Instruction MANUAL

SERIES 30 FUNCTION GENERATOR

INTERSTATE ELECTRONICS CORPORATION
A Subsidiary Of A-T-O Inc.
Department 7000 707 EAST VERMONT AVENUE, ANAHEIM, CALIFORNIA 92803 • (714) 772-2811

WARRANTY

Interstate Electronics Corporation warrants its function generators against defects in material and workmanship for a period of one year from date of shipment. We will repair or replace defective products during the warranty period provided that such defect developed under normal and proper use and that transportation costs are paid by the purchaser. We are not liable for consequential damages nor is any other warranty expressed or implied.

RECEIVING AND INSPECTION

Immediately upon receipt of the instrument, inspect the exterior of the shipping container for physical damage and notify carrier if such damage is visible. After carefully removing all packing materials, inspect the instrument to ensure that it is free of mars and blemishes.

CLAIM FOR DAMAGED SHIPMENT

If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy of the report should be sent to IEC. After receiving this report, IEC will advise you of the disposition of the instrument and arrange for its repair or replacement.

POWER

This instrument operates from a-c power only, either 115 or 230 vac, 50 to 400 Hz. A slide switch at the rear of the equipment readily selects the desired power line voltage.

CAUTION

Operation at the wrong power line voltage switch setting may damage the instrument.

PERFORMANCE TESTS

Electrical performance tests should be concluded as soon as possible. See paragraph 4-2, Section 4.

CONTENTS

ILLUSTRATIONS

TABLES

Section 1

SPECIFICATIONS AND INSTALLATION

1-1. INTRODUCTION

This manual has been carefully prepared to complement the actual hardware design features of your IEC SERIES 30 function generator by providing data on its operation, maintenance, and performance testing. The manual provides the operator with understanding of the functions, maintenance, and troubleshooting of the units, and provides specific calibration laboratory tolerances, specifications, measurements, and adjustments in the event a malfunction occurs. However, it should be noted that the function generators have been designed so that constant reference to the manual is not necessary to operate the equipment.

1-2. DESCRIPTION

Your IEC SERIES 30 function generator is a state-of-the-art signal source designed for great versatility, maximum ease of operation, and long operational life.

The case enclosing the equipment provides exceptional physical ruggedness and utility together with effective electrostatic shielding. The latter is important for the radio-frequency operating ranges of the instruments. Attention has been given to ground isolation applications and a grounding strap is provided at the rear of each instrument.

The serial number and other identification data are located at the rear of the instrument. The rear panel also serves as the primary heatsink for the power supply.

1-3. RECEIVING AND INSPECTION

Immediately upon receipt of the instrument, inspect the exterior of the shipping container for physical damage and notify the carrier if such damage is visible. After carefully removing all packing materials, inspect the instrument to ensure that it is free of mars and blemishes.

Confirm electrical performance that meets or exceeds the specifications as soon as possible. Section 4 contains a suggested receiving performance test procedure.

1-4. INSTALLATION

This instrument may be used on the workbench or rigidly mounted in a RETMA rack structure by means of an optional rack-mounting kit. As initially shipped, the instrument has a handle that facilitates carrying and a bottom-mounted tilt mechanism for optimum panel viewing angle. The feet and handle must be removed for proper rack mounting.

This all solid-state instrument requires no special cooling facilities when operated within the specified temperature limits. Care must be taken to ensure that a 2-inch minimum clearance is provided at the rear of the instrument for proper convection cooling of the heatsink.

1-5. POWER REQUIREMENTS

This instrument operates from a-c power only, either 115 or 230 vac , 50 to 400 Hz. A slide switch at the rear of the equipment readily selects the desired power line voltage. Fuses for the instrument are contained in a separate envelope. Install the proper fuse for the line voltage selected.

CAUTION

Operation at the wrong power line voltage switch setting may damage the instrument.

A three-conductor cord is supplied with the equipment to permit referencing the chassis and case to power system ground. This safety feature is recommended by the National Electrical Manufacturers Association (NEMA). The offset pin on the power cord connector is the ground wire. Generator circuitry (including input and output BNC's) may be isolated from the case ground by removing a grounding screw on the back panel of the instrument.

1-6. REPACKAGING

If it becomes necessary to pack the instrument for shipment, the following procedure is recommended:

a. Attach a tag bearing the owner's name, address, and telephone number together with a brief description of the purpose of the shipment and the date its return is desired.

b. Wrap the equipment in heavy paper or plastic before placing it in an inner container.

c. Liberally use soft packing material around all sides of the instrument inside the inner container.

d. Enclose the inner container in a rugged carton or wood box with suitable packaging material to prevent movement in any direction and seal the outer container with heavy tape or metal bands.

e. Mark the shipping container with the shiping address and "DELICATE INSTRUMENT" labels.

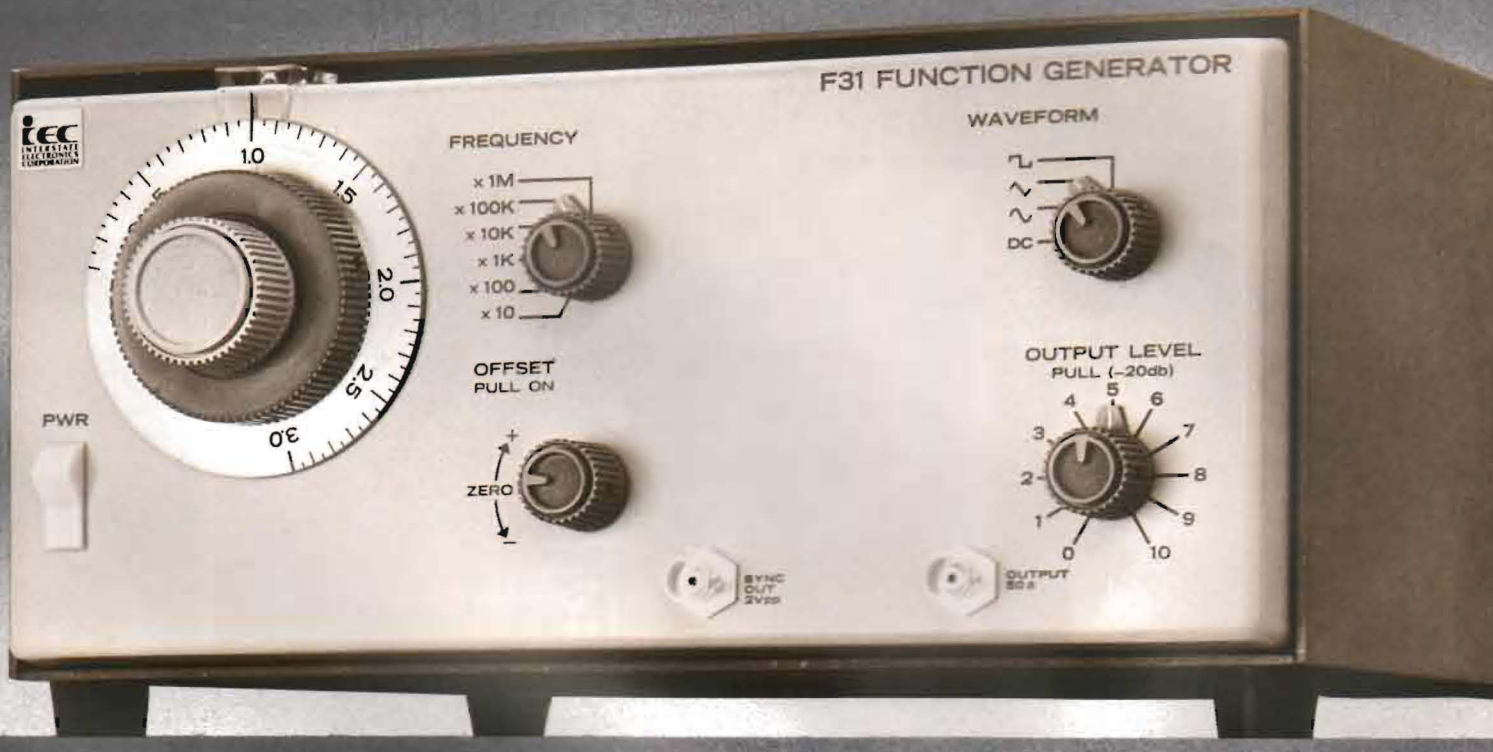
1-7. DISASSEMBLY

To remove the function generator from its case, remove the two 6-32 retaining screws mounted in the bottom of the case at the rear of the unit and slide the electronics forward.

1-8. SPECIFICATIONS

The following data sheets provide the specifications on the F31, F32, F33, and F34 function generators. While these data sheets represent the most accurate specifications available at the time of publication, IEC reserves the right to modify the specifications at any time and to note such modifications in an errata page at the back of this manual.

F31 FUNCTION GENERATOR



WIDE—0.03Hz to 3MHz—FREQUENCY RANGE

- Sine, square, triangle
- Adjustable d-c level
- ±5V offset into 50Ω
- 2-step, 40-db attenuator

F31

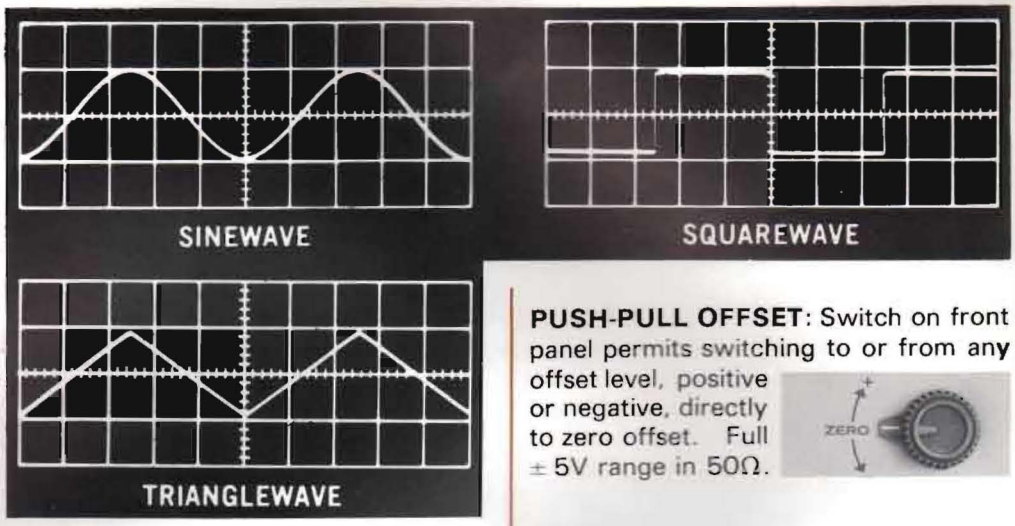
IEC's inexpensive, versatile F31 function generator provides sine, square, and triangle waveforms in the 0.03Hz to 3MHz frequency range at levels up to 10V p-p into 50Ω. F31 offers these outstanding features at a budget price:

CALIBRATED COARSE-FINE TUNE: Operates over full 1000:1 manual tuning range. Smooth-acting planetary drive permits precise frequency setting with either coarse or fine tune verniers.

2-STEP, 40-db ATTENUATOR: For maximum resolution and signal-to-noise ratio, especially at low signal levels.

PLUG-IN IC's: On critical circuits, plus fully accessible components and adjustments for easy maintenance.

ADJUSTABLE D-C LEVEL: "Zero waveform" for tests requiring active source without a-c signal presence and as d-c source for d-c gain tests.



PUSH-PULL OFFSET: Switch on front panel permits switching to or from any offset level, positive or negative, directly to zero offset. Full ±5V range in 50Ω.

SPECIFICATIONS

WAVEFORMS

VARIABLE AMPLITUDE: Sine, square, triangle, adjustable d-c level (no a-c waveform). All waveforms symmetrical about ground or may be offset. Output impedance is 50 Ω.

FIXED AMPLITUDE: Sync out. Squarewave, 2 v p-p minimum into open circuit, symmetrical about ground. Rise-fall times less than 50 nsec. Output impedance is 50 Ω.

FREQUENCY

RANGE: 0.03 Hz to 3 MHz in six decade ranges with 1000:1 continuous course and fine vernier adjustment within any range.

DIAL ACCURACY: ±2% of full-scale.

TIME SYMMETRY: >99% to 1 MHz.

AMPLITUDE

MAXIMUM OUTPUT: 20 v p-p into open circuit.

ATTENUATOR: Two steps, 0 and −20 db with additional 0 to 20 db continuous vernier; total range >40 db.

SINE FLATNESS: Better than ±0.5% 0.3 Hz to 300 kHz, better than ±2% on X1M range.

SINE DISTORTION: <0.3% on lowest four ranges; <0.5% on x100K range; <2% on X1M range.

SQUAREWAVE: Rise-fall times <60 nsec, <5% total aberration.

TRIANGLE LINEARITY: >99% between 3 Hz and 300 kHz.

OFFSET

Continuously variable ±10 v into open circuit, push-pull selector. Total signal plus offset limited to ±10 volts independent of vernier control, attenuated proportionally with step attenuator.

STABILITY

Frequency, amplitude, offset stability better than 0.05% for 10 minutes; 0.25% for 24 hours.

ISOLATION

Detachable ground strap may be removed to electrically isolate all BNC connectors and circuit grounds from case and powerline ground. Maximum isolation is ±500 v.

OPERATING TEMPERATURE

0° to 50°C.

POWER

115 vac ±10% or 230 vac ±10%, 50-400 Hz, 25 w maximum.

DIMENSIONS

11⅛" (28.2 CM) W x 5¼" (13.3 CM) H x 12¾" (32.3 CM) D.

WEIGHT

11 lb. (5 kg) Net, 15 lb. (7 kg) shipping.

NOTES: Except where indicated, specifications apply with 25°C±5°C ambient; with 50Ω resistive load; 0 vdc offset; frequency controls set between 0.3 and 3 on the frequency dial; all external inputs removed and after 30-minute warm-up.

INTERSTATE ELECTRONICS CORPORATION
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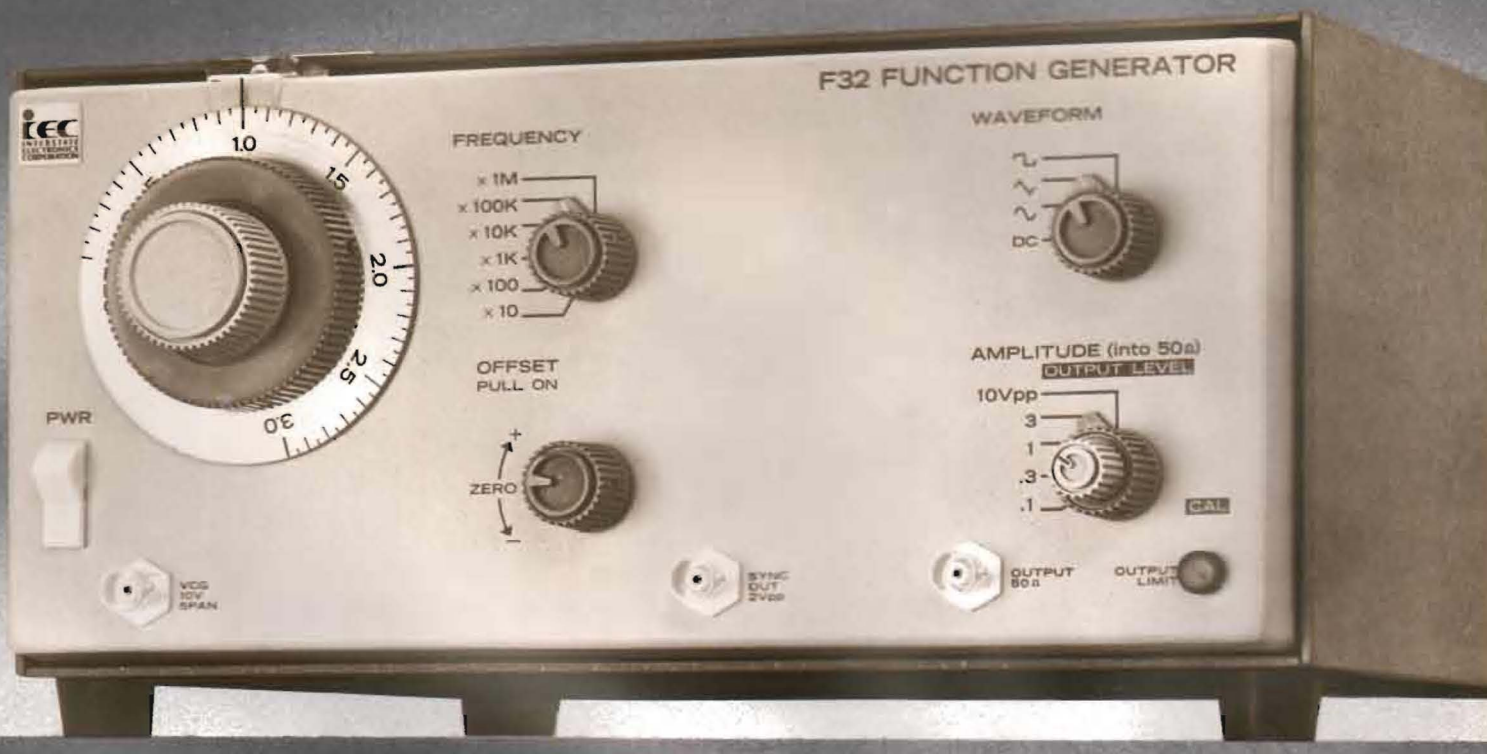
F32 FUNCTION GENERATOR



WIDE—0.03Hz to 3MHz—FREQUENCY RANGE

- 5-step, 60-db attenuator
- 1000:1 VCG
- Output limit indicator
- Sine, square, triangle
- Adjustable d-c level
- ±5V offset into 50Ω

F32

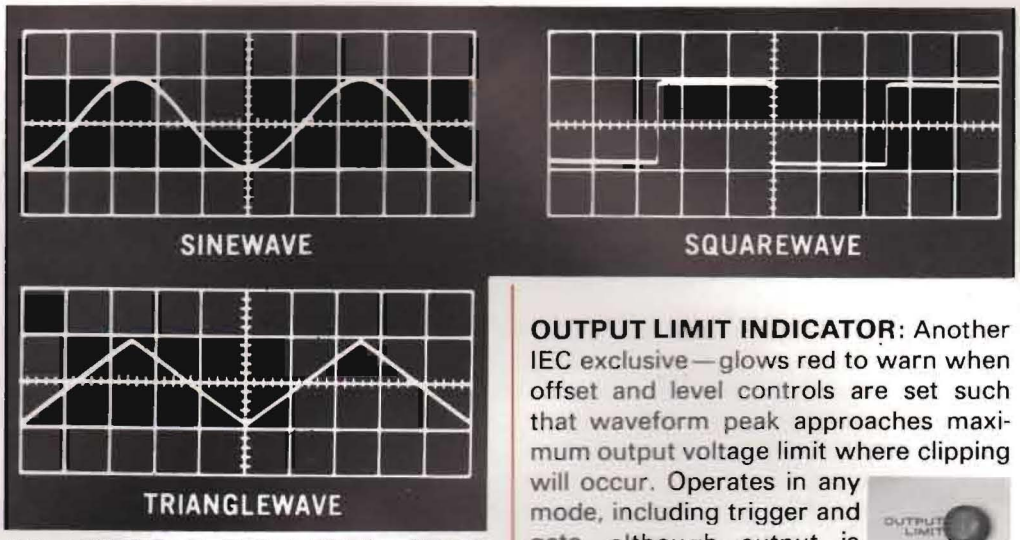
IEC's inexpensive, versatile F32 function generator provides sine, square, and triangle waveforms in the 0.03Hz to 3MHz frequency range at levels up to 10V p-p into 50Ω. F32 offers these outstanding features at a budget price:

CALIBRATED COARSE-FINE TUNE: Operates over full 1000:1 manual tuning range. Smooth-acting planetary drive permits precise frequency setting with either coarse or fine tune verniers.

5-STEP, 60-db ATTENUATOR: For maximum resolution and signal-to-noise ratio, especially at low signal levels.

PLUG-IN IC's: On critical circuits, plus fully accessible components and adjustments for easy maintenance.

PUSH-PULL OFFSET: Switch on front panel permits switching to or from any offset level, positive or negative, directly to zero offset. Full ±5V range in 50Ω.



ADJUSTABLE D-C LEVEL: "Zero waveform" for tests requiring active source without a-c signal presence and as d-c source for d-c gain tests.

OUTPUT LIMIT INDICATOR: Another IEC exclusive—glows red to warn when offset and level controls are set such that waveform peak approaches maximum output voltage limit where clipping will occur. Operates in any mode, including trigger and gate although output is only on during trigger or gate interval.

SPECIFICATIONS

WAVEFORMS

VARIABLE AMPLITUDE: Sine, square, triangle, adjustable d-c level (no a-c waveform). All waveforms symmetrical about ground or may be offset. Output impedance is 50 Ω.

FIXED AMPLITUDE: Sync out. Squarewave, 2 v p-p minimum into open circuit, symmetrical about ground. Rise-fall times less than 50 nsec. Output impedance is 50 Ω.

FREQUENCY

RANGE: 0.03 Hz to 3 MHz in six decade ranges with 1000:1 continuous course and fine vernier adjustment within any range.
DIAL ACCURACY: ±2% of full scale.

TIME SYMMETRY: >99% to 1 MHz.

AMPLITUDE

MAXIMUM OUTPUT: 20 v p-p into open circuit.
ATTENUATOR: 0 to −40 db in 10-db steps; with additional 0 to 20 db continuous vernier; total range >60 db.

SINE FLATNESS: Better than ±0.5% 0.3 Hz to 300 kHz; better than ±2% on X1M range.

SINE DISTORTION: <0.3% on lowest four ranges; <0.5% on x100K range; <2% on X1M range.

SQUAREWAVE: Rise-fall times <60 nsec, <5% total aberration.

TRIANGLE LINEARITY: >99% between 3 Hz and 300 kHz.

