

FICO

378 / Audio Generator



OPERATING MANUAL

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GENERAL DESCRIPTION

Based on a highly reliable circuit, the Model 378 Audio Generator produces a very low distortion sine wave signal over a very wide range of frequencies and is ideal for use in testing audio amplifiers for gain and frequency response, as a signal source for various bridge measuring circuits, for modulation of RF signal generators, or any other application where a stable, accurate audio sine wave must be used.

Unlike most other audio generators that require interpretation of a dial setting with possible error, the frequency-determining elements of the Model 378 are not continuously variable, but are set by positive-setting detent switches that select combinations of 1% resistors and 2% capacitors that make up the frequency-selecting network. This method of tuning enables repeatable accurate setting to any individual cycle between 1 cps and 110kc.

The output level of this instrument can be set with great accuracy between 0 and 10 volts RMS (or between -70 and +22db) on a 4-1/2 inch, 2% full-scale accuracy meter.

Below 1 volt RMS output, the instrument is provided with a switch-selected internal 600 Ω load that can be disconnected as desired.

FUNCTION OF CONTROLS

- a. OUTPUT/FINE control. This continuously variable control determines the signal level at the OUTPUT terminal.
- b. LOAD switch. Below 1 VRMS level selects either an internal load of 600 Ω in parallel with the external load of 10K Ω or more, or permits output without the internal 600 Ω load. Automatically removed when the OUTPUT RANGE switch is in the 3 or 10 VRMS positions.
- c. OUTPUT RANGE switch selects any of eight output levels indicated either in DB or VRMS.
- d. CYCLES switches selects 10's and units of frequency between 1 and 110 cps in discrete switch positions.
- e. FREQ. MULTIPLIER switch multiplies setting of CYCLES switches by 1, 10, 100, or 1000 enabling generation of frequencies between 1 cps and 110kc.
- f. The meter is calibrated in two voltage ranges (0 to 1 and 0 to 3 VRMS) and -20 through 0 to +2db. The actual value of these scales are determined by the OUTPUT RANGE switch setting. True 0db on the scale equals 1 mw into 600 Ω . If used with the internal 600 Ω load, or an external 600 Ω load, the meter reading is expressed in dbm and the reference level is automatically read off the scale.

TECHNICAL SPECIFICATIONS

FREQUENCY RANGE: 1 cps to 110kc

TUNING METHOD: Switch selected, two significant figures and multiplier

FREQUENCY ACCURACY: $\pm 5\%$

- OUTPUT LEVEL RANGES:
- a. Meter indicated 0-3 \times 10 volts RMS into a high-Z external load (10K Ω minimum).
 - b. Meter indicated 0 to .003, .01, .03, .1, .3, and 1 volt into a switch-selected internal load of 600 Ω and external load of 10K Ω or greater: or into an external load of approximately 600 Ω .

SOURCE IMPEDANCE: 0 to 10 volt range: varies between 0 and 1000 Ω .
0 to 3 volt range: varies between 800 and 1000 Ω
0 to 1 volt range and below: 600 Ω external load
290 Ω internal load

DB RANGES: -70db to +22db in switched-selected 10db steps (0 dbm = 1mw -600 Ω).

OUTPUT INDICATOR: 4-1/2 inch 200 μ A meter incorporating voltage and db scales.

METER ACCURACY: 2% full scale.

OUTPUT DISTORTION: Less than .1% from 20 to 20,000 cps

TUBE COMPLEMENT: 6CL6, 6AU6, 6X4

POWER REQUIREMENT: 105-125 VAC, 50-60 cps, 40 watts

DIMENSIONS: 12-1/2" wide, 8-1/2" high, 7-1/2" deep

WEIGHT: 13 lbs.

CIRCUIT DESCRIPTION

The Model 378 Audio Generator can be divided into four sections: power supply; oscillator; attenuator; and metering circuits.

POWER SUPPLY: This is a conventional fuse-protected, transformer-powered, full-wave circuit using a 6X4 rectifier and a choke-capacitor filter delivering 410 VDC, and filament voltage, to the generator.

OSCILLATOR: The oscillator uses a 6AU6 as a voltage amplifier directly coupled to a triode-connected 6CL6 cathode follower. Phasing of the circuit is such that regenerative (positive) feedback is coupled from the cathode of the 6CL6 to the cathode of the 6AU6 via capacitor C7 and the tungsten filament bulb R27, while degenerative (negative) feedback is coupled from the cathode of the 6CL6 through a switch-selected frequency-sensitive network making up a capacitor-shunted "T" network.

