator easily moved and allow it to be set almost anywhere.

SPECIFICATIONS

Frequency Range1 Hz to 1 MHz.
Frequency Accuracy	±3% of full scale on dial.
Functions	
Triangle Waveform	Nonlinearity, 5% maximum. Symmetry within 10% of 50% duty cycle.
Square waveform	100 nsec maximum rise or fall time. Symmetry within 10% of 50% duty cycle.
Sine waveform	Harmonic distortion, 3% maximum, 5 Hz to 100 kHz.
Attenuator	0 to 50 dB in 10 dB steps. 0 to 20 dB minimum variable. ± 1 dB accuracy.
Output	10 volts peak-to-peak into 50 ohms. 50 ohms impedance ±5%. ±1.5 dB flatness from .1 Hz to 1 MHz.
Power Requirements	105-130 volts or 210-260 volts RMS, 50-60 Hz. 15 watts maximum.
Operating Temperature	0 to 40°C ambient.
Dimensions	8-7/8" deep, 7-1/4" wide, 3" high (with handle removed).
Net Weight	4.2 lbs.

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

OPERATION

NOTE: For best results in the square wave mode, the generator output should be connected through a 50 Ω coaxial line to a 50 Ω load.

Refer to Figure 1 for the location of the controls and connector described below.

FREQUENCY DIAL – Adjusts the frequency over a 100 to 1 ratio.

FREQUENCY MULTIPLIER – This multiplies the frequency range over which the frequency dial operates. Using both the frequency multiplier and the frequency dial, you can select any frequency from 0.1 Hz to 1 MHz.

FUNCTION – This switch selects a sine wave, square wave, or triangle wave signal and connects it to the output.

ATTENUATION (dB) – This switch provides six steps of attenuation that add 10 dB of attenuation per step.

VARIABLE/PWR OFF – This switch applies or removes power from the Generator circuits. Also further rotation of this control will provide decreased attenuation of the output signal.

OUTPUT 50 Ω – This provides a signal output matched for a 50 Ω load.

ATTENUATION-OUTPUT CHART

This chart shows comparative generator output voltage divisions with each setting of the attenuation control. Each division is made using zero attenuation output as a reference (variable attenuation set for 10V P-P output). For example: If your generator output with zero attenuation is 10 volts peak-to-peak, this same output will be 1 volt peak-to-peak with 20 dB attenuation. $10V\ P-P \div 10 = 1\ volt\ P-P$ (second line on chart).

ATTENUATION (dB)	DIVIDE ZERO ATTENUATION OUTPUT BY:	OUTPUT VOLTAGES INTO A 50 Ω LOAD
0 dB	1.0	10 V P-P
10 dB	3.16	3.16 V P-P
20 dB	10	1 V P-P
30 dB	31.6	.316 V P-P
40 dB	100	.1 V P-P
50 dB	316	.0316 V P-P