OFFSET

Continuously variable ±10 v into open circuit, push-pull selector. Total signal plus offset limited to ±10 volts independent of vernier control, attenuated proportionally with step attenuator.

OUTPUT LIMIT INDICATOR

Glows when any combination of signal plus offset level settings approach maximum operating swing of generator output amplifier independent of waveform or mode selected.

STABILITY

Frequency, amplitude, offset stability better than 0.05% for 10 minutes; 0.25% for 24 hours.

VCG

External d-c or a-c voltage control of output frequency; 0 to +10 v change at VCG input changes output frequency upward 1000:1 from minimum dial setting; 0 to −10 v changes output frequency downward 1000:1 from maximum dial setting; within any multiplier range. Linear to within 0.25%. Bandwidth is 100 kHz, limited to 0.3 v/μsec. Input impedance is >10 kΩ.

ISOLATION

Detachable ground strap may be removed to electrically isolate all BNC connectors and circuit grounds from case and powerline ground. Maximum isolation is ±500 v.

OPERATING TEMPERATURE

0° to 50°C.

POWER

115 vac ±10% or 230 vac ±10%, 50-400 Hz, 25 w maximum.

DIMENSIONS

11⅛" (28.2 CM) W x 5¼" (13.3 CM) H x 12¾" (32.3 CM) D.

WEIGHT

11 lb. (5 kg) Net, 15 lb. (7 kg) shipping.

NOTES: Except where indicated, specifications apply with 25°C±5°C ambient; with 50Ω resistive load; 0 vdc offset; frequency controls set between 0.3 and 3 on the frequency dial; all external inputs removed and after 30-minute warm-up.

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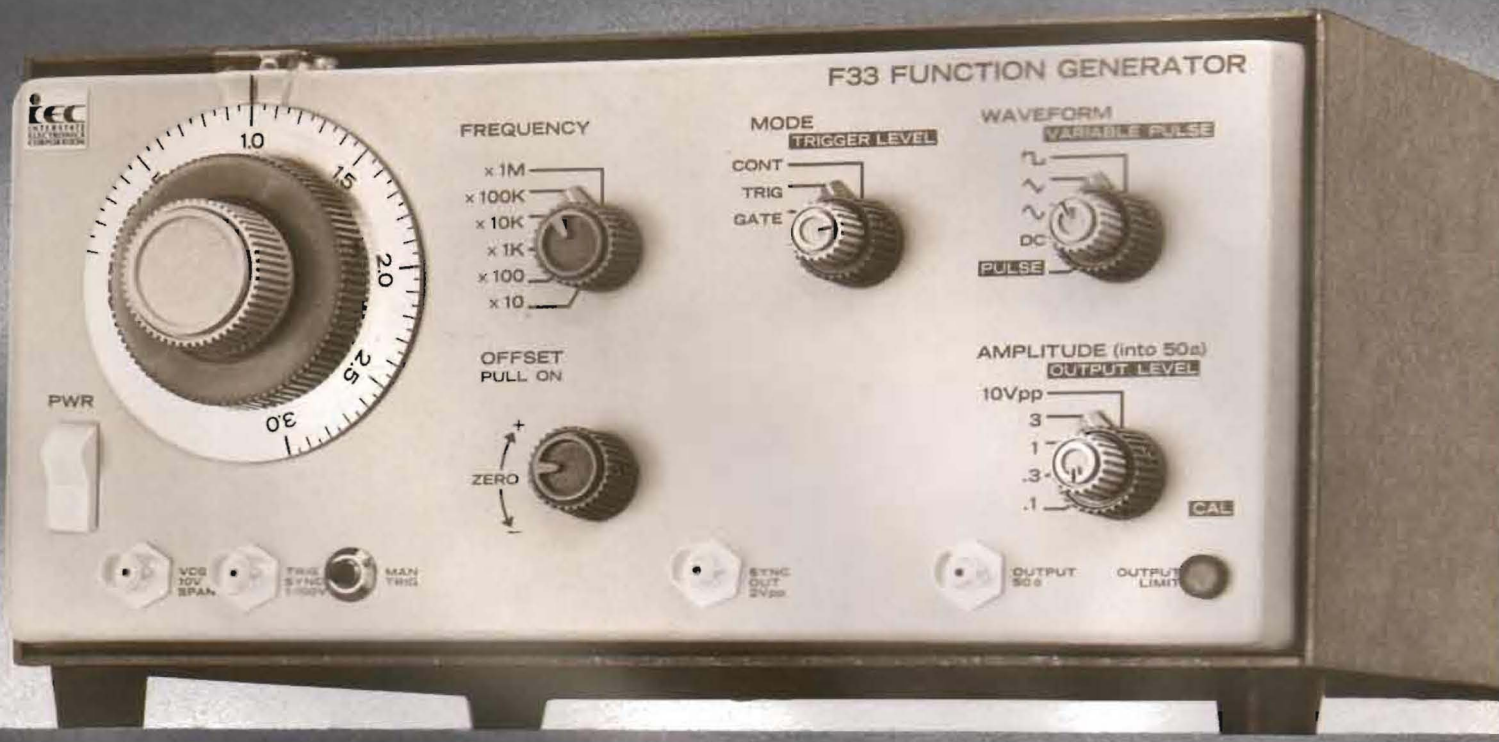
F33 FUNCTION GENERATOR



WIDE — 0.03Hz to 3MHz — FREQUENCY RANGE

- Variable width pulse
- Trigger & gate modes
- External synchronization
- 5-step, 60-db attenuator
- 1000:1 VCG
- Output limit indicator
- Sine, square, triangle
- Adjustable d-c level
- ±5V offset into 50Ω

F33

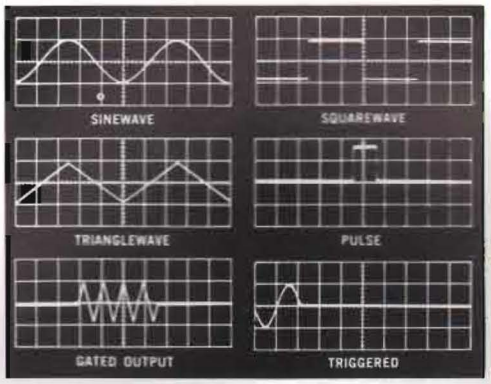
IEC's inexpensive, versatile F33 function generator provides sine, square, and triangle waveforms in the 0.03Hz to 3MHz frequency range at levels up to 10V p-p into 50Ω. F33 offers these outstanding features at a budget price:

CALIBRATED COARSE-FINE TUNE: Operates over full 1000:1 manual tuning range. Smooth-acting planetary drive permits precise frequency setting with either coarse or fine tune verniers.

5-STEP, 60-db ATTENUATOR: For maximum resolution and signal-to-noise ratio, especially at low signal levels.

PLUG-IN IC's: On critical circuits, plus fully accessible components and adjustments for easy maintenance.

PUSH-PULL OFFSET: Switch on front panel permits switching to or from any offset level, positive or negative, directly to zero offset. Full ±5V range in 50Ω.



VARIABLE WIDTH PULSE: In addition to sine, square, and triangle output functions. Permits use in both waveform and pulse generator applications.

ADJUSTABLE D-C LEVEL: "Zero waveform" for tests requiring active source without a-c signal presence and as d-c source for d-c gain tests.

EXTERNAL SYNCHRONIZATION: Of output frequency with external reference for tests requiring coherent signals, for modifying waveforms of precision reference to sine, square, triangle, or pulse. Synchronizes to fundamental, multiple, or submultiple of reference frequency.

OUTPUT LIMIT INDICATOR: Another IEC exclusive—glows red to warn when offset and level controls are set such that waveform peak approaches maximum output voltage limit where clipping will occur. Operates in any mode, including trigger and gate although output is only on during trigger or gate interval.

SPECIFICATIONS

WAVEFORMS

VARIABLE AMPLITUDE: Sine, square, triangle, adjustable d-c level (no a-c waveform), variable duty cycle pulse variable 5 to 95% of full duty cycle (135 nsec minimum). All waveforms, symmetrical about ground or may be offset. Output impedance is 50 Ω.
FIXED AMPLITUDE: Sync out. Squarewave, 2 v p-p minimum into open circuit, symmetrical about ground. Rise-fall times less than 50 nsec. Output impedance is 50 Ω.

FREQUENCY

RANGE: 0.03 Hz to 3 MHz in six decade ranges with 1000:1 continuous course and fine vernier adjustment within any range.
DIAL ACCURACY: ±2% of full scale.
TIME SYMMETRY: >99% to 1 MHz.

AMPLITUDE

MAXIMUM OUTPUT: 20 v p-p into open circuit.
ATTENUATOR: 0 to −40 db in 10-db steps; with additional 0 to 20 db continuous vernier; total range >60 db.
SINE FLATNESS: Bet[illegible] than ±0.5% [illegible] to 300 kHz; better than ±2% on X1M range
SINE DISTORTION: <0[illegible]% on low s[illegible]ges; <0.5% on [illegible]0K rang[illegible]2% o[illegible]
SQUARE WAVE AND PULSE: Ris[illegible] in [illegible] nsec, <5% total abe[illegible]n.
TRIANGLE LINEARITY: 99% b[illegible] to 300 kHz.

OFFSET

Continuously variable ±10 v into open circuit, push-pull selector. Total signal plus offset limited to ±10 v independent of vernier control, attenuated proportionally with step attenuator.

OUTPUT LIMIT INDICATOR

Glows when any combination of signal plus offset level settings approach maximum operating swing of generator output amplifier independent of waveform or mode selected.

STABILITY

Frequency, amplitude, offset stability better than 0.05% for 10 minutes, 0.25% for 24 hours.

VCG

External d-c or a-c voltage control of output frequency; 0 to +10 v change at VCG input changes output frequency upward 1000:1 from minimum dial setting; 0 to −10 v changes output frequency downward 1000:1 from maximum dial setting; within any multiplier range. Linear to within 0.25%. Bandwidth is 100 kHz, limited to 0.3 v/μsec. Input impedance is >10 kΩ.

EXTERNALLY SYNCHRONIZED

Output frequency can be synchronized to external periodic reference signal >3 v p-p (100 v max) applied to Trigger/Sync input when generator is tuned within 1% of reference frequency. Input impedance is 5 kΩ.

MODES

CONTINUOUS: Operates as standard Function Generator with frequency determined by frequency control settings in parallel with VCG input.
TRIGGER: Manual or external signal >±1 v (±3 v on X1M range), 100 v max, at Trigger/Sync input initiates one complete waveform cycle. Trigger Level control determines any triggering point on input waveform. Input impedance is 10 kΩ.
GATE: Manual or external signal >±1 v (±3 v on X1M range), 100 v max, at the Trigger/Sync input gates main generator output on for the duration of the gate signal with last cycle completed after gate is removed.

ISOLATION

Detachable ground strap may be removed to electrically isolate all BNC connectors and circuit grounds from case and powerline ground. Maximum isolation is ±500 v.

OPERATING TEMPERATURE

0° to 50°C.

POWER

115 vac ±10% or 230 vac ±10%, 50-400 Hz, 25 w maximum.

DIMENSIONS

11⅛" (28.2 CM) W x 5¼" (13.3 CM) H x 12¾" (32.3 CM) D.

WEIGHT

11 lb. (5 kg) Net, 15 lb. (7 kg) shipping.

NOTES: Except where indicated, specifications apply with 25°C±5°C ambient; with 50Ω resistive load; 0 vdc offset; frequency controls set between 0.3 and 3 on the frequency dial; all external inputs removed and after 30-minute warm-up.

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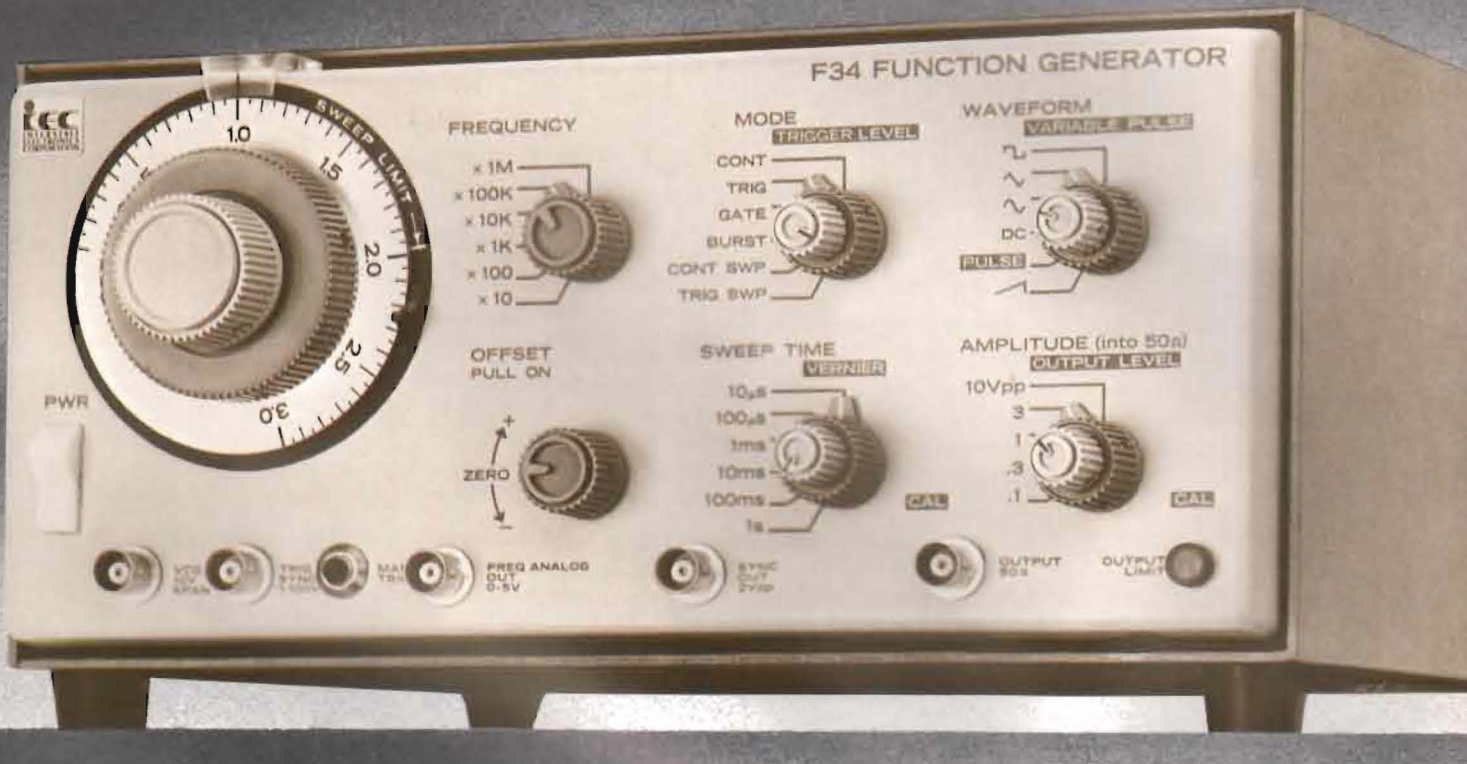
F34 FUNCTION GENERATOR



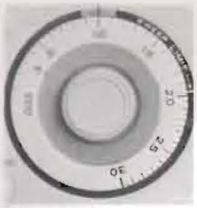
WIDE—0.03Hz to 3MHz—FREQUENCY RANGE

- Sweep, continuous & triggered
- Direct-reading sweep limit
- Burst
- Analog of frequency out
- Variable width pulse
- Trigger & gate modes
- External synchronization
- 5-step, 60-db attenuator
- 1000:1 VCG
- Output limit indicator
- Sine, square, triangle
- Adjustable d-c level
- ±5V offset into 50Ω

IEC

F34

IEC's inexpensive, versatile F34 function generator provides sine, square, and triangle waveforms in the 0.03Hz to 3MHz frequency range at levels up to 10V p-p into 50Ω. F34 offers these outstanding features at a budget price:



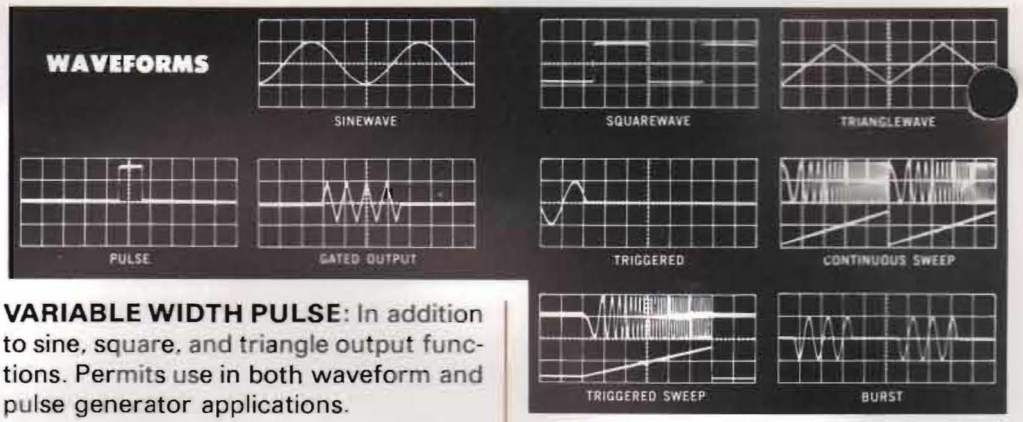
CALIBRATED COARSE-FINE TUNE: Operates over full 1000:1 manual tuning range. Smooth-acting planetary drive permits precise frequency setting with either coarse or fine tune verniers.

DIRECT-READING SWEEP LIMIT: An IEC exclusive—for easy set up of sweep width limits, eliminates need for calculations, scopes, or other instruments in setting sweep width limits.

ANALOG OF FREQUENCY: Voltage output directly proportional to operation frequency for driving x-y plotters and other displays. Output is present in any mode of operation.

5-STEP, 60-db ATTENUATOR: For maximum resolution and signal-to-noise ratio, especially at low signal levels.

PUSH-PULL OFFSET: Switch on front panel permits switching to or from any offset level, positive or negative, directly to zero offset. Full ±5V range in 50Ω.



VARIABLE WIDTH PULSE: In addition to sine, square, and triangle output functions. Permits use in both waveform and pulse generator applications.

ADJUSTABLE D-C LEVEL: "Zero waveform" for tests requiring active source without a-c signal presence and as d-c source for d-c gain tests.

EXTERNAL SYNCHRONIZATION: Of output frequency with external reference for tests requiring coherent signals, for modifying waveforms of precision reference to sine, square, triangle, or pulse. Synchronizes to fundamental, multiple, or submultiple of reference frequency.

OUTPUT LIMIT INDICATOR: Another IEC exclusive—glows red to warn when offset and level controls are set such that waveform peak approaches maximum output voltage limit where clipping will occur. Operates in any mode, including trigger and gate although output is only on during trigger or gate interval.

PLUG-IN IC's: On critical circuits, plus fully accessible components and adjustments for easy maintenance.

SPECIFICATIONS

WAVEFORMS

VARIABLE AMPLITUDE: Sine, square, triangle, adjustable d-c level (no a-c waveform), sweep sawtooth, variable duty cycle pulse variable 5 to 95% of full duty cycle (135 ns. minimum). All waveforms, except sweep sawtooth, symmetrical about ground. Sweep is 0 vdc based negative going. All waveforms may be offset. Output impedance is 50 Ω.

FIXED AMPLITUDE: Sync out. Squarewave, 2 v p-p minimum into open circuit, symmetrical about ground. Rise-fall times less than 50 nsec. Output impedance is 50 Ω. Sweep Monitor/Sync. Ramp, 0 to +3 v minimum into open circuit. Output impedance is 600 Ω.

FREQUENCY ANALOG: D-C voltage proportional to output frequency on any multiplier range; 0 to +5 volts ±10%, linear to within 0.25%; output impedance is 600 Ω.

FREQUENCY

RANGE: 0.03 Hz to 3 MHz in six decade ranges with 1000:1 continuous course and fine vernier adjustment within any range.

DIAL ACCURACY: ±2% of full scale.

TIME SYMMETRY: >99% to 1 MHz.

SWEEP SAWTOOTH: 0.01 Hz to approx. 90 kHz.

AMPLITUDE

MAXIMUM OUTPUT: 20 v p-p into open circuit; sweep sawtooth to 10 v p-p into open circuit negative going.

ATTENUATOR: 0 to −40 db in 10-db steps; with additional 0 to 20 db continuous vernier; total range >60 db.

SINE FLATNESS: Better than ±0.5% 0.3 Hz to 300 kHz; better than ±2% on X1M range.

SINE DISTORTION: <0.3% on lowest four ranges; <0.5% on x100K range; <2% on X1M range.

SQUAREWAVE AND PULSE: Rise-fall times <60 nsec, <5% total aberration.

TRIANGLE LINEARITY: >99% between 3 Hz and 300 kHz.

OFFSET

Continuously variable ±10 v into open circuit, push-pull selector. Total signal plus offset limited to ±10 v independent of vernier control, attenuated proportionally with step attenuator.

OUTPUT LIMIT INDICATOR

Glows when any combination of signal plus offset level settings approach maximum operating swing of generator output amplifier independent of waveform or mode selected.

STABILITY

Frequency, amplitude, offset stability better than 0.05% for 10 minutes, 0.25% for 24 hours.

VCG

External d-c or a-c voltage control of output frequency; 0 to +10 v change at VCG input changes output frequency upward 1000:1 from minimum dial setting; 0 to −10 v changes output frequency downward 1000:1 from maximum dial setting; within any multiplier range. Linear to within 0.25%. Bandwidth is 100 kHz, limited to 0.3 v/μsec. Input impedance is >10 kΩ.

EXTERNALLY SYNCHRONIZED

Output frequency can be synchronized to external periodic reference signal >3 v p-p (100 v p-p max) applied to Trigger/Sync input when generator is tuned within 1% of reference frequency. Input impedance is 5 kΩ.

