TEKTRONIX®

FUNCTION GENERATOR

FG 501

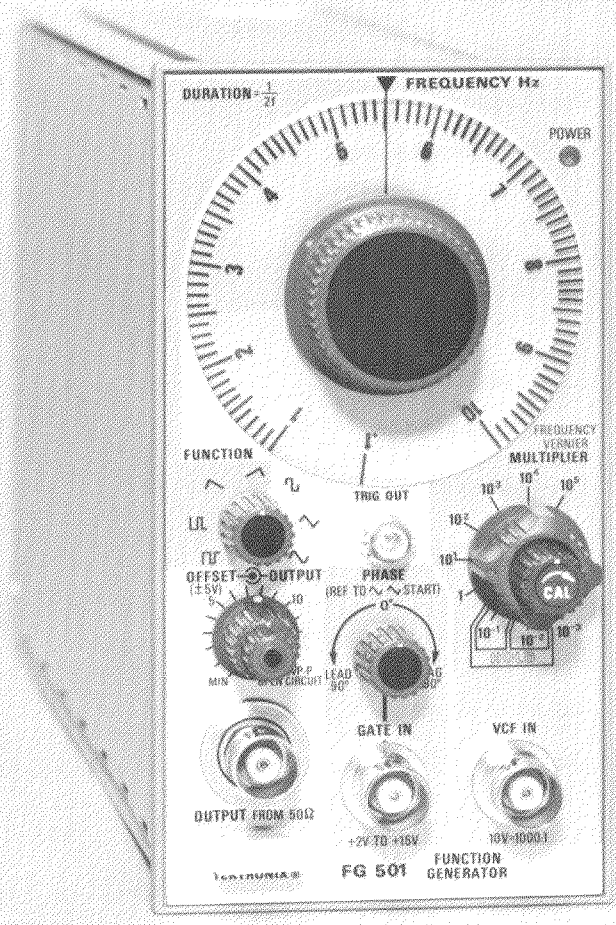
INSTRUCTION MANUAL

Tektronix, Inc. ● P.O. Box 500 ● Beaverton, Oregon 97005 ● Phone: 644-0161 ● Cables: Tektronix

070-1431-00

872

TABLE OF CONTENTS


DURATION ÷ 1/21
FREQUENCY Hz
POWER
FREQUENCY VERNIER
MULTIPLIER
FUNCTION
TRIG OUT
OFFSET
OUTPUT
PHASE
(REF TO START)
CAL
GATE IN
VCF IN
OUTPUT FROM 50Ω
+2V TO +15V
10V-1000:1
FG 501
FUNCTION GENERATOR

SECTION 1 OPERATING INSTRUCTIONS

INSTRUMENT DESCRIPTION

The FG 501 Function Generator is designed to operate in a TM 500 Series Power Module. Low distortion sine, square, triangle, pulse and ramp waveforms from 0.001 Hz to 1 MHz as well as a +2.5 V square-wave trigger are available at the front panel. Variable DC offset of ±5 V is also provided. A "hold" feature allows the generator output to be abruptly halted at its instantaneous voltage level and held there until manually switched on again.

A voltage-controlled frequency (VCF) input is provided to control the output frequency from an external voltage source. The output frequency can be swept above or below the selected frequency to a maximum of 1000:1 depending on the polarity and amplitude of the VCF input and the selected output frequency.

Also included is an external gate input which allows the generator to be turned on for the duration of an externally applied gating signal. This mode provides either a single cycle output or a train (burst) of preselected waveforms depending on the gating signal width and the generator frequency setting. The phase (start level) of the waveform burst can be varied ±90° by a front-panel control.

The variety of swept and modulated signals available from the FG 501 make it especially useful for such applications as testing servo-system or amplifier response, distortion and stability; FM generation and frequency multiplication, or simply used as a variable beat-frequency oscillator, repetition-rate or tone-burst generator. The square-wave trigger output can be used as a source for TTL logic or to synchronize an external device such as an oscilloscope or counter.

PREPARATION FOR USE

Introduction

The FG 501 is calibrated and ready for use when received. It is designed to operate in any compartment of a TM 500 Series Power Module only. Refer to the Power Module Instruction Manual for line voltage requirements and Power Module operation.

Installation and Removal

CAUTION

Turn the Power Module off before inserting the plug-in; otherwise, damage may occur to the plug-in circuitry.

1. Install the FG 501 in the Power Module by aligning the upper and lower rails of the FG 501 with the Power Module tracks. Insert gently until the FG 501 front panel is flush with the Power Module front panel.

2. Remove the FG 501 from the Power Module by pulling the release latch at the bottom of the front panel and sliding the unit straight out of the Power Module.

Turn-On Procedure

1. Check that the FG 501 is fully inserted into the Power Module.

2. Pull the PWR switch on the front panel of the Power Module to apply power to the FG 501. Observe that the POWER indicator light on the FG 501 comes on.

OPERATING CONSIDERATIONS

NOTE

Before using the FG 501 for the first time, read the Operating Considerations in this section and the description of the front-panel controls, connectors, and indicators on the Controls and Adjustments foldout page at the back of this manual.

Output Connections

The output of the FG 501 is designed to operate as a voltage source in series with 50 Ω and working into a 50 Ω load. At the higher frequencies an unterminated or improperly terminated output will cause excessive aberrations on the output waveform (see Impedance Matching discussion). Loads less than 50 Ω will reduce the waveform amplitude.

Excessive distortion or aberrations due to improper termination is less likely to occur at the lower frequencies (especially with sine and triangle waveforms). However, to insure that waveform purity is preserved, observe the following precautions:

1. Use quality 50 Ω coaxial cables and connectors.

2. Make all connections tight and as short as possible.

3. Use quality attenuators, if necessary, to reduce waveform amplitude to sensitive circuits.

4. Use terminators or impedance—matching devices to avoid reflections when using long cables, i.e., 6 feet or more.

5. Insure that attenuators, terminations, etc. have adequate power handling capabilities for the output waveform (approximately 0.5 W into a 50 Ω load).

Power output is determined by the selected waveform, its amplitude, and the amount of offset voltage selected.

The physical and electrical characteristics of the pulse transmitting cable determine the characteristic impedance, velocity of propagation, and amount of signal loss. Signal loss, due to energy dissipation in the cable dielectric, is proportional to the frequency; therefore, a few feet of cable can attenuate high frequency information in a fast-rise pulse. It is important therefore, to keep these cables as short as possible.

When signal comparison measurements or time difference determinations are made, the two signals from the test device should travel through coaxial cables with identical loss and time delay characteristics.

If there is a DC voltage across the output load, the output pulse amplitude will be compressed, or in some cases; if the voltage exceeds ±10 V, it may short the output. To prevent this from occurring, the output must be coupled through a DC blocking capacitor to the load. The time constant of the coupling capacitor and load must be long enough to maintain pulse flatness.

Risetime and Falltime

If the output pulse from the FG 501 is used for measuring the rise or falltime of a device, the risetime characteristics of associated equipment may have to be considered. If the risetime of the device under test is at least 10 times greater than the combined risetimes of the FG 501 plus the monitoring oscilloscope and associated cables, the error introduced will not exceed 1% and generally can be ignored. If the rise or falltime of the test device, however, is less than 10 times as long as the combined risetimes of the testing system, the actual risetime of the device will have to be determined from the risetime of each component making up the system. This equals the square root of the sum of the squares of the individual risetimes. Conversely, the risetime of the device under test can be found from the same relationship if the actual risetimes in the system are known except that of the device under test.

Impedance Matching

Reflections As a pulse travels down a transmission line, each time it encounters a mismatch, or different impedance than the transmission line, a reflection is generated and sent back along the line to the source. The amplitude and polarity of the reflections are determined by the amount of the encountered impedance in relation to the characteristic impedance of the cable. If the mismatch impedance is higher than the line, the reflection will be of the same polarity as the applied signal, if it is lower, the reflection will be of opposite polarity. If the reflected signal returns before the pulse is ended it adds to or subtracts from the amplitude of the pulse. This distorts the pulse shape and amplitude.

Matching Networks. The following describes methods for matching impedance networks into relatively low impedances. If the FG 501 is driving a high impedance, such as the 1 MΩ input impedance of the vertical input for an oscilloscope, the transmission line must be terminated into a 50 Ω attenuator and 50 Ω termination at the oscilloscope input. The attenuator isolates the input capacity of the device. Distortion can be caused by this input capacity.

A simple resistive impedance-matching network, that provides minimum attenuation, is illustrated in Fig. 1-1. To match impedance with the illustrated network, the following conditions must exist:

$$\frac{(R_1 + Z_2)R_2}{R_1 + Z_2 + R_2} \text{ must equal } Z_1$$

and

$$R_1 + \frac{Z_1 R_2}{Z_1 + R_2} \text{ must equal } Z_2$$

Therefore:

$$R_1 R_2 = Z_1 Z_2; \text{ and } R_1 Z_1 = R_2(Z_2 - Z_1)$$

$$\text{or } R_1 = \sqrt{Z_2(Z_2 - Z_1)}$$

$$\text{and } R_2 = Z_1\sqrt{\frac{Z_2}{Z_2 - Z_1}}$$

For example; to match a 50 Ω system to a 125 Ω system, Z_1 equals 50 Ω and Z_2 equals 125 Ω.

Therefore:

$$R_1 = \sqrt{125(125 - 50)} = 96.8 \text{ ohms}$$

$$\text{and } R_2 = 50\sqrt{\frac{125}{125 - 50}} = 64.6 \text{ ohms}$$

When constructing such a device, the environment surrounding the components should also be designed to provide a transition between the impedances. Keep in mind that the characteristic impedance of a coaxial device is determined by the ratio between the outside diameter of the inner conductor to the inside diameter of the outer conductor. $z_o = 138/\sqrt{\epsilon}\ \log_{10} D/d$, where D is the inside diameter of the outer conductor, and d is the outside diameter of the inner conductor. ϵ is the dielectric constant (1 in air).

Attenuation Ratios. Though the network in Fig. 1-1 provides minimum attenuation for a purely resistive impedance-matching device, the attenuation as seen from one end does not equal that seen from the other end. A signal (E_1) applied from the lower impedance source encounters a voltage attenuation (A_1) which is greater than 1 and less than 2, as follows:

$$A_1 = \frac{E_1}{E_2} = \frac{R_1}{Z_2} + 1$$

A signal (E_2) applied from the higher impedance source (Z_2) encounters a greater voltage attenuation (A_2) which is greater than 1 and less than $2(Z_2/Z_1)$:

$$A_2 = \frac{E_2}{E_1} = \frac{R_1}{R_2} + \frac{R_1}{Z_1} + 1$$

In the example of matching 50 Ω to 125 Ω,

$$A_1 = \frac{96.8}{125} + 1 = 1.77$$

and

$$A_2 = \frac{96.8}{64.6} + \frac{96.8}{50} + 1 = 4.44$$

The illustrated network can be modified to provide different attenuation ratios by adding another resistor (less than R_1) between Z_1 and the junction of R_1 and R_2.

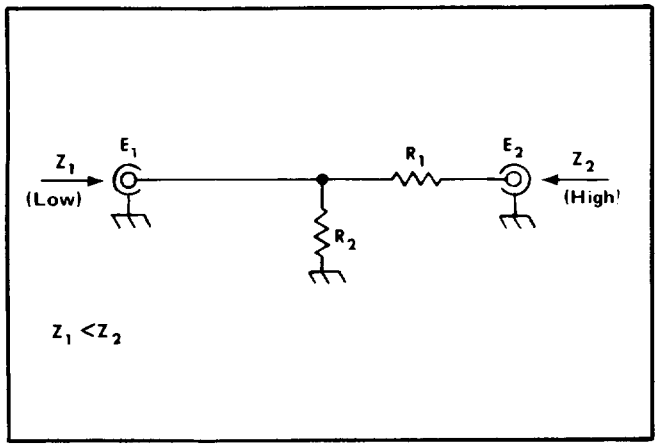


Fig. 1-1. Impedance matching network that provides minimum attenuation.

Duration of Ramps and Pulses

The duration of ramp and pulse waveforms is always equal to the half-cycle time of the sine, square, or triangle waveform frequency. For MULTIPLIER settings of 1 or greater, the retrace/off time is such that the waveform has a duty cycle of approximately 80%, i.e., frequency equals approximately 1.6X FREQUENCY Hz dial setting. For MULTIPLIER settings less than 1, the retrace/off time is from 10 ms to 100 ms which results in duty cycles approaching 100%, i.e., frequency equals approximately 2X FREQUENCY Hz dial setting.

OPERATION

Free-Running Output

The following procedure provides a free-running waveform output with variable frequency and amplitude.

1. Set the OUTPUT control to the fully ccw position and the OFFSET control to the 0 (centered) position. Check that the PHASE control is pushed in (off).

2. Set the FUNCTION selector to the desired waveform (see Fig. 1-2).

3. Select the desired frequency with the MULTIPLIER selector and FREQUENCY Hz dial. For example, if the MULTIPLIER selector is set to the 10^5 position and the FREQUENCY Hz dial is at 5, output frequency is 500 kHz, i. e., MULTIPLIER setting X FREQUENCY Hz setting. The output frequency is calibrated when the FREQUENCY VERNIER control is in the fully cw position. The duration of ramp and pulse waveforms is dependent on the MULTIPLIER setting. See Duration of Ramps and Pulses under Operating Considerations for further information.

4. Connect the load to the OUTPUT connector and adjust the OUTPUT control for the desired output amplitude.

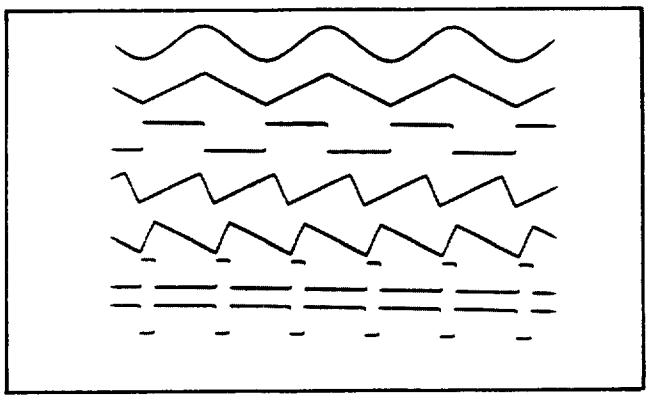


Fig. 1-2. Output waveforms available from the FG 501.

Variable DC Offset

Adjust the OFFSET control to position the DC level (baseline) of the output waveform ± 5 V about ground. For example, +5 V of offset will increase the DC + peak AC

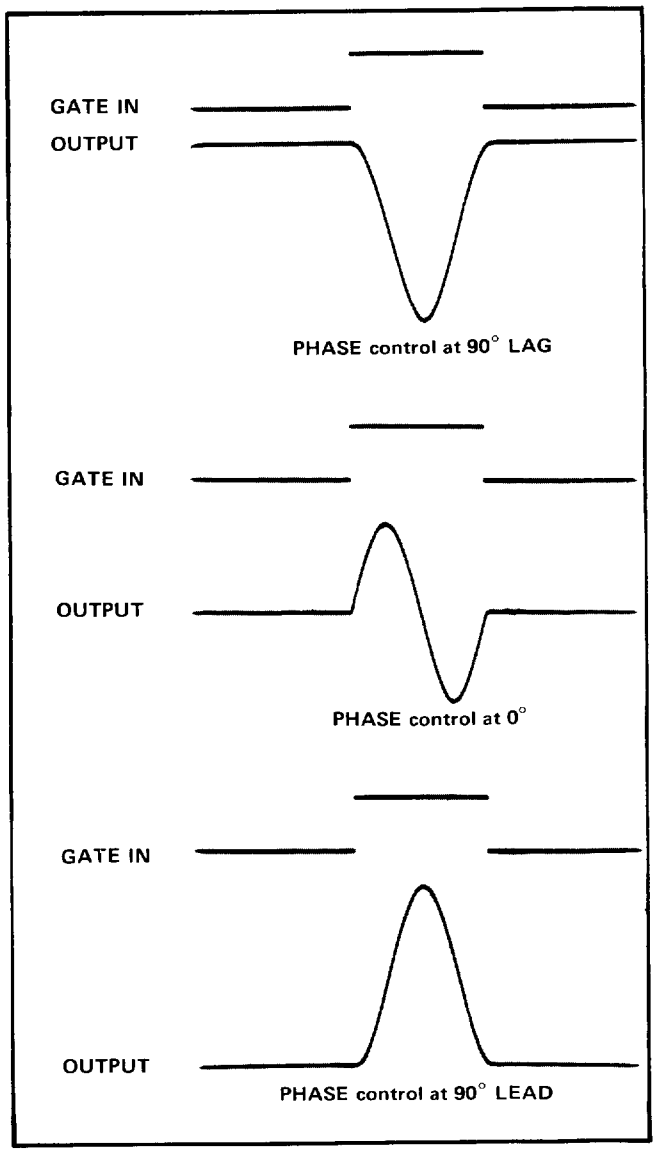


Fig. 1-3. Single cycle output with variable phase

voltage of a 7.5 V P-P output to 12.5 V DC + peak AC while −5 V of offset will reduce the DC + peak AC output to 2.5 V.

Gated (Burst) Output and Variable Phase

A gating signal of at least 2 to 15 V amplitude applied to the GATE IN connector with the PHASE control pulled out will provide a burst of cycles at the OUTPUT connector. The duration of the burst and number of cycles in the burst depends on the gating signal duration and the output frequency selected. When the gating signal goes to the zero level, the generator completes its last cycle and remains quiescent until the next gating signal.

Single cycles can be obtained by applying a gating signal with a period approximately equal to the period of the FG 501 output waveform. The number of cycles per burst can be approximated by dividing the gating signal duration by the period of the FG 502 output frequency.

The phase (start level) of the waveform burst can be varied ±90° by pulling out and turning the PHASE control either ccw or cw from the 0 (centered) position (see Fig. 1-3). The phase of the output burst is referenced to the sine or triangle waveform 0° start point.

Output frequency can be varied during the burst duration by applying a voltage controlled frequency (VCF) signal to the VCF IN connector.

Voltage–Controlled Frequency (VCF) Output

The output frequency of any selected waveform can be swept within a range of 1000:1 by applying a 0 to 10 V signal to the VCF IN connector. The polarity of the VCF input signal determines which direction the output frequency sweeps from the frequency set by the MULTIPLIER selector and FREQUENCY Hz dial, i. e., a + signal sweeps the frequency upward as shown in Fig. 1-4(A), a − signal sweeps the frequency downward as shown in Fig. 1-4(B).

The maximum swept frequency range of 1000:1 encompasses the sensitive uncalibrated range of the FREQUENCY Hz dial, i. e., < .1 to 1. Therefore, to insure that the frequency does sweep at least a range of 1000:1, it is recommended that the FREQUENCY Hz dial be set at 10 and a 0 to −10 V signal be applied to the VCF IN connector. The output will thus sweep downward at least 1000:1 from a FREQUENCY Hz dial setting of 10 as shown in Fig. 1-4(B). It may be necessary to vary the CAL control to obtain the full 1000:1 swept range or the lowest swept frequency desired.

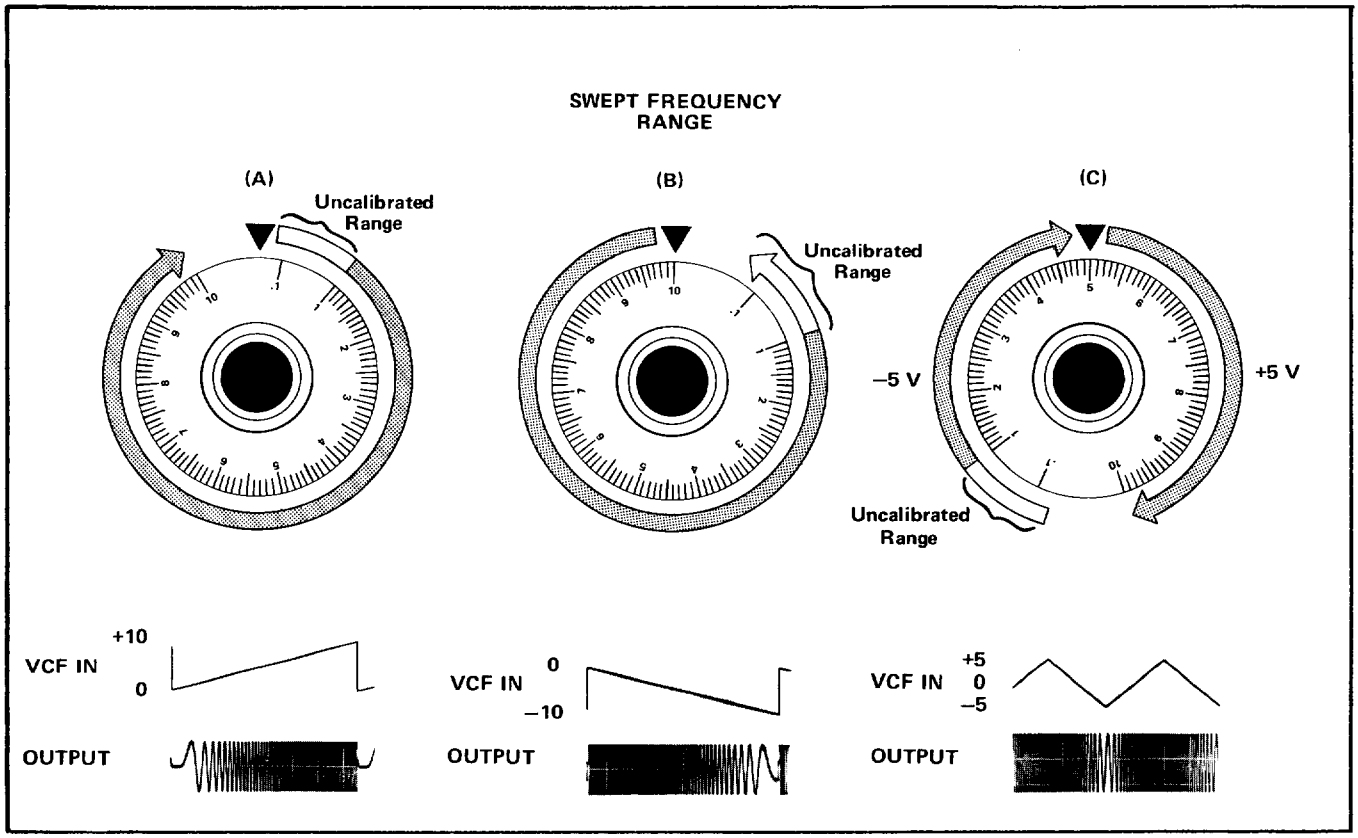


Fig. 1-4. Swept Frequency range with 10 V signals applied to VCF IN connector.

