Errata

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OPERATING AND SERVICE MANUAL

(HP PART NO. 03300-90002)

MODEL 3300A

FUNCTION GENERATOR

SERIALS PREFIXED 630-

Information required to adapt this manual to instruments serial prefixed 519-, 533-, 609-, 616- and 622- is outlined in a special Supplement B. If Supplement B is needed contact your local -hp- Sales and Service Office, giving full instrument name, model and serial number. (See Appendix B for office location).

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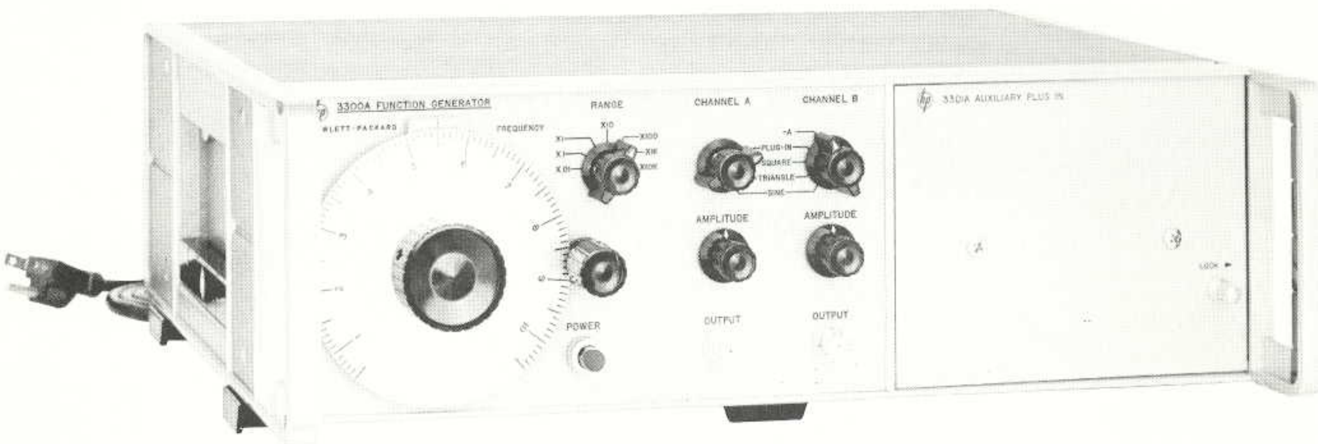


Figure 1-1. Model 3300A Function Generator

Table 1-1. Specifications

OUTPUT WAVEFORMS: Sinusoidal, square, and triangle selected by panel switch. (Any two outputs available simultaneously.

FREQUENCY RANGE: 0.01 Hz to 100 kHz in seven decade ranges.

FREQUENCY RESPONSE: ±1%, 0.01 Hz to 10 kHz; ±3%, 10 kHz to 100 kHz.

DIAL ACCURACY: ±1% of maximum dial setting (1 minor division) 0.01 Hz to 10 kHz; ±2% of maximum dial setting (2 minor divisions) 10 kHz to 100 kHz. T.C. 0.1%/^{o}C.

MAXIMUM OUTPUT PER CHANNEL: >35 volts peak-to-peak open circuit; >15 volts peak-to-peak into 600 ohms; >2 volts peak-to-peak into 50 ohms.

OUTPUT IMPEDANCE: 600 ohms nominal (both channels).

SINE WAVE DISTORTION: <1%, 0.01 Hz to 10 kHz; <3%, 10 kHz to 100 kHz.

SQUARE WAVE RESPONSE: <250 nsec rise and fall time on all ranges; <1% sag; <5% overshoot at full output; <1% symmetry error.

TRIANGLE LINEARITY: <1% 0.01 Hz to 10 kHz; <2%, 10 kHz to 100 kHz <1% symmetry error.

SYNC PULSE OUTPUT: >10 volts peak-to-peak open circuit, <5 μsec duration. Sync pulse occurs at crest of sine and triangle wave.

DC STABILITY: Drift: <±0.25% of peak-to-peak amplitude over a period of 24 hours. (After 30 minute warmup).

REMOTE FREQUENCY CONTROL: 0 to -10 volts will linearly change frequency >1 decade within a single range. Frequency resetability with respect to voltage ±1% of maximum frequency on range selected.