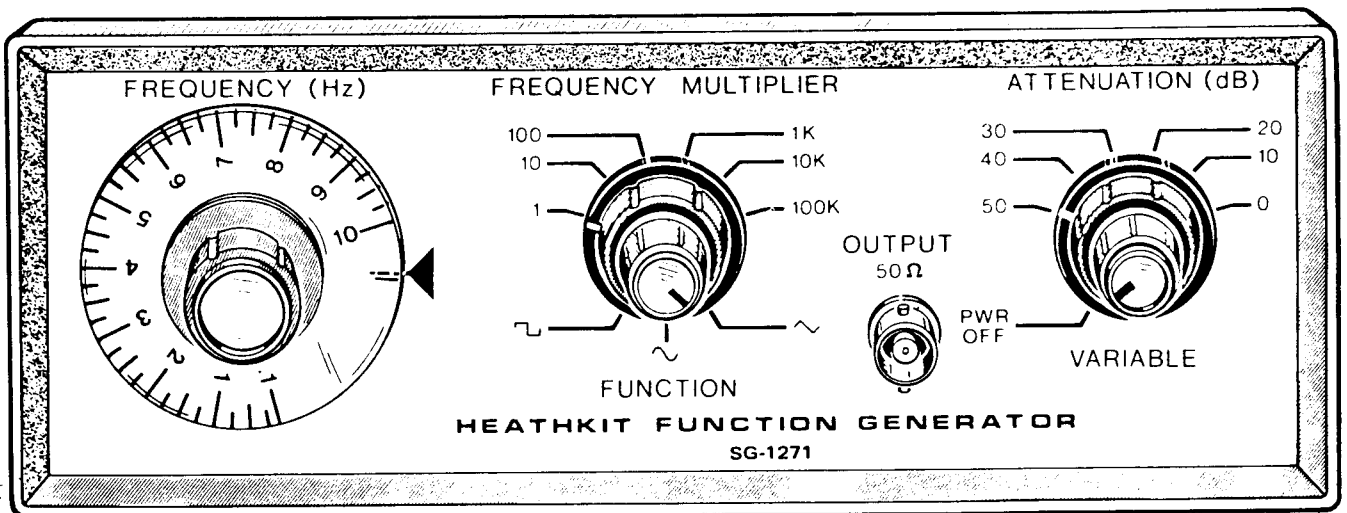


Figure 1

120 VAC-240 VAC OPERATION

When shipped, this instrument is ready for operation from a 105-130 volt AC source. If 210-260 volt operation is desired, remove the top cover of the Generator and move the slide in switch SW4 (120-240 switch) so that the number 240 (240 VAC) is showing. Remove the 1/8-ampere fuse and replace it with the 1/16-ampere fuse supplied. (See Figure 2.) The unit can now be operated from a 240 VAC source.

