

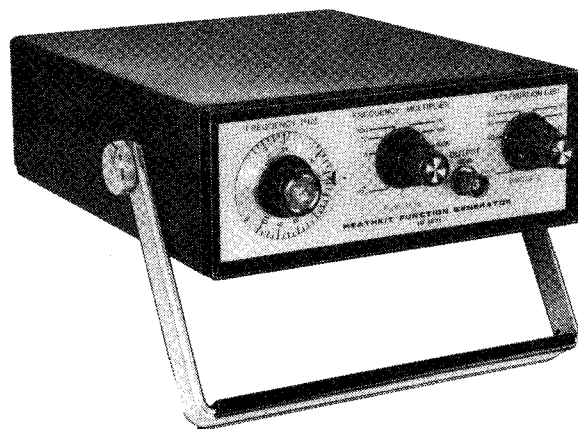
# Heathkit® Manual

for the

## FUNCTION GENERATOR

Model IG-1271

595-1655-13



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**HEATH COMPANY**  
BENTON HARBOR, MICHIGAN 49022

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## INTRODUCTION

The IG-1271 Function Generator is a quality test instrument that will produce sine, square, and triangle waveforms over a frequency range of 0.1 Hz to 1 MHz. This wide range of frequencies is divided into six smaller 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.

Most of the components are mounted on one circuit board which makes this unit easy to assemble. The compact size and light weight allows the Generator to be easily moved and allows it to be set almost anywhere.

Refer to the "Kit Builders Guide" for information on tools, wiring, soldering, and parts identification.

## PARTS LIST

Check each part against the following list. Make a check (✓) in the space provided as you identify each part. Any part that is packed in an individual envelope with a part number on it should be placed back in the envelope after you identify it until it is called for in a step. Do not throw away any packing material until all parts are accounted for.

To order a replacement part, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of the Manual. For pricing information, refer to the separate "Heath Parts Price List."

Each circuit part in this kit has its own component number (R2, C4, etc.). Use these numbers when you want to positively identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

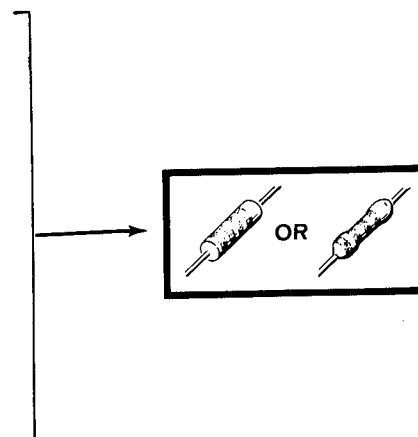
- In the Parts List,
- At the beginning of each step where a component is installed,
- In some illustrations,
- In the Schematic,
- In the sections at the rear of the Manual.

QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
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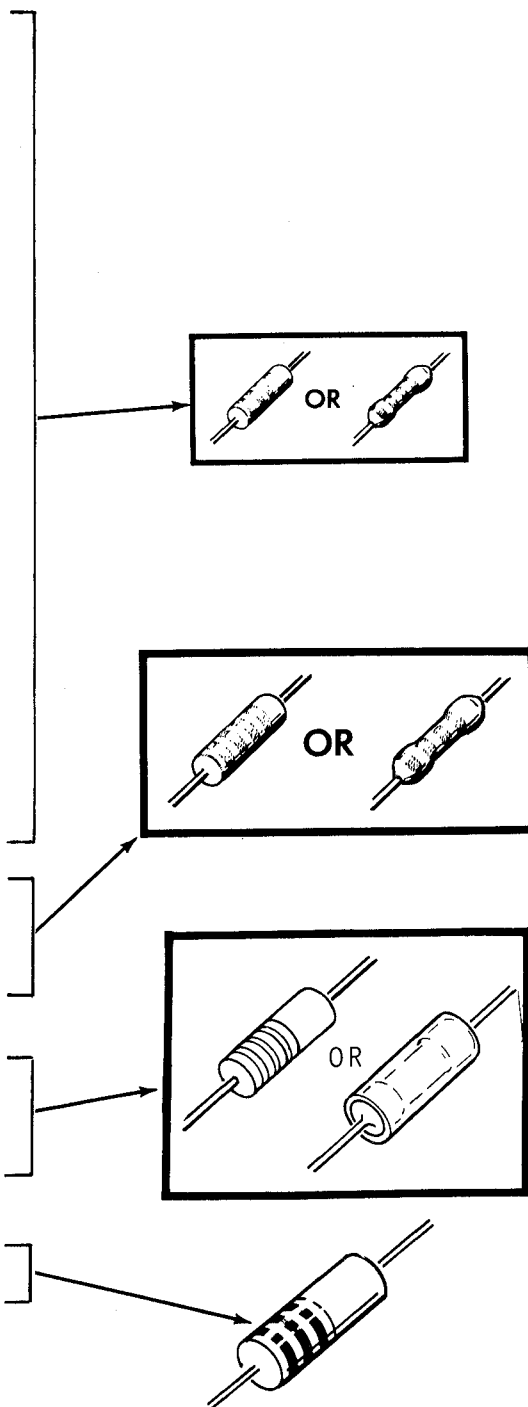
### RESISTORS

#### 1/4-Watt

(✓)	2	2.2 Ω, 5% (red-red-gold-gold)	6-229-12	R1, R3
(✓)	2	47 Ω, 5% (yellow-violet-black-gold)	6-470-12	R36, R37
(✓)	2	150 Ω, 5% (brown-green-brown-gold)	6-151-12	R31, R61
(✓)	1	220 Ω, 5% (red-red-brown-gold)	6-221-12	R8
(✓)	2	330 Ω, 5% (orange-orange-brown-gold)	6-331-12	R19, R35
(✓)	1	470 Ω, 5% (yellow-violet-brown-gold)	6-471-12	R20
(✓)	1	560 Ω, 5% (green-blue-brown-gold)	6-561-12	R21



QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
<b>RESISTORS (Cont'd.)</b>			
(✓)	1 620 Ω, 5% (blue-red-brown-gold)	6-621-12	R63
(✓)	1 680 Ω, 5% (blue-gray-brown-gold)	6-681-12	R38
(✓)	1 820 Ω, 5% (gray-red-brown-gold)	6-821-12	R41
(✓)	2 1000 Ω, 5% (brown-black-red-gold)	6-102-12	R22, R34
(✓)	2 2200 Ω, 5% (red-red-red-gold)	6-222-12	R12, R62
(✓)	1 2400 Ω, 5% (red-yellow-red-gold)	6-242-12	R9
(✓)	1 3600 Ω, 5% (orange-blue-red-gold)	6-362-12	R39
(✓)	2 4700 Ω, 5% (yellow-violet-red-gold)	6-472-12	R11, R43
(✓)	1 6800 Ω, 5% (blue-gray-red-gold)	6-682-12	R65
(✓)	2 8200 Ω, 5% (gray-red-red-gold)	6-822-12	R25, R28
(✓)	1 18 kΩ, 5% (brown-gray-orange-gold)	6-183-12	R42
(✓)	1 22 kΩ, 5% (red-red-orange-gold)	6-223-12	R64
(✓)	1 47 kΩ, 5% (yellow-violet-orange-gold)	6-473-12	R5
<b>1/2-Watt</b>			
(✓)	2 15 Ω, 5% (brown-green-black-gold)	6-150	R45, R46
(✓)	1 510 Ω, 5% (green-brown-brown-gold)	6-511	R15
<b>1-Watt</b>			
(✓)	1 330 Ω, 5% (orange-orange-brown-gold)	1-60-1	R18
(✓)	1 1500 Ω, 10% (brown-green-red-silver) <i>7 yll</i>	1-22-1	R44
<b>2-Watt</b>			
(✓)	1 47 Ω (yellow-violet-black)	1-41-2	R47



QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
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**RESISTORS (Cont'd.)****Precision, 1%**

All color coded 1% resistors have five color bands (last band brown). This brown band is set apart from the other bands. The last band (brown) will not be called out. Some 1% resistors have the value rather than color bands marked on them.

NOTE: Precision resistors vary in size physically.

(✓)	~2	51.0 $\Omega$ (green-brown-black-gold), 1-watt	6-5109-1	R54, R56
(✓)	~2	61.1 $\Omega$ (blue-brown-brown-gold), 1-watt	6-6119-1	R51, R53
(✓)	1	71.2 $\Omega$ (violet-brown-red-gold), 1-watt	6-7129-1	R58
(✓)	~2	96.3 $\Omega$ (white-blue-orange-gold), 1/2-watt	6-9639	R57, R59
(✓)	1	248 $\Omega$ (red-yellow-gray-black), or, 247.5 $\Omega$ (printed on the resistor), 1/2-watt	6-2480	R52
(✓)	~4	1000 $\Omega$ (brown-black-black-brown), 1/4-watt	6-1001-12	R13, R16, R24, R27
(✓)	1	2500 $\Omega$ (red-green-black-brown), 1/4-watt	6-2501-12	R55
(✓)	1	4530 $\Omega$ (yellow-green-orange-brown), 1/4-watt	6-4531-12	R29
(✓)	~4	14.3 k $\Omega$ (brown-yellow-orange-red), 1/4-watt	6-1432-12	R14, R17, R66, R67
(✓)	1	16 k $\Omega$ (brown-blue-black-red), 1/4-watt	6-1602-12	R103
(✓)	1	24 k $\Omega$ (red-yellow-black-red), 1/4-watt	6-2402-12	R102
(✓)	1	48 k $\Omega$ (yellow-gray-black-red), 1/4-watt	6-4802-12	R101

**RESISTOR MODULES**

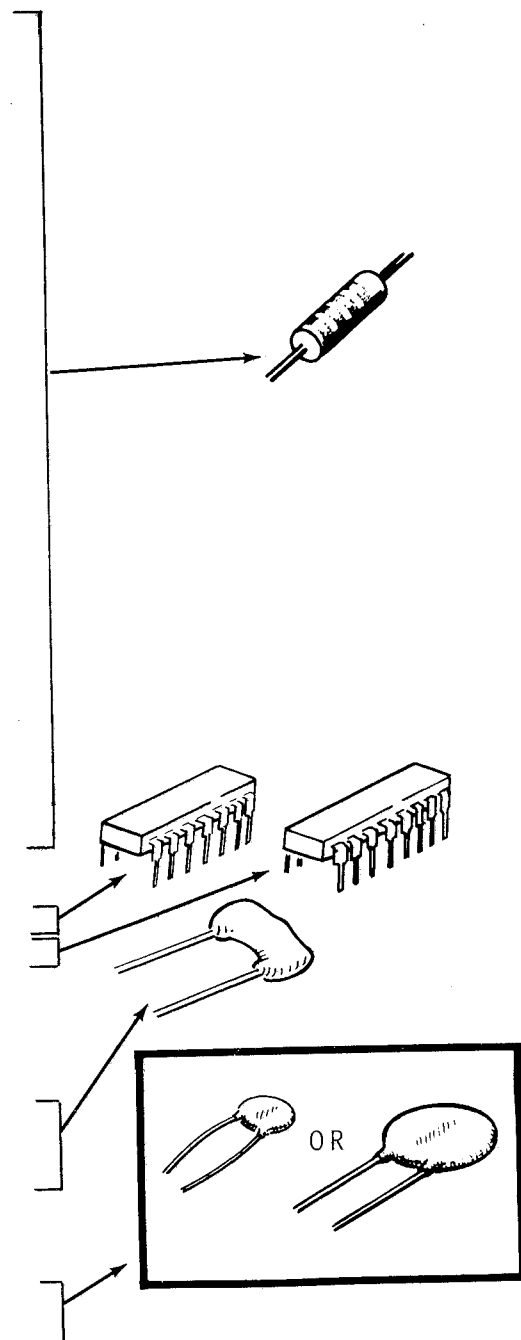
(✓)	1	14-pin module	9-61	RP1
(✓)	1	18-pin module	9-62	RP2

**CAPACITORS****Mica**

(✓)	~2	42 pF	20-174	C16, C17
(✓)	1	56 pF	20-78	C20
(✓)	1	430 pF	20-133	C5

**Disc**

(✓)	1	15 pF	21-111	C11
(✓)	1	.01 $\mu$ F 1.6 kV	21-42	C23



QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
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## Capacitors (cont'd.)

