Tektronix®

COMMITTED TO EXCELLENCE

FUNCTION GENERATOR

FG 501

INSTRUCTION MANUAL

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INSTRUCTION MANUAL

Tektronix, Inc.
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WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

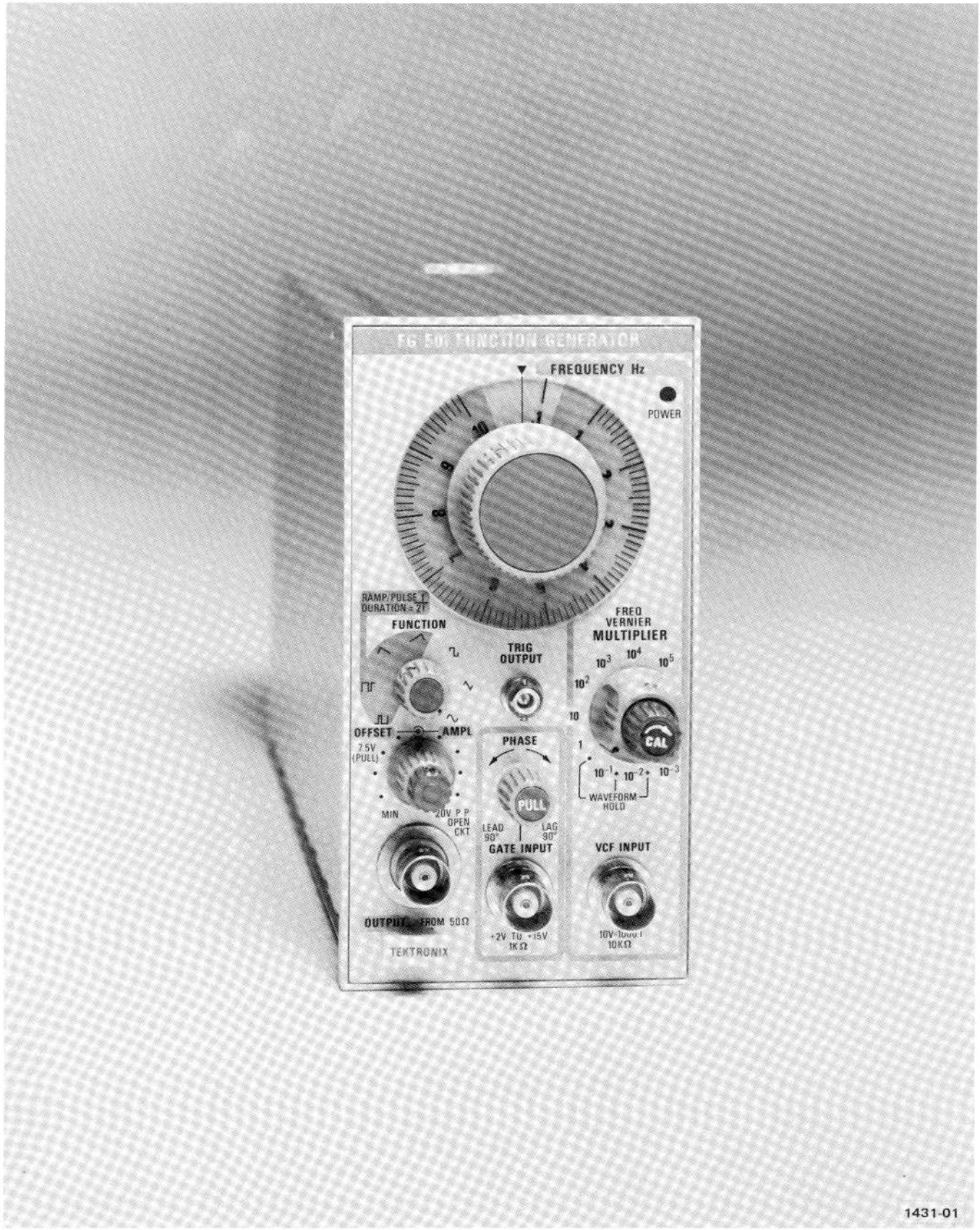


Fig. 1-1. FG 501 Function Generator

OPERATING INSTRUCTIONS

INTRODUCTION

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 volt square-wave trigger are available at the front panel. Variable DC offset of ±7.5 volts 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 that 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 transistor-transistor logic (TTL) or to synchronize an external device such as an oscilloscope or counter.

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. Because of the high current drawn by the FG 501, it is also recommended that the power module be turned off before removing the FG 501. Refer to Fig. 1-2. Check to see that the plastic barriers on the interconnecting jack of the selected power module compartment match the cut-outs in the FG 501 circuit board edge connector.

Align the FG 501 chassis with the upper and lower guides of the selected compartment. Push the module in and press firmly to seat the circuit board in the interconnecting jack.

Pull the Power 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.

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.

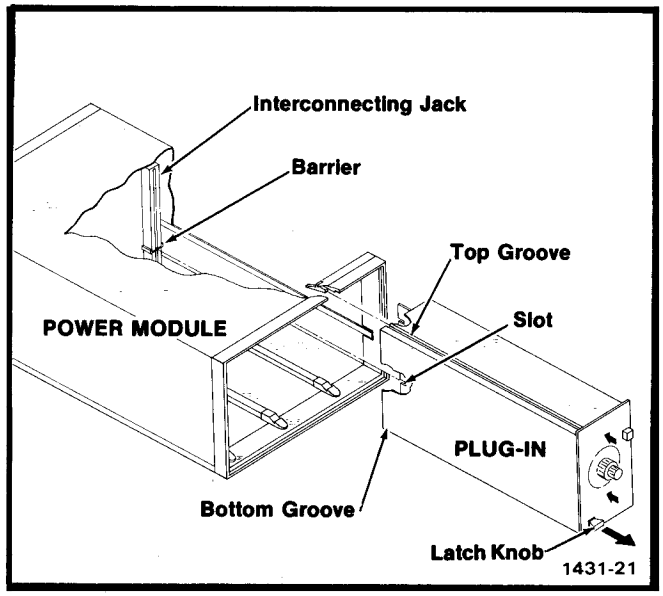


Fig. 1-2. Plug-in installation and removal.

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 in Fig. 1-3.

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 ensure 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., six feet or more.