An input signal that varies symmetrically about a 0 V level will also sweep the generator symmetrically about the center frequency set by the MULTIPLIER selector and FREQUENCY Hz dial as shown in Fig. 1-4(C).

Since the VCF input amplitude vs frequency is a linear relationship, the frequency output range can be determined from the VCF input amplitude.

Hold Mode

Three detented HOLD positions are provided between the lowest three MULTIPLIER selector positions. By switching to any one of the HOLD positions, the generator can be stopped at its instantaneous voltage level and held there until the MULTIPLIER selector setting is changed.

Trigger Output

A TTL-compatible +2.5 V square wave is available from the TRIG OUT connector. The frequency of the trigger output is determined by the output frequency selected by the MULTIPLIER selector and FREQUENCY Hz dial.

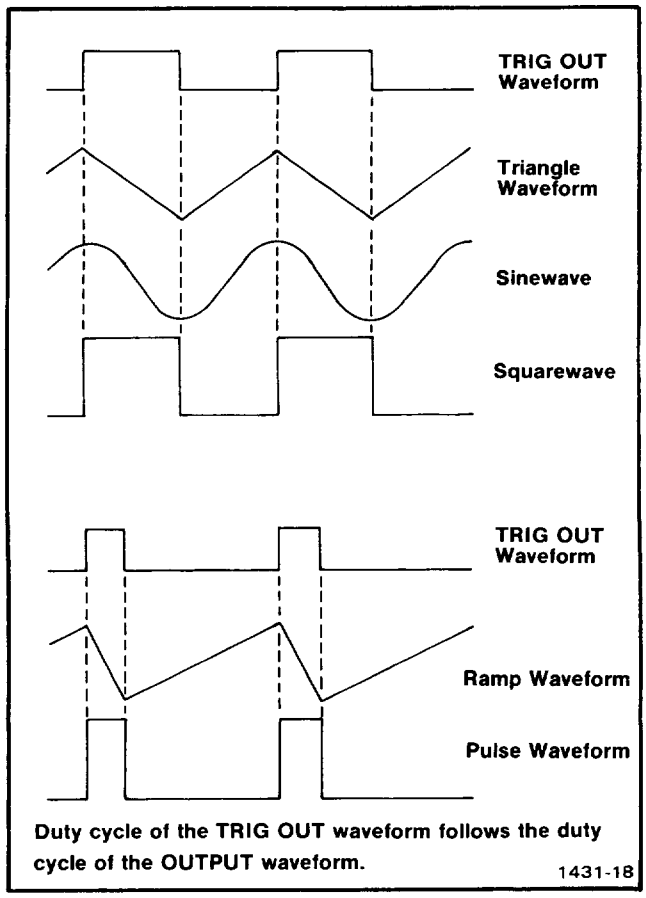


Fig. 1-5. Phase relationships between various OUTPUT waveforms and the TRIG OUT waveform.

APPLICATIONS

Response Analysis

The FG 501 is particularly suited for determining response characteristics of circuits or systems. This application utilizes the VCF input of the FG 501 to sweep the generator over a range of frequencies. By applying the desired waveform from another FG 501 Waveform Generator, or equivalent, to a device under test and sweeping the waveform frequency over a selected range, various response characteristics can be observed on a monitoring oscilloscope.

The following procedure describes a technique for determining response characteristics of any frequency sensitive device that operates within the frequency range of the FG 501. Refer to the Voltage-Controlled Frequency (VCF) Output discussion under Operation for additional information.

1. Connect the equipment as shown in Fig. 1-6.

2. Set the MULTIPLIER selector and FREQUENCY Hz dial for the desired upper or lower frequency limit (depending on the direction you wish to sweep).

3. Apply the desired waveform to the VCF IN connector. (A positive-going waveform will sweep the frequency upwards from the FREQUENCY Hz dial setting while a negative-going waveform will sweep downwards.)

4. Adjust the amplitude of the VCF input waveform for the desired output frequency range.

5. Observe the response characteristics on the monitoring oscilloscope.

The frequency at which a displayed response characteristic occurs can be determined by first removing the VCF input waveform, then manually adjusting the FREQUENCY Hz dial to again obtain the particular characteristic observed in the swept display and reading that frequency on the FREQUENCY Hz dial.

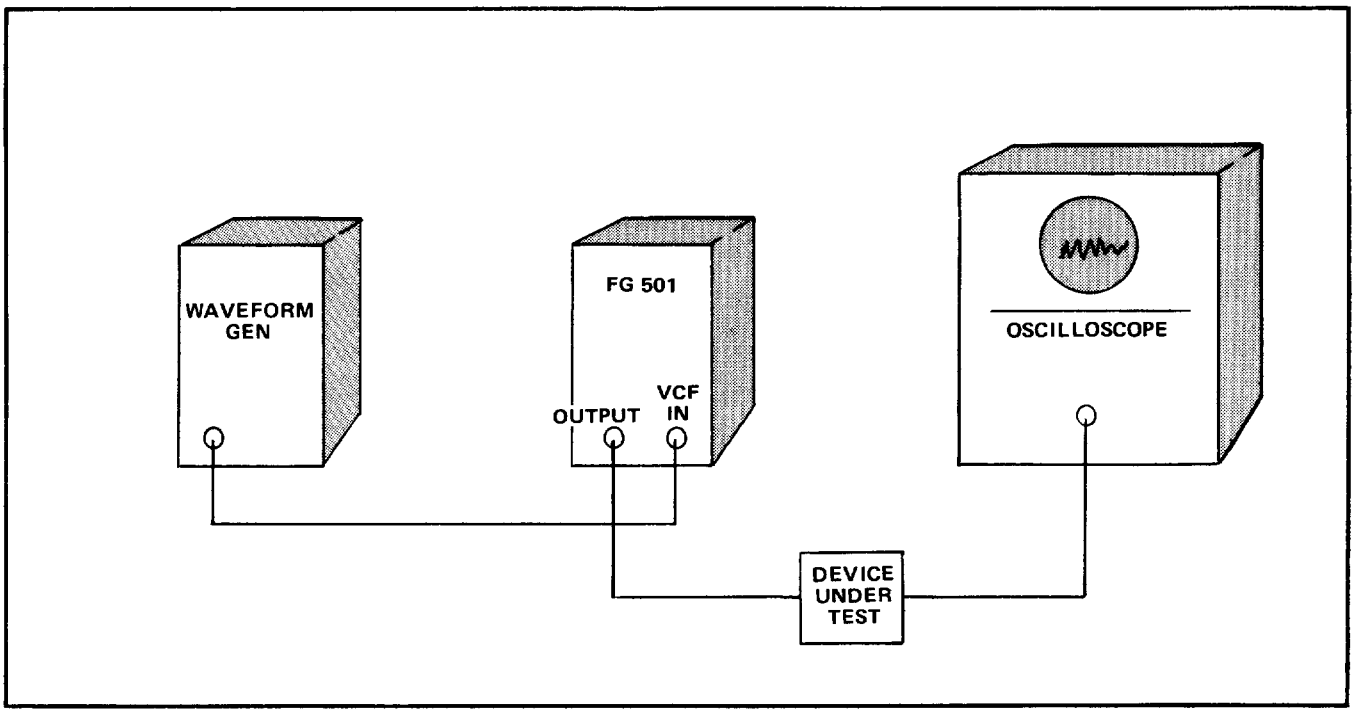


Fig. 1-6. Analyzing circuit or system response.

Tone-Burst Generation or Stepped Frequency Multiplication

The FG 501 can be used as a tone-burst generator or frequency multiplier for checking tone-controlled devices. This application utilizes a Ramp Generator, such as the TEKTRONIX RG 501, as a VCF signal source and a Pulse Generator, such as the TEKTRONIX PG 501, as a gating signal source.

The following procedure describes a technique for obtaining a tone-burst or frequency multiplied output from the FG 501. Refer to the Gated (Burst) Output and Variable Phase and the Voltage-Controlled Frequency (VCF) Output discussions under Operation for additional information.

1. Connect the equipment as shown in Fig. 1-7.

2. Pull out the FG 501 PHASE control. Set the Ramp Generator for the desired ramp duration and polarity.

3. Adjust the Pulse Generator period for the desired number of bursts within the selected ramp duration. Adjust the Pulse Generator duration for the desired burst width.

4. Select the sweep frequency range by adjusting the FREQUENCY Hz dial for one end of the swept range (upper or lower limit depending on the polarity of the ramp). Then adjust the Ramp Generator amplitude for the other swept frequency limit.

Various other tone-burst or frequency multiplied characteristics can be obtained by using different gating input waveforms, i. e., triangle, sine, square, etc.

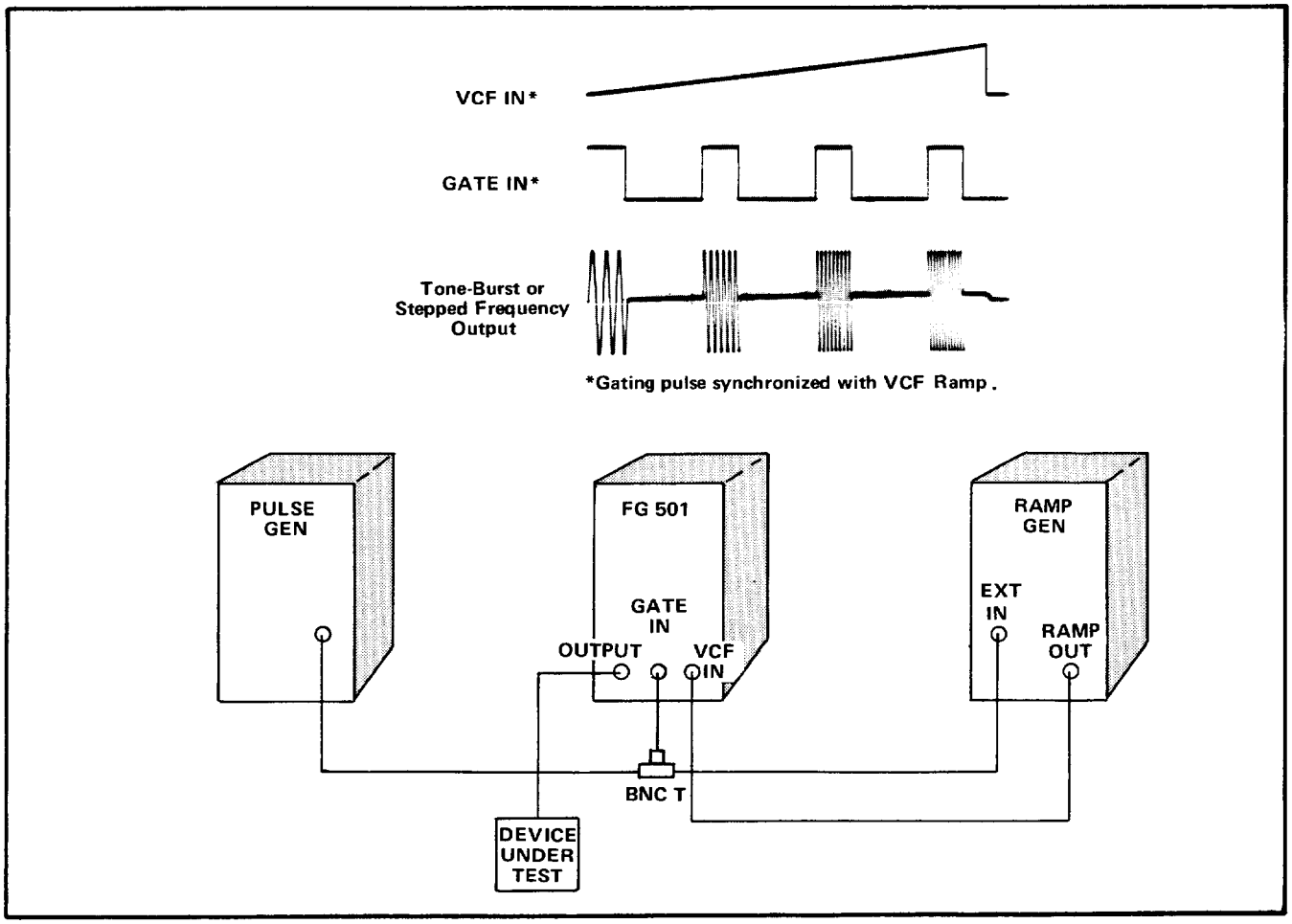


Fig. 1-7. Tone burst generation or stepped frequency multiplication.

ELECTRICAL CHARACTERISTICS

Performance Conditions

The electrical characteristics are valid only if the FG 501: (1) has been calibrated at an ambient temperature between +20°C and +30°C and (2) is operating at an ambient temperature between 0°C and +50°C unless otherwise noted.

OUTPUTS: Sine, triangle, square, ramp, and pulse waveforms selectable by the front panel FUNCTION selector. Also +2.5 V square-wave trigger from front-panel TRIG OUT connector.

AMPLITUDE (EXCLUDING OFFSET): 15 V P-P open circuit. 7.5 V P-P into 50 Ω load. Sine, triangle and square-wave amplitudes within 5% for single setting of OUTPUT control.

OFFSET RANGE: + and −5 V open circuit. + and −2.5 V into 50 Ω load.

FREQUENCY RANGE: 0.001 Hz to 1 MHz in 9 decade steps.

FREQUENCY RESOLUTION: 1 part in 10^4 of full scale with FREQUENCY VERNIER control.

DIAL RANGE AND ACCURACY: 1 to 10 within 3% of full scale (.1 to <1 uncalibrated).

TIME SYMMETRY: Within 1% from 0.001 Hz to 1 MHz on calibrated portion (1 to 10) of FREQUENCY Hz dial. Within 10% on uncalibrated portion (0.1 to 1) of FREQUENCY Hz dial from 20°C to 50°C.

HOLD MODE STABILITY: Within 5% of output voltage in 1 hour at +25°C on 0.001 Hz range.

FREQUENCY AND AMPLITUDE (INCLUDING OFFSET) STABILITY: Temperature—Within 2% from 0.1 Hz to 1 MHz. Within 10% from 0.001 Hz to < 0.1 Hz. Time—Within 0.1% for 10 minutes. Within 0.25% for 24 hours.

TRIANGLE/RAMP OUTPUT

LINEARITY: Within 1% from 0.001 Hz to < 100 kHz. Within 2% from 100 kHz to 1 MHz.

RAMP DURATION: $\frac{1}{2f}$ (see Operating Considerations).

SINE WAVE OUTPUT

DISTORTION: 1% or less from 0.001 Hz to 1 Hz 0.5% or less from > 1 Hz to 20 kHz. 1% or less from > 20 kHz to 100 kHz. 2.5% or less from > 100 kHz to 1 MHz. Applies to calibrated portion of dial only. Valid from 10°C to 40°C.

SQUARE WAVE/PULSE OUTPUT

RISETIME: 100 ns or less.

ABERRATIONS: 5% or less measured P-P with output amplitude at 7.5 V P-P into external 50 Ω load.

PULSE DURATION: $\frac{1}{2f}$ (see Operating Considerations).

EXTERNAL GATE INPUT

INPUT SIGNAL: 0 V to at least +2 V square wave not to exceed +15 V. Bursts are synchronous with the gate.

BURST LENGTH: Determined by selected output frequency and gating pulse width.

PHASE: Continuously variable from −90° to +90° referred to 0° sine and triangle start points.

INPUT IMPEDANCE: ≈ 1 kΩ.

EXTERNAL VOLTAGE-CONTROLLED FREQUENCY (VCF) INPUT

OUTPUT FREQUENCY RANGE: At least 1000:1 with 10 V VCF input. Negative-going voltage decreases frequency; positive-going voltage increases frequency. f_{max} = 10X MULTIPLIER setting, $f_{min} = \frac{\text{MULTIPLIER setting.}}{100}$

SLEW RATE: ≈ 1/2 V/μs.

TRIGGER OUTPUT

AMPLITUDE: +2.5 V square wave into a 600 Ω load.

SECTION 2 THEORY OF OPERATION

Introduction

The following is a description of the electrical circuits in the FG 501. Refer to the simplified block diagram and the detailed schematic diagrams on the foldout pages at the back of the manual to aid in understanding this description.

LOOP GENERATOR

Triangle Waveform Generation

Operational amplifiers U45 and U48 in conjunction with Q45A/B and Q48A/B are voltage followers. Thus, the voltage at pin 3 of U45 and U48 is also present at the emitters of Q45A/B and Q48A/B. Switch S50 (MULTIPLIER) and resistance network R53 through R60 provide constant current to the emitters of Q45A/B which, together with U45, comprise a positive current source that charges the timing capacitor selected by S50 (C72 through C79). Resistor network R63 through R70 provides constant current to the emitters of Q48A/B which, together with U48, comprise a negative current source that also charges the timing capacitor selected by S50.

The current sources for the operational amplifiers and the timing capacitor are separate. Thus, input current requirements of the amplifiers have little effect upon the timing current supply. Q45A and Q45B are identical current sources. Q45A supplies approximately 70 nA to U45 input (the remaining current goes to ground), while Q45B supplies charging current to the timing capacitor.

The current switch, composed of CR100 through CR103 and emitter-coupled transistors Q85 and Q90, determines whether the positive current source or negative current source charges the timing capacitor. For example, if CR100 is turned off, all the current from Q45B goes through CR102 to charge the timing capacitor in the positive direction at a linear rate. Emitter follower Q138 passes the linear ramp through divider network R190/R191 and to pins 3 and 5 of upper and lower level comparators U195A/B. The voltage at pin 2 of U195A sets the upper hysteresis. The voltage at pin 6 sets the lower hysteresis. With CR100 off, U195A is in the negative state until the ramp at pin 3 reaches +1.77 V; then the output at pin 10 goes positive. The output of inverting amplifier U80C then goes negative, which causes nor gate U80D output to go positive, Thus, pin 9 of lower-level comparator U195B goes positive, which enables lower-level comparator U195B. Consequently, emitter-coupled switch Q85 turns on. The collector of Q85 moves in the negative direction, which turns on CR100 and turns off CR101. Thus, the negative current source now charges the timing capacitor and the ramp starts to go negative at a linear rate. Again, the ramp is applied to the divider network R190/R191, and to pin 5 of U195B. When the ramp reaches P1.77 V, the output at pin 10 of U195B goes negative. This causes the output of U80C to go positive, pin 13 of U80D goes negative, Q85 turns off, and Q90 turns on. CR101 turns on again, while CR100 turns off. This action is repeated to form a triangle waveform output from the loop generator. The slope (frequency) of the triangle is determined by how much current the positive and negative current sources provide to the timing capacitors.

Potentiometer R25 (FREQUENCY Hz) provides 0 V to approximately 10 V to pin 3 of voltage follower U30. The output of U30 is fed to pin 2 of voltage summing amplifier U15 where it is summed with an offset voltage (approximately −7 V) from potentiometer R38 (X1 Cal) and any VCF input applied to J10. Voltage summing amplifier U15 has an output range of +7 to +17 V which drives the positive current source. This 10 V swing across the timing resistors provides a wide current (frequency) range.

The negative current source is also driven by the positive voltage output of U15. However, the polarity is reversed by inverting amplifier U40. Thus, the voltage change at pin 3 of U48 in the negative current source very closely tracks that at pin 3 of U45 in the positive current source. Low frequency symmetry is adjustable by potentiometer R45 (X.1 Sym).

Frequency Switching

Frequency (decade) switching from 1 Hz to 1 MHz is accomplished by changing timing capacitors and from 1 Hz to 0.0001 Hz by changing timing resistors.

External Voltage-Controlled Frequency (VCF) Mode

Voltage-controlled frequency is accomplished by applying a voltage to J10 (VCF IN) which is summed with the voltage set by R25 (FREQUENCY Hz). Subsequently, the current to the timing capacitor is changed, which changes the generator output frequency as described under Triangle Waveform Generation.