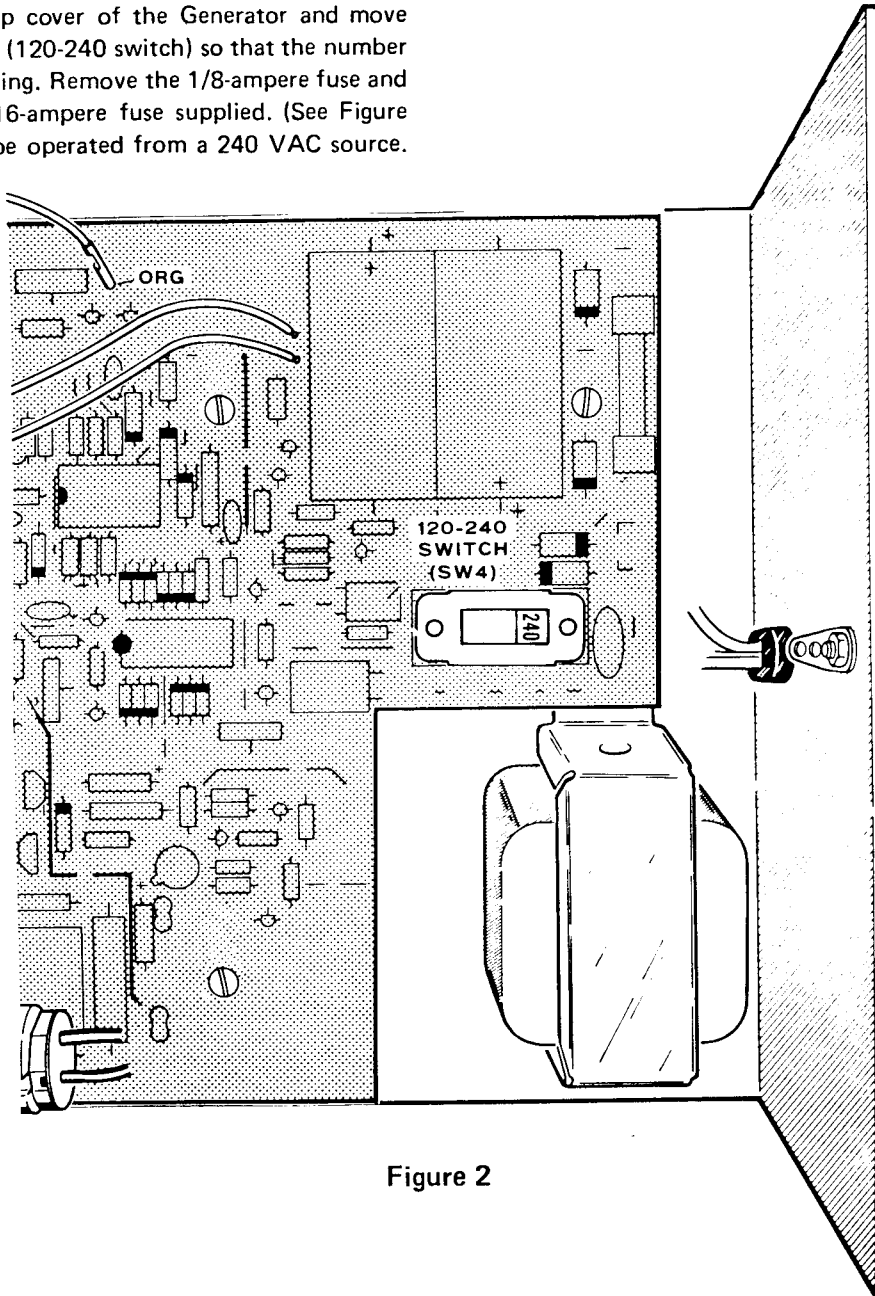


Figure 2

RECALIBRATION

Your Function Generator comes to you completely calibrated and ready for use. If you feel that your Generator is in need of recalibration after some time, you can send the unit to the Heath Company or take it to any Heathkit Electronic Service Center. If you wish to recalibrate the Generator yourself, and the proper equipment is available, use the following procedure.

CAUTION: Dangerous AC voltage present around the line cord leads on the circuit board and on the back of switch SW3 (see Figure 3). Keep your hands clear of these areas as you make the calibration adjustments.

Equipment needed:

- Oscilloscope.
- Frequency counter.
- Distortion analyzer.