### Electrolytic

(✓)	3	2.2 $\mu$ F, 15V tantalum	25-195	C12, C13, C26
(✓)	2	2.2 $\mu$ F, 50V tantalum	25-180	C19, C21
(✓)	7	10 $\mu$ F	25-917	C1, C2, C14, C15, C18, C27, C28
(✓)	2	1500 $\mu$ F	25-208	C24, C25

### Mylar\*

(✓)	1	6800 pF (.0068)	27-42	C102
(✓)	1	3300 pF (.0033)	27-68	C101
(✓)	1	.01 $\mu$ F	27-106	C103

### Other

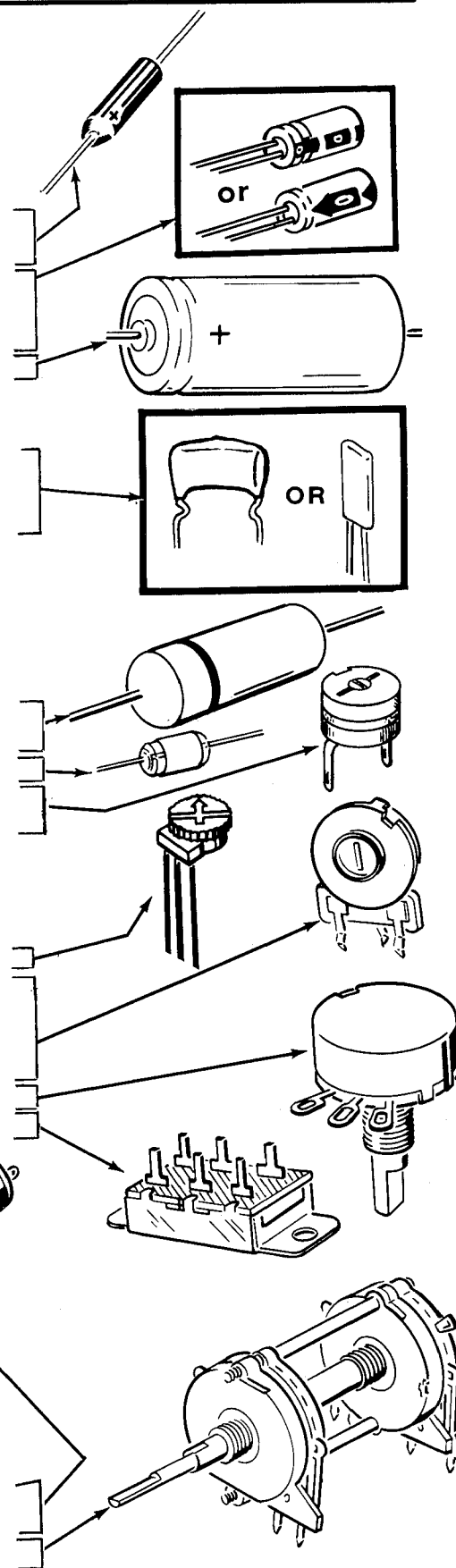
(✓)	1set	Mylar* (four matched capacitors)	27-119	C6, C7, C8, C9
(✓)	1	2700 pF polystyrene	29-3	C22
(✓)	1	Ceramic trimmer (8-50)	31-36	C3
(✓)	1	Ceramic trimmer (10-75)	31-78	C4

## CONTROLS-SWITCHES

(✓)	1	500 $\Omega$ control w/leads	10-1174	R32
(✓)	1	300 $\Omega$ control	10-949	R7
(✓)	1	750 $\Omega$ control	10-295	R4
(✓)	1	1000 $\Omega$ control	10-936	R2
(✓)	2	2000 $\Omega$ (2 k) control	10-398	R23, R26
(✓)	1	1000 $\Omega$ (1 k) control	10-1001	R301
(✓)	1	Slide switch	60-68	SW4

(✓)	1	Rotary switch with control	63-696	SW3/R33
(✓)	1	Rotary switch	63-697	SW1/SW2

\*DuPont registered trademark



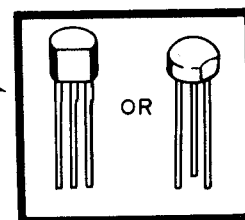
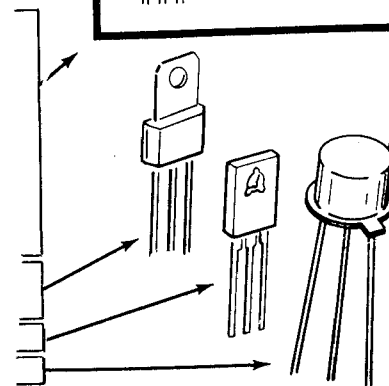
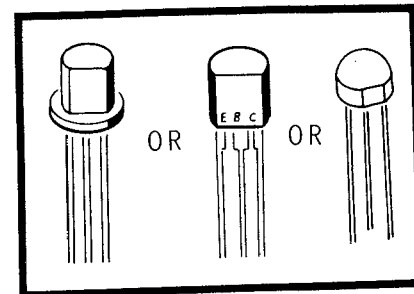
QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
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## TRANSISTORS

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways.

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers; the letters may be different or missing.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

(✓)	1	X29A829	417-201	Q26
(✓)	1	2N5249A	417-213	Q4
(✓)	-10	2N4121	417-235	Q2, Q3, Q5, Q7, Q11, Q12, Q14, Q16, Q27, Q28
(✓)	-8	MPSA20	417-801	Q1, Q6, Q8, Q13, Q15, Q19, Q20, Q23
(✓)	1	MPSU05	417-224	Q22
(✓)	1	MPSU55	417-225	Q24
(✓)	1	SJE607	417-263	Q25
(✓)	1	SGC5283	417-270	Q21
(✓)	-4	E304 (selected)	417-828	Q9, Q10, Q17, Q18

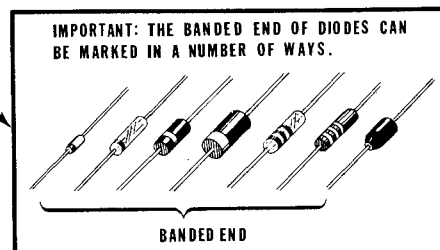
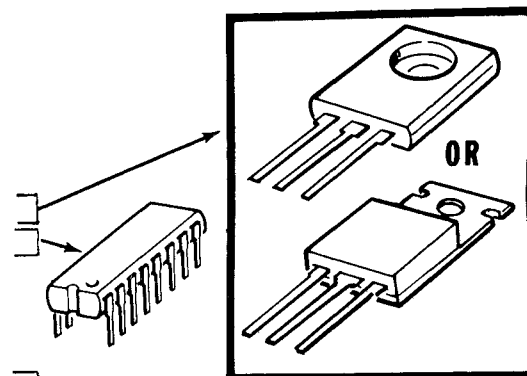


## INTEGRATED CIRCUITS (IC's)

(✓)	1	UA7815	442-63	IC2
(✓)	1	75107	442-73	IC1

## DIODES

(✓)	2	1N751 zener	56-16	ZD1, ZD5
(✓)	1	1N750 zener	56-59	ZD3
(✓)	-2	1N3017 zener	56-97	ZD2, ZD4
(✓)	-13	1N4149	56-56	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13
(✓)	1	Stabistor	56-61	D14
(✓)	-4	1N4002	57-65	D15, D16, D17, D18



QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
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### LAMP-FUSE

(✓)	1	Lamp	412-72
(✓)	1	1/8-ampere slow-blow fuse	421-26
(✓)	1	1/4-ampere slow-blow fuse	421-33

### CONNECTOR-SOCKET

(✓)	1	BNC connector and hardware	432-758
(✓)	1	IC socket	434-298

### HARDWARE

NOTE: All hardware drawings are actual size.

#### #2 Hardware

(✓)	2	2-56 x 3/16" self-tapping screw	250-212
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#### #4 Hardware

(✓)	1	4-40 x 3/8" screw	250-4
(✓)	1	4-40 nut	252-2
(✓)	1	#4 lockwasher	254-9

#### #6 Hardware

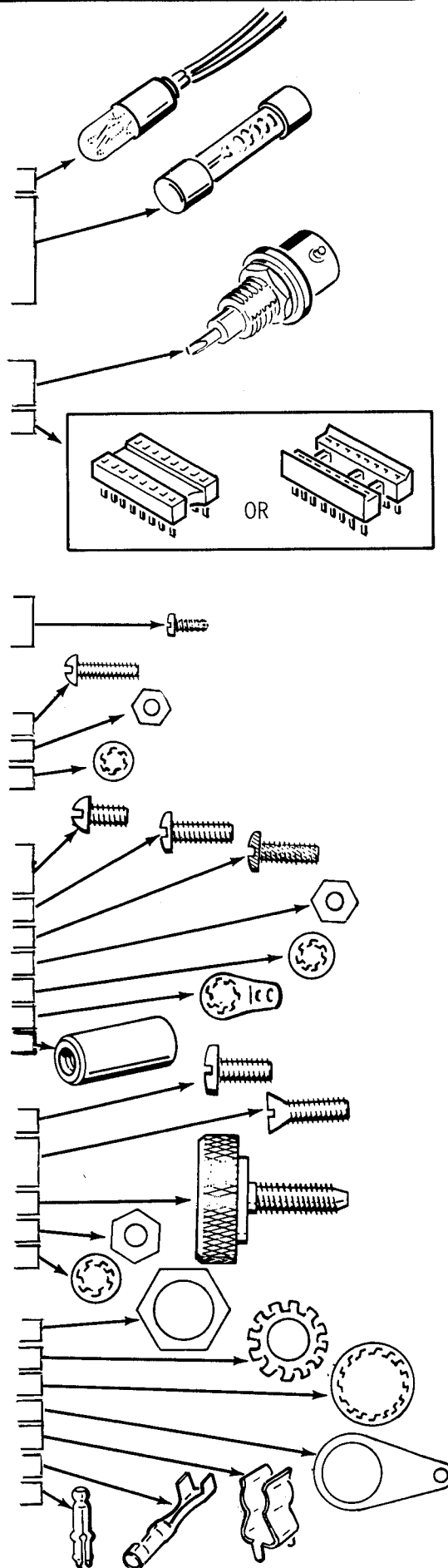
(✓)	1	6-32 x 1/4" round head screw	250-31
(✓)	4	6-32 x 5/16" screw	250-587
(✓)	9	6-32 x 3/8" black screw	250-381
(✓)	2	6-32 nut	252-3
(✓)	5	#6 lockwasher	254-1
(✓)	1	#6 solder lug	259-1
(✓)	4	6-32 x 5/8" spacer	255-142

#### #8 Hardware

(✓)	1	8-32 x 5/16" screw	250-362
(✓)	1	8-32 x 1/2" flat head screw	250-571
(✓)	2	Thumbscrew	250-527
(✓)	2	8-32 nut	252-4
(✓)	2	#8 lockwasher	254-2

#### Other Hardware

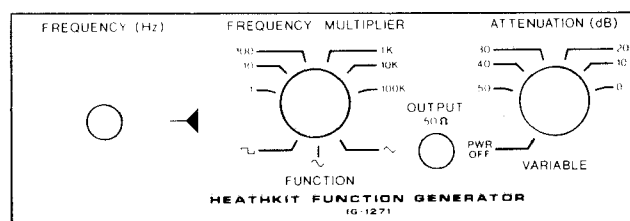
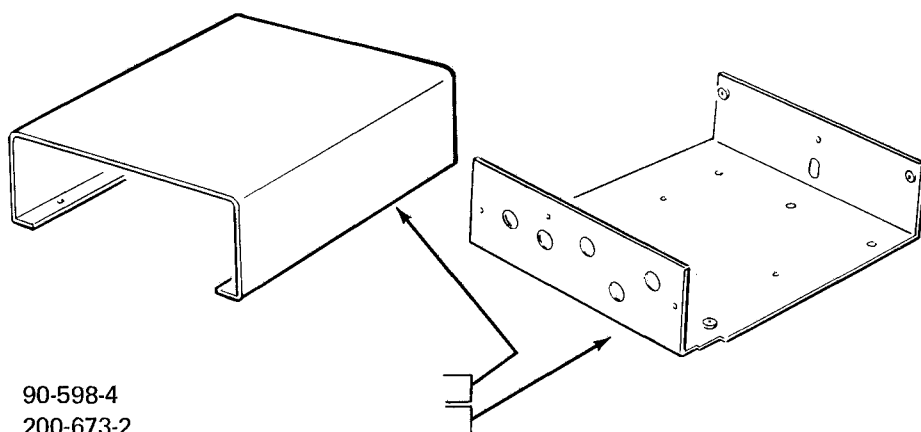
(✓)	5	Control nut	252-76
(✓)	2	1/4" external lockwasher	254-12
(✓)	3	Control lockwasher	254-5
(✓)	1	Control solder lug	259-27
(✓)	2	Fuse clip	260-65
(✓)	5	Female connector	432-120
(✓)	5	Male connector	432-121