POWER: 115 or 230 volts ±10%, 50 to 1000 Hz. Approximately 50 watts.

DIMENSIONS: (inches and millimeters) 5" high (127 mm), 16" wide (406 mm), 11" deep (279 mm).

WEIGHT: Net 20 lbs (9 kg).

SECTION I
GENERAL INFORMATION

1-1. GENERAL.

1-2. The Hewlett-Packard Model 3300A Function Generator is a solid state instrument useful for most general purpose frequency testing applications. Three output waveforms are available from front panel connectors; sine, square, and triangle. A sync pulse is also available from a rear panel connector.

1-3. The -hp- Model 3300A Function Generator is a type of relaxation oscillator. The triangle and square wave voltage functions are inherent in the oscillatory system. The sine wave is produced by synthesizing the triangle wave.

1-4. The -hp- Model 3301A Auxiliary Plug-in or another 3300A plug-in is required to provide internal connection for basic unit (main frame) operation.

1-5. ELECTRONIC FREQUENCY CONTROL.

1-6. Frequency of the -hp- Model 3300A can be controlled by either the front panel frequency dial or an external voltage applied to a rear terminal connector. This feature is useful for sweeping filters, amplifiers and other frequency-dependent devices and for externally programming frequencies for production testing. An input voltage of approximately -0.5 to -10 volts will linearly control the frequency over any one range (one decade).

If desired the frequency can be controlled over more than one decade, by applying a +0.3 to -10 volts to the FREQUENCY CONTROL BNC. A +0.3 to -10 V input will linearly control the frequency over approximately a 50:1 range.

1-7. OUTPUT SYSTEM.

1-8. The -hp- Model 3300A has two completely separate output channels. Each output is dc coupled and can be fully floating with respect to power line ground. An internal shield reduces radiated interference and provides common mode rejection with floating output. Separate connectors on the rear panel provide terminals for circuit ground (⏚), output ground (▽), shield ground (▽), and power line ground (⏚). The output ground may be floated from power line ground by up to ±250 volts. Any two of the three waveforms are available simultaneously from the front panel connectors.

1-9. INSTRUMENT AND MANUAL IDENTIFICATION.

1-10. Hewlett-Packard uses a two-section eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 3300A described in this manual.

1-11. If the first three digits of the serial number are prefixed with an E or a G, your instrument was produced in Europe. An E000-00000 serial number indicates that the instrument was manufactured in England; a G000-00000 serial number indicates that the instrument was manufactured in Germany.

NOTE

In this manual, the international standard unit of frequency, the Hertz, will be used rather than cycles per second.

1 Hertz (Hz) = 1 cycle per second

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for the installation and shipping of the Model 3300A Function Generator. Included are initial inspection procedures, power and grounding requirements, installation information, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also check for supplied accessories and test the electrical performance of the instrument using the Performance Checks outlined in Section V.

2-5. POWER REQUIREMENTS.

2-6. The Model 3300A can be operated from any source of 115 or 230 volts (± 10%), at 50 - 1000 cps. With the instrument disconnected from the ac power source, move the slide switch (located on the rear panel) until the desired line voltage appears. Power dissipation is approximately 50 watts.

2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-9. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-10. INSTALLATION.

2-11. The Model 3300A is fully transistorized; therefore, no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F).

2-12. BENCH MOUNTING.

2-13. The Model 3300A is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

2-14. RACK MOUNTING.

2-15. The Model 3300A may be rack mounted by using the 5" Rack Mount Kit (-hp- Part No. 5060-0775). Instructions for the conversion are included with the kit. The rack mout for the Model 3300A is a standard width of 19 inches.

2-16. REPACKAGING FOR SHIPMENT.

2-17. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-18 if the original container is to be used: 2-19 if it is not. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix B for office locations).

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicate the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number and serial number prefix.

2-18. If original container is to be used, proceed as follows:

a. Place instrument in original container if available. If original container is not available, one can be purchased from your nearest -hp- Sales and Service Office.

b. Ensure that container is well sealed with strong tape or metal bands.

