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FUNCTION GENERATOR

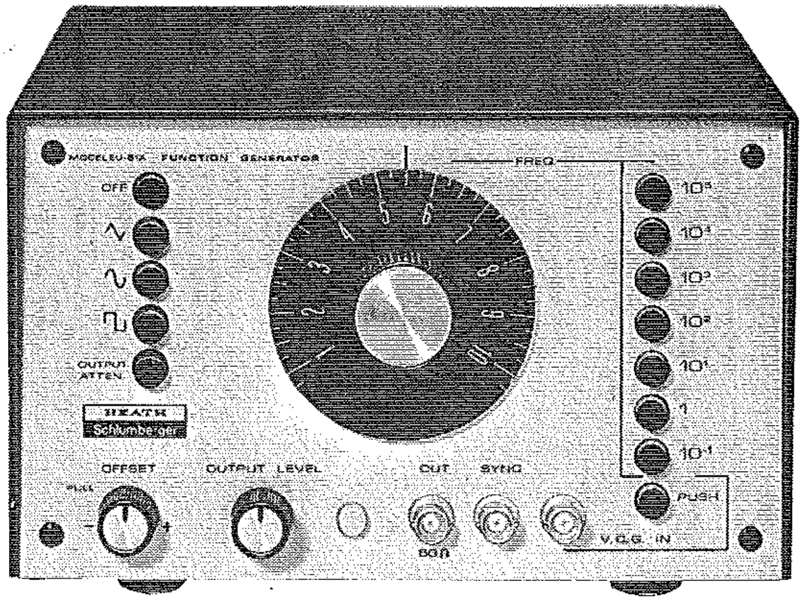
Model EU-81A

595-1312

THE HEATH

FUNCTION GENERATOR

Model EU-81A



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HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022
a Schlumberger company

INTRODUCTION

The Heath Model EU-81A is a versatile general purpose generator of precise sine, square, and triangular waveforms for the scientific laboratory. It has a seven-decade frequency range extending from the sub-audio into the radio frequencies. Its frequency stability and amplitude constancy are exceptional. In addition, this Function Generator provides the convenience of internal adjustable dc offset, external voltage control of the generator frequency, synchronizing output signal, and a wide-range output attenuator.

There are countless measurement and generation applications in the laboratory for such a precise and versatile signal source. It can provide modulating and/or sweep signals for innumerable systems. It can be used to test servo systems response. It can provide the voltage-controlled oscillator in a phase-lock-loop for FM detection or precise frequency multiplication. It can be used to test amplifier frequency response, distortion, and stability. It can be a repetition rate generator, a variable beat oscillator, a tone generator, and many others.

The Model EU-81A Function Generator is an attractive unit, a perfect companion to the EU-70A Dual-Trace Oscilloscope, and a part of the Heath/Malmstadt-Enke Laboratory Station.

SPECIFICATIONS

Output	All modes — 50 ohm source. 10 V (P-P) into 50 ohm load. 20 V (P-P) open circuit. Adjustable dc offset continuously variable to maximum signal amplitude.
Frequency Range	0.1 Hz to 1 MHz in 7 decades. Continuously adjustable with Linear dial.
Triangular Waveform	95% linearity to 100 kHz.
Sine Waveform	Harmonic distortion; 1% 5 Hz to 100 kHz (1/2% typical). Less than 2% to 1 MHz.
Square Wave	125 ns rise or fall time.
Waveform Symmetry	±2% to 100 kHz.
Frequency Dial Accuracy	±3% of full scale.
Frequency Stability after 1 Hour	±0.05% for 10 min. (1 Hz to 1 MHz). ±0.3% for 24 hours (1 Hz to 1 MHz). ±0.25% for 10 min. (0.1 Hz to 1 Hz) above with external voltage control.
Amplitude Precision	
Triangular Wave	0.2 dB to 1 MHz.
Square Wave	0.2 dB to 1 MHz.
Sine Wave	0.2 dB to 100 kHz. 2 dB down at 1 MHz.
External Frequency Control	
Sweep Mode	±10 V maximum into 10 kΩ.
Voltage Control Mode	0 to 10 volts into 100 kΩ.
Operating Temperature	10° C to 40° C.
Power Consumption	18 watts.
Line Voltage	105-125 Vac, 50/60 Hz (may be rewired for 210-250 Vac).
Dimensions	11-1/8" deep, 8-7/8" wide, 5-5/8" high/6-7/8" high (with bail extended).
Net Weight	6 lbs.

OPERATION

This section of the manual will describe the power transformer wiring for operation from 105-125 volts or 210-250 volts, and then will describe the function of each switch, control, and connector.