Level Shifting

Level shifting occurs in the circuit composed of Q125 and Q130. Q130 is a current source for Q125. Q130 also assures that any bias across source follower Q120 is dropped across R127, which shifts the level of the input to the sine shaper circuit (Q150 and Q170) with respect to 0 V (+5 V to −5 V).

Sine Waveform Generation

The sine shaper is composed of Q150, Q170 and an associated divider-diode network. The resistor network composed of R155, R156, R158, R160, and R162 forms a voltage divider with a diode connected to each junction. In series with the diodes are resistors R157, R159, R161, and R163. A positive-going ramp from the emitter of Q138 will turn on the diode with the least current first, in this case, CR162. Diode CR162 has the least effect on the incoming ramp. Each successive diode has a greater effect. CR155 has the maximum effect since there is no resistor at its anode end. Thus, the peaks of the triangle waveform are clipped harder than are the remaining portions. The reverse is true of the negative half of the sine shaper, i.e., Q170 and its associated divider-diode network. Potentiometers R150 (Upper Level) and R170 (Lower Level) at the bases of Q150 and Q170 adjust for minimum distortion of the sine shaper output. Thus, a sine waveform is derived from the triangle waveform.

Square Waveform Generation

A square waveform output is derived by taking the available square waveform from the collector of current switch driver Q90 and feeding it through divider R102-R105 and to switch S250 (FUNCTION).

External Gate Mode

Gating is accomplished by applying an external signal to J215 (GATE IN) and closing S245 (PHASE). As long as pin 12 of nor gate U80D is near ground, the loop generator is functioning. However, a positive voltage at pin 12 of U80D will disable the loop generator.

In normal operation with no external gating signal at J215 (GATE IN), transistors Q80 and gate amplifier Q225 are on (saturated), which holds phase clamp switch Q230 off. When Q230 is off, the phase clamping circuit (composed of U235 and current boosting transistors Q240 and Q242) does not affect the gate of source follower Q120. Assume that switch S245 (PHASE) is closed and a squarewave is applied to J215 (GATE IN). During the positive transition of the gating signal, the loop generator continues to run, since Q80 and Q225 are already on. However, when the gating signal goes negative, Q80 turns off, since the input impedance of the gating input drops to 1 k (R220 vs R81), thereby turning off Q80 and Q225. Pin 12 of U80D is pulled up and the loop generator is disabled. Simultaneously, Q230 turns on, which also turns on diodes CR245 through CR248. The gate of source follower Q120 is now clamped to the voltage set by U235 and associated current-boosting transistors Q240 and Q242. By adjusting the input to pin 3 of U235 with potentiometer R235 (PHASE), the clamping voltage to the gate of Q120 can be shifted to start the triangle waveform anywhere from +90° to −90° from the sine and triangle 0° start point.

Hold Mode

Cam switch S50 (MULTIPLIER) has three positions between the three lowest frequency range settings that stop the triangle waveform at its instantaneous voltage level (i.e., the timing capacitor charge holds at its instantaneous level) until S50 is switched back to a range position. The hold contacts on cam switch S50 are normally closed.

OUTPUT AMPLIFIER

Cam switch S250 (FUNCTION) selects a triangle, square, or sine waveform and feeds it to the output amplifier.

Transistors Q250 and Q255 are complementary emitter followers which offset any differential between the input and output voltage and provide temperature compensation.

Assume that a triangle waveform is selected by S250 (FUNCTION). The triangle waveform voltage applied to the output amplifier is varied in amplitude by potentiometer R260A (OUTPUT), then summed with the voltage selected by potentiometer R260B (OFFSET). The output amplifier is basically an operational amplifier. Its gain is determined by input resistor R279 and feedback resistor R281. Transistor Q270 provides the positive input. Now, when Q270 turns on, i.e., a positive voltage is applied to its base; Q290 turns on which turns on Q295 and pulls the output up. If Q276 turns on, i.e., Q270 turns off when a negative voltage is applied to its base; Q280 turns on, which turns on

Q285. Consequently, Q298 turns on and pulls the output down. R298 establishes the source impedance of the output.

Pulse and Ramp Generation

Switch S250 (FUNCTION) also applies pulses and ramp waveforms to the output amplifier.

When a positive or negative ramp waveform is selected by S250, a lower resistance is switched into the positive or negative current sources, depending on the polarity of the selected ramp waveform. For instance, if the positive current source had the least resistance, then current would increase in that source and consequently increase the slope of that particular side of the ramp. The reverse is true if the negative current source has the least resistance.

Positive or negative pulses are obtained by changing the duty cycle of the square waveform. The output pulse is derived from the "on" portion of the square waveform. The triangle generator frequency determines the frequency of the square waveform and, thus, the pulse frequency.

POWER SUPPLIES

+20 V Reference Supply

The +20 V supply is the reference for all the supplies. Diode bridge network CR400 and capacitor C400 convert the raw 25 V AC from the Power Module to +33 V DC, which is then fed to the +20 V reference supply. Field effect transistor Q400 along with R405 comprise a constant current source for 6.2 V zener diode VR405. VR405 is temperature compensated at approximately 7 mA when potentiometer R400 (Reference Current) is adjusted for 7 V across R405, which then establishes the 6.2 V reference for non-inverting operational amplifier U410. Negative feedback is provided through resistor network R410-R415. Potentiometer R415 (+20 Volts) is adjusted for +20 V output. When output current exceeds 200 mA, sensing resistor R417 in the emitter of series pass transistor Q410 turns Q415 on, which pulls down the base of Q410 and shuts the +20 V supply off.

+20 V Decoupled Supply

Voltage follower U420, in conjunction with current booster Q420, drives the series pass transistor in the Power Module. Current sensing resistor R424 turns on Q424 when output current exceeds 400 mA, which pulls down the base of Q420 and shuts off the +20 V decoupled supply.

−20 V Reference Supply

The −20 V supply consists of inverting operational amplifier U480. Input resistor R481 and feedback resistor R482 are 0.1%, thereby assuring that the −20 V reference supply accurately follows the +20 V reference supply. As in the +20 V reference supply, series pass transistor Q488, current sensing resistor R487, and transistor Q485 provide overcurrent shutdown (in excess of 200 mA).

−20 V Decoupled Supply

Voltage follower U470 with its associated current booster Q472 and current sensing resistor R473 operate identically to the +20 V decoupled supply.

+17 V Supply

Voltage follower U430 with voltage divider R430/R431 comprise the +17 V supply. Divider R430-R431 establishes +17 V at pin 3 of U430, while feedback is supplied to pin 2 from current booster Q430. There is no current sensing resistor in the 17 V supply since the voltage for the 17 V supply is supplied by the +20 V reference supply, which has overcurrent protection.

−17 V Supply

The −17 V supply consists of inverting operational amplifier U460, current booster Q468 and 0.1% resistors R464 and R465 which provide an accurate −17 V with respect to the +17 V Supply.

+5 V Supply

Divider R441-R442 provides +5 V to pin 3 of voltage follower U440. If excessive current is drawn, current sensing resistor R446 turns on Q447 which pulls down the base of current booster Q445 and shuts off the +5 V supply. The collector of Q445 connects to the unregulated +11.5 V from the Power Module.

−5 V Supply

The −5 V supply consists of emitter follower Q450. No current limiting is provided since the collector is tied to the current limited −20 V reference supply. Diode CR450 provides temperature compensation for Q450.

SECTION 3 SERVICING INFORMATION

Contents

This section of the manual contains information necessary to service the FG 501. Adjustment procedures are provided on the Controls and Adjustments foldout page with supporting illustrations that show internal adjustment locations and describe front-panel control functions. Also included is the electrical parts list with an illustration on the Component Location foldout page that shows the physical location of components on the etched circuit board with an alpha-numeric grid keyed to the electrical parts list (see Grid Loc column in the parts list). A schematic diagram is located opposite both the electrical parts list and the circuit board illustration to further facilitate the location of components. Rear connector pin assignments are listed in Table 3-1.

Mechanical parts are listed at the rear of this section with an exploded view of the instrument. A list of standard accessories and a carton assembly drawing are on the back of the exploded view foldout page.

Maintenance

General system maintenance procedures are provided in the Power Module instruction manual, i.e., preventive maintenance, troubleshooting aids, parts removal and replacement procedures, parts ordering information, etc.

Service Available

Tektronix, Inc. provides complete instrument repair and calibration at local Field Service centers and at the Factory Service Center. Contact your local TEKTRONIX Field Office or representative for further information.

ADJUSTMENT PROCEDURE

Introduction

The adjustment procedure on the Controls and Adjustments foldout page is intended to return the circuits of the FG 501 within their designed operating capabilities. Adjustment is generally required after a repair has been made, or after long time intervals in which normal aging of components may affect instrument accuracy. Before making adjustments, verify instrument operation by performing the procedure described under Operation in Section 1.

Test Equipment Required

The following test equipment and accessories or the equivalent, are required for complete adjustment of the FG 501. Specifications given for the test equipment are the minimum necessary for accurate adjustment. Therefore, some of the specifications listed may be less rigorous than the actual performance capabilities of the test equipment. All test equipment is assumed to be correctly calibrated and operating within their listed specifications.

If other test equipment is substituted, control settings or set-up may need altering to meet the requirements of the equipment used. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is needed.

1. Oscilloscope. TEKTRONIX 7403 with 7A15 Single-Trace Amplifier and 7B50 Time Base plug-ins recommended.

2. Digital Voltmeter. ±10 V to ±20 V within 0.5%.

3. 10X Probe. TEKTRONIX P6053 recommended.

4. 50 Ω Termination. TEKTRONIX Part No. 011-0049-01 recommended.

5. Plug-in Extension. TEKTRONIX Calibration Fixture 067-0645-02. Note: Do not use this extension to plug the FG 501 into any instrument other than the TM 500 series Power Module.

6. 10 kHz Notch Filter (or Distortion Analyzer). Construct Notch Filter as shown in Fig. 3-1, for performing sine waveform upper and lower level adjustments (R150 and R170):

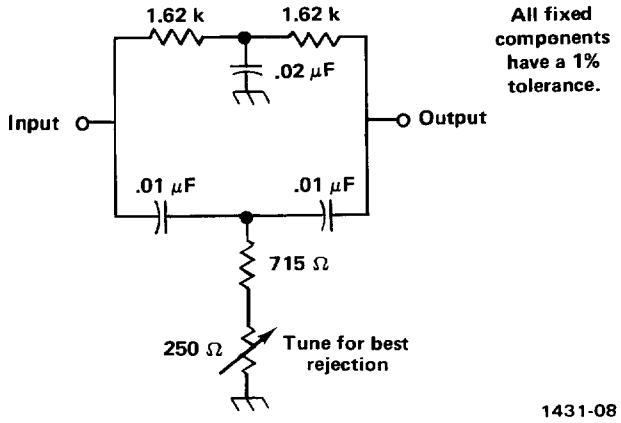


Fig. 3-1. 10 kHz Notch Filter.

Preliminary Considerations

Read the Operating Considerations in Section 1 before adjusting the FG 501.

This instrument should be adjusted at an ambient temperature between +20 °C and +30°C (+68°F and +86°F) for best accuracy.

Do not preset internal controls unless they are known to be significantly out of adjustment, or unless repairs have been made in the circuit. In these instances, the internal adjustments can be set to midrange.

Preparation

1. Remove the cover from the left side of the FG 501 and, if necessary, blow off accumulated dust with low-pressure compressed air.

2. Connect the FG 501 to the Power Module through the Plug-in Extension.

3. Apply power to the Power Module. Check that the POWER indicator on the FG 501 is lit.

4. Refer to the Controls and Adjustments foldout page in this section for internal adjustment procedures.

NOTE

If a malfunction is detected during adjustment, refer to system maintenance in the Power Module instruction manual for troubleshooting techniques, parts removal and replacement procedures, parts ordering information, etc.

Repackaging for Shipment

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing: owner (with address) and the name of an individual at your firm that can be contacted, complete instrument serial number and a description of the service required.

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

1. Obtain a carton of corrugated cardboard having inside dimensions of no less than six inches more than the instrument dimensions; this will allow for cushioning. Refer to the following table for carton test strength requirements.

2. Surround the instrument with polyethylene sheeting to protect the finish of the instrument.

3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between carton and instrument, allowing three inches on all sides.

4. Seal carton with shipping tape or industrial stapler.

SHIPPING CARTON TEST STRENGTH

Gross Weight (lb)	Carton Test Strength (lb)
0-10	200
10-30	275
30-120	375
120-140	500
140-160	600

TABLE 3-1

Rear Connector Pin Assignments

Pin No.	Left (A)	Right (B)
28	Output	Trigger Output Common
27	Output Common	Trigger Output
26	Not Used	Not Used
25	Not Used	Gate In Common
24	Not Used	Gate In
23	Not Used	Not Used
22	Not Used	VCF In Common
21	Not Used	VCF In
14 through 20	Not Used	Not Used
13	25 VAC Winding	25 VAC Winding
12	+33.5 V Filtered DC	+33.5 V Filtered DC
11	Base of Series Pass PNP Transistor	Collector of Series Pass PNP Transistor
10	Emitter of Series Pass PNP Transistor	Not Used
9	+33.5 V Common	+33.5 V Common
8	—33.5 V Filtered DC	—33.5 V Filtered DC
7	Emitter of Series Pass NPN Transistor	Collector of Series Pass NPN Transistor
6	Base of Series Pass NPN Transistor	Not Used
5	Not Used	Not Used
3 and 4	+11.5 V Common	+11.5 V Common
2	+11.5 V Filtered DC	+11.5 V Filtered DC
1	25 VAC Winding	25 VAC Winding

DIAGRAMS, PARTS LISTS, AND ILLUSTRATIONS

Symbols and Reference Designators

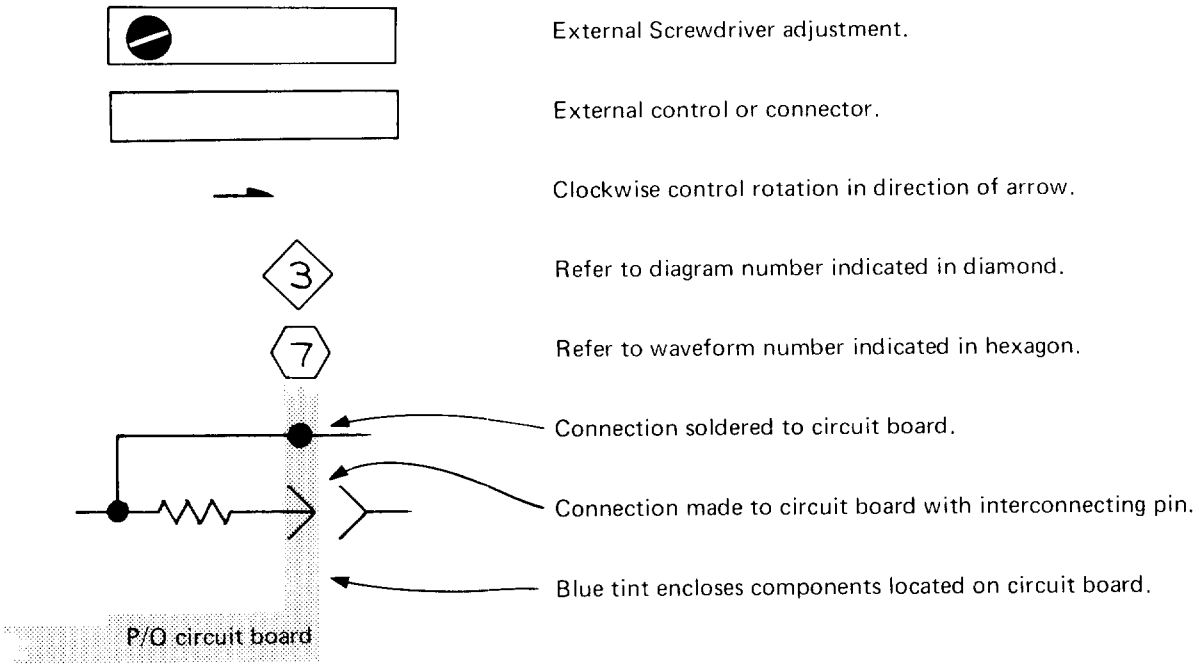
Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).
Resistors = Ohms (Ω)

Symbols used on the diagrams are based on ANSI Y32.2 – 1970.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



External Screwdriver adjustment.

External control or connector.

Clockwise control rotation in direction of arrow.

Refer to diagram number indicated in diamond.

Refer to waveform number indicated in hexagon.

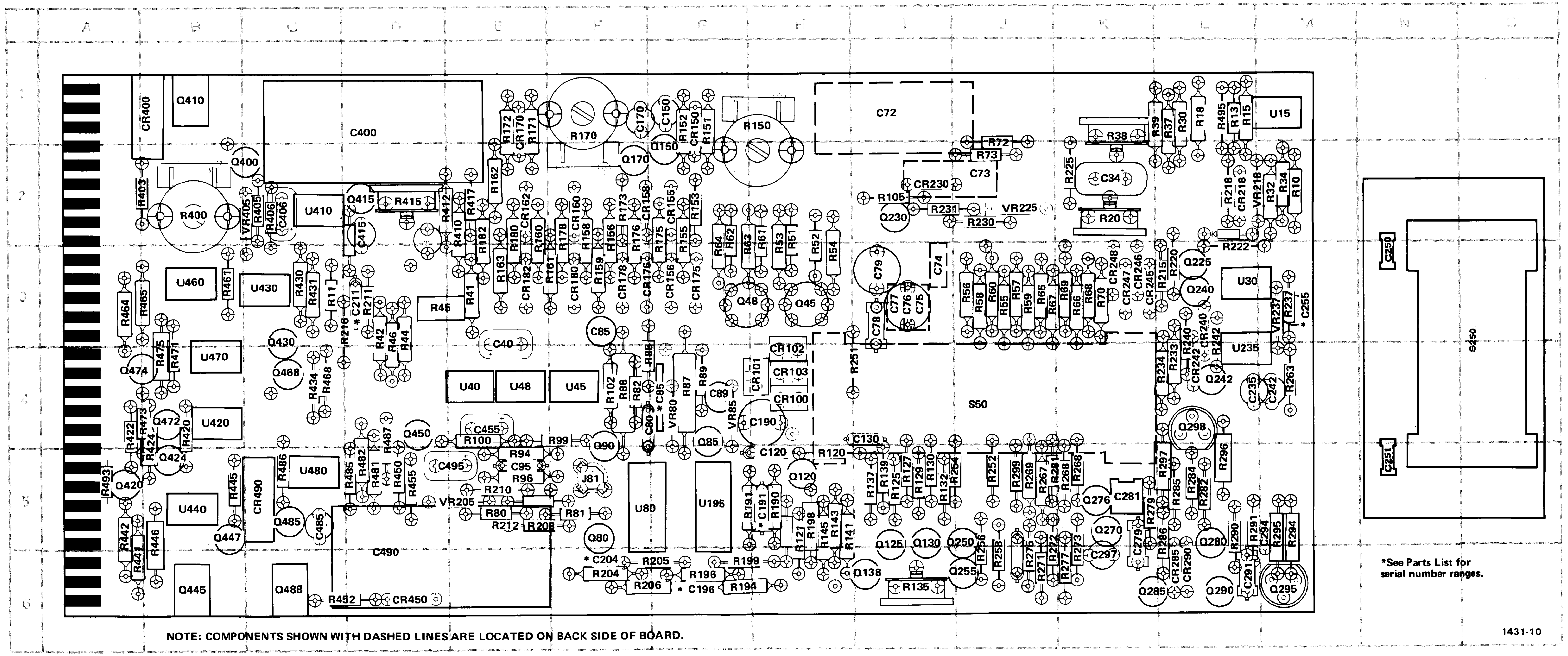
Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

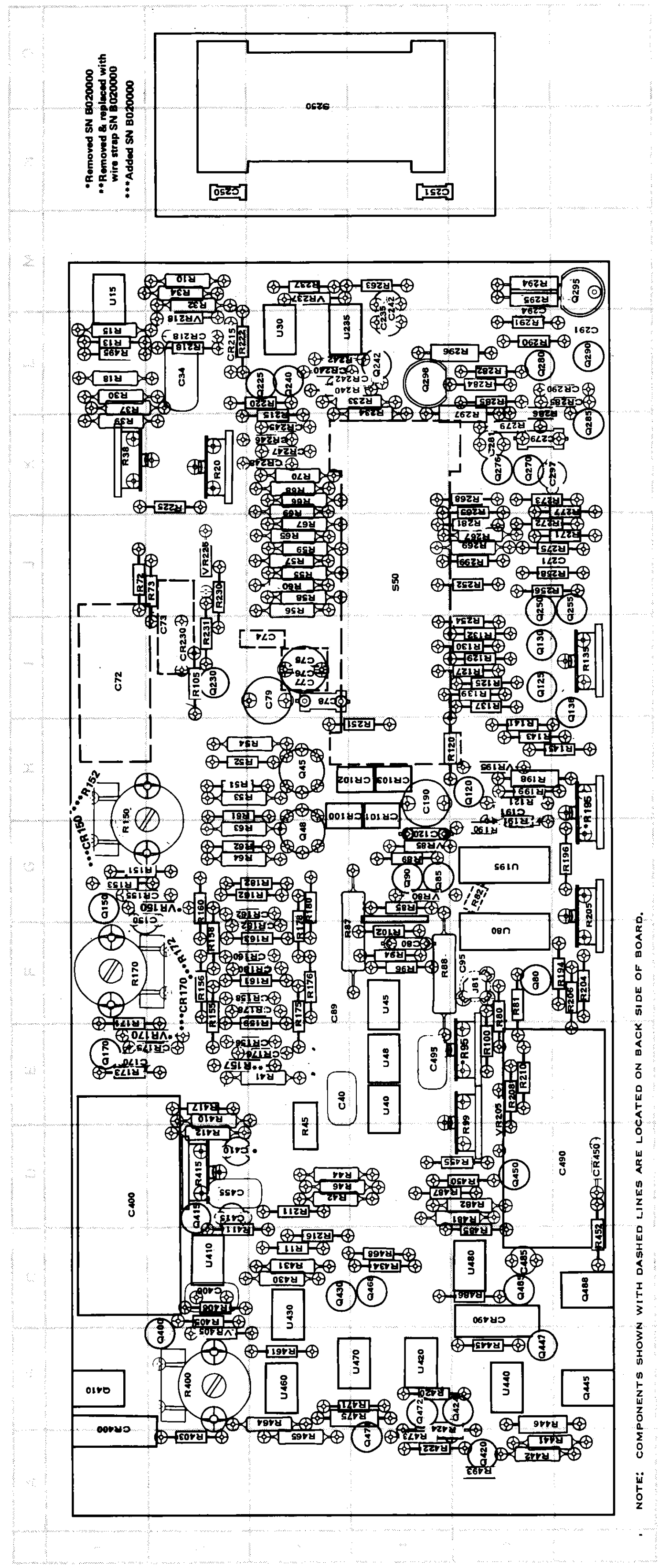
Blue tint encloses components located on circuit board.