MODES

CONTINUOUS: Operates as standard Function Generator with frequency determined by frequency control settings in parallel with VCG input.

SWEEP: Continuous Sweep: Linearly sweeps the main generator upward between limits set with main frequency dial and Sweep Limit cursor. Maximum sweep range is 1000:1. Sweep Time control with six decade ranges and 100:1 continuous vernier provides sweep durations f 10 μsec to 100 sec.

Triggered Sweep: Manual or external command >±1 v (100 v max) initiates one sweep cycle. Main output is on only during sweep interval.

BURST: Integral number of main generator waveform cycles (as set with Trigger Level control) are repetitively triggered by internal sweep generator at rates up to 90k bursts/sec.

TRIGGER: Manual or external signal >±1 v (±3 v on X1M range), 100 v max, at Trigger/Sync input initiates one complete waveform cycle. Trigger Level control determines any triggering point on input waveform. Input impedance is 10 kΩ.

GATE: Manual or external signal >±1 v (±3 v on X1M range), 100 v max, at the Trigger/Sync input gates main generator output on for the duration of the gate signal with last cycle completed after gate is removed.

ISOLATION

Detachable ground strap may be removed to electrically isolate all BNC connectors and circuit grounds from case and powerline ground. Maximum isolation is ±500 v.

OPERATING TEMPERATURE

0° to 50°C.

POWER

115 vac ±10% or 230 vac ±10%, 50-400 Hz, 25 w maximum.

DIMENSIONS

11⅛" (28.2 CM) W x 5¼" (13.3 CM) H x 12¾" (32.3 CM) D.

WEIGHT

11 lb. (5 kg) Net, 15 lb. (7 kg) shipping.

NOTES: Except where indicated, specifications apply with 25°C±5°C ambient; with 50Ω resistive load; 0 vdc offset; frequency controls set between 0.3 and 3 on the frequency dial; all external inputs removed and after 30-minute warm-up.

IEC
A Subsidiary Of A-T-O Inc.

INTERSTATE ELECTRONICS CORPORATION

Department 7000

707 E. VERMONT AVE., P.O. BOX 3117, ANAHEIM, CALIFORNIA 92803 (714) 772-2811

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Section 2
OPERATING INSTRUCTIONS

2-1. INTRODUCTION

Your IEC SERIES 30 function generator is designed to permit the operator to realize the full potential of the instrument without extensive reference to the manual. However, for personnel not familiar with this type of equipment, figures 2-1 and 2-2 are provided for quick reference.

As shown in Figures 2-1 and 2-2, there is a high degree of commonality in the controls among the various models. Refer to the individual function generator pictures on the specification data sheets (paragraph 1-8) for detailed differences in controls and nomenclature.

2-2. OPERATING FEATURES

The names and functions of the front and rear panel controls, terminals, and indicators are shown in Figures 2-1 and 2-2.

2-3. OPERATING NOTES

While operation of your IEC function generator is quick and straightforward, the following notes and comments are offered to aid the user in realizing the full potential of the instrument:

a. D-C WAVEFORM.- Removes all a-c components from the output of the main amplifier while retaining any d-c offset that may be set up. Turning off the OFFSET control, leaves only the 50-ohm output impedance coupled into the device under test (Thevenin equivalent).

b. D-C OFFSET VS AMPLITUDE CONTROLS.- The output d-c offset is independent of the continuously variable OUTPUT LEVEL control, but is controlled by the AMPLITUDE step attenuator control. Thus, signal amplitude may be varied over a 10:1 range (20 db) without affecting the d-c offset.

c. RAMP WAVEFORM (F34 only).- No ramp waveform will appear at the output unless the MODE switch is in the BURST, CONT SWP, or TRIG SWP position. In the latter mode, the ramp may be triggered just as any other waveform (negative-going ramps in all cases).

d. POSITIVE RAMP WAVEFORM (F34 only).- A positive-going ramp may be obtained by taking the output from the FREQ ANALOG connector while in the CONT SWP OR TRIG SWP mode. The ramp amplitude is controlled by adjusting the SWEEP LIMIT control and a positive d-c offset may be added by adjusting the main frequency dial (within the mechanical interlocks).

e. TRIGGERED BURST (F34 only). - Under normal operation, triggered burst is not available since the main generator is triggered by the free-running internal sweep generator. However, a triggered burst may be created by setting (1) the MODE control to TRIG SWP, (2) the SWEEP LIMIT control to zero sweep width, and (3) by introducing a trigger signal at the

TRIG SYNC input connector (or triggering manually). The period of each cycle in the burst is controlled by the main generator frequency controls, and the duration of the burst is controlled by the SWEEP TIME controls. Interesting effects such as discrete fractions of a cycle may be created. Swept burst may also be created by adjusting the SWEEP LIMIT control. Actual frequency end points of a swept burst are best determined by careful measurement of the FREQ ANALOG voltage.

g. OUTPUT LIMIT LIGHT (F32, F33, F34). - Glows when any combination of the D-C OFFSET and the continuously variable OUTPUT LEVEL control is such that the maximum voltage swing of the output amplifier is approached. Adjusting the output AMPLITUDE step attenuator will not affect this light because the attenuator will not affect this light because the attenuator is located after the amplifier final stage. This is a "predictor" circuit; it operates independent of mode or waveform selection.

h. SWEEP RAMP TIME (F34 only). - The SWEEP TIME controls are calibrated in ramp up time (±5 percent) and this does not include the retrace (ramp return time) of about 10 percent. Thus, the sweep repetition rate is not a simple reciprocal of the sweep time.

i. EXTERNAL SYNC (F33, F34). - This feature (sometimes called "simple sync") permits the function generator main oscillator to be "pulled" to match the repetition rate of an external periodic signal. This pulling action is limited to about 1 percent of the operating frequency and tends to degrade above 1 MHz. The sync action is also useful in generation of harmonic and subharmonic relationships to the external signal.

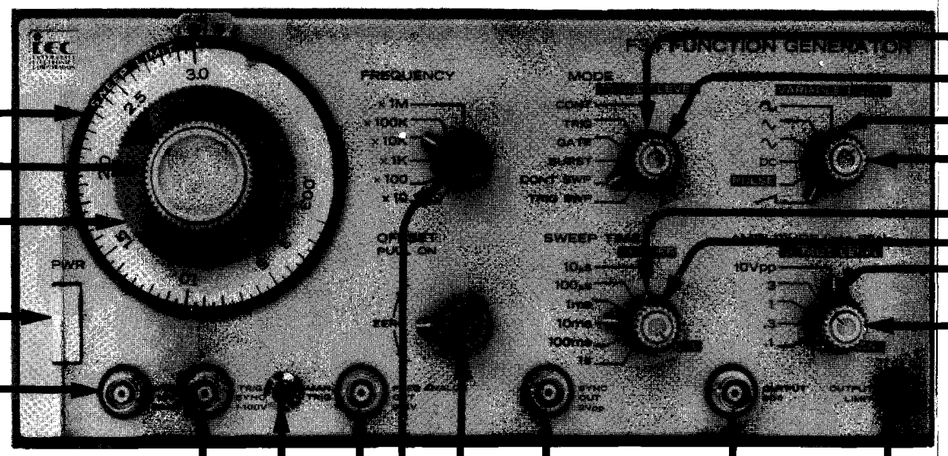
NOTE

Be certain to remove the external signal when not using it because it will introduce phase jitter when not synchronized.

j. SLEW RATE LIMITATIONS (F32, F33, F34). - Either the VCG input or the internal sweep generator may be adjusted occasionally to create voltage slewing rate commands in excess of the specified (0.3v/ sec) ability of the instrument to follow. Problems of this type will reflect in the behavior of the instrument in the following manner:

- Output Frequency - The change in output frequency will be less than expected for a slower slew rate.
- Freq Analog Output - The voltage swing will be less than expected and may have a d-c offset.
- CONT SWP Mode - In this mode of operation, the slew limitation may be encountered in the sweep ramp retrace period because it slews at ten times the rate of the basic ramp.

k. CHART RECORDER DRIVE (F34 Only). - A constant-amplitude, positive-going sweep voltage is supplied at the rear panel for driving the x-axis of scopes and chart recorders.



SWEEP LIMIT Dial (F34)

Dial is directly coupled to SWEEP LIMIT potentiometer and provides a means of selecting the maximum frequency in the SWEEP mode.

FREQ Vernier

Planetary drive control provides a 6:1 vernier on the FREQ dial.

FREQ Dial

Larger knob and dial are directly coupled to the frequency control potentiometer which provides a means of adjusting the frequency (continuously) over a 1000:1 range.

PWR Switch

Push-rocker switch controls input power to the instrument. The switch is illuminated in the ON position.

VCG Input Conn. (F32, F33, F34)

BNC connector provides a means to apply input voltage which controls the frequency generation over a 1000:1 range.

TRIG SYNC Input Conn. (F33, F34)

Dual-purpose BNC connector provides an input for trigger signals in the following modes: TRIG, GATE, BURST (F34 only), and TRIG SWP (F34 only).

In the CONTinuous mode the BNC provides means to synchronize the function generator to an external signal. Tune generator within 1 percent of external signal for sync on fundamental. (See Section 4.)

MAN TRIG Pushbutton (F33, F34)

Pushbutton permits manual triggering for the following modes: TRIG, GATE, BURST (F34 only), and TRIG SWP (F34 only).

FREQ ANALOG OUT (F34)

Output BNC provides a voltage analog of the main generator frequency including VCG, sweep, and dial variables. (Also provides inverted sweep waveform in sweep modes.)

FREQUENCY Multiplier Switch

Rotary switch selects one of six frequency decade ranges.

OUTPUT LIMIT Light (F32, F33, F34)

Warns the user when the output amplitude is near saturation or distortion because of misadjustment of OFFSET and/or OUTPUT LEVEL potentiometer.

NOTE

Light is independent of step attenuator setting.

OUTPUT Conn.

Main generator output as selected by the waveform switch.

SYNC OUT Conn.

BNC connector provides a 2-volt peak-to-peak (open circuit) squarewave.

OFFSET

Dual control combining a push-pull offset switch and waveform d-c offset potentiometer.

In the push-in position the potentiometer is disabled and 0 volts offset results.

In the PULL-ON position the output offset is continuously variable from -10 to +10 volts (open circuit).

MODE Switch (F34)
6-position rotary switch provides selection of one of six function generator modes of operation: CONTinuous, TRIGgered, GATEd, BURST, CONT SWP (turns on sweep generator), and TRIG SWP (one sweep cycle).

TRIGGER LEVEL Potentiometer (F33, F34)
Provides a means to control the triggering sensitivity of the logic to inputs on the TRIG SYNC input BNC. This control is useful for the TRIG, GATE, BURST (adjusts number of cycles/burst), and TRIG SWP mode positions.

WAVEFORM Switch (F31, F32)
Rotary switch selects one of four waveforms: ⎍, ∿, ∿ and DC.

WAVEFORM Switch (F33)
5-position rotary switch selects one of five waveforms: ⎍, ∿, ∿, DC, and PULSE.

WAVEFORM Switch (F34)
6-position rotary switch selects one of six waveforms: ⎍, ∿, ∿, DC, PULSE, and ⟍
NOTE
⟍ appears only when CONT SWP, BURST, or TRIG SWP mode has been selected.

VARIABLE PULSE Vernier (F33, F34)
Potentiometer controls the duty cycle of the rectangular pulse duration of the VARIABLE waveform.

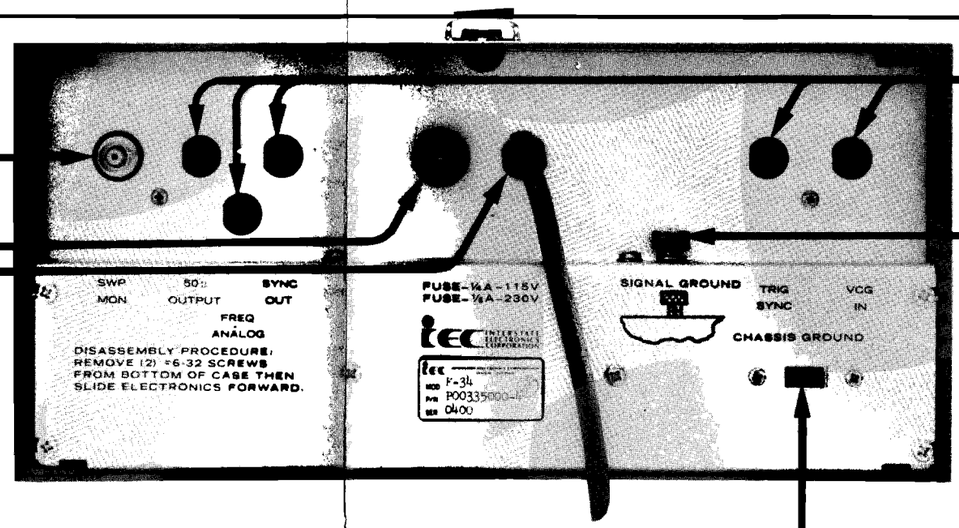
SWEEP TIME Switch (F34)
6-position rotary switch provides selection of six ranges of sweep duration: 10 μsec, 100 μsec 1 msec, 10 msec, 100 msec, and 1 sec.

SWEEP TIME Vernier (F34)
Potentiometer provides a continuous 100:1 control of the sweep time. Full-scale sweep time, as indicated by SWP TIME switch, is obtained at the CAL position.

AMPLITUDE OUTPUT (F32, F33, F34)
5-position rotary switch, 10-db step attenuator provides 10, 3.16, 1.0, 0.316 and 0.10 volts peak-to-peak maximum signal amplitudes.

OUTPUT LEVEL Potentiometer (F32, F33, F34)
20-db range potentiometer used for continuous amplitude control. Pull out on F31 only for additional 20 db attenuation.

Figure 2-1. Front Panel Controls and Indicators



Power Cord
Power cord may be used for nominal 115 or 230 vac applications. Includes safety ground prong which is connected to chassis.

VOLTAGE Switch
DPDT slide switch provides easy means of a-c line voltage selection.

FUSE
Power fuse holder allows easy replacement: 1/4-amp SLO BLO for 115 vac, 1/8-amp SLO BLO for 230 vac.

CKT GRD ISOLATION
6-32 screw provides a connection between chassis ground and signal ground. Loosen to isolate ground.

SWEEP MONITOR BNC (F34 only)

Optional BNC Connector (F34)
Five BNC ports are provided for optional connections, rear panel indicates use of each BNC.

Figure 2-2. Rear Panel Fuse and Connectors

Section 3
CIRCUIT DESCRIPTION

3-1. INTRODUCTION

Figure 3-1, the simplified block diagram, shows the major functional blocks of the system. For more detailed reference, see the circuit schematic at the back of manual.

3-2. POWER SUPPLY

a. UNREGULATED D-C AND RECTIFIERS. - Two unregulated d-c voltages, +22 volts and -22 volts, are generated to supply the output amplifier directly and to supply power to the regulator circuits which serve the balance of the instrument. One tapped secondary transformer winding serves two full wave rectifiers.

b. REGULATED SUPPLIES. - There are two regulated d-c supplies, ±15 volts, with medium current capabilities. The +15-volt supply is used as a reference for the other regulated supplies.

NOTE

If the +15-volt supply is inoperative all other supplies are also inoperative.

The +15-volt supply uses VR4 as a reference voltage for its error signal. The +15-volt level is adjusted by R145. A low-impedance output is provided by the Darlington pair Q23 and Q24. A current-limit circuit is formed by Q25 and R140. This circuit provides protection for Q23 and Q24 in the event the +15-volt supply is shorted or overloaded.

The +5-volt supply derives its output current and reference voltage from the +15-volt supply. Q26 provides a low-output impedance for the +5-volt supply, and Q27 provides the output current for the +5-volt supply. The -15-volt and -5-volt supplies operate in the same manner as the +15-volt and +5-volt supplies. The -15-volt supply derives its reference voltage from the +15-volt supply and the resistor divider circuit R158 and R159.

3-3. TRIANGLE GENERATION

The basic loop concept consists of generating a voltage proportional to desired frequency and converting this level to a constant current used to charge a capacitor. At some defined positive voltage level across the capacitor, a voltage-level sensor operates to cause an equal and opposite current to be applied to the integrating capacitor. When an equal negative voltage level is detected, the process repeats.

a. FREQUENCY CONTROL. - A single operational amplifier, IC12, is used to generate a voltage representing the summation of all frequency commands. In addition to the voltage derived from the Frequency Dial control, R5, voltages present on the VCG input connector and any sweep voltage appearing on Sweep

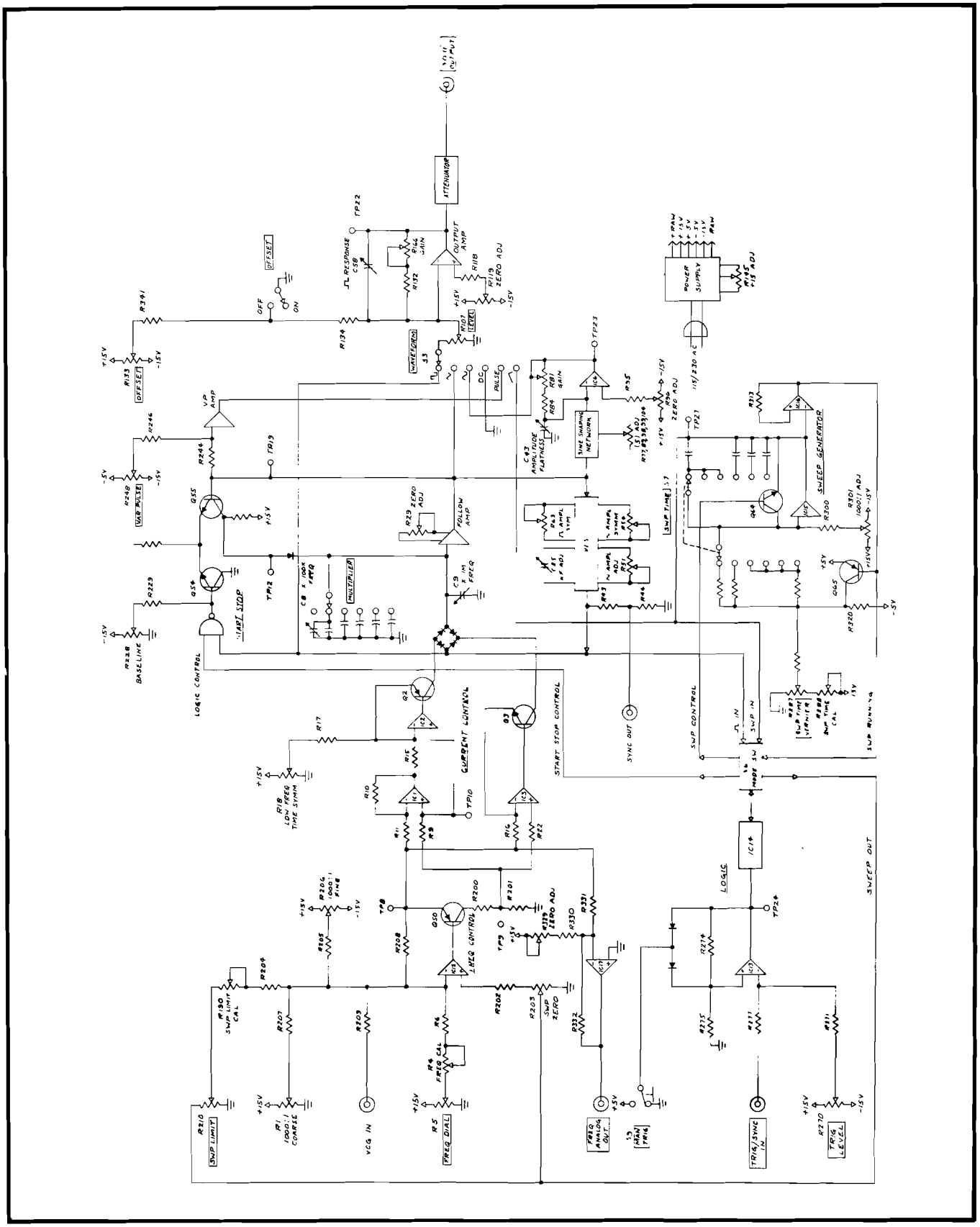


Figure 3-1. Simplified Block Diagram

Width control R210 are summed. Q50 is an output buffer for providing a frequency analog voltage to the current control circuits and also to IC17 which drives an external frequency analog out connector (F34 only).

b. CURRENT SOURCES. - Generation of two equal and opposite currents is accomplished by IC3 and Q3 for negative current, and IC1, IC2, and Q2 for the positive current. The diode switching bridge, CR3 through CR10, allows only one current at a time to be applied to the integrating capacitors, C1 through C10. A voltage level generated in the VLS section selects the polarity of the current.

c. FOLLOW AMPLIFIER. - The follow amp is a unity gain amplifier with extremely high input impedance that prevents integrating capacitor loading which would result in a bowed triangle waveform. Low-impedance outputs provide triangle waveforms to the system. The input of the follow amp is a JFET source follower. The Vgs offset is compensated by adjusting R29.

d. VOLTAGE LEVEL SENSOR. - The voltage level sensor (VLS) provides switching signals to the diode bridge and also generates low-impedance squarewaves of controlled amplitude to the output amplifier and logic sections. The rising triangle voltage level present at the follow amplifier output is compared with a reference voltage at the input to the differential comparator, IC5. When the follow amplifier output reaches the reference voltage, IC5 changes state producing a signal which is fed back to the diode bridge (CR3 through CR10) in the current amplifier. It also produces a new reference comparison voltage at pin 4 of IC5 which generates the required hysteresis. Adjustments R51 and R54 enable the reference voltage to be set up so that a symmetrical waveform is produced.

Q7 and Q8 form a complementary emitter follower with low-output impedance. This output is the squarewave function which may be selected by the waveform switch. R63 provides an adjustment for the d-c level (amplitude symmetry) of the squarewave output.