This instrument was carefully checked and calibrated at the Heath factory and should be ready for operation when it is unpacked and connected to a power line. If the shipping container shows evidence of rough handling, carefully inspect the unit for shipping damage. Report any damage to the carrier and to the Heath Company.

POWER TRANSFORMER WIRING

The primary windings of the power transformer are wired for operation from a 105-125 volt ac power line. Leads from these windings are connected to a 4-lug terminal strip on which jumper wires are connected to link the proper windings. To change the wiring for operation from a 210-250 volt ac voltage, refer to Figure 1 and complete the following steps. Be sure the line cord is disconnected from the ac outlet before you begin.

1. Remove the jumper wires (or wire) presently connected on the terminal strip.
2. Install the jumper wire (or wires) required for the new primary voltage. Solder the ends of each jumper to the terminal strip lugs.
3. Install the appropriate line fuse in the fuseholder on the rear panel; use a 1/8-ampere fuse for 210-250 volt operation, or a 1/4-ampere fuse for 105-125 volt operation.

NOTE: A special line cord plug may be required for 210-250 volt operation in some areas. If so, either replace the plug or the 3-wire line cord and plug.

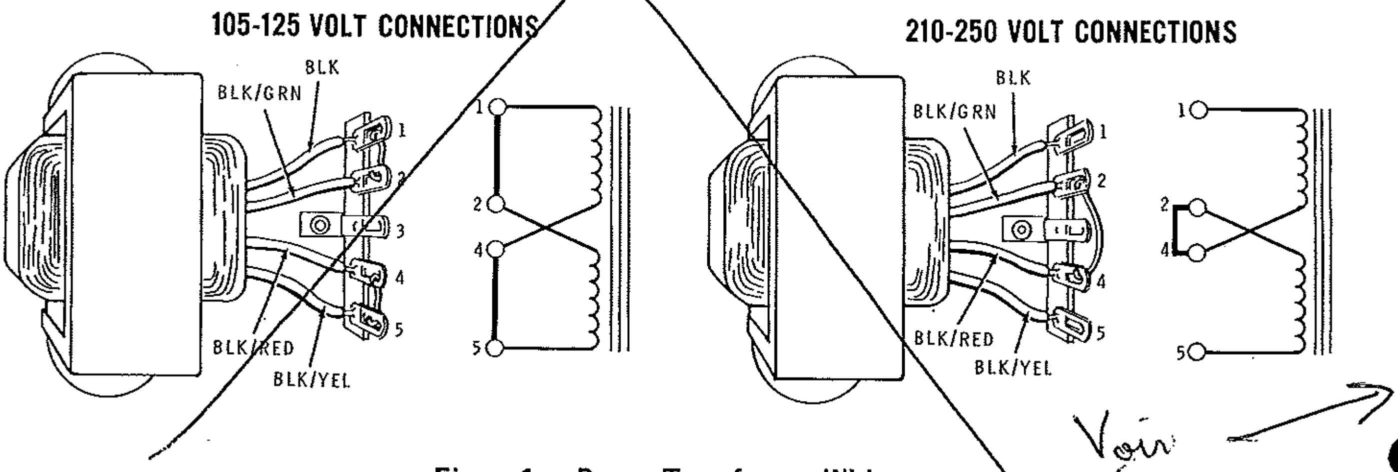


Figure 1 Power Transformer Wiring

SWITCHES, CONTROLS, CONNECTORS

Refer to Figure 2 for the location of the controls, connectors, and switches described below.

FREQUENCY DIAL — Continuous frequency adjustment over 1 decade; 1-10 multiplied by the Decade Frequency buttons, 10^5 through 10^{-1} for 1 MHz to 0.1 Hz output.

MODE BUTTONS — Triangular, Sine, and Square. Pressing a Mode button turns the unit on and connects the selected waveform to the output amplifier.

OUTPUT ATTENUATOR — When the Attenuator button is depressed, a nominal 20 dB attenuator is inserted between the output amplifier and output connector.

OUTPUT LEVEL CONTROL — This control continuously adjusts the amplitude of the output between 20 V P-P and 200 mV P-P.

OFFSET — This control must be pulled out to provide dc offset to the output. Positive offset is provided by clockwise rotation and negative by counterclockwise rotation. Push the knob in to disconnect the Offset control from the circuit. The offset may be set to any level where the signal plus the offset does not exceed the maximum output as clipping will result beyond this point.

EXTERNAL VOLTAGE CONNECTOR — This is a provision for external voltage control of the current generator. With the Voltage Control button in the OUT position, the voltage applied to the VCG connector is summed with voltage from the Frequency Control dial. The frequency will be controlled or swept by this input and be the sum of the dial frequency and this input. Either polarity may be applied to the VCG input to raise or lower the frequency, but must never exceed 10 volts. The input impedance in this mode is 10 kΩ.