The phase shifting property of the switch-selected network is such that the negative feedback applied to the 6AU6 control grid cancels amplification at all frequencies except that selected by the network.

Once the network values are selected, oscillation will build up across the two tubes to an amplitude sufficient to cause waveform distortion. However, the positive feedback path to the 6AU6 cathode is completed through the tungsten filament bulb R27. The characteristics of this bulb is such that as the signal amplitude rises, current flow through the bulb increases and the bulb filament temperature goes up, increasing its resistance. This tends to reduce the amount of current flowing, thus reducing signal amplitude. If the system draws less current, the bulb filament decreases in temperature (and resistance) and allows more current to flow. In this manner, R27 stabilizes the current flow through the circuit and thus signal amplitude is stabilized.

The frequency of the network is determined by the value and ratio of capacitor C1 and C2 (see Figure 1), and the value of the shunting resistors R1, R6, R9 and R14.

If the value of the capacitors are reduced by a factor of 10, then the frequency will increase by a factor of 10. This is the purpose of the **FREQ. MULTIPLIER** switch.

The left-hand **CYCLES** switch determines the equal-valued resistors R1 and R6 for the decade level, while the right-hand **CYCLES** switch selects shunting resistors R9 and R14 whose values are so arranged that it becomes possible to choose individual cycles within the decade.

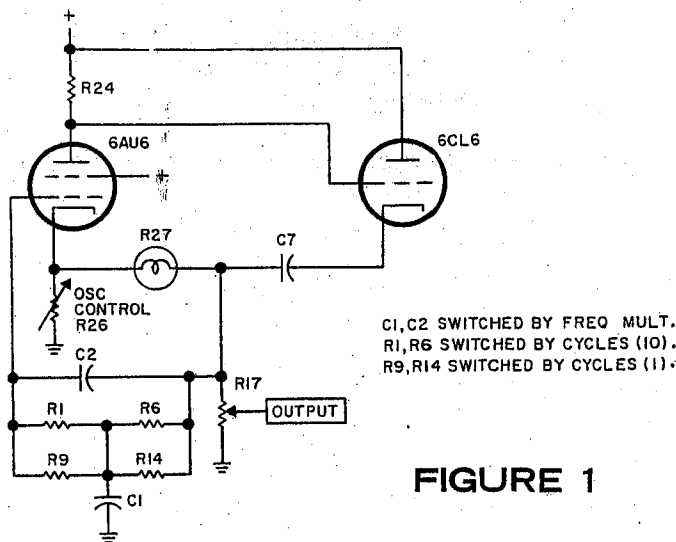


FIGURE 1

ATTENUATOR: The attenuator consists of the continuously-variable OUTPUT/FINE control R17 connected between the output of the oscillator and ground, and supplies this voltage to the OUTPUT RANGE step attenuator. This attenuator reduces the signal in 8 discrete 10db steps from +20 to -50db (RMS voltages from .10 to .003 volts).

The attenuator system is arranged for a 600Ω output up to 1 volt and a high impedance at the 3 and 10 volt levels. If desired, the 600Ω positions (up to 1 VRMS on the OUTPUT RANGE switch) may be terminated by an internal 600Ω load (selected by the LOAD switch) for high-impedance operation, or the internal 600Ω load may be disconnected by the LOAD switch, if an external 600Ω load is used. In both the 3 and 10 VRMS positions of the OUTPUT RANGE switch, the internal 600Ω cannot be switched in.

METER CIRCUIT: This circuit uses a 200uA meter in a bridge circuit to measure the voltage level at the OUTPUT CONTROL rotating arm. A portion of this voltage is selected by the meter control R22 for use by the meter circuit. The non-linearity of the diode half-bridge at low signal levels is compensated by the use of a third diode connected across the meter.

The meter has three scales: 0 to 1 volt RMS; 0 to 3 volts RMS; and an associated -20 through 0 to +2db scale. The actual values on each scale is determined by the setting of the OUTPUT RANGE switch.

When the audio generator is properly terminated, the meter and the OUTPUT RANGE switch will indicate the actual signal level between the OUTPUT and GND terminals.

DB SCALE

Unlike volts, amperes, ohms, inches, feet, or other standard measurements, a decibel is the relationship between two power levels, and is expressed mathematically as

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

where P2 is the output power, P1 is the input power, and the common logarithm (base 10) is used.