Q51 (F33, F34) provides a means of shifting the VLS reference level approximately 1 percent. When an external repetitive waveform is applied at the Trigger/Sync connector, Q51 serves to advance the VLS switching point and thus obtain synchronous operation.

e. START/STOP CONTROL (F33, F34 only). - This circuit forms a three-element gate whose inputs are two logic levels and one analog level. When a stop command level is present and the VLS squarewave signal indicates that the triangle is negative going, the output of the follow amplifier is compared to a reference level (zero volts). When the triangle voltage reaches this reference, the Start/Stop Amplifier becomes active and causes the integrating capacitor charging current to be bypassed from the capacitors through CR58, thereby clamping the voltage of the triangle waveform to the reference. When the stop command ceases, the integration process resumes as the Start/Stop Amplifier is deactivated and CR58 is reverse biased.

3-4. SINE SHAPER

Sinewaves are produced by shaping the triangle waveform with shunt diode-resistor networks. Integrated circuits IC7 and IC8 contain matched diode sets which, in series with R74 resistor elements, load the triangle and

thereby inscribe a sinewave into the original trianble waveform. IC6 functions as an inverting operational differential buffer amplifier with emitter follower output, which reconstitutes the peak-to-peak value of the sinewave to the same amplitude as the incoming triangle. Potentiometer R81 adjusts the gain of the buffer amplifier. Q13 and Q14 act as diode shunts as well as common-base amplifiers which aid in the generation of a zero slope at the sine peaks. This is done by injecting a common mode signal via R98 and R97 into the noninverting side of the buffer amplifier.

3-5. VARIABLE PULSE GENERATOR (F33, F34, only)

Variable pulses are generated by comparing the voltage summation of the triangle waveform plus an adjustable d-c level (R248, VAR PULSE control) to a reference level by use of a differential pair, Q60 and Q59. Q60 and Q59, in addition, form a "Schmitt trigger" in conjunction with R245 and R241 which provide positive feedback and hysteresis. When the triangle amplitude at Q60 base rises above the d-c level at Q59, Q60 turns on forcing Q59 off. The complementary emitter follower output, Q57 and Q58, then switches from -3 to +3-volt output. The output will remain at +3 volts until the triangle waveform ramps negatively through the reference level at which time the output goes to -3 volts.

3-6. OUTPUT AMPLIFIER

The output amplifier provides an inverted 20-volt, peak-to-peak output from a 6-volt, peak-to-peak level present at waveform switch S3. A 50-ohm source resistance allows 10 volts peak-to-peak into a 50-ohm load.

IC9, Q17, and Q18 form a high-gain differential amplifier to drive a complementary follower, Q19 and Q20. Feedback controls R166 and C58 adjust the gain and transient response of the amplifier, while R119 is used to adjust offset. A constant current from Q33 is used to maintain slew rates and waveform quality at low-line potentials.

Offset capability is provided by inserting a variable d-c current into amplifier summing point IC9, pin 9, via R134.

3-7. LOGIC CIRCUITS (F33, F34 only)

All functional modes are accomplished by comparator amplifier IC13, four TTL and gates, IC14, and mode switch S6. The comparator amplifier sums a waveform from the trigger input connector (or from the sweep waveform) with a d-c voltage obtained from trigger level control R270. Depending on the input level and setting of R270, a positive transition of IC13 pin 9 is achieved once per input waveform.

IC14 logic levels are +3 to +5 volts high and 0 to +0.5 volts low. If either gate input is low, a high output results. Both inputs must be high to obtain a low output. Two of the gates are arranged to form a flip-flop whose output, TP25, is used to command all triggered or gated functions. TP25 is normally low and rises to high to initiate a "run" command. A timing diagram showing logic sequence is shown in figure 3-2.

- Inputs to the logic section are:
  Trigger/Sync connector.
  VLS squarewave (±3 volts) indicating state of main loop.
  Sweep "running" signal, TP29.
  Sweep waveform (used as "Burst" trigger).

- Outputs from the logic section are:

  Start/Stop command line (R283, C115 junction).

  Sweep run command line, S6 - 2B wiper.

  Last cycle completion circuit defeat, S6 - 1A pole.

3-8. SWEEP GENERATOR (F34)

The Sweep Generator consists of operational integrator Q51, IC15; voltage-level comparator IC16, Q62; and input-voltage reversing switch Q65. Sweep time vernier control R287 applies a variable voltage level to an integrator input resistor. Sweep time range switch S7 selected an appropriate feedback capacitor for the operational integrator. As the voltage at IC15 pin 12 rises, a level is reached which will cause comparator IC16 to reverse. This action energizes Q65 and causes voltage of an opposite polarity to appear across a portion of the integrator input resistor, reversing the integrator. This results in a larger charging current and faster retrace in the sweep. As this action occurs, a new reference level is set into comparator IC16 pin 4. When the integrator level has reduced sufficiently, the comparator will again reverse, establishing original conditions. Q66 and Q64 are activated by a logic signal which stalls integrator action by shorting the timing capacitors. Q63 is a buffer amplifier which supplies a "sweep running" signal to the Logic Section.

3-9. OUTPUT LIMIT CIRCUIT

The Output Limit circuit is a d-c analog computer which turns on the OUTPUT Limit light if the amplifier is being driven close to saturation. IC18 is an operational amplifier which sums a d-c analog of the signal amplitude with a portion of the d-c offset signal. The summation is fed to a level detector (Q48, Q49) which turns on DS2 light if the level is too high.

Since the offset signal is bipolar, diodes CR48 and C49 are required to steer the currents in order to sum the absolute value of the offset.

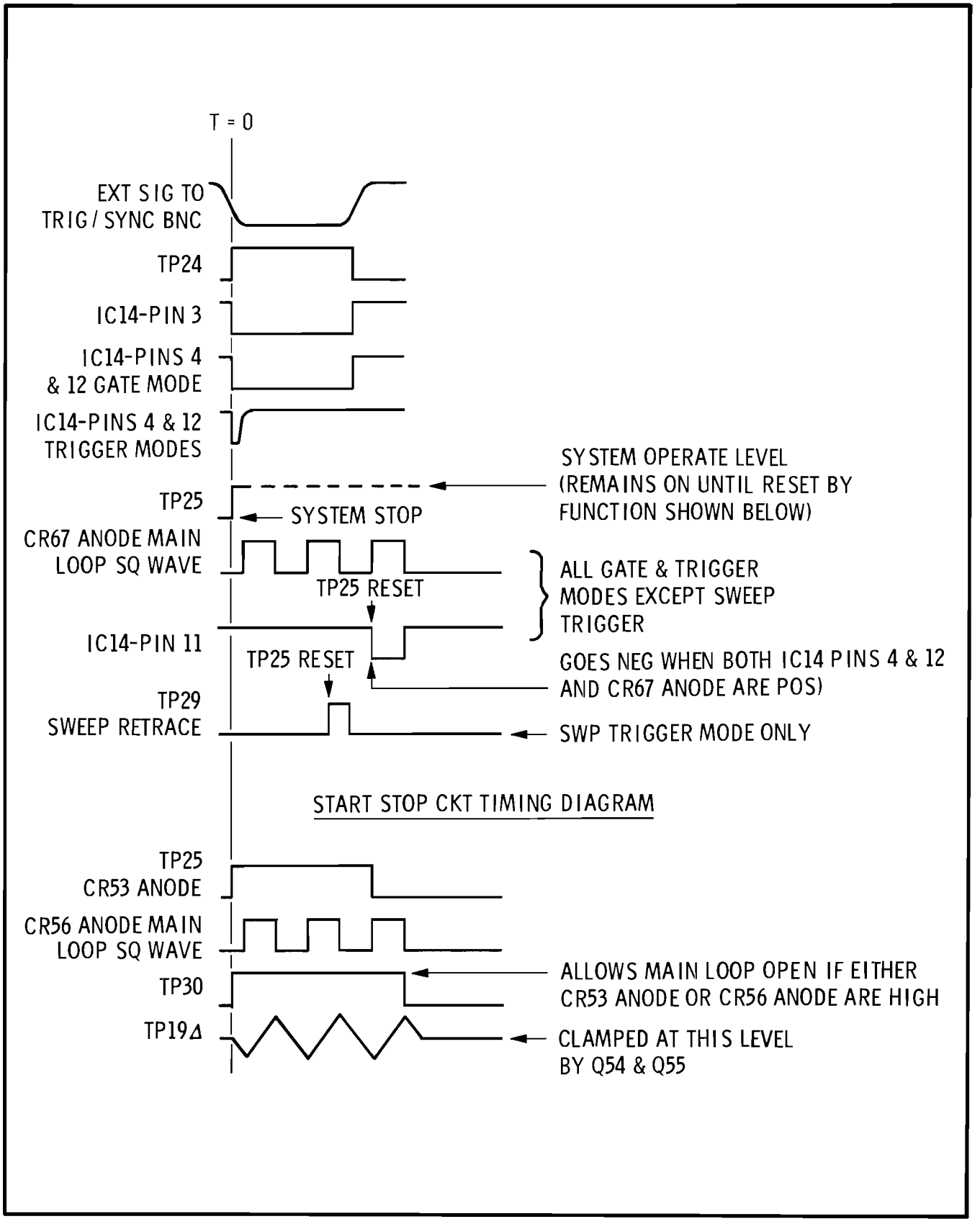


Figure 3-2. Logic Sequence Timing Diagram (F32, F33, F34)

Section 4

CALIBRATION AND PERFORMANCE

4-1. INTRODUCTION

This section contains the necessary equipment list and the detailed procedures for checking your Series 30 function generator for proper operation and/or for calibrating all elements of the instrument. Table 4-1 presents a recommended list of test equipment and table 4-2 provides the recommended sequence and methods. Figure 4-1 is an Adjustment Location Diagram and figure 4-2 is a Test Point Location Diagram.

4-2. SUGGESTED RECEIVING INSPECTION TESTS.

Certain steps in the Calibration Procedure (table 4-2) have been designated with an asterisk (*) as appropriate for Receiving Inspection Performance tests. Only those portions of the Procedure relating to measurements are to be used; adjustments are for calibration. These checks are recommended for customers who have not developed their own formal acceptance test procedures for this class of equipment.

TABLE 4-1. TEST EQUIPMENT REQUIRED

Test Equipment	Suggested Model	General Requirements For Calibration
Digital Voltmeter	John Fluke 8300A	DC: 1-mv resolution up to 15.0 vdc. AC: Average reading 1-mv resolution up to 10 vac.
Counter	HP 5326A	FREQ: 5-digit resolution up to 5 MHz. PERIOD: 200 sec with 0.1-sec resolution. TIME INTERVAL:
RF Voltmeter	Boontoon 91C, D, or HP 3406	50-MHz bandwidth and 0.1-db resolution.
Oscilloscope	Tektronix 453, 454 or 585	50 MHz bandwidth. 0.1 v/cm vertical sensitivity.
Voltage Source	Electronic Development Corp MV100N	10.0v maximum. Settable to 1.0 mv.
Function Generator or Oscillator	IEC F31-F34 or IEC F51-F55	10v p-p sinewave into 50 ohms.
Distortion Analyzer	HP 333A	FREQ RANGE: 5 Hz to 600 kHz. Distortion introduced by instrument: <0.03 percent from 5 Hz to 200 kHz. <0.06 percent from 200 to 600 kHz.

TABLE 4-2. CALIBRATION AND PERFORMANCE CHECKS

Step	Calibration	Control Setting	Test Equipment (Mode)	Procedure
1.0	POWER SUPPLY	PWR - ON	DVM-DC	1. Adjust R145 for +15.00 ±0.02v @ TP6. 2. Measure: -15.0 ±0.1v @ TP3. +5.0 ±0.25v @ TP5. -5.0 ±0.25v @ TP4.
2.0	MAIN LOOP ADJUSTMENT			
2.1	Follow Amplitude Zero Adjust	FREQ Mult @ 1K Dial @ 2.5 WAVEFORM @ Sine MODE @ Cont	DVM-DC	1. Short TP11 to ground. 2. Adjust R29 for 0 ±50 mv dc @ rear side of TP19. 3. Remove C9 short.
2.2	Triangle Amplitude Symmetry Adjust			Adjust R54 for 0 ±2 mv dc @ rear side of TP19.
2.3	Triangle Amplitude Adjust		DVM-AC	Adjust R51 for 1.66v ±3 mv ac @ rear side of TP19.
2.4	Frequency Calibration Adjust	FREQ Dial @ 3.0	Counter-Frequency	Adjust R4 for 3.0 kHz ±10 Hz @ Sync Out.
2.5	1000:1 Frequency Adjust	FREQ Mult @ 10K		1. Measure 30 kHz ±600 Hz @ Sync Out.
		FREQ Mult @ 10K Dial @ CW	Counter-Period	2. Adjust R1 (Coarse) for 67 ±33 ms @ Sync Out. 3. Adjust R206 (Fine) for 67 ±7 ms @ Sync Out.
	Low-Frequency Symmetry Adjust		Counter Time Interval	4. Adjust R18 for equal 1/2 period measurements to within ±2 ms @ Sync Out.
			Counter Period	5. Readjust R206 for 67 ±7 ms @ Sync Out.
3.0	HIGH RANGES ADJUSTMENTS			
3.1	Triangle Flatness 1 MHz	FREQ Mult @ 1M MODE @ Cont	Counter-Frequency	1. Connect Sync Out to counter via 50 ohms terminated coax.

Table 4-2. Calibration and Performance Checks (Continued)

Step	Calibration	Control Setting	Test Equipment (Mode)	Procedure
3.1 (Cont)			RF Voltmeter	2. Adjust C9 to mid-range. 3. Rotate the FREQ dial between .3 and 3.0 on dial. Adjust C25 for flat triangle response ±0.2 db.
3.2	Frequency Calibration 1M Range	FREQ Dial @ 3.0 Mult @ 1M		Adjust C9 for 3.0 ±0.02 MHz.
3.3	Frequency Calibration 100K Range	FREQ Mult @ 100K	Counter-Frequency	Adjust C8 for 300 ± 2 kHz.
* 3.4	Dial Linearity and Frequency Calibration	MODE @ Cont	Counter-Frequency or Period	Check frequency vs dial indication on each range per the following schedule. It is recommended that a FREQ dial setting be made and the MULT switch be switched from x1M through x10 prior to resetting the dial. Period measurement for low frequency.

Frequency vs Dial Accuracy

Range / Dial Setting	X1M (MHz)	X100K (KHz)	X10K (KHz)	X1K (KHz)	X100 (Hz)	X10 Frequency (Hz)	X10 Period (ms)
3.0	2.94 - 3.06	294 - 306	29.4 - 30.6	2.94 - 3.06	294 - 306	29.4 - 30.6	34 - 32.6
2.0	1.94 - 2.06	194 - 206	19.4 - 20.6	1.94 - 2.06	194 - 206	19.4 - 20.6	51.5 - 48.5
1.0	0.94 - 1.06	94 - 106	9.4 - 10.6	.94 - 1.06	94 - 106	9.4 - 10.6	106 - 94.3
0.3	.24 - .36	24 - 36	2.4 - 3.6	.94 - 3.6	24 - 36	2.4 - 3.6	416 - 277
Stop	.001 - .003	.1 - .03	.01 - .03	.001 - .003 (1.0 - .33) Sec.	.1 - .3 (10 - 3.3) Sec.		(100 - 33.3) Sec.

Table 4-2. Calibration and Performance Checks (Continued)

Step	Calibration	Control Setting	Test Equipment (Mode)	Procedure
4.0	WAVEFORMS			
4.1 *	Output Amplifier Zero Adjust	FREQ Mult @ 1K Dial @ 2.5 WAVEFORM @ DC LEVEL @ CW (Max)	DVM-DC SCOPE-DC	1. DVM to OUTPUT BNC via unterminated coax with scope as monitor. 2. Adjust R119 for 0 ±5mv dc on the DVM.
* 4.2	Gain Adjust	WAVEFORM @ Triangle	DVM-AC	Adjust R166 for reading of 5.556 ±.010v (20.0 ±0.036v p-p).
4.3 * *	Output Amplifier Squarewave Response	FREQ Mult @ 1M Dial @ 3.0 WAVEFORM @ Sq		1. Adjust the level for 10v p-p on the scope. 2. Adjust C58 for ideal square waveform. Overshoot or aberration must be less than 5% p-p. 3. Measure rise and fall between 10% and 90% of amplitude (tr and t_f <60 ns).
* 4.4	Square Amplitude Symmetry	WAVEFORM @ Sq FREQ Mult @ 1K LEVEL @ mid range	DVM-DC	1. DVM to OUT BNC via unterminated coax. 2. Adjust R63 for 0 ±5 mv dc.
* 4.5	Square Amplitude	LEVEL @ CW (max)	DVM-AC	Measure 11.11 ±0.24 vac
4.6	Sine Zero	WAVEFORM @ Sine	DVM-DC	Adjust R96 for 0.0 ±5 mv dc.
4.7	Sine Distortion	FREQ Mult @ 1K Dial @ 1.0	Distortion Analyzer Scope	1. Connect the distortion analyzer to the output BNC via 50-ohm terminated coax with scope as monitor. 2. Adjust R77 and R89 alternately for minimum distortion.

Table 4-2. Calibration and Performance Checks (Continued)

Step	Calibration	Control Setting	Test Equipment (Mode)	Procedure
*				3. Adjust R99 and R102 alternately for minimum distortion. 4. Repeat Procedures 2 and 3 above, as necessary, to retain total harmonic distortion <0.3%.
4.8	Sine Zero Slope	FREQ Mult @ 10K Dial @ 3.0	Scope-AC Distortion Analyzer	Observe sine peaks @ 1 v/CM. Adjust R98 for the most rounded appearance (zero slope) which provides distortion less than 0.3%.
* 4.9	Sine Amplitude Adjust	FREQ Mult @ 1K Dial @ 3.0	DVM-AC	1. Remove distortion analyzer and connect DVM to output BNC. 2. Adjust R81 for reading of 7.07 ±.012 vac (20.0 ±.036v p-p).
* 4.10	Sine Zero		DVM-DC	Readjust R96 for 0.0 ±5mv dc if required.
4.11 *	Sine Flatness	FREQ Mult @ 1M	RF Voltmeter Scope	1. Remove the DVM and connect the RF voltmeter to the output BNC monitor with scope. 2. Rotate FREQ dial between .3 and 3.0. Adjust C43 for ±0.2 db over the range.
5.0	OFFSET			
* 5.1	Zero	FREQ Mult @ 1K WAVEFORM @ DC OFFSET @ IN AMPLITUDE @ 10v p-p LEVEL @ CW stop	DVM-DC	Connect DVM (unterminated) to output BNC coax. Output shall read 0.0 ±.01 vdc.
* 5.2	Variable	OFFSET pulled On		1. Rotate the OFFSET pot to the CW stop. DVM shall read 10.0 ±.5v.

Table 4-2. Calibration and Performance Checks (Continued)

Step	Calibration	Control Setting	Test Equipment (Mode)	Procedure
5.2 (Cont)				2. Rotate the OFFSET pot to the CCW stop. DVM shall read -10 ±.5 vdc.
* 6.0	OUTPUT ATTENUATOR (F31)	FREQ Mult @ 1K Dial @ 3 WAVEFORM @ Sine LEVEL @ CW stop and PULL	DVM-AC	Measure 0.707 ±.015 vac @ output BNC unterminated.
7.0	OUTPUT ATTENUATOR (F32-34)			
* 7.1	-10 db	FREQ Mult @ 1K Dial @ 3 WAVEFORM @ Sine AMPLITUDE @ 3v p-p LEVEL @ CW stop	DVM-AC	Measure 2.236 ±.045 vac @ output BNC unterminated.
* 7.2	-20 db	AMPLITUDE @ 1v p-p		Measure 0.707 ±.014 vac.
* 7.3	-30 db	AMPLITUDE @ .3v p-p		Measure 0.224 ±.009 vac.
* 7.4	-40 db	AMPLITUDE @ .1v p-p		Measure 0.071 ±.003 vac.
8.0	VARIABLE PULSE (F32-F34)			
* 8.1	Range	FREQ Mult @ 1K Dial @ 3.0 WAVEFORM to Variable Pulse VARIABLE PULSE Vernier @ Midrange LEVEL @ CW stop	Scope-DC	1. Measure 10.0 ±1.0v p-p at OUT BNC with 50-ohm termination. 2. Slowly rotate the V. P. vernier from stop to stop. Observe that a full range of pulse widths are produced from -10 vdc @ the CW stop to +10 vdc @ the CCW stop.

Table 4-2. Calibration and Performance Checks (Continued)

Step	Calibration	Control Setting	Test Equipment (Mode)	Procedure
* 8.2	Minimum Pulse	FREQ Mult @ 1M Dial @ .5		1. Slowly rotate the vernier for minimum duration pulses. 2. Pulse duration measured shall be less than 100 ±35 ns @ 50% of amplitude level.
* 9.0	OUTPUT LIMIT CIRCUITRY (F32-34)			
		FREQ Mult to 1K Dial to 1 WAVEFORM to DC OFFSET to ON Position * LEVEL to CW Stop	DVM-DC	1. Connect DVM to output BNC via unterminated coax. 2. Adjust OFFSET for +2.5v. Limit lamp should glow. Adjust OFFSET to -2.5v. Lamp should glow. 3. Turn off OFFSET. Lamp should go out.
10.0	VCG (F32-34)			
		FREQ Mult @ 1K Dial @ CW stop	Counter-Frequency	1. Apply 10.0 ±.01v to VCG BNC.
		WAVEFORM @ Sine	Voltage Source	2. Connect SYNC OUT BNC to counter via 50-ohm terminated coax.
*				3. Frequency read shall be 3 kHz (+.18 - .33kHz).
11.0	START/STOP (F33/F34)			
		FREQ Mult @ 1K MODE @ TRIG AMPLITUDE @ 10 v p-p	DVM-DC	1. Adjust R228 for 0 ±60 mv dc. 2. Rotate the FREQ dial between 0.3 and 3.0. Observe a shift in DVM reading of less than 30 mv dc.

