EXACT

ELECTRONICS, INC.

INSTRUCTION MANUAL

Type 240 s/n _____

T.O. 33A1-8-376-1

INSTRUCTION MANUAL

Type 240 s/n _____

EXACT Electronics, Inc

455 S. 2ND AVE.
HILLSBORO, OREGON
PHONE (503) 648-6661
TWX (503) 821-6927

INDEX

SECTION 1 OPERATION

TYPE 240 FUNCTION GENERATOR

TYPE 240 FUNCTION GENERATOR

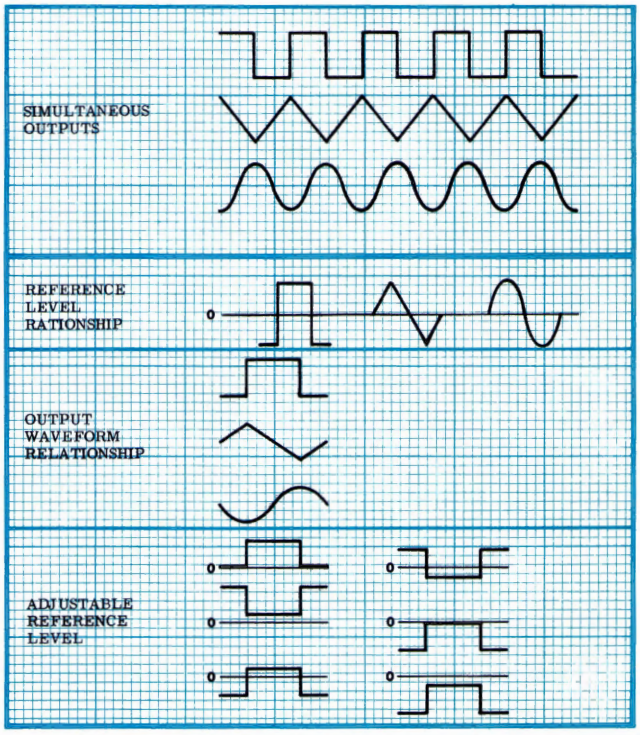
TYPE 240 FUNCTION GENERATOR. Here's a Function Generator that simultaneously produces four separate outputs. Three of the outputs are fixed amplitude square, triangle, and sine waveforms. The fourth output (MAIN) is switched to provide any of the three waveforms, with adjustable amplitude and reference level. The 240 is a reliable general purpose Function Generator for use in circuit design, equipment checkout and calibration, and in quality control applications.

SIMULTANEOUS OUTPUTS. All outputs of the 240 are simultaneous and synchronized throughout the frequency range. Phase relationship is unique in that the triangle and sine waveform peaks occur at the rise and fall points of the square waveform.

MAIN OUTPUT REFERENCE LEVEL. The main output reference level control enables the output waveform reference level (center of triangle, sine and square) to be shifted between -15 and +15 volts or, in the switched position, set to approximately 0 volts. Also, circuit ground can be either strapped to chassis ground or left isolated.

PACKAGING. The 240 is 5-1/4" high by 15-1/2" wide, and weighs only 18 lbs. net. The 240 can be supplied in rackmount version (240RM) at no additional cost. Front panel is dark grey in color, with silkscreened white callouts. End bells and cabinet are medium grey. All exterior finishes are oven baked for durability.

* SIMULTANEOUS OUTPUTS
* SQUARE - TRIANGLE - SINE
* 300mv to 25 volts P-P
* 0.001 to 10,000 KC



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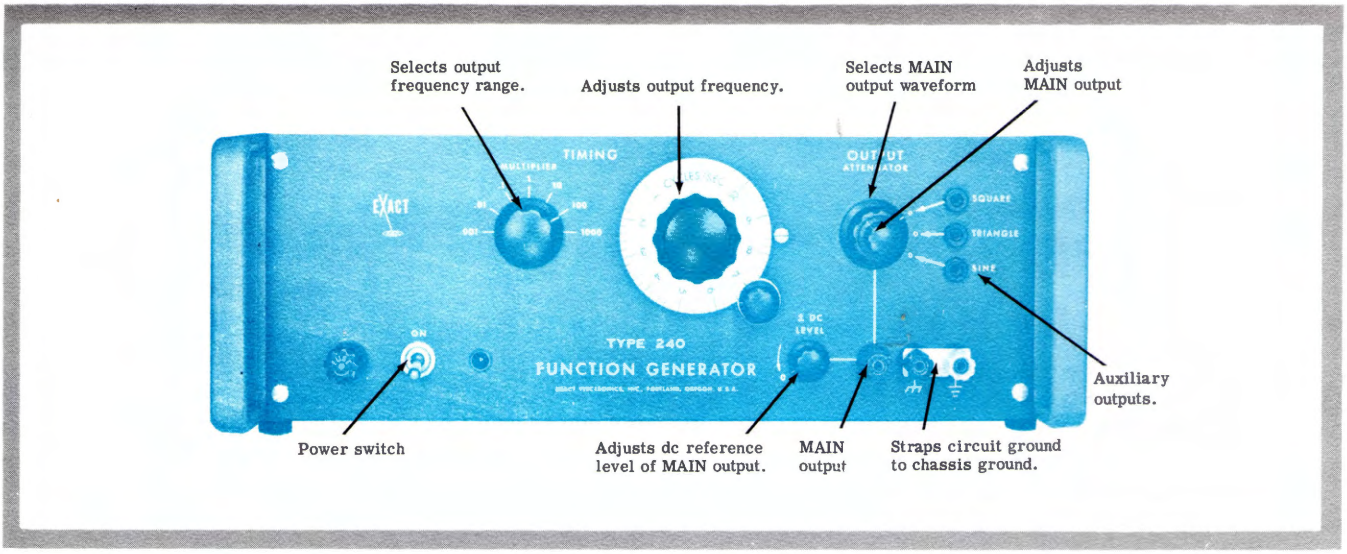


SPECIFICATIONS

MAIN OUTPUT

Amplitude*. . . . . 300 mv to 25 volts P-P (min)
. . . . . 25 volts into 5K load
Stability/Repeatability
. . . . . 50 mv (10 min), 150 mv (24 hrs)
Amplitude Change with Frequency . . . . . 0.5% to 1kc
. . . . . 1% to 10kc
Amplitude Change with Function . . . . . 1% max
DC Reference Level
Range*. . . . -15 to +15 volts or switched to 0 volts
Frequency Range . . . . . 0.001 cps to 10 kc
Frequency Deviation from Absolute . . . . . 3% max
Long Term Frequency Stability . . . . . ±1%

POWER REQUIREMENTS

Line Voltage. . . . . 105 to 125 or 200 to 250 vac
Line Frequency. . . . . 50 to 400 cps
Power . . . . . 125 watts

PHYSICAL CHARACTERISTICS

Weight . . . . . 18 lbs net, 25 lbs gross
Volume . . . . . 2 cu ft gross
Dimensions . . . . . 15-1/2w X 5-1/4h X 13d

SQUARE WAVEFORM

Risetime . . . . . 5 usecs or faster
Symmetry 99.5%
Overshoot . . . . . 1% max
Droop . . . . . 1% max

TRIANGLE WAVEFORM

Linearity 99.5%
Symmetry 99.5%

SINE WAVEFORM

Total Distortion.. Less than 2% over entire freq. range

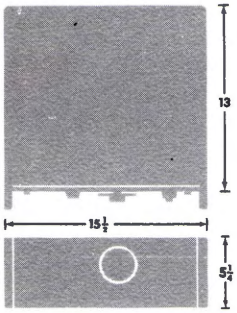
AUXILIARY OUTPUTS

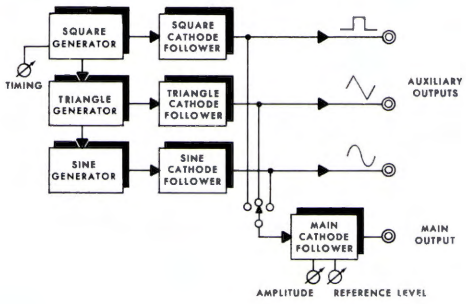
Amplitude*. . . . . 30 volts P-P (min)
. . . . . 30 volts into 7K
Stability/Repeatability . . . . . (same as main)
Amplitude Change with Frequency . . (same as main)
DC Reference Level. . . . . 0 volts (fixed)
Frequency Range . . . . . Synchronized with main

*Max Current. . . . . 15 ma @ +15 vdc reference level
. . . . . 3 ma @ -15 vdc reference level

PRICE

F.O.B. Factory $475.00





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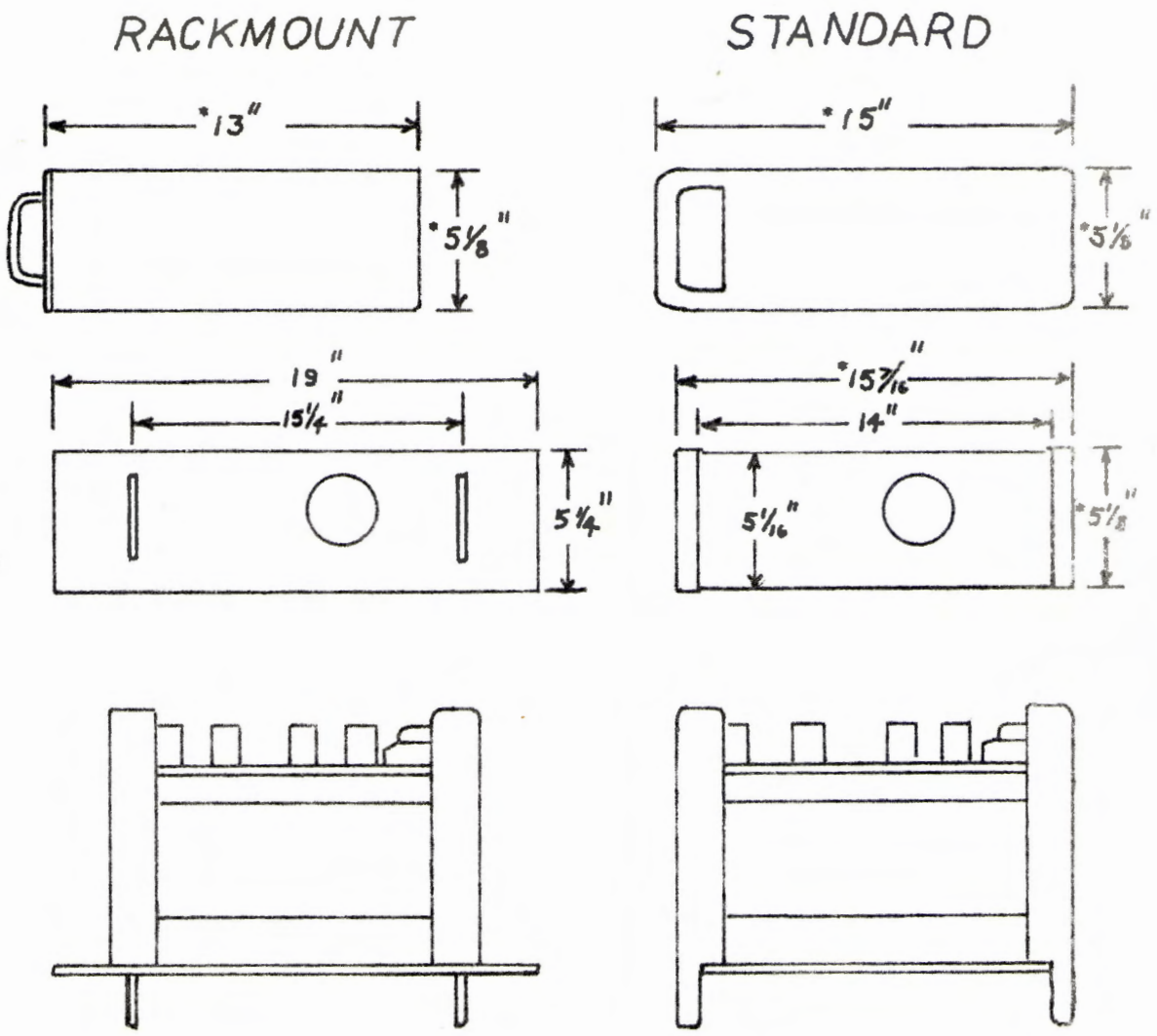
455 S.E. 2nd Avenue, Hillsboro, Oregon 97123

Telephone (503) 648-6661 □ TWX: 503-821-6927

6-64

1.1 SPECIFICATIONS (CONTINUED)

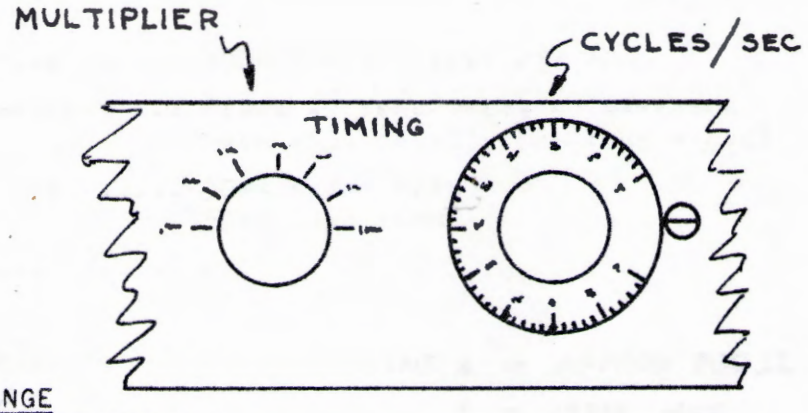
DIMENSIONS:



* THESE MEASUREMENTS ARE CORRECT WITHIN ±1/16" DUE TO THE CASTING OF THE ALUMINUM ENDBELLS.