Because the decibel (abbreviated DB) is based on a power ratio, voltage or current ratio can be used only when the impedance value is the same for both measured quantities. When this is the case, then the voltage ratio becomes

$$DB = 20 \log \frac{V_2}{V_1} \text{ and current ratio becomes } DB = 20 \log \frac{I_2}{I_1}.$$

When the Model 378 Audio Generator is terminated either in its internal 600Ω load, or an external 600Ω load, all calculations are performed automatically, and the results can be read out on the meter and the setting of the OUTPUT RANGE control.

The meter DB scale indicated value changes as the OUTPUT RANGE switch is operated, with 0db indication becoming the value marked for that particular OUTPUT RANGE switch setting. To use, merely add the value of meter indicated DB to the OUTPUT RANGE switch value.

For example: OUTPUT RANGE on -50db, meter indication -11db. The signal present on the OUTPUT terminal is therefore $-50 + (-11)$ or -61db. In another example, OUTPUT RANGE on +10db, meter indicates -3db. The signal present at the OUTPUT terminal is therefore $+10 + (-3)$ or +7db.

This composite meter/switch arrangement permits measurements to be made between -70 and +22db.

INITIAL TEST AND ADJUSTMENT

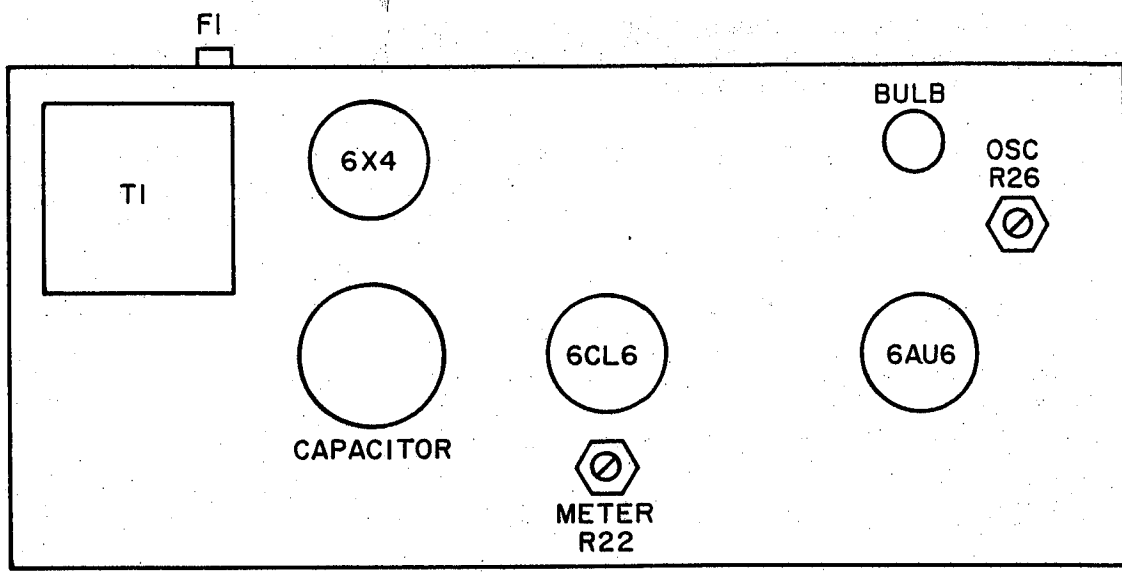
PRELIMINARY

- a. With the chassis removed from the cabinet, and before plugging the unit into a power source, check that the meter pointer is at the "0" position. If not, use a small screwdriver to gently rotate the meter mechanical zero screw (located on the lower portion of the meter case) until it indicates zero.
- b. Set oscillator control R26 and meter control R22 at their approximate mid-range position (see Figure 2).
- c. Set both CYCLES switches to any position other than "0".
- d. Plug the line cord into a 105-125 VAC, 50-60 cps outlet. DO NOT plug it into a source of higher voltage, different frequency range, or into a DC outlet as an incorrect power source will damage the instrument.
- e. Place the POWER switch in the ON position. The front-panel pilot lamp should come on and the tube filaments should glow. If not, turn the instrument off and investigate the filament wiring.
- f. Adjust the OUTPUT/FINE control for some meter indication. If this does not happen, turn the instrument off and investigate the wiring.