Table 4-2. Calibration and Performance Checks (Continued)

Step	Calibration	Control Setting	Test Equipment (Mode)	Procedure
*12.0	TRIG MODE OPERATION (F33/34)	FREQ Mult @ 1K Dial @ 3.0 MODE @ Trig WAVEFORM @ Sine	Function Generator Scope	1. Apply 3v p-p square-wave @ 1 kHz to the TRIGGER/SYNC BNC. 2. Connect Scope to Output BNC. 3. Adjust the TRIGGER LEVEL pot until a single sine cycle is produced at the output BNC.
*13.0	GATE MODE OPERATION (F33-F34)	FREQ Mult @ 1K Dial @ 3.0 MODE @ Gate WAVEFORM @ Sine	Function Generator Scope	1. Apply 3v p-p sinewave @ 0.3 kHz to the TRIG./SYNC BNC. 2. Connect scope to Output BNC. 3. Rotate the TRIGGER LEVEL pot from stop to stop. Observe that any number of complete cycles may be produced from 1 to 10 before repetition.
*14.0	FREQUENCY ANALOG (F34)			
14.1	Zero	FREQ Mult @ 1K Dial @ CW Stop	DVM-DC	1. Connect DVM to FREQ ANALOG BNC.
14.2	Full-Scale			2. Adjust R329: for 0 ±10mv dc. 3. Rotate the FREQ dial to 3.0. DVM shall read 5.0 (+.3 - .55) vdc.

Table 4-2. Calibration and Performance Checks (Continued)

Step	Calibration	Control Setting	Test Equipment (Mode)	Procedure
15.0	SWEEP (F34)			
15.1	AMPLITUDE	SWP TIME @ 10 ms SWP VERN @ Cal MODE @ CONT SWP	DVM-AC DVM-DC	1. Connect DVM to 1C15 pin 12. Measure .833 ± .016 vac (1.55 ±0.30 vdc)
15.2	DIAL CALIB A	FREQ Mult @ 10K Dial @ 3.0 MODE @ CONT	Counter-Freq.	1. Connect counter to Sync Out BNC. 2. Measure & record freq. F. 3. Set FREQ dial @ 1.0 Measure and record freq: F_2
15.3	ZERO SWEEP ADJ.	FREQ DIAL @ 0.3 MODE @ CONT Swp SWP LIM @ ccw Stop SWP TIME @ 1 sec SWP VERN @ Cal	Scope	1. Connect scope to OUT BNC. 2. Adj. R203 for zero sweep (FM) on scope display
15.4	DIAL CALIB: high	SWP LIM @ 3.0	Counter-Freq	1. Connect counter to Sync Out BNC 2. Adj. SWP VERN to best observe max. frequency on counter. 3. Adj. R190 to obtain the same max. freq value recorded as F, above (15.1.2) within ±1%.
15.5	DIAL CALIB: Low	SWP LIM @ 1.0		1. Adj. SWP VERN to best observe maximum frequency on counter. 2. Measure and record max freq: F_3 3. If F_3 is more than 5% higher than F_2 (recorded in stop 15.1.3 above): loosen hex nut on SWP LIM pot R210 and rotate pot CW. Remeasure F_3.

Table 4-2. Calibration and Performance Checks (Continued)

Step	Calibration	Control Setting	Test Equipment (Mode)	Procedure
15.5	DIAL CALIB: Low (Cont'd)			4. If F_3 is more than 5% lower than F_2: Loosen hex nut on pot R210 and rotate pot CCW. Remeasure F_3. 5. Repeat steps 15.2, 15.3 and 15.4 until $F_3 = F_2 \pm 5\%$
15.6	SWEEP TIME CAL.	MODE @ Cont Swp WAVEFORM @ Swp SWP TIME @ Ims SWP VERNIER @ Cal.	Counter-Time Interval	1. Connect time interval counter to TP29 via 10 Megohms < 15 pf probe. 2. Measure time interval between positive going and negative going transitions of TP29. Adj. R288 for 1000 ±5 us. 3. Set SWP Time @ 10 us. Time interval (ramp up) of 10 ±0.2 us. 4. Check time intervals of 100 us, 10 ms, 100 ms and 1 s SWPTIME ranges for proper reading ±3%.
15.7	100:1 Adj.	SWP TIME @1ms SWP VERN @ CCW stop SWP TIME @ 1s SWP VERN @ CCW stop		1. Adj. R301 for time interval of 115 ±10 ms. 2. Time interval shall be between 105s and 130s.
15.8	SWP Base Line	SWP TIME @ 10 us SWP VERN @ Cal	SCOPE	1. Connect Scope to TP27 via x10 probe. SWP retrace not to overshoot DC Zero by more than 20 mv.

Table 4-2. Calibration and Performance Checks (Continued)

Step	Calibration	Control Setting	Test Equipment (Mode)	Procedure
16.0	SWEEP MODES			
*16.1	TRIG SWP Mode	MODE @ Trig Swp	Function Generator	1. Connect 3v p-p sine-wave @ 50 Hz to TRIG/ SYNC input.
		SWP TIME @ 10 ms SWP VERN @ Cal FREQ Mult @ 1K FREQ Dial @ 1.0		
		SWP LIMIT Dial @ 3.0 WAVEFORM @ Triangle	Scope	2. Observe waveform as shown on scope at OUTPUT BNC. (Approximately 20 cycles of Triangular waveform with decreasing period.)
*16.2	CONT SWP Mode	MODE @ Cont Swp		1. Remove the sinewave from the TRIG/SYNC BNC. 2. Observe on the scope the repeating swept waveform as shown at the output BNC.
*16.3	BURST Mode	MODE @ Burst		Rotate the TRIGGER LEVEL pot from stop to stop. Observe that any number of complete cycles may be produced from one to 10 before repetition.

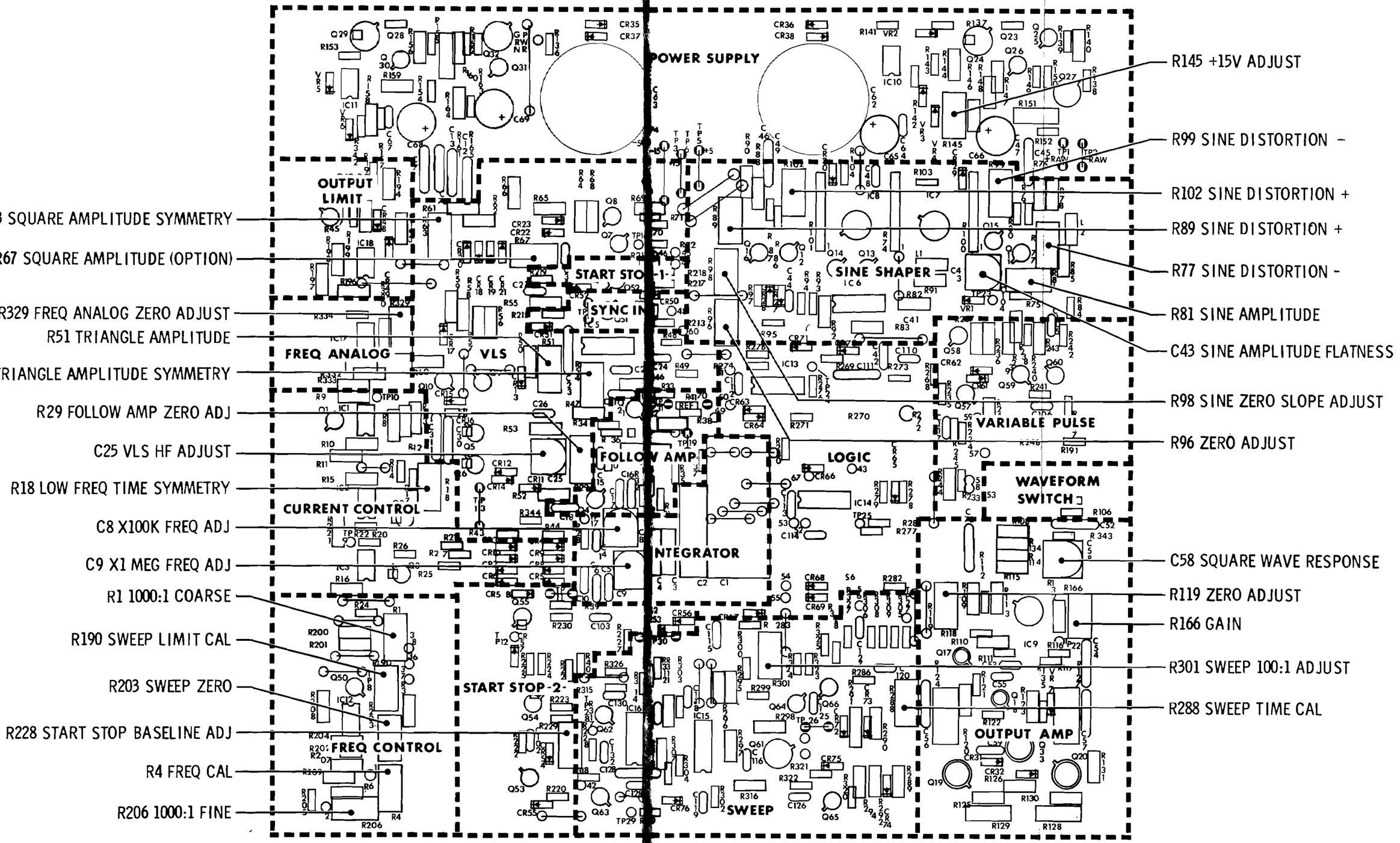


Figure 4-1. Adjustment Location Diagram

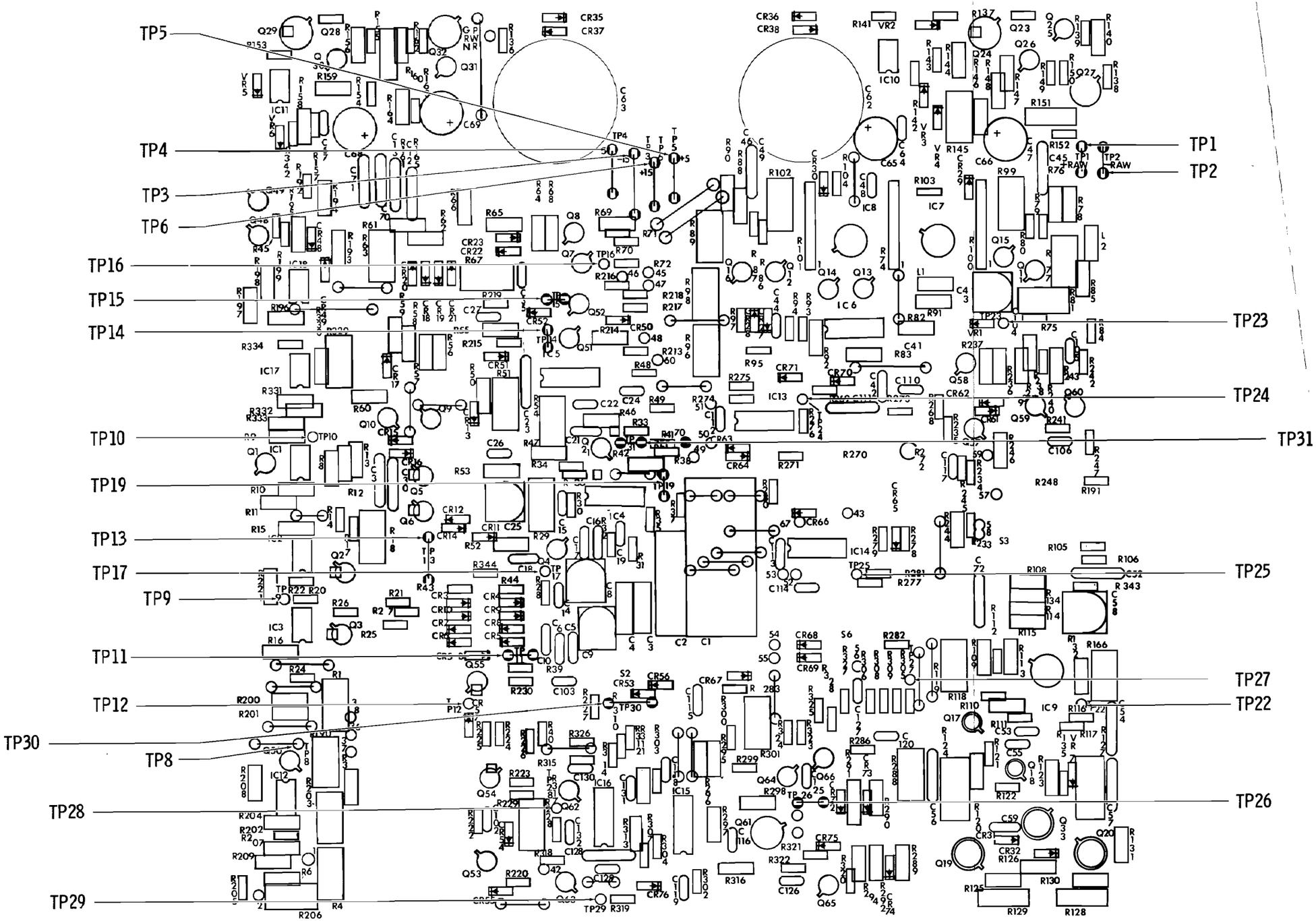


Figure 4-2. Test Point Location Diagram

Section 5

MAINTENANCE

5-1. INTRODUCTION

This section of your SERIES 30 manual was prepared with service personnel in mind. Accordingly, the schematic diagram at the back of the manual provides waveform information at critical points in the instrument to aid in diagnosing instrument failures. Figures 5-1 through 5-4 are switch assembly diagrams, and the Troubleshooting Guide (table 5-1) provides detailed information for a number of possible malfunctions. Logic and Start-Stop timing diagrams are shown in figure 3-2, Section 3.

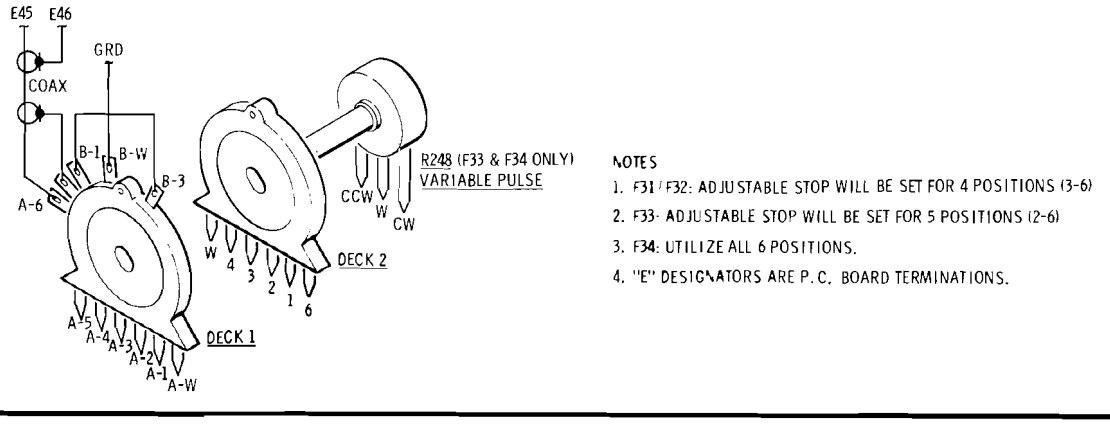


Figure 5-1. Waveform Switch (S3)

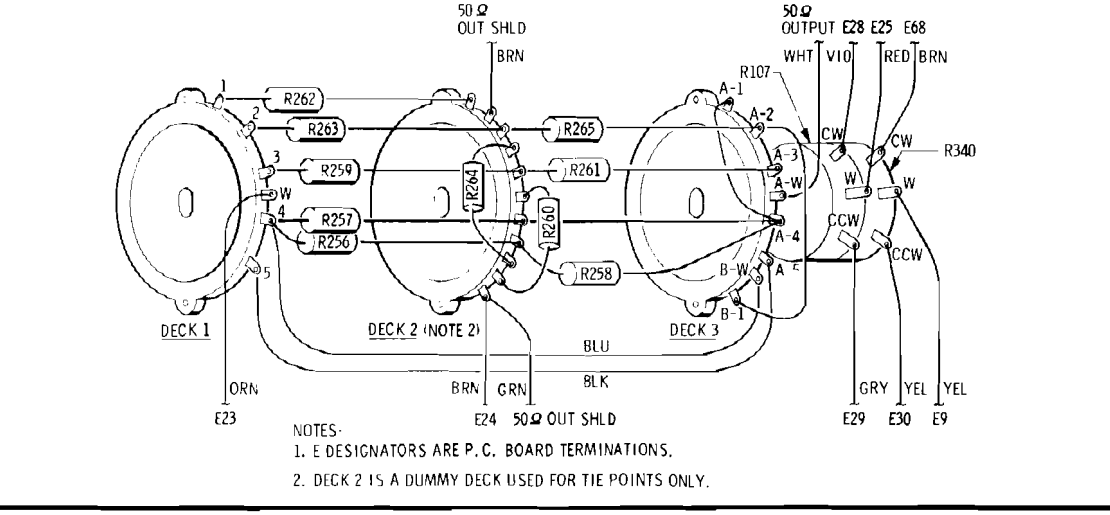


Figure 5-2. Attenuator Switch (S5)

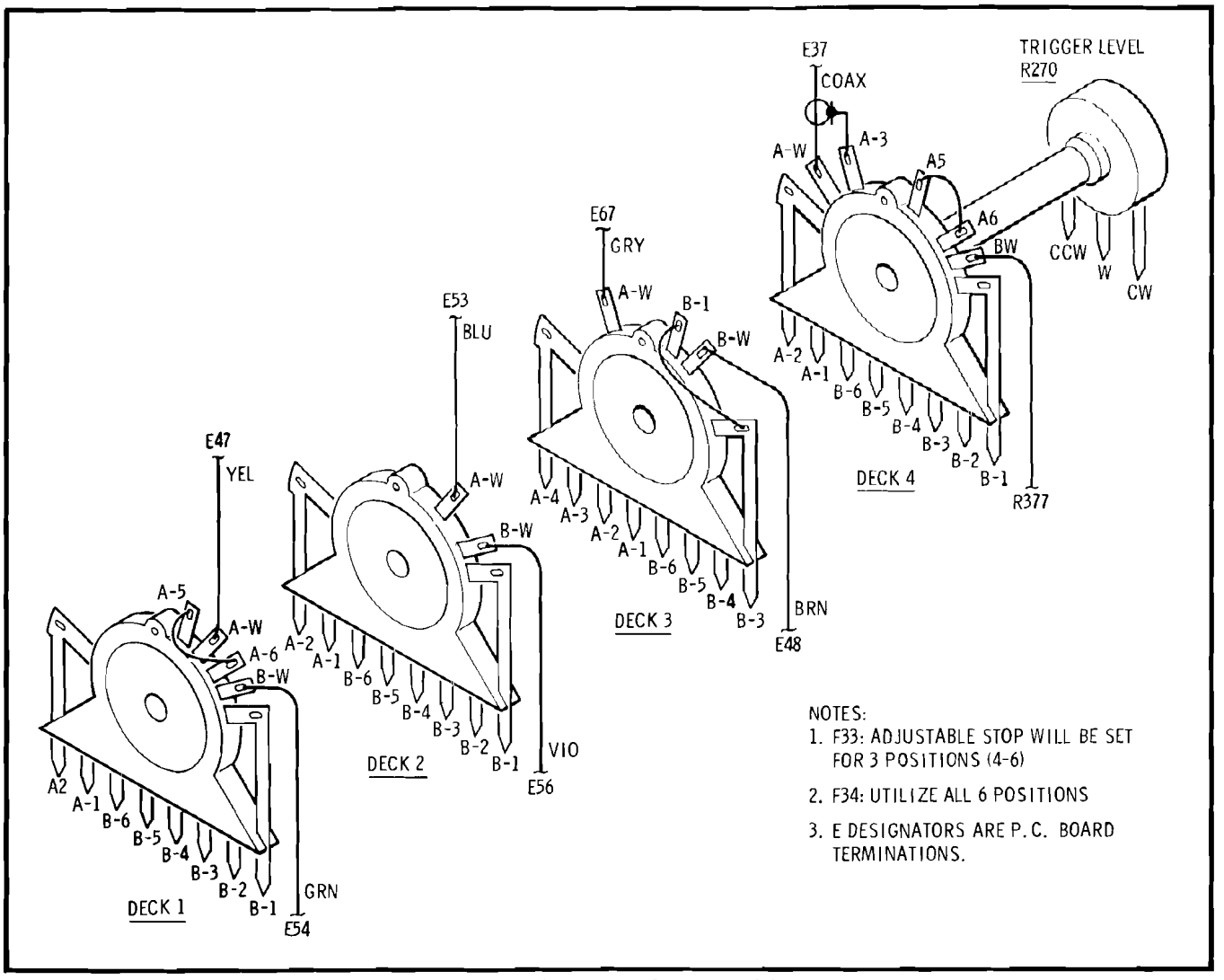


Figure 5-3. Mode Switch (S6)