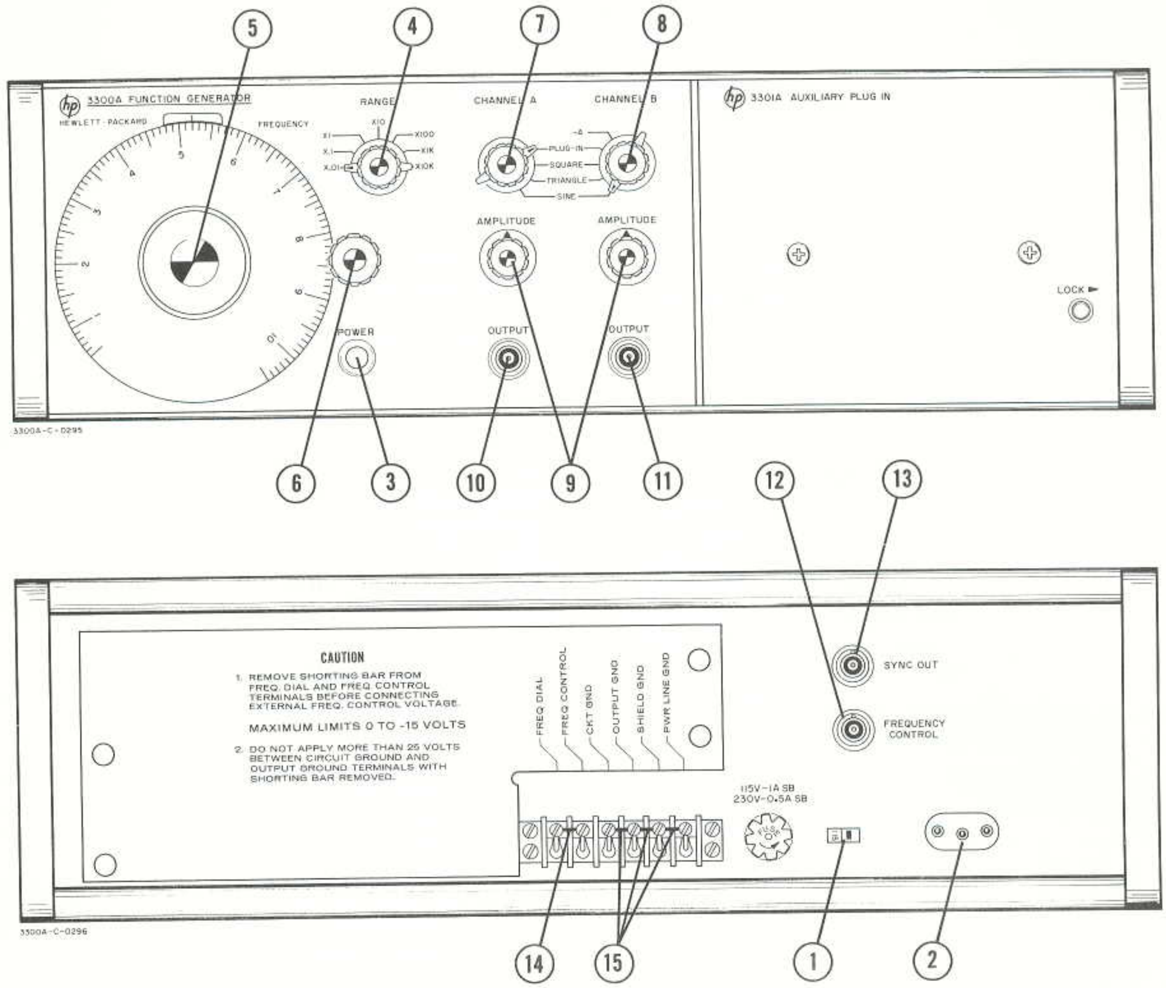
2-19. If original container is not to be used, proceed as follows:

a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of instrument and protect panel face with cardboard strips.

c. Place instrument and inner container in heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE", etc.



(1) 115V/230V Slide Switch: S2 makes proper connections in primary of input transformer for selected input line voltage.

(2) Power Input Jack: J1, male receptacle for input power cable.

(3) POWER Pushbutton: S1, a on-off switch which illuminates when in the on position and power is applied to the instrument.