1.2 FRONT PANEL FAMILIARITY

1.2.1 TIMING

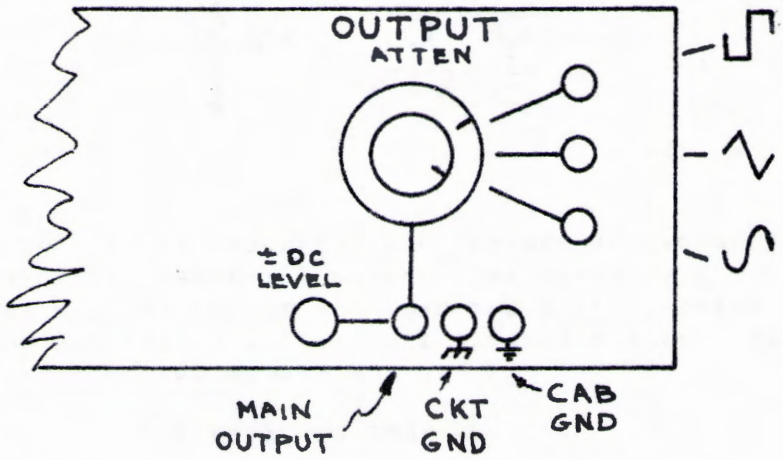


(A) TIMING RANGE
.001 CPS TO 10,000 CPS

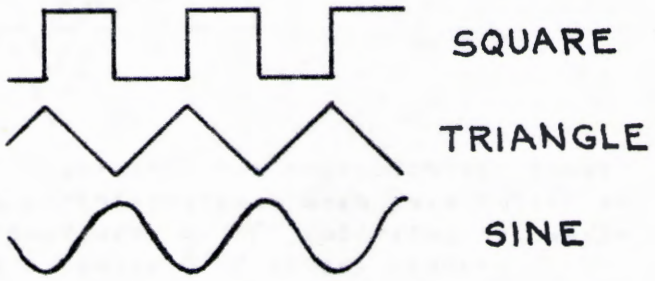
(B) TIMING ACCURACY MAXIMUM 2% DEVIATION BETWEEN ANY COMBINATION OF MULTIPLIER AND DIAL SETTING AND ABSOLUTE TIME

(C) TIMING STABILITY MAXIMUM 1% DEVIATION FROM ORIGINAL SET FREQUENCY OVER A 24 HOUR PERIOD. TIMING IS MORE CRITICAL AT X1 END OF THE CYCLES/SEC DIAL

1.2.2 OUTPUT



(A) TIME-PHASE RELATION OF OUTPUTS



1.2.2. OUTPUT (CONTINUED)

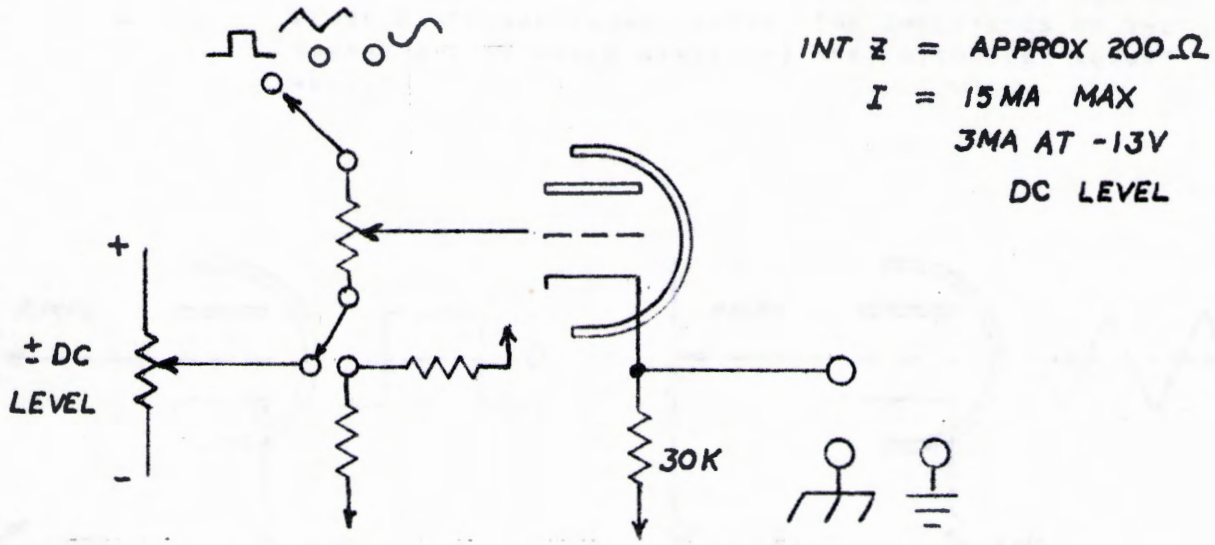
(B) MAIN OUTPUT

(1) AMPLITUDE ..... 300MV TO AT LEAST 25V PP

(2) DC COMPONENT ... FIXED AT ZERO VOLTS OR VARIABLE FROM -13V TO +13V (MINIMUM RANGE)

(3) STABILITY ..... 50MV SHORT TERM
150MV LONG TERM

(4) IMPEDANCE .....



(C) POLARITY

CIRCUIT GROUND CAN BE ISOLATED FROM CABINET GROUND BY REMOVING THE INTERCONNECTING STRAP. THE OUTPUT WILL NOW BE FLOATING. IF YOU DO NOT LOAD THE OUTPUT, THERE WILL BE SOME HUM PICKUP AND A 1 µFD CAPACITOR SHOULD BE PLACED BETWEEN THE TWO GROUND POSTS.

MAXIMUM ELEVATION POTENTIAL -- 500V

(D) DC LEVEL

THE ABOVE SKETCH ILLUSTRATES THE OPERATION AND RANGE OF THE ± DC LEVEL POTENTIOMETER. WHEN THIS POTENTIOMETER IS IN THE "SWITCHED" OR "0" POSITION, THE WAVEFORMS SHOULD HAVE A CENTER 0 DC LEVEL. INTERNAL ADJUSTMENTS ON ALL WAVEFORME ASSURE THAT THIS CAN ALWAYS BE TRUE. THE SINE AND SQUARE OFFSETS ARE SIMILAR TO THE ABOVE TRIANGLE OFFSETS.

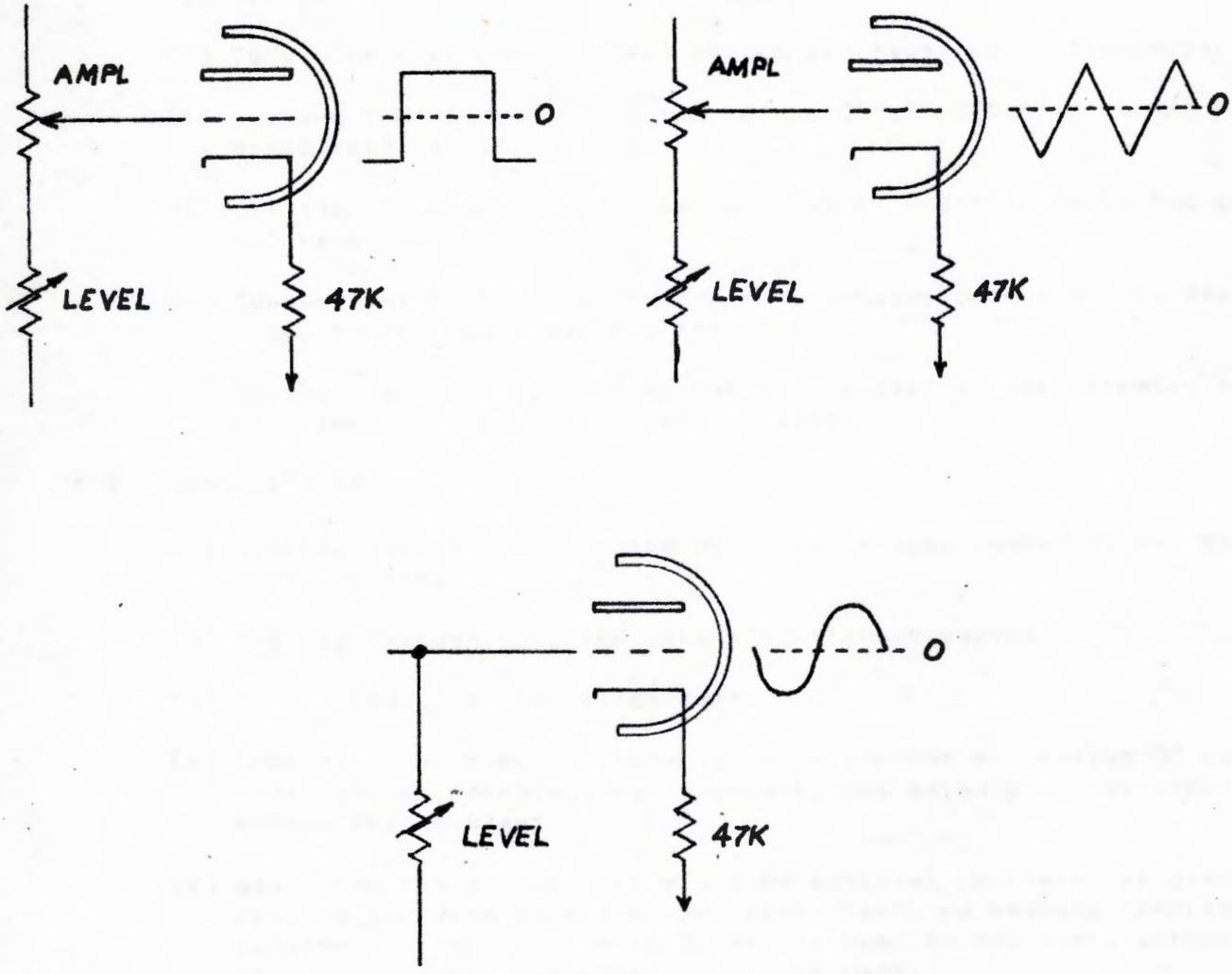
1.2.2 OUTPUT (CONTINUED)

(E) AMPLITUDES

THE AMPLITUDES OF ALL WAVEFORMS ARE THE SAME WITHIN 2%. INTERNAL ADJUSTMENTS ON THE SQUARE AND TRIANGLE WAVEFORMS ASSURE THAT THEIR AMPLITUDES CAN BE ADJUSTED TO WITHIN 2% OF THE SINE WAVE AMPLITUDE.

(F) SIMULTANEOUS OUTPUTS

THE SIMULTANEOUS OUTPUT WAVEFORMS ARE AT A FIXED DC LEVEL (INTERNAL ADJUSTMENT). THE AMPLITUDES OF THE SQUARE AND TRIANGLE WAVEFORMS ARE INTERNALLY ADJUSTABLE.



1.3 PURPOSE

THE GENERAL PURPOSE OF THE TYPE 240 IS TO GENERATE SQUARE, TRIANGLE AND SINE WAVEFORMS OVER A CONTINUOUSLY VARIABLE FREQUENCY RANGE OF 0.001 CPS TO 10,000 CPS. THESE WAVEFORMS ARE AVAILABLE SIMULTANEOUSLY FROM THE DESIGNATED JACKS ON THE RIGHT HAND SIDE OF THE FRONT PANEL AND/OR SINGLY AS SELECTED FROM THE MAIN OUTPUT TERMINAL.

1.4 OPERATION

FOR FIRST-TIME OPERATION, THE FOLLOWING PROCEDURE SHOULD BE USED:

(A) CHECK FOR STRAP BETWEEN THE GROUND POSTS.

(B) SET THE POWER SWITCH TO ON.

(C) ALLOW A TEN-MINUTE WARM-UP PERIOD.

(D) SET THE OUTPUT SWITCH TO TRIANGLE WAVEFORM.

(E) TURN OUTPUT ATTENUATOR (RED CONCENTRIC KNOB) FULLY CLOCKWISE.

(F) SET THE TIMING MULTIPLIER SWITCH AND CYCLES/SEC DIAL TO THE DESIRED FREQUENCY.

(G) SET THE ±DC LEVEL TO 0 . (SWITCH CLOSED) POSITION OR TO THE OUTPUT LEVEL DESIRED.

(H) CONNECT THE MAIN OUTPUT AND/OR SIMULTANEOUS OUTPUT TO THE SYSTEM, CIRCUIT, AND OSCILLOSCOPE, ETC.

(J) CONNECT THE SIMULTANEOUS SQUARE WAVE OUTPUT TO THE EXTERNAL TRIGGER INPUT OF THE MONITOR OSCILLOSCOPE.

1.5 APPLICATIONS

(A) GENERAL WAVEFORM SOURCE FOR RESEARCH, ANALOG COMPUTERS AND SYSTEMS CHECKING

(B) THE LOW FREQUENCY SQUARE WAVE FOR RESPONSE CHECKS

(C) THE TRIANGLE AS RASTER GENERATOR

(D) LINEARITY CHECKING OF INSTRUMENTS OR SYSTEMS BY VARYING DC LEVEL AMPLITUDE OR FREQUENCY WHILE HOLDING ONE OR BOTH OF THE OTHER PARAMETERS CONSTANT

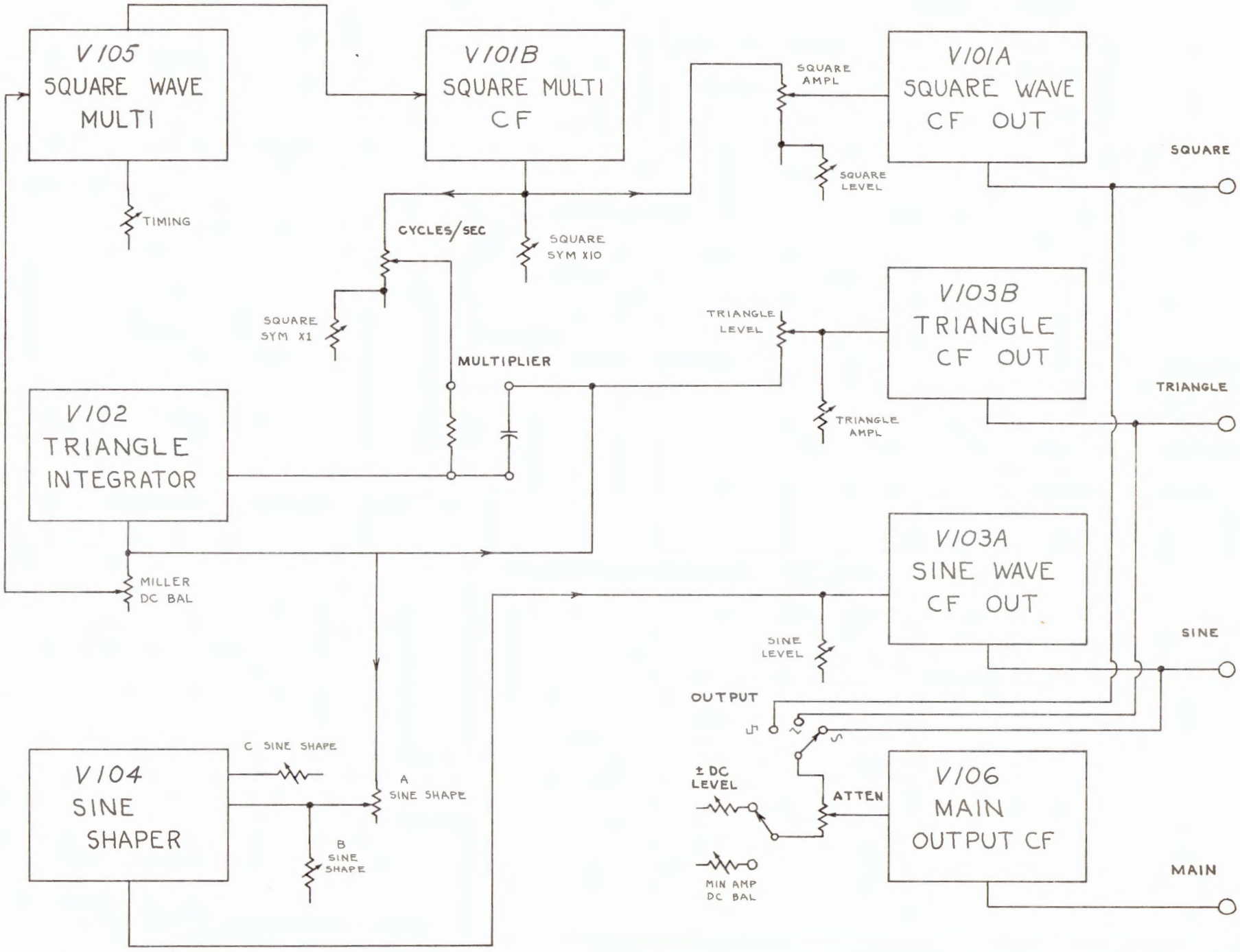
(E) WAVEFORMS CAN BE DIRECTLY MIXED BY PATCHING TOGETHER THE SIMULTANEOUS AND MAIN OUTPUT AT THE FRONT PANEL TO PRODUCE COMPLEX WAVEFORMS. IF YOU WISH TO DC OFFSET SOME OF THE SIMULTANEOUS OUTPUTS, INTERNAL ADJUSTMENTS CAN BE MADE.