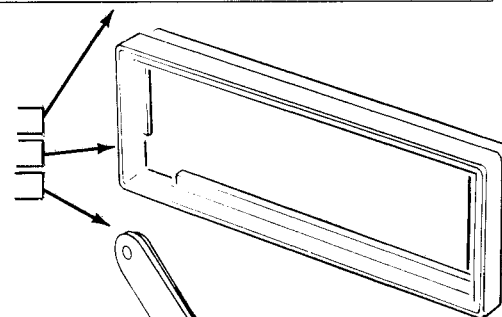
QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
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### CHASSIS AND CABINET PARTS

(✓)	1	Cabinet top	90-598-4
(✓)	1	Chassis	200-673-2

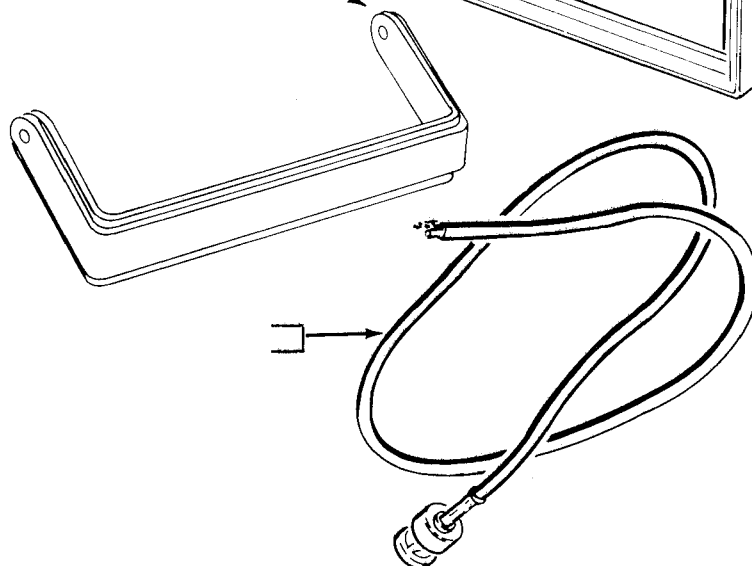


(✓)	1	Plastic front panel	203-1613
(✓)	1	Bezel	210-89
(✓)	1	Handle	211-63



### WIRE-SLEEVING

(✓)	1	Line cord	89-22
(✓)	1	Test cable	134-237
(✓)	1	Bare wire	340-8
(✓)	1	Large orange stranded wire	344-30
(✓)	1	Small orange stranded wire	344-93
(✓)	1	Blue solid wire	344-56
(✓)	1	Blue stranded wire	344-96
(✓)	1	Green stranded wire	344-95
(✓)	1	White-orange wire	344-116
(✓)	1	Small sleeving	346-35
(✓)	1	Large sleeving	346-46





QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
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### KNOBS-BUSHINGS

(✓)	1	Calibrated knob	462-919
(✓)	2	Large knob	462-361
(✓)	2	Small knob	462-363
(✓)	1	Large bushing with large hole	455-50
(✓)	2	Large bushing with small hole	455-71
(✓)	2	Small bushing with large hole	455-613

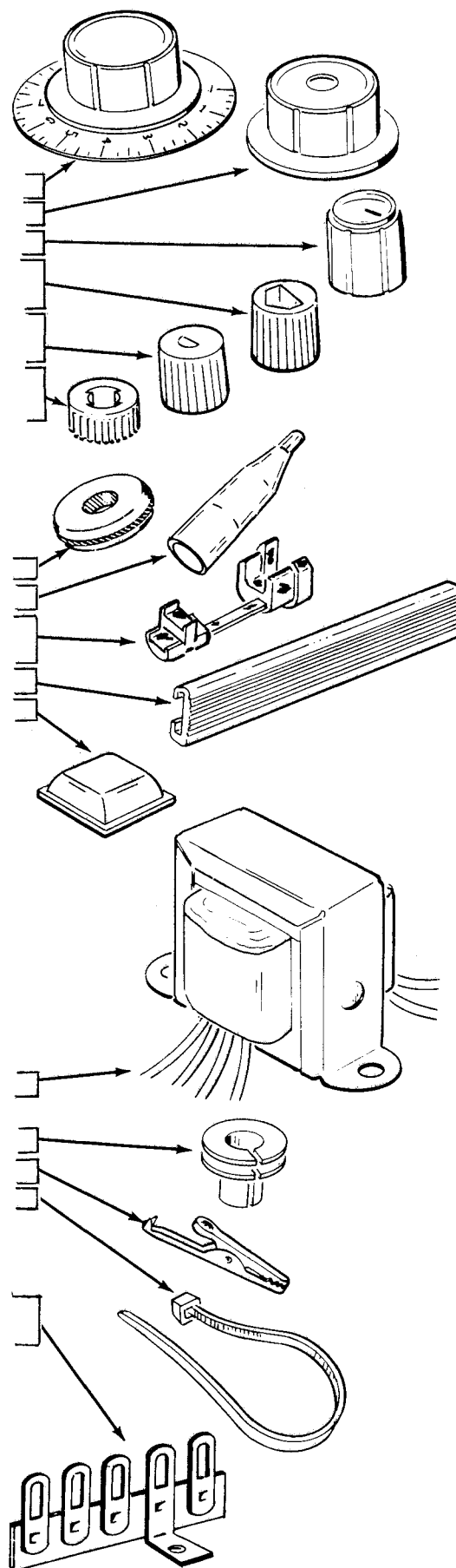
### INSULATORS-FEET

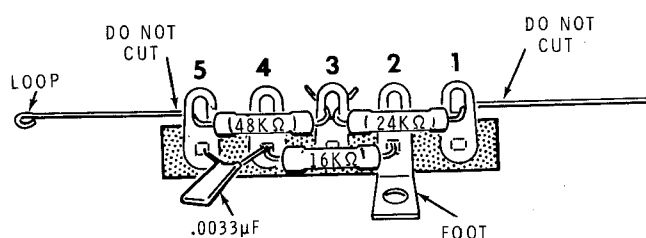
(✓)	1	Rubber grommet	73-1
(✓)	2	Test clip insulator	73-34
(✓)	1	Line cord strain relief	75-182
(✓)	1	Rubber channel strap	211-59
(✓)	4	Plastic foot	261-34

### MISCELLANEOUS

(✓)	1	Power transformer	54-271
(✓)	1	Circuit board	85-2149-3
(✓)	1	Heat sink	215-31
(✓)	2	Alligator clip	260-16
(✓)	1	Cable tie	354-7
(✓)	1	Caution label	390-926
(✓)	1	Blue and white label	391-34
(✓)	1	5-lug terminal strip	431-77
(✓)	1	Parts Order Form	597-260
(✓)	1	Kit Builders Guide	597-308
(✓)	1	Assembly Manual (See Page 1 for part number.)	

Solder



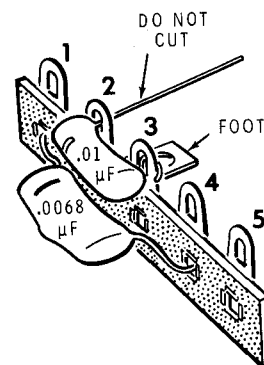


PICTORIAL 2-8

## NOTCH FILTER ASSEMBLY

Refer to Pictorial 2-8 for the following steps.

- (✓) Locate the 5-lug terminal strip and position it as shown with the foot toward you.
- (✓) C101: Connect a .0033  $\mu\text{F}$  Mylar capacitor between the eyelet of lug 5 (S-1) and the eyelet of lug 4 (NS).
- (✓) R103: Connect a 16 k $\Omega$  (brown-blue-black-red), precision resistor between the eyelet of lug 4 (NS) and the eyelet of lug 2 (S-1).
- (✓) R101: Connect a 48 k $\Omega$  (yellow-gray-black-red), precision resistor between lugs 5 (S-1) and 3 (NS). Then bend a loop in the end of the indicated lead. Do not cut this lead off.
- (✓) R102: Connect a 24 k $\Omega$  (red-yellow-black-red), precision resistor between lugs 3 (NS) and 1 (S-1). Do not cut off the lead coming from lug 1.



PICTORIAL 2-9

Refer to Pictorial 2-9 for the following steps.

- (✓) Position the terminal strip so the foot is facing away from you.
- (✓) C102: Connect a .0068  $\mu\text{F}$  Mylar capacitor between the eyelet of lug 1 (S-1) and the eyelet of lug 4 (S-3).
- (✓) C103: Connect a .01  $\mu\text{F}$  Mylar capacitor between lugs 2 (S-1) and 3 (S-3). Do not cut off the lead coming from lug 2.

This completes the notch filter assembly. Temporarily set the notch filter aside and proceed to "Calibration."

## CALIBRATION

### FREQUENCY AND SYMMETRY ADJUSTMENTS

#### CALIBRATION

**NOTE:** The accuracy of the calibration of your Function Generator is dependent upon the accuracy of your oscilloscope.

There are two methods described here for calibrating your Function Generator. Method #1 requires the use of a triggered oscilloscope and a frequency counter. Method #2 requires the use of a triggered oscilloscope only. If you have the required equipment, use Method #1 to calibrate your Function Generator.

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

#### METHOD #1

Equipment needed:

Triggered oscilloscope.  
Frequency counter.

- (✓) Refer to Figure 1-1 (fold-out from Page 33) and connect the oscilloscope and the frequency counter to the Function Generator.

Set the front panel controls on the Generator as follows:

- (✓) ATTENUATION (dB) (SW3; black knob) to 10.
- (✓) FREQUENCY MULTIPLIER (SW1; black knob) to 1k.
- (✓) FUNCTION (SW2; red knob) to  $\sim$ .

Refer to Figure 1-2 (fold-out from Page 33) for the following steps.

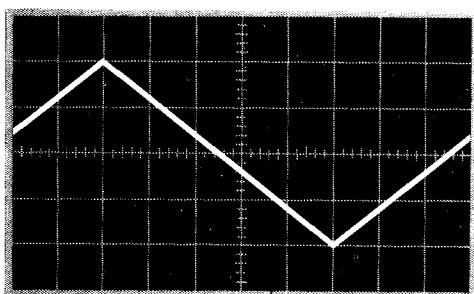
Set the controls on the circuit board as follows:

- (✓) HIGH FREQ DIAL ADJ (R4) to the center of rotation.
- (✓) LOW FREQ DIAL ADJ (R2) to the center of rotation.
- (✓) SYM ADJ (R7) to the center of rotation.

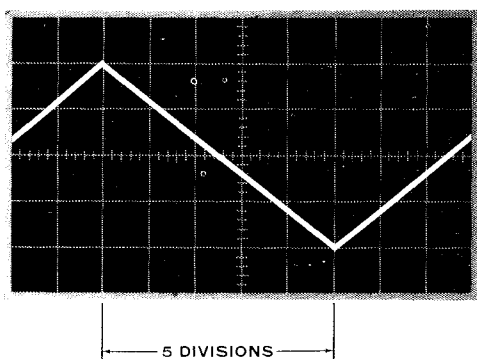
- ( ) Connect the line cords of the Function Generator, oscilloscope, and frequency counter to AC outlets.

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

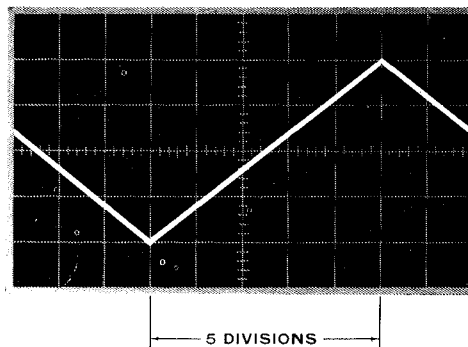
1. (✓) Set the oscilloscope TIME/CM switch to 1 mSEC/DIV.
2. (✓) Set the front panel FREQUENCY (Hz) control (R301) to 0.1.
3. (✓) Adjust the oscilloscope to obtain the following trace. NOTE: It may be necessary to adjust the LOW FREQUENCY DIAL ADJ to obtain this trace.