5. Ensure 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 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.

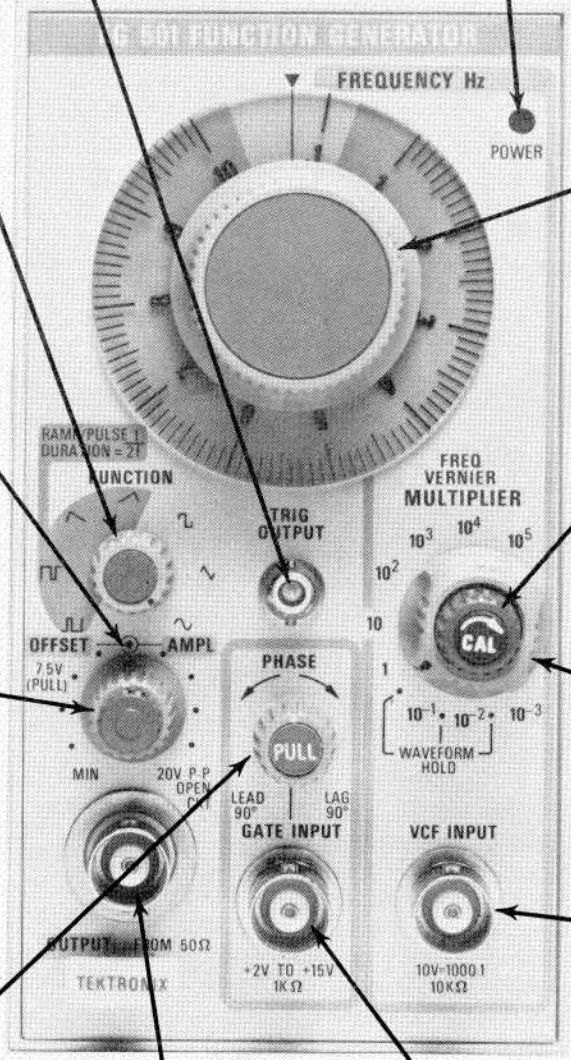
Risetime and Falltime

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 all 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 an impedance different 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



TRIG OUTPUT Connector

Bsm connector that provides a +2.5 V square-wave trigger output into a 600 Ω load.

POWER Indicator

Lights when power is applied to the FG 501.

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 Hz Dial

The frequency of sine, triangle and square waveforms is the dial reading times multiplier. Ramp and pulse waveforms have a frequency approximately 1.6X dial setting times multiplier with the MULTIPLIER at 1 or above and a frequency of approximately 2X dial setting on the three lowest ranges of the MULTIPLIER selector.

AMPL Control

Concentric with OFFSET control. Varies amplitude of waveform at the OUTPUT connector from less than 500 mV (fully ccw) to 20 V p-p open circuit (SN B130000-up). For SN below B130000, control is label OUTPUT and provides a maximum of 15 V p-p open circuit.

FREQ 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.

OFFSET Control

Concentric with AMPL control. For SN B130000-up, control pullout provides a variable dc offset voltage from zero (centered) to either −7.5 V (fully ccw) or +7.5 V (fully cw). When pushed in provides zero off-set. For SN below B130000 control does not pull out and offset limits are −5 V to +5 V.

MULTIPLIER Selector

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

VCF INPUT 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.

PHASE Control

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

OUTPUT Connector

Bnc connector that provides the output waveform selected by the FUNCTION selector.

GATE INPUT Connector

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

1431-13A

Fig. 1-3. Operating controls and connectors.

into a 50 Ω attenuator and a 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. 1-4. 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

$$R_1 + \frac{Z_1R_2}{Z_1 + R_2} \text{ must equal } Z_2$$

Therefore:

$$R_1R_2 = Z_1Z_2; \text{ and } R_1Z_1 = R_2(Z_2 - Z_1)$$

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

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

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:

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

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

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. $z_o = 138/\ \varepsilon \log_{10} D/d$, 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. 1-4 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 (Z_1) encounters a voltage attenuation (A_1) which is greater than 1 and less than 2, as follows:

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

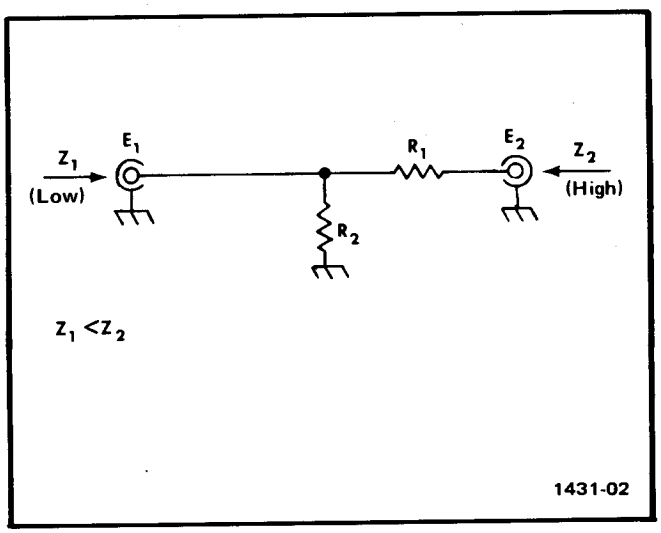


Fig. 1-4. Impedance-matching network that provides minimum attenuation.

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.

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

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

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.

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 AMPL control to the fully counterclockwise 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. 1-5).

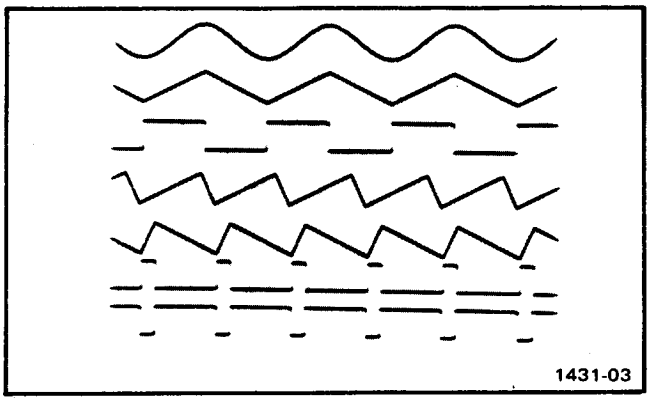


Fig. 1-5. Output waveforms available from the FG 501.

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 clockwise 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 AMPL control for the desired output amplitude.

Variable DC Offset

Pull outward on the OFFSET control (pull switch added at SN B020000) to position the dc level (baseline) of the output waveform. For example, +5 V of offset will increase the dc + peak ac voltage of a 7.5 V p-p output to +5 and +12.5 V dc + peak ac while −5 V of offset will reduce the dc + peak ac output to +2.5 V and −5 V.

Gated (Burst) Output and Variable Phase

A gating signal of 2 to 15 V amplitude applied to the GATE INPUT 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 depend 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 501 output frequency.