SECTION II MAINTENANCE

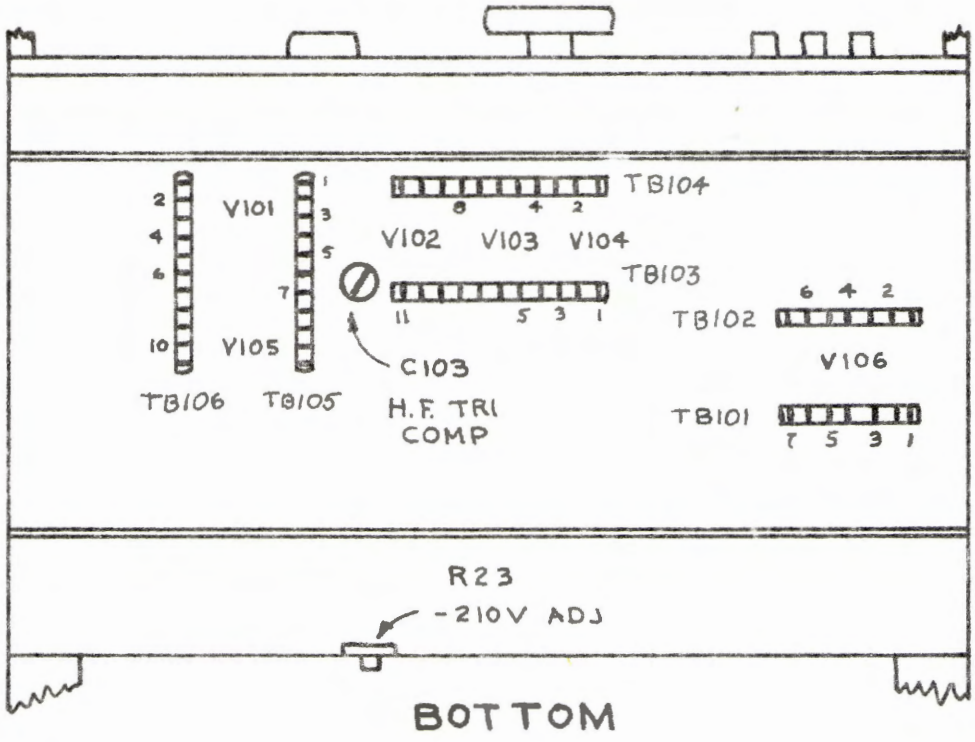
CAUTION TO ASSURE DRIFT-FREE OPERATION WITHIN THE INSTRUMENT CAPABILITIES, AGED TUBES SHOULD BE USED FOR REPLACEMENT.

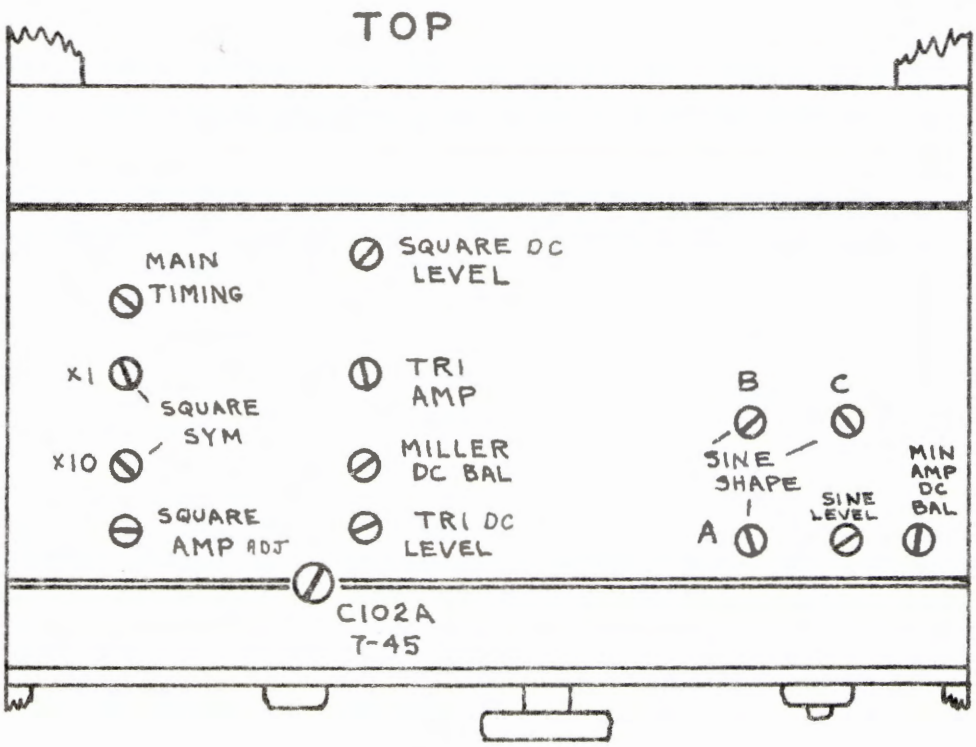
TYPE 240 BLOCK DIAGRAM

640110FT



2.2 CHASSIS LAYOUT





2.3 CIRCUIT DESCRIPTION

2.3.1 POWER SUPPLY

THE THREE POWER SUPPLIES ARE ALL BASED ON THE SAME PRINCIPLE: A DC AMPLIFIER IS REFERENCED TO A STANDARD VOLTAGE (A 5651 GAS TUBE OR PRECISION DIVIDERS FROM -210V). ANY VARIATION FROM LINE OR LOAD IS AMPLIFIED BY THE DC AMPLIFIER AND PASSED ALONG AS A CONTROL VOLTAGE TO THE SERIES REGULATOR TUBE. THE FILAMENT SUPPLY IS REGULATED BY A TRANSISTOR REFERENCED TO A ZENER DIODE.

2.3.2 SQUARE WAVEFORM GENERATOR

(A) V105 IS A CATHODE COUPLED MULTIVIBRATOR. ITS OUTPUT (PIN #6) SWINGS FROM BELOW -100V, WHEN V105B IS CONDUCTING, TO +100V WHEN IT IS CUT OFF. THE TIME DURATION OF EACH HALF-CYCLE IS DETERMINED BY THE TRIANGLE WAVEFORM AT GRID PIN #9 OF V105A. THE TRIANGLE NOW DETERMINES THE SWITCHING OF THE MULTIVIBRATOR. THE TRIANGLE MUST ALWAYS PASS THROUGH THE SAME DC LEVELS TO SWITCH V105 AND THEREFORE THIS PARTLY DETERMINES THE TIMING OF THE INSTRUMENT.

(B) THE LOOP GAIN OF THE CATHODE COUPLED MULTIVIBRATOR IS DETERMINED BY ITS CATHODE CURRENT. THIS DETERMINES THE FINAL TIMING AND IS CONTROLLED BY R105.

(C) V101B IS A CATHODE FOLLOWER WHOSE OUTPUT HAS THREE FUNCTIONS:

(1) SQUARE WAVE SYMMETRY (X10), R111 PROVIDES FOR EQUAL VOLTAGE BUT OPPOSITE POLARITY AT X10 END OF CYCLES/SEC DIAL FOR EACH HALF-CYCLE OF V105.

(2) PROVIDES STANDARD SQUARE WAVE TO OUTPUT CATHODE FOLLOWER V101A.

(3) PROVIDES SQUARE WAVE TO MILLER INTEGRATOR TIMING RESISTORS AND CAPACITORS (R134-R136 AND C102A-F).

2.3.3 TRIANGLE WAVEFORM GENERATOR

V102 IS A MILLER INTREGRATOR AMPLIFIER WITH AN ASSOCIATED CATHODE FOLLOWER. THE SYMMETRICAL SQUARE WAVE FROM V101B IS FED TO GRID PIN #2 OF V102 AND THE INTEGRATOR ACTION PRODUCES A TRIANGLE WAVEFORM AT THE CATHODE (PIN #8 OF V102). TIME CONSTANTS FOR THE INTEGRATOR ARE C102 (A-F), R116 AND R134, R135, R136. MILLER DC BAL R132 DETERMINES THE LEVEL AND AMPLITUDE OF THE SIGNAL BEING FED BACK TO THE GRID PIN #9 OF V105.

2.3.4 SINE WAVEFORM GENERATOR

V104 IS A PENTODE WHOSE BIAS CHARACTERISTICS ARE ADJUSTED BY THREE SINE SHAPING ADJUSTMENTS, R139, R143 AND R145. THE LINEAR TRIANGLE FROM V102 IS SHAPED BY THESE ADJUSTMENTS TO PRODUCE A VERY LOW DISTORTION SINE WAVE AT THE PLATE PIN #5.

2.3.4 SINE WAVEFORM GENERATOR (CONTINUED)

SINE ADJ A (R139) CONTROLS THE DC LEVEL OF THE GRID.

SINE ADJ B (R143) CONTROLS THE AMPLITUDE OF THE TRIANGLE INTO GRID PIN #1 OF V104.

SINE ADJ C (R145) CONTROLS THE SUPPRESSOR BIAS OF V104.

2.3.5 MAIN OUTPUT

V106 IS A CONVENTIONAL CATHODE FOLLOWER. THE PROPER WAVEFORM BEING FED TO THE GRID IS SELECTED BY THE OUTPUT SWITCH, SW104. THE DC LEVEL OF THE CONTROL GRID IS DETERMINED BY:

(A) R158, R159 AND R161 IF ±DC OUTPUT LEVEL SWITCH IS CCW IN SWITCHED POSITION.

(B) R162 IF ±DC OUTPUT LEVEL SWITCH IS CW FROM SWITCHED POSITION.

2.3.6 SIMULTANEOUS OUTPUTS

V101A, V103B AND V103A ARE STANDARD CATHODE FOLLOWERS PROVIDING LOW IMPEDANCE OUTPUTS FOR THE INDIVIDUAL SQUARE, TRIANGLE AND SINE WAVEFORMS. THE SINE WAVEFORM CATHODE FOLLOWER (V103A) HAS A DC LEVEL CONTROL ONLY, WHILE THE SQUARE WAVE AND TRIANGLE WAVEFORM CATHODE FOLLOWERS (V101B AND V103B) HAVE BOTH DC LEVEL AND AMPLITUDE CONTROLS.

2.4 TROUBLESHOOTING PROCEDURE

2.4.1 POWER SUPPLY

(A) ALL CIRCUITS DEPEND ON THE REGULATED -210V, +100V AND +250V. THE MORE CRITICAL GENERATING CIRCUITS ALSO DEPEND ON THE -11V FILAMENT REGULATION. ALWAYS CHECK THESE SUPPLIES FOR CORRECT VOLTAGE AND MINIMUM RIPPLE (BELOW 10MV ON HIGH-VOLTAGE SUPPLIES AND BELOW 100MV ON -11V SUPPLY).

(1) FOR -210V PROBLEMS CHECK V1, V2 AND V3; CHECK -210 ADJ R23; CHECK DIODES D9 THROUGH D12.

(2) FOR +100V PROBLEMS CHECK -210V, V3 AND V4, DIVIDER VOLTAGE AT PIN #1 OF V4 AND DIODES D5 THROUGH D8.

(3) FOR +250V PROBLEMS CHECK -210V, V5 AND V6, DIVIDER VOLTAGE AT PIN #1 OF V6 AND DIODES D1 THROUGH D4.

(4) FOR -11V PROBLEMS CHECK Q1, ZENER DIODE D17 AND DIODES D13 THROUGH D16.

(B) WHEN EXPERIENCING HUM, DRIFT OR JITTER, CHECK THE REGULATION OF THE POWER SUPPLIES AND/OR INSURE THAT THE STRAP IS INSTALLED BETWEEN THE CHASSIS GROUND AND THE CIRCUIT GROUND TERMINALS.

2.4.1 POWER SUPPLY (CONTINUED)

(c) SHORTED RECTIFIER DIODES MAY CAUSE FUSE BLOWING.

2.4.2 SQUARE WAVEFORM

V105 GENERATES THE SQUARE WAVEFORM. THE FLIP TIME IS DETERMINED BY THE TRIANGLE WAVEFORM PRESENT AT THE GRID (PIN #9 OF V105) WHICH IS DERIVED FROM V102 CATHODE FOLLOWER. PROBLEMS INVOLVING SQUARE WAVEFORM ONLY SHOULD BE TRACED TO V101 AND V105 IN THAT ORDER. IF EXPERIENCING AN UNSYMMETRICAL SQUARE WAVEFORM, VERIFY THAT THE TWO SYMMETRY ADJUSTMENTS R111 AND R120 ARE CORRECT (SEE PARAGRPH 3.2.4).

2.4.3 TRIANGLE WAVEFORM

V102 IS A MILLER INTEGRATOR. THE INTEGRATOR INPUT IS A SQUARE WAVEFORM FROM V101B. THE INTEGRATOR OUPUT IS A POSITIVE AND NEGATIVE GOING VOLTAGE IN THE FORM OF A TRIANGLE. PROBLEMS INVOLVING TRIANGLE ONLY SHOULD BR TRACED TO V103B, V102, R133 AND R105 SETTINGS IN THAT ORDER.

2.4.4 SINE WAVEFORM

V104 SHAPES THE TRIANGLE WAVEFORM INTO A SINE WAVEFORM. THIS SHAPING DEPENDS ON ACCURATE SYMMETRY OF THE SQUARE AND TRIANGLE WAVEFORMS. THE INPUT DC LEVEL AND AMPLITUDE OF THE TRIANGLE WAVEFORM ARE CRITICAL. ALL PREVIOUS SETTINGS AND CALIBRATION PROCEDURES SHOULD BE CHECKED BEFORE FURTHER TROUBLESHOOTING OF THE SINE WAVEFORM. ONLY THEN SHOULD PROBLEMS BE TRACED TO V103A, V102, SINE SHAPE ADJUSTMENTS (R139, R143 AND R145) AND SINE DC LEVEL R154 IN THAT ORDER.

2.4.5 DC LEVELS

INCORRECT DC LEVELS OF OUTPUT WAVEFORMS MAY BE CAUSED BY INCORRECT INTERNAL DC LEVEL ADJUSTMENTS (SEE PARAGRAPH 3.5).

2.5 RESISTANCE AND DC VOLTAGE CHARTS

2.5.1 POWER SUPPLY RESISTANCE AND DC VOLTAGE CHART

(A) RESISTANCE MEASUREMENTS

THE RESISTANCE MEASUREMENTS WERE MADE ON A COLD INSTRUMENT WITH CONTROLS SET AS FOLLOWS:

MULTIPLIER	100
CYCLES/SEC DIAL	10
ATTENUATOR	FULL CW
POWER OFF-ON	OFF

2.5.1 POWER SUPPLY RESISTANCE AND DC VOLTAGE CHART (CONTINUED)

(B) DC VOLTAGE MEASUREMENTS

(1) THE DC VOLTAGE MEASUREMENTS WERE MADE WITH A VTVM HAVING AN 11 MEGOHM INPUT RESISTANCE. THE INSTRUMENT INPUT VOLTAGE WAS ADJUSTED TO 117 VAC

(2) THE FUNCTION GENERATOR CONTROLS WERE SET AS FOLLOWS:

MULTIPLIER	100
CYCLES/SEC DIAL	10
ATTENUATOR	FULL CW
POWER OFF-ON	ON

2.5.2 MAIN CHASSIS RESISTANCE AND DC VOLTAGE CHART

(A) RESISTANCE MEASUREMENTS

THE RESISTANCE MEASUREMENTS WERE MADE ON A COLD INSTRUMENT WITH THE INSTRUMENT CONTROLS SET AS FOLLOWS:

MULTIPLIER	100
CYCLES/SEC DIAL	10
ATTENUATOR	FULL CW
POWER OFF-ON	OFF

(B) DC VOLTAGE MEASUREMENTS

(1) THE DC VOLTAGE MEASUREMENTS WERE MADE WITH A VTVM HAVING AN 11 MEGOHM INPUT RESISTANCE. THE INSTRUMENT INPUT VOLTAGE WAS ADJUSTED TO 117VAC.