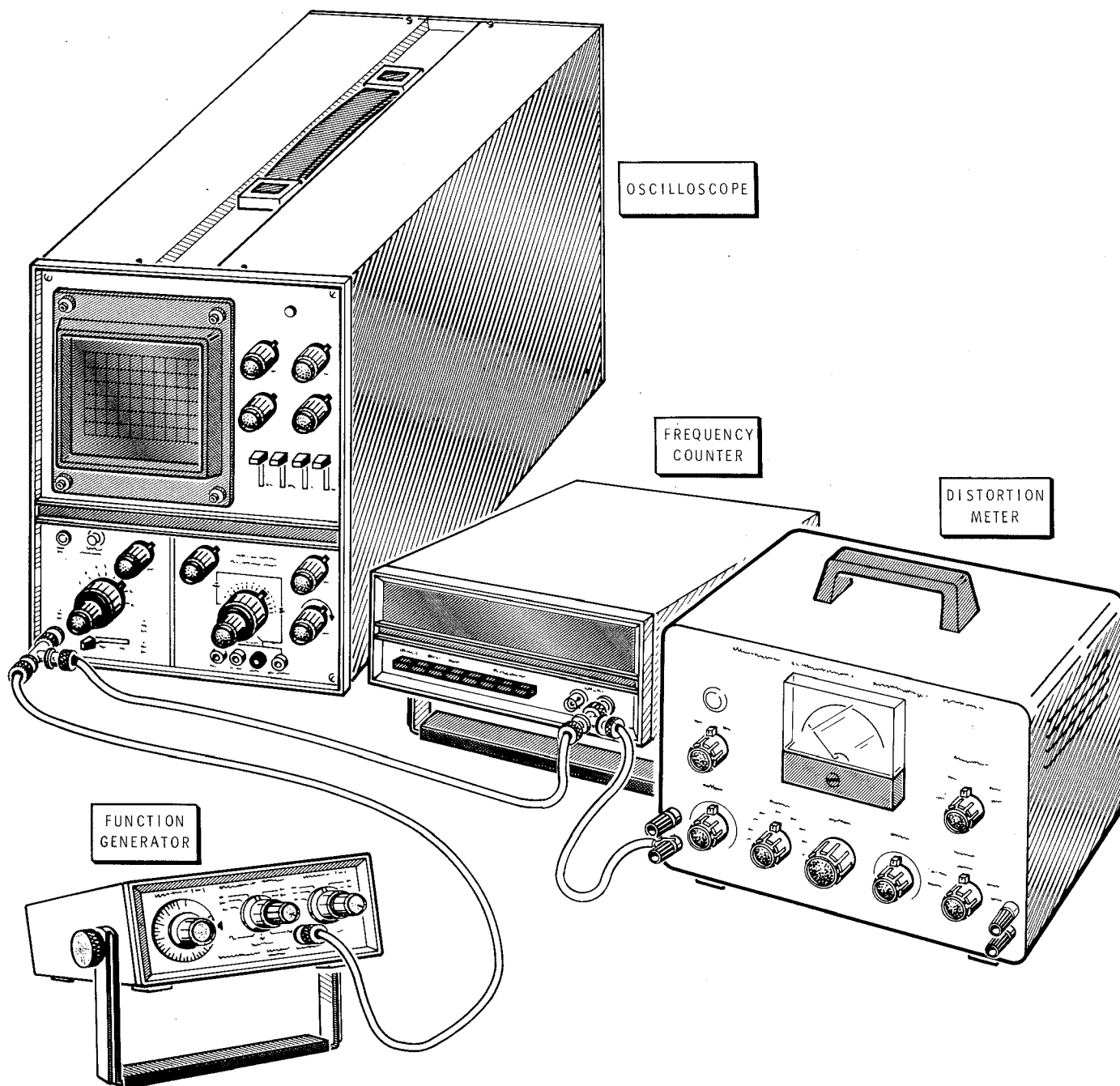
4. (✓) Turn the LOW FREQ DIAL ADJ control (R2) on the circuit board so that the negative going ramp covers five divisions.



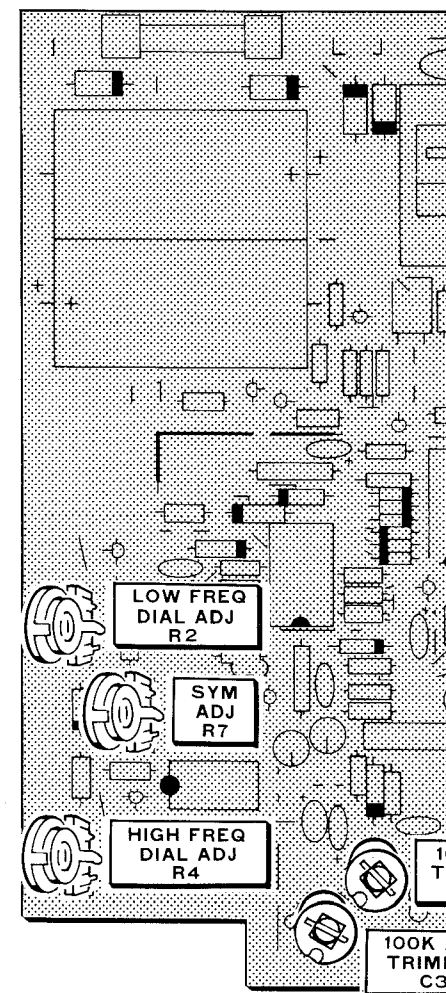
5. (✓) Now turn the SYM ADJ control (R7) on the circuit board so that the positive going ramp covers five divisions.



6. (✓) Turn DC OFFSET ADJ control R32 to move the wave-shape so it is equally positioned above and below the zero reference line on the oscilloscope.
7. (✓) Set the FREQUENCY (Hz) dial (R301) on the front panel of the Generator to 10.
8. (✓) Turn the HIGH FREQ DIAL ADJ control (R4) on the circuit board until the frequency counter reads 10 kHz.
9. ( ) Set the FREQUENCY (Hz) dial (R301) on the front panel of the Generator to 1.
10. (✓) Now turn LOW FREQ DIAL ADJ control (R2) for 1000 Hz on the counter.
11. (✓) Repeat steps 1 through 10 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.
12. (✓) Set the Frequency (Hz) dial (R301) on the front panel of the Generator to 10.
13. (✓) Set the FREQUENCY MULTIPLIER on the front panel of the Generator to 10 k.
14. (✓) Turn the 10 k ADJ trimmer (C4) on the circuit board until the frequency counter reads 100 kHz.
15. (✓) Set the FREQUENCY MULTIPLIER SW1 on the front panel of the Generator to 100 k.
16. (✓) Turn the 100 k ADJ trimmer (C3) 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.



**Figure 1-1**



**Figure 1-2**

RTION  
TER

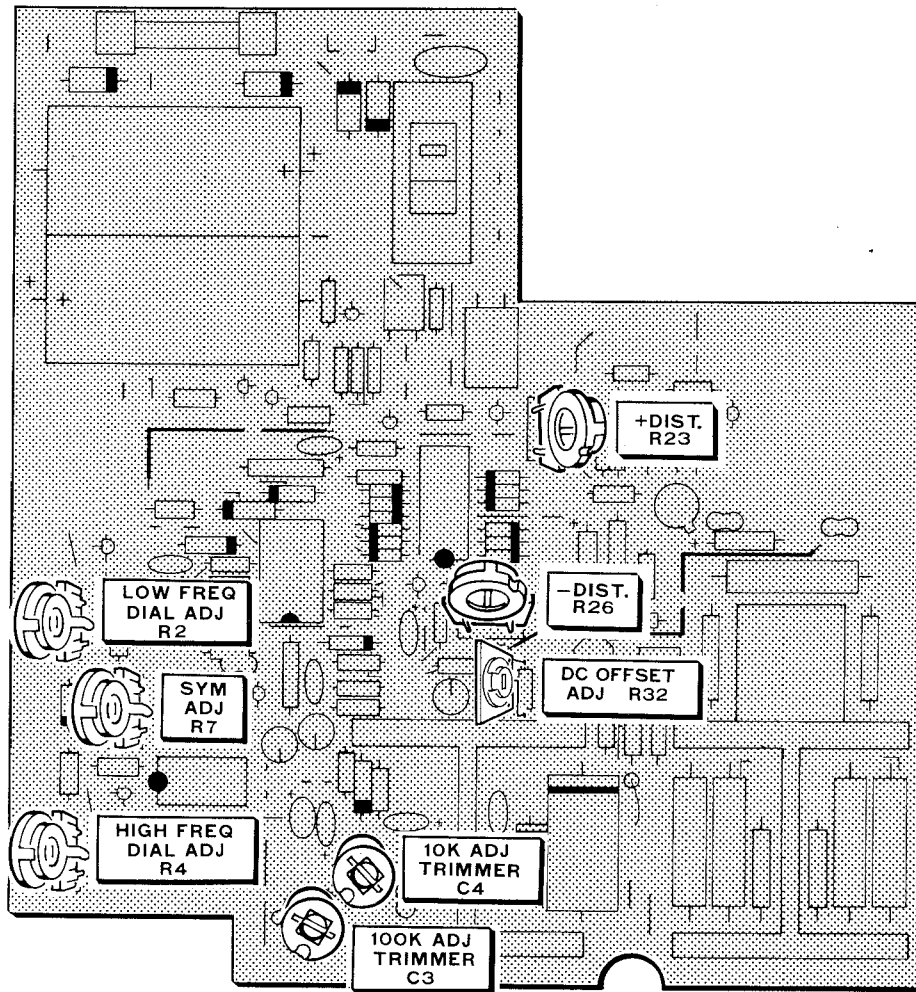
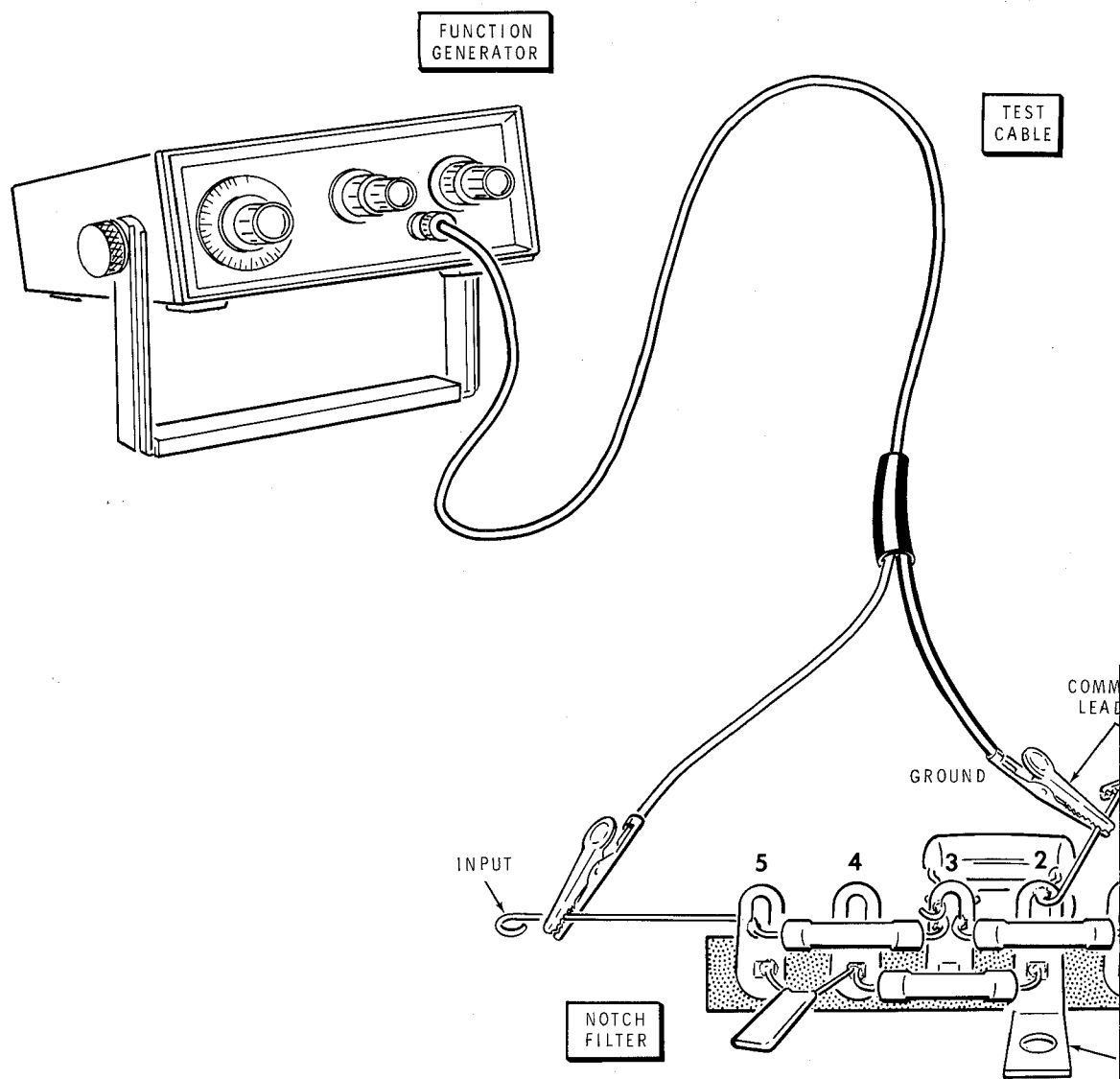
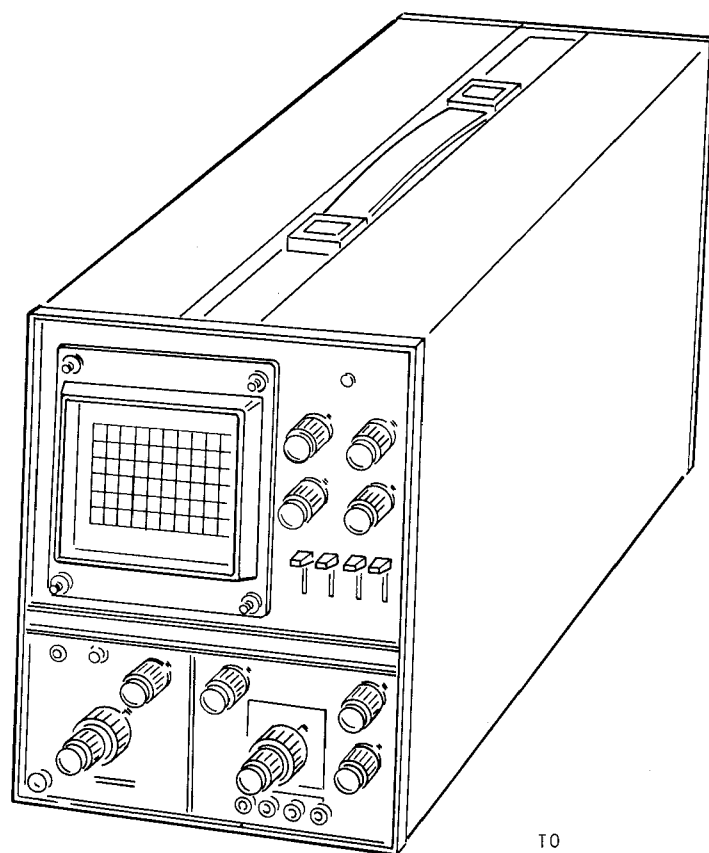