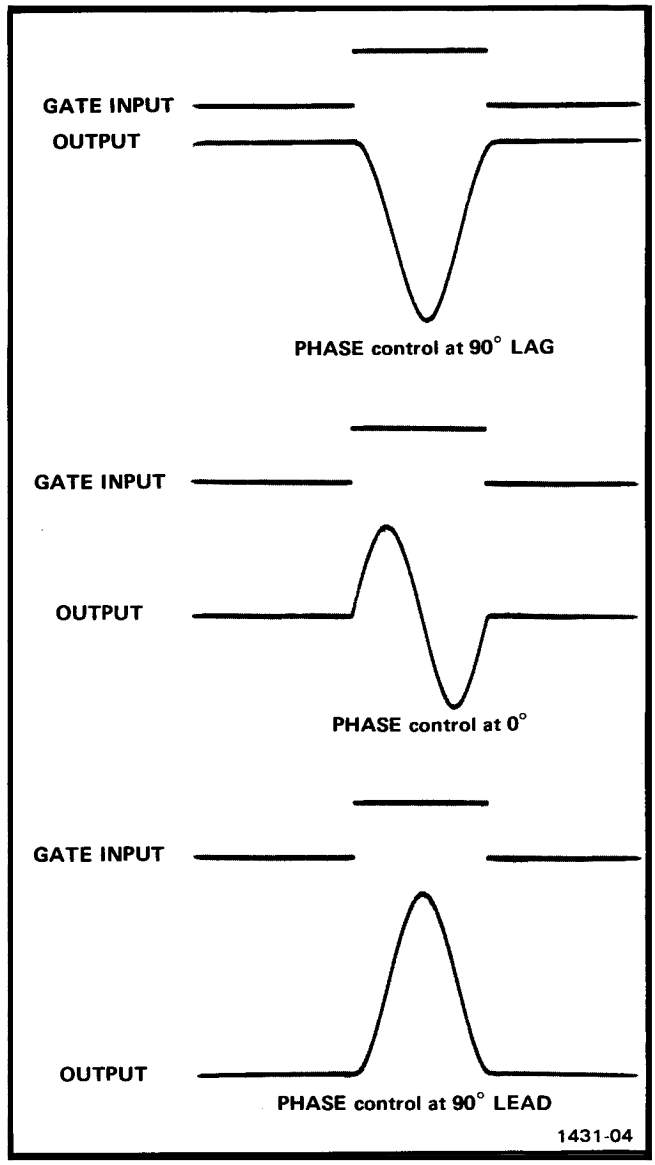


Fig. 1-6. Single cycle output with variable phase.

The phase (start level) of the waveform burst can be varied ±90° by pulling out and turning the PHASE control either counterclockwise or clockwise from the 0 (centered) position (see Fig. 1-6). 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 INPUT 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 INPUT 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. 1-7(A), a − signal sweeps the frequency downward as shown in Fig. 1-7(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 ensure 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. 1-7(B). It may be necessary to vary the CAL control to obtain the full 1000:1 swept range or the lowest swept frequency desired.

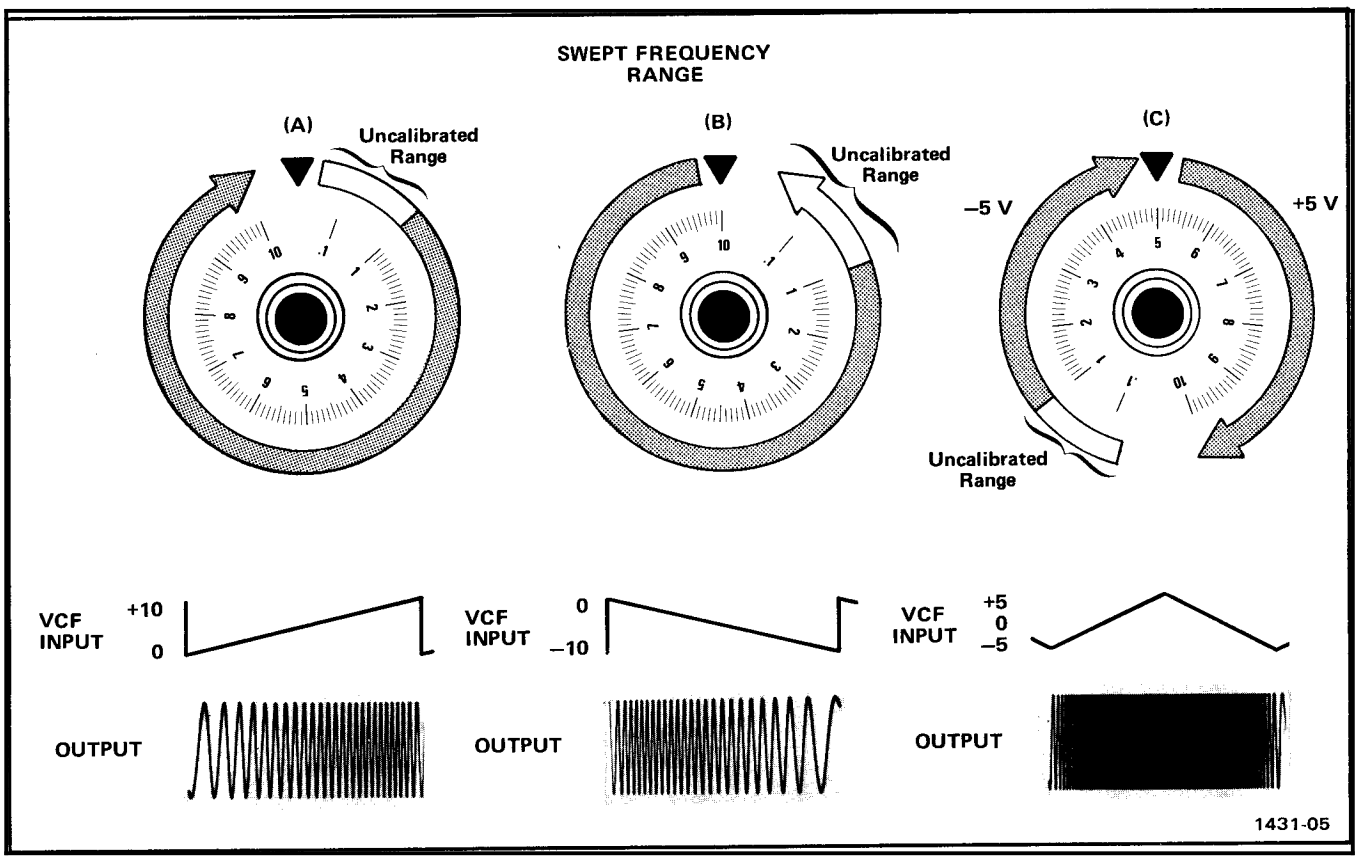


Fig. 1-7. Swept Frequency range with 10 V signals applied to VCF IN connector.

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. 1-7(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 OUTPUT connector. The frequency of the trigger output is determined by the output frequency selected by the MULTIPLIER selector and FREQUENCY Hz dial (see Fig. 1-8). When the FUNCTION selector is set for ramp or pulse, the trigger output frequency is about 1.6 times the dial indications. Output impedance is 600 Ω.