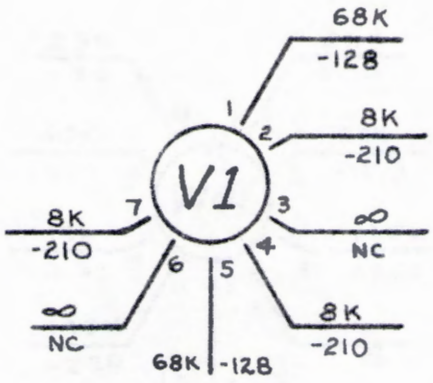
(2) THE FUNCTION GENERATOR CONTROLS WERE SET AS FOLLOWS:

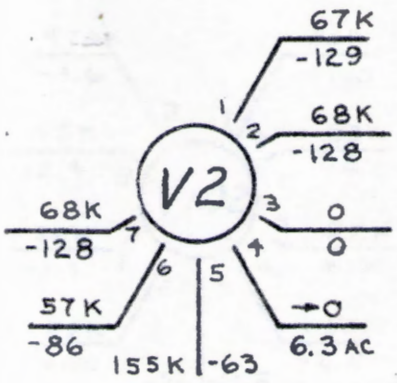
MULTIPLIER	100
CYCLES/SEC DIAL	10
ATTENUATOR	FULL CW
POWER OFF-ON	ON

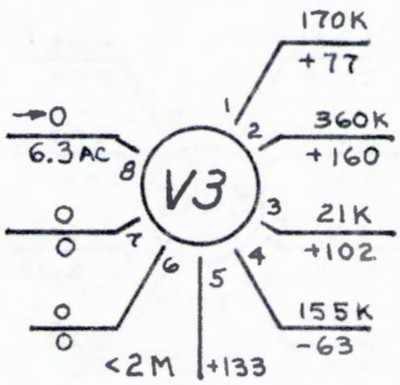
2.6 WAVEFORM AMPLITUDE AND DC LEVEL CHART

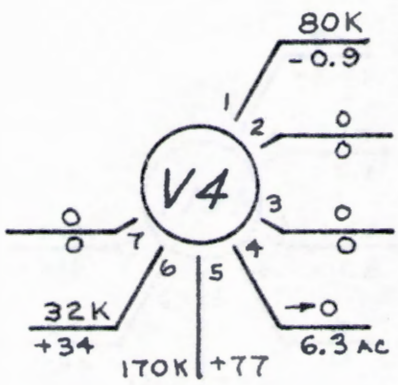
THE WAVEFORM AMPLITUDES AND DC LEVELS WERE MEASURED USING A TEKTRONIX TYPE 532 OSCILLOSCOPE WITH A TYPE CA DUAL TRACE PLUG-IN.

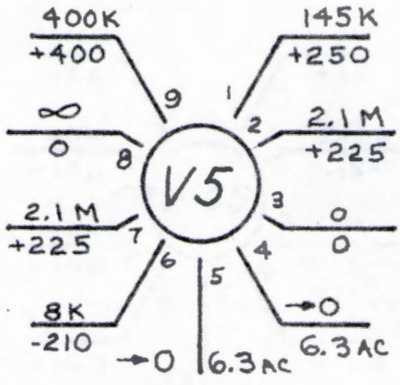
POWER SUPPLY DC VOLTAGE AND RESISTANCE CHART

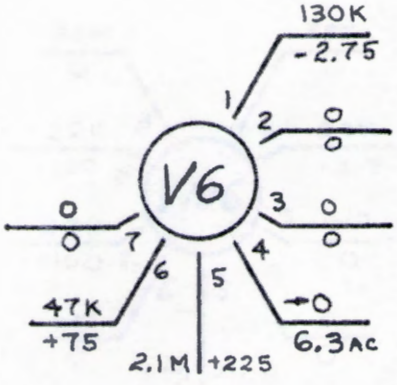


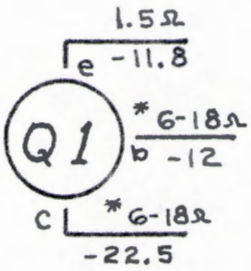






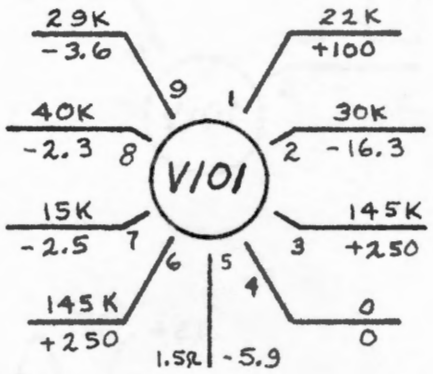


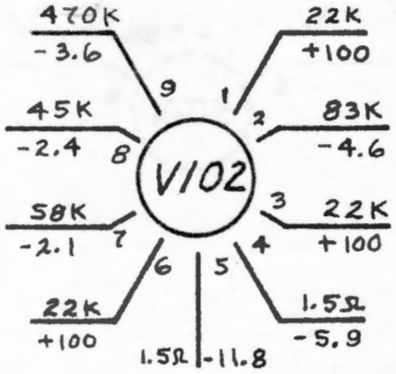


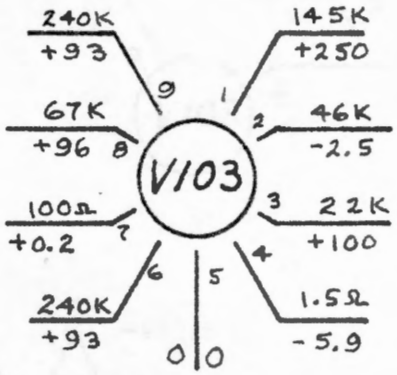


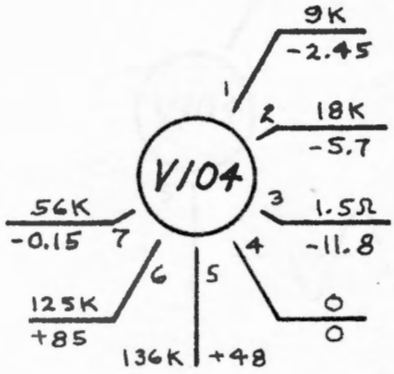
* DEPENDS ON METER POLARITY

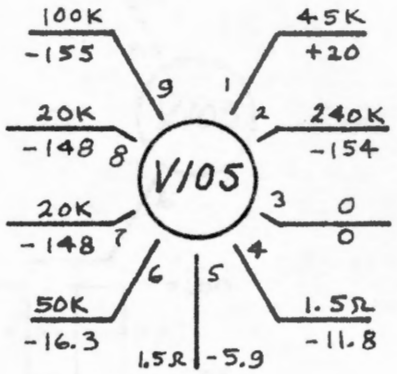
MAIN CHASSIS DC VOLTAGE AND RESISTANCE CHART

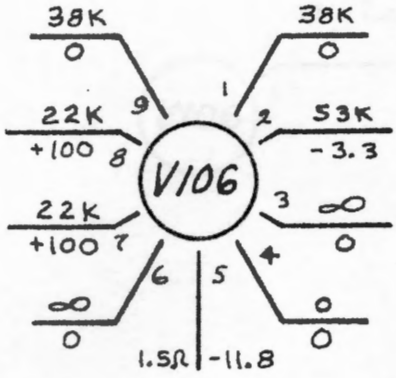




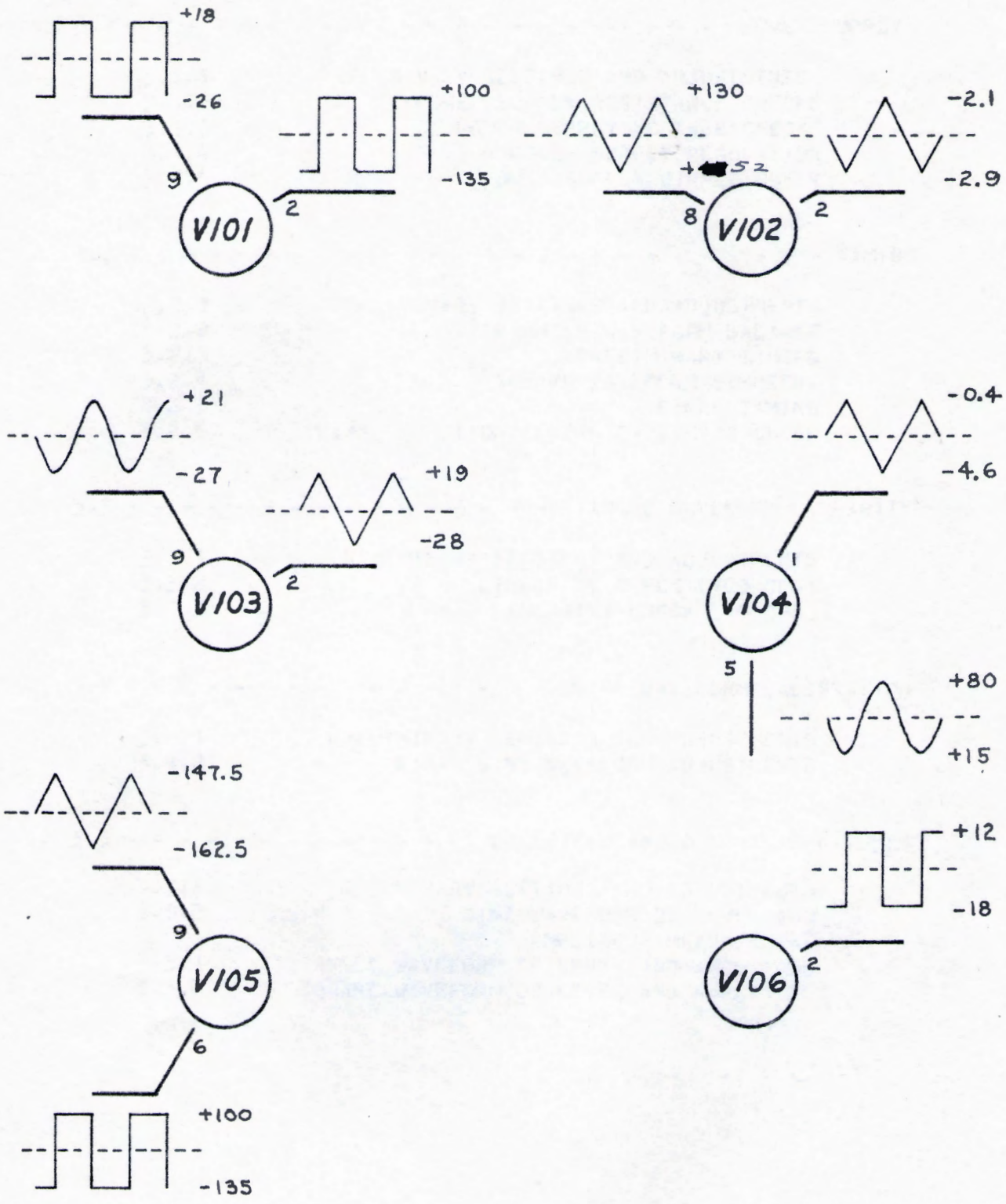








MAIN CHASSIS WAVEFORM AMPLITUDE AND DC LEVEL CHART



SECTION III CALIBRATION

CAUTION COVERS MUST BE IN PLACE DURING FINAL CALIBRATION.

CALIBRATION PROCEDURE

THE FOLLOWING TEST EQUIPMENT OR SUITABLE EQUIVALENTS OF KNOWN ACCURACY ARE REQUIRED FOR COMPLETE CALIBRATION OF THE TYPE 240 FUNCTION GENERATOR.

1. MULTIMETER	TRIPLETT MODEL 630
2. OSCILLOSCOPE	TEKTRONIX 503
3. DISTORTION ANALYZER	HEWLETT PACKARD 330B
4. AUTO TRANSFORMER	GENERAL RADIO TYPE M5

3.1 POWER SUPPLY

3.1.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) PLACE A STRAP BETWEEN THE CHAS GRD AND CKT GRD.

(B) SET THE MULTIPLIER SWITCH TO .001 AND THE CYCLES/SEC DIAL TO X1.

3.1.2 POWER SUPPLY RESISTANCE CHECKS

USING THE MULTIMETER, VERIFY THAT THE POWER SUPPLY RESISTANCES ARE AS SPECIFIED BELOW:

-210 VOLT SUPPLY APPROXIMATELY	8,000 OHMS
+250 VOLT SUPPLY APPROXIMATELY	60,000 OHMS MINIMUM
+100 VOLT SUPPLY APPROXIMATELY	22,000 OHMS

3.1.3 POWER SUPPLY VOLTAGE CHECKS

(A) CONNECT THE FUNCTION GENERATOR THROUGH THE VARIAC TO 117V, 60 CPS.

(B) USING THE MULTIMETER, VERIFY THAT THE POWER SUPPLY VOLTAGES ARE AS SPECIFIED BELOW:

-210 VOLT SUPPLY	-210VDC (ADJUSTABLE)
+100 VOLT SUPPLY	+100 ±5VDC
+250 VOLT SUPPLY	+250 ±13VDC
- 11 VOLT SUPPLY	- 11 ±1.1VDC

3.1.4 POWER SUPPLY REGULATION

VERIFY THAT ALL SUPPLIES REGULATE AS THE INPUT VOLTAGE IS VARIED FROM 105 TO 125 VAC.

3.1.5 POWER SUPPLY RIPPLE CHECK

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	MAX.
INPUT COUPLING	AC
SWEEP TIMING	10 MSEC/CM
TRIGGER	CONTINUOUSLY RUNNING

3.1.5 POWER SUPPLY RIPPLE CHECK (CONTINUED)

(B) AT THE FUNCTION GENERATOR REMOVE V105.

(C) USING THE OSCILLOSCOPE, VERIFY THAT RIPPLE VOLTAGES DO NOT EXCEED THE VOLTAGE SPECIFIED FOR EACH SUPPLY LISTED BELOW:

-210 VOLTS	10MV MAX.
+100 VOLTS	10MV MAX.
+250 VOLTS	10MV MAX.
- 11 VOLTS	100MV MAX.

(D) AT THE FUNCTION GENERATOR REPLACE V105.

3.2 TIMING

3.2.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MULTIPLIER	10

(B) CHECK THE CYCLES/SEC DIAL FOR MECHANICAL CENTER AND SET TO X10.

(C) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	1 V/CM
INPUT COUPLING	DC
SWEEP TIMING	10 MSEC/CM
TRIGGER	INTERNAL

3.2.2 TRIANGLE WAVEFORM BALANCE

THE INSTRUMENT SHOULD BE ON AT LEAST 15 MINUTES BEFORE ANY OF THE FOLLOWING ADJUSTMENTS ARE MADE.

CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO PIN #8 OF V102 AND ADJUST THE MILLER DC BAL R132 UNTIL THE BOTTOM OF THE TRIANGLE WAVEFORM IS AT +52 ±2V. THE AMPLITUDE OF THE WAVEFORM AT THIS LEVEL WILL VARY SLIGHTLY FROM INSTRUMENT TO INSTRUMENT. HOWEVER THE MOST IMPORTANT SETTING IS TO HAVE THE NEGATIVE PEAK OF THE TRIANGLE WAVEFORM AT +52 ±2V.

3.2.3 PRELIMINARY TIMING

(A) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE TRIANGLE WAVEFORM OUTPUT TERMINAL. VERTICAL SENSITIVITY SHOULD BE SET TO 10 V/CM.