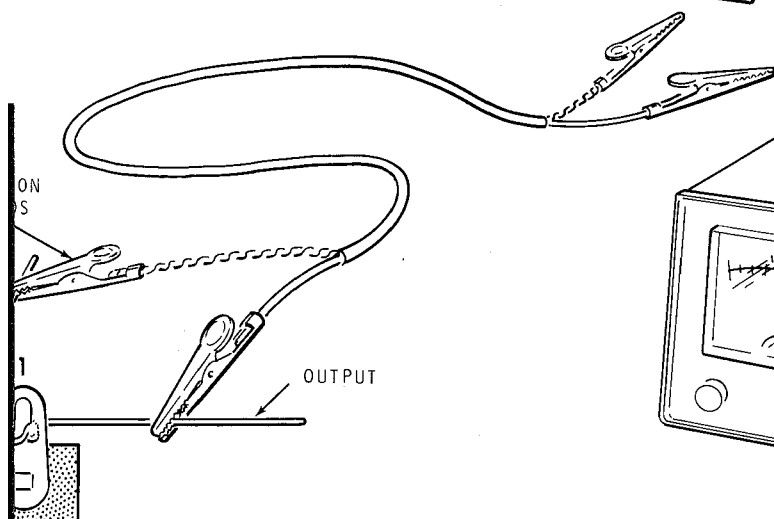
Figure 1-2



Figure



TO  
OSCILLOSCOPE  
OR  
AUDIO VOLTMETER



ON  
S

OUTPUT

FOOT

**e 1-4**

## METHOD #2

Equipment needed:

Triggered oscilloscope.

- ( ) Refer to Figure 1-3 and connect the triggered oscilloscope to the Function Generator output.

Set the front panel controls on the Generator as follows:

- ( ) ATTENUATION (dB) (SW3; black knob) to 10.
- ( ) FREQUENCY MULTIPLIER (SW1; black knob) to 1k.
- ( ) FUNCTION (SW2; red knob) to  $\sim$ .

Refer to Figure 1-2 (fold-out from Page 33) for the following steps;

Set the controls on the circuit board as follows:

- ( ) HIGH FREQ DIAL ADJ (R4) to the center of rotation.
- ( ) LOW FREQ DIAL ADJ (R2) to the center of rotation.
- ( ) SYM ADJ (R7) to the center of rotation.

- ( ) Connect the line cords of the Function Generator and oscilloscope to AC outlets.

- ( ) Turn the Function Generator and oscilloscope power switches on.

1. ( ) Set the oscilloscope TIME/CM switch to 1 mSEC/DIV.
2. ( ) Set the front panel FREQUENCY (Hz) control (R301) to 0.1.
3. ( ) Adjust the oscilloscope to obtain the following trace. NOTE: It may be necessary to adjust the LOW FREQUENCY DIAL ADJ control (R2) of the Generator to obtain this trace.

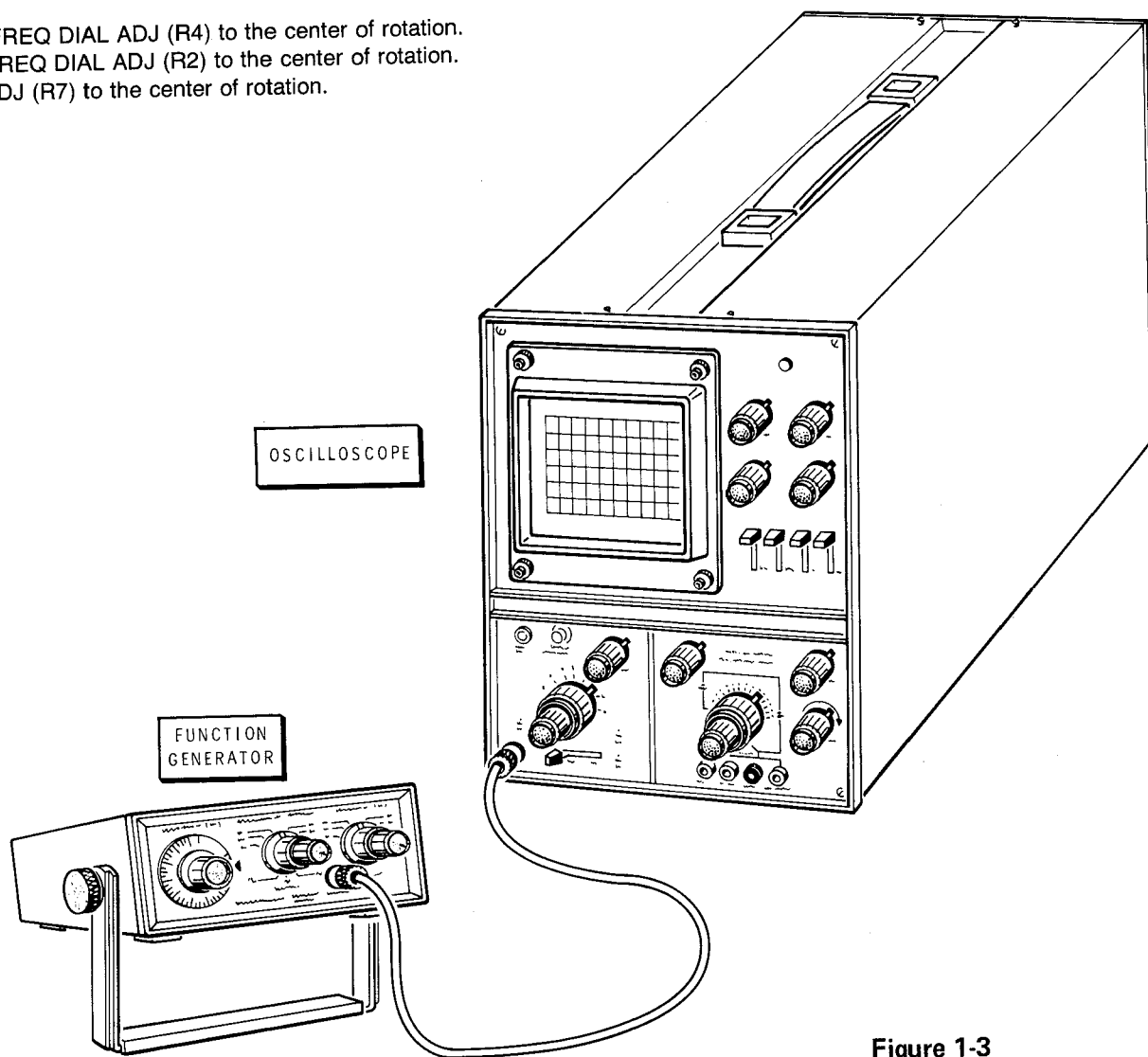
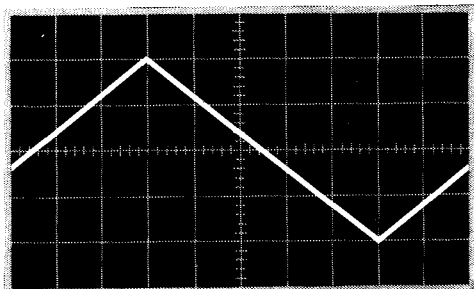
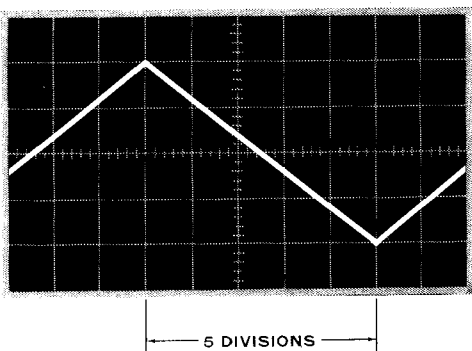


Figure 1-3

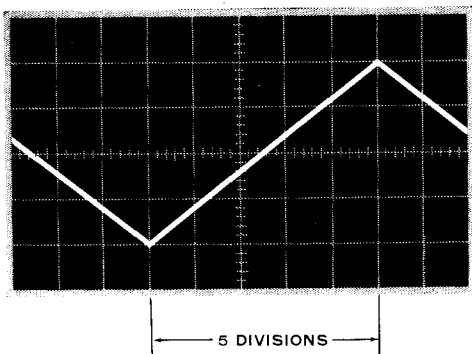




4. ( ) Turn the LOW FREQ DIAL ADJ control (R2) on the circuit board so that the negative going ramp of the waveform covers five divisions.

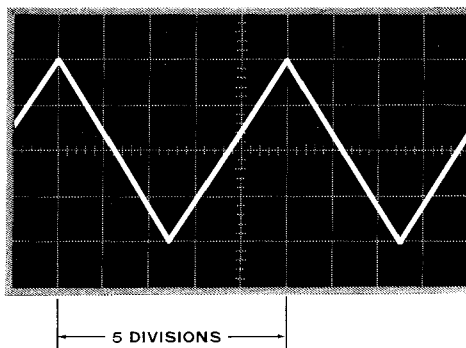


5. ( ) Now turn the SYM ADJ control (R7) on the circuit board so that the positive going ramp of the waveform covers five divisions.

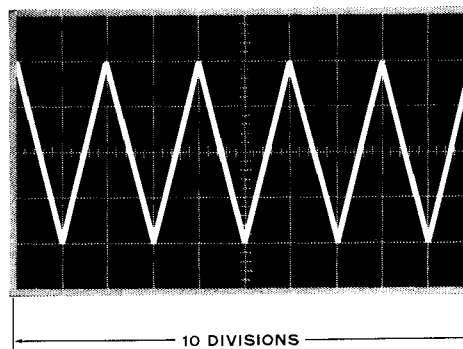


6. ( ) Set the FREQUENCY dial (R301) on the front panel of the Generator to 10.
7. ( ) Set the oscilloscope TIME/CM switch to 10  $\mu$ SEC/DIV.
8. ( ) Turn the HIGH FREQ DIAL ADJ control (R4) on the circuit board so that the positive going ramp plus the negative going ramp covers ten divisions.

9. ( ) Repeat steps 1 through 8 at least twice more to achieve a greater accuracy, since adjustment of one control affects other adjustments.
10. ( ) Make sure that the FREQUENCY (Hz) dial (R301) on the front panel of the Generator is set at 10.
11. ( ) Set the FREQUENCY MULTIPLIER (SW1) on the front panel of the Generator to 10 k.
12. ( ) Set the oscilloscope TIME/CM switch to 2  $\mu$ SEC/DIV.
13. ( ) Turn the 10 k ADJ trimmer (C4) on the circuit board so the positive going ramp plus the negative going ramp covers five divisions.



14. ( ) Set the FREQUENCY MULTIPLIER (SW1) on the front panel of the Generator to 100 k.
15. ( ) Set the oscilloscope TIME/CM switch to .5  $\mu$ SEC/DIV.
16. ( ) Turn the 100 k ADJ trimmer (C3) on the circuit board so that five cycles cover ten divisions.



This completes "Frequency and Symmetry Adjustments." Proceed to "Distortion Adjustments."

## DISTORTION ADJUSTMENTS

Equipment needed:

Oscilloscope (with a 100 mV/div sensitivity) or an audio voltmeter (with a 300 mV full-scale sensitivity).