COMPONENT LOCATION GRID

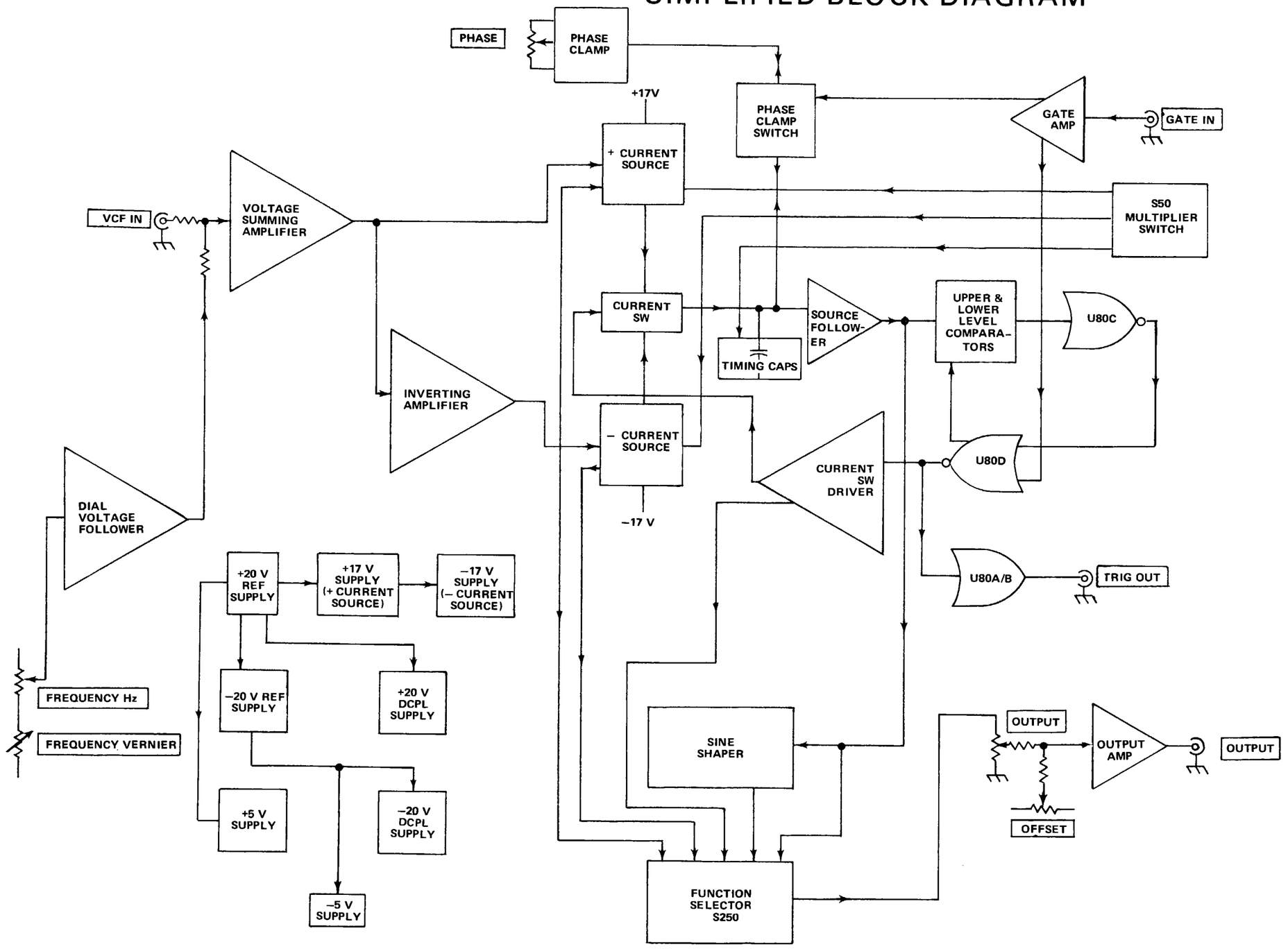
SN B020000-up



REV. F. JUNE 1975



SIMPLIFIED BLOCK DIAGRAM



Ⓐ1

ADJUSTMENT PROCEDURE

SN B020000-up

1. Presets

Preset the following controls:

FUNCTION	∿ (triangle)
OUTPUT	Fully cw
OFFSET	Midrange
PHASE	Off (pushed in)
FREQUENCY VERNIER	Calibrated (fully cw)
MULTIPLIER	10^2

2. Reference current

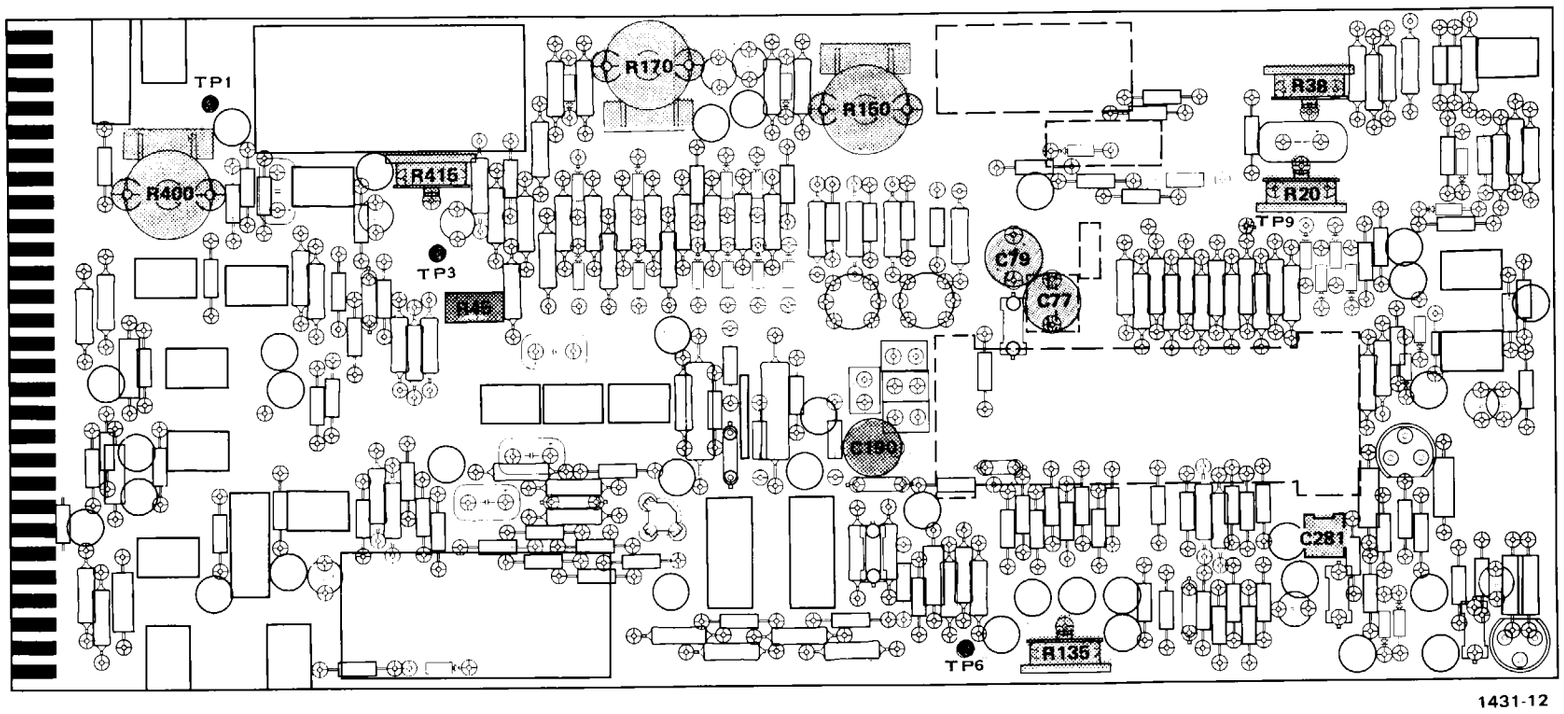
Connect Digital Voltmeter to **TP1** Adjust **R400** Ref Current) for 13.8 V.

3. +20 Volts

Connect Digital Voltmeter to **TP3**. Adjust **R415** (+20 Volts) for +20.0 V.

4. −17 Volts

Connect Digital Voltmeter to **TP9**. Check for −17.0 V.



1431-12

5. Triangle DC Level

Connect 10X Probe to **TP6** Adjust **R135** (∿ DC Level) so the display is equally divided above and below graticule center.

6. Square High Frequency Comp

Set Oscilloscope sweep rate for 2 μs/div. Adjust **C281** (⊓⊔HF Comp) for the best square corner and flat top on the display.

7. Dial Calibration

Set FUNCTION to ∿ (triangle waveform) and oscilloscope sweep rate for 1 ms/div. Set FREQUENCY Hz for maximum displayed frequency. Check that the FREQUENCY Hz dial reads 10. If not, loosen two set screws on brass collar behind knob and position dial to 10 while holding dial shaft with needle-nose pliers.

8. X10 Calibration

Adjust **R20** (X10 Cal) for 1 triangle waveform/div.

9. X1 Calibration

Set FREQUENCY Hz to 1 and Oscilloscope sweep rate for 10 ms/div. Adjust **R38** (X1 Cal) for 1 triangle waveform/div.

10. X1 Calibration (cont)

Set FREQUENCY Hz to 10 and Oscilloscope sweep rate for 1 ms/div. If necessary, readjust **R20** (X10 Cal) for 1 triangle waveform/div. Repeat step 9 and 10.

11. X1 Symmetry

Set MULTIPLIER to 10^3 FUNCTION to ⊓⊔ (square waveform) and Oscilloscope sweep rate for 0.1 ms/div. Adjust FREQUENCY Hz for 1 cycle/10 div. Adjust **R45** (X.1 Sym) so the upper and lower portions of the square waveform are of equal duration.

12. 10^5 X10 Timing

Set FUNCTION to ∿ (triangle waveform), MULTIPLIER to 10^5, FREQUENCY Hz to 10 and Oscilloscope sweep rate for 1 μs/div. Adjust **C190** (10^5 X 10 Timing) for 1 triangle waveform/div.

13. 10^5 X 1 Timing

Set FREQUENCY Hz to 1 and Oscilloscope sweep rate for 10 μs/div. Adjust **C79** (10^5 X 1 Timing) for 1 triangle waveform/div. Repeat step 12 and 13.

14. 10^4 X 10 Timing

Set MULTIPLIER to 10^4, FREQUENCY Hz to 10 and Oscilloscope sweep rate for 10 μs/div. Adjust **C77** (10^4 X 10 Timing) for 1 triangle waveform/div.

15. Sine Upper and Lower Level

Set FUNCTION to ∿ (sine waveform), MULTIPLIER to 10^4 and the FREQUENCY Hz to 1. Connect the Notch Filter (described under Test Equipment Required) through a 50 Ω cable between the FG 501 OUTPUT and the Oscillscope vertical input at a deflection factor of 1 V/div.

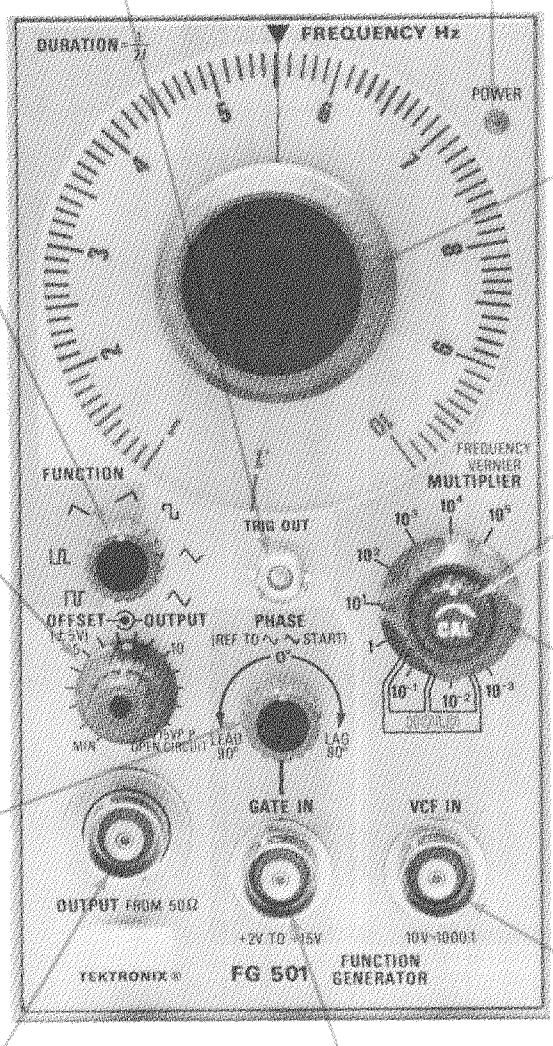
16. Sine Upper and Lower Level (cont)

Set Oscilloscope sweep rate for 50 μs/div and adjust FREQUENCY Hz dial for minimum display amplitude.

17. Sine Upper and Lower Level (cont)

Set Oscilloscope for a 4 div display. Alternately adjust **R150** (∿ Upper Level) then **R170** (∿ Lower Level) for minimum distortion. (disregard amplitude of fundamental). Readjust FREQUENCY Hz dial for minimum amplitude and repeat the adjustment of **R150** and **R170**.

FRONT PANEL CONTROLS AND CONNECTORS



TRIG OUT Connector

BSM connector that provides a +2.5 V squarewave trigger output into a 600 Ω load.

POWER Indicator

Lights when power is applied to the FG 501.

FREQUENCY Hz Dial

The frequency of sine, triangle and square waveforms is read directly from the dial. Ramp and pulse waveforms have a frequency approximately 1.6X dial setting with the MULTIPLIER at 1 or above, and a frequency of approximately 2X dial setting on the three lowest ranges of the MULTIPLIER selector. The maximum Frequency is limited to 1 MHz.

FUNCTION Selector

Selects sine, triangle, square, ramp, and pulse output waveforms. Pulse and ramp waveform duration is 1/2f. See Operating Considerations for additional information.

FREQUENCY VERNIER Control

Provides vernier selection of output frequency from the fully cw (calibrated) position to approximately 0.35% of full scale in the fully ccw position.

OUTPUT/OFFSET Controls

Concentric controls that adjust the waveform amplitude at the OUTPUT connector from less than 500 mV (fully ccw) to 15 V P-P open circuit (fully cw) and provide a variable DC offset voltage from zero (centered) to either −5 V (fully ccw) or +5 V (fully cw).

MULTIPLIER Selector

Selects frequency range in 9 decade steps and provides three "hold" positions between the lowest three multiplier positions which hold the generator output at any desired instantaneous voltage level.

PHASE Control

When pulled out provides continuously variable selection of the gated output waveform start level (phase) from +90° (fully ccw) to −90°C (fully cw) referenced to the sine or triangle waveform 0° starting point. Used in conjunction with the GATE IN connector when operating in gated output (burst) mode.

VCF IN Connector

BNC connector for applying an external voltage for controlling the output frequency of the generator. A 10 V input provides a frequency range of 1000:1.

OUTPUT Connector

BNC connector which provides the output waveform selected by the FUNCTION selector.

GATE IN Connector

BNC connector for applying a +2 V to +15 V gating signal to the generator.

ADJUSTMENT PROCEDURE

Below SN B020000

1. Presets

Preset the following controls:

FUNCTION	∿ (triangle)
OUTPUT	Fully cw
OFFSET	Midrange
PHASE	Off (pushed in)
FREQUENCY VERNIER	Calibrated (fully cw)
MULTIPLIER	10^2

2. Reference current

Connect Digital Voltmeter to TP1 Adjust R400 Ref Current) for 13.8 V.

3. +20 Volts

Connect Digital Voltmeter to TP3. Adjust R415 (+20 Volts) for +20.0 V.

4. −17 Volts

Connect Digital Voltmeter to TP9. Check for −17.0 V.

5. +4.5 Volts Triangle Amplitude

Connect oscilloscope through the 10X probe to TP6. Adjust FREQUENCY Hz for maximum number of displayed waveforms at 0.2 V/div. Ground the oscilloscope vertical input and position the trace to graticule center. Set the vertical input selector to DC.

6. +4.5 Volts Triangle Amplitude (cont)

Adjust R195 (+4.5 Volts ∿ Ampl) so the positive peaks on the display extend 2.25 div above graticule center.

7. −4.5 Volts Triangle Amplitude

Adjust R205 (−4.5 Volts ∿ Ampl) so the negative peaks on the display extend 2.25 div below graticule center. Repeat step 6 and 7 until there is no interaction.

8. Triangle DC Level

Connect 10X Probe to TP7. Adjust R135 (∿ DC Level) so the display is equally divided above and below graticule center.

9. Gate Centering

Connect 10X Probe to TP5. Center the display and reconnect the 10X Probe to the center tap of R95 (Gate Centering). Adjust R95 to center the display.

10. Square Amplitude

Connect 50 Ω cable and 50 Ω termination from FG 501 OUTPUT connector to the Oscilloscope. Adjust OFFSET and OUTPUT for a 6 div display. Set FUNCTION to ⊓⊔ (square waveform).

11. Square Amplitude (cont)

Adjust R99 (⊓⊔ Ampl Cal) for a 6 div display. (If necessary, adjust OFFSET to keep display centered.)

12. Square High Frequency Comp

Set Oscilloscope sweep rate for 2 μs/div. Adjust C281 (⊓⊔HF Comp) for the best square corner and flat top on the display.

13. Dial Calibration

Set FUNCTION to ∿ (triangle waveform) and oscilloscope sweep rate for 1 ms/div. Set FREQUENCY Hz for maximum displayed frequency. Check that the FREQUENCY Hz dial reads 10. If not, loosen two set screws on brass collar behind knob and position dial to 10 while holding dial shaft with needle-nose pliers.

14. X10 Calibration

Adjust R20 (X10 Cal) for 1 triangle waveform/div.

15. X1 Calibration

Set FREQUENCY Hz to 1 and Oscilloscope sweep rate for 10 ms/div. Adjust R38 (X1 Cal) for 1 triangle waveform/div.

16. X1 Calibration (cont)

Set FREQUENCY Hz to 10 and Oscilloscope sweep rate for 1 ms/div. If necessary, readjust R20 (X10 Cal) for 1 triangle waveform/div. Repeat step 15 and 16.

17. X1 Symmetry

Set MULTIPLIER to 10^3, FUNCTION to ⊓⊔ (square waveform) and Oscilloscope sweep rate for 10 ms/div. Adjust R45 (X.1 Sym) so the upper and lower portions of the square waveform are of equal duration.

18. 10^5 X10 Timing

Set FUNCTION to ∿ (triangle waveform), MULTIPLIER to 10^5, FREQUENCY Hz to 10 and Oscilloscope sweep rate for 1 μs/div. Adjust C190 (10^5 X 10 Timing) for 1 triangle waveform/div.

19. 10^5 X 1 Timing

Set FREQUENCY Hz to 1 and Oscilloscope sweep rate for 10 μs/div. Adjust C79 (10^5 X 1 Timing) for 1 triangle waveform/div. Repeat step 18 and 19.

20. 10^4 X 10 Timing

Set MULTIPLIER to 10^4, FREQUENCY Hz to 10 and Oscilloscope sweep rate for 10 μs/div. Adjust C77 (10^4 X 10 Timing) for 1 triangle waveform/div.