With the External VCG button depressed, the dial is disconnected and the frequency is determined by the external control frequency of 1-10 volts. Input impedance in this mode is greater than 100 kΩ.

SYNC OUT — This connector provides a TTL compatible square wave of the same frequency as the output.

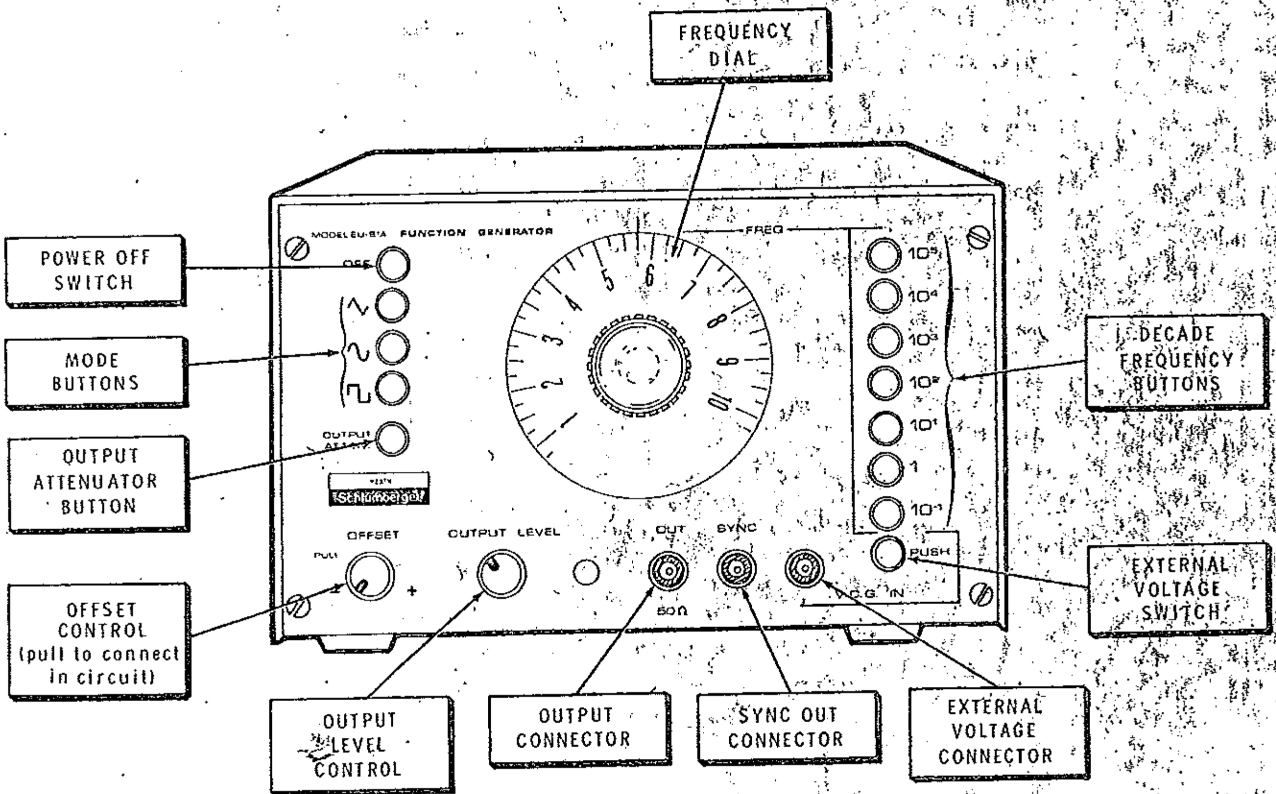


Figure 2 Location of Controls and Connectors

HEATH
SCIENTIFIC INSTRUMENTS

MANUAL CORRECTION

An error has been discovered in the manual for your Model EU-81A Function Generator. The power transformer primary connections shown in Figure 1 and on the Schematic are incorrectly labeled.

Please paste the Figure 1 (below) over that figure on Page 4 of your manual. Then relabel the transformer leads accordingly on the Schematic that folds out from Page 6.