Refer to Figure 1-4 (fold-out from Page 1-34) for the following steps.

- (✓) Connect the test cable to the Function Generator.
- (✓) Connect the inner lead at the other end of the test cable to the input lead of the notch filter. This is the lead with the loop, coming from lug 5.
- ( ) Connect the shield lead of the test cable to the ground lead of the notch filter. This is the lead coming from lug 2.
- (✓) Connect the positive lead coming from the oscilloscope or audio voltmeter to the output lead of the notch filter. This is the lead coming from lug 1.
- ( ) Connect the negative lead coming from the oscilloscope or audio voltmeter to the ground lead of the notch filter.

- ( ) Set the Function Generator controls as follows:

FREQUENCY (Hz) dial: Full counterclockwise.  
FREQUENCY MULTIPLIER (black knob): 1k.  
FUNCTION (red knob): ~.  
ATTENUATION (black knob): 0 dB.  
VARIABLE (red knob): Full clockwise.

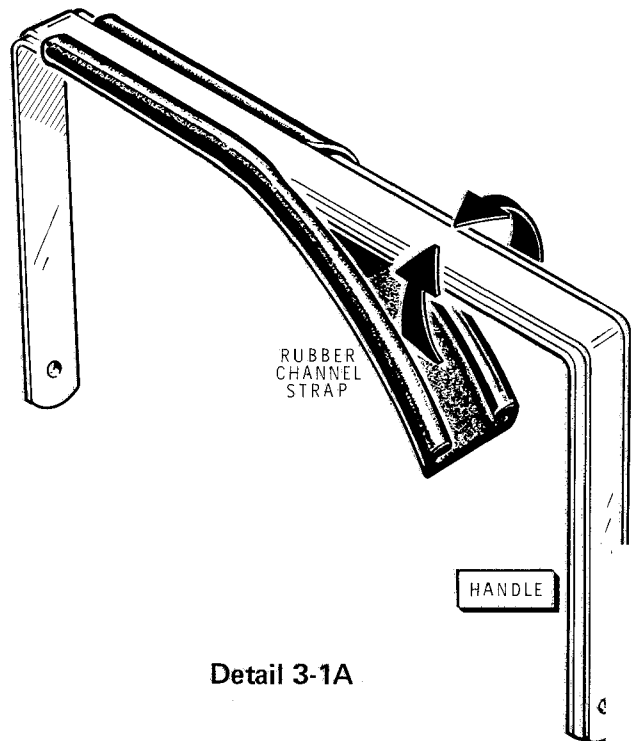
- (✓) Turn the equipment on and permit a short time for warmup.
- (✓) NOTE: It is suggested that you perform the following adjustments once to become familiar with the procedure. Then perform the adjustments again.
- (✓) Slowly turn the FREQUENCY (Hz) dial clockwise to obtain a minimum output indication on the oscilloscope or audio voltmeter.
- (✓) Adjust the + DIST (R23) and the - DIST (R26) controls to obtain a minimum output indication on the oscilloscope or audio voltmeter.

This completes the calibration of your Function Generator. Proceed to "Final Assembly."

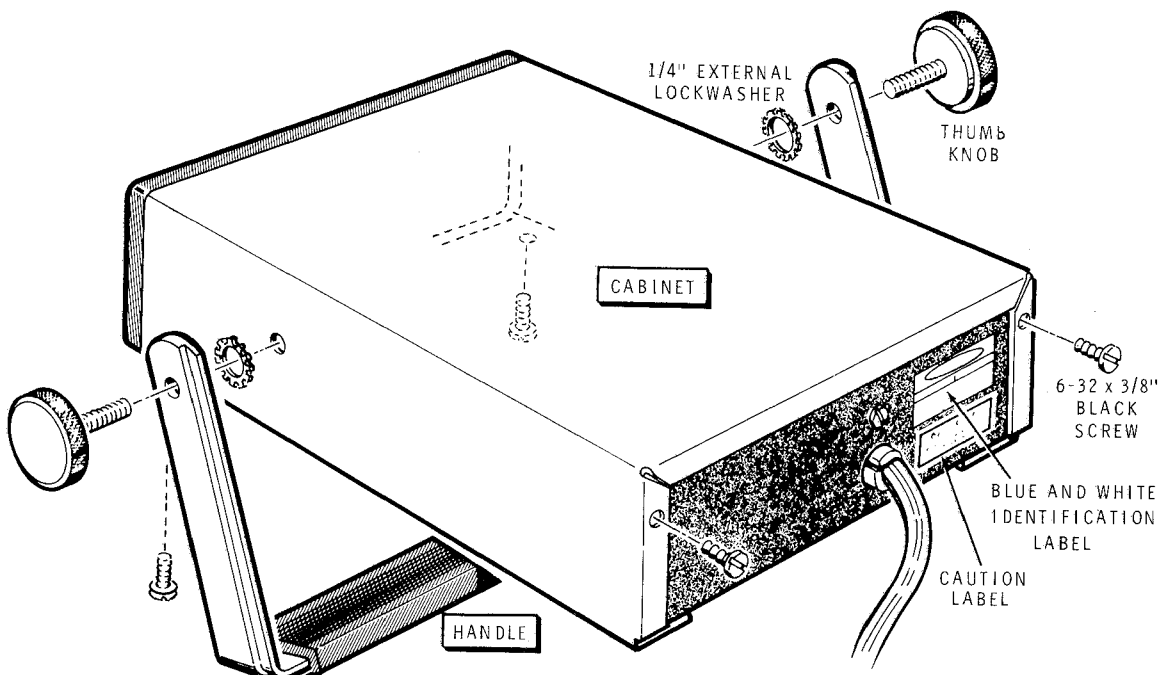
## FINAL ASSEMBLY

Refer to Pictorial 3-1 for the following steps.

- ( ) Slide the cabinet onto the Generator from the back. Secure the cabinet with four 6-32 x 3/8" black screws.
- ( ) Locate the rubber channel strap and the handle. Fit the channel strap around the underside of the handle.
- ( ) Mount the handle to the cabinet with two 1/4" external lockwashers and two thumb knobs. Position the lockwasher between the handle and the cabinet.
- ( ) Peel the protective paper backing from the caution label. Affix this label to the back of the Function Generator near the line cord.
- ( ) Peel the protective paper backing from the blue and white identification label. Then press the label onto the back of the Function Generator. Refer to the numbers on this label in any communications you have with the Heath Company about this kit.



Detail 3-1A

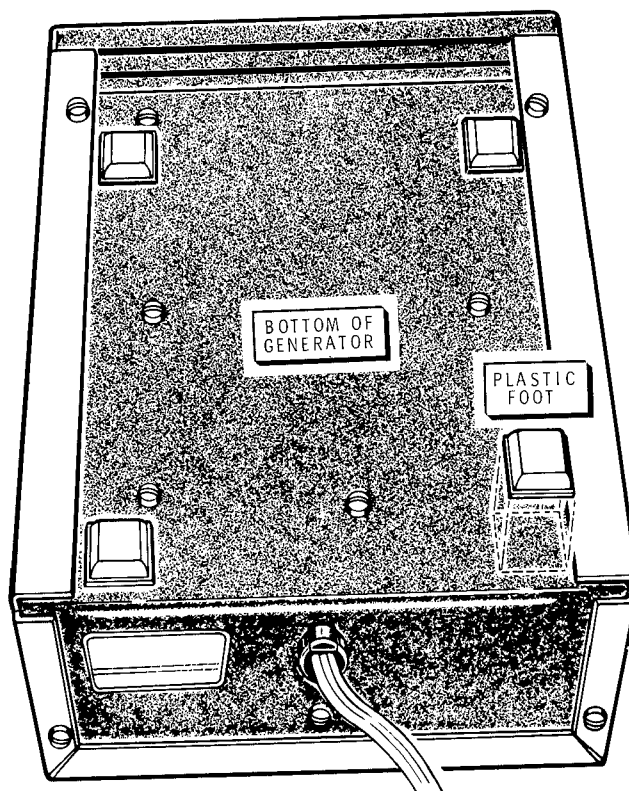


PICTORIAL 3-1

Refer to Pictorial 3-2 for the following step.

- ( ) Peel the protective paper backing from the plastic feet and press the feet onto the bottom of the Generator as shown. Position the back feet at least 1/2" from the rear edge of the chassis.

This completes the "Final Assembly" of your Function Generator. Proceed to "Operation."



PICTORIAL 3-2

## OPERATION

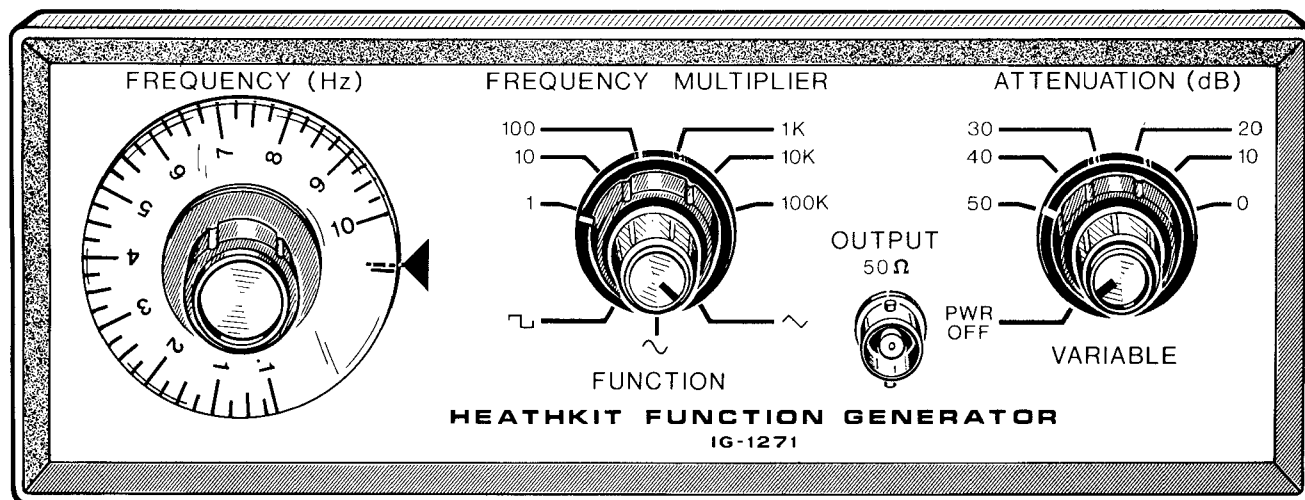


Figure 2-1

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

**CAUTION:** Never operate the Generator into less than a 50  $\Omega$  load.

Refer to Figure 2-1 for the locations of the controls and connector described below.

**FREQUENCY (Hz) DIAL (R5)** - Adjusts the frequency over 100 to 1 ratio.

**FREQUENCY MULTIPLIER (SW1)** - 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 (SW2)** - This switch selects a sine wave, square wave, or triangle wave signal, and connects it to the output.

**ATTENUATION (dB) (SW3)** - This switch provides six steps of attenuation that add 10 dB of attenuation per step. (See the attenuation-output chart.)

**VARIABLE/PWR OFF (R33-SW5)** - 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  $\Omega$**  - This provides a signal output matched for a 50  $\Omega$  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.  $10V\ P-P \div 10 = 1\ volt\ P-P$  (third line on chart).

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

## IN CASE OF DIFFICULTY

This section of the Manual is divided into two parts. The first part is a list of "General Checks." These are the most commonly made errors.

The second section, the "Troubleshooting Chart," contains symptoms and their possible causes. Along with the possible causes you will be instructed to make voltage measurements and check for waveforms with an oscilloscope.

Refer to the schematic diagram (fold-out from Page 49) and the circuit board voltages on Page 48 for the correct voltage readings. Also read the "Circuit Description" for a better understanding of the circuits.

**CAUTION:** The full AC line voltage is present inside the chassis as shown on Page 47. Be careful to avoid electrical shock when you work on the unit.

If you are unable to resolve your problem with the "General Check" or the "Troubleshooting Chart," refer to "Customer Service" inside the rear cover of the Manual.