(B) ADJUST THE MAIN TIMING ADJ R105 AND VERIFY THAT TEN TRIANGLES APPEAR FOR 10 CM OF SWEEP ON THE OSCILLOSCOPE.

3.2.4 SQUARE WAVEFORM SYMMETRY

(A) SET THE CONTROLS OF THE OSCILLOSCOPE AS FOLLOWS:

VERTICAL SENSITIVITY	10 V/CM
INPUT COUPLING	DC
SWEEP TIMING	1 MSEC/CM
TRIGGER	INTERNAL

(B) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE SQUARE WAVE OUTPUT TERMINAL OF THE FUNCTION GENERATOR. ADJUST THE OSCILLOSCOPE TRIGGERING SO THAT A CHANGE FROM PLUS TO MINUS INTERNAL TRIGGERING WILL CAUSE A STATIONARY POLARITY REVERSAL OF ONE CYCLE OF THE SQUARE WAVE.

(C) POSITION THE RISE OR FALL OF THE SQUARE WAVE TO THE CENTER OF THE GRATICULE AND TURN THE OSCILLOSCOPE MAGNIFIER TO ON.

(D) WHILE SWITCHING THE OSCILLOSCOPE TRIGGER BETWEEN PLUS AND MINUS INTERNAL TRIGGERING, ADJUST THE SQUARE SYMMETRY (X10) R111 FOR NO SHIFT IN THE WAVEFORM (EQUAL POSITIVE AND NEGATIVE PORTIONS REFERENCED TO TIME).

(E) SET THE FUNCTION GENERATOR CYCLES/SEC DIAL TO X1, THE MULTIPLIER TO 100 AND THE OSCILLOSCOPE SWEEP TO 1 MSEC/CM.

(F) REPEAT THE PROCEDURE IN 3.2.4 (D) ADJUSTING THE SQUARE SYMMETRY (X1) R120 FOR NO SHIFT IN THE WAVEFORM.

3.2.5 FINAL TIMING

(A) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MULTIPLIER	10
CYCLES/SEC DIAL	10

(B) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	10 V/CM
INPUT COUPLING	DC
SWEEP TIMING	10 MSEC/CM
TRIGGER	EXTERNAL (NEGATIVE)
MAGNIFIER	OFF

(C) CONNECT THE EXTERNAL TRIGGER INPUT OF THE OSCILLOSCOPE TO THE SQUARE WAVEFORM OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(D) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE TRIANGE WAVEFORM OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(E) RECHECK THE TIMING, AND IF NECESSARY, READJUST THE MAIN TIMING ADJ (PARAGRAPH 3.2.3 (B)).

(F) ADJUST THE CYCLES/SEC DIAL TOWARD X1, UNTIL 1 TRIANGLE APPEARS FOR 10 CM OF SWEEP ON THE OSCILLOSCOPE.

3.2.5 FINAL TIMING (CONTINUED)

(G) OBSERVE THE AMOUNT OF ERROR AT THIS END OF THE DIAL. LOOSEN THE SET SCREW AND MECHANICALLY SHIFT THE DIAL TO COMPENSATE FOR THE ERROR. SNUB THE SET SCREW BUT DO NOT LOCK.

NOTE: R116 (CYCLES/SEC VARIABLE RESISTOR) IS VERY SENSITIVE AT THE X1 END, THEREFORE CARE MUST BE TAKEN WHEN THIS SETTING IS MADE.

(H) ADJUST THE CYCLES/SEC DIAL OF THE FUNCTION GENERATOR TOWARD X10 UNTIL 10 TRIANGLES APPEAR FOR 10 CM OF SWEEP ON THE OSCILLOSCOPE.

(J) OBSERVE THE AMOUNT OF ERROR AT THIS END OF THE DIAL. IF THERE IS LESS THAN 2%, LOCK THE SET SCREWS.

(K) SET THE OSCILLOSCOPE SWEEP TIMING TO 100μSEC, THE FUNCTION GENERATOR MULTIPLIER SWITCH TO 1000 AND THE CYCLES/SEC DIAL TO X1.

(L) ADJUST 1000 CYCLES TIMING CAPACITOR C102A FOR 1 TRIANGLE IN 10 CM OF OSCILLOSCOPE SWEEP.

(M) SET THE FUNCTION GENERATOR CYCLES/SEC DIAL TO X10. ADJUST HIGH FREQUENCY COMPENSATION TRIMMER CAPACITOR C103 FOR 10 TRIANGLES IN 10 CM OF OSCILLOSCOPE SWEEP.

(N) REPEAT (K), (L) AND (M) AS NECESSARY SO THAT BOTH ENDS OF THE DIAL ARE ACCURATE.

3.2.6 FINAL FUNCTION GENERATOR TIMING CHECK

(A) HIGH FREQUENCY TIMING CHECK

(1) SET THE OSCILLOSCOPE SWEEP TIMING TO 10μSEC, THE FUNCTION GENERATOR MULTIPLIER SWITCH TO 1000 AND THE CYCLES/SEC DIAL TO X10.

(2) VERIFY THAT THE FUNCTION GENERATOR IS CORRECTLY TIMED AT 10,000 CYCLES PER SECOND BY OBSERVING ONE CYCLE OF THE TRIANGLE WAVEFORM FOR 10 CM OF SWEEP ON THE OSCILLOSCOPE.

(3) SET THE OSCILLOSCOPE SWEEP TIMING TO 100μSEC/CM, THE FUNCTION GENERATOR MULTIPLIER SWITCH TO 1000, AND THE CYCLES/SEC DIAL TO X1.

(4) VERIFY THAT THE FUNCTION GENERATOR IS CORRECTLY TIMED AT 1000 CYCLES PER SECOND BY OBSERVING ONE CYCLE OF THE TRIANGLE WAVEFORM FOR 10 CM OF SWEEP ON THE OSCILLOSCOPE.

3.2.6 FINAL FUNCTION GENERATOR TIMING CHECK (CONTINUED)

(B) MID-FREQUENCY TIMING CHECK

(1) SET THE OSCILLOSCOPE SWEEP TIMING TO 100μSEC/CM, THE FUNCTION GENERATOR MULTIPLIER SWITCH TO 100 AND THE CYCLES/SEC DIAL TO X10.

(2) VERIFY THAT THE FUNCTION GENERATOR IS CORRECTLY TIMED AT 1000 CYCLES PER SECOND BY OBSERVING ONE CYCLE OF THE TRIANGLE WAVEFORM FOR 10 CM OF SWEEP ON THE OSCILLOSCOPE.

(3) SET THE OSCILLOSCOPE SWEEP TIMING TO 1 MSEC/CM, THE FUNCTION GENERATOR MULTIPLIER SWITCH TO 100 AND THE CYCLES/SEC DIAL TO X1.

(4) VERIFY THAT THE FUNCTION GENERATOR IS CORRECTLY TIMED AT 100 CYCLES PER SECOND BY OBSERVING ONE CYCLE OF THE TRIANGLE WAVEFORM FOR 10 CM OF SWEEP ON THE OSCILLOSCOPE.

(C) LOW FREQUENCY TIMING CHECK

(1) SET THE OSCILLOSCOPE SWEEP TIMING TO 10 MSEC/CM, THE FUNCTION GENERATOR MULTIPLIER SWITCH TO 1 AND THE CYCLES/SEC DIAL TO X10.

(2) VERIFY THAT THE FUNCTION GENERATOR IS CORRECTLY TIMED AT 10 CYCLES PER SECOND BY OBSERVING ONE CYCLE OF THE TRIANGLE WAVEFORM FOR 10 CM OF SWEEP ON THE OSCILLOSCOPE.

(3) SET THE OSCILLOSCOPE SWEEP TIMING TO 100 MSEC/CM, THE FUNCTION GENERATOR MULTIPLIER SWITCH TO 1 AND THE CYCLES/SEC DIAL TO X1.

(4) VERIFY THAT THE FUNCTION GENERATOR IS CORRECTLY TIMED AT 1 CYCLE PER SECOND BY OBSERVING ONE CYCLE OF THE TRIANGLE WAVEFORM FOR 10 CM OF SWEEP ON THE OSCILLOSCOPE.

(D) REPEAT STEPS 3.2.6 (C) 1 THROUGH 4 FOR FREQUENCIES .1, .01, AND .001.

3.3 TRIANGLE LINEARITY

NOTE: IN THIS CHECK IT IS VERY IMPORTANT THAT AN OSCILLOSCOPE WHOSE CRT GEOMETRY AND LINEARITY ARE CALIBRATED TO 1/2% OR BETTER BE USED. (CHECK THE OSCILLOSCOPE LINEARITY BY OBSERVING THE OSCILLOSCOPE'S SAWTOOTH OUT.)

3.3.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	10 V/CM
SWEEP TIMING	0.5 MSEC/CM
INPUT COUPLING	DC
TRIGGER	EXTERNAL (NEGATIVE)

3.3.1 PRELIMINARY SETTINGS AND ADJUSTMENTS (CONTINUED)

(B) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MULTIPLIER	10
CYCLES/SEC DIAL	10

3.3.2 LINEARITY CHECK (100 CYCLES/SEC)

(A) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE TRIANGLE WAVEFORM OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(B) ADJUST THE VERTICAL GAIN AND THE SWEEP VERNIER OF THE OSCILLOSCOPE TO DISPLAY ONLY THE RISING HALF CYCLE OF TRIANGLE WAVEFORM OVER THE ENTIRE GRATICULE AREA.

(C) OBSERVE THE LINEARITY OF THE WAVEFORM.

(D) SET THE OSCILLOSCOPE TRIGGERING TO EXTERNAL (POSITIVE).

(E) OBSERVE THE LINEARITY OF THE FALLING HALF CYCLE OF THE TRIANGLE WAVEFORM OCCUPYING THE ENTIRE GRATICULE AREA.

3.3.3 LINEARITY CHECK (10 CYCLES/SEC)

(A) SET THE OSCILLOSCOPE SWEEP TIMING TO 5.0 MSEC/CM AND THE FUNCTION GENERATOR CYCLES/SEC DIAL TO X1.

(B) REPEAT PARAGRAPHS 3.3.2 (A) THROUGH (E) AT THE X1 END OF THE CYCLES/SEC DIAL.

NOTE: VERIFY THAT THE NON-LINEARITY IS LESS THAN 1% THROUGHOUT THE TESTS IN PARAGRAPHS 3.3.2 (A) THROUGH 3.3.3 (B). IF EXCEEDING 1%, TRY CHANGING V102 AND REPEAT CALIBRATION PARAGRAPHS 3.2.1 THROUGH 3.2.5.

3.4 SINE WAVEFORM CALIBRATION

NOTE: A SINE WAVE WITH MINIMUM DISTORTION IS DEPENDENT UPON THE ACCURACY OF THE PRECEDING ADJUSTMENTS AS WELL AS THE FOLLOWING SINE SHAPE ADJUSTMENTS. ANY SUBSEQUENT CHANGES OR RECALIBRATION OF PREVIOUS STEPS WILL MAKE IT NECESSARY THAT SINE CALIBRATION BE RECHECKED.

3.4.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	10 V/CM
SWEEP TIMING	2 TO 5 MSEC/CM
INPUT COUPLING	DC
TRIGGER	EXTERNAL

(B) SET THE CONTROLS OF THE FUNCTION GENERATOR AS FOLLOWS:

MULTIPLIER	10
CYCLES/SEC DIAL	10

3.4.1 PRELIMINARY SETTINGS AND ADJUSTMENTS (CONTINUED)

(C) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE SINE WAVEFORM OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(D) SHAPE THE SINE WAVE AS FOLLOWS

(1) ADJUST C SINE SHAPE R145 FULLY CCW (GROUND).

(2) USING FIGURES 1 THROUGH 5 WITH THEIR RESPECTIVE NOTES, ADJUST A SINE SHAPE AND B SINE SHAPE (R139 AND R143) FOR THE BEST SINE WAVE POSSIBLE.

NOTE: THESE ADJUSTMENTS ARE VERY INTERDEPENDENT. ONE CAN BE AT A SETTING WHERE IT IS IMPOSSIBLE FOR THE OTHER TO CORRECT. B SINE SHAPE CONTROLS MORE OF THE AMPLITUDE AND A SINE SHAPE MORE OF THE SHAPE ITSELF. IT IS BEST TO SET B FOR NEARLY MAXIMUM AMPLITUDE, THEN AS A IS ADJUSTED B CAN BE REDUCED IN AMPLITUDE TO MAINTAIN PROPER SHAPE. THIS IS AN OPTIMUM WAVE SHAPE AT THIS POINT.

(3) ADJUST C SINE SHAPE TO ROUND THE BOTTOM OF THE SINE WAVE. A SINE SHAPE AND B SINE SHAPE MAY BE READJUSTED FOR FINAL SMOOTHING.

3.4.2 FINAL SINE WAVEFORM ADUSTMENTS

(A) CONNECT THE DISTORTION ANALYZER INPUT TO THE SINE WAVEFORM OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(B) CAREFULLY ADJUST SINE SHAPE A, B AND C FOR MINIMUM HARMONIC DISTORTION.

(C) VERIFY THAT THE TOTAL HARMONIC DISTORTION IS LESS THAN 2%.

NOTE 1: IF THE ABOVE SPECIFICATIONS CANNOT BE MET, CHANGING OF V104 AND REPEATING CALIBRATION PARAGRAPHS 3.4.1 THROUGH 3.4.2 (C) SHOULD BE ACCOMPLISHED.

NOTE 2: IF A WAVEFORM ANALYZER IS USED IN PLACE OF A DISTORTION ANALYZER, THE FIRST 10 HARMONICS SHOULD BE CHECKED WITH ADJUSTMENTS MADE CONSIDERING THE FIRST 5.

3.5 DC LEVELS AND OUTPUT AMPLITUDES

3.5.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	APPROX. 5 V/CM
SWEEP TIMING	10 MSEC/CM
INPUT COUPLING	DC
TRIGGER	EXTERNAL

3.5.1 PRELIMINARY SETTINGS AND ADJUSTMENTS (CONTINUED)

(B) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MULTIPLIER	10
CYCLES/SEC DIAL	10

(C) CALIBRATE THE OSCILLOSCOPE AS FOLLOWS:

(1) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO A CALIBRATED SIGNAL SOURCE (BUILT-IN OSCILLOSCOPE CALIBRATOR).

(2) SET THE CALIBRATOR OUTPUT FOR 10 VPP.

(3) ADJUST THE VERTICAL GAIN OF THE OSCILLOSCOPE AND CALIBRATE SO THAT 40 VPP IS EQUAL TO 4CM DEFLECTION.

(4) GROUND THE INPUT OF THE VERTICAL AMPLIFIER AND USING THE VERTICAL POSITIONING CONTROL OF THE OSCILLOSCOPE SET THE SWEEP EXACTLY ON THE VERTICAL CENTER LINE OF THE GRATICULE.

NOTE: THE OSCILLOSCOPE IS NOW CALIBRATED TO DISPLAY A WAVEFORM OF 40 VPP/4CM WITH THE DC GROUND ON THE CENTER OF THE GRATICULE.

DO NOT TOUCH THE VERTICAL CONTROLS OF THE OSCILLOSCOPE DURING THE FOLLOWING PROCEDURE.

(D) AT THE FUNCTION GENERATOR ADJUST THE ATTENUATOR TO FULL CCW AND CONNECT THE MULTIMETER BETWEEN GROUND AND THE MAIN OUTPUT TERMINAL.

(E) ADJUST THE MIN. AMP. DC BAL R158 FOR 0 VOLTS AS INDICATED BY THE MULTIMETER. REMOVE METER.