METER CALIBRATION

- a. Set the OUTPUT/FINE control to MAX.
- b. Set both CYCLES switches to "0". (The position of the FREQ. MULTIPLIER switch is not important).
- c. Set the OUTPUT RANGE switch to the 10 VRMS position.
- d. Set LOAD switch to EXT.
- e. Temporarily connect a wire between pin 4 of V3 (6X4) and the OUTPUT binding post.
- f. Adjust R22 (Figure 2) for a 6.3 VRMS indication on the meter (1-1/2 divisions above .6 on the meter upper scale).
- g. Remove the test wire from both ends. (Pin 4 of V3 and OUTPUT terminal).

If an accurate AC voltmeter of at least 1000Ω-per-volt, or an AC reading VTVM is available, then it can be connected in parallel with an external AC signal (the 6.3-volt source as shown in step "e" above, or any other source of AC below 10 volts RMS) to the OUTPUT terminal and R22 adjusted until the panel meter indicates the same level as the external meter. Make sure that the external meter is accurate at the AC frequency applied.



FRONT
FIGURE 2

OSCILLATOR ADJUSTMENT

With no connections to the OUTPUT terminal, perform the following steps:

- a. Set **FREQ. MULTIPLIER** to X1000.
- b. Left-hand **CYCLES** switch to 50.
- c. Right-hand **CYCLES** switch to 5.
- d. **OUTPUT RANGE** switch to 10 VRMS.
- e. **LOAD** to EXT.
- f. **OUTPUT/FINE** switch to MAX.
- g. Rotate oscillator control R26 (See Figure 2) for slightly more than full-scale meter indication.
- h. Sequentially set **FREQ. MULTIPLIER** to X100, X10 and X1 positions while noting that the meter indication remains slightly over full scale. If not, touch up R26 and recheck all positions of **FREQ. MULTIPLIER** switch for slightly over full-scale indication.

At this point, the output sine wave will have excellent purity characteristics. However, if required for highly exacting work, an oscilloscope or distortion analyzer can be used to determine the purity of the sine wave output at all frequencies. R26 can be slightly adjusted for precise measurements.

i. After performing the meter calibration and oscillator adjustments, install the chassis in the cabinet and secure with the screws provided.

MAINTENANCE – TROUBLESHOOTING

a. To remove the instrument from its cabinet, first disconnect it from the power line and remove the two screws from the rear of the cabinet. Slide the chassis out the front of the cabinet.

b. Visually inspect for signs of malfunction such as tube filaments dark, discoloration of resistors due to overheating, blown fuse, etc. Make a continuity check of R27 (115 V, 3 watt bulb). This bulb does not visibly glow during instrument operation.

c. With the audio generator set to some medium frequency, use a VTVM to measure tube voltages from socket pins to chassis for close correspondence with those given below:

Tube	Pins								
	1	2	3	4	5	6	7	8	9
6X4	320 AC	—	—	6.3 AC	—	320 AC	410	—	—
6AU6	1.5	4	—	6.3 AC	200	140	4	—	—
6CL6	210	200	410	—	6.3 AC	410	210	410	200

Minor variations of indicated voltages may be due to line voltage variations or slight changing of component tolerances.

For further troubleshooting, measure value of each resistor and capacitor for close correspondence with the values shown on the schematic or called out in the parts list.

An understanding of the method of sine wave generation used in this instrument will greatly assist troubleshooting.

PRICE
EACH SYM. # STOCK# DESCRIPTION

RESISTORS

.44	R1,6	11079	100KΩ, 1/2W, 1%	(2)
.44	R2,5	11022	50KΩ, 1/2W, 1%	(2)
.40	R3,8	12002	33.3KΩ, 1/2W, 1%	(2)
.40	R4,7	12003	25KΩ, 1/2W, 1%	(2)
.29	R9,14	11548	1MΩ, 1/2W, 5%	(2)
.16	R10,13	11586	510KΩ, 1/2W, 5%	(2)
.13	R11,16	11550	330KΩ, 1/2W, 5%	(2)
.13	R12,15	11587	240KΩ, 1/2W, 5%	(2)
.08	R18,19	10400	10KΩ, 1/2W, 10%	(2)
.14	R20	11551	2KΩ, 1/2W, 5%	(1)
.08	R21	10430	4.7KΩ, 1/2W, 10%	(1)
.08	R23	10444	120KΩ, 1/2W, 10%	(1)
.34	R24	10955	47KΩ, 2W, 10%	(1)
.11	R25	10438	330Ω, 1/2W, 10%	(1)
1.17	R27	92001	3 watt lamp	(1)
.75	R28	14358	5KΩ, 20W, 10%	(1)
.08	R29	10436	47Ω, 1/2W, 10%	(1)
.09	R30	10433	560Ω, 1/2W, 10%	(1)
.18	R31	10210	750Ω, 1/2W, 5%	(1)
.14	R32,34, 36,40,41	11542	1.6KΩ, 1/2W, 5%	(5)
.16	R33,35, 39,42,43	11588	1.1KΩ, 1/2W, 5%	(5)
.14	R37	11512	2.4KΩ, 1/2W, 5%	(1)
.29	R38	11582	390Ω, 1/2W, 5%	(1)
.08	R44	10426	33KΩ, 1/2W, 10%	(1)