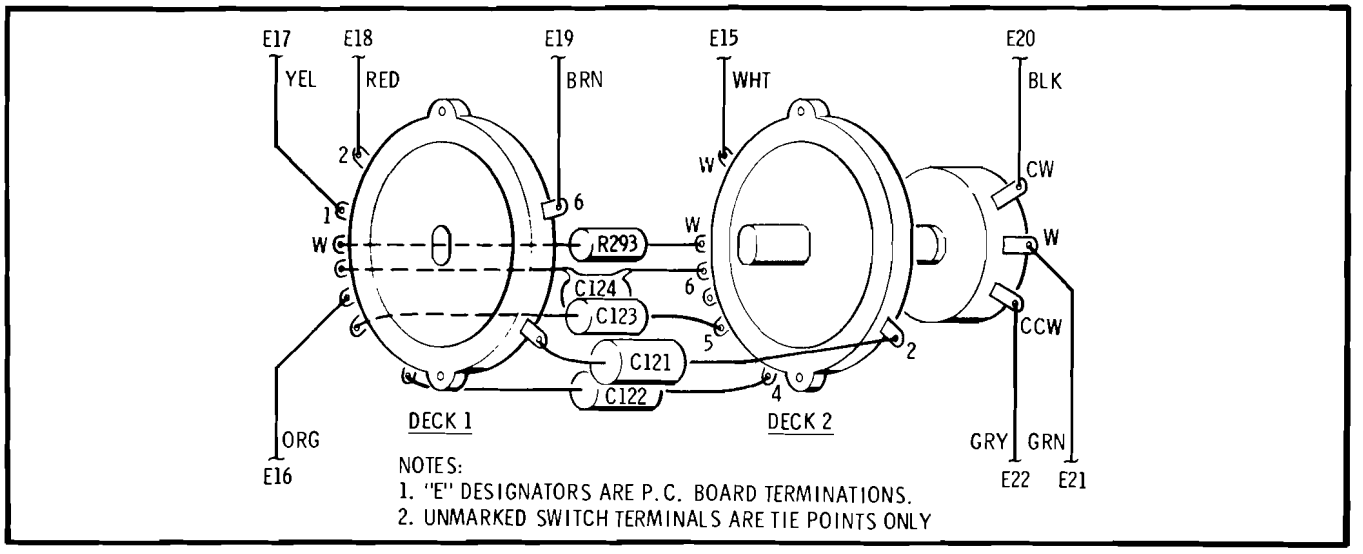


Figure 5-4 Sweep Time Switch (S7) and Sweep Time Vernier (R287)

TABLE 5-1. TROUBLESHOOTING GUIDE

Symptom/Step	Possible Cause	Remarks
1. NO OUTPUT		
a. For all waveform positions	1. Output amp disabled.	See step 14.
	2. Power supply disabled.	See step 20.
b. For all waveform positions except (offset) dc	Triangle loop stalled.	See steps 15 and 4b.
c. No sine waveform output	Sine shaper disabled.	See step 21.
d. No square output	1. Short to ground between CR19 cathode and Q7 or Q8 base.	
	2. Open CR19 or CR21, R61, R62 or R63.	
	3. Open R64 or R65, Q7 or Q8.	
e. No offset capability	S4 not functioning (always closed).	
f. No variable pulse (33, 34)	1. Variable pulse circuit disabled.	See step 24.
	2. Wiper of R248 shorted to ground.	
g. No sweep (F34)	1. Switch not in SWP mode position.	
	2. Logic "0" from S6-2B wiper.	See step 22.
2. NO SYNC OUT, Loop Functioning	1. Open circuit between TP13 and Sync Out BNC.	
	2. Short to ground between R44 and Sync Out BNC.	
3. NO FREQ ANALOG OUT (F34)	1. Faulty IC-17.	
	2. Open circuit between IC17-6 and Analog Out BNC.	
4. OUTPUT LEVEL Improper		
a. Low amplitude	1. Output amp faulty.	See step 14.
	2. Misadjusted R166.	
	3. Failure in attenuator S5.	Check attenuator calibration.
	4. Failure in LEVEL potentiometer (R107).	
b. Large d-c Offsets	1. S4 failure.	
	2. Misadjusted R119.	
	3. Output amplifier faulty.	See part 14.

Table 5-1. Troubleshooting Guide (Continued)

Symptom/Step	Possible Cause	Remarks
5. OUTPUT WAVEFORMS IMPROPER		
a. Time nonsymmetry at all dial frequencies (Δ, ∿, ⎍).	1. R18, R205 or R1 misadjusted. 2. Current control problems.	See step 18.
b. Time nonsymmetry at low dial frequencies (Δ, ∿, ⎍).	1. R18 misadjusted. 2. Current control problems. 3. Leaky Q2 or Q3 (collector to base). 4. Leaky CR58 or Q4. 5. Shorted or leaky CR4, CR5, CR8 or CR9.	See step 18.
c. Amplitude, nonsymmetry.	1. R54 misadjusted. 2. VLS faulty.	See step 16.
d. All waveforms clipped.	Output amplifier faulty.	See part 14.
e. Sine and Triangle waveforms clipped.	Misadjusted R29.	
f. Sinewave only clipped.	1. Sine shaper or sine amplifier faulty. 2. Sine shaper calibration.	See step 21.
g. Squarewave clipped.	VLS faulty.	See step 16.
h. Nonlinear triangle in all FREQ MULT positions.	Leaky components: CR9, CR8, CR4, CR5, CR58, Q2 (C to B) or Q3 (collector to base).	
i. Nonlinear triangle in specific FREQ MULT positions.	C1, C2, C3, C4, or C5.	
j. Excessive overshoot or ringing on squarewave.	1. Output amplifier trouble. 2. Open C52, C54, C56, or C57.	See step 14.
k. Excessive rise and fall times on variable pulse.	Variable pulse rise and fall excessive (F33, F34).	See step 24.
l. Excessive sine distortion.	1. Improper triangle input level, amplitude symmetry, time symmetry, or linearity. 2. Sine shaper calibration improper. 3. Sine shaper faulty.	See step 4. See step 21.

Table 5-1. Troubleshooting Guide (Continued)

Symptom/Step	Possible Cause	Remarks
m. AM or FM on output.	1. Power supply ripple.	See step 20.
	2. Frequency control oscillations.	See step 19.
	3. Current control oscillations.	See step 18.
	4. Misadjusted R203 (F34).	
6. FREQENCY CALIBRATION IMPROPER		
a. Large freqency error in specific FREQ mult position.	1. Faulty C1 through C4.	
	2. Faulty S2 contact.	
b. Large freq. error in all FREQ mult positions.	1. Q4 open drain.	
	2. VLS faulty (C25 shorted)	See step 16.
	3. Misadjusted R5 or tuning assy out of alignment.	
	4. IC4 faulty.	
	5. Frequency Control faulty.	See step 19.
	6. Current Control faulty.	See step 18.
7. INSUFFICIENT FREQ RANGE		
a. <1000: 1 VCG	1. Misadjustment of R205 and R1.	
	2. Failure in frequency control section.	
	3. Misadjustment of R5, or tuning assembly out of mechanical alignment.	
b. <1000:1 Sweep	1. Misadjustment of R205 and R1.	
	2. Failure in frequency control section.	
	3. Misadjustment of R5 or R210, or tuning assembly out of mechanical alignment.	
c. <1000:1 Dial Range	1. Misadjustment of R205 and R1.	
	2. Misadjustment of R5 or tuning assembly out of mechanical alignment.	
	3. Failure in frequency control section.	See step 19.

Table 5-1. Troubleshooting Guide (Continued)

Symptom/Step	Possible Cause	Remarks
8. OUTPUT LIMIT LIGHT FAULTS (F32 thru F34)		
a. On prematurely	1. Misadjustment of R166.	
b. On always	1. Q49 shorted.	
	2. Q48 open.	
c. Off always	1. Lamp failure.	
	2. Q49 open.	
	3. Q48 shorted.	
	4. IC 18 faulty.	
9. GATE MODE FAULTS (F33/F34)		
a. No dynamic gating	1. Trig level pot open circuit to ±15v.	
	2. Open circuit from TRIG/SYNC BNC to R277.	
	3. S9 faulty, open circuit to ground.	
	4. S6-2A, 4B open.	
	5. Logic trouble.	See step 22.
	6. Start/Stop trouble.	See step 23.
b. No manual gating	1. S9 faulty.	
	2. 1 and 4 from 9a above.	
c. Incomplete last cycle	1. S6 - 1B open.	
	2. Logic trouble.	See step 22.
	3. Start/Stop trouble.	See step 23.
d. Baseline of triangle and sine offset from zero.	1. R228 misadjusted.	
	2. Start/Stop trouble.	See step 23.
e. Baseline oscillation	Start/Stop trouble.	See step 23.
10. TRIGGER MODE FAULTS (F33/F34)		
a. Double triggers or Incomplete cycle.	1. Start/Stop trouble.	See step 23.
	2. Logic trouble.	See step 22.

Table 5-1. Troubleshooting Guide (Continued)

Symptom/Step	Possible Cause	Remarks
b. Base line of triangle and sine offset from zero.	Misadjustment of R228.	
c. No dynamic triggering.	Same as 9a.	
d. No manual triggering.	Same as 9b.	
e. Baseline oscillations.	Start/Stop trouble.	See step 23.
11. BURST MODE FAULTS.		
a. No burst output.	1. Open circuit from TP27 to R277 when in burst mode. 2. Same as 9a.	
b. Continuous output only.	Same as 9a.	
12. SWEEP FAULTS		
a. Waveform nonlinearity.	1. Q61, Q64, Q65 leaky. 2. CR73, CR74, CR75 leaky. 3. C121-C125 leaky.	
b. Vernier <100:1 sweep time range.	IC15 faulty.	
c. No Sweep	Same as 1g.	
13. TRIGGERED SWEEP FAULTS		
a. No sweep.	Same as 1g.	
b. Double sweep.	Excessive rate on TRIG/SYNC input.	
c. Interrupted sweep.	1. Q63 failure. 2. Logic Failure.	See step 22.
14. OUTPUT AMP FAULTS		
a. Positive Output (<11v open circuit) at all times.	1. Q33, Q17, CR31 or CR32 open. 2. Negative supply not operating. 3. VR7 shorted. 4. IC9 faulty.	

Table 5-1. Troubleshooting Guide (Continued)

Symptom/Step	Possible Cause	Remarks
b. Negative output (<-11 open circuit) at all times.	1. Q18, or VR7 open. 2. Negative regulated supply not operating. 3. IC9 faulty.	
c. Small offsets only.	1. IC9 faulty. 2. Q17 shorted base to emitter or open collector.	
d. Clipped waveforms.	1. Q19 or Q20 open. 2. IC9 faulty.	
e. Oscillations.	1. C55 or C53 open. 2. C58 misadjusted. 3. C56, C59, C57, or C52 open. 4. Feedback path partially shorted: R166 or R132.	
f. Squarewave for all Waveforms positions, saturating at both ends.	Feedback path open: R166 or R132 open.	
g. Low amplitude	1. Feedback path shorted or partially shorted: R166, R132. 2. Q18 or IC9: low current gain.	
h. 0v Output	C58 shorted.	
15. TRIANGLE LOOP INOPERATIVE a. Squarewave locked up @ +3v @ TP16 or Triangle locked up @ >+3v @ TP19.	1. IC5 faulty. 2. Q9 or Q6 open. 3. CR11, CR12, CR13 or CR14 open.	
b. Squarewave locked up at -3v @ TP16 or Triangle locked up >-3v @ TP19.	1. IC5 faulty. 2. Q9 or Q6 open. 3. CR11, CR12, CR13, or CR14 open.	
c. Squarewave locked up @ ±3v @ TP16 or Triangle locked up ≈0v.	1. C1, C2, C3, C4, C5, C6, C8, C9, C10, or C14 shorted to common. 2. IC4 faulty. 3. TP9 or junction of R12 and R13 shorted to common.	

Table 5-1. Troubleshooting Guide (Continued)

Symptom/Step	Possible Cause	Remarks
d. Both squarewave and triangle wave at ≈ 0v.	Power supply disabled.	See step 20.
16. VLS FAULTS a. TP16 @ +3v and TP13 @ +5v always.	1. Q9 open collector or base-emitter short. 2. IC5-9 does not go to + logic level (≈3v): faulty IC or no input. 3. Q6 open. 4. Q5 or Q10 shorted. 5. TP19 open circuit. 6. TP13 open.	
b. TP16 @ -3v and TP13 @ -5v always.	1. Q9 shorted. 2. IC5-9 does not go to - 10gic level (≈1v), or no input. 3. CR17 open. 4. TP19 jumper open circuit. 5. TP13 jumper open circuit.	
17. FOLLOW AMPLIFIER a. TP19 @ +5v.	1. IC4 faulty. 2. Q4 shorted (drain to source) 3. Q21 or R29 open.	
b. TP19 @ more negative than -5v.	1. IC4 faulty. 2. Q4 open. 3. Q21 shorted.	
c. TP19 between +3v and -3v.	1. IC4 faulty. 2. Short to ground, from E49 to S3.	
18. CURRENT CONTROL DISABLED a. Set FREQ dial @ 3.0 and short TP17 to ground for test. Voltage @ CR9 cathode <330mv Voltage @ CR4 cathode +5v.	1. Q2 open. 2. IC2 faulty. 3. Voltage across R15 less than 5.8v: (a) IC1 faulty or Q1 open; (b) voltage at TP8 improper. FREQ Control faulty.	See step 19.

Table 5-1. Troubleshooting Guide (Continued)

Symptom/Step	Possible Cause	Remarks
b. Set FREQ dial @ 3.0 and short TP17 to ground for test. Voltage @ CR9 cathode less negative than -330 mv. Voltage @ CR4 cathode -5v.	1. Q3 open. 2. IC2 faulty. 3. Voltage across R16 less than 5.8v: Voltage at TP8 improper. FREQ Control faulty.	See step 19.
19. FREQUENCY CONTROL a. TP8 less negative than TP9 when FREQ Dial @ CW Stop.	1. Q59 open. 2. IC12 faulty. 3. R1 open or misadjusted. 4. R5 misadjusted or tuning assembly out of mechanical alignment.	
b. Dial Linearity poor @ Top of FREQ Dial.	Q50 open collector.	
20. POWER SUPPLY a. Entirely dead.	1. Fuse blown. 2. S1, S8 open.	
b. All voltages too high.	1. IC10 open. 2. R145 open. 3. VR4, Q23, Q24 shorted. 4. VR2 open.	
c. All voltages too low.	1. VR2 shorted. 2. VR4 open.	
d. No regulated voltages.	1. Q25 shorted. 2. Q23, Q24 open.	
e. No negative regulated voltages.	1. Q28, Q29 open. 2. Q30 short. 3. IC11 open.	
f. +5v too high.	Q26, Q27 short.	
g. +5v too low.	Q26, Q27 open.	
h. -5v too high.	Q31, Q32 shorted.	

Table 5-1. Troubleshooting Guide (Continued)

Symptom/Step	Possible Cause	Remarks
i. -5v too low.	Q31, Q32 open.	
21. SINE SHAPER FAULTS		
a. Sine Amplifier no output.	1. IC6 faulty. 2. VR1 faulty. 3. C43 shorted.	
b. Excessive distortion.	1. IC6 faulty. 2. Open diode in IC7 or IC8. 3. CR29, CR30 shorted. 4. Open resistor in R100 or R101.	
c. Clipped Waveforms.	1. Open CR29, CR30. 2. Q11, Q12, Q15, Q16 faulty. 3. Q13, Q14 shorted.	
22. LOGIC FAULTS		
a. Logic "0" at TP30 in CONT mode.	1. Open CR53. 2. Short to ground at CR54, CR68, CR69 or S6-1B.	
b. Logic "0" always at TP30 in GATE, BURST and SWP CONT modes.	1. IC14 faulty. 2. IC13 faulty. 3. S9 faulty.	
23. START-STOP FAULTS		
a. No Gating.	1. Q52 open. 2. Open circuit between E47 and TP25.	
b. Incomplete last Triangle Cycle.	CR56 open.	
c. Loop Stalled Negative @ TP13.	1. Q52, Q53 or Q54 shorted. 2. Q55 open.	
d. Loop Stalled Positive @ TP13.	CR58 shorted.	

Table 5-1. Troubleshooting Guide (Continued)

Symptom/Step	Possible Cause	Remarks
24. VARIABLE PULSE FAULTS		
a. Output at +5v.	1. Q57, Q60 shorted. 2. Q59, Q58 or CR61 open.	
b. Output at -5v.	1. Q58, Q59 shorted. 2. Q57, Q60 or CR62 open.	

Section 6

PARTS LIST

6-1. INTRODUCTION

This section contains information for identifying and ordering replacement parts. Replacement parts may be ordered from Interstate Electronics Corporation. Be certain that the order or inquiry identifies the part by description and part number.

Table 6-1 is a listing of all manufacturers supplying parts used in the function generator. Manufacturers are listed numerically by their respective code symbols.

6-2. PARTS LIST TABLES

Table 6-2 lists all electrical and electronic parts in alphanumeric order by reference designators and provides the following information for each part, where applicable: (a) value, (b) description, (c) manufacturer's code symbol, and (d) original manufacturer's part number.

TABLE 6-1. LIST OF MANUFACTURERS

Code	Manufacturer
01295	Texas Instruments Inc., Dallas, Texas
04713	Motorola Semiconductor Products Inc., Phoenix, Arizona
07263	Fairchild Camera and Instrument Corporation, Mountain View, California
07421	Interstate Electronics Corporation, Anaheim, California
07994	American Radionic Co., Danbury, Connecticut
13103	Thermalloy Co., Dallas, Texas
22753	UID Electronics, Hollywood, Florida
28480	Hewlett-Packard Co., Palo Alto, California
56289	Sprague Electric Co., North Adams, Massachusetts
71590	Centralab, Milwaukee, Wisconsin
74950	E. F. Johnson Co., Waseca, Minnesota
75042	I R C Inc., Philadelphia, Pennsylvania
75915	Littelfuse Inc., Des Plaines, Illinois
76433	General Instrument Corporation, Newark, New Jersey
76493	J. W. Miller Co., Los Angeles, California
82389	Switchcraft Inc., Chicago, Illinois
84171	Arco Electronics Inc., Great Neck, New York
90201	Mallory Capacitor Co., Indianapolis, Indiana

TABLE 6-2. PARTS LIST

REF DESIG	VALUE	DESCRIPTION	MFG CODE	PART NUMBER
C1-C4	820pf	C: Metal Mylar 1% Matched Set	07421	P00347750
C5	820pf	C: Mica 500 volts ±5%	84171	CM06CC821J
C8-C9	2.4-24.5pf	C: Variable Air Dielectric	74970	189-509-5
C10	47pf	C: Mica 500 volts ±10%	84171	CM05ED470K
C12	0.1µf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C13	0.1µf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C14	18pf	C: Mica 500 volts ±10%	84171	CM05ED180K
C15	0.01µf	C: Ceramic 100 volts ±20%	56289	C023A101F103M
C16	3.3pf	C: Ceramic 1000 volts ±0.5pf	56289	C030A102E3R3D
C17	0.01µf	C: Ceramic 100 volts ±20%	56289	C023A101F103M
C18	0.01µf	C: Ceramic 100 volts ±20%	56289	C023A101F103M
C19	12pf	C: Mica 500 volts +0.5pf -0.5pf	84171	CM05ED120D
C21	68pf	C: Mica 500 volts ±5%	84171	CM05ED680J
C22	3.3pf	C: Ceramic 1000 volts ±0.5pf	56289	C030A102E3R3D
C23	0.1µf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C24	0.01µf	C: Ceramic 100 volts ±20%	56289	C023A101F103M
C25	2.4-24.5pf	C: Variable Air Dielectric	74970	189-509-5
C26	36pf	C: Mica 500 volts ±10%	84171	CM05ED360K
C27	36pf	C: Mica 500 volts ±10%	84171	CM05ED360K
C30	0.1µf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C31	0.1µf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C35	5pf	C: Mica 500 volts ±10%	84171	CM05CD050K
C42	3.3pf	C: Ceramic 1000 volts ±0.5pf	56289	C030A102E3R3D
C43	2.4-24.5pf	C: Variable Air Dielectric	74970	189-509-5
C44	510pf	C: Mica 500 volts ±10%	84171	CM05ED511K
C45	0.1µf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C46	0.1µf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C48	0.01µf	C: Ceramic 100 volts ±20%	56289	C023A101F103M
C52	0.1µf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C53	200pf	C: Mica 500 volts ±10%	84171	CM05ED201K
C54	0.1µf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C55	130pf	C: Mica 500 volts ±10%	84171	CM05ED131K
C56	0.1µf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C57	0.1µf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C58	1.8-16.7pf	C: Variable Air Dielectric	74970	189-506-5
C59	0.01µf	C: Ceramic 100 volts ±20%	56289	C023A101F103M
C62	2500µf	C: Electrolytic 35 volts -10% +150%	76433	2407044
C63	2500µf	C: Electrolytic 35 volts -10% +150%	76433	2407044
C64	0.01µf	C: Ceramic 100 volts ±20%	56289	C023A101F103M
C65	100µf	C: Electrolytic 50 volts -10% +100%	90201	MTV20-44818
C66	100µf	C: Electrolytic 15 volts -10% +100%	90201	MTV20-44823
C67	0.01µf	C: Ceramic 100 volts ±20%	56289	C023A101F103M
C68	100µf	C: Electrolytic 50 volts -10% +100%	90201	MTV20-44818

Table 6-2. Parts List (Continued)