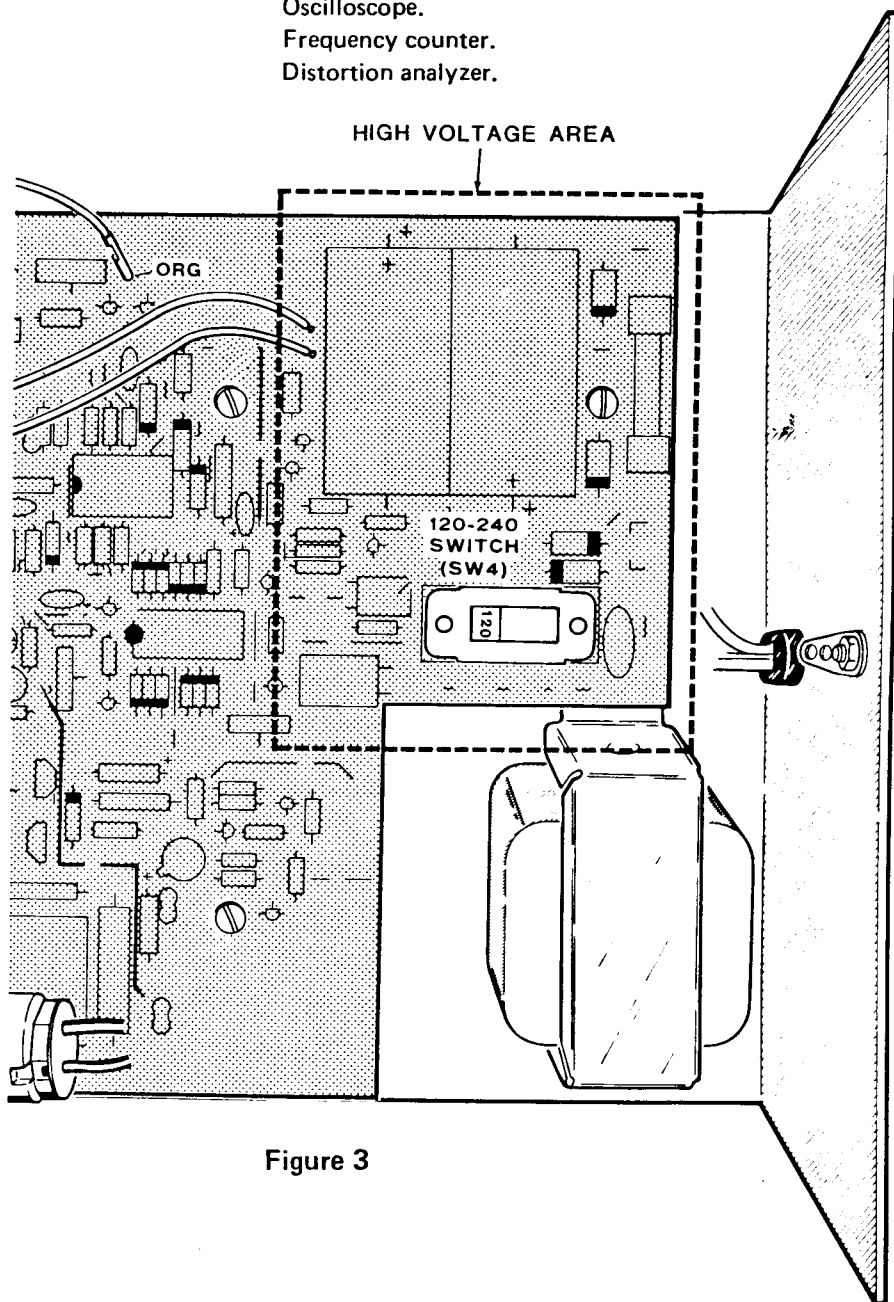



Figure 3

() Refer to Figure 4 and connect the oscilloscope and the frequency counter to the Function Generator.

Set the front panel controls on the Function Generator as follows:

- () ATTENUATION (dB) (black knob) to 10.
- () FREQUENCY MULTIPLIER (black knob) to 1 k.
- () FUNCTION (red knob) to 
- () FREQUENCY (Hz) dial to 0.1.