(4) RANGE Switch: S3, a seven position rotary switch which selects frequency determining feedback parameters in the basic oscillatory circuit.

(5) FREQUENCY Dial: R4, a linear dial which controls frequency within the decade selected by the RANGE Switch (4).

(6) Vernier Frequency Control: a fine frequency adjustment knob.

(7) CHANNEL A Function Switch: S4, a four position rotary switch which selects the desired OUTPUT (10).

(8) CHANNEL B Function Switch: S5, a five position rotary switch which selects the desired OUTPUT (11).

(9) AMPLITUDE Controls: R12 and R9 attenuators which vary the output level of the respective channels.

(10) and (11) OUTPUT Connectors: J2 and J3, BNC jacks for connection to the respective outputs of the function generator.

(12) FREQUENCY CONTROL: J5, a BNC jack for applying external frequency control voltage.

(13) SYNC OUT: J4, a BNC jack for connection to sync pulse which occurs at the crests of the sine and triangle wave.

(14) FREQ DIAL-FREQ CONTROL Shorting Bar: completes the circuits to the FREQUENCY Dial for internal frequency control.

(15) Common Grounding Straps: ties circuit, output, and shield grounds to power-line ground.

Figure 3-1. Description of Front and Rear Panel Controls and Connectors

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section consists of instructions and information necessary for the operation of the -hp- Model 3300A Function Generator.

3-3. CONTROLS AND INDICATORS.

3-4. Each operating control and connector located on the 3300A is identified and described in Figure 3-1. The description of each component is keyed to an illustration of that component.

3-5. TURN ON PROCEDURE.

3-6. To turn on the Model 3300A, proceed as follows: (Refer to Figure 3-1).

a. Set 115/230 V slide switch (1) to line voltage to be used, and check for proper value fuse (.6 amp slow-blow for 115 volt operation, .4 amp slow-blow for 230 volt operation).

b. Connect Power Input Jack (2) to the ac line voltage with the power cord furnished with instrument.

c. Depress POWER button (3) ; ensure that light in button illuminates.

3-7. OPERATING INSTRUCTIONS.

NOTE

For small signal applications to obtain optimum signal to noise performance, use an external 20 dB attenuator.

3-8. To operate the Model 3300A locally using the FREQUENCY dial, proceed as follows: (See Figure 3-1.)

a. Select desired frequency by setting RANGE Switch (4) and FREQUENCY Dial (5) .

b. Select desired function by setting CHANNEL A and/or CHANNEL B Function Switch (7) or (8) . PLUG-IN position is used for plug-in function(s).

c. Set AMPLITUDE controls (9) for desired output at the OUTPUT connectors (10) or (11) .

3-9. To control the frequency of the Model 3300A externally (remotely) proceed as follows:

a. Remove FREQ DIAL-to-FREQ CONTROL shorting bar (14) .

CAUTION

VOLTAGE APPLIED TO FREQ CONTROL BNC SHOULD BE LIMITED TO A VALUE BETWEEN +0.3 AND -15 VOLTS. VOLTAGES OUTSIDE THIS RANGE WILL DAMAGE THE INSTRUMENT.

b. Apply a negative dc voltage from -0.5 to -10 volts to the FREQUENCY CONTROL BNC (12) .

NOTE

-0.5 to -10 volts will linearly control the frequency over one decade of range selected. A +0.3 to -10 volts will linearly control the frequency over 50:1 range.

c. Select desired frequency range and set amplitude of externally applied voltage for desired frequency.

d. All 3300A controls except the FREQUENCY dial are operated in the same manner as in Paragraph 3-8.

3-10. To dc offset the output function of the 3300A with either the 3301A or 3302A Plug-In, proceed as follows:

a. Remove CKT GND-to-OUTPUT GND shorting bar (15).

CAUTION

DO NOT EXCEED ±25 V DC OFFSET VOLTAGE BETWEEN OUTPUT GROUND AND CIRCUIT GROUND.

b. Connect desired dc offset voltage between CKT GND and the common grounds.

NOTE

If additional offset is required apply dc voltage up to ±250 V between output ground and power-line ground. With dc offset voltage applied between output ground and power-line ground the outside conductor on the OUTPUT BNC connector will be at the potential of the offset voltage.