Thank you

HEATH COMPANY

#591-950
EU-81A

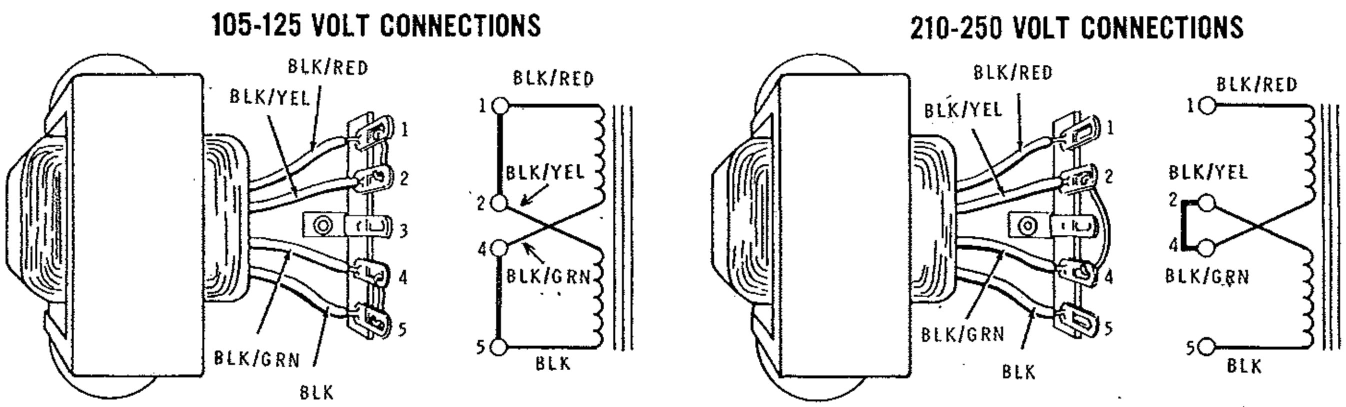


Figure 1 Power Transformer Wiring

FREQUENCY CONTROL SECTION

Frequency generation in this section depends on the fact that with a constant current charging a given capacitance, the time to charge to a given voltage is inversely proportional to the charging current ($t = cv/i$). By varying the capacitance and/or the charging current, the time to charge to a given voltage is changed in predictable steps.

VOLTAGE CONTROL

Figure 4 is a simplified schematic of the voltage control circuit.

Varying Frequency control potentiometer R301, taps from 1 to 10 volts from the voltage divider consisting of R101, R102, R103, and R301. This voltage through emitter follower Q101 feeds inverting unity gain amplifier IC-101A. The output IC-101A provides voltage control for constant current sink transistor Q103 and feeds the second inverting unity gain amplifier IC-101B. This amplifier provides voltage control for constant current source transistor Q102. Thus, from the control (R301) we have tracking positive and negative control voltage for the current control transistors.

With S101-H in the NORMAL position, an external signal connected to the summing junction of IC-101-A through R108 will change the control voltage from level set by R301. This may be used to sweep or offset the dial frequency. With S101-H in the EXTERNAL position, the Frequency potentiometer is disconnected and a control voltage of 1 to 10 volts will control the generator.