21. Sine Upper and Lower Level

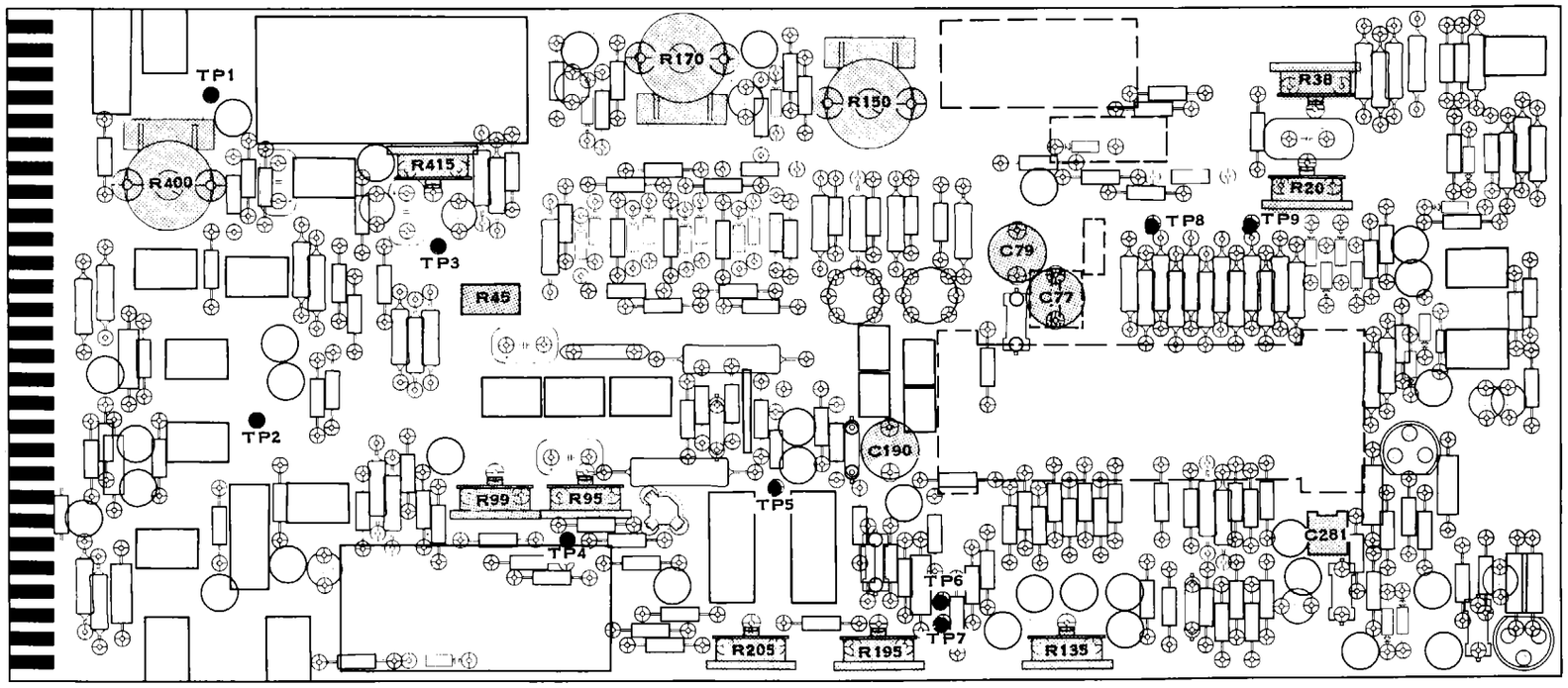
Set FUNCTION to ∿ (sine waveform), MULTIPLIER to 10^4 and the FREQUENCY Hz to 1. Connect the Notch Filter (described under Test Equipment Required) through a 50 Ω cable between the FG 501 OUTPUT and the Oscillscope vertical input at a deflection factor of 1 V/div.

22. Sine Upper and Lower Level (cont)

Set Oscilloscope sweep rate for 50 μs/div and adjust FREQUENCY Hz dial for minimum display amplitude.

23. Sine Upper and Lower Level (cont)

Set Oscilloscope for a 4 div display. Alternately adjust R150 (∿ Upper Level) then R170 (∿ Lower Level) for minimum distortion. (disregard amplitude of fundamental). Readjust FREQUENCY Hz dial for minimum amplitude and repeat the adjustment of R150 and R170.



Ⓑ

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
05091	TRI-ORDINATE CORPORATION	343 SNYDER AVENUE	BERKELEY HEIGHTS, NJ 07922
05397	UNION CARBIDE CORPORATION, MATERIALS SYSTEMS DIVISION	11901 MADISON AVENUE	CLEVELAND, OH 44101
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
24931	SPECIALTY CONNECTOR CO., INC.	3560 MADISON AVE.	INDIANAPOLIS, IN 46227
34553	AMPEREX ELECTRONIC CORP., COMPONENT DIV.	35 HOFFMAN AVE.	HAPPAUGE, NY 11787
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71450	CTS CORP.	1142 W. BEARDSLEY AVE.	ELKHART, IN 46514
71744	CHICAGO MINIATURE LAMP WORKS	4433 RAVENSWOOD AVE.	CHICAGO, IL 60640
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
74868	BUNKER-RAMO CORP., THE AMPHENOL RF DIV.	33 E. FRANKLIN ST.	DANBURY, CT 06810
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
81483	INTERNATIONAL RECTIFIER CORP.	9220 SUNSET BLVD.	LOS ANGELES, CA 90069
84411	TRW ELECTRONIC COMPONENTS, TRW CAPACITORS	112 W. FIRST ST.	OGALLALA, NE 69153
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E WASHINGTON STREET P O BOX 372	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601
91836	KINGS ELECTRONICS CO., INC.	40 MARBLEDALE ROAD	TUCKAHOE, NY 10707

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-2105-00	B010100	B125502	CKT BOARD ASSY:MAIN	80009	670-2105-00
A1	670-2105-01	B125503		CKT BOARD ASSY:MAIN	80009	670-2105-01
A2	670-2248-00			CKT BOARD ASSY:FUNCTION	80009	670-2248-00
C34	290-0519-00			CAP.,FXD,ELCTLT:100UF,20%,20V	56289	196D107X0020MA3
C40	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C72, C73, C74, C75, C76 [1]	295-0126-00	B010100	B119999	CAP.SET,MTCHD:10,1,0.1,0.01UF,990PF	84411	TEK55-0005R5
C72, C73, C74, C75, C76 [1]	295-0164-00	B120000		CAP.,SET,MTCHD:10,0.01UF,995PF	80009	295-0164-00
C77	281-0167-00	B010100	B059999X	CAP.,VAR,CER DI:9-45PF,200V	72982	538-011-D 9-45
C77	281-0513-00	XB125503		CAP.,FXD,CER DI:27PF,+/-5.4PF,500V	72982	301-000P2G0270M
C78	281-0540-00			CAP.,FXD,CER DI:51PF,5%,500V	72982	301-000U2J0510J
C79	281-0092-00			CAP.,VAR,CER DI:9-35PF,200V	72982	538-011 D9-35
C80	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C85	290-0527-00	XB060000	B089999	CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C85	290-0536-00	B090000		CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C89	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C95	290-0512-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	196D226X0015KA1
C120	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C130	283-0003-00	XB060000		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C150	290-0572-00			CAP.,FXD,ELCTLT:0.1UF,20%,50V	56289	196D104X0050HA1
C170	290-0572-00			CAP.,FXD,ELCTLT:0.1UF,20%,50V	56289	196D104X0050HA1
C190	281-0092-00			CAP.,VAR,CER DI:9-35PF,200V	72982	538-011 D9-35
C191	281-0629-00	B010100	B019999	CAP.,FXD,CER DI:33PF,5%,600V	72982	308-000C0G0330J
C191	281-0511-00	B020000	B059999X	CAP.,FXD,CER DI:22PF,+/-2.2PF,500V	72982	301-000C0G0220K
C196	283-0001-00	XB060000		CAP.,FXD,CER DI:0.005UF,+100-0%,500V	72982	831-559E502P
C204	283-0001-00	XB110000		CAP.,FXD,CER DI:0.005UF,+100-0%,500V	72982	831-559E502P
C211	283-0067-00	XB020000		CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C235	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C242	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C250	281-0651-00	B010100	B059999	CAP.,FXD,CER DI:47PF,5%,200V	72982	374-001T2H0470J
C250	281-0511-00	B060000		CAP.,FXD,CER DI:22PF,+/-2.2PF,500V	72982	301-000C0G0220K
C251	283-0637-00			CAP.,FXD,MICA D:20PF,2.5%,100V	00853	D151E200D0
C255	290-0529-00	XB060000	B109999	CAP.,FXD,ELCTLT:47UF,20%,20V	05397	T368C476M020AZ
C255	290-0719-00	B110000		CAP.,FXD,ELCTLT:47UF,20%,25V	56289	196D476X0025TE3
C271	283-0178-00			CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131N145 E 104Z
C279	281-0627-00			CAP.,FXD,CER DI:1PF,+/-0.25PF,500V	72982	301-000C0K0109C
C281	281-0151-00	B010100	B010203	CAP.,VAR,CER DI:1-3PF,100V	72982	518-600A1-3
C281	281-0178-00	B010204		CAP.,VAR,PLSTC:1-3.5PF,500V	34553	2222-809-05001
C291	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C294	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C297	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C400	290-0324-00			CAP.,FXD,ELCTLT:750UF,+75-10%,40V	56289	D46454
C406	290-0524-00			CAP.,FXD,ELCTLT:4.7UF,20%,10V	90201	TDC475M010EL
C415	283-0000-00	B010100	B019999	CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C415	290-0517-00	B020000		CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C455	290-0531-00			CAP.,FXD,ELCTLT:100UF,20%,10V	90201	TDC107M010WLC

[1]Individual timing capacitors in this assembly must be ordered by the 9-digit part number, letter suffix and tolerance printed on the timing capacitor to be replaced. The letter suffix and the tolerance should be the same for all of the timing capacitors in the assembly.
EXAMPLE: 285-XXXX-XX F-

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C482	283-0111-00	XB125503		CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C485	283-0000-00	B010100	B019999	CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C485	290-0517-00	B020000		CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C490	290-0324-00			CAP.,FXD,ELCTLT:750UF,+75-10%,40V	56289	D46454
C495	290-0531-00			CAP.,FXD,ELCTLT:100UF,20%,10V	90201	TDC107M010WLC
CR100	152-0249-00			SEMICOND DEVICE:SILICON,DIODE ASSY	80009	152-0249-00
CR101	152-0249-00			SEMICOND DEVICE:SILICON,DIODE ASSY	80009	152-0249-00
CR102	152-0249-00			SEMICOND DEVICE:SILICON,DIODE ASSY	80009	152-0249-00
CR103	152-0249-00			SEMICOND DEVICE:SILICON,DIODE ASSY	80009	152-0249-00
CR150	152-0141-02	XB020000		SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR155	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR156	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR158	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR160	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR162	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR170	152-0141-02	XB020000		SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR175	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR176	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR178	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR180	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR182	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR215	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR218	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR230	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR240	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR242	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR245	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR246	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR247	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR248	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR285	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR290	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR400	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	80009	152-0488-00
CR450	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR490	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	80009	152-0488-00
DS495	150-0109-00			LAMP,INCAND:18V,26MA	71744	CM7220
J10	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
J80	131-0282-00			CONNECTOR,RCPT,:FEEDTHRU	74868	74300MB
J81	131-1003-00			CONNECTOR BODY,:CKT CD MT,3 PRONG	80009	131-1003-00
J215	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
J290	131-0679-00	B010100	B103149	CONNECTOR,RCPT,:BNC W/HARDWARE	24931	28JR168-1
J290	131-0679-02	B103150	B125502	CONNECTOR,RCPT,:BNC W/HARDWARE	24931	28JR270-1
J290	131-0274-00	B125503		CONNECTOR,RCPT,:BNC	91836	KC79-67
LR298	108-0105-00	XB030000		COIL,RF:1.8UH	80009	108-0105-00
Q45A,B	151-0261-00			TRANSISTOR:SILICON,PNP,DUAL	80009	151-0261-00
Q45A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q80	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q85	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q90	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q120A,B	151-1042-01			TRANSISTOR:SILICON,FET,MATCHED PAIR	80009	151-1042-01
Q125	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q130	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q138	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q150	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q170	151-0188-00	B010100	B059999	TRANSISTOR:SILICON,PNP	01295	2N3906
Q170	151-0164-00	B060000		TRANSISTOR:SILICON,PNP	80009	151-0164-00
Q225	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q230	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q240	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q242	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q250	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q255	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q270	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q276	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q280	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q285	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q290	151-0133-00			TRANSISTOR:SILICON,PNP	80009	151-0133-00
Q295	151-0136-00			TRANSISTOR:SILICON,NPN	02735	35495
Q298	151-0322-00			TRANSISTOR:SILICON,PNP	80009	151-0322-00
Q400	151-1066-00			TRANSISTOR:SILICON,FE,P-CHANNEL	80009	151-1066-00
Q410	151-0311-01			TRANSISTOR:SILICON,NPN	04713	MJE340
Q415	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q420	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q424	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q430	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q445	151-0311-01			TRANSISTOR:SILICON,NPN	04713	MJE340
Q447	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q450	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q468	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q472	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q474	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q485	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q488	151-0335-00			TRANSISTOR:SILICON,PNP	80009	151-0335-00
R10	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R11	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R13	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R15	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R18	321-0272-00	B010100	B069999	RES.,FXD,FILM:6.65K OHM,1%,0.125W	91637	MFF1816G66500F
R18	315-0822-00	B070000		RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R20	311-1314-00			RES.,VAR NONWIR:5K OHM,30%,0.25W	71450	201-YA5551
R25	311-1392-00			RES.,VAR WW:10K OHM,5%,2W	02111	140-9504
R27	311-0169-00			RES.,VAR,NONWIR:100 OHM,20%,0.50W	01121	W-7564B
R30	321-0001-00			RES.,FXD,FILM:10 OHM,1%,0.125W	75042	CEAT0-10R00F
R32	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R34	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R37	321-0240-00			RES.,FXD,FILM:3.09K OHM,1%,0.125W	91637	MFF1816G30900F
R38	311-1328-00			RES.,VAR,NONWIR:100 OHM,30%,0.25W	71450	201-YA5553
R39	321-0153-00			RES.,FXD,FILM:383 OHM,1%,0.125W	91637	MFF1816G383R0F
R41	321-0926-07	B010100	B019999	RES.,FXD,FILM:4K OHM,0.1%,0.125W	91637	MFF1816C40000B
R41	321-0289-07	B020000		RES.,FXD,FILM:10K OHM,0.1%,0.125W	91637	MFF1816C10001B
R42	321-0926-07	B010100	B019999	RES.,FXD,FILM:4K OHM,0.1%,0.125W	91637	MFF1816C40000B
R42	321-0289-07	B020000		RES.,FXD,FILM:10K OHM,0.1%,0.125W	91637	MFF1816C10001B
R44	321-0289-03	B010100	B019999	RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R44	321-0289-07	B020000		RES.,FXD,FILM:10K OHM,0.1%,0.125W	91637	MFF1816C10001B
R45	311-1175-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	73138	66WR101KSM

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R46	321-0289-03	B010100	B019999	RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R46	321-0289-07	B020000		RES.,FXD,FILM:10K OHM,0.1%,0.125W	91637	MFF1816C10001B
R51	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R52	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R53	321-0261-00	B010100	B099999	RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R53	321-0260-00	B100000		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R54	321-0261-00	B010100	B099999	RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R54	321-0260-00	B100000		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R55	321-0775-00			RES.,FXD,FILM:45K OHM,1%,0.125W	91637	MFF1816G45001F
R56	321-0775-00			RES.,FXD,FILM:45K OHM,1%,0.125W	91637	MFF1816G45001F
R57	321-0982-00			RES.,FXD,FILM:450K OHM,1%,0.125W	91637	MFF1816G45002F
R58	321-0982-00			RES.,FXD,FILM:450K OHM,1%,0.125W	91637	MFF1816G45002F
R59	321-0983-00			RES.,FXD,FILM:4.5M OHM,1%,0.125W	91637	HMF188G45003F
R60	321-0983-00			RES.,FXD,FILM:4.5M OHM,1%,0.125W	91637	HMF188G45003F
R61	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R62	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R63	321-0261-00	B010100	B099999	RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R63	321-0260-00	B100000		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R64	321-0261-00	B010100	B099999	RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R64	321-0260-00	B100000		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R65	321-0775-00			RES.,FXD,FILM:45K OHM,1%,0.125W	91637	MFF1816G45001F
R66	321-0775-00			RES.,FXD,FILM:45K OHM,1%,0.125W	91637	MFF1816G45001F
R67	321-0982-00			RES.,FXD,FILM:450K OHM,1%,0.125W	91637	MFF1816G45002F
R68	321-0982-00			RES.,FXD,FILM:450K OHM,1%,0.125W	91637	MFF1816G45002F
R69	321-0983-00			RES.,FXD,FILM:4.5M OHM,1%,0.125W	91637	HMF188G45003F
R70	321-0983-00			RES.,FXD,FILM:4.5M OHM,1%,0.125W	91637	HMF188G45003F
R72	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R73	307-0113-00			RES.,FXD,CMPSN:5.1 OHM,5%,0.25W	01121	CB51G5
R80	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R81	315-0363-00			RES.,FXD,CMPSN:36K OHM,5%,0.25W	01121	CB3635
R82	315-0102-00	XB010204		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R85	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R87	323-0176-00			RES.,FXD,FILM:665 OHM,1%,0.50W	75042	CECT0-6650F
R88	323-0135-00			RES.,FXD,FILM:249 OHM,1%,0.50W	91637	MFF1226G249R0F
R89	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R94	315-0362-00	B010100	B019999	RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R94	321-0235-00	B020000		RES.,FXD,FILM:2.74K OHM,1%,0.125W	91637	MFF1816G27400F
R95	311-1308-00	B010100	B019999X	RES.,VAR,NONWIR:250 OHM,30%,0.25W	71450	201-YA5550
R96	315-0202-00	B010100	B019999	RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R96	321-0209-00	B020000		RES.,FXD,FILM:1.47K OHM,1%,0.125W	91637	MFF1816G14700F
R99	311-1308-00	B010100	B019999	RES.,VAR,NONWIR:250 OHM,30%,0.25W	71450	201-YA5550
R99	307-0113-00	B020000		RES.,FXD,CMPSN:5.1 OHM,5%,0.25W	01121	CB51G5
R100	315-0301-00	B010100	B019999	RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R100	322-0154-00	B020000		RES.,FXD,FILM:392 OHM,1%,0.25W	91637	MFF1421G392R0F
R102	315-0102-00	B010100	B019999	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R102	321-0192-00	B020000		RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
R105	315-0182-00	B010100	B019999	RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R105	321-0217-00	B020000		RES.,FXD,FILM:1.78K OHM,1%,0.125W	91637	MFF1816G17800F
R120	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R121	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R125	315-0910-00			RES.,FXD,CMPSN:91 OHM,5%,0.25W	01121	CB9105
R127	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R129	315-0103-00	B010100	B099999	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R129	315-0822-00	B100000		RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R130	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R132	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R135	311-1408-00			RES.,VAR,NONWIR1K OHM,0.25W	71450	X201R102B
R137	315-0910-00			RES.,FXD,CMPSN:91 OHM,5%,0.25W	01121	CB9105
R139	315-0242-00	B010100	B019999	RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R139	315-0152-00	B020000		RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R141	315-0621-00	B010100	B019999	RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R141	321-0168-00	B020000		RES.,FXD,FILM:549 OHM,1%,0.125W	91637	MFF1816G549R0F
R143	315-0112-00	B010100	B019999	RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R143	321-0197-00	B020000		RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R145	315-0511-00	B010100	B019999	RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R145	321-0166-00	B020000		RES.,FXD,FILM:523 OHM,1%,0.125W	91637	MFF1816G523R0F
R150	311-1199-00	B010100	B019999	RES.,VAR,NONWIR:10K OHM,30%,0.25W	71450	201-YA5543
R150	311-1120-00	B020000		RES.,VAR,NONWIR:100 OHM,30%,0.25W	71450	201-YA5531
R151	315-0152-00	B010100	B019999	RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R151	321-0243-00	B020000		RES.,FXD,FILM:3.32K OHM,1%,0.125W	91637	MFF1816G33200F
R152	321-0158-00	XB020000		RES.,FXD,FILM:432 OHM,1%,0.125W	91637	MFF1816G432R0F
R153	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R155	315-0204-00	B010100	B019999	RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R155	321-0037-00	B020000		RES.,FXD,FILM:23.7 OHM,1%,0.125W	91637	MFF1816G23R70F
R156	315-0430-00	B010100	B019999	RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
R156	321-0063-00	B020000		RES.,FXD,FILM:44.2 OHM,1%,0.125W	91637	MFF1816G44R20F
R157	315-0300-00	B010100	B019999X	RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R158	315-0750-00	B010100	B019999	RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R158	321-0085-00	B020000		RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R159	315-0681-00	B010100	B019999	RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R159	321-0154-00	B020000		RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392R0F
R160	315-0101-00	B010100	B019999	RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R160	321-0097-00	B020000		RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R161	315-0152-00	B010100	B019999	RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R161	321-0205-00	B020000		RES.,FXD,FILM:1.33K OHM,1%,0.125W	91637	MFF1816G13300F
R162	315-0750-00	B010100	B019999	RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R162	321-0085-00	B020000		RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R163	315-0332-00	B010100	B019999	RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R163	315-0242-00	B020000		RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R170	311-1199-00	B010100	B019999	RES.,VAR,NONWIR:10K OHM,30%,0.25W	71450	201-YA5543
R170	311-1120-00	B020000		RES.,VAR,NONWIR:100 OHM,30%,0.25W	71450	201-YA5531
R171	315-0152-00	B010100	B019999	RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R171	321-0243-00	B020000		RES.,FXD,FILM:3.32K OHM,1%,0.125W	91637	MFF1816G33200F
R172	321-0158-00	XB020000		RES.,FXD,FILM:432 OHM,1%,0.125W	91637	MFF1816G432R0F
R173	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R175	315-0240-00	B010100	B019999	RES.,FXD,CMPSN:24 OHM,5%,0.25W	01121	CB2405
R175	321-0037-00	B020000		RES.,FXD,FILM:23.7 OHM,1%,0.125W	91637	MFF1816G23R70F
R176	315-0430-00	B010100	B019999	RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
R176	321-0063-00	B020000		RES.,FXD,FILM:44.2 OHM,1%,0.125W	91637	MFF1816G44R20F
R178	315-0750-00	B010100	B019999	RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R178	321-0085-00	B020000		RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R180	315-0101-00	B010100	B019999	RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R180	321-0097-00	B020000		RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R182	315-0750-00	B010100	B019999	RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R182	321-0085-00	B020000		RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R190	315-0153-00	B010100	B019999	RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R190	321-0239-00	B020000		RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R191	315-0103-00	B010100	B019999	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035