3.5.2 SINE WAVEFORM DC LEVEL AND AMPLITUDE MEASUREMENTS

(A) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE MAIN OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(B) SET THE FUNCTION GENERATOR ATTENUATOR TO FULL CW.

(C) WITH THE OUTPUT SELECTOR SWITCH SET TO SINE WAVEFORM, ACCURATELY MEASURE AND RECORD THE PP AMPLITUDE OF THE SINE WAVEFORM.

(D) CONNECT THE MULTIMETER BETWEEN THE MAIN OUTPUT AND GROUND. THE MULTIMETER SHOULD BE SET ON THE 10 VDC SCALE.

(E) ADJUST SINE DC LEVEL R154 FOR ZERO INDICATION ON METER. INCREASE METER SINSITIVITY AS NEEDED.

3.5.3 TRIANGLE WAVEFORM DC LEVEL AND AMPLITUDE

(A) REPEAT PARAGRAPHS 3.5.2 (A) AND (B).

(B) WITH THE OUTPUT SLECTOR SWITCH SET TO TRIANGLE WAVEFORM AND USING TRIANGLE AMPL. ADJ R124, SET THE TRIANGLE AMPLITUDE EQUAL TO THAT OF THE SINE WAVEFORM.

(C) CONNECT THE MULTIMETER BETWEEN THE MAIN OUTPUT AND GROUND. THE MULTIMETER SHOULD BE SET ON THE 10 VDC SCALE.

(D) ADJUST TRIANGLE DC LEVEL R122 FOR ZERO INDICATION ON THE METER. INCREASE METER SENSITIVITY AS NEEDED.

3.5.4 SQUARE WAVEFORM DC LEVEL AND AMPLITUDE

(A) REPEAT PARAGRAPHS 3.5.2 (A) AND (B).

(B) WITH THE OUTPUT SELECTOR SWITCH SET TO SQUARE WAVEFORM AND USING SQUARE AMP ADJ R112, SET THE SQUARE AMPLITUDE EQUAL TO THAT OF THE SINE WAVEFORM.

(C) CONNECT THE MULTIMETER BETWEEN THE MAIN OUTPUT AND GROUND. THE MULTIMETER SHOULD BE SET ON THE 10 VDC SCALE.

(D) ADJUST SQUARE DC LEVEL R115 FOR ZERO INDICATION ON THE METER. INCREASE METER SENSITIVITY AS NEEDED.

FIGURE 1

SINE ADJ B ABOUT CORRECT, BUT SINE ADJ A TOO FAR CW. ROTATE "A" CCW UNTIL BOTTOM IS LESS FLAT AND TOP MORE FULL AND ROUND.

FIGURE 2

SINE ADJ B TOO FAR CCW. ROTATE CW UNTIL TOP IS PROPER SHAPE. IF BOTH TOP AND BOTTOM ARE FLAT, REDUCE AMPLITUDE WITH SINE ADJ B (CW ROTATION) AND ADJUST "A" TO RE-CENTER WAVEFORM (SYMMETRICAL SHAPE).

FIGURE 3

NOT ENOUGH ADJUSTMENT OF EITHER "A" OR "B". INCREASE AMPLITUDE (CW) WITH SINE ADJ B AND ADJUST "A" CW TO RE-CENTER WAVEFORM.

FIGURE 4

APPROXIMATELY OPTIMUM SETTING OF "A" AND "B" AND NOW AN ADJUSTMENT OF SINE ADJ C WILL ROUND THE BOTTOM OF THE WAVEFORM PROPERLY.

FIGURE 5

SINE ADJ C MADE PROPERLY. OPTIMUM SINE WAVEFORM.

THE "B" ADJUSTMENT ADDS SIGNAL TO THE SHAPING CIRCUIT; CCW ROTATION CAUSES FLATTENING, CW ROTATION CAUSES THE SINE WAVE TO APPROACH A TRIANGLE WAVE. "A" ADJUSTMENT CONTROLS DC LEVEL AND RE-CENTERS THE WAVEFORM. "C" ADJUSTMENT SERVES TO SHAPE ONLY THE BOTTOM OF THE WAVEFORM.

SECTION IV

PARTS LIST

ABBREVIATIONS USED IN OUR PARTS LIST

Cer.	ceramic	uu	Micromicro
Comp	composition	m	milli
EMC	electrolytic, metal cased	Prec.	precision
EMT	electrolytic, metal tubular	PT	paper tubular
fd	farad	Tub.	tubular
h	henry	v	working volts DC
k	thousands of ohms	Var.	variable
meg	megohms	w	watt
MF	metal film	WW	wire wound
u	micro		

The columns preceding the parts numbers contains the abbreviations of the manufacturers from whom we purchase the specified part. These abbreviations are listed below.

AB	Allen Bradley
AMX	Amperex
BB	Birnbach
CD	Continental Device Corp.
CL	Clarostat
CLR	Centralab
CNG	Corning Resistor
CR	Claro Resistor
CTS	CTS Corp. (Chicago Telephone)
DE	Delco
DI	Diodes Inc.
ER	Erie Technological Products
EX	Exact Electronics Inc.
GE	General Electric Co.
GR	Grayhill
IRC	International Resistance Corp.
LF	Littlefuse
MA	Mallory
OAK	Oak Electronics Corp.
PEN	Penn Resistor Corp.
RCA	Radio Corp. of America
RMC	Radio Materials Co.
SG	Signalite
SPR	Sprague Electric
SR	Sartron Inc.
ST	Sarkes Tarzian Inc.
TI	Texas Instruments
TS	Tung-Sol
WH	Westinghouse
WL	Ward Leonard

240 POWER SUPPLY

BULBS

B1	#12	6v				GE	150018

CAPACITORS

C1	80ufd	500v	EMC			SPR	290028
C2A&B	20/20ufd	450v	EMC			SPR	290009
C3	80ufd	500v	EMC			SPR	290028
C4A&B	20/20ufd	450v	EMC			SPR	290009
C5A&B	20/20ufd	450V	EMC			SPR	290009
C6	.01ufd	400v			10%	AMX	285203
C7	.01ufd	400v			10%	AMX	285203
C8	.01ufd	400v			10%	AMX	285203
C9	2000ufd	20v	EMC			SPR	290029

DIODES

D1-D12	IN3194					RCA	152016
D13-D16	IN1217					WH	152005
D17	ZA12B Zener					MA	152022

FUSES

F1	2A 3AG					LF	159020

RESISTORS

R1	120K	1/2W	Fixed	Comp.	10%	AB	302124
R2	1M	1/2W	Fixed	Comp.	10%	AB	302105
R3	100K	1/2W	Fixed	Comp.	10%	AB	302104
R4	1.5M	1/2W	Fixed	Comp.	10%	AB	302155
R5	10ohm	1W	Fixed	Comp.	10%	AB	304100
R6	39K	1/2W	Fixed	Comp.	10%	AB	302393
R7	680K	1/2W	Fixed	Comp.	10%	AB	302684
R8	100K	1/2W	Fixed	Comp.	10%	AB	302104
R9	1.5M	1/2W	Fixed	Comp.	10%	AB	302155
R10	10ohm	1/2W	Fixed	Comp.	10%	AB	302100
R11	10ohm	1/2W	Fixed	Comp.	10%	AB	302100
R12	390K	1/2W	Fixed	Comp.	10%	AB	302394
R13	47K	1/2W	Fixed	Comp.	10%	AB	302473
R14	330K	1/2W	Fixed	Comp.	10%	AB	302334
R15	1.5M	1/2W	Fixed	Comp.	10%	AB	302155
R16	68K	1W	Fixed	Comp.	10%	AB	304683
R17	200K	1/2W	Fixed	Prec.	1%	CR	309051
R18	165K	1/2W	Fixed	Prec.	1%	CR	309050

240 POWER SUPPLY

RESISTORS (cont)

R19	100K	1/2W	Fixed	Prec.	1%	CR	309045
R20	210K	1/2W	Fixed	Prec.	1%	CR	309126
R21	150K	1/2W	Fixed	Prec.	1%	CR	309049
R22	100K	1/2W	Fixed	Prec.	1%	CR	309045
R23	15K	5W	VAR.	WW	-210v ADJUST	CTS	311013
R24							
R25							
R26	270ohm	2W	Fixed	Comp.	10%	AB	306271
R27	25ohm	5W	Fixed	WW	5%	SPR	308026

SWITCHES

SW1	Power Switch, SPST Toggle	BB	260134

TRANSFORMERS

T1	Power	117/220v Primary	SR	120014

TRANSISTORS

Q1	2N176	-11v Series Regulator	DE	156004

VACUUM TUBES

V1	5651	Voltage Reference	TS	154052
V2	6AU6	-210v DC Amplifier	WH	154022
V3A	1/2-6080	+95v Series Regulator	TS	154056
V3B	1/2-6080	-210v Series Regulator	TS	154056
V4	6AU6	+95v DC Amplifier	WH	154022
V5	12B4	+250v Series Regulator	TS	154045
V6	6AU6	+250v DC Amplifier	WH	154022

240 MAIN GENERATOR

CAPACITORS

C100	4.7 uufd	500V	Tub.	10%		ER	281501
C101	.01 ufd	500V	Discap			RMC	283005
C102A	7-45 uufd		Var.	10%		ER	281012
C102B	82 uufd	500V	Tub.	10%		ER	281528
C102C	.001 ufd)						
C102D	.01 ufd)						
C102E	.1 ufd)	Matched timing capacitors				EX	295215
C102F	1. ufd)						
C103	7-45 uufd		Var.	10%		ER	281012
C104	.01 ufd	500V	Discap			RMC	283005
C105	.01 ufd	500V	Discap			RMC	283005

DIODES

D101	T155				TI	152009
D102*	CD1541	400V			CD	152010

*selected for low leakage

RESISTORS

R100	68.1K	1/2W	Fixed	MF	1%	IRC	310625
R101	475K	1/2W	Fixed	MF	1%	IRC	310602
R102	100K	1/2W	Fixed	MF	1%	IRC	310590
R103	100K	1/2W	Fixed	MF	1%	IRC	310590
R104	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R105	15K	5W	Var.	WW	TIMING	CTS	311013
R106	15K	5W	Fixed	WW	5%	WL	308108
R107	47K	1/2W	Fixed	Comp.	10%	AB	302473
R108	220K	1W	Fixed	MF	5%	PEN	310726
R109	4K	5W	Fixed	WW	5%	WL	308102
R110	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R111	15K	5W	VAR	WW	SQ. WAVE SYMMETRY (X10)	CTS	311013
R112	50K	1/4W	VAR	COMP	SQ.WAVE AMPLITUDE	CTS	311077
R113	100K	1/2W	Fixed	Comp.	10%	AB	302104
R114	162K	1/2W	Fixed	MF	1%	IRC	310603
R115	15K	5W	VAR	WW	SQ. WAVE DC LEVEL	CTS	311013
R116	30K	4W	VAR	WW	CYCLES/SEC	CL	311021
R117	3K	1/2W	Fixed	MF	1%	IRC	310622
R118	182K	1/2W	Fixed	MF	1%	IRC	310598
R119	47K	2W	Fixed	Comp.	10%	AB	306473
R120	100K	1/4W	VAR	COMP.	SQ. WAVE SYMMETRY (X1)	CTS	311080

RESISTORS (cont.)

R121	82K	1/2W	Fixed	Prec.	1%	CR	309117
R122	50K	1/4W	VAR	COMP.	TRIANGLE DC LEVEL	CTS	311077
R123	150K	1/2W	Fixed	MF	1%	CR	309049
R124	1.5M	1/4W	VAR	COMP.	TRI. AMP.	CTS	311079
R125	165K	1/2W	Fixed	Prec.	1%	CR	309050
R126	100K	1/2W	Fixed	MF	1%	IRC	310590
R127	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R128	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R129	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R130	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R131	200K	1/2W	Fixed	MF	1%	IRC	310615
R132	15K	5W	VAR	WW	MILLER DC BALANCE	CTS	311013
R133	22.1K	1/2W	Fixed	MF	1%	IRC	310626
R134	60M	2W	Fixed	Prec.	1%	CR	310731
R135	6M	1/2W	Fixed	Prec.	1%	CR	310720
R136	600K	1/2W	Fixed	Prec.	1%	CR	309142
R137	47K	2W	Fixed	Comp.	10%	AB	306473
R138	121K	1/2W	Fixed	MF	1%	IRC	310591
R139	15K	5W	VAR	WW	A SINE SHAPE	CTS	311013
R140	182K	1/2W	Fixed	MF	1%	IRC	310598
R141	1K	1/2W	Fixed	MF	1%	IRC	310605
R142	1M	1/2W	Fixed	MF	1%	IRC	310609
R143	15K	5W	VAR	WW	B SINE SHAPE	CTS	311013
R144	10K	1/2W	Fixed	MF	1%	IRC	310600
R145	15K	5W	VAR	WW	C SINE SHAPE	CTS	311013
R146	600K	1/2W	Fixed	Prec.	1%	CR	309142
R147	162K	1/2W	Fixed	MF	1%	IRC	310603
R148	1.5M	1/2W	Fixed	MF	1%	IRC	310612
R149	82.5K	1/2W	Fixed	MF	1%	IRC	310616
R150							
R151	1K	1/2W	Fixed	MF	1%	IRC	310605
R152							
R153	121K	1/2W	Fixed	MF	1%	IRC	310591
R154	50K	2W	VAR	COMP.	SINE DC LEVEL	CL	311023
R155	1.5M	1/2W	Fixed	MF	1%	IRC	310612
R156	523K	1/2W	Fixed	MF	1%	IRC	310618
R157	47K	2W	Fixed	MF	5%	CNG	310716
R158	15K	5W	Fixed	WW	5%	WL	308108
R159	15K	5W	VAR	WW	MIN.AMP. DC BALANCE	CTS	311013
R160	22K	1W	Fixed	MF	5%	CNG	310751
R161	1K	1/2W	Fixed	MF	1%	IRC	310605
R162	50K	2W	VAR (PART OF ± DC LEVEL SW105)			CTS	311025
R163	4.7K	1/2W	Fixed	MF	1%	IRC	310599
R164	47K	1/2W	Fixed	Comp.	10%	AB	302473
R165	100K	2W	VAR	Comp.	OUTPUT ATTEN.	AB	311026
R166	30K	5W	Fixed	WW	5%	SPR	308101
R167	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101