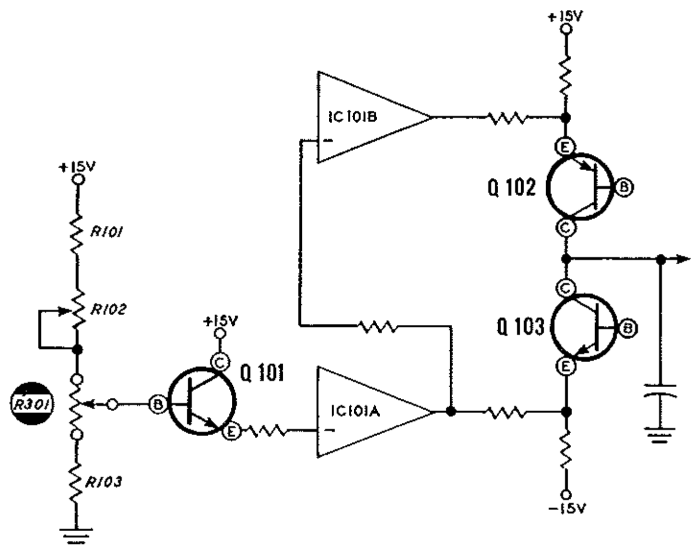


Figure 4 Simplified schematic of voltage control circuit

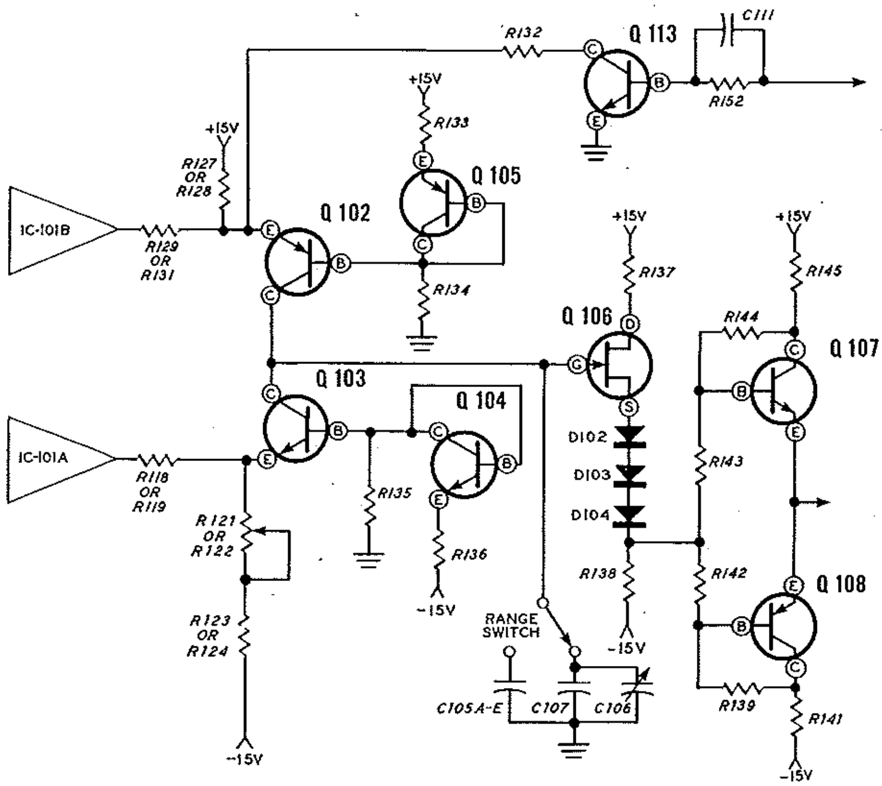


Figure 5 Simplified schematic of current generator circuit

CURRENT GENERATOR

Figure 5 is a simplified schematic of the current generator circuit.

The compensated divider (R133, R134, and Q105) holds a constant voltage on the base of Q102. Q102 is an emitter follower whose emitter voltage is fixed since its base voltage is fixed. Since the voltage across R127 or R128 is constant, the current through Q102 must also be constant. Neglecting the base current, the collector current equals the emitter current.

Transistor Q103 generates a current opposite in polarity to that generated by Q102 The emitter resistors for Q103 are twice the value of those of Q102, therefore, the current through Q103 is one half that of Q102. One half of the current passed by Q102 is used to charge the capacitor selected by S101-A, B, C, D, or E. When Q113 is turned on, the emitter voltage of Q102 is dropped below its base voltage and Q102 turns off.

Q103 continues to draw the same amount of current but from the capacitor rather than from Q102. This discharges the capacitor at exactly the same rate as it was charging.

FREQUENCY SELECTOR SWITCH

Decade steps in frequency are selected by pushbutton switch S101 (sections A through G). The sections are mechanically interlocked to release all sections except the one that is depressed. Sections A through F select a capacitor that is ten times the value of the capacitor in the preceding section. Pushbutton S101-F releases all sections so that capacitor C105A is in the charging circuit, while S101-G uses this same capacitor and decreases the charging current by a factor of 10.

For continuous frequency control between switch-selected decades, the charging current must be made variable. Since the collector and emitter currents are equal in each current source transistor (Q102 and Q103), any current diverted from the emitters will not pass through the collectors.

Variable voltage source IC-101 is connected to the emitters of the current source transistors through resistors. When the voltages of IC-101 are equal to the emitter voltages, there is no current flow through these resistors and all the current passes through Q102 and Q103. As the voltage from IC-101A and IC-101B is decreased, current flows through the connecting resistors R118/R119 and R129/R131 and the current through Q102 and Q103 decreases. The time to charge the selected capacitor to a given voltage increases directly as the current decreases. The triangular waveform produced by the linear charging and discharging of the capacitor is taken directly from the follower amplifier consisting of Q106, Q107, and Q108 to the output circuits.

SQUARE WAVE—SYNC GENERATOR—LEVEL DETECTOR

Integrated circuits IC-102, IC-103, and IC-104 control the polarity of the current generator and produce the square wave and sync output signals, as shown in Figure 6.

Transistors Q106, Q107, and Q108 form a follower that passes the triangular waveform through dividers R146-R147 and R154-R156 to level detectors IC-102 and IC-103. Positive level detector IC-102 is a voltage comparitor with its non-inverting input referenced to a positive level by R149 and R151. When the triangular waveform applied to the inverting input is less positive than the reference, the output is high. When the input signal becomes more positive than the reference, the output goes low. This low output is connected to a two-input NAND gate, IC-104A, which is cross-coupled with IC-104B. The output of IC-104A, through transistor Q113, controls the polarity of the current generator.