POTENTIOMETERS

1.19	R17	18009	5KΩ, linear	(1)
.95	R22	18107	10KΩ, linear	(1)
1.04	R26	16008	600Ω, linear	(1)

CAPACITORS

3.76	C1	20099	.5uf, mylar, 2%	(1)
.16	C2	20100	.05uf, mylar, 2%	(1)
.14	C3	20101	.005uf, mylar, 2%	(1)
.07	C4	21263	500uuf, mica, 2%	(1)
.39	C5	21262	47uuf, mica, 2%	(1)
1.20	C6	23003	elec., 16uf, 350V	(1)
1.55	C7	23088	elec., 20uf, 350V	(1)
3.25	C8	24038	elec., 2x40uf, 450V	(1)

SWITCHES

4.13	S1	60181	rotary, multiplier	(1)
4.68	S2,3	60183	rotary, cycles	(2)
4.80	S4	60182	rotary, output range	(1)
.32	S5,6	62030	slide, power, load	(2)

PRICE
EACH SYM. # STO

TUBES

2.08	V1	9002
3.88	V2	9005
1.72	V3	9003

TERMINAL STRIPS

.10		5400
.10		5400
.10		5407
.10		5400

MISCELLANEOUS COM

17.80	M1	7201
1.08	CR1,2,3	9500
10.80	T1	3008
2.40	T2	3400
.54	L1	9771
.14	F1	9100
.54		5700
.99		9780
.10		8210
5.60		8148
10.00		8811
5.85		8018
1.92		8600
.53		5303
1.50		6617
1.50		6640
.02		4600
.06		4601

TUBE SOCKETS

.23	97081	9 pin
.17	97022	7 pin
.37	97705	

HARDWARE

.02	43001	lug,
.02	43000	lug,
.01	43004	lug,
.01	41140	scre
.01	41090	scre
.01	41091	scre
.01	41086	scre
.01	41088	scre
.01	41003	scre
.01	40007	nut,