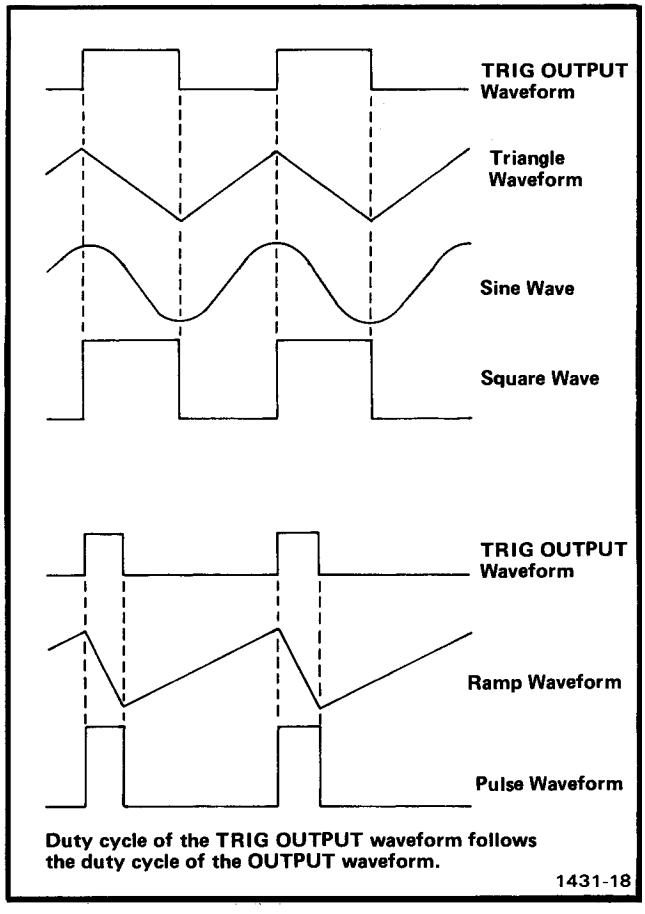


Fig. 1-8. Phase relationships between various waveforms from OUTPUT and TRIG OUTPUT connectors.

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 (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. 1-9.

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 INPUT 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.

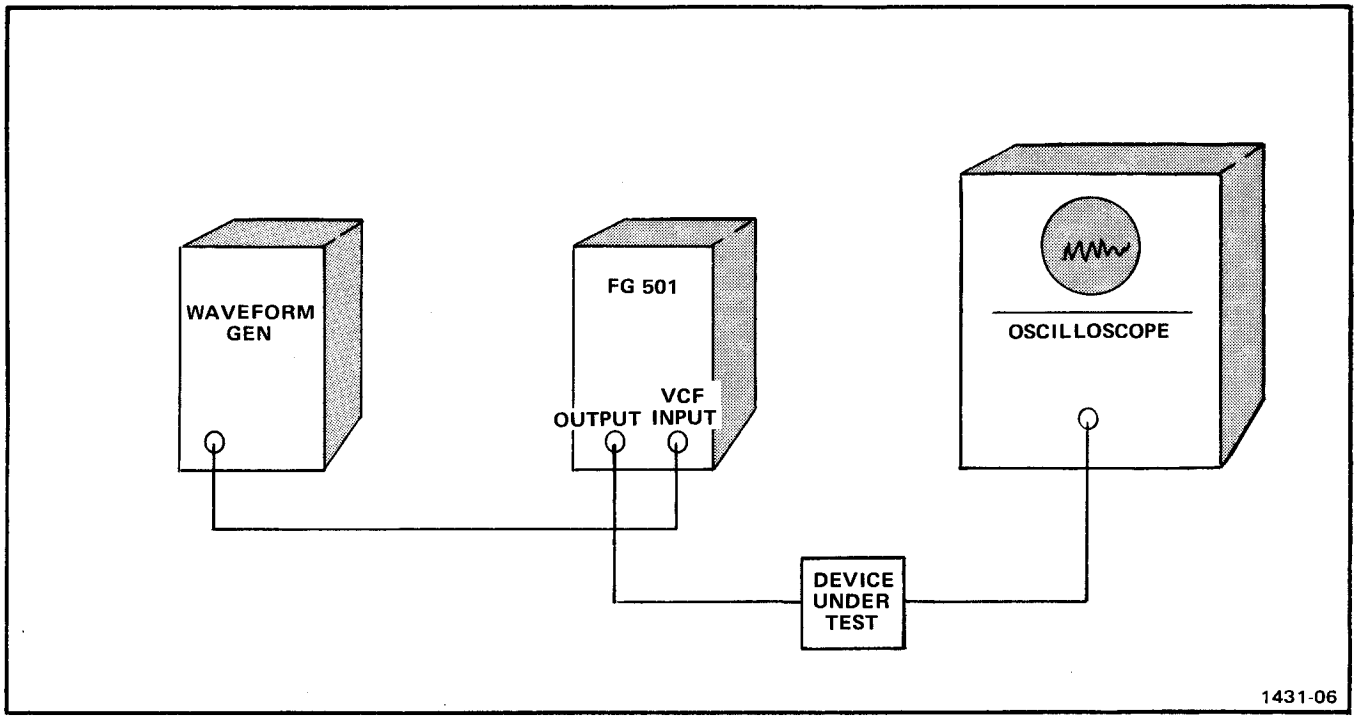


Fig. 1-9. Analyzing circuit or system response.

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. 1-10.

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.