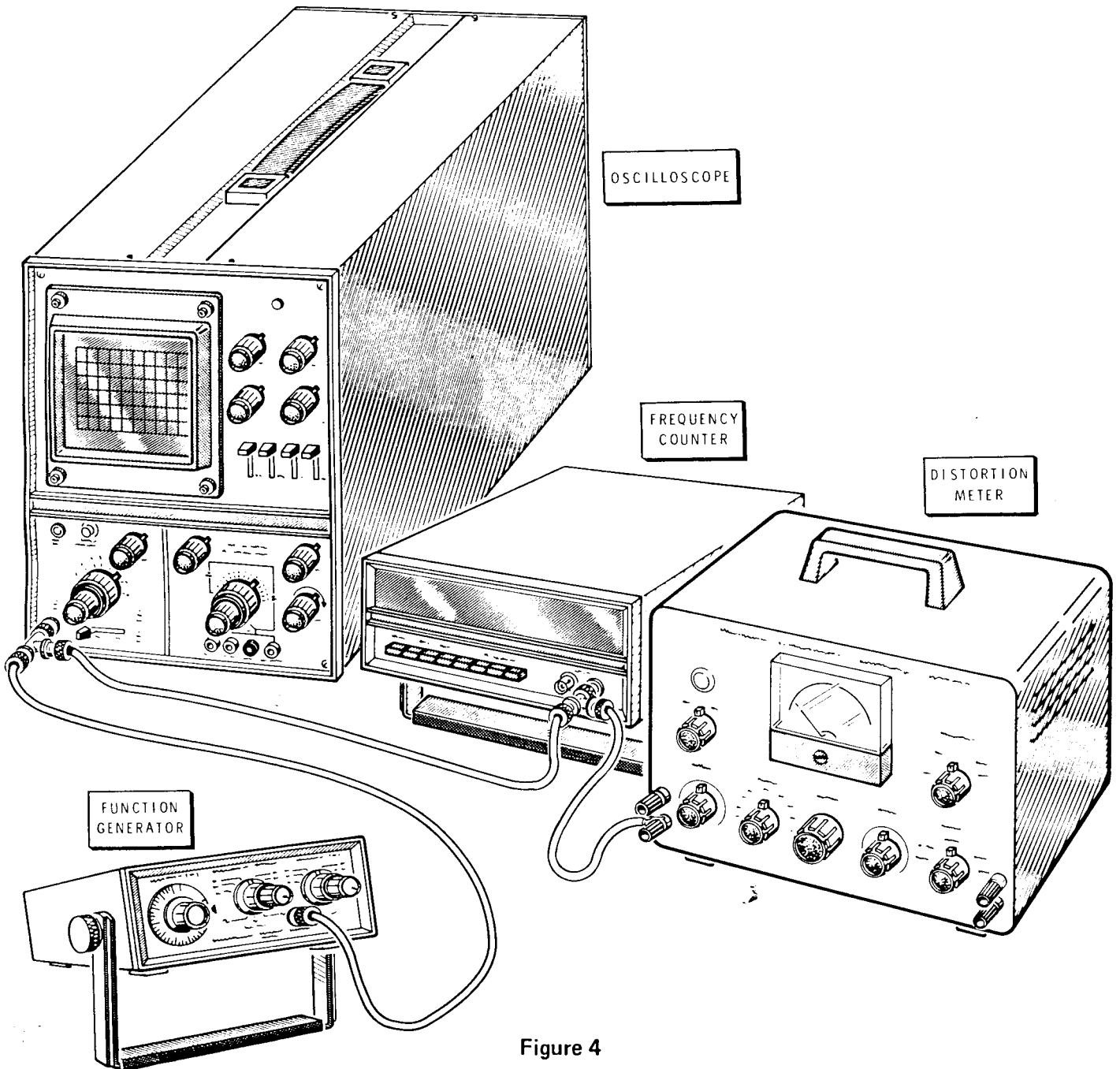


Figure 4

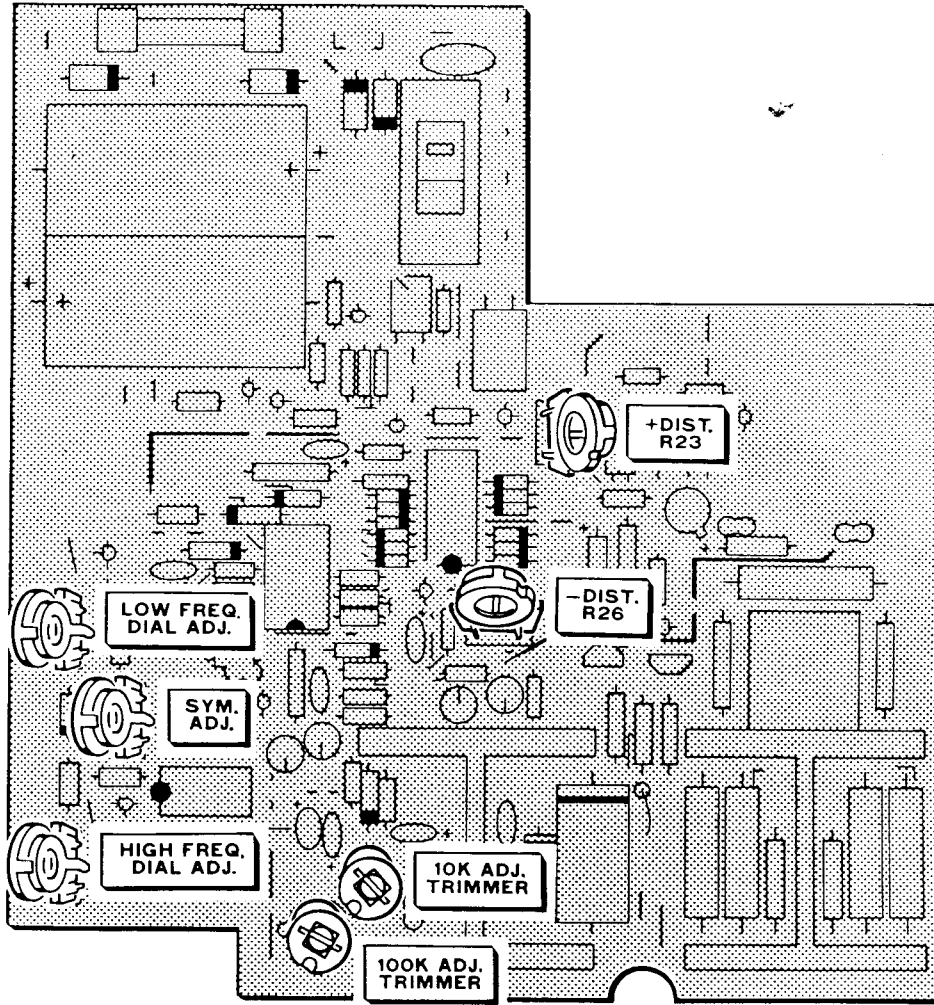


Figure 5

Refer to Figure 5 for the following steps.