Integrated circuit IC-103 is a negative level detector with its inverting input referenced to a negative voltage. When the signal is less negative than the reference voltage, the output is high. When the signal is more negative that the reference, the output goes low and switches the output of IC-104B to high. This changes the state of the latch and the polarity of the current generator. The output of IC-104B is also connected to the inputs of IC-104C which drives the Sync Output, and to one input of IC-104D which gates the square wave output. The signal is buffered and inverted by IC-104D and drives the square wave amplifier where it is converted to a higher-amplitude bipolar signal. Switch S201D disables the output of IC-104D unless the square wave signal has been selected.

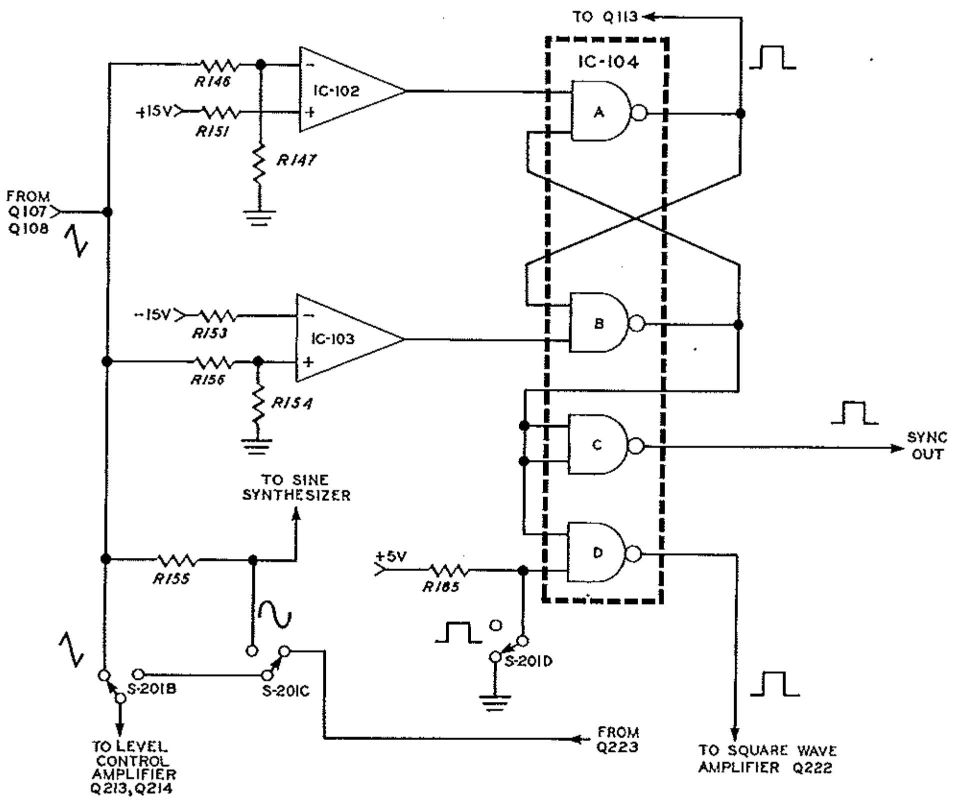


Figure 6 Square wave and sync generator

WAVE SHAPING SECTION

SINE SYNTHESIZER

Figure 7 shows the sine synthesizer circuit.

A sine wave is generated by feeding the triangular wave through R155 where it looks into a non-linear load. Resistors R164, R167, R171, R174, R177, and R179 form a positive voltage divider to provide back bias for D106, D108, D110, D112, D114, and D116. Resistors R162, R165, R168, R172, R175, and R178 form a negative divider providing back bias for diodes D105, D107, D109, D111, D113, and D115. When the input signal is at zero, all the diodes are back biased and R155 sees no load. As the input signal becomes more positive, the back bias of D116 is overcome and R176 loads the input. As the positive voltage continues to increase, D112, D110, D108, and D106 are turned on in turn and R173, R169, R166, and R163 are added to the load on R155 at regular intervals.

The greater the amplitude of the triangular wave applied to R155, the lower the impedance of the load on R155, and the greater the voltage drop across R155. The negatively-biased section of the synthesizer function in a similar manner. The effect of the synthesizer on the triangular wave is shown in the waveform above R155 in Figure 7.

Emitter follower transistors Q111 and Q112 permit the positive voltage level on the non-linear load to be set; the voltage ratio between them is set by divider R159 and R161. Q109 and Q110, with divider R181 and R184, set the negative level.