240 MAIN GENERATOR

SWITCHES

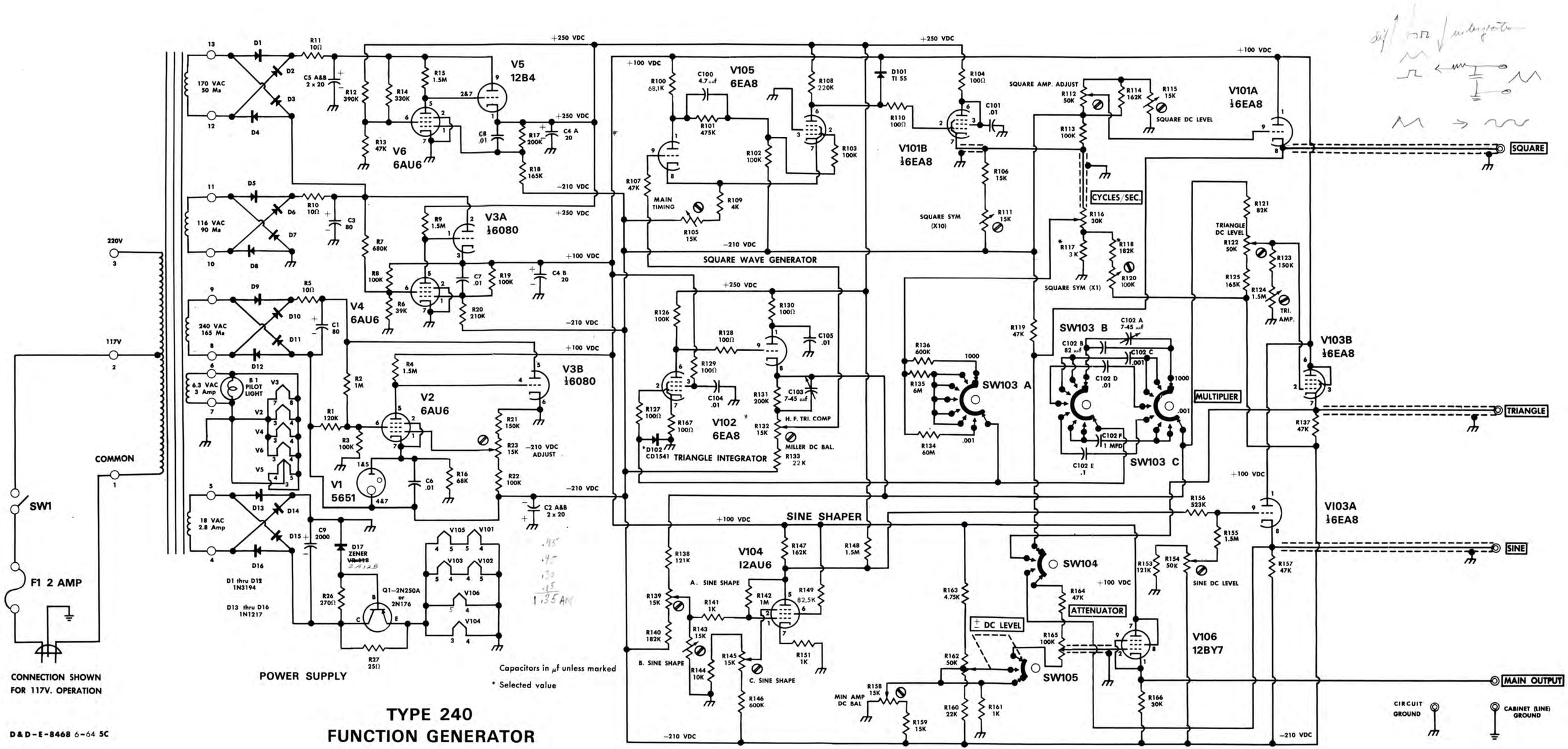
SW103	3 wafer, 7 pos., rotary	Timing	OAK	260017
SW104	1 wafer, 3 pos., rotary	Output Selector	OAK	260018
SW105	±DC Level (ganged with R162)	SPDT	CTS	311025

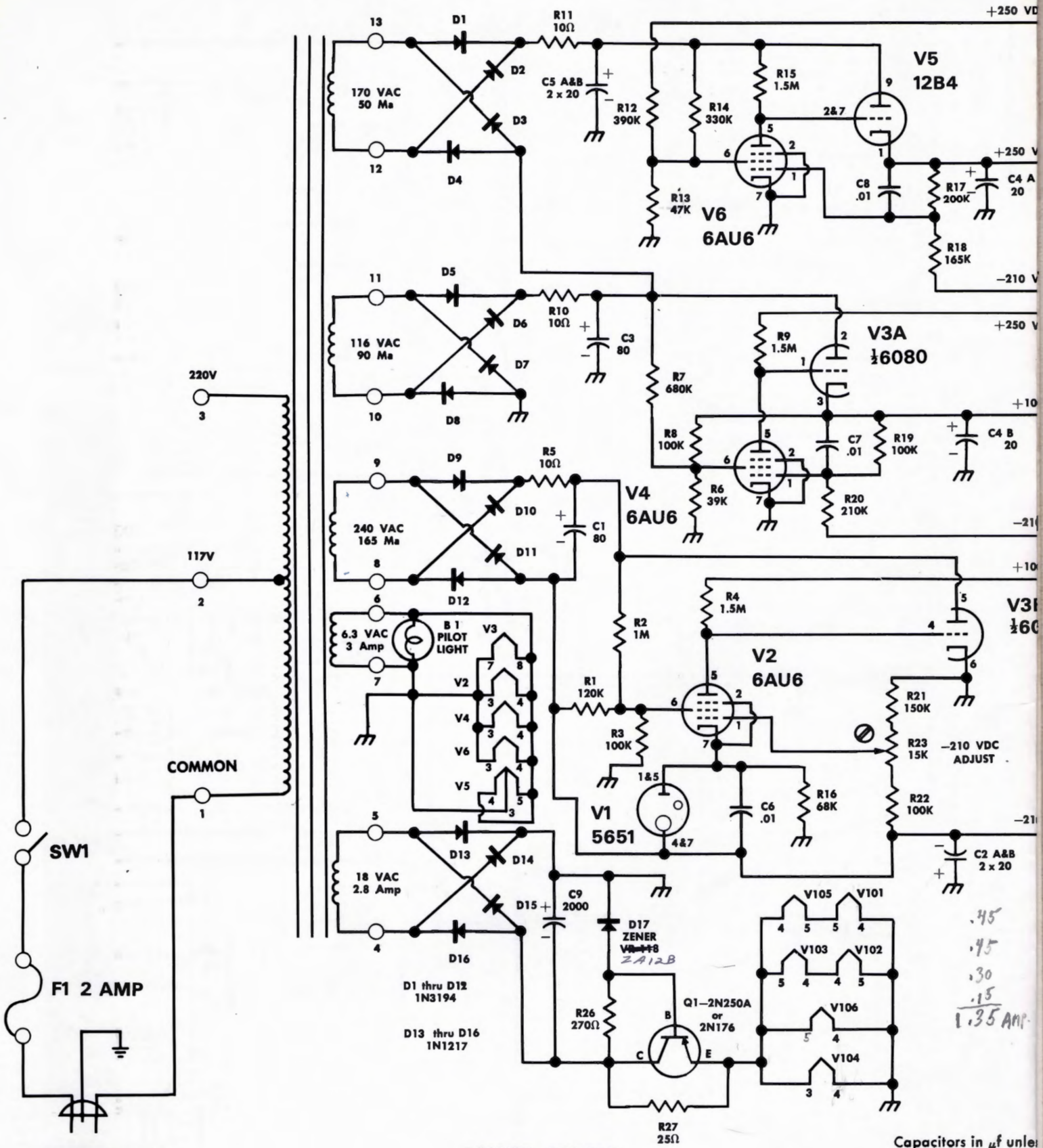
VACUUM TUBES

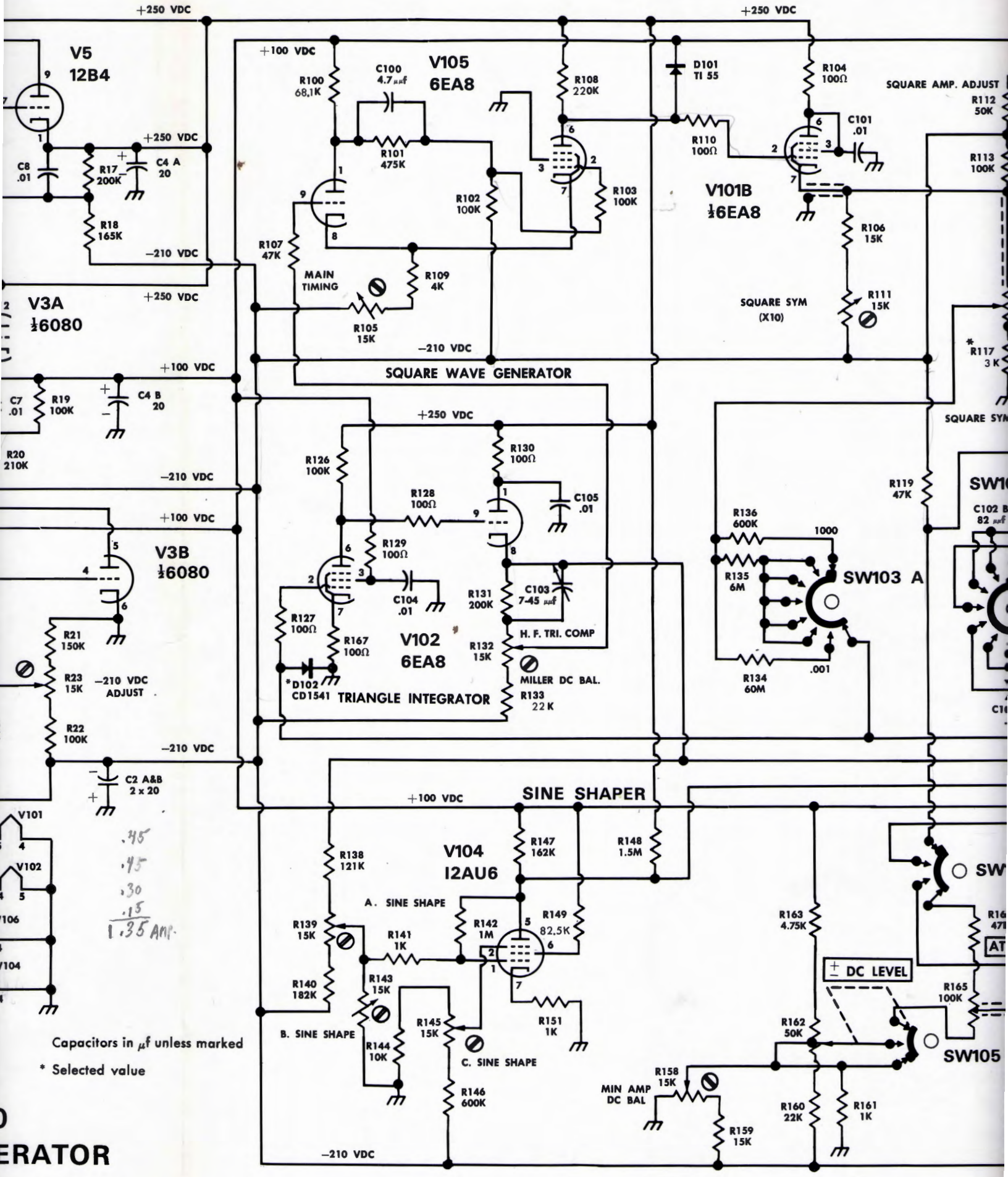
V101	6EA8	Sq. W. Cathode Follower	GE	154023
V102A	1/2-6EA8	Miller Integrator	GE	154023
V102B	1/2-6EA8	Miller Integrator CF	GE	154023
V103A	1/2-6EA8	Sine Out CF	GE	154023
V103B	1/2-6EA8	Triangle Out CF	GE	154023
V104	12AU6	Sine Shaper Amplifier	WH	154044
V105	6EA8	Square Wave Generator	GE	154023
V106	12BY7	Main Output CF	WH	154047

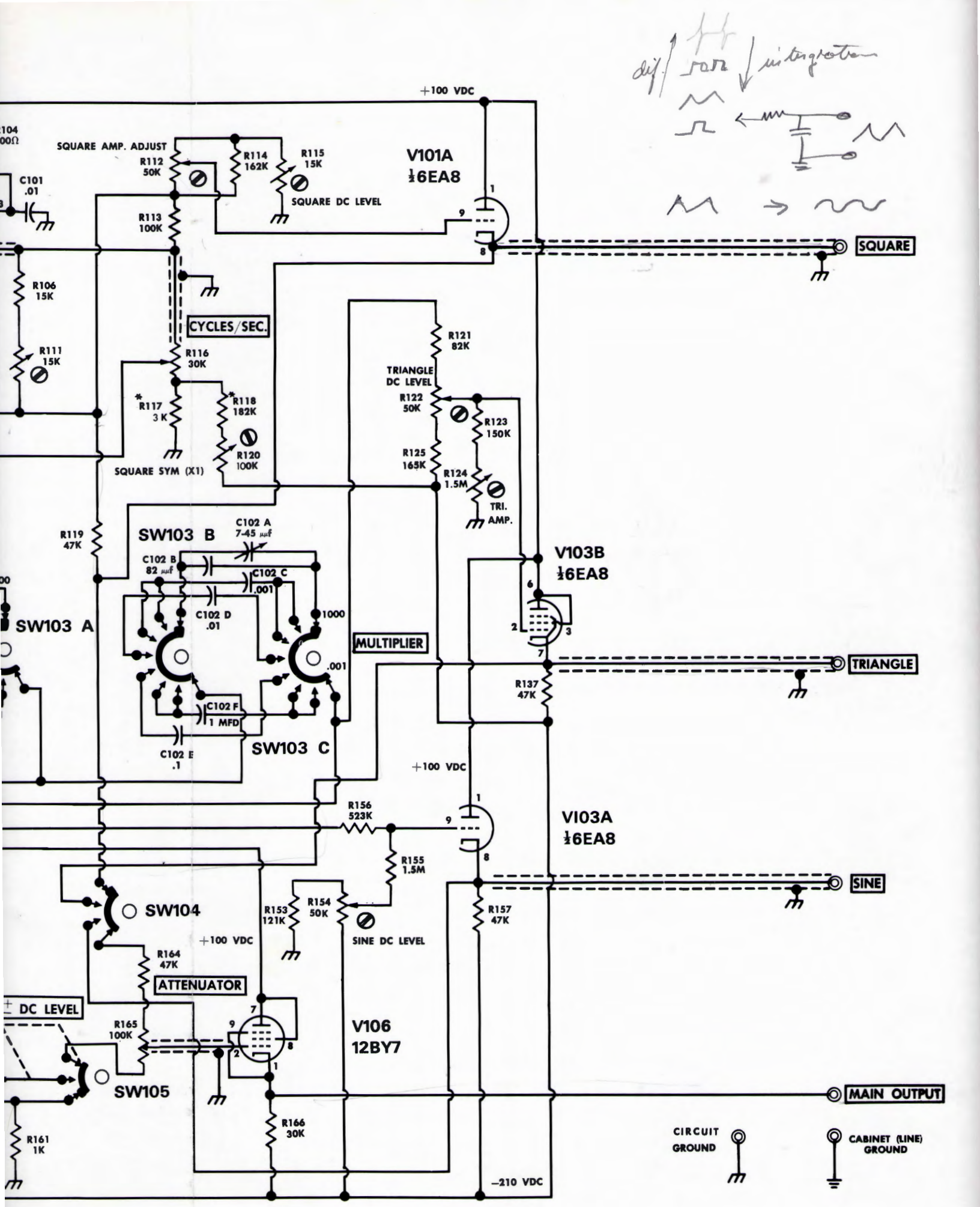
SECTION V

CIRCUIT DIAGRAM


TYPE 240
FUNCTION GENERATOR
POWER SUPPLY
SQUARE WAVE GENERATOR
TRIANGLE INTEGRATOR
SINE SHAPER
MULTIPLIER
SQUARE
TRIANGLE
SINE
MAIN OUTPUT
CONNECTION SHOWN FOR 117V. OPERATION
Capacitors in μf unless marked
* Selected value
D&D-E-8468 6-64 5C