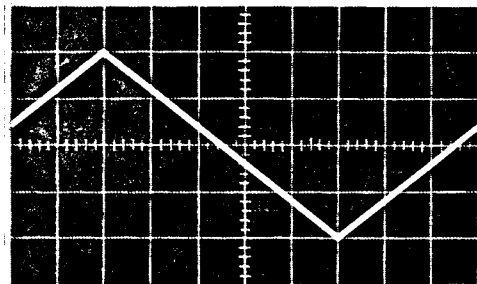
2. () Adjust the oscilloscope to obtain the following trace. NOTE: It may be necessary to adjust the LOW FREQUENCY DIAL ADJ to obtain this trace.

Set the controls on the circuit board as follows:

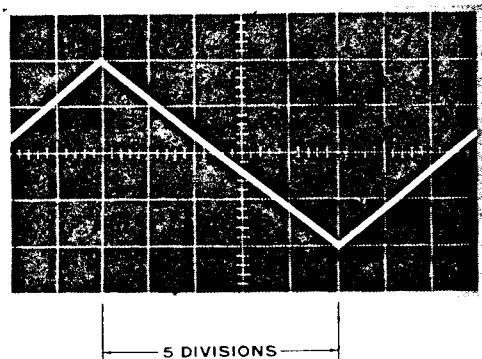
- () HIGH FREQ DIAL ADJ to the center of rotation.
- () LOW FREQ DIAL ADJ to the center of rotation.
- () SYM ADJ to the center of rotation.
- () - DIST (R26) to the center of rotation.
- () + DIST (R23) to the center of rotation.

- () Turn the equipment on and let it warm up.

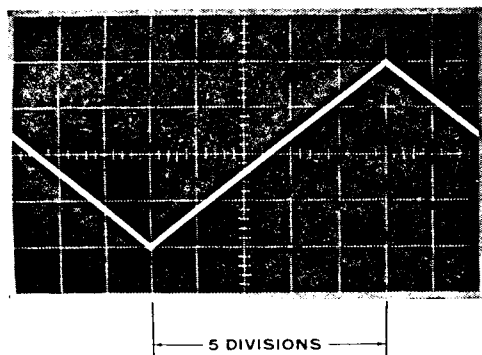
1. () Set the oscilloscope TIME/DIV switch to 1m SEC/DIV.



3. () Turn the LOW FREQ DIAL ADJ control on the circuit board so that the negative going ramp covers five divisions.



4. () Now turn the SYM ADJ control on the circuit board so that the positive going ramp covers five divisions.



5. () Set the FREQUENCY (Hz) dial on the front panel of the Generator to 10.
6. () Turn the HIGH FREQ DIAL ADJ control on the circuit board until the frequency counter reads 10 kHz.
7. () Set the FREQUENCY (Hz) dial (R301) on the front panel of the Generator to 0.1.
8. () Now turn LOW FREQ DIAL ADJ (R2) for 100 Hz on the frequency counter.
9. () Repeat steps 1 through 8 twice more. The adjustment of the Low Frequency Dial Adj control and the Sym Adj control interact and have a direct relation to the amount of distortion out of the Generator. Therefore do these adjustments carefully.

10. () Set the FREQUENCY (Hz) dial (R301) on the front panel of the Generator to 10.
11. () Set the FREQUENCY MULTIPLIER on the front panel of the Generator to 10 k.
12. () Turn the 10 k ADJ trimmer on the circuit board until the frequency counter reads 100 kHz.
13. () Set the FREQUENCY MULTIPLIER on the front panel of the Generator to 100 k.
14. () Turn the 100 k ADJ trimmer on the circuit board until the frequency counter reads 1 MHz.
- () Disconnect the oscilloscope and frequency counter from the Generator. These instruments will not be used any more.

DISTORTION ADJUSTMENT

Set the Generator front panel controls as follows:

- () FUNCTION switch to \sim .
- () FREQUENCY MULTIPLIER to 10 k.
- () FREQUENCY (Hz) dial to 0.1.
- () Connect the distortion analyzer to the Function Generator output.
- () Adjust controls +DIST (R23) and -DIST (R26) on the circuit board to obtain minimum distortion.

This completes the calibration of your Function Generator. Turn the equipment off and disconnect the line cord plugs from the AC sockets. Then disconnect the distortion analyzer from the Generator. Proceed to "Final Assembly."