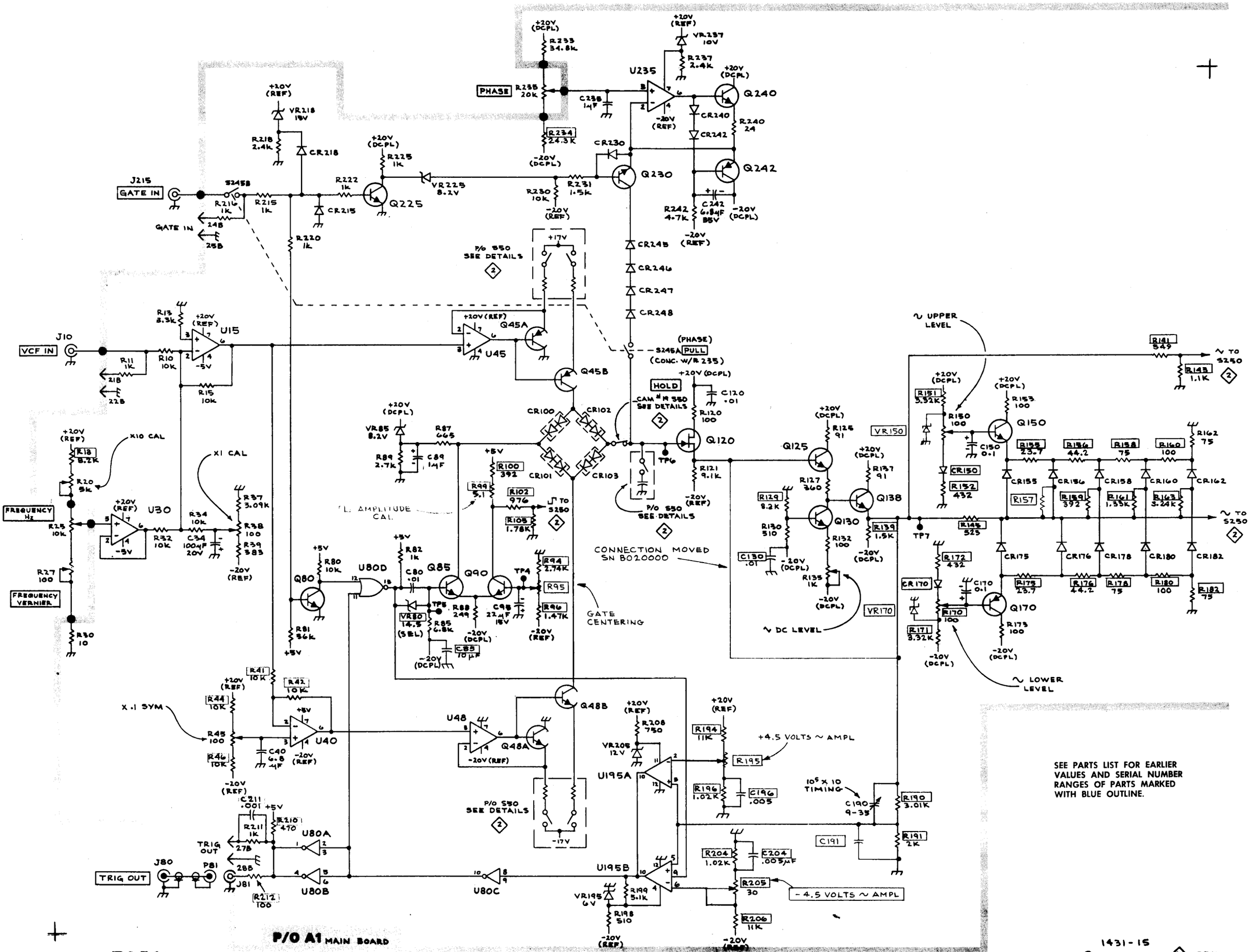
Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R191	321-0222-00	B020000		RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R194	315-0132-00	B010100	B019999	RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
R194	321-0293-00	B020000		RES.,FXD,FILM:11K OHM,1%,0.125W	91637	MFF1816G11001F
R195	311-1308-00	B010100	B019999X	RES.,VAR,NONWIR:250 OHM,30%,0.25W	71450	201-YA5550
R196	315-0101-00	B010100	B019999	RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R196	321-0194-00	B020000		RES.,FXD,FILM:1.02K OHM,1%,0.125W	91637	MFF1816G10200F
R198	301-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.50W	01121	EB5115
R199	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R204	315-0101-00	B010100	B010203	RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R204	315-0100-00	B010204	B019999	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R204	321-0194-00	B020000		RES.,FXD,FILM:1.02K OHM,1%,0.125W	91637	MFF1816G10200F
R205	311-1308-00	B010100	B019999	RES.,VAR,NONWIR:250 OHM,30%,0.25W	71450	201-YA5550
R205	315-0300-00	B020000		RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R206	315-0152-00	B010100	B019999	RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R206	321-0293-00	B020000		RES.,FXD,FILM:11K OHM,1%,0.125W	91637	MFF1816G11001F
R208	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R210	315-0751-00	B010100	B019999	RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R210	315-0471-00	B020000		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R211	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R212	315-0101-00	XB020000		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R215	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R216	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R218	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R220	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R222	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R225	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R230	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R231	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R233	321-0341-00			RES.,FXD,FILM:34.8K OHM,1%,0.125W	91637	MFF1816G34801F
R234	321-0330-00	B010100	B099999	RES.,FXD,FILM:26.7K OHM,1%,0.125W	91637	MFF1816G26701F
R234	321-0326-00	B100000		RES.,FXD,FILM:24.3K OHM,1%,0.125W	91637	MFF1816G24301F
R235[1]	311-1310-00			RES.,VAR,NONWIR:20K OHM,20%,1W	01121	10M654
R237	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R240	315-0240-00			RES.,FXD,CMPSN:24 OHM,5%,0.25W	01121	CB2405
R242	317-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.125W	01121	BB4725
R251	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R252	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R254	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R256	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R258	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R260A,B	311-1432-00			RES.,VAR,NONWIR:2 X 1K OHM,20%,0.50W	01121	11M688
R263	315-0300-00			RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R265	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R267	321-0216-00			RES.,FXD,FILM:1.74K OHM,1%,0.125W	91637	MFF1816G17400F
R268	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R269	321-0213-00			RES.,FXD,FILM:1.62K OHM,1%,0.125W	91637	MFF1816G16200F
R271	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R272	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R273	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R275	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R277	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R279	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R281	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R282	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015

[1]Furnished as a unit with S245.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R284	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R285	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R286	315-0111-00			RES.,FXD,CMPSN:110 OHM,5%,0.25W	01121	CB1115
R290	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R291	307-0104-00			RES.,FXD,CMPSN:3.3 OHM,5%,0.25W	01121	CB33G5
R294	301-0100-00	B010100	B125502	RES.,FXD,CMPSN:10 OHM,5%,0.50W	01121	EB1005
R294	308-0776-00	B125503		RES.,FXD,WW:10 OHM,5%,1W	75042	BW-20100HM5%
R295	301-0100-00	B010100	B125502	RES.,FXD,CMPSN:10 OHM,5%,0.50W	01121	EB1005
R295	308-0776-00	B125503		RES.,FXD,WW:10 OHM,5%,1W	75042	BW-20100HM5%
R296	301-0100-00	B010100	B125502	RES.,FXD,CMPSN:10 OHM,5%,0.50W	01121	EB1005
R296	308-0776-00	B125503		RES.,FXD,WW:10 OHM,5%,1W	75042	BW-20100HM5%
R297	301-0100-00	B010100	B125502	RES.,FXD,CMPSN:10 OHM,5%,0.50W	01121	EB1005
R297	308-0776-00	B125503		RES.,FXD,WW:10 OHM,5%,1W	75042	BW-20100HM5%
R298	303-0510-00	B010100	B039999	RES.,FXD,CMPSN:51 OHM,5%,1W	01121	GB5105
R298	303-0470-00	B040000		RES.,FXD,CMPSN:47 OHM,5%,1W	01121	GB4705
R299	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R400	311-1123-00			RES.,VAR,NONWIR:1K OHM,30%,0.25W	71450	201-YA5532
R403	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R405	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R406	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R410	321-0285-00	B010100	B079999	RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R410	321-0261-00	B080000		RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R411	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R412	321-0826-08	B010100	B079999	RES.,FXD,FILM:4.48K OHM,1%,0.125W	91637	MFF1816D44800F
R412	321-0231-00	B080000		RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
R415	311-1408-00			RES.,VAR,NONWIR1K OHM,0.25W	71450	X201R102B
R417	307-0110-00			RES.,FXD,CMPSN:3 OHM,5%,0.25W	01121	CB30G5
R420	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R422	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R424	308-0685-00			RES.,FXD,WW:1.5 OHM,10%,1W	75042	BW20-1R500J
R430	321-0240-00			RES.,FXD,FILM:3.09K OHM,1%,0.125W	91637	MFF1816G30900F
R431	321-0312-00			RES.,FXD,FILM:17.4K OHM,1%,0.125W	91637	MFF1816G17401F
R434	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R441	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R442	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R445	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R446	308-0685-00			RES.,FXD,WW:1.5 OHM,10%,1W	75042	BW20-1R500J
R450	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R452	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R455	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R461	315-0512-00	B010100	B019999	RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R461	315-0202-00	B020000		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R464	321-0926-07			RES.,FXD,FILM:4K OHM,0.1%,0.125W	91637	MFF1816C40000B
R465	321-0926-07			RES.,FXD,FILM:4K OHM,0.1%,0.125W	91637	MFF1816C40000B
R468	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R471	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R473	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R475	308-0685-00			RES.,FXD,WW:1.5 OHM,10%,1W	75042	BW20-1R500J
R481	321-0926-07			RES.,FXD,FILM:4K OHM,0.1%,0.125W	91637	MFF1816C40000B
R482	321-0926-07			RES.,FXD,FILM:4K OHM,0.1%,0.125W	91637	MFF1816C40000B
R485	315-0103-00	B010100	B019999	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R485	315-0202-00	B020000		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R487	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R487	307-0110-00			RES.,FXD,CMPSN:3 OHM,5%,0.25W	01121	CB30G5

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R493	307-0106-00			RES.,FXD,CMPSN:4.7 OHM,5%,0.25W	01121	CB47G5
R495	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
S50	105-0376-00			ACTR ASSY,CAM S:	80009	105-0376-00
S245[1]						
S250	105-0378-00			ACTR ASSY,CAM S:	80009	105-0378-00
U15	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U15	156-0067-06	B010204		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U30	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U30	156-0067-06	B010204		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U40	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U40	156-0067-06	B010204		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U45	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U45	156-0067-06	B010204		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U48	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U48	156-0067-06	B010204		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U80	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U195	156-0116-00			MICROCIRCUIT,LI:DUAL COMPARATOR	04713	MC1711CL
U235	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U235	156-0067-06	B010204		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U410	156-0067-00	B010100	B019999	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U410	156-0067-06	B020000		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U420	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U420	156-0067-06	B010204		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U430	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U430	156-0067-06	B010204		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U440	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U440	156-0067-06	B010204		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U460	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U460	156-0067-06	B010204		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U470	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U470	156-0067-06	B010204		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U480	156-0067-00	B010100	B019999	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U480	156-0067-06	B020000		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
VR80	152-0243-00	B010100	B019999	SEMICOND DEVICE:ZENER,0.4W,15V,5%	81483	1N965B
VR80	153-0050-00	B020000		SEMICOND DEVICE:ZENER,0.4W,14.5V,5%,SEL	80009	153-0050-00
VR85	152-0437-00			SEMICOND DEVICE:ZENER,SI,8.2V,2%,0.4W	80009	152-0437-00
VR150	152-0306-00	B010100	B019999X	SEMICOND DEVICE:ZENER,0.4W,9.1V,5%	81483	1N960B
VR170	152-0306-00	B010100	B019999X	SEMICOND DEVICE:ZENER,0.4W,9.1V,5%	81483	1N960B
VR195	152-0461-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	1N821
VR205	152-0168-00			SEMICOND DEVICE:ZENER,0.4W,12V,5%	04713	1N963B
VR218	152-0243-00			SEMICOND DEVICE:ZENER,0.4W,15V,5%	81483	1N965B
VR225	152-0437-00			SEMICOND DEVICE:ZENER,SI,8.2V,2%,0.4W	80009	152-0437-00
VR237	152-0149-00			SEMICOND DEVICE:ZENER,0.4W,10V,5%	04713	1N961B
VR405	152-0461-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	1N821

[1]Furnished as a unit with R235.



SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

P/O A1 MAIN BOARD

FG 501

REV. H, OCT 1977

1431-15

GENERATOR ① DEH

P/O A1 MAIN BOARD

A2 FUNCTION BOARD

+17V

-17V

FROM R105

FROM R141

FROM R163

C251 20

C250 22

CCW 2 1 4 3 5 6 7 8 9 10 11 CW

FUNCTION S250

R59 4.5M

R57 450k

R55 45k

R53 4.99k

R51 1.5k

R60 4.5M

R58 450k

R56 45k

R54 4.99k

R52 1.5k

TO Q45A

TO Q45B

R61 1.5k

R62 1.5k

R63 4.99k

R64 4.99k

R65 45k

R66 45k

R67 450k

R68 450k

R69 4.5M

R70 4.5M

TO Q48A

TO Q48B

CCW 10⁻³ 10⁻² 10⁻¹ X1 10¹ 10² 10³ 10⁴ 10⁵ CW

6 5 4 3 2 1 7 8 9 10 11 12 13 14 15 16 17 18 19

MULTIPLIER S50

HOLD (OPEN BETWEEN DETENT POSITIONS)

C72 10µF

R72 10

C73 1µF

C74 0.1

R73 5.1Ω

C75 .01

C77 27

C76 .450

C78 51

C79 9-35

10⁵ X1 TIMING

10⁴ X10 TIMING

TO GATE Q120

+20V (DCPL)

C271 0.1

R271 1k

HF COMP

R290 240

R291 3.3Ω

C291 100

C294 6.8µF 35V

R294 10

Q290

Q295

R295 10

CR290

C255 47µF

OUTPUT

R284 510

R256 2.4k

R260A 1k

Q250

Q255

R251 820

R252 10k

R258 510

R263 30

-20V (DCPL)

R265 3.6k

Q276

Q270

R272 10

R273 10

R275 2.4k

R277 1k

Q280

R282 100

C281 1-3

R281 68k

R279 20k

C279 1

R267 1.74k

OFFSET

R260B 1k

R268 6.8k

R269 1.62k

R284 5.1k

R285 300

Q285

R286 110

CR285

R299 30k

28A

27A

R296 10

Q298

R297 10

C297 6.8µF 35V

R298 4.7

LR298 1.8µH

15M

J290 OUTPUT

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

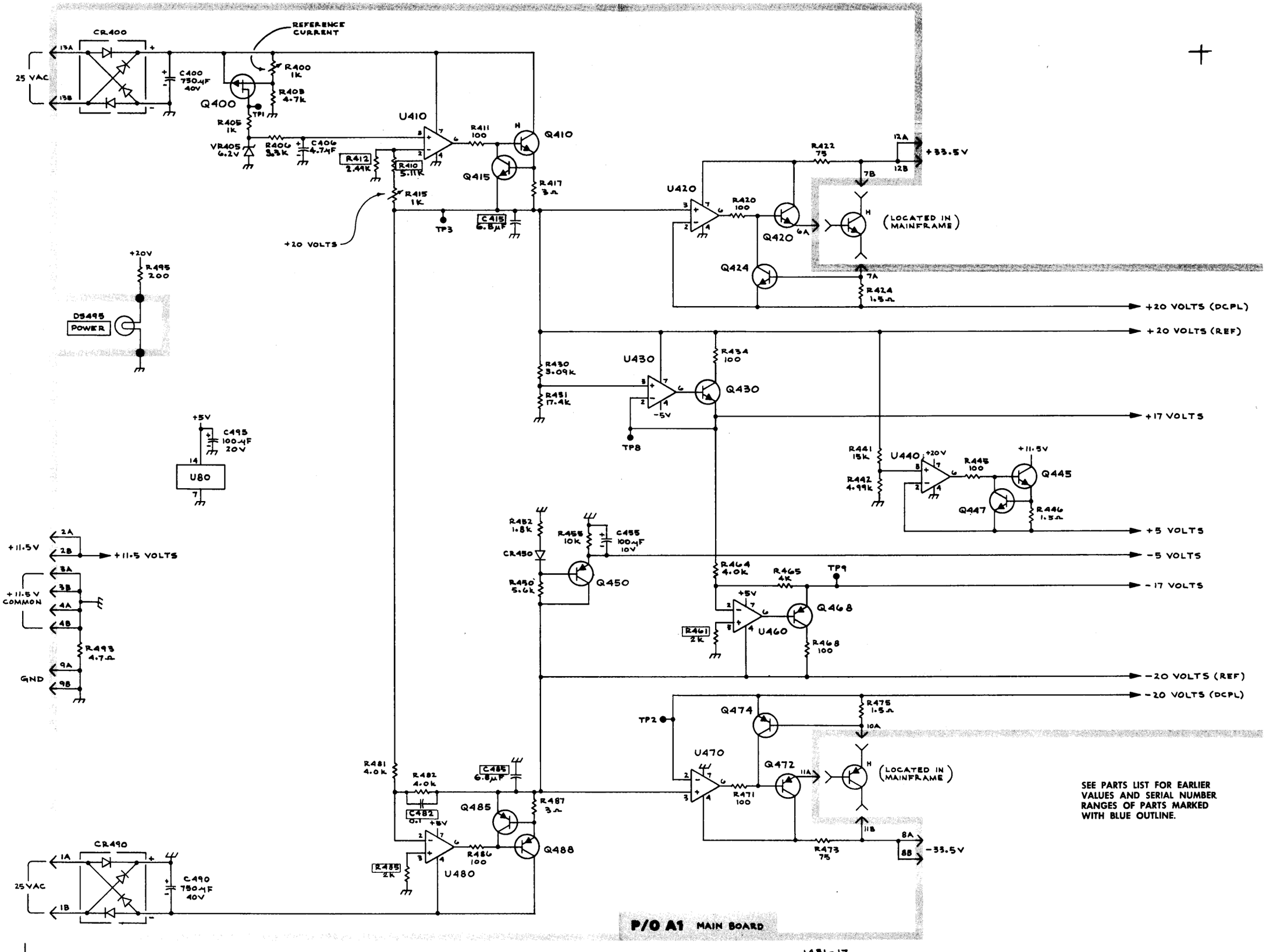
FG 501

REV. F, JUNE 1975

1431-16

OUTPUT AMPLIFIER AND SWITCH DETAILS (2)