### GENERAL CHECKS

1. About 90% of the kits that are returned for repair do not work properly because of poor solder connections. Therefore, many difficulties can be eliminated by careful inspection of connections to make sure they are soldered as described in the "Soldering" section of the "Kit Builders Guide." Reheat any connections that look doubtful and be sure all the wires are soldered at places where more than one wire is connected to the same lug.
2. Check the circuit board to be sure that there are no solder bridges between adjacent foils. Remove any solder bridges that may exist.
3. Make sure that each transistor and integrated circuit is in its proper location. Make sure that each transistor lead is in its correct hole and properly soldered.
4. Check capacitor values carefully. Be sure that the proper part is installed at each location. Check each electrolytic capacitor to be sure that the plus (+) marked lead is properly positioned.
5. Check the resistors carefully. It would be easy to install a 220  $\Omega$  (red-red-brown) resistor in place of a 22 k $\Omega$  (red-red-orange) for example.
6. Be sure of correct diode locations and installation. For instance, the stabistor diode (#56-61) may be the same size, shape, and color as the 1N4149 diode (#56-65). Yet these diodes will not operate if they are interchanged. Also, the 1N751 diode (#56-16), which may be marked with (violet-green-brown) color bands, could be mistakenly installed for a 1N750A diode (#56-59), which may be marked with (violet-green-black-brown) color bands.
7. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as you check it. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you have overlooked.
8. Check the wires and cables around the front panel controls. Make sure none of these wires are pinched by the cabinet. Also check for pinched wires under the spacers that mount the circuit board to the chassis.
9. Check for excess lead lengths on the foil side of the circuit board that may touch each other or the chassis when the board is mounted.

## Troubleshooting Chart

An oscilloscope and a high impedance voltmeter will be required for this section. Refer to the "Schematic" Diagram (fold-out from Page 49) for voltages and waveforms. Refer to the "Circuit Board Voltages" on Page 48 for voltages.

SYMPTOM	POSSIBLE CAUSE
Fuse blows.	<ol style="list-style-type: none"> <li>1. Power transformer incorrectly wired.</li> <li>2. Diodes D15, D16, D17, D18, may be incorrectly installed or shorted.</li> <li>3. IC2 or transistor Q25 may be incorrectly installed or shorted.</li> <li>4. Transistor Q22 or Q24 incorrectly installed or shorted.</li> </ol>
No output.	<ol style="list-style-type: none"> <li>1. Check power supply voltages.</li> <li>2. If power supply voltages are correct, check for triangle waveform at Gate of transistor Q17.</li> <li>3. If waveform is present at Q17, trouble is in power amplifier. Check voltages.</li> <li>4. If waveform is not present at Q17, check voltages on transistors Q4, Q5, Q6, Q7, and Q8.</li> </ol>
Triangle and square waves are obtainable, but no sine wave.	<ol style="list-style-type: none"> <li>1. Resistor R22, diodes D2 and D8, and transistors Q13 and Q14.</li> </ol>
Sine wave is distorted on the negative half cycle.	<ol style="list-style-type: none"> <li>1. Transistors Q14 and Q16, and diodes D8 through D13.</li> </ol>
Sine wave is distorted on the positive half cycle.	<ol style="list-style-type: none"> <li>1. Transistors Q13 and Q15, and diodes D2 through D7.</li> </ol>
Triangle wave is obtainable but no square wave.	<ol style="list-style-type: none"> <li>1. Transistor Q12, diode ZD4, capacitor C16, and resistor R19.</li> </ol>
DC is offset at the output on the triangle and sine waves only.	<ol style="list-style-type: none"> <li>1. Transistors Q17 and Q18.</li> <li>2. Capacitors C12, C13, and C17.</li> <li>3. Resistors R13, R14, R16, R17, R31, and R32.</li> </ol>
DC is offset at the output on the square wave only.	<ol style="list-style-type: none"> <li>1. Transistor Q12.</li> <li>2. Diode ZD4.</li> <li>3. Capacitor C16 and resistors R19 and R21.</li> </ol>

## 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. Refer to the Schematic Diagram (fold-out from Page 49) while you read this description.

## 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.

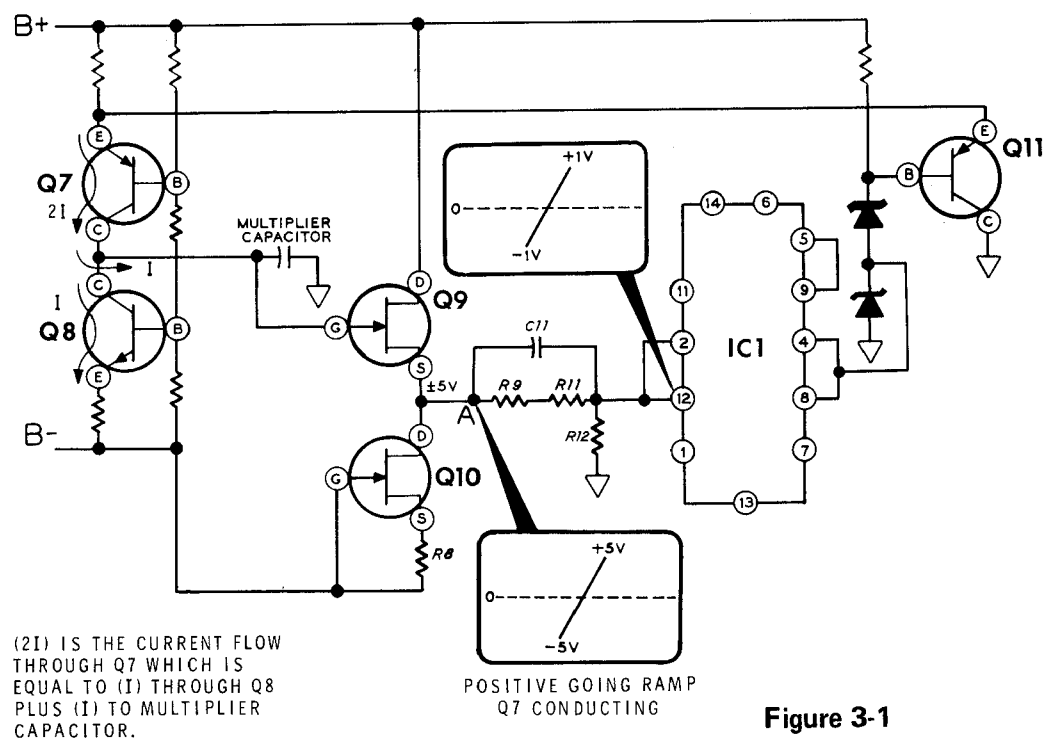
Transistor Q7 conducts only on the positive going ramp of each waveform. Transistor Q8, however, conducts all the time. The current that is supplied by transistor Q7 is divided exactly in half by transistor Q8. Half of this current is directed through Q8 and the remaining half is coupled to the multiplier capacitor to charge it. This is shown in Figure 3-1.

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 3-1 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 4 and 8 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 4 and 8 becomes low (+.4 volt). This causes transistor Q11 to conduct, which cuts off transistor Q7.

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 3-2.

During the negative going ramp, the voltage at pins 4 and 8 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 4 and 8 becomes high (approximately  $+5$  volts). This allows transistor Q7 to conduct again and another positive going ramp starts.



### Figure 3-1





## 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.

Transistor Q13 and Q15 sets 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, each diode in turn begins to conduct and reduces the total resistance of the network.

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 R38 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 -15 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 R18, R15, and zener diodes ZD1, ZD5, supply the positive and negative 5 volts needed to operate IC1.

## SPECIFICATIONS

Frequency Range . . . . .	1.0 Hz to 1 MHz.
Functions	
Triangle Waveform . . . . .	Nonlinearity, 5% maximum. Symmetry within 10% of 50% duty cycle.
Square Waveform . . . . .	100 ns 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, 20 volts peak-to-peak into open circuit. 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.

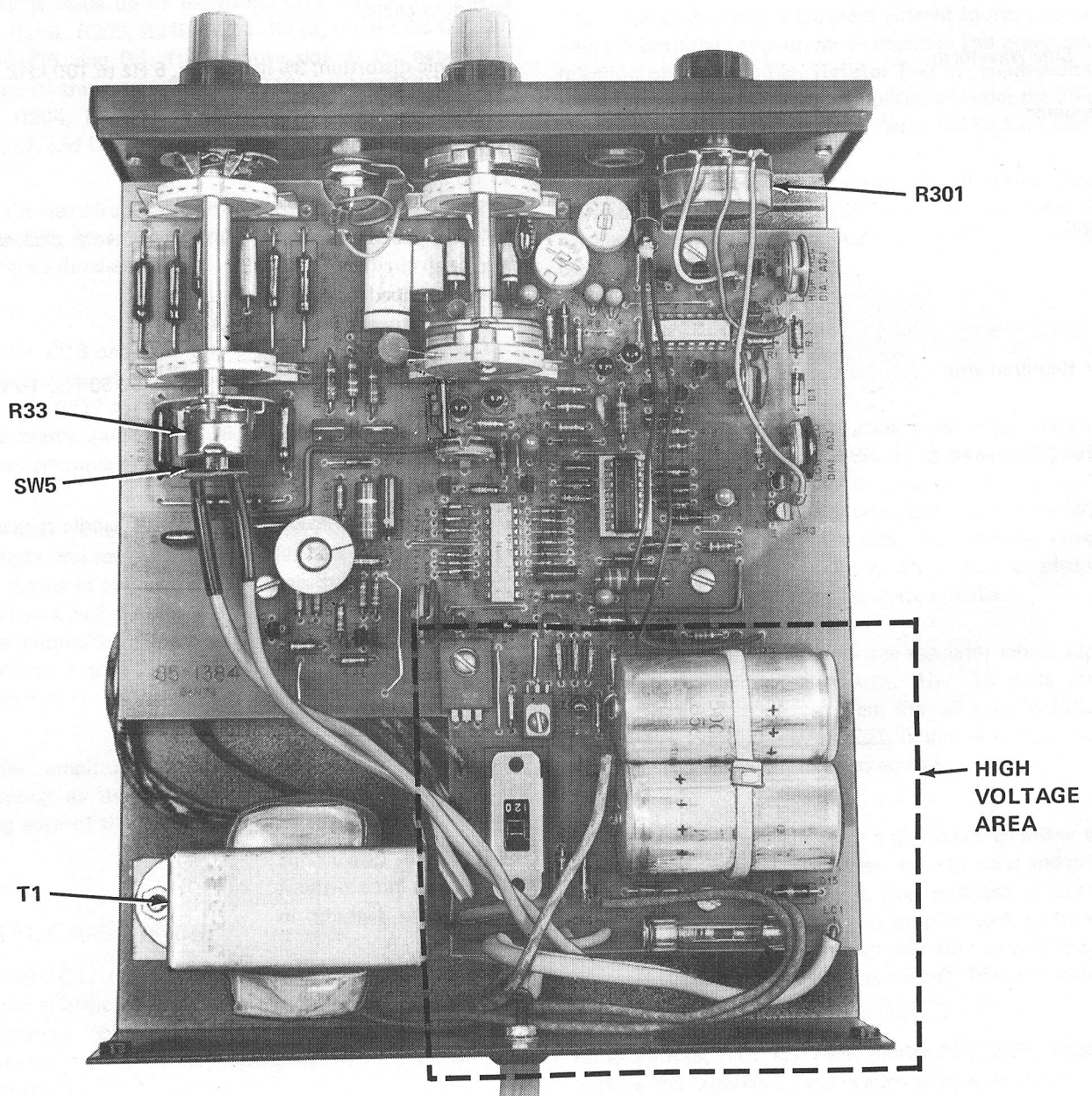
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The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