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains a description of the theory of operation of the -hp- Model 3300A Function Generator with the -hp- Model 3301A Auxiliary Plug-in.

4-3. GENERAL DESCRIPTION.

4-4. The Model 3300A comprises a frequency control network, two current sources, a triangle integrator, a voltage comparator multivibrator, a sine wave synthesizer and output amplifiers. (Refer to Figure 4-1).

4-5. The Model 3301A Auxiliary Plug-in comprises shorting wires to provide internal connections for Model 3300A operation.

4-6. The voltage comparator multivibrator, current sources and triangle integrator form the basic function generating loop. The voltage comparator multivibrator changes state at predetermined limits on the positive and negative slopes of the output of the triangular integrator. The effect of the change of state in the upper current source, reverses the input to the triangle integrator. A cycle is as follows: when the amplitude of the positive slope of the triangle wave reaches the upper predetermined limit of the voltage comparator multivibrator, the multivibrator changes state. This change of state reverses the current into the triangle integrator through control of the upper current source which causes the output of the integrator to decrease. The decrease continues until the amplitude of the negative slope reaches the lower predetermined limit. At this point, the voltage comparator multivibrator changes state and again reverses the direction of current at the input of the integrator and causes the output of the integrator to rise. This rise continues until the voltage comparator multivibrator again changes state thus completing the cycle.

4-7. The frequency control network, governed internally by the FREQUENCY Dial or externally through the FREQUENCY CONTROL, determines the amount of current in the current sources, which varies the frequency as follows: an increase or decrease in input current increases or decreases the slope of the triangle wave, respectively. (A change in direction of input current reverses the slope.) Frequency will increase if the + and - slopes are increased, as less time is required for the + or - slope of the triangle wave to reach the predetermined limits in the voltage comparator multivibrator.

4-8. The sine wave is synthesized from the triangle wave by a nonlinear network. This network consists of resistors and diodes biased so different diodes conduct during different voltage levels of the triangle wave. These diodes, when conducting, provide additional shunt paths within the network. Each additional shunt path changes the slope of the triangle wave so that the wave is shaped to approximate a sine wave.

4-9. The output amplifiers are dc coupled and fully floating with respect to power line ground. CHANNEL A and CHANNEL B amplifiers are identical and use a differential amplifier at the input. To maintain the same peak-to-peak amplitude regardless of function selected, the overall closed loop gain of the amplifier is varied with function selection.