REF DESIG	VALUE	DESCRIPTION	MFG CODE	PART NUMBER
C69	100μf	C: Electrolytic 15 volts -10% +100%	90201	MTV20-44823
C70	0.1μf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C71	0.1μf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C72	0.1μf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C102	15pf	C: Mica 500 volts ±10%	84171	CM05CD150K
C103	47pf	C: Mica 500 volts ±10%	84171	CM05ED470K
C105	0.01μf	C: Ceramic 100 volts ±20%	56289	C023A101F103M
C106	20pf	C: Mica 500 volts ±10%	84171	CM05ED200K
C110	0.01μf	C: Ceramic 100 volts ±20%	56289	C023A101F103M
C111	0.1μf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C112	150pf	C: Mica 500 volts ±10%	84171	CM05CD151K
C113	100pf	C: Mica 500 volts ±10%	84171	CM05ED101K
C114	1000pf	C: Ceramic 300 volts ±20%	56289	C016A102G102M
C115	270pf	C: Mica 500 volts ±10%	84171	CM05ED271K
C116	3.3pf	C: Ceramic 1000 volts ±0.5pf	56289	C030A102E3R3D
C117	3.3pf	C: Ceramic 1000 volts ±0.5pf	56289	C030A102E3R3D
C118	47pf	C: Mica 500 volts ±10%	84171	CM05ED470K
C119	47pf	C: Mica 500 volts ±10%	84171	CM05ED470K
C120	500pf	C: Ceramic 300 volts ±10%	56289	C016A102F501K
C121-C123				
C124	820pf	C: Mica 300 volts ±5%	84171	CM06CC821J
C126	20pf	C: Mica 500 volts ±10%	84171	CM05ED200K
C127	75pf	C: Mica 500 volts ±10%	84171	CM05ED750K
C128	0.1μf	C: Dip Mylar 50 volts ±40%	07994	FM0104U
C129	0.01μf	C: Ceramic 100 volts ±20%	56289	C023A101F103M
C130	10pf	C: Mica 500 volts ±10%	84171	CM05ED100K
C131	180 pf	C: Mica 500 volts ±5%	84171	CM05ED181J
C132	10pf	C: Mica 500 volts ±10%	84171	CM05ED100K
CR3		Diode: Hot Carrier	28480	HP5082-2811
CR4-5		Diode: Silicon	03508	1N914A
CR6-7		Diode: Hot Carrier	28480	HP5082-2811
CR8-9		Diode: Silicon	03508	1N914A
CR10		Diode: Hot Carrier	28480	HP5082-2811
CR11-CR23		Diode: Silicon	03508	1N914A
CR27		Diode: Silicon	03508	1N914A
CR28		Diode: Silicon	03508	1N914A
CR29-CR30		Diode: Silicon Matched Set	07421	P00347301
CR31		Diode: Silicon	03508	1N645
CR32		Diode: Silicon	03508	1N645
CR35-CR38		Diode: Silicon	04713	1N4002
CR48-CR58		Diode: Silicon	03508	1N914A
CR61-CR71		Diode: Silicon	03508	1N914A
CR72		Diode: Silicon	07263	FD333

Table 6-2. Parts List (Continued)

REF DESIG	VALUE	DESCRIPTION	MFG CODE	PART NUMBER
CR73-CR75		Diode: Silicon	03508	1N914A
CR76		Diode: Silicon	01295	1N4448
DS2		Lamp: 28 volts 40ma Red	MURA	L28/40-R
F1	1/4 Amp	Fuse: SloBlo for 115 volts operation	75915	313.250
F1	1/8 Amp	Fuse: SloBlo for 230 volts operation	75915	313.125
IC1-3		Integrated Circuit: 741 8-Pin Dip	01295	2N72741P
IC4		Integrated Circuit: 3046 14-Pin Dip	02735	CA3046
IC5		Integrated Circuit: 710 14-Pin Dip	02195	SN72710N
IC6		Integrated Circuit: 3046 14-Pin Dip	02735	CA3046
IC7-8		Integrated Circuit: 3039 12-Pin T05	02735	CA3039
IC9		Integrated Circuit: 3018A 12-Pin T05	02735	CA3018A
IC10-IC12		Integrated Circuit: 741 8-Pin Dip	01295	SN72741P
IC13		Integrated Circuit: 710 14-Pin Dip	01295	SN72710N
IC14		Integrated Circuit: 7200 14-Pin Dip	01295	SN7400N
IC15		Integrated Circuit: 3030 14-Pin Dip	02735	CA3030
IC16		Integrated Circuit: 710 14-Pin Dip	01295	SN72710N
IC17		Integrated Circuit: 741 8-Pin Dip	01295	SN72741P
IC18		Integrated Circuit: 741 8-Pin Dip	01295	SN72741P
L1	62μh	Inductor: Fixed	76493	9210-66
L2	2.7μh	Inductor: Fixed	76493	9310-22
Q1		TSTR: Silicon NPN	04713	2N3904
Q2-Q3		TSTR: Silicon Matched Set	07421	P00347099
Q4		TSTR: N Channel JFET	07421	P00347205
Q5		TSTR: Silicon NPN	04713	2N3904
Q6		TSTR: Silicon PNP	04713	2N3906
Q7		TSTR: Silicon NPN	04713	2N3904
Q8		TSTR: Silicon PNP	04713	2N3906
Q9		TSTR: Silicon NPN	04713	2N3904
Q10		TSTR: Silicon NPN	04713	2N3904
Q11		TSTR: Silicon PNP	04713	2N3906
Q12		TSTR: Silicon PNP	04713	2N3906
Q13		TSTR: Silicon NPN	04713	2N3904
Q14		TSTR: Silicon PNP	07421	2N3906
Q15		TSTR: Silicon NPN	04713	2N3904
Q16		TSTR: Silicon NPN	04713	2N3904
Q17		TSTR: Silicon PNP	04713	MM3906
Q18		TSTR: Silicon PNP	04713	2N3251A
Q19		TSTR: Silicon NPN	07421	P00347006
Q20		TSTR: Silicon PNP	04713	2N2905A
Q21		TSTR: Silicon NPN	04713	2N3904
Q23		TSTR: Silicon NPN	01295	TIP29A
Q24		TSTR: Silicon NPN	01295	2N2219A
Q25		TSTR: Silicon NPN	01295	2N3904

Table 6-2. Parts List (Continued)

REF DESIG	VALUE	DESCRIPTION	MFG CODE	PART NUMBER
Q26		TSTR: Silicon NPN	01295	2N3904
Q27		TSTR: Silicon PNP	01395	2N2905A
Q28		TSTR: Silicon PNP	01295	TIP30A
Q29		TSTR: Silicon PNP	01295	2N2905A
Q30		TSTR: Silicon PNP	01295	2N3906
Q31		TSTR: Silicon PNP	01295	2N3906
Q32		TSTR: Silicon NPN	01295	2N2219A
Q33		TSTR: Silicon NPN	01295	2N2219A
Q48		TSTR: Silicon PNP	01295	2N3906
Q49		TSTR: Silicon PNP	01295	2N3906
Q50		TSTR: Silicon PNP	01295	2N3906
Q51		TSTR: Silicon NPN	01295	2N3904
Q52		TSTR: Silicon PNP	01295	2N3906
Q53		TSTR: Silicon PNP	01295	2N3906
Q54		TSTR: Silicon NPN	01295	2N3904
Q55		TSTR: Silicon NPN	01295	2N3904
Q57		TSTR: Silicon NPN	01295	2N3904
Q58		TSTR: Silicon PNP	01295	2N3906
Q59		TSTR: Silicon NPN	01295	2N3904
Q60		TSTR: Silicon NPN	01295	2N3904
Q61		TSTR: N Channel Dual FET	07421	P00347201
Q62		TSTR: Silicon NPN	01295	2N5187
Q63		TSTR: Silicon NPN	01295	2N3904
Q64		TSTR: Silicon NPN	07421	P00347000
Q65		TSTR: Silicon PNP	01295	2N3906
Q66		TSTR: Silicon NPN	01295	2N3904
R1	5K	R: Variable 1/4 Watt ±30%	71590	TSV-5K
R3	8.25K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-8251F
R4	10K	R: Variable 1/4 Watt ±30%	71590	TSV-10K
R5	5K	R: Variable 2 Watt	07421	P00347678-2
R6	18.7k	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1872F
R8-R9	15.0K	R: Metal Film 1/2 Watt Matched Set	07421	P00347616-1502
R10-R11	15.0K	R: Metal Film 1/2 Watt Matched Set	07421	P00347616-1502
R12	2.05K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2051F
R13	1.30K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1301F
R14	2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-202J
R15-R16	1.69K	R: Metal Film 1/2 Watt Matched Set	07421	P00347616-1691
R17	1Meg	R: Metal Glaze 1/4 Watt ±5%	75042	GBT1/4-105J
R18	50K	R: Variable 1/4 Watt ±30%	71590	TSV-50K
R20	100	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-102J
R21	100	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-101J
R22	2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-202J

Table 6-2. Parts List (Continued)

REF DESIG	VALUE	DESCRIPTION	MFG CODE	PART NUMBER
R24	100	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-102J
R25	100	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-101J
R26	18Meg	R: Metal Glaze 1/4 Watt ±5%	75042	GBT1/4-186J
R27	18Meg	R: Metal Glaze 1/4 Watt ±5%	75042	GBT1/4-186J
R28	100	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-101J
R29	2.5K	R: Variable 1/4 Watt ±30%	71590	TSV-2.5K
R30	390	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-391J
R31	200	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-201J
R32	4.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-472J
R33	2.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-222J
R34	3.3K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-332J
R35	3.3K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-332J
R36	1.1K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-112J
R37	51	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-510J
R38	51	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-510J
R39	620	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-621J
R40	680	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-681J
R42	1.3K	R: Metal Glaze 1/2 Watt ±5%	75042	RG20-132J
R43	220	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-221J
R44	68	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-680J
R45	750K	R: Metal Glaze 1/4 Watt ±5%	75042	GBT1/4-754J
R46	1.50K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1501F
R47	3.01K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3011F
R48	390	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-391J
R49	100	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-101J
R50	976	R: Metal Film 1/2 Watt ±1%	01295	MC60D-9760F
R51	100	R: Variable 1/4 Watt ±30%	71590	TSV-100
R52	6.19K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-6191F
R53	5.76K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-5761F
R54	1K	R: Variable 1/4 Watt ±30%	71590	TSV-1K
R55	2.37K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2371F
R56	1.82K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1821F
R57	1.3K	R: Metal Glaze 1/4 Watt ±5%	75042	RG20-132J
R58	301	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3010F
R59	2.32K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2321F
R60	3.01K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3011F
R61	3.74K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3741F
R62	3.57K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3571F
R63	500	R: Variable 1/4 Watt ±30%	71590	TSV-500
R64	7.50K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-7501F
R65	7.50K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-7501F
R66	1.37K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1371F
R68	200	R: Metal Glaze 1/2 Watt ±5%	75042	RG20-201J
R69	200	R: Metal Glaze 1/2 Watt ±5%	75042	RG20-201J

Table 6-2. Parts List (Continued)

REF DESIG	VALUE	DESCRIPTION	MFG CODE	PART NUMBER
R70	10	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-100J
R71	10	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-100J
R72	39	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-390J
R74		R: Network ±1%	07421	PR0347404
R76	13.0K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1302F
R77	500	R: Variable 1/4 Watt ±30%	71590	TSV-500
R78	1.62K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1621F
R79	20K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-203J
R80	47	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-470J
R81	1K	R: Variable 1/4 Watt ±30%	71590	TSV-1K
R82	3.09K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3091F
R83	3.09K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3091F
R84	51	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-510J
R85	1.2K	R: Metal Glaze 1/2 Watt ±5%	75042	RG20-122J
R86	47	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-470J
R87	20K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-203J
R88	13.0K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1302F
R89	500	R: Variable 1/4 Watt ±30%	71590	TSV-500
R90	1.62K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1621F
R91	2.00K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2001F
R92	2.49K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2491F
R93	47K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-473J
R94	1.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-122J
R95	150K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-154J
R96	50K	R: Variable 1/4 Watt ±30%	71590	TSV-50K
R97	10K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-103J
R98	1K	R: Variable 1/4 Watt ±30%	71590	TSV-1K
R99	100	R: Variable 1/4 Watt ±30%	71590	TSV-100
R100	R:	R: Network ±1%	07421	PR0347401
R101		R: Network ±1%	07421	PR0347401
R102	100	R: Variable 1/4 Watt ±30%	71590	TSV-100
R103	4.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-472J
R104	10K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-103J
R105	680	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-681J
R106	68	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-680J
R107	1K	R: Variable 2 Watts 10% Part of S5 Assy		
R108	2.00K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2001F
R109	2.00K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2001F
R110	2.00K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2001F
R111	33	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-330J
R112	68K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-683J
R113	31.6	R: Metal Film 1/2 Watt ±1%	01295	MC60D-31R6F
R114	3.32K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3321F
R115	31.6	R: Metal Film 1/2 Watt ±1%	01295	MC60D-31R6F
R116	68K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-683J
R117	1.8K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-182J

Table 6-2. Parts List (Continued)

REF DESIG	VALUE	DESCRIPTION	MFG CODE	PART NUMBER
R118	150K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-154J
R119	50K	R: Variable 1/4 Watt ±30%	71590	TSV-50K
R120	243	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2430F
R121	22	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-220J
R122	22	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-220J
R123	51	R: Metal Film 1/2 Watt ±1%	01295	MC60D-5110F
R124	62	R: Carbon 2 Watts ±5%	75042	RC42-620J
R125	7.5	R: Metal Glaze 1/2 Watt ±5%	75042	RG20-7R5J
R126	7.5	R: Metal Glaze 1/2 Watt ±5%	75042	RG20-7R5J
R127	62	R: Carbon 2 Watts ±5%	75042	RC42-620J
R128	24.9	R: Metal Film 1 Watt ±1%	01295	MC66D-24R9F
R129	24.9	R: Metal Film 1 Watt ±1%	01295	MC66D-24R9F
R130	464	R: Metal Film 1/2 Watt ±1%	01295	MC60D-4640F
R131	51.1	R: Metal Film 1/2 Watt ±1%	01295	MC60D-51R1F
R132	6.98K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-6981F
R133	10K	R: Variable 2 Watts ±10% Part of S4 Assy		
R134	9.31K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-9311F
R135	3.9K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-392J
R137	2.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-272J
R138	15K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-153J
R139	390	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-391J
R140	2.7	R: Carbon 1/2 Watt ±5%	75042	RC20GF2R7J
R141	470	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-471J
R142	5.6K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-562J
R143	2.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-222J
R144	10.0K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1002F
R145	2.5K	R: Variable 1/4 Watt ±30%	71590	TSV-2.5K
R146	4.75K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-4751F
R147	4.99K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-4991F
R148	3.01K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3011F
R149	10K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-103J
R150	220	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-221J
R151	100	R: Carbon 1 Watt ±5%	75042	RC32GF101J
R152	470	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-471J
R153	2.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-272J
R154	15K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-153J
R155	390	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-391J
R156	2.7	R: Carbon 1/2 Watt ±5%	75042	RC20GF2R7J
R157	4.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-472J
R158	10.0K	R: Metal Film 1/2 Watt ±0.25%	01295	MC60D-1002C
R159	10.0K	R: Metal Film 1/2 Watt ±0.25%	01295	MC60D-1002C
R160	4.99K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-4991F
R161	3.01K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3011F
R162	10K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-103J
R163	220	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-221J
R164	100	R: Carbon 1 Watt ±5%	75042	RC32GF101J

Table 6-2. Parts List (Continued)

REF DESIG	VALUE	DESCRIPTION	MFG CODE	PART NUMBER
R165	220	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-221J
R166	1K	R: Variable 1/4 Watt ±30%	71590	TSV-1K
R190	2.5K	R: Variable 1/4 Watt ±30%	71590	TSV-2.5K
R191	910	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-911J
R192	24K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-243J
R193	73.2K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-7322F
R194	86.6K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-8662F
R195	97.6K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-9762F
R196	66.5K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-6652F
R197	10.0K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1002F
R198	12.4K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1242F
R199	10K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-103J
R200	2.05K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2051F
R201	1.30K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1301F
R202	6.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-622J
R203	500	R: Variable 1/4 Watt ±30%	71590	TSV-500
R204	3.32K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3321F
R205	15Meg	R: Metal Glaze 1/4 Watt ±5%	75042	GBT1/4-156J
R206	50K	R: Variable 1/4 Watt ±30%	71590	TSV-50K
R207	25.5K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2552F
R208	10.0K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1002F
R209	16.5K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1652F
R210	1K	R: Variable 2 Watt	07421	P00347678-1
R213	1Meg	R: Metal Glaze 1/4 Watt ±5%	75042	GBT1/4-105J
R214	5.1K	R: Metal Glaze 1/2 Watt ±5%	75042	RG20-512J
R215	27K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-273J
R216	1.1K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-112J
R217	8.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-822J
R218	3.9K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-392J
R219	4.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-472J
R220	8.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-822J
R222	6.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-622J
R223	6.8K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-682J
R224	10	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-100J
R225	100	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-100J
R226	560	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-561J
R227	2.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-222J
R228	50K	R: Variable 1/4 Watt ±30%	71590	TSV-50K
R229	12K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-123J
R230	130	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-131J
R233	39	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-390J
R234	10	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-100J
R235	10	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-100J
R236	7.50K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-7501F
R237	7.50K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-7501F

Table 6-2. Parts List (Continued)

REF DESIG	VALUE	DESCRIPTION	MFG CODE	PART NUMBER
R238	3.32K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3321F
R239	1.24K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1241F
R240	1.3K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1301F
R241	3.32K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3321F
R242	100	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-101J
R243	1.21K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1211F
R244	4.99K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-4991F
R245	43K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-433J
R246	7.87K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-7871F
R247	10	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-100J
R248	10K	R: Variable 2 Watts Part of S3 Assy		
R256	95.3	R: Metal Film 1/2 Watt ±1%	01295	MC60D-95R3F
R257	71.5	R: Metal Film 1/2 Watt ±1%	01295	MC60D-71R5F
R258	97.6	R: Metal Film 1/2 Watt ±1%	01295	MC60D-97R6F
R259	40.2	R: Metal Film 1/2 Watt ±1%	01295	MC60D-40R2F
R260	10.0	R: Metal Film 1/2 Watt ±1%	01295	MC60D-10R0F
R261	41.2	R: Metal Film 1/2 Watt ±1%	01295	MC60D-41R2F
R262	71.5	R: Metal Film 1/2 Watt ±1%	01295	MC60D-71R5F
R263	158	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1580F
R264	10.7	R: Metal Film 1/2 Watt ±1%	01295	MC60D-10R7F
R265	39.2	R: Metal Film 1/2 Watt ±1%	01295	MC60D-39R2F
R268	18K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-183J
R269	4.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-472J
R270	10K	R: Variable 2 Watts Part of S6 Assy		
R271	30K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-303J
R272	10K	R: Metal Glaze 1 Watt ±5%	75042	RG32-103J
R273	390	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-391J
R274	82K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-823J
R275	4.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-472J
R276	1.8K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-182J
R277	4.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-472J
R278	1K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-102J
R279	1.5K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-152J
R280	2.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-222J
R281	2.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-222J
R282	560	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-561J
R283	200	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-201J
R286	43	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-430J
R287	5K	R: Variable 2 Watts Part of S7 Assy		
R288	5K	R: Variable 1/4 Watt ±30%	71590	TSV-5K
R289	42.2K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-4222F
R290	422K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-4223F
R291	4.22Meg	R: Metal Film 1/2 Watt ±1%	01295	CD1/2MR-4224F
R292	12.1K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1212F
R293	1.33K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1331F

Table 6-2. Parts List (Continued)

REF DESIG	VALUE	DESCRIPTION	MFG CODE	PART NUMBER
R294	133K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1333F
R295	30.1K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3012F
R296	30.1K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3012F
R297	10.0K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1002F
R298	10.0K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1002F
R299	39K	R: Metal Glaze 1/2 Watt ±5%	75042	RG1/4-393J
R300	1.8Meg	R: Metal Glaze 1/4 Watt ±5%	75042	RBT1/4-185J
R301	50K	R: Variable 1/4 Watt ±30%	71590	TSV-50K
R302	1K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-102J
R303	1K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-102J
R304	1.8K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-182J
R305	51	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-510J
R306	560	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-561J
R307	1K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-102J
R308	51	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-510J
R309	100	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-101J
R310	390	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-391J
R311	1.00K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1001F
R312	1.5K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-152J
R313	1.69K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1691F
R314	6.8K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-682J
R315	1.5K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-152J
R316	2.00K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-2001F
R317	68K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-683J
R318	1Meg	R: Metal Glaze 1/4 Watt ±5%	75042	GBT1/4-105J
R319	4.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-472J
R320	4.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-472J
R321	2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-202J
R322	3.3K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-332J
R323	4.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-472J
R324	47K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-473J
R325	2.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-222J
R326	6.8K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-682J
R327	4.7K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-472J
R328	36K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-363J
R329	10K	R: Variable 1/4 Watt ±30%	71590	TSV-10K
R330	33.2K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-3322F
R331	13.3K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1332F
R332	11.0K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1102F
R333	604	R: Metal Film 1/2 Watt ±1%	01295	MC60D-6040F
R334	6.2K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-622J
R340	10K	R: Variable 2 Watts Part of S5 Assy		
R341	1.18K	R: Metal Film 1/2 Watt ±1%	01295	MC60D-1181F
R342	470	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-471J
R343	3.6K	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-362J
R344	51	R: Metal Glaze 1/4 Watt ±5%	75042	RG1/4-510J

Table 6-2. Parts List (Continued)

REF DESIG	VALUE	DESCRIPTION	MFG CODE	PART NUMBER
S1		Switch: Slide W/Ind DS1 Power	22753	LRSW322-1-28V-W
S2		Switch: Rotary Multiplier	07421	PR0347904
S3		Switch: Rotary F31, F32 Only Waveform	07421	PR0347902-1
S3		Switch: Rotary W/R248 F33, F34 Waveform	07421	PR0347902-2
S4		Switch: Pull W/R133 Offset	07421	PR0347910
S5		Switch: Pull W/R107 F31 Only Attenuator	07421	PR0347909
S5		Switch: Rotary W/R107 F32, F33, F34 Attenuator	07421	PR0347908
S6		Switch: Rotary W R270 Mode	07421	PR0347906
S7		Switch: Rotary W/R287 Sweep Time	07421	PR0347907
S8		Switch: Slide Power Selector	82389	46256LF
S9		Switch: Pushbution Manual Trigger	82389	963
T1		Transformer: Power	07421	PR0347800
VR1	5.1V	Diode: Zener 400 mw ±5%	04713	1N5231B
VR2	12V	Diode: Zener 400 mw ±5%	04713	1N5242B
VR3	6.8V	Diode: Zener 400 mw ±5%	04713	1N5235B
VR4	5.1V	Diode: Zener 400 mw ±5%	04713	1N5231B
VR5	12V	Diode: Zener 400 mw ±5%	04713	1N5242B
VR6	6.8V	Diode: Zener 400 mw ±5%	04713	1N5235B
VR7	6.8V	Diode: Zener 400 mw ±5%	04713	1N5235B
		Knob: Frequency F31, F32, F33	07421	P00333100-4
		Knob: Frequency F34	07421	P00333100-5
		Knob: Frequency Vernier	07421	PR0335022-3
		Knob: Pointer	07421	PR0335022-2
		Knob: Pointer Concentric Set	07421	PR0335022-1
		Heat Sink: Large TO-5	13103	TXBF2227C
		Heat Sink: Medium TO-5	13103	TXBF2226C
		Heat Sink: Small TO-18	13103	TXBF2224C

WAVEFORM TEST CONDITIONS: UNLESS OTHERWISE SPECIFIED.