DEH



SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

FG 501

REV. E, OCT 1977

1451-17

POWER SUPPLY 3

DEH 273

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```
1 2 3 4 5                          Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
        - - - * - - -
  Detail Part of Assembly and/or Component
  Attaching parts for Detail Part
        - - - * - - -
    Parts of Detail Part
    Attaching parts for Parts of Detail Part
        - - - * - - -
```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

"	INCH
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

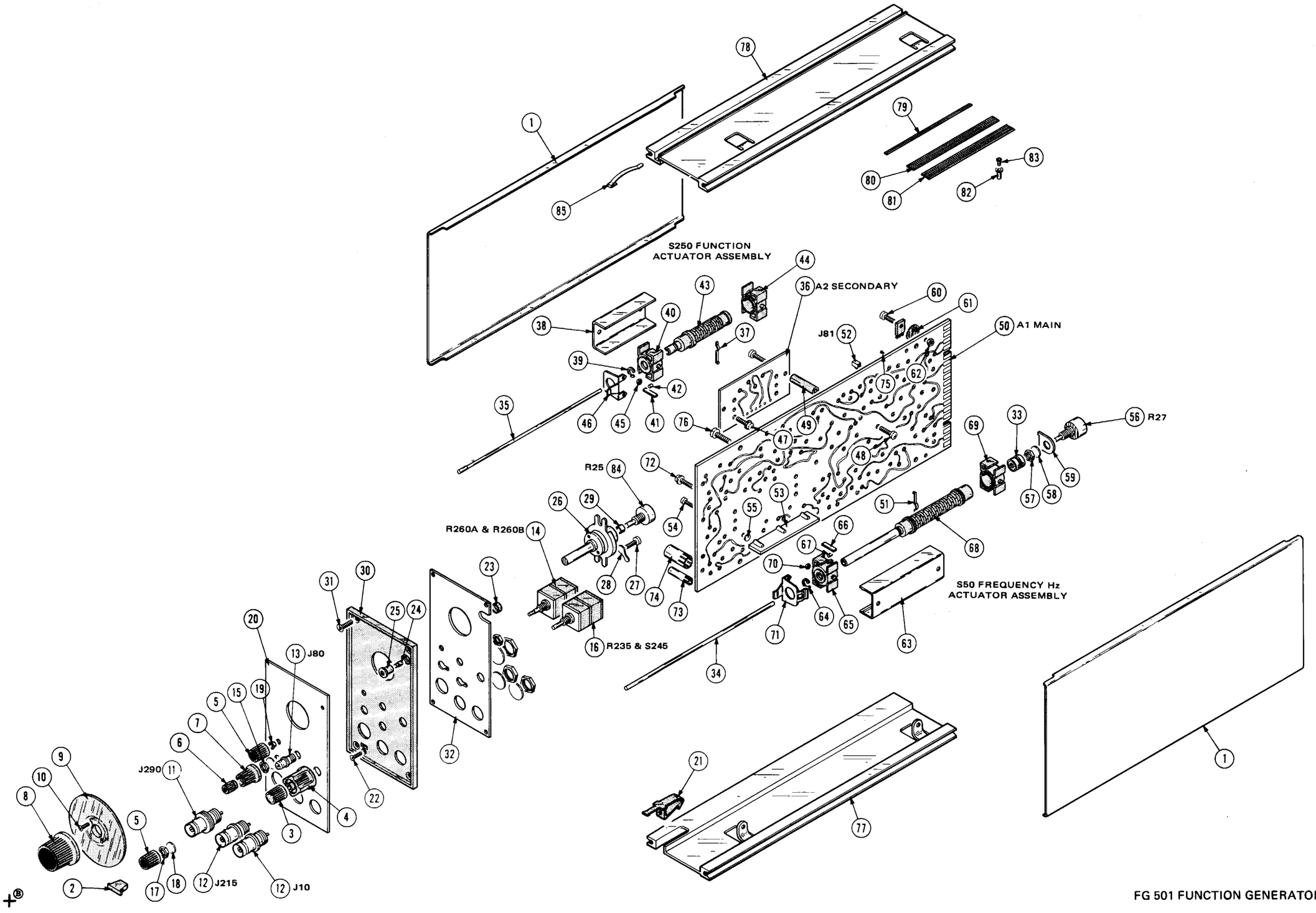
Mfr. Code	Manufacturer	Address	City, State, Zip
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
05091	TRI-ORDINATE CORPORATION	343 SNYDER AVENUE	BERKELEY HEIGHTS, NJ 07922
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
10539	JACKSON BROS., LONDON, LTD.		CROYDEN, SURREY, ENGLAND
12360	ALBANY PRODUCTS CO., DIV. OF PNEUMO DYNAMICS CORPORATION	145 WOODWARD AVENUE	SOUTH NORWALK, CT 06586
24931	SPECIALTY CONNECTOR CO., INC.	3560 MADISON AVE.	INDIANAPOLIS, IN 46227
45722	USM CORP., PARKER-KALON FASTENER DIV.		CAMPBELLSVILLE, KY 42718
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16875
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
74868	BUNKER-RAMO CORP., THE AMPHENOL RF DIV.	33 E. FRANKLIN ST.	DANBURY, CT 06810
77250	PHEOLL MANUFACTURING CO., DIVISION OF ALLIED PRODUCTS CORP.	5700 W. ROOSEVELT RD.	CHICAGO, IL 60650
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
79136	WALDES, KOHINOOR, INC.	47-16 AUSTEL PLACE	LONG ISLAND CITY, NY 11101
79807	WROUGHT WASHER MFG. CO.	2100 S. O BAY ST.	MILWAUKEE, WI 53207
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
91836	KINGS ELECTRONICS CO., INC.	40 MARBLEDALE ROAD	TUCKAHOE, NY 10707
98978	INTERNATIONAL ELECTRONIC RESEARCH CORP.	135 W. MAGNOLIA BLVD.	BURBANK, CA 91502

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	337-1399-00			2		SHLD,ELECTRICAL:SIDE	80009	337-1399-00
-2	366-1422-00	B010100	B019999	1		KNOB:LATCH	80009	366-1422-00
	366-1422-01	B020000		1		KNOB:LATCH	80009	366-1422-01
	214-1840-00	XB020000		1		. PIN,KNOB SECRG:0.094 OD X 0.120 INCH LONG	80009	214-1840-00
-3	366-1031-03			1		KNOB:RED--CAL	80009	366-1031-03
	213-0153-00			1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-4	366-1170-01			1		KNOB:GRAY,4 SIDED	80009	366-1170-01
	213-0153-00			2		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-5	366-1023-01	B010100	B059999	2		KNOB:GRAY	80009	366-1023-01
	366-1023-01	B060000		1		KNOB:GRAY	80009	366-1023-01
	366-1023-03	B060000		1		KNOB:GRAY--PULL	80009	366-1023-03
	213-0153-00			1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-6	366-1319-00			1		KNOB:GRAY	80009	366-1319-00
	213-0725-00			1		. SETSCREW:3-48 X 0.095 INCH,HEX SOC STL	74445	OBD
-7	366-1077-00			1		KNOB:GRAY	80009	366-1077-00
	213-0153-00			1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-8	366-1004-00	B010100	B089999	1		KNOB:GRAY	80009	366-1004-00
	366-1007-01	B090000		1		KNOB:GRAY	80009	366-1007-01
	213-0153-00			2		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-9	354-0437-01			1		RING,KNOB SKIRT:	80009	354-0347-01
-10	211-0030-00	B010100	B099999	2		SCREW,MACHINE:2-56 X 0.25"82 DEG,FLH STL	83385	OBD
	211-0088-00	B010000		1		SCREW,MACHINE:2-56 X 0.281"82 DEG,FLH STL	77250	OBD
-11	131-0679-00	B010100	B103149	1		CONNECTOR,RCPT,:BNC W/HARDWARE	24931	28JR168-1
	131-0679-02	B103150	B125502	1		CONNECTOR,RCPT,:BNC W/HARDWARE	24931	28JR270-1
	131-0274-00	B125503		1		CONNECTOR,RCPT,:BNC	91836	KC79-67
						(ATTACHING PARTS)		
	220-0497-00	B103150		1		NUT,PLAIN,HEX.:0.5-28 X 0.562 INCH HEX,BRS	73743	OBD
	210-1039-00	B103150		1		WASHER,LOCK:INT,0.521 ID X 0.625 INCH OD	24931	OBD
						- - - * - - -		
-12	131-0955-00			2		CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
-13	131-0282-00			1		CONNECTOR,RCPT,:FEEDTHRU	74868	74300MB
-14	----- -----			1		RESISTOR,VAR:(SEE R206A AND R206B EPL)		
						(ATTACHING PARTS)		
-15	210-0583-00			1		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
	210-0940-00			1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
-16	----- -----			1		RESISTOR,VAR:(SEE R235 AND R245 EPL)		
						(ATTACHING PARTS)		
-17	210-0583-00			1		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-18	210-0940-00			1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
						- - - * - - -		
-19	358-0378-00			1		BUSHING,SLEEVE:PRESS MOUNT	80009	358-0378-00
-20	333-1644-00	B010100	B109999	1		PANEL,FRONT:	80009	333-1644-00
	333-1644-01	B110000		1		PANEL,FRONT:	80009	333-1644-01
-21	214-1513-00	B010100	B019999	1		LCH,PLUG-IN RET:	80009	214-1513-00
	214-1513-01	B020000		1		LCH,PLUG-IN RET:	80009	214-1513-01
						(ATTACHING PARTS)		
-22	213-0254-00			1		SCR,TPG,THD CTG:2-32 X 0.250,100 DEG,FLH	45722	OBD
						- - - * - - -		
-23	200-0935-00			1		BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-24	378-0602-00			1		LENS,LIGHT:GREEN	80009	378-0602-00
-25	352-0157-00			1		LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-26	401-0206-00			1		GR ASSY,SP RDCN:	10539	4511/DAF
						(ATTACHING PARTS)		
-27	213-0088-00	B010100	B010203	2		SCR,TPG,THD CTG:4-24 X 0.25 INCH,PNH STL	83385	OBD
	213-0044-00	B010204	B099999	2		SCR,TPG,THD FOR:5-32 X 0.188 INCH,PNH STL	83385	OBD
	213-0138-00	B010000		2		SCR,TPG,THD FOR:4-40 X 0.188 INCH,PNH STL	83385	OBD
-28	210-0201-00			1		TERMINAL,LUG:SE #4	78189	2104-04-00-2520N
						- - - * - - -		
-29	358-0481-00			1		BUSHING,SLEEVE:SPLIT,0.128 ID X 0.25 INCH OD	80009	358-0481-00
-30	386-2372-00	B010100	B109999	1		SUBPANEL,FRONT:	80009	386-2372-00
	386-2372-01	B110000		1		SUBPANEL,FRONT:	80009	386-2372-01
						(ATTACHING PARTS)		
-31	213-0229-00			4		SCR,TPG,THD FOR:6-20 X0.375"100 DEG,FLH STL	83385	OBD
						- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-32	337-1713-00	B010100	B109999	1		SHIELD,ELEC:SUBPANEL,FRONT	80009	337-1713-00
	337-1713-01	B110000		1		SHIELD,ELEC:SUBPANEL,FRONT	80009	337-1713-01
-33	376-0051-00	B010100	B089999	1		CPLG,SHAFT,FLEX:FOR 0.125 INCH DIA SHAFTS	80009	376-0051-00
	376-0051-01	B090000		1		CPLG,SHAFT,FLEX:FOR 0.125 INCH DIA SHAFTS	80009	376-0051-01
	376-0049-00			1		. CPLG,SHAFT,FLEX:PLASTIC	80009	376-0049-00
	354-0251-00			2		. RING,COUPLING:0.251 ID X 0.375 INCH OD,AL	80009	354-0251-00
	213-0022-00	B010100	B089999	4		. SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	OBD
	213-0178-00	B090000		4		. SETSCREW:4-40 X 0.125 INCH,HEX,SOC STL	74445	OBD
-34	384-0209-00			1		EXTENSION SHAFT:0.125 OD X 6.064 INCH LONG	80009	384-0209-00
-35	384-0406-00			1		EXTENSION SHAFT:0.125 OD X 5.937 INCH LONG	80009	384-0406-00
-36	----- -----			1		CKT BOARD ASSY:SECONDARY(SEE A2 EPL)		
-37	131-0604-00			11		. CONTACT,ELEC:CKT CD SW,SPR	80009	131-0604-00
	105-0378-00			1		. ACTR ASSY,CAM S:(S250)	80009	105-0378-00
-38	200-1435-00			1		. . COVER,CAM SW:	80009	200-1435-00
-39	354-0219-00			1		. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
-40	401-0155-00			1		. . BEARING,CAM SW:FRONT	80009	401-0155-00
-41	214-1704-00[1]			1		. . SPRING,FLAT:CAM SW DETENT,0.006 INCH THK	80009	214-1704-00
	214-1704-01[1]			1		. . SPRING,FLAT:CAM SW DETENT,0.008 INCH THK	80009	214-1704-01
	214-1704-02[1]			1		. . SPRING,FLAT:CAM SW DETENT,0.010 INCH THICK	80009	214-1704-02
-42	214-1127-00			1		. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-43	105-0377-00			1		. . ACTUATOR,CAM SW:	80009	105-0377-00
-44	401-0156-00			1		. . BEARING,CAM SW:REAR	80009	401-0156-00
-45	210-0406-00			4		. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-46	131-1248-00			1		. . CONTACT,ELEC:GROUND	80009	131-1248-00
						(ATTACHING PARTS FOR ACTR ASSY)		
-47	211-0116-00			4		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
						- - - * - - -		
						(ATTACHING PARTS FOR CKT BD ASSY)		
-48	211-0008-00			2		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
	211-0168-00			2		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	12360	OBD
-49	129-0080-00			2		POST,ELEC-MECH:0.875 INCH LONG	80009	129-0080-00
						- - - * - - -		
-50	----- -----			1		CKT BOARD ASSY:MAIN(SEE A1 EPL)		
	131-0566-00	XB020229		1		. LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
-51	131-0604-00			19		. CONTACT,ELEC:CKT CD SW,SPR	80009	131-0604-00
-52	131-1003-00			1		. CONNECTOR BODY,:CKT CD MT,3 PRONG	80009	131-1003-00
-53	337-1418-01			1		. SHIELD,ELEC:CAM SWITCH	80009	337-1418-01
						(ATTACHING PARTS)		
-54	211-0001-00			3		. SCREW,MACHINE:2-56 X 0.25 INCH,PNH STL	83385	OBD
	210-1008-00			3		. WASHER,FLAT:0.09 ID X 0.188" OD,BRS	12360	OBD
-55	342-0167-00			1		. INSULATOR,PLATE:2.45 INCH LONG	80009	342-0167-00
						- - - * - - -		
-56	----- -----			1		. RESISTOR,VAR:(SEE R27 EPL)		
						(ATTACHING PARTS)		
-57	210-0583-00			1		. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-58	210-0046-00			1		. WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
-59	407-0579-00			1		. BRKT,RES.MTG:	80009	407-0579-00
						- - - * - - -		
-60	211-0008-00			3		. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-61	210-0921-00			3		. WASHER,MICA:0.50 X 0.141 X0.005 INCH THK	80009	210-0921-00
-62	210-0406-00			3		. NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
	105-0376-00			1		. ACTR ASSY,CAM S:(S50)	80009	105-0376-00
-63	200-1434-00			1		. . COVER,CAM SW:	80009	200-1434-00
-64	354-0219-00			1		. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
-65	401-0155-00			1		. . BEARING,CAM SW:FRONT	80009	401-0155-00
-66	214-1704-00[1]			1		. . SPRING,FLAT:CAM SW DETENT,0.006 INCH THK	80009	214-1704-00
	214-1704-01[1]			1		. . SPRING,FLAT:CAM SW DETENT,0.008 INCH THK	80009	214-1704-01
	214-1704-02[1]			1		. . SPRING,FLAT:CAM SW DETENT,0.010 INCH THICK	80009	214-1704-02
-67	214-1127-00			1		. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-68	105-0375-00			1		. . ACTUATOR,CAM SW:	80009	105-0375-00
-69	401-0156-00			1		. . BEARING,CAM SW:REAR	80009	401-0156-00
-70	210-0406-00			4		. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402

[1]Replace only with part bearing the same color code as the original part in your instrument.

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-71	131-1248-00			1		. . CONTACT,ELEC:GROUND	80009	131-1248-00
						(ATTACHING PARTS FOR ACTR ASSY)		
-72	211-0116-00			4		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
						- - - * - - -		
-73	214-0269-00			2		. HEAT SINK,XSTR:0.312 DIA X 0.75 L	98978	TXD-032-75
-74	214-0693-00			3		. HEAT SINK, ELEC:0.25 ID X 0.75 INCH LONG	98978	TXD017-075
	214-0579-00	XB010204		9		. TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-75	136-0252-00			209		. SOCKET,PIN TERM:0.145 INCH LONG	00779	2-330808-7
						(ATTACHING PARTS FOR CKT BD ASSY)		
-76	213-0146-00			4		SCR,TPG,THD FOR:6-20 X 0.313 INCH,PNH STL	83385	OBD
						- - - * - - -		
-77	426-0724-00			1		FR SECT,PLUG-IN:BOTTOM	80009	426-0724-00
-78	426-0725-00			1		FR SECT,PLUG-IN:TOP	80009	426-0725-00
-79	175-0825-00			FT		WIRE,ELECTRICAL:2 WIRE RIBBON,0.531 FT LONG	08261	OBD
-80	175-0828-00			FT		WIRE,ELECTRICAL:5 WIRE RIBBON,0.334 FT LONG	08261	OBD
-81	175-0829-00			FT		WIRE,ELECTRICAL:6 WIRE RIBBON,0.334 FT LONG	08261	OBD
-82	210-0774-00			1		EYELET,METALLIC:0.152 OD X 0.245 INCH L,BRS	80009	210-0774-00
-83	210-0775-00			1		EYELET,METALLIC:0.126 OD X 0.23 INCH L,BRS	80009	210-0775-00
-84	----- -----			1		RESISTOR,VAR:(SEE R25 EPL)		
-85	214-1061-00	XB050297		1		SPRING,GROUND:FLAT	80009	214-1061-00



FG 501 FUNCTION GENERATOR

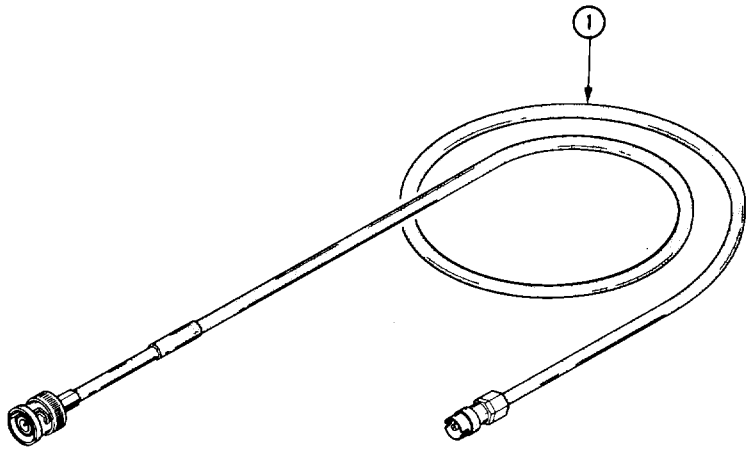


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5 Name & Description	Mfr Code	Mfr Part Number
2-	012-0127-00			1	CABLE ASSY,RF:18.50 INCHES LONG	80009	012-0127-00
	070-1431-00			1	MANUAL,TECH:INSTRUCTION	80009	070-1431-00

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 ns into 50 Ω.	107 - Risetime less than 3.0 ns into 50 Ω.
108	PG 501 - 5 V output pulse; 3.5 ns Risetime.	108 - 10 V output pulse; 1 ns Risetime.
111	PG 501 - Risetime less than 3.5 ns; 8 ns Pretrigger pulse delay.	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger Pulse delay.
114	PG 501 - ±5 V output.	114 - ±10 V output. Short proof output.
115	PG 501 - Does not have Paired, Burst, Gated, or Delayed pulse mode; ±5 V dc Offset. Has ±5 V output.	115 - Paired, Burst, Gated, and Delayed pulse mode; ±10 V output. Short-proof output.
PG 502 replaces 107		
108	PG 502 - 5 V output	108 - 10 V output.
111	PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay.	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay.
114	PG 502 - ±5 V output	114 - ±10 V output. Short proof output.
115	PG 502 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; Has ±5 V output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; ±10 V output. Short-proof output.
2101	PG 502 - Does not have Paired or Delayed pulse. Has ±5 V output.	2101 - Paired and Delayed pulse; 10 V output.
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
191	SG 503 - Frequency range 250 kHz to 250 MHz.	191 - Frequency range 350 kHz to 100 MHz.
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
TG 501 replaces 180, 180A	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Marker outputs, 5 sec to 1 μs. Sinewave available at 20, 10, and 2 ns. Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns.	181 - Marker outputs, 1, 10, 100, 1000, and 10,000 μs, plus 10 ns sinewave.
184	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Marker outputs, 5 sec to 2 ns. Sinewave available at 50, 20, 10, 5, and 2 ns. Separate trigger pulses of 1 and .1 sec; 10, 1, and .1 ms; 10 and 1 μs. Marker amplifier provides positive or negative time marks of 25 V min. Marker intervals of 1 and .1 sec; 10, 1, and .1 ms; 10 and 1 μs.
2901	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Marker outputs, 5 sec to 0.1 μs. Sinewave available to 50, 10, and 5 ns. Separate trigger pulses, from 5 sec to 0.1 μs. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in instruments require TM 500-Series Power Module.

TEKTRONIX®
committed to technical excellence

MANUAL CHANGE INFORMATION

PRODUCT FG 501
070-1431-00

CHANGE REFERENCE C3/1177
DATE 11-10-77

CHANGE:	DESCRIPTION

ADJUSTMENT PROCEDURE CHANGES FOR ALL SN B020000 & UP

Page 3-1