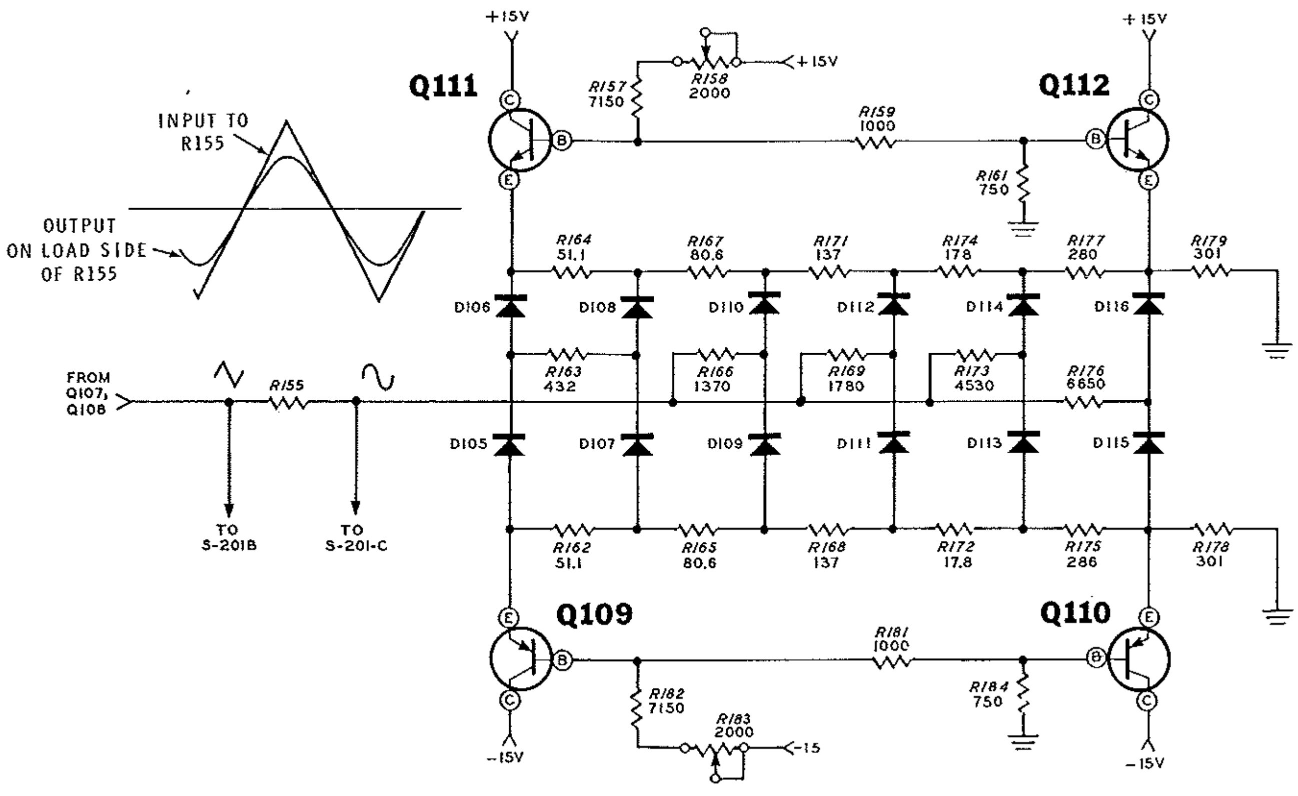


Figure 7 Sine synthesizer circuit

OUTPUT SECTION

OUTPUT WAVEFORM SELECTION

Switch S201-B connects the triangle waveform from R155 to the level control amplifier (Q213 and Q124). S201-C connects the sine waveform from R155 to the Amplifier. S201-D enables the square wave gate and releases S201-B and C to the normally open position so the output of square wave amplifier Q222 is connected to the level amplifier. The level control amplifier provides a low impedance signal to drive the Level control without loading the three waveform sources.

OUTPUT AMPLIFIER

The output of Level control R302 drives Q215 which, with Q216 form a differential pair. R303 supplies the adjustable dc offset to the base of Q216. The collector drop of Q216 drives phase splitter Q218 which drives the output pair (Q219 and Q220). Additional sections of S201-B and S201-C select the correct feedback for sine, square, and triangular outputs.

POWER SUPPLY

Figure 8 is a simplified block diagram of the power supply circuit.

Powered by the 40-volt center-tapped secondary of transformer T1, diodes D201 and D202, with capacitor C202, provide a positive unregulated voltage with reference to ground, while D203 and D204, with capacitor C204 provide a negative unregulated voltage. Decoupling network R201 and C201 provide the +25-volt unregulated supply, while R211 and C203 provide the −25-volt supply.

Transistor Q204 is used as a zener diode, connected in series with resistor R205 across the + and − supplies. Transistor Q205 and Q206 operate as a sense amplifier, referenced to to the −15 volt supply. As the output increases, base current of Q206 increases, as does its collector current, which reduces the voltage at the base of Q202. As a Darlington pair, Q202 and Q203 are referenced by current source transistor Q201. The reduced voltage at the base of Q202 causes Q203 to conduct less, reducing the output voltage.