FREQ MULT @ 10K
FREQ DIAL @ 3.0
WAVEFORM @ SINE
OFFSET @ OFF
AMPLITUDE @ 10V (IN FOR F31)
OUTPUT @ CW STOP

VOLTAGES @ TP1: +22.2 ± 3.2 VDC
TP2: -22.1 ± 3.2 VDC
TP6: +15 ± 0.1 VDC

T/C 1. +10.0 VCG INPUT WITH FREQ DIAL @ CW STOP.

T/C 2. WAVEFORM @ VAR PULSE, VAR PULSE CENTERED.

T/C 3. MODE @ TRIG; TRIG LEVEL -CENTERED; TRIG/SYNC INPUT 2V PP; SINE @ 10KHZ. SYNC SCOPE TO EXTERNAL INPUT.

T/C 4. MODE @ GATE; TRIG LEVEL -CENTERED; TRIG/SYNC INPUT 2V PP; SINE @ 10KHZ.

T/C 5. MODE @ CONT SWP; WAVEFORM @ SWP; SWP TIME @ 1MS; SWP VERNIER @ CAL.

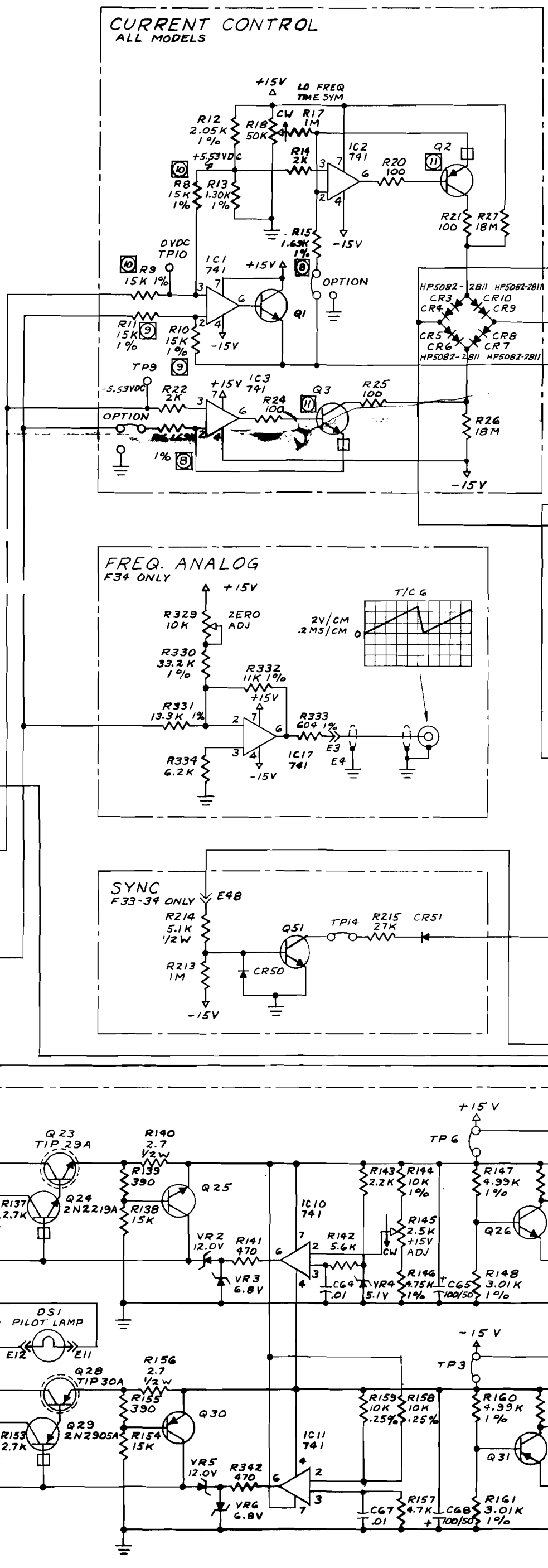
T/C 6. MODE @ CONT SWP; WAVEFORM @ SINE; SWPTIME @ 1 MS; SWP VERNIER @ CAL., SWP LIMIT @ MAX.

NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL PNP TRANSISTORS ARE P00347102 (2N3906).
2. ALL NPN TRANSISTORS ARE P00347001 (2N3904).
3. ALL RESISTORS ARE ± 5%, 1/4 W.
4. ALL 1% RESISTORS ARE 1/2 W.
5. ALL DIODES ARE IN914A.
6. ALL CAPACITORS IN DECIMALS (0.01) ARE IN µf.
7. ALL CAPACITORS NOT IN DECIMALS ARE IN pf.
8. INDICATED RESISTORS ARE MATCHED TO WITHIN 4Ω.
9. INDICATED RESISTORS ARE MATCHED TO WITHIN 30Ω.
10. INDICATED RESISTORS ARE MATCHED TO WITHIN 30Ω.
11. INDICATED TRANSISTORS MATCHED PER P00347099.
12. INDICATED COMPONENTS ARE SELECTED IN TEST.

REF DESIG	APPROX VALUE
C6	0
C10	47
C35	10
C125	0
C131	200
R221	113K

14. RESISTORS NOTED IN 8, 9 & 10 ARE MATCHED PER P00347616.
13. INDICATED CAPACITORS MATCHED PER P00347750.
16. INDICATED CAPACITORS MATCHED PER P00347751.
17. INDICATED DIODES MATCHED PER P00347301.



START STOP
F33 & 34 ONLY

T/C 3 2V/CM 10µS/CM

(FROM LOGIC SECTION, R283)

CR53 TP30 CR56 CR54 CR55

Q53 Q54 Q55

+15V -15V -5V

R220 8.2K C102 15 R222 6.2K R223 6.8K R221 R224 10 R225 10 R226 560 R227 2.2K CR57 TP12 R228 50K BASE LINE ADJ CW R230 130 R229 12K C103 47 CR58

T/C 3 2V/CM 10µS/CM

CURRENT CONTROL
ALL MODELS

+15V LO FREQ TIME SYM R12 2.05K 1% R18 50K CW R17 1M R14 2K IC2 741 R20 100 Q2 R8 15K 1% R13 1.30K 1% +5.53VDC R15 1.69K 1% -15V R21 100 R27 18M

0VDC TP10 R9 15K 1% IC1 741 +15V OPTION Q1 R11 15K 1% R10 15K 1% -15V

HP5082-2811 CR3 CR4 CR10 CR9 CR5 CR6 CR8 CR7 HP5082-2811

TP9 -5.53VDC R22 2K IC3 741 +15V R24 100 Q3 R25 100 OPTION R16 1.69K 1% R26 18M -15V

INTEGRATOR
ALL MODELS

T/C 3 1V/CM 10µS/CM TP11 1V/CM 5µS/CM TP17

MULTIPLIER S2 CW

X10 X100 X1K X10K X100K X1M C1 C2 C3 C4 C5 C6 C8 2-24 C9 2-24 C10 47 C14 18 R28 100

X100K FREQ ADJ X1M FREQ ADJ

FOLLOW AMP
ALL MODELS

+15V Q4 P00347205 ZERO ADJ R29 2.5K CW C18 .01 C15 .01 R30 390 C16 3.3 IC4A RCA 3046 IC4B R32 4.7K C19 12 R31 200 C17 .01 R35 3.3K Q21 IC4E R33 2.2K R34 3.3K R36 1.1K -15V

FREQ. ANALOG
F34 ONLY

+15V R329 10K ZERO ADJ R330 33.2K 1% R331 13.3K 1% R332 11K 1% +15V R333 604 1% R334 6.2K IC17 741 -15V E3 E4

T/C 6 2V/CM .2 MS/CM

VOLTAGE LEVEL SENSOR
ALL MODELS

T/C 0 2V/CM 5µS/CM SYNC OUT E6 E5 R344 51 R44 68 R43 220 TP13

+15V R48 390 C22 3 Pf C24 .01 IC5 710 R46 1.50K 1% C21 68 R47 3.01K 1% C23 .1 R49 100 -5V +15V R52 6.19K 1% CR11 CR12 CR13 CR14 R50 976 R51 100 TRIANGLE AMPLITUDE HF ADJ C25 2-24 C26 36 R53 5.76K 1% R54 1K TRIANGLE AMPLITUDE SYMMETRY R56 1.82K 1% -15V

C27 36 R55 2370 1%

+15V R57 1.3K 1/2W +5V CR15 C30 .1 C31 .1 CR18 CR19 CR20 CR21 C35 5 CR16 -5V CR23 R62 3570 1% R63 500 R67 R66 1.37K 1% R61 3740 1% R64 7.5K 1% CR22 R68 200 1/2W R65 7.5K 1% R69 200 1/2W Q5 Q6 Q9 Q10 SQ AMPL SYMMETRY R60 3.01K 1% CR17 R58 301 1% R59 2.32K 1% -15V

SYNC
F33-34 ONLY

E48 R214 5.1K 1/2W Q51 TP14 R215 27K CR51 R213 1M CR50 -15V

VARIABLE PULSE
F33 & 34 ONLY

T/C 2 1V/CM 5µS/CM

+15V +5V R233 39 Q57 R234 10 R236 7.5K 1% R238 3320 1% CR61 Q58 R235 10 CR62 R237 7.5K 1% R239 1180 1% R242 100 C106 20 R241 3.32K 1% R240 1.3K 1% Q59 Q60 R246 7.87K CW 1% -5V C105 0.01 R243 1210 1% C117 3.3 R245 43K -15V

+15V R140 2.7 1/2W R139 390 Q25 R138 15K VR2 12.0V R141 470 VR3 6.8V IC10 741 R142 5.6K R143 2.2K R144 10K 1% R145 2.5K +15V ADJ CW R146 4.75K 1% R147 4.99K 1% R149 10K Q26 Q27 2N2905A R150 220 R151 100 1W R152 4.70 TP5 +5V C64 .01 VR4 5.1V C65 100/50 R148 3.01K 1% C66 100/15 C70 .1 C13 .1

-15V R156 2.7 1/2W R155 390 Q30 R154 15K VR5 12.0V R342 470 VR6 6.8V IC11 741 R159 10K .25% R158 10K .25% R160 4.99K 1% R162 10K Q31 Q32 2N2219A R163 220 R164 100 1W R165 220 TP3 TP4 -5V C67 .01 R157 4.7K C68 100/50 R161 3.01K 1% C69 100/15 C71 .1 C12 .1

OUTPUT LIMIT
F32-34 ONLY

+15V
IC18 741
CR48
CR49
R197 10K 1%
Q48
Q49
R196 66.5K 1%
R194 86.6K 1%
R193 73.2K 1%
R195 97.6K 1%
R198 12.4K 1%
R199 10K
R45 750K
E12
DS2
E13
OUTPUT LIMIT
E10
R192 2K
R191 68
E30
R340 1K
E9
E68
CW
-15V
- RAW DC

OUTPUT AMPLIF
ALL MODELS

OFFSET
ALL MODELS

+15V
R341 1.18K 1%
R133 10K
CW
-15V
ON
S4
OFFSET
E26 OFF
E71
R134 3.3K 1%
C72 .1

IC9 RCA CA3018A
R109 2K 1%
R343 3.6K
R113 31.6 1%
R108 2K 1%
R132 6.98K 1%
R166 1K GAIN
R112 68K
C58 SQ WAVE 2-16 RESPONSE

WAVEFORM SWITCH S3
ALL MODELS

E28
LEVEL
R107 1K
CW
E25
E29
R106 68
1A
1B
2
3
1
E57
E58
R105 680
DC
SWP

FOLLOW AMP
ALL MODELS

+15V
Q4 P00347205
ZERO ADJ
R29 2.5K
CW
C15 .01
R30 390
C16 3.3
C18 .01
R32 4.7K
IC4A RCA 3046
IC4B
IC4C
IC4D
IC4E
+5V
R39 620
R40 680
-15V
R37 51
TP19
SAME WAVEFORM AS TP17
C19 12
R31 200
C17 .01
TP31
R35 3.3K
Q21
R33 2.2K
R34 3.3K
R36 1.1K
R42 1.3K 1/2W
R41 OPT
E70
R38 51
E50
E49

+15V
R68 200 1/2W
R57 1.3K 1/2W
+5V
CR15
C30 .1
R61 3740 1%
R64 7.5K 1%
CR22
Q7
1V/CM 5μS/CM
TP16
R70 10
R72 39
E45
E46
C31 .1
CR18
CR19
C35 5
CR20
CR21
CR23
R67
R66 137K 1%
CR16
-5V
R62 3570 1%
R63 500
R65 7.5K 1%
R71 10
Q8
SQ AMPL SYMMETRY
Q10
R69 200 1/2W
R60 3.01K 1%
CR17
R58 301 1%
R59 2.32K 1%
-15V

SINE SHAPER
ALL MODELS

E51
R75
R84 51
GAIN R81 1K
+15V
R78 1.62K 1%
R77 500 DIST ADJ
CW
R76 13K 1%
R79 20K
R80 47
-15V
Q11
Q15
C43 2-24 SINE FLATNESS
R82 3.09K 1%
C42 3.3P
R83 3.09K 1%
R94 1.2K
R91 2K 1%
SUBST
VR1 5.1V
TP23
IC6 RCA3046
R92 2.49K 1%
R95 150K
R93 47K
R85 1.2K 1/2W
R96 50K ZERO ADJ
L1 62μh
1V/CM 5μS/CM
C44 510
CR27
CR28
R97 10K
C45 .1
C46 .1
R98 ZERO SLOPE 1K ADJ
Q13
Q14
L2 2.7μH
R74 P00347404
150
71.5
237
453
681
1.40K
R100 P00347401
IC7 RCA3039
IC8 RCA3039
R101 P00347401
22.6
15.8
21
30.1
51.1
- DIST ADJ R99 100
+ DIST ADJ R102 100
1.21K
R104 10K
R103 4.7K
CR29
CR30
C48 .01
+15V
-15V

BLE PULSE
4 ONLY

+5V
+15V
R233 39
Q57
R234 10
R236 7.5K 1%
R238 3320 1%
CR61
CR62
Q58
R235 10
R239 1180 1%
R237 7.5K 1%
R242 100
R244 4.99K 1%
C106 20
R241 3.32K 1%
-5V
R247 10
R240 1.3K 1%
Q59
Q60
R246 7.87K CW 1%
R248 10K
VAR PULSE
C105 0.01
R243 1210 1%
C117 3.3
R245 43K
-15V

IT AMPLIFIER

+RAW DC
E66

R109 2K 1%
R110 2K 1%
C52 .1
Q17 P00397104
R120 243 1/2W, 1%
R121 22
R122 22
C55 130
Q18 2N3251A
R124 62 2W
C56 .1

R111 33
C53 200

MBA

SUB-STRATE

ZERO ADJ
R118 150K
+15V
CW
R119 50K
-15V
R117 1.8K

Q19 P00347006

CR31 IN645
CR32 IN645
C59 .01

R125 7.5 1/2W
R126 7.5 1/2W

TP22
R128 24.9 1%, 1W
R129 24.9 1%, 1W

5V/CM
5μS/CM

T/C 5
2V/CM
.2MS/CM

Q33 2N2219A
R135 3.9K
C57 .1
Q20 2N2905

R112 68K
R113 31.6 1%
R114 3.32K 1%
R115 31.6 1%
R116 68K
R123 511 1%
VR7 6.8V
C54 .1
R127 62 2W

C58 SQ WAVE 2-16 RESPONSE

EG4
-RAW DC

SWEEP
F34 ONLY

SWEEP TIME
S7-2
C124 820
C123
C122
C121

R286 43
R289 42.2K 1%
R287 5K 10%
E22
E21
E19
S7-1 10μS
E15 TP26
100μS
1MS
10MS
100MS
1S
R293 1.33K 1%
SWEEP TIME VERNIER
CW
CR74
CR73
R290 422K 1%
E18
E20
R291 4.22M 1% 1/2W
R292 12.1K 1%
R294 133K 1%
E17
CR72 FD333
R288 5K
CW
SWEEP TIME CAL.

C116 3.3

C125
+5V
Q65
R321 2K
R22 3.3K
C126 20
Q64 P00
R323 4.7K
R320 4.7K
CR75
-5V
SWP LIMIT
E38
R210 1K
E36
CW
R190 2.5K SWP LIMIT CAL
R204 3.32K 1%
E37
R324 47K
Q66
-15V

ATTENUATOR
F32-34 ONLY

ATTEN
S5 (B)
E23
S5-1
R257 71.5 1%
R256 95.3 1%, 1/2W
R258 97.6 1%
R259 40.2 1%, 1/2W
R260 10 1%
R261 41.2 1%
R263 158 1%
R265 39.2 1%
R262 71.5 1%, 1/2W
R264 10.7 1%
0db
S5-3B
50Ω OUTPUT
-10 db
-20 db
-30 db
-40 db
S5-3A

LOGIC
F33-34 ONLY

TRIGGER SYNC
E48
3B
CONT 4B
4A
TRIG
GATE
BURST
CONT SWP
TRIG SWP
T/C 3 & 4
2V/CM
10MS/CM
1V/CM
10μS/CM
CR65
TRIG LEVEL
+15V
R273 390
R270 10K
R271 30K
R272 10K 1W
CR63
CR64
C110 .01
IC13 HA710
R275 4.7K
C112 150
-5V
CR71
MAN TRIG

1V/CM
5μS/CM

+15V
R86 47
R87 20K
R88 13K 1%
Q12
Q16
CW
R89 500 + DIST ADJ
R90 1.62K 1%
VR1 5.1V
TP23
R96 50K ZERO ADJ
R85 1.2K 1/2W
C45 .1
C46 .1

ATTENUATOR
F31 ONLY

ATTEN
S5(A)
E23
50Ω OUTPUT
R130 464 1% 1/2W
R131 51.1 1%
E27

SWEEP
F34 ONLY

SWEEP TIME
S7-2
C124 820
C123
C122
C121
16
E16
R306 560
73
SWP MON
74
+15V
R286 43
E22
R289 42.2K 1%
R287 5K 10%
CW
SWEEP TIME VERNIER
E21
E19
S7-1
10µS
100µS
1MS
10MS
100MS
1S
R293 1.33K 1%
E15
TP26
Q61 P00347201
R299 39K
R300 1.8M
CW
R301 50K 100:1 ADJ
C116 3.3
R297 10K 1%
R298 10K 1%
R295 30.1K 1%
R296 30.1K 1%
R302 1K
C119 47
IC15 CA3030
R303 1K
C118 47
R304 1.8K
C120 500
R309 100
TP27
R305 51
T/C 5
1V/CM .2MS/CM
2V/CM .2MS/CM
5V/CM .2MS/CM
E20
R290 422K 1%
CR74
CR73
E18
R291 4.22M 1% 1/2W
R292 12.1K 1%
R294 133K 1%
CR72 FD333
E17
R288 5K
CW
SWEEP TIME CAL.
C125
12
R325 2.2K
TP28
R310 390
R316 2K 1%
R319 4.7K
TP29
+5V
E42
Q65
Q64 P00347000
CR76 IN4448
R307 1K
IC16 UA710
Q62 2N5187
C130 10
R317 68K
C132 10
Q63
R321 2K
R22 3.3K
C126 20
R323 4.7K
R326 6.8K
R313 1690 1%
C129 .01
-5V
R315 1.5K
R320 4.7K
CR75
SWP LIMIT
E38
R210 1K
CW
E36
R204 3.32K 1%
R190 2.5K SWP LIMIT CAL
CW
E37
Q66
R324 47K
R328 36K
R327 4.7K
C127 75
R308 51
C131 180
R312 1.5K
R311 1K 1%
C128 .1
R314 6.8K
R318 1M
-15V

LOGIC
F33-34 ONLY

TRIGGER SYNC
E48
3B
CONT
4B
TRIG
GATE
BURST
CONT SWP
TRIG SWP
4A
2A
E53
C114 1000
MODE
SG
3A
E67
E43
CR67
E55
START STOP SECTION
CR53
CR69
CR68
1B
E54
2B
E56
1A
R282 5K
R283 200
C115 270
R280 2.2K
CR66
-5V
T/C 4
2V/CM 10µS/CM
T/C 3 & 4
2V/CM 10µS/CM
1V/CM 10µS/CM
C113 100
CR65
R278 1K
+5V
+15V
R273 390
R277 4.7K
TP24
TRIG LEVEL
+15V
R270 10K
R271 30K
-15V
R272 10K 1W
C111 .1
IC13 UA710
CR63
CR64
C110 .01
R279 1.5K
IC14 SN7400N
R281 2.2K
TP25
R275 4.7K
C112 150
R274 82K
R276 1.8K
-5V
R269 4.7K
CR71
CR70
R268 18K
T/C 3
2V/CM 10µS/CM
MAN TRIG
S9

SERIES 30 FUNCTION GENERATORS

Detailed Schematic

INTERSTATE ELECTRONICS CORPORATION
A Subsidiary Of A-T-O Inc.
707 E. VERMONT AVE., P.O. BOX 3117, ANAHEIM, CALIFORNIA 92803 (714) 772-2811
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