DELETE: Existing Test Equipment Required items 1 through 5 and replace with the following items 1 through 9:

1. Oscilloscope. Bandwidth, dc to 15 MHz; Deflection factor, 10 mV/div to 5 V/div; Sweep rate 20 ns/div to 1 ms/div. Tektronix T921 or equivalent (SC 502[1] may be used if available, and SC 501[1] may be used if it is not considered necessary to check risetime in Adjustment Step 6).

2. TM 500-series Power Module(s). Compartments enough to accommodate the FG 501 and items 1, 3, 4, and 5 if TM 500-series instruments are used for these functions. Tektronix TM 501, TM 503, TM 504, TM 506, TM 515 or combinations as required.

3. Digital Voltmeter. Range, 0 to ±20 Vdc; Displayed error, less than 0.5%. Tektronix DM 501[1], DM 501 Option 1[1], or equivalent. With included test leads.

4. Frequency Counter. Frequency, 0.1 Hz to above 1 MHz; Accuracy, within one part in 10^5 ±1 count. Tektronix DC 504[1] or equivalent.

5. Pulse or Function Generator. Output, square-wave, Amplitude, 0 to +2 V into 50 Ω termination; Period, .2 ms; Duration, .1 ms. Tektronix PG 501[1], FG 501[1], FG 502[1], or equivalent.

6. Plug-in Extension. Tektronix Calibration Fixture, Part No. 067-0645-02. NOTE: Do not use this extension to plug the FG 501 into any instrument other than TM 500-series Power Modules.

7. Cable (2 required). Impedance, 50 Ω; Length, 42 inch; Connectors, bnc. Tektronix Part No. 012-0057-01.

8. Termination (2 required). Impedance, 50 Ω; Connectors, bnc. Tektronix Part No. 011-0049-01.

9. Termination. Impedance, 600 Ω; Connectors, bnc. Tektronix Part No. 011-0092-00.

[1]Requires TM 500-series Power Module.

CHANGE:	DESCRIPTION

Page 3-2 Item 6 in first column.

CHANGE: Item number from 6 to 10.

Page 3-2 Preparation, step 3.

CHANGE TO:

3. Apply power to the Power Module(s) and test equipment, and turn them on. Check that the POWER indicator on the FG 501 is lit. Allow at least 20 minutes equipment warmup before commencing with adjustment procedure.

CONTROLS AND ADJUSTMENTS PULLOUT PAGE

CHANGE: Existing TP6 on Adjustment location drawing to read TP7.

ADD: TP6 at right of C190 on Adjustment Locations drawing.

ADD: TP8 at left of TP9 and above R60 (see Component Locations for R60).

REPLACE: Existing ADJUSTMENT PROCEDURE SN B020000-UP, steps 1 through 17 with the following:

1. Preliminary Control Settings:

FUNCTION	⋀⋁ (triangle)
OUTPUT	Fully cw
OFFSET	Midrange
PHASE	Off (pushed in, set to 0°)
FREQUENCY VERNIER	Calibrated (fully cw)
MULTIPLIER	10^4
FREQUENCY Hz	5

2. Reference Current Adjustment (+13.8 V dc)
   a. Set digital voltmeter to 20 V dc range and connect the Lo input lead to ground (at negative end of C400). Connect the Hi input meter lead to TP1 on the FG 501.
   b. ADJUST--R400 (Reference Current) for a meter reading of +13.8 V dc.

3. +20 Volt Supply Adjustment
   a. Move digital voltmeter Hi input lead to TP3 on the FG 501.
   b. ADJUST--R415 (+20 Volts) for a meter reading of +20.0 V dc.

4. +17 Volt Supply Check
   a. Move digital voltmeter Hi input lead to TP8 on the FG 501.
   b. CHECK--For a meter reading of +17 V dc, ±200 mV (+16.80 V to +17.20 V).

CHANGE:	DESCRIPTION

5. -17 Volt Supply Check

   a. Move digital voltmeter Hi input lead to TP9 on the FG 501.

   b. CHECK--For a meter reading of -17 V dc, ±200 mV (-17.20 to -16.80V).

   c. Disconnect digital voltmeter leads from the FG 501.

6. Adjust Square-wave High-frequency Compensation and Check Risetime

   a. Set oscilloscope Volts/div to 1 V; Input Coupling to dc; Time/div to 2 µs (Mag off). Set FG 501 FUNCTION to ⌐⌐ (square-wave).

   b. Connect FG 501 OUTPUT through a 50 Ω cable to a 50 Ω termination at the oscilloscope vertical input connector. Check that display amplitude is at least 7.5 V p-p.

   c. Set oscilloscope Variable Volts/div, triggering, intensity, focus, and position controls for a visible, triggered, vertically centered 5-division display.

   d. ADJUST--C281 (⌐⌐ HF comp) for a square front corner and flat top with minimum aberrations on the positive-going portion of the square-wave display (this adjustment will affect square-wave risetime).

   e. Set oscilloscope Time/div to 20 ns (Mag on), and intensity, triggering, and position as necessary to observe the positive-going square-wave leading edge over approximately five horizontal graticule divisions.

   f. Measure risetime of leading edge (refer to oscilloscope manual for risetime measurement techniques). Adjust position controls as required. At 20 ns/div, risetime reading should be no more than 5 horizontal divisions between 10% and 90% risetime points (100 ns or less).

   g. If necessary, repeat parts d through f for a compromise of best leading edge, flat top with minimum aberrations (not to exceed 5%) and risetime of no more than 100 ns.

7. Dial Calibration

   a. Set FUNCTION to ∧∨ (triangle waveform) and oscilloscope Time/div to 10 µs; triggering for a triggered display.

CHANGE:	DESCRIPTION

7. Dial Calibration (cont.)

b. Set FREQUENCY Hz dial just to the point (near 10) where frequency of the displayed waveform becomes maximum and there is no further change. This will be a few degrees before waveform disappears (dial rotates continuously, there is no stop, and no signal output for a part of the area above 10 and below .1). For ease in determining point of maximum frequency, use oscilloscope Horizontal Position control to move display so right end of sweep can be viewed.

c. CHECK--That FREQUENCY Hz dial reads 10 at the point where frequency of output signal ceases to increase.

d. If dial does not read 10, loosen two setscrews on brass collar behind dial and panel, and position the dial to 10 while holding the potentiometer shaft with needle-nose pliers. Re-tighten the setscrews.

8. X.1 Symmetry Adjustment

a. Set FUNCTION to ⊓⊔ (square-wave signal) and FREQUENCY Hz dial near 1 to display one full triggered square-wave cycle over 10 graticule divisions.

b. ADJUST--R45 (X.1 Sym) so the positive-going and negative-going portions of the signal are of equal durations (set the oscilloscope Horizontal Position as necessary). Switch oscilloscope Triggering Slope repeatedly from plus to minus while making final adjustment of R45.

c. Disconnect 50 Ω termination from oscilloscope vertical input connector.

9. X10 Calibration

a. Set MULTIPLIER to 10^3; FREQUENCY Hz to 10, and FUNCTION to ∧∨ (triangle waveform).

b. Connect a bnc "T" connector to the frequency counter input, the 50 Ω termination (at end of cable from FG 501 OUTPUT connector) to one input of the "T", and a 50 Ω bnc cable from the other input of the "T" to the test oscilloscope vertical input connector.

c. Set counter Function to 1 Hz; Hold-knob, fully ccw; Source, Ext; Trigger Level to 0.

d. Set oscilloscope Time/div to .1 ms, and triggering for a stable, triggered display.

e. ADJUST--R20 (X10 Cal) for a counter reading of 10,000 (note an oscilloscope display of approximately one cycle/div).

CHANGE:	DESCRIPTION

10. X1 Calibration

a. Set FG 501 FREQUENCY Hz to 1, and oscilloscope Time/div to 1 ms.

b. ADJUST--R38 (X1 Cal) for a counter reading of 1.0000 (note an oscilloscope display of about one cycle/div).

c. Set FG 501 FREQUENCY Hz to 10, and oscilloscope Time/div to .1 ms.

d. CHECK--For a counter reading of 10.000. If necessary, re-adjust R20 (X10 Cal) for a 10.000 reading (note an oscilloscope display of about one cycle/div).

e. Repeat steps 9 and 10 as necessary.

11. 10^5 X10 Timing Adjustment

a. Set FG 501 MULTIPLIER to 10^5; FREQUENCY Hz to 10; oscilloscope Time/div to 1 μs; and counter to .1 kHz.

b. ADJUST--C190 (10^5 X10 Timing) for a counter reading of 1.0000 (note oscilloscope display of about one cycle/div).

12. 10^5 X1 Timing Adjustment

a. Set FG 501 FREQUENCY Hz to 1, and oscilloscope Time/div to 10 μs.

b. ADJUST--C79 (10^5 X1 Timing) for a counter reading of .1000 (note oscilloscope display of about one cycle/div).

13. 10^4 X10 Timing (Below SN B060000 only)

a. Set FG 501 MULTIPLIER to 10^4 and FREQUENCY Hz to 10.

b. ADJUST--C77 (10^4 X10 Timing) for a counter reading of .1000 (note oscilloscope display of about one cycle/div).

14. Sine-wave Upper and Lower Level Adjustment

a. Set FG 501 FUNCTION to ∿ (sine-wave signal); MULTIPLIER to 10^4, and FREQUENCY Hz to 1. Set oscilloscope Time/div to .1 ms and triggering source to EXT.

b. Remove the "T" connector from the counter and the 50 Ω cable from the oscilloscope vertical input connector. Connect the 50 Ω termination on the cable from the FG 501 directly to the oscilloscope vertical input.

c. Connect the special FG 501 trigger output cable (included standard accessory) from the FG 501 TRIG OUT connector to a 600 Ω termination (item 9 of Test Equipment Required) at the oscilloscope external triggering input connector.

CHANGE:	DESCRIPTION

14. Sine-wave Upper and Lower Level Adjustment (cont.)

d. Verify a 5-division vertical amplitude oscilloscope display. Adjust the variable volts/div for five divisions if necessary.

e. Disconnect the 50 Ω termination from the oscilloscope vertical input, and insert the notch filter (item 10 of Test Equipment Required) and a 50 Ω bnc cable between the 50 Ω termination and the oscilloscope vertical input.

f. Set oscilloscope Volts/div to 10 mV without changing variable setting, and set triggering for a stable display.

g. Set FREQUENCY Hz dial (at a point between 1 and 10) and the 250 Ω potentiometer in the notch filter to settings that result in minimum display amplitude.

h. ADJUST--R150 (∩ Upper Level) and R170 (∩ Lower Level) alternately for minimum distortion on displayed waveform. Ignore spikes (fundamental component) while making these adjustments. Re-set FREQUENCY Hz dial (at some point between 1 and 10) and the 250 Ω notch filter potentiometer to settings that result in minimum display amplitude.

i. Repeat all of parts f and g to achieve minimum amplitude and minimum distortion (less than 0.5% referenced to level set in part c) of displayed waveform.

j. Remove notch filter and 50 Ω cable, and connect the 50 Ω termination directly to the oscilloscope vertical input.

k. Disconnect TRIG OUT cable and 600 Ω termination, Set oscilloscope Triggering Source to Int, and Volts/div to 1 V.

15. Triangle DC Level and Phase Range Adjustment

a. Set FG 501 FUNCTION to ∧∨ (triangle waveform); MULTIPLIER to 10^4; and FREQUENCY Hz to 10.

b. Set pulse generator (item 5 of equipment required) for a .2 ms period and .1 ms duration positive-going pulse with between 1 and 2 volts amplitude into 50 Ω termination.

c. Connect pulse generator + output through a 50 Ω bnc cable to a 50 Ω termination at the FG 501 GATE IN connector.

CHANGE:	DESCRIPTION

15. Triangle DC Level and Phase Range Adjustment (cont.)

d. Pull FG 501 PHASE control button out (on).

e. CHECK--Display should be several bursts of triangle waveforms with a horizontal bar connecting one burst to the next. Rotate the PHASE knob fully clockwise and the horizontal bars should move to at least the top of the triangle burst waveforms. Rotate the PHASE control fully counterclockwise, and the horizontal bar should move to at least the bottom of the triangle burst waveforms.

f. ADJUST--R135 (⋀⋁ DC Level) if operation is not as described in part e (adjust for equal movement of bar above and below burst waveforms).

g. Repeat parts e and f as necessary.

h. Return PHASE knob to 0° and push button in (off). Disconnect test equipment for the FG 501.

THIS COMPLETES THE FG 501 ADJUSTMENT PROCEDURE

TEKTRONIX®
committed to technical excellence

MANUAL CHANGE INFORMATION

PRODUCT FG 501
070-1431-00

CHANGE REFERENCE M30947
DATE 1-31-78

CHANGE:	DESCRIPTION

EFF SN B130000

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

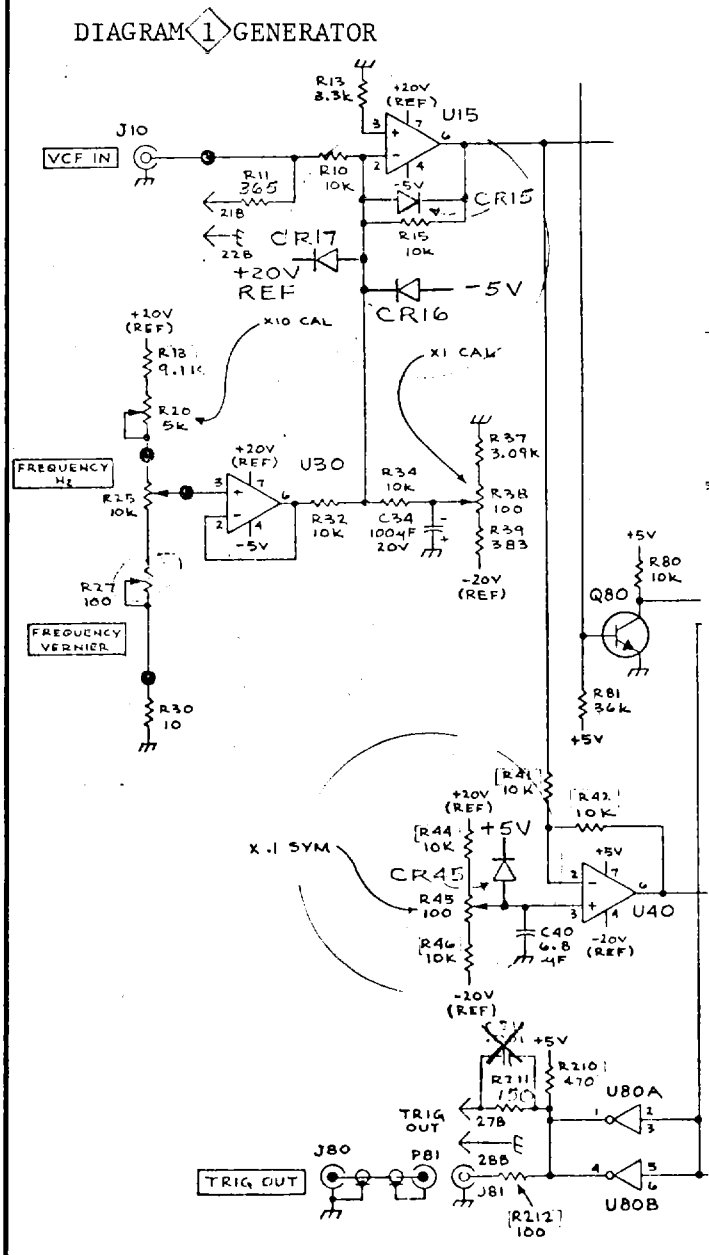
A1	670-2105-02	CKT BOARD ASSY:MAIN
A2	670-2248-01	CKT BOARD ASSY:FUNCTION
Q295	151-0439-00	TRANSISTOR:SILICON,NPN,D40E7
Q298	151-0440-00	TRANSISTOR:SILICON,PNP,D41E4
R11	321-0151-00	RES.,FXD,FILM:365 OHM,1%,0.125W
R18	315-0912-00	RES.,FXD,CMPSN:9.1K OHM(NOM VALUE)SEL
R211	315-0151-00	RES.,FXD,CMPSN:150 OHM,5%,0.25W
R260A,B	311-1950-00	RES.,VAR,NONWIR:2 X 1K OHM,20%,0.50W
R267	321-0213-00	RES.,FXD,FILM:1.6K OHM,1%,0.125W
R271	315-0821-00	RES.,FXD,CMPSN:820 OHM,5%,0.25W
R277	315-0821-00	RES.,FXD,CMPSN:820 OHM,5%,0.25W
R279	321-0213-00	RES.,FXD,FILM:1.62K OHM,1%,0.125W
R281	321-0276-00	RES.,FXD,FILM:7.32K OHM,1%,0.125W
R282	315-0821-00	RES.,FXD,CMPSN:820 OHM,5%,0.25W
R284	315-0100-00	RES.,FXD,CMPSN:10 OHM,5%,0.25W
R285	315-0821-00	RES.,FXD,CMPSN:820 OHM,5%,0.25W
R286	315-0241-00	RES.,FXD,CMPSN:240 OHM,5%,0.25W
R298	305-0101-00	RES.,FXD,CMPSN:100 OHM,5%,2W
U410	156-0400-00	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,MC1436CG
U420	156-0400-00	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,MC1436CG
U470	156-0400-00	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,MC1436CG
U480	156-0400-00	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,MC1436CG

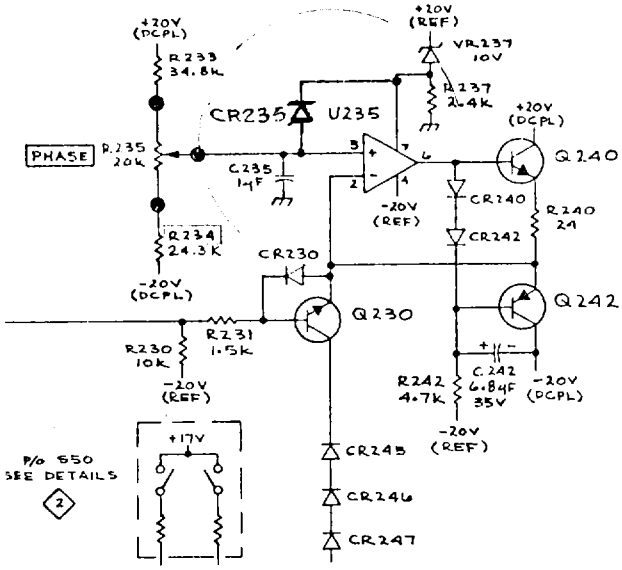
CHANGE:		DESCRIPTION
REMOVE:		
C211	283-0067-00	CAP.,FXD,CER DI:0.001UF,10%,200V
C251	283-0637-00	CAP.,FXD,MICA D:20PF,2.5%,100V
C279	281-0627-00	CAP.,FXD,CER DI:1PF,+/-0.25PF,500V
LR298	108-0105-00	COIL,RF:1.8UH
R272	315-0100-00	RES.,FXD,CMPSN:10 OHM,5%,0.25W
R273	315-0100-00	RES.,FXD,CMPSN:10 OHM,5%,0.25W
ADD:		
C162	281-0519-00	CAP.,FXD,CER DI:47PF,+/-4.7PF,500V
C286	281-0523-00	CAP.,FXD,CER DI:100PF,+/-20PF,500V
CR15	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR16	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR17	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR45	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR235	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
CR410	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA.1N4152
R266	321-0186-00	RES.,FXD,FILM:845 OHM,1%,0.125W
R274	311-1568-00	RES.,VAR,NONWIR:50 OHM,0.5W
R293	305-0101-00	RES.,FXD,CMPSN:100 OHM,5%,2W
S260		FURNISHED AS A UNIT WITH R260A,B.

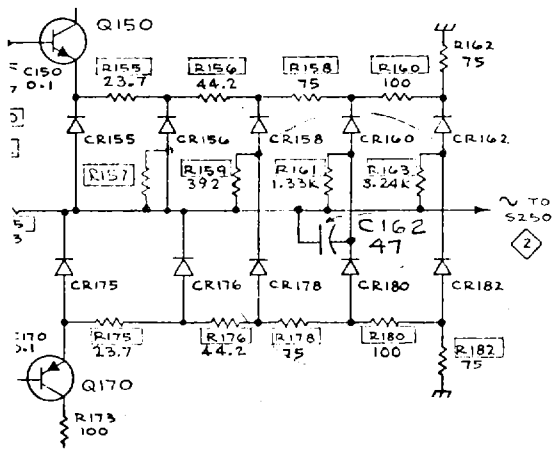
CHANGE:	DESCRIPTION

SCHEMATIC CHANGES

DIAGRAM 1 GENERATOR







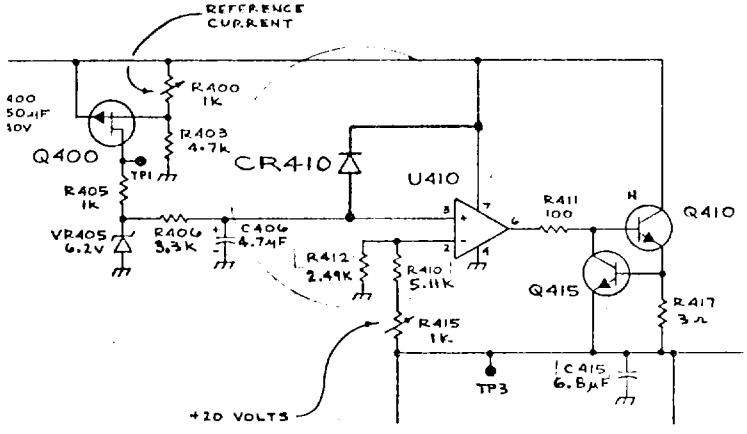


DIAGRAM 3 POWER SUPPLY

CHANGE:	DESCRIPTION

SCHEMATIC CHANGES

DIAGRAM 2 OUTPUT AMP & SWITCH DETAILS - Partial