SW

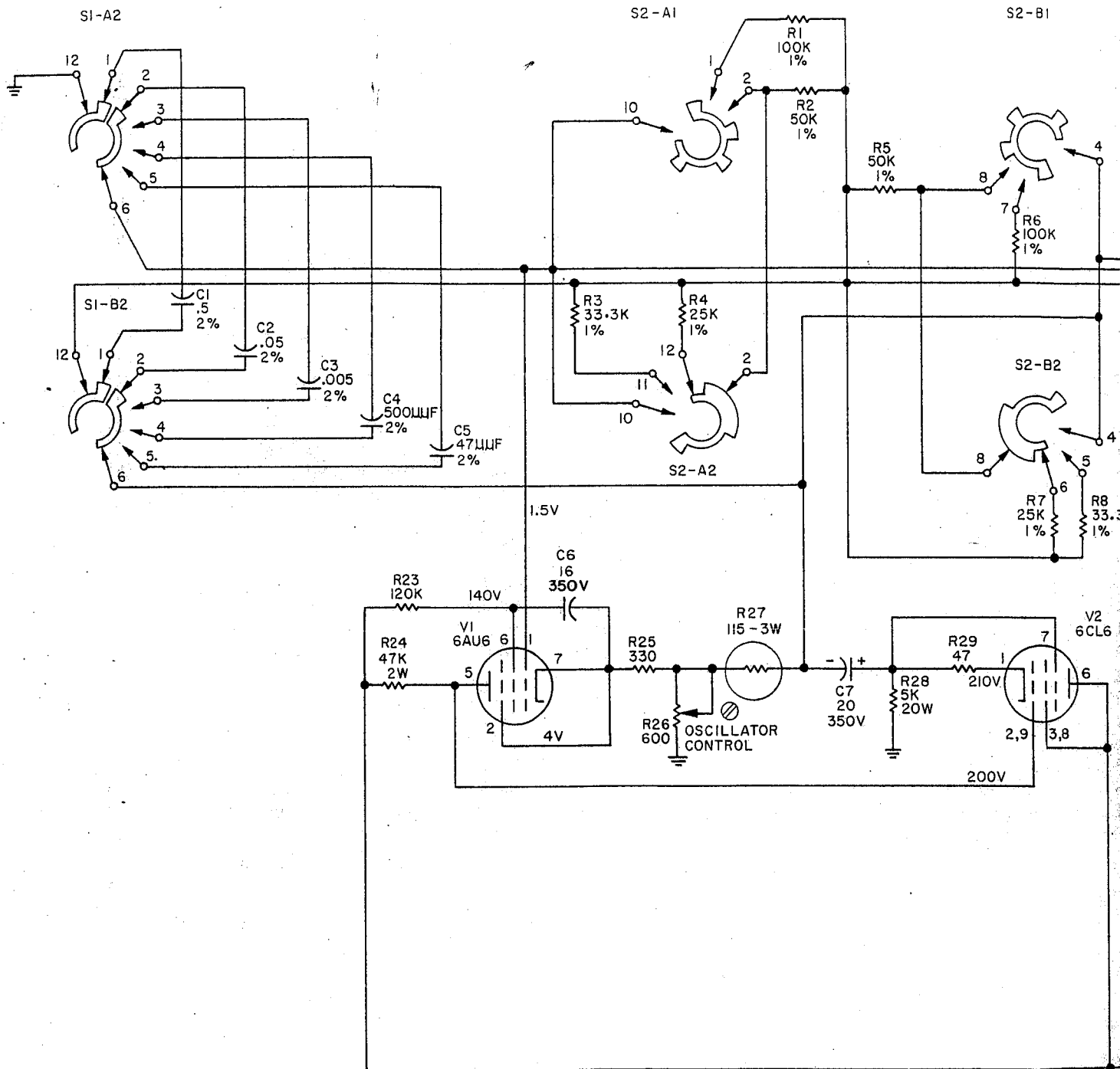
S1
S2
S3
S4
S5
S6

PARTS LIST

K#	DESCRIPTION	PRICE EACH	STOCK#	DESCRIPTION	
		.01	40000	nut, hex, #6-32	(5)
		.02	40001	nut, hex, 3/8-32	(7)
6AU6	(1)	.07	40016	nut, hex, 1/2-24	(1)
6CL6	(1)	.03	40017	nut, Tinnerman #8	(2)
6X4	(1)	.04	40019	nut, Tinnerman #6	(1)
		.04	40034	nut, Tinnerman #4	(4)
		.02	40055	nut, hex, #8-32 x 11/32	(10)
		.02	42000	washer, lock 3/8	(3)
3 post, 2 right	(3)	.01	42001	washer, flat 3/8	(7)
2 post right w/gnd	(1)	.01	42002	washer, lock #6	(5)
3 post right w/gnd	(1)	.01	42007	washer, lock #4	(6)
1 post left	(1)	.01	42008	washer, lock #8	(6)
		.03	42029	washer, rubber, 1/2	(1)
		.02	42060	washer, shoulder, plastic	(4)
		.01	42061	washer, flat #8	(2)
		.01	42062	washer, split #8	(2)
		.02	42511	retainer, indicator	(1)
		.34	52007	binding post	(2)
		.01/ft.	58004	wire, hook-up, black, 19"	
		.01/ft.	58005	wire, hook-up, brown, 22"	
		.01/ft.	58006	wire, hook-up, red, 13"	
		.01/ft.	58007	wire, hook-u orange, 4"	
		.01/ft.	58008	wire, hook-up, yellow, 13"	
		.01/ft.	58009	wire, hook-up, green, 2"	
		.01/ft.	58010	wire, hook-up, blue, 24"	
		.01/ft.	58011	wire, hook-up, violet, 4"	
		.03/ft.	58036	wire, clt., black-white, 11"	
		.03/ft.	58037	wire, clt., grey-black, 15"	
		.03/ft.	58055	wire, clt., yellow-black, 15"	
		.09/ft.	58300	tubing, 4"	
		.01/ft.	58501	wire, bare, 18"	
		.10	89679	bracket, handle mounting	(2)
		.20	89680	plate, handle mounting	(2)
		1.08	87007	handle, plastic	(1)
		n/c	89369	label, nomenclature	(1)
	(1)				
	(2)				
	(1)				
ground, 3/8	(2)				
ground, #6	(1)				
ground, #8	(2)				
v, #6-32 x 1/4, Ph. Hd.	(10)				
Type F					
v, #4-40 x 5/16, B.H.	(6)				
v, #4-40 x 1/4, F.H.	(4)				
v, #6-32 x 5/16, B.H.	(6)				
v, #6-32 x 3/8, F.H.	(1)				
v, #8-32 x 3/8	(8)				
hex, #4-40	(6)				