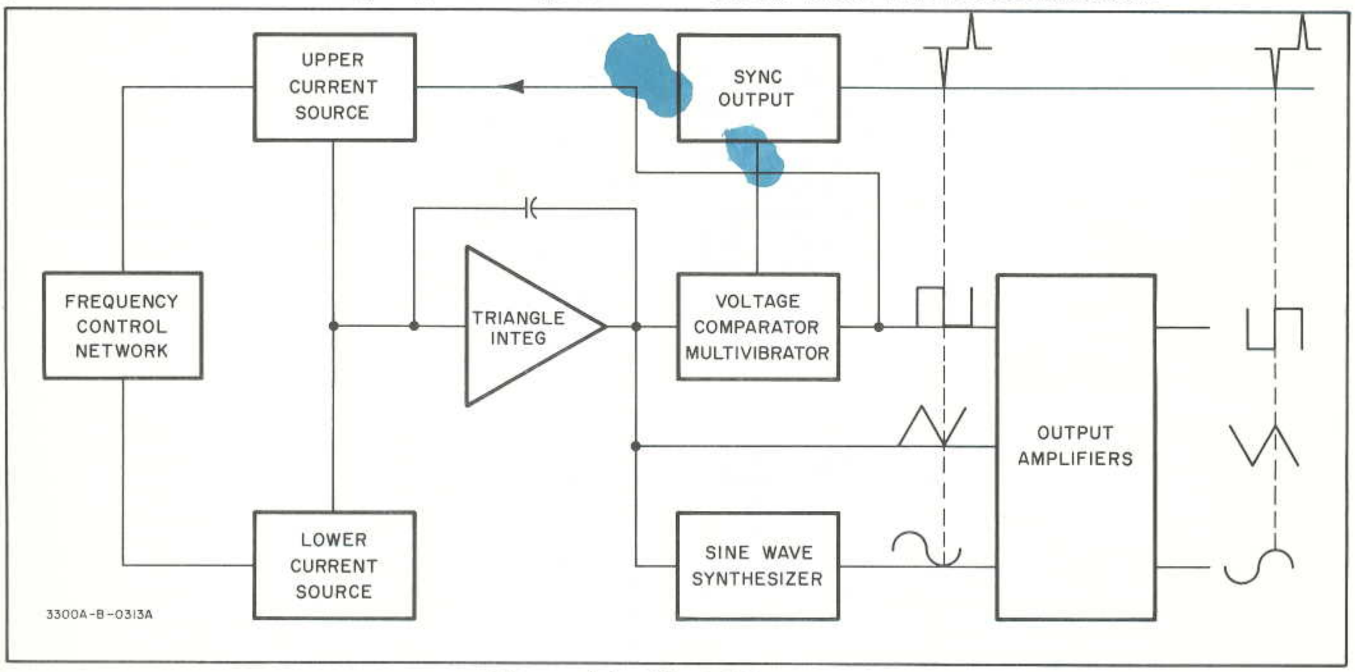


Figure 4-1. Block Diagram

4-10. The sync pulse is produced by an RC differentiating network. The negative pulse at the output is in phase with the positive crest of the sine and triangle wave.

4-11. Power Supply (Refer to Figure 6-5) can operate on either 115 or 230 volts input and delivers 3 pairs of voltages, ±40 V, ±26.5 V, and ±20 V. The 40 volt supply provides power for the oven heater. The 26.5 volt supplies are regulated and the 20 volt supplies are double regulated.

4-12. Critical temperature sensitive components are housed within an oven in which the temperature is maintained at approximately 80° C (176° F).

4-13. SCHEMATIC THEORY.

4-14. FREQUENCY CONTROL NETWORK.

4-15. (Refer to Figure 6-2) The FREQUENCY dial (R4) in conjunction with the RANGE switch (S3) provides internal frequency control. The basic frequency equation can be expressed as

$$F = \frac{i}{2C\,\Delta\, e_{out}}$$

Where i is the current to the triangle integrator, C is the triangle integrator feedback capacitor and e_{out} is the peak-to-peak voltage of the triangle wave.

The position of the RANGE switch determines the integrating capacitor C. The FREQUENCY dial or external control voltage determines the current i. The frequency control voltage is applied to the current control transistor A11Q5, which establishes the amount of current available to the triangle integrator from the current sources A11Q6 and A11Q7.

4-16. CURRENT SOURCES.

The state of current source A11Q6 is controlled by the voltage comparator multivibrator, and in turn, controls the direction of the current in the input of the triangle integrator. When A11Q6 is on, a current, a i, flows through it and divides, i into the integrator and i through current source A11Q7. When the bi-stable multivibrator changes state and gates A11Q6 off, 2 i no longer flows; however, the current through A11Q7 remains the same. Therefore, a current equal to i but opposite in direction flows from the triangle integrator input.

4-17. TRIANGLE INTEGRATOR.

The triangle integrator consists of an impedance converter A11Q8 (a field effect transistor), a differential amplifier A13Q1 and A13Q2, an emitter follower A13Q3, diode A13CR1, and the capacitive feedback network: this circuit integrates the constant current inputs into the positive and negative slopes which make up the triangle wave. The triangle wave is applied to the inputs of the output amplifiers, sine wave synthesizer and voltage comparator multivibrator.

4-18. VOLTAGE COMPARATOR MULTIVIBRATOR.