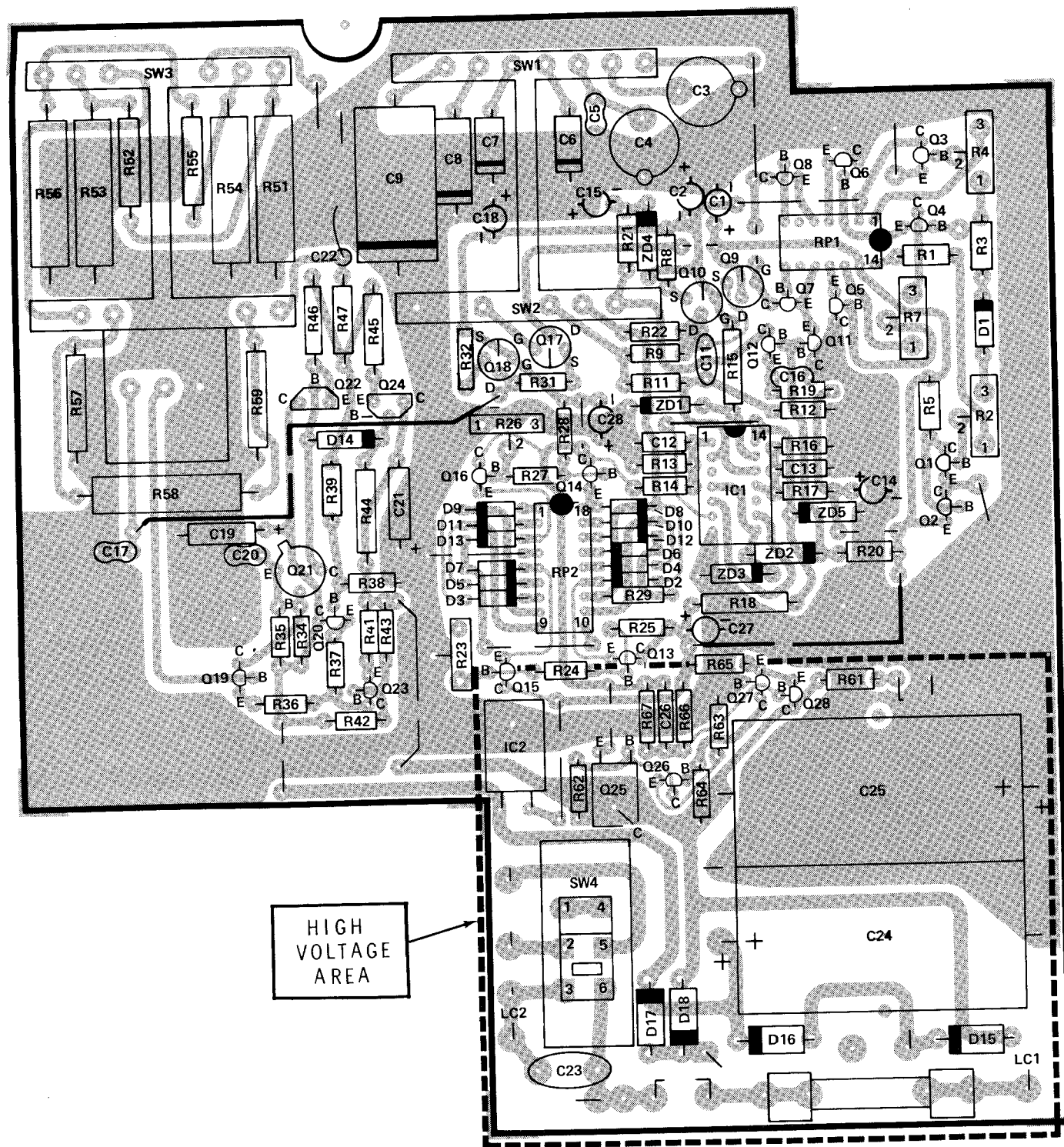
## CHASSIS PHOTOGRAPH

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

- A. Find the circuit component number (R5, C3, etc.) on the "X-Ray View" or "Chassis Photograph."
- B. Locate this same number in the "Circuit Component Number" column of the "Parts List" in the front of this Manual.
- C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.

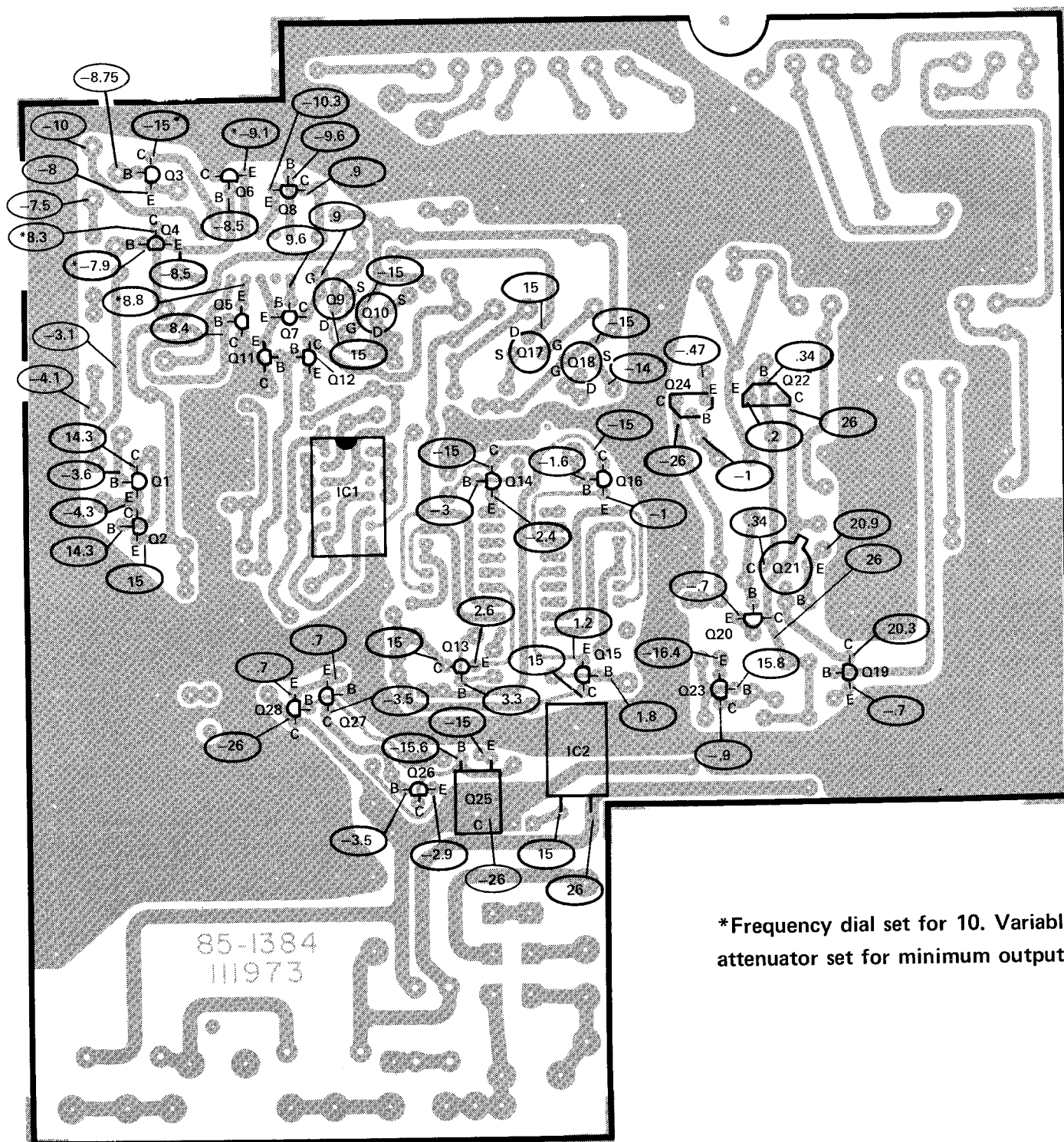


# CIRCUIT BOARD X-RAY VIEW



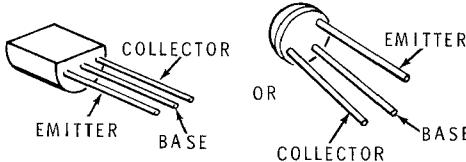
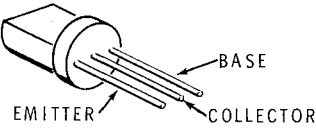
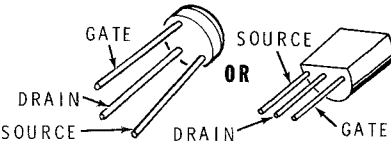
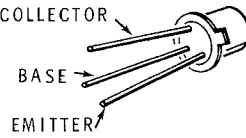
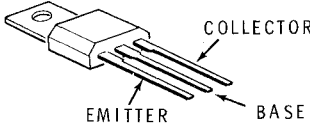
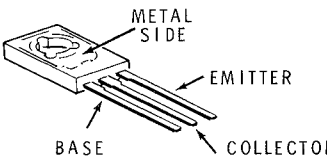
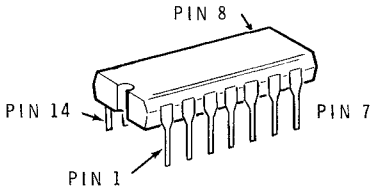
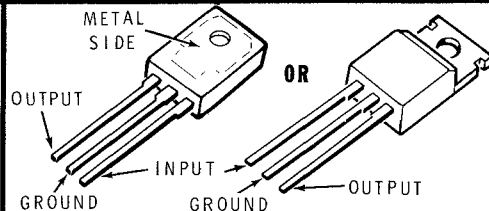


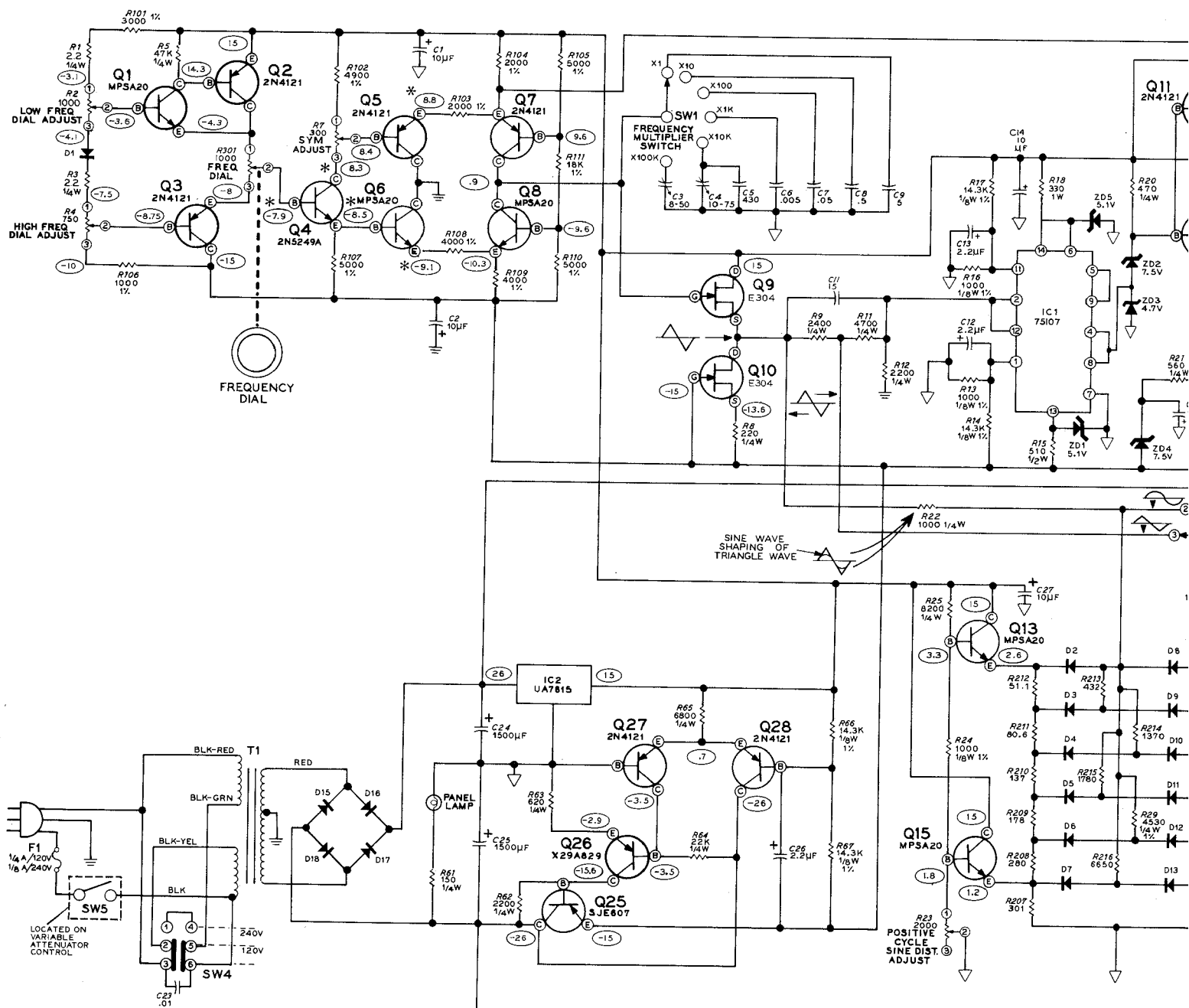
## CIRCUIT BOARD VOLTAGE CHART



(SHOWN FROM FOIL SIDE)

## IDENTIFICATION CHART

SCHEMATIC REFERENCE NUMBER	HEATH PART NUMBER	MANUFACTURER'S NUMBER	BASE DIAGRAM
Q1, Q6, Q8, Q13, Q15, Q19, Q20, Q23.	417-801	MPSA20	
Q2, Q3, Q5, Q7, Q11, Q12, Q14, Q16, Q27, Q28.	417-235	2N4121	
Q4	417-213	2N5249A	
Q26	417-201	X29A829	
Q9, Q10, Q17, Q18.	417-828	E304 (SELECTED)	
Q21	417-270	SGC5283	
Q22	417-224	MPSU05	
Q24	417-225	MPSU55	
Q25	417-263	SJE607	
IC-1	442-73	75107	
IC-2	442-63	UA7815	



**SCHEMATIC OF THE  
HEATHKIT®  
MODEL IG-1271  
FUNCTION GENERATOR**