To order replacement parts, specify description and part number. Remittance must be made with order, and include \$1.00 for mailing and handling with each order (\$1.50 for each transformer if order includes 1 or more output or power transformers.) Prices subject to change without notice.

FREQ MULTIPLIER

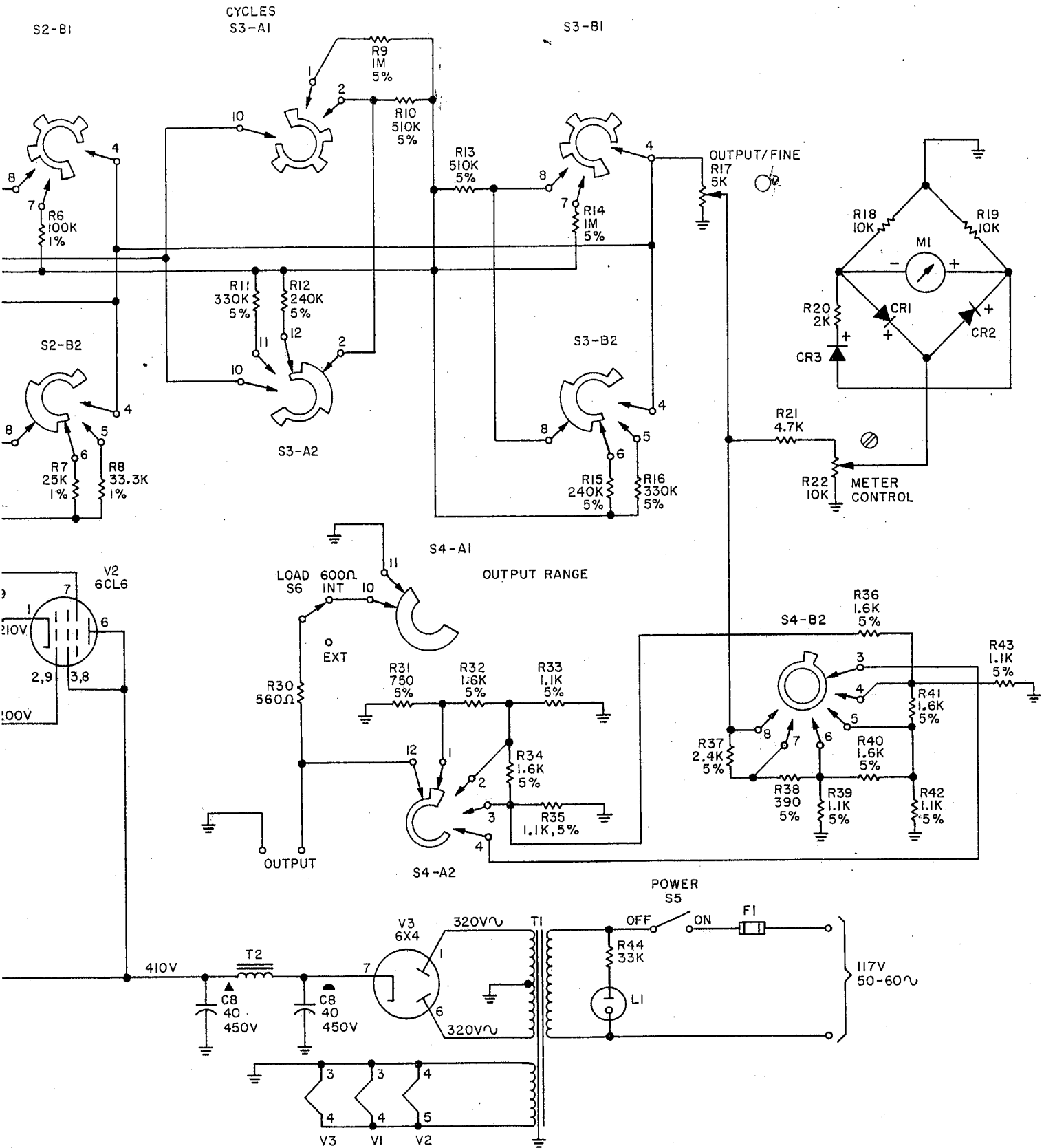


SWITCHES

- S1 - FREQ MULTIPLIER
- S2 - CYCLES
- S3 - CYCLES
- S4 - OUTPUT RANGE
- S5 - POWER (ON-OFF)
- S6 - LOAD (EXT-600Ω INT)