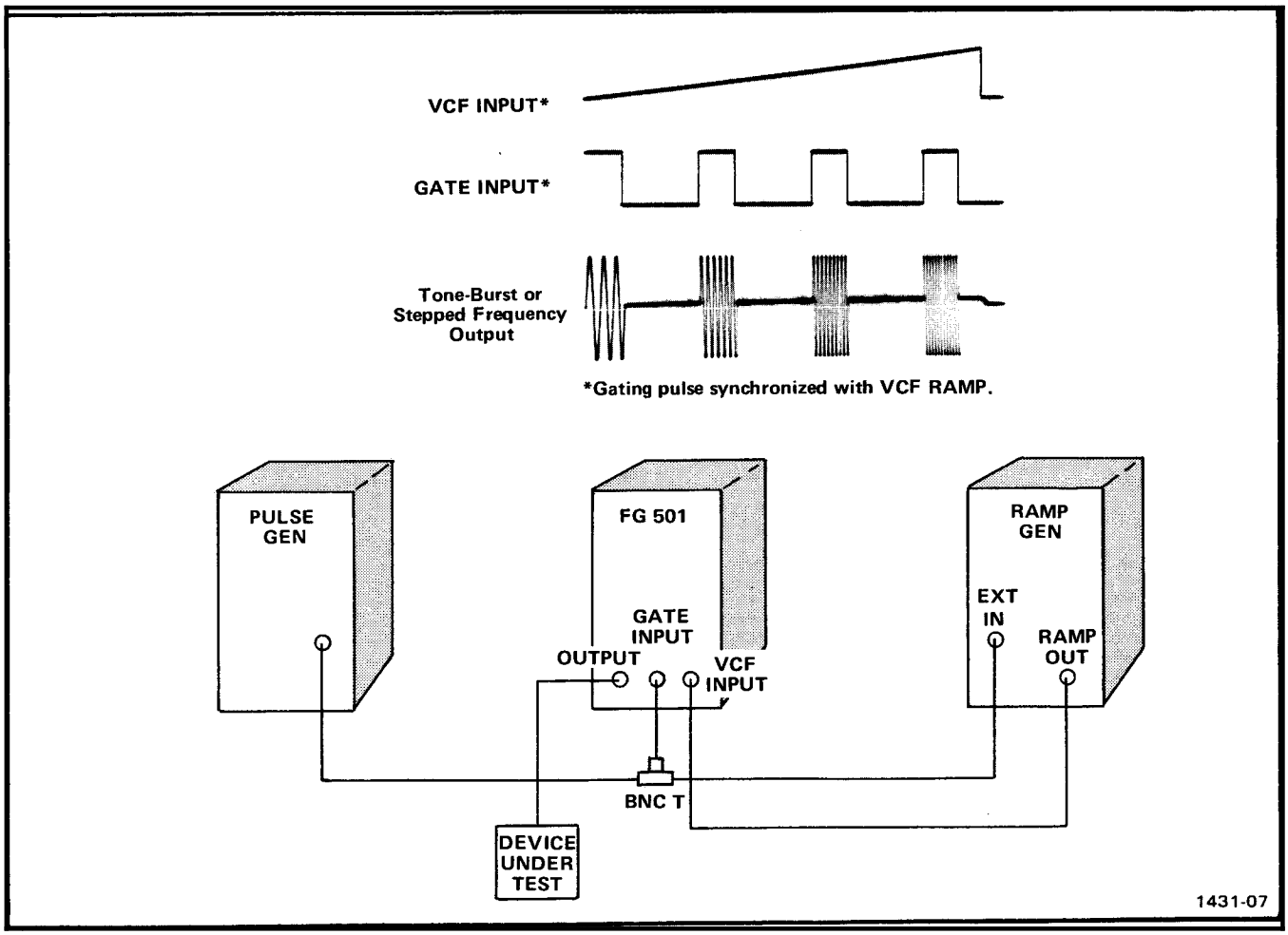


Fig. 1-10. Tone-burst generation or stepped frequency multiplication.

SPECIFICATION AND PERFORMANCE CHECK

SPECIFICATION

Performance Conditions

The electrical characteristics are valid only if the FG 501 has been calibrated at an ambient temperature between +20° C and +30° C and is operating at an ambient temperature between 0° C and +50° C unless otherwise noted. Forced air circulation is required for ambient temperature above +40° C.

Only those items listed in the Performance Requirements column of the Electrical Characteristics table are normally verified when doing the Performance Check procedure of this manual. Items listed in the Supplemental Information column are either explanatory notes or minimum performance characteristics for which no tolerance ranges are specified, and which normally require verification only after repairs or parts replacement.

Table 2-1

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Frequency		
Range Sine Wave, Square Wave, and Triangle	0.01 Hz to 1 MHz in 9 decade steps.	
Accuracy	Within 3% of full scale 1 to 10; .1 to 1 uncalibrated.	
Resolution		1 part in 10^4 of full scale with FREQUENCY VERNIER control.
Stability Temperature		Within 2% from 0.1 Hz to 1 MHz, and within 10% from 0.001 Hz to 0.1 Hz, 0° C to +50° C.
Time		Within 0.1% for 10 minutes. Within 0.25% for 24 hours.
Pulse and Ramp range		≈2X dial setting with MULTIPLIER at 10^{-3} to ≈1.6X dial setting with MULTIPLIER AT 10^5 setting.
Time Symmetry Sine Wave, Square Wave, and Triangle	Within 1% from 0.001 Hz to 1 MHz on calibrated portion (1 to 10) of FREQUENCY Hz dial, +20° C to +50° C.	Within 10% on uncalibrated portion (0.1 to 1) of FREQUENCY Hz dial.

Table 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
Amplitude (excluding offset)	SN B130000-up: 20 V p-p open circuit. 10 V p-p into 50 Ω load. Sine, triangle, and square wave amplitudes matched within 5% for single setting of AMPLITUDE control. Below SN B130000, OUTPUT control provides 15 V p-p open circuit and 7.5 V p-p into 50 Ω load.	Power-supply limiting causes compression of output waveform when maximum amplitude and maximum offset are used simultaneously.
Stability Temperature		Within 2% from 0.1 Hz to 1 MHz. Wtihin 10% from 0.001 Hz to 0.1 Hz, 0°C to +50°C.
Time		Within 0.1% for 10 minutes. Within 0.25% for 24 hours.
Hold Mode Stability		Within 5% of full output voltage in 1 hour at +25°C on 0.001 Hz range.
Offset Amplitude Into Open Circuit	SN B130000-up: + or − 7.5 V SN below B130000: + or − 5 V	
Into 50 ohm Load	SN B130000-up: + or − 5 V SN below B130000: + or − 2.5 V	
Range Into Open Circuit	At least + and − 15 V peak signal plus offset.	
Into 50 ohm Load	SN B130000-up: At least + and −6 V peak signal plus offset. SN below B130000: At least + and − 5 V peak signal plus offset.	
Output Impedance		50 Ω.
Trigger Output Amplitude	⩾ +2.5 V square wave into a 600 Ω load.	
Frequency	Same as frequency at output connector.	
Triangle and Ramp Linearity (between 10% and 90% points)		Within 1% from 0.001 Hz to 100 kHz excluding first 200 ns after switch points. Within 2% from 100 kHz to 1 MHz, excluding first 200 ns after switch points.

Table 2-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
Ramp Duration		$\approx \frac{1}{2f}$ (see Operating Considerations).
Sine Wave 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 at 10^5 MULTIPLIER setting.	Applies to calibrated portion of dial only (1 to 10). Valid from +10°C to +50°C.
Square Wave and Pulse Outputs		
Risetime	100 ns or less.	10% to 90%.
Aberrations	5% or less measured p-p with output amplitude at 10 V into external 50 Ω load.	
Pulse Duration		$\approx \frac{1}{2f}$ (see Operating Considerations).
External Gate Input		
Input Signal		Square wave at least +2 V, but not to exceed +15 V. Output bursts are synchronized with gate input.
Burst Length		Determined by selected output frequency and gating pulse width.
Phasing		Continuously variable from −90@ to +90° referred to 0° sine or 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 increases frequency. f_{max} = 10X MULTIPLIER setting, $f_{min} = \frac{\text{MULTIPLIER setting}}{100}$	
Slew Rate		≈0.5 V/μs.

Table 2-2

ENVIRONMENTAL CHARACTERISTICS

Characteristics	Information
Temperature	
Operating	0°C to 50°C.
Storage	−40°C to +75°C.
Altitude	
Operating	To 15,000 feet. Maximum operating temperature decreased by 1°C/100 feet from 5000 to 15,000 feet.
Storage	To 50,000 feet.
Vibration	
Operating and non-operating	With the instrument complete, vibration frequency swept from 10 to 55 to 10 Hz at 1 minute per sweep. Vibrate 15 minutes in each of the three major axes at 0.015" total displacement. Hold 10 minutes at any major resonance; or, if none, at 55 Hz. Total time, 75 minutes.
Shock	
Operating and non-operating	30 g, 1/2 sine, 11 ms duration, 3 shocks in each direction along 3 major axes, for a total of 18 shocks.
Transportation	Qualified under National Safe Transit Committee Test Procedure 1A, Category II.