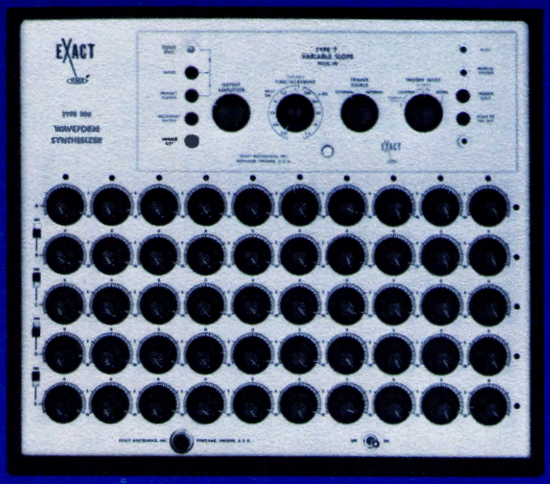

220V
117V
COMMON
SW1
F1 2 AMP
CONNECTION SHOWN
FOR 117V. OPERATION
13
12
170 VAC
50 Ma
11
10
116 VAC
90 Ma
9
8
240 VAC
165 Ma
6
7
6.3 VAC
3 Amp
B 1
PILOT
LIGHT
5
4
18 VAC
2.8 Amp
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
D14
D15
D16
D1 thru D12
1N3194
D13 thru D16
1N1217
R11
10Ω
R10
10Ω
R5
10Ω
C5 A&B
2 x 20
C3
80
C1
80
C9
2000
R12
390K
R14
330K
R15
1.5M
R13
47K
R7
680K
R9
1.5M
R8
100K
R6
39K
R4
1.5M
R2
1M
R1
120K
R3
100K
R21
150K
R23
15K
R22
100K
R16
68K
C6
.01
C7
.01
C8
.01
R17
200K
R18
165K
R19
100K
R20
210K
C4 A
20
C4 B
20
C2 A&B
2 x 20
V5
12B4
V6
6AU6
V3A
½6080
V4
6AU6
V2
6AU6
V1
5651
V3
V2
V4
V6
V5
V105
V101
V103
V102
V106
V104
D17
ZENER
ZA12B
Q1—2N250A
or
2N176
R26
270Ω
R27
25Ω
+250 VD
+250 V
+250 V
+10
+10
-210 V
-21(
-21
-21
-210 VDC
ADJUST
.45
.45
.30
.15
1.35 AMP.
POWER SUPPLY
Capacitors in μf unle
* Selected value
TYPE 240
FUNCTION GENERATOR
D&D-E-8468 6-64 5C


+250 VDC
V5
12B4
C8
.01
R17
200K
C4 A
20
R18
165K
−210 VDC
V3A
½6080
+100 VDC
C7
.01
R19
100K
C4 B
20
R20
210K
V3B
½6080
R21
150K
R23
15K
−210 VDC
ADJUST
R22
100K
C2 A&B
2 x 20
V101
V102
V106
V104
.45
.45
.30
.15
1.35 AMP.
+100 VDC
R100
68.1K
C100
4.7 μf
R101
475K
V105
6EA8
R108
220K
R102
100K
R103
100K
R107
47K
MAIN
TIMING
R109
4K
R105
15K
SQUARE WAVE GENERATOR
D101
TI 55
R110
100Ω
R104
100Ω
C101
.01
V101B
½6EA8
SQUARE AMP. ADJUST
R112
50K
R113
100K
R106
15K
SQUARE SYM
(X10)
R111
15K
R117
3 K
SQUARE SYM
R126
100K
R130
100Ω
R128
100Ω
C105
.01
R129
100Ω
C104
.01
R131
200K
C103
7-45 μf
H. F. TRI. COMP
R132
15K
MILLER DC BAL.
R133
22 K
R127
100Ω
R167
100Ω
*D102
CD1541
TRIANGLE INTEGRATOR
V102
6EA8
R136
600K
1000
R135
6M
SW103 A
.001
R134
60M
R119
47K
SW1
C102 B
82 μμf
C1
SINE SHAPER
R138
121K
V104
I2AU6
R147
162K
R148
1.5M
A. SINE SHAPE
R139
15K
R141
1K
R142
1M
R149
82.5K
R140
182K
R143
15K
B. SINE SHAPE
R144
10K
R145
15K
C. SINE SHAPE
R146
600K
R151
1K
R163
4.75K
± DC LEVEL
R165
100K
R162
50K
SW105
R158
15K
MIN AMP
DC BAL
R159
15K
R160
22K
R161
1K
SW
AT
Capacitors in μf unless marked
* Selected value
−210 VDC


+100 VDC
SQUARE AMP. ADJUST
R112 50K
R114 162K
R115 15K
SQUARE DC LEVEL
V101A ½6EA8
C101 .01
R113 100K
SQUARE
R106 15K
R111 15K
CYCLES/SEC.
R116 30K
R117 3 K
R118 182K
R120 100K
SQUARE SYM (X1)
R121 82K
TRIANGLE DC LEVEL
R122 50K
R123 150K
R125 165K
R124 1.5M
TRI. AMP.
R119 47K
SW103 B
C102 A 7-45 μμf
C102 B 82 μμf
C102 C .001
C102 D .01
1000
.001
SW103 A
MULTIPLIER
V103B ½6EA8
TRIANGLE
R137 47K
C102 F 1 MFD
C102 E .1
SW103 C
+100 VDC
R156 523K
VI03A ½6EA8
R155 1.5M
SINE
SW104
R153 121K
R154 50K
SINE DC LEVEL
R157 47K
+100 VDC
R164 47K
ATTENUATOR
DC LEVEL
R165 100K
V106 12BY7
SW105
MAIN OUTPUT
R166 30K
R161 1K
CIRCUIT GROUND
CABINET (LINE) GROUND
-210 VDC

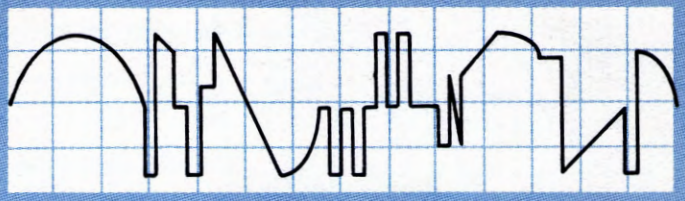
EXACT Electronics, Inc

PRECISION TEST EQUIPMENT



WAVEFORM SYNTHESIZER
FUNCTION GENERATORS

CONDENSED CATALOG C-4



TYPE 200 WAVEFORM SYNTHESIZER with Types C,D,E, and F Plug-in Units

TYPE 200 WAVEFORM SYNTHESIZER

The TYPE 200 WAVEFORM SYNTHESIZER generates complex waveforms by producing 50 sequential increments. Two waveform parameters are adjustable during each increment. The front panel of the synthesizer contains 50 dual-controls, arranged in five rows of ten. A waveform may consist of 10, 20, 30, 40 or 50 increments. Each dual-control adjusts the waveform during one time increment. The two adjustable parameters can be amplitude and slope, amplitude and width, or slope and width, depending on the type Plug-In Unit used. Output programs can be either free-running or triggered at 1-program/trigger, 1-row/trigger, or 1-increment/trigger. Program duration is adjustable from 33 μsec. to over 1 minute. Typical output waveforms may consist of selected slopes, both positive and negative going; pulses of various widths and amplitudes; or a wide variety of both slopes and pulses. Pulse trains or intentionally distorted waveforms can easily be generated. Waveforms representing natural phenomena can be duplicated. Shaker tables can be programed to produce unconventional motions or to counteract overshoot or "ringing".

Risetime/Falltime	0.25 μsecs max.
Amplitude Stability	2%
Time Jitter	1 part in 500
Repeatability	2% (short term) 5% (long term)
Power	105-125/210-250 vac—50-60 cps, 375 watts
Size	17½w x 15½h x 14½d
Weight	Type 200: 51 lbs. Plug-In Units: 6 lbs.

Prices (FOB Factory):

Type 200	$1,925.00
Type C Plug-In Unit	350.00
Type D Plug-In Unit	400.00
Type E Plug-In Unit	350.00
Type F Plug-In Unit	350.00

(Overseas prices approximately 5% higher)

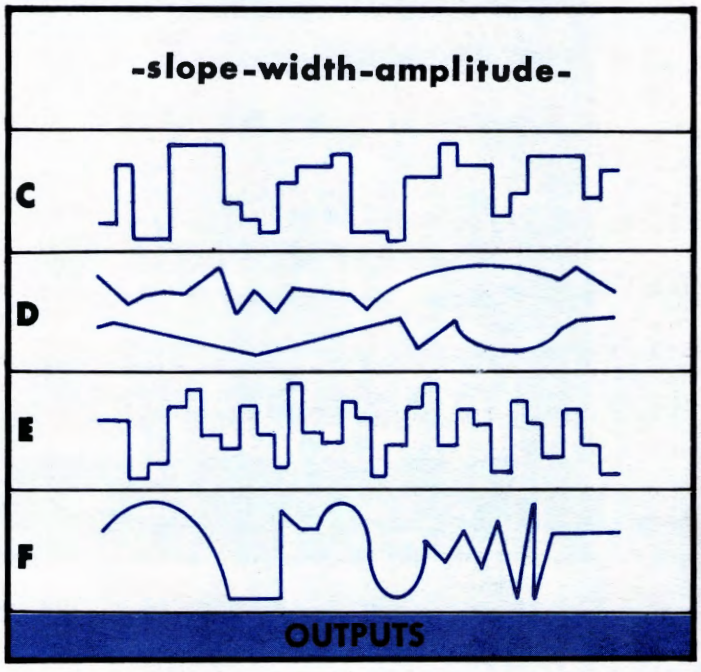
PLUG-IN UNITS

TYPE C PLUG-IN UNIT. When a Type C Plug-In Unit is used with a Waveform Synthesizer, each dual-control adjusts the amplitude and width during each respective increment. The duration of the program consists of the sum of the increment widths.

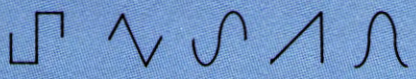
TYPE D PLUG-IN UNIT. When a Type D Plug-In Unit is used with a Waveform Synthesizer, two simultaneous outputs are generated. Each dual-control adjusts the slope of each waveform during each respective increment. The two waveforms consist of continuous slopes, i.e. the end of one increment is the starting point of the next increment.

TYPE E PLUG-IN UNIT. When a Type E Plug-In Unit is used with a Waveform Synthesizer, 100-increment programs can be produced. Each dual-control adjusts the amplitude during two increments (1 and 50, 6 and 56, 24 and 74 etc.).

TYPE F PLUG-IN UNIT. When a Type F Plug-In Unit is used with a Waveform Synthesizer, each dual-control adjusts the slope and amplitude during each respective increment. Two outputs are provided, one with continuous slopes (see D plug-in) and one with non-continuous slopes.







FUNCTION GENERATORS
TYPES 240, 250 251, and 255

TYPE 240	TYPE 250	TYPE 251	TYPE 255
SQUARE	SQUARE	SQUARE	SQUARE
TRIANGLE	TRIANGLE	TRIANGLE	TRIANGLE
SINE	SINE	SINE	SINE
	RAMP	RAMP	RAMP
		COSINE	

EXTERNAL TRIGGERING, (except Type 240)

Each external trigger pulse provides one complete output waveform, at all outputs. Push-button for manual triggering.

SIMULTANEOUS OUTPUTS

3, 4, or 5 different waveforms (depending on model) simultaneously. Separate auxiliary-output jacks for each waveform. Timing controls determine frequency of all outputs.

DC TRIGGERING LEVEL ADJUSTMENT

Starting point on sine and triangle waveforms may be shifted up to **160°**.

10^7 FREQUENCY RANGE

5¼″ HIGH—19 LBS.

SEPARATE RAMP GENERATOR (255)

Separate frequency controls allow independent adjustment of ramp time base—variable from 100 μscs to 16 minutes. However, ramp generator is automatically synchronized with Main Generator in Tracking Mode. In this mode, Main Generator timing-dial controls both ramp and main base-frequency, while respective multipliers operate independently.

DELAY AND GATING CIRCUITS (255)

The Ramp Generator output is switched into the Main Generator trigger circuits to provide delaying and gating functions. Front panel switches permit selection of triggering mode for both generators. Either generator can be used to trigger the other—or the Ramp Generator, with its separate timing controls, can be used to gate or delay the Main Generator output.

WAVEFORM CHARACTERISTICS:

Squarewave:

Risetime	5 μsecs or faster
Symmetry	99.5%
Overshoot	1% max
Droop	1% max

Triangle:

Linearity	99.5%
Symmetry	99.5%

Sinewave:

Total Distortion	Less than 1% to 1KC 2% to 10KC

Ramp:

Linearity	99.5%
Fall Time	6% of period max

Cosine:

Total Distortion	Less than 1% to 1KC 2% to 10KC

MAIN OUTPUT:

Amplitude	300 mv to 25 volts P-P (min.)
Impedance	200 ohms (cathode follower)
Current	−3 to +15 ma max
Amplitude Stability	0.5% of output amplitude
Amplitude Change with Frequency	0.5% @ 0.001 to 1000 cps*
Amplitude Change with Function	Less than 2%
	SQUARE-TRI-SINE
Frequency Range	0.001 to 10,000 cps
Frequency Deviation from Absolute	3%
Long-Term Frequency Stability	±1%
DC Reference Level Range	−15 to +15 volts or switched to Ov
DC Reference Level Stability	±100 mv at 25 volts output*

AUXILIARY OUTPUTS:

Amplitude	30 volts P-P (min)
Impedance	500 ohms (cathode follower)
Current	5 ma max
Amplitude Stability	0.5%*
Amplitude Change w/Frequency	Same as main output*
DC Reference Level	0 volts (fixed)
Frequency Range	Same as main output

*Cosine specs. somewhat broader.

DOMESTIC PRICES:* (approx. 5% higher overseas)

240	$475.00
250	$595.00
251	$685.00
255	$785.00

***Complete with 2 instruction manuals. 240RM, 250RM and 251 RM (rack-mount models) available at no additional cost.**

All Exact Instruments are fully warranted against defective materials and workmanship for 1 year. Responsible maintenance centers are located in major cities. However, unit may be returned to plant at manufacturer's expense if user finds unacceptable.

EXACT ELECTRONICS, INC.

455 S. 2nd Avenue
Hillsboro, Oregon

(503) 648-6661
TWX: 503-821-6927

REPRESENTATIVES

ARIZONA	Hytronic Measurements, Inc.
CALIFORNIA	J. T. Hill Co.
CANADA	Allan Crawford Associates
COLORADO	Hytronic Measurements, Inc.
CONNECTICUT	Technical Instruments, Inc.
FLORIDA	Fact-Tronics
ILLINOIS	Bard Associates, Inc.
KANSAS	Leemark Associates, Inc.
MARYLAND	C. E. Snow Co.
MASSACHUSETTS	Tech. Instruments, Inc.
MICHIGAN	S. Sterling Company
MINNESOTA	Northport Engineering, Inc.
MISSOURI	Leemark Associates, Inc.
NEW JERSEY	NLR Associates
NEW MEXICO	Hytronic Measurements, Inc.
NEW YORK (upstate)	Martin P. Andrews, Inc.
(metro)	NLR Associates
OHIO	S. Sterling Company
PENNSYLVANIA	C. E. Snow Co.
TEXAS	SEI, Inc.
UTAH	Hytronic Measurements, Inc.
VIRGINIA	C. E. Snow Co.
WASHINGTON, D. C.	C. E. Snow Co.
WASHINGTON	Comptronics

APPLICATIONS

VARIABLE TIME-DELAY GENERATOR

ANALOG-COMPUTER FUNCTION GENERATOR

ELECTRO-MECHANICAL STUDIES

MARGINAL TESTING

DISTORTION STUDIES

SWEEP GENERATOR

MEDICAL-ELECTRONICS RESEARCH

DESIGN STUDIES

SERVO DESIGN

CALIBRATION

SHOCK GENERATION

FILTER-ANALYSIS

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