Similar circuits in the −15 volt supply operate in the same manner except that sense amplifier Q211 and Q212 is referenced to ground.

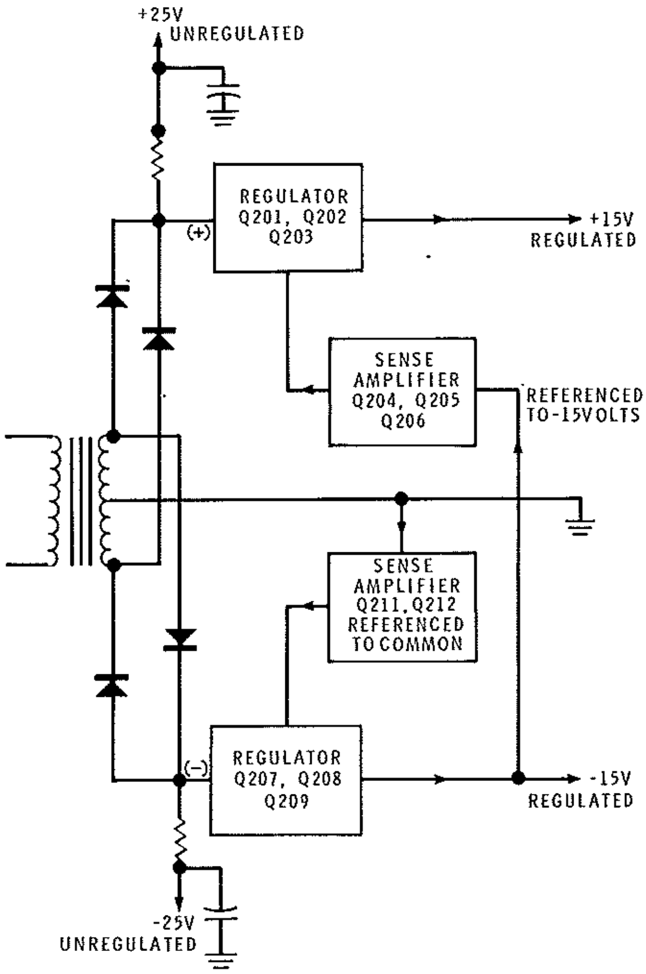


Figure 8 Simplified block diagram of power supply circuit

IN CASE OF DIFFICULTY

This section of the Manual will help you locate and repair minor difficulties that might arise in the operation of this Function Generator. General Troubleshooting describes a basic checkout procedure to identify common problems. Circuit Board Repair tells how to replace components and how to repair a circuit board foil.

Electronic Circuit Troubleshooting requires special training and test equipment. Do not attempt repairs unless you have the technical skill and equipment.

GENERAL TROUBLESHOOTING

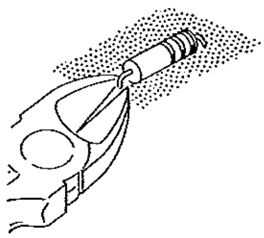
Visual inspection may reveal a damaged component or a break in the foil. If you find a burned-out part, such as a charred resistor, be sure to locate and correct the cause before you replace the part or put the equipment back into operation.

CIRCUIT BOARD REPAIR

The correct procedure for replacing components and connectors, and for repairing circuit board foils, is presented in the following paragraphs.

Components

Faulty resistors or capacitors should first be clipped from the circuit board with diagonal cutters as shown. Remove the component leads from the circuit board by heating the solder on the foil side and allowing the lead to fall out of the hole.



Preshape the leads of the replacement part and insert them in the holes in the circuit board; the body of the part should be flush against the board. Then solder the leads to the foil and cut off the excess lead lengths.

Transistors can be removed in the same manner as resistors or capacitors. The replacement transistor must be installed with its leads in the proper holes; then solder the leads quickly to avoid heat damage. Clip off the excess lead lengths.

Foil Repair

A break in a circuit board foil can be soldered. Large gaps in a foil should be bridged with a short length of bare wire. Lay the bare wire across the gap and solder each end to the foil.

NOTE: Refer to the Service Information inside the rear cover of this Manual for information on Factory Service, Technical Consultation, Replacement Parts, and Warranty.

ELECTRONIC CIRCUIT TROUBLESHOOTING

Voltage Control

A series of simple voltage checks will tell you if the circuit is functioning properly. Check for:

1. 1 to 10 volts on the wiper of R301, depending on the position of R301.
2. –1 to –10 volts on Pin 7 of IC-101A.
3. 1 to 10 volts on Pin 1 of IC-101B.
4. Voltages on pins 1 and 7 of IC-101 should be of equal magnitude, but opposite in polarity. Differences in magnitude will cause the output waveforms to be nonsymmetrical.