Table 2-3

PHYSICAL CHARACTERISTICS

Characteristic	Dimension
Overall Size (measured at maximum points)	
Height	5.0 in (12.7 cm)
Width	2.6 in (6.6 cm)
Length	12.2 in (31 cm)
Net Weight (Instrument only)	2 lbs (0.906 kg)

@

PERFORMANCE CHECK

Introduction

This procedure checks the electrical characteristics of the FG 501 that appear in the Specification section of this manual. This procedure can also be used by an incoming inspection facility to determine acceptability of performance. If the instrument fails to meet the requirements given in this performance check, the adjustment procedure should be performed.

The electrical characteristics in Table 2-1 are valid only if the FG 501 is calibrated at an ambient temperature of +20°C to +30°C and operated at an ambient temperature of 0°C to +50°C. Forced air circulation is required for ambient temperature above +40°C.

Tolerances that are specified in this performance check procedure apply to the instrument under test and do not include test equipment error.

Test Equipment Required

The test equipment listed in Table 2-4, or equivalent, is required to perform the performance check. Test equipment characteristics listed are the minimum required to verify the performance of the equipment under test. Substitute equipment must meet or exceed the stated requirements. All test equipment is assumed to be operating within tolerance.

Table 2-4

LIST OF TEST EQUIPMENT REQUIREMENTS

Performance Description	Requirement	Application	Example
Oscilloscope	Bandwidth dc to 15 MHz; deflection factor 10 mV/div to 5 V/div; sweep rate 20 ns/div to 1 ms/div.	Steps 1, 2, 3, 5, 7, 8, and 9.	TEKTRONIX T921 or equivalent.
Power Module	Three compartments or more.	All tests.	TEKTRONIX TM 503, TM 504, or equivalent.
Digital Voltmeter	Range 0 to ±20 V dc; displayed error less than 0.5%.	VCF INPUT and Offset range checks.	TEKTRONIX DM 501[a].
Frequency Counter	Frequency range 0.1 Hz to above 1 MHz; accuracy within one part of 10^5 ±1 count.	Basic timing & VCF INPUT.	TEKTRONIX DC 504[a] or equivalent.
Pulse Generator	0 to +2 V square-wave output into 50 Ω load. Period 0.2 ms; duration 0.1 ms.	Phase range check.	TEKTRONIX PG 501[a] or equivalent.
Variable dc Power Supply	Output 0 to 20 V at 0.4 A or greater.	Check VCF INPUT.	TEKTRONIX PS 501[a] or equivalent.

[a]**Requires TM 500-Series power module.**

Table 2-4 (cont)

Performance Description	Requirement	Application	Example
Distortion Analyzer	Frequency range from 1 Hz to at least 600 kHz. Distortion resolution <0.5%.	Check sine wave distortion.	Hewlett-Packard 334A Distortion Analyzer or equivalent.
50 Ω Feedthrough Termination (2)	bnc connectors.	Steps 1, 2, 3, 5, 6, 8, and 9.	Tektronix Part No. 011-0049-01.
600 Ω Feedthrough Termination	bnc connectors.	TRIG OUTPUT Amplitude check	Tektronix Part No. 011-0092-00.
50 Ω Coaxial Cables (2 ea)	bnc connectors.	All.	Tektronix Part No. 012-0057-01.
Adapter	bsm-to-bnc.	TRIG OUTPUT Amplitude check.	Tektronix Part No. 103-0036-00.
Adapter	Dual banana plug-to-bnc female.	VCF INPUT check.	Tektronix Part No. 103-0090-00.
Tee Connector	bnc connectors.	Basic timing check.	Tektronix Part No. 103-0030-00.
10X Attenuator	bnc connectors 50 Ω impedance.	Square wave checks.	Tektronix Part No. 011-0059-02.

PRELIMINARY PROCEDURE

1. Ensure that the correct nominal line selector block has been installed on the line selector pins on the power module interface board, and the regulating range selected includes the applied line voltage. Refer to the installation section of the power module manual.

2. Ensure that all test equipment is suitably adapted to the applied line voltage.

3. Install the FG 501 into the power module and, if applicable, install the TM 500-Series test equipment into the test equipment power module.

4. Connect the equipment under test and the test equipment to a suitable line voltage source. Turn on all equipment and allow at least 20 minutes for the equipment to stabilize.

[1]**Below SN B130000 AMPL control is labeled OUTPUT.**
[2]**For SN below B130000 set OFFSET to zero.**

PERFORMANCE CHECK PROCEDURE

1. Dial Alignment

a. Set the FG 501 controls as follows:

FUNCTION	Triangle
AMPL[1]	Fully cw
OFFSET[2]	Midrange and In
PHASE	In
MULTIPLIER	10^3
FREQ VERNIER	Fully cw
FREQUENCY Hz	Near 10

b. Adjust the oscilloscope vertical for dc coupling at 2 V/div sensitivity. Set the time base sweep speed to .1 ms/div. Set the triggering controls to internal source + slope operation.

c. Connect the OUTPUT of the FG 501 through a 50 Ω coaxial cable and a 50 Ω termination, with the 50 Ω termination at the vertical input of the oscilloscope.

d. Adjust the oscilloscope trigger level control for a stable display of approximately 1 cycle per division.

e. CHECK—that the display stops changing frequency within ±.5 minor division of the 10 mark as the FREQUENCY Hz dial is adjusted back and forth around 10. (For ease in viewing the change in frequency, position the waveform so the trailing edge can be observed.)

f. Disconnect the 50 Ω cable and termination from the oscilloscope vertical input.

2. Square Wave Aberrations and Symmetry

a. Set the FG 501 controls as follows:

FUNCTION	Square Wave
AMPL[1]	Fully cw
OFFSET[2]	In
PHASE	In
MULTIPLIER	10^5
FREQ VERNIER	Fully cw
FREQUENCY Hz	8.0

b. Set the oscilloscope for a dc-coupled vertical input at 1 V/div sensitivity and a sweep speed of .05 μs/div. Trigger on + slope.

c. Connect the FG 501 OUTPUT through a 50 Ω coaxial cable and a 50 Ω termination to the oscilloscope vertical input.

d. Adjust the test oscilloscope trigger level control to display the entire rising portion of the square wave.

e. Adjust the FG 501 OFFSET and AMPL controls for a five-division display (2.5 divisions above and below the graticule centerline).

f. Adjust the FG 501 high frequency compensation (C281) for a risetime of approximately 70 ns (10% to 90%).

g. Adjust the test oscilloscope trigger level to display the entire falling portion of the square wave. Check that the falltime is approximately 70 ns. Readjust C281 (if necessary) to balance risetime and falltime.

h. Set the oscilloscope time/div to .5 μs/div. Check that aberrations on the positive and negative front corners of the square wave are less than 5%.

i. Set the oscilloscope vertical sensitivity to 1 V/div.

j. Adjust the oscilloscope sweep speed and variables to display one full cycle of the square wave in 10 divisions.

k. Set the oscilloscope X10 sweep magnifier on. Position the square-wave center voltage transition to exact display center.

l. Change the trigger polarity from + slope to − slope.

m. CHECK—that the center transition of the display does not shift horizontally more than 1 division (within 1%).

n. Disconnect the 50 Ω cable and 50 Ω termination.