The voltage comparator multivibrator consists of a voltage comparator switching network, A14Q8, A14CR13 and A14CR14; a bi-stable multivibrator A14Q9 and Q10 and an emitter follower A14Q11. A14CR19 and R45 provide a low resistive path to ensure rapid rise and fall time of the square wave in the event the capacitance of the load is high. When the positive slope of the triangle wave reaches +20 volts, A14CR13 is turned on. A14Q9 is then turned on which turns A14Q10 off. The rise in the collector voltage of A14Q10 is coupled through emitter follower A14Q11 and through A14CR20 and A14CR21 into the emitter circuit of A11Q6, and turns it on. The output slope then becomes negative. A11Q6 remains on until the negative slope reaches zero volts. At the zero point on the negative slope A14CR14 is turned on which causes the bi-stable multivibrator to change state so that A14Q9 is now off and A14Q10 is on. The decrease in A14Q10 collector voltage gates the current source, A11Q6, off which reverses the integrator input current. The positive slope then begins increasing toward the upper limit, +20 volts. The output of the emitter follower is differentiated by A14C7 and A14R48 to provide the sync output. A negative sync pulse occurs at the crest of sine and triangular wave, see Figure 4-1.

4-19. SINE WAVE SYNTHESIZER.

(See Figure 6-2) The sine wave synthesizer comprises four control transistors, the biased diodes with associated voltage dividers, a differential amplifier A14Q5, A14Q6 and the output amplifier A14Q7. A14R17 and A14R29 adjust the operating points of the voltage dividers to minimize distortion. The diodes are biased by the four control transistors A14Q1 through A14Q4 and the voltage dividers to provide twelve different current paths in the input to the differential amplifier as the triangle wave progresses. Each slope of the triangle wave is modified in twelve steps so that the waveform appearing at the base of A14Q5 approximates a sine wave. The sine wave synthesizing network is isolated by the differential amplifier A14Q5 and A14Q6 and amplifier A14Q7.

4-20. OUTPUT AMPLIFIERS. Figure 6-4).

The etched circuit assemblies A15 and A16 are identical. CHANNEL A and CHANNEL B differ due to the -A output of CHANNEL B. The input for CHANNEL B with its function switch in -A position, A16 Pin 5, is taken from the junction of A15R20 and R21, XA15 Pin 10. The output amplifiers are variable gain amplifiers. Gain is varied by changing the amount of feedback for the different functions. The following reference designators should be prefixed by applicable assembly number. The feedback is varied by resistors R1 through R5 and R23 C8 combination, to maintain equal peak-to-peak amplitude of the various functions for a given AMPLITUDE control setting. A differential amplifier, Q1 and Q2, make up the first stage followed by two additional amplifiers Q3 and Q4. The trimmer C2 in the feedback network is used to shape the square wave. The AMPLITUDE control provides a nominal 600 ohms output impedance, independent of amplitude control setting.

4-21. POWER SUPPLY. (Figure 6-5).

The power supply comprises two full wave rectifiers CR1 thru CR4 and four series regulated supplies. A11CR1 provides the reference point for the two negative regulated supplies which in turn are the references for the two positive regulated supplies. The two 20 volt supplies are double regulated. The operation of the four supplies is similar. A differential amplifier senses and amplifies any change. The change is applied through a driver stage to the series regulator which then changes its conduction to oppose the change. The diodes in the + and -26.5 volt supplies are used to limit the current through the series regulator. The operation is the same in both supplies, the +26.5 supply is discussed. As the current through Q1 increases the IR drop across A12R5 and A12R6 increases. This increase decreases the forward bias on Q1 which decreases the current through Q1. The forward bias on Q1 is a function of the Vbe of A12Q2, the breakdown voltage of the forward biased diodes A12CR2 through A12CR5, and the variable IR drop across the parallel network of A12R5 and A12R6.

4-22. OVEN.

(See Figure 6-5) The oven temperature is automatically maintained at the desired temperature by a thermal control loop. The loop consists of a thermistor, a signal amplifier, a power amplifier, and the heater resistors. The operation of the loop is as follows: The resistance of RT1 (thermistor) decreases with an increase in temperature which causes the base voltage of A11Q9 to rise. The corresponding decrease of A11Q9 collector voltage is coupled into the base circuit of the power amplifier Q7. The collector current of Q7 then decreases which decreases the current through the heater resistors generating less heat and the temperature decreases. The response of the loop is improved by the physical location of A11R27 in close proximity to the thermistor.

A thermal fuse (between +40 volts and the heating resistors) opens at approximately 194°F (90°C) to protect the oven board if the thermal control loop becomes inoperative with heating current flowing. If the thermal fuse opens, the only apparent effect is that symmetry will be out of specifications at the low end of the FREQUENCY Dial.