NOTES

1. ALL RESISTOR VALUES ARE IN OHMS.
2. ALL RESISTORS ARE RATED 1/2 WATT, AND ARE NOT REQUIRED TO BE MORE THAN ±10% ACCURATE UNLESS OTHERWISE STATED.
3. ALL CAPACITORS ARE IN UF UNLESS OTHERWISE STATED.
4. ALL ROTARY SWITCHES ARE SHOWN FROM KNOB END WITH SWITCHES IN EXTREME COUNTER-CLOCKWISE POSITION.
5. M = MEGOHMS (1,000,000 OHMS).
K = KILOHMS (1,000 OHMS).
6. PF (PICOFARAD) IS IDENTICAL WITH UUF (MICRO-MICROFARAD).
7. ○ DENOTES FRONT PANEL CONTROL.
⊗ DENOTES SCREWDRIVER ADJUST.



EICO 378 SCHEMATIC DIAGRAM

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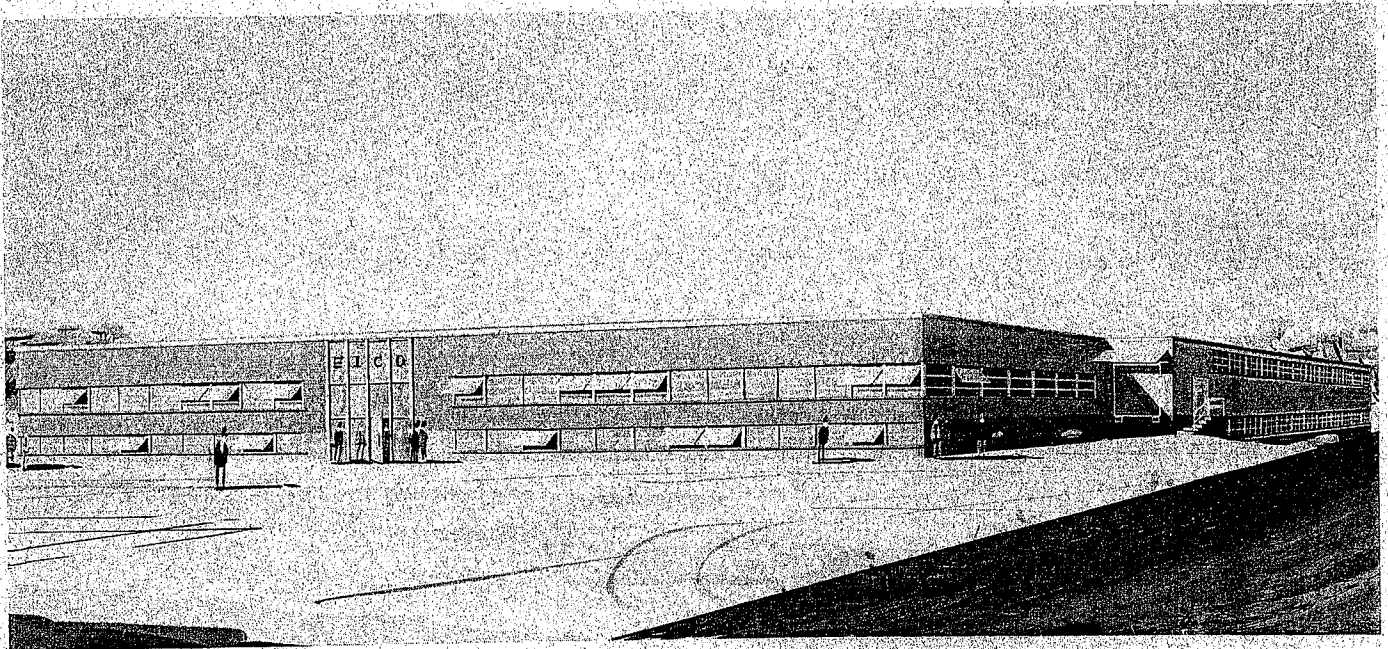
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