3. Basic Timing

a. Set the FG 501 controls as follows:

FUNCTION	Triangle
AMPL[1]	Fully cw
OFFSET[2]	Off (in)
PHASE	In
MULTIPLIER	10^5
FREQ VERNIER	Fully cw
FREQUENCY Hz	10 (exactly)

b. Connect a 50 Ω coaxial cable and 50 Ω termination from the FG 501 OUTPUT to the frequency counter input.

[1]Below SN B130000 AMPL control is labeled OUTPUT.
[2]For SN below B130000 set OFFSET to zero.

c. CHECK—the FG 501 timing according to the following chart.

Counter Measurement Interval	FG 501 Frequency Hz Dial	FG 501 Multiplier	Frequency (±3% of full scale)
.1 SEC	10	10^5	1 MHz ±30 kHz (1.03 MHz—.970 MHz)
1 SEC	10	10^4	100 kHz ±3 kHz (103 kHz—97 kHz)
1 SEC	10	10^3	10 kHz ±300 Hz (10.3 kHz—9.7 kHz)
1 SEC	10	10^2	1 kHz ±30 Hz (1.03 kHz—.97 kHz)
10 SEC	1	10^2	100 Hz ±30 Hz (130 Hz—70 Hz)
1 SEC	1	10^3	1 kHz ±300 Hz (1.3 kHz—700 Hz)
1 SEC	1	10^4	10 kHz ±3 kHz (13 kHz—7 kHz)
1 SEC	1	10^5	100 kHz ±30 kHz (130 kHz—70 kHz)

d. Set the frequency counter (dc coupled) to measure period for FG 501 MULTIPLIER settings slower than 10^2 in the following chart.

Counter	FG 501 Frequency Hz Dial	FG 501 Multiplier	Period (±3% of full scale)
10 SEC	10	10	10.0 ms ±.33 ms (10.33—9.67 ms)
1 SEC	10	1	100 ms ±3.3 ms (103.3—96.7 ms)
1 SEC	10	10^{-1}	1000 ms ±33.3 ms (1033.3—976.7 ms)

e. Disconnect the coaxial cables, terminations and tee connectors from all units.

[1]**Below SN B130000 AMPL control is labeled OUTPUT.**
[2]**For SN below B130000 set OFFSET to zero.**

4. VCF INPUT

a. Set the FG 501 controls as follows:

FUNCTION	Triangle
AMPL[1]	Fully cw
OFFSET[2]	In
PHASE	In
MULTIPLIER	10^5
FREQ VERNIER	Fully cw
FEQUENCY Hz	10 (exactly)

b. Connect a 50 Ω coaxial cable and 50 Ω feedthrough termination from the FG 501 OUTPUT to the frequency counter input for a reading of 1 MHz.

c. Adjust the 0-20 V power supply for zero volts out.

d. Connect a banana-to-bnc adapter and 50 Ω cable from the 0-20 V power supply output to the FG 501 VCF INPUT. Make sure the ground side of the banana-to-bnc adapter goes to the + terminal on the power supply.

e. Adjust the power supply output voltage to change the frequency of the FG 501 as read on the digital counter to 0.001 MHz.

f. Disconnect the bnc cable from the FG 501 VCF INPUT and connect the variable dc power supply to the digital voltmeter input.

g. CHECK—that the voltage measured on the digital voltmeter is ≤ -10 V.

h. Adjust the power supply output voltage to zero.

i. Disconnect the cables and termination from all units.

5. OUTPUT Signal Amplitude and Waveshape

a. Set the FG 501 controls as follows:

FUNCTION	Sinewave
AMPL[1]	Fully cw
OFFSET[2]	In
PHASE	In
MULTIPLIER	10^3
FREQ VERNIER	Fully cw
FREQUENCY Hz	10

b. Set the oscilloscope vertical for dc-coupling at 2 V/div sensitivity. Set the triggering controls to internal, + slope. Set the time base sweep speed to 20 μs.

c. Connect a 50 Ω coaxial cable and 50 Ω termination from the FG 501 OUTPUT to the oscilloscope vertical input and obtain a triggered display.

d. Turn the FG 501 FUNCTION selector to each position.

e. CHECK—that the peak-to-peak amplitude of each output signal is ≥10 volts for SN B130000-up; ≥7.5 volts for SN below B130000.

f. CHECK—that the waveform for each position of the FUNCTION selector corresponds to that shown on the front panel of the FG 501.

g. Disconnect the 50 Ω termination and 50 Ω cable from the oscilloscope.

6. OFFSET Range

a. Set the FG 501 as follows:

FUNCTION	Triangle
AMPL	Fully ccw
OFFSET	OUT (SN B130000-up)
PHASE	In
MULTIPLIER	10^3
FREQ VERNIER	Fully cw
FREQUENCY Hz	10

b. Set the digital voltmeter to the 20 dc volts scale.

c. Connect the FG 501 OUTPUT with a 50 Ω coaxial cable terminated in 50 Ω at the digital multimeter input.

d. Adjust the FG 501 OFFSET to the fully clockwise position.

e. CHECK—SN B130000-up for at least +3.75 V; SN below B130000 for at least +2.5 V.

f. Adjust the FG 501 OFFSET to the fully counterclockwise position.

g. CHECK—SN B130000-up for at least −3.75 V; SN below B130000 for at least −2.5 V.

[1]**Below SN B130000 AMPL control is labeled OUTPUT.**
[2]**For SN below B130000 set OFFSET to zero.**

h. Disconnect the 50 Ω cable and 50 Ω termination from the digital voltmeter.

7. TRIG OUTPUT Amplitude

a. Set the FG 501 as follows:

FUNCTION	Triangle
AMPL[1]	Fully cw
OFFSET[2]	In
PHASE	In
MULTIPLIER	10^3
FREQ VERNIER	Fully cw
FREQUENCY Hz	10

b. Set the oscilloscope for 1 V/div vertical sensitivity.

c. Connect a bsm-to-bnc adapter to the FG 501 TRIG OUTPUT. Connect a 50 Ω coaxial cable from the adapter to a 600 Ω through-signal termination. Connect the 600 Ω termination to the oscilloscope vertical input. Set oscilloscope triggering to internal and + slope. Set the triggering level for a stable display.

d. CHECK—for a square wave display equal to or greater than 2.5 volts in amplitude.

e. Disconnect the adapter, cable, and 600 Ω termination from both units.

8. Sine Wave Distortion

a. Set the FG 501 controls as follows:

FUNCTION	Sine wave
AMPL[1]	Fully cw
OFFSET[2]	In
PHASE	In
MULTIPLIER	10
FREQ VERNIER	Fully cw
FREQUENCY Hz	10

b. If using a distortion analyzer similar to the HP 334A, connect the 50 Ω cable and 50 Ω termination from the FG 501 OUTPUT connector to the distortion analyzer input. Place a 50 Ω termination on the FG 501 VCF IN connector.

c. CHECK—the sine wave distortion at frequencies and amplitudes as shown on the following chart:

FG 501 Frequency	FG 501 Multiplier	Distortion Analyzer Frequency	Percent Distortion
10	10	100 Hz	0.5%
10	10^3	10 kHz	0.5%
10	10^4	100 kHz	1.0%
6	10^5	1 MHz	2.5%
5	10^3	5 kHz	0.5%

d. Disconnect cable and terminations from FG 501 and distortion analyzer.

9. Phase Range

a. Set the FG 501 controls as follows:

FUNCTION	Triangle
AMPL[1]	Midrange
OFFSET[2]	In
PHASE	In
MULTIPLIER	10^3
FREQ VERNIER	Fully cw
FREQUENCY Hz	10

b. Set the oscilloscope vertical for dc-coupling at 1 V/div sensitivity. Trigger on the + slope, automatic, internal, and ac coupled. Set the time base sweep speed to 50 μs.

c. Connect a 50 Ω coaxial cable from the pulse generator + output to a 50 Ω termination at the vertical input of the oscilloscope.

d. Adjust the pulse generator for a 2-volt square wave, 0.1 ms duration and 0.2 ms period.

e. Disconnect the pulse generator output cable and termination from the oscilloscope and connect them to the FG 501 GATE IN.

f. Connect a 50 Ω coaxial cable from the FG 501 OUTPUT to a 50 Ω termination at the oscilloscope vertical input.

g. Pull the FG 501 PHASE control knob out and turn it fully clockwise.

h. Check—that the flat portion of the display moves to the top peak of the triangle waveform as observed on the oscilloscope.

i. Set the FG 501 PHASE control fully counterclockwise.

j. Check—that the flat portion of the display moves to the bottom peak of the triangle.

k. Set the FG 501 PHASE control to 0° and push it in.

l. Adjust the FG 501 PHASE control fully clockwise and counterclockwise.

m. Check—that there is no change in the oscilloscope display.

n. Disconnect all cables and terminations.

This concludes the FG 501 Performance Check.

[1]Below SN B130000 AMPL control is labeled OUTPUT.
[2]For SN below B130000 set OFFSET to zero.

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

ADJUSTMENT

Introduction

This adjustment procedure is to be used to restore the FG 501 to original performance specifications. Adjustment need not be performed unless the instrument fails to meet the Performance Requirements of the Electrical Characteristics listed in the Specification section, or the Performance Check cannot be completed satisfactorily.

Completion of all adjustment steps in this procedure ensures that the instrument will meet the performance requirements listed in the Specification section. However, to fully ensure satisfactory performance, it is recommended that the Performance Check be performed after any adjustment is made.

Services Available

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

Recalibration Interval

Recommended recalibration interval is 2000 hours of operation or six months, whichever occurs first.

Test Equipment Required

The test equipment listed in Table 3-1, or equivalent, is required for adjustment of the FG 501. Specifications given for the test equipment are the minimum necessary for accurate adjustment and measurement. All test equipment is assumed to be correctly calibrated and operating within specification.

If other test equipment is substituted, control settings or calibration setup may need to be altered to meet the requirements of the equipment used.

A flexible TM 500 extender cable, Tektronix Part No. 067-0645-02, is useful for troubleshooting or adjusting the FG 501; however, the complete Adjustment Procedure can be performed without use of the extender.

Table 3-1

LIST OF TEST EQUIPMENT REQUIREMENTS

Description	Performance Requirement	Application	Example
Oscilloscope	Bandwidth dc to 15 MHz; deflection factor 10 mV/div to 5 V/div; sweep rate 20 ns/div to 1 ms/div.	Steps 4 through 15	TEKTRONIX T921 or equivalent
Power Module	Three compartments or more	All steps	TEKTRONIX TM 503, TM 504, or equivalent
Digital Voltmeter	Range 0 to ±20 V dc; displayed error less than 0.5%.	Set power supply voltages	TEKTRONIX DM 501[a]
Frequency Counter	Frequency range 0.1 Hz to above 1 MHz; accuracy within one part in 10^5 ±1 count.	Basic timing & VCF INPUT	TEKTRONIX DC 504[a] or equivalent
Pulse Generator	0 to +2 V square-wave output into 50 Ω load. Period 0.2 ms; duration 0.1 ms.	Set phase range	TEKTRONIX PG 501[a] or equivalent

Table 3-1 (cont)

Description	Performance Requirement	Application	Example
Distortion Analyzer	Frequency range from 1 Hz to at least 600 kHz. Distortion resolution <0.5%.	Set sine wave for minimum distortion	Hewlett-Packard 334A Distortion Analyzer or equivalent
50 Ω Feedthrough Termination (2)	bnc connectors	As required	Tektronix Part No. 011-0049-01
600 Ω Feedthrough Termination	bnc connectors	Sine wave upper and lower level adjustment	Tektronix Part No. 011-0092-00
50 Ω Coaxial Cables (2 ea)	bnc connectors	As required	Tektronix Part No. 012-0057-01
Adapter	bsm-to-bnc	Sine wave upper and lower level adjustment	Tektronix Part No. 103-0036-00
Tee Connector	bnc connectors	As required	Tektronix Part No. 103-0030-00
10X Attenuator	bnc connectors; 50 Ω impedance.	As required	Tektronix Part No. 011-0059-02
Variable Autotransformer	Output to 135 V (270 V) at ≈500 W	Setting power supplies	General Radio W10MT3W or equivalent
TM 500 Extender Cable	Make connections between FG 501 and power module.	As required	Tektronix Part No. 067-0645-02 or equivalent

[1]Requires TM 500-Series Power Module.

Adjustment Locations

See Fig. 3-1 for the locations of all adjustable components and test points mentioned in this procedure. All adjustable components are located on the left side of the FG 501 circuit board.

Preparation

a. Disconnect the power module from the power source. Make sure the power module is set for the line voltage to be applied (see power module manual for line voltage setting). If the adjustments are to be made with the FG 501 plugged into the power module, remove the covers from the power module. If the adjustments are to be made with the FG 501 on an extender cable (Tektronix Part No. 067-0645-02), be sure the extender cable is oriented with the top of one connector toward the top of the FG 501 and the top of the other connector toward the top of the power module.

b. Remove the side covers of the FG 501 to gain access to the components and test points on the circuit board. Pull the rear end of the side cover outward from the side of the instrument (the covers snap into place).

c. Install all required TM 500-Series test equipment into the power module(s). Install the FG 501 (in left compartment of power module if extender cable is not used).

d. Connect the power module that powers the FG 501 to a variable autotransformer that is set to the middle of the line voltage operating range selected by the line voltage selector block in the power module. Connect the autotransformer to a line voltage source and turn the FG 501 on.

e. Connect all test equipment to a suitable line voltage source and turn it on. Allow at least 30 minutes warmup time before starting the adjustment procedure. All adjustments must be made at an ambient temperature between +20°C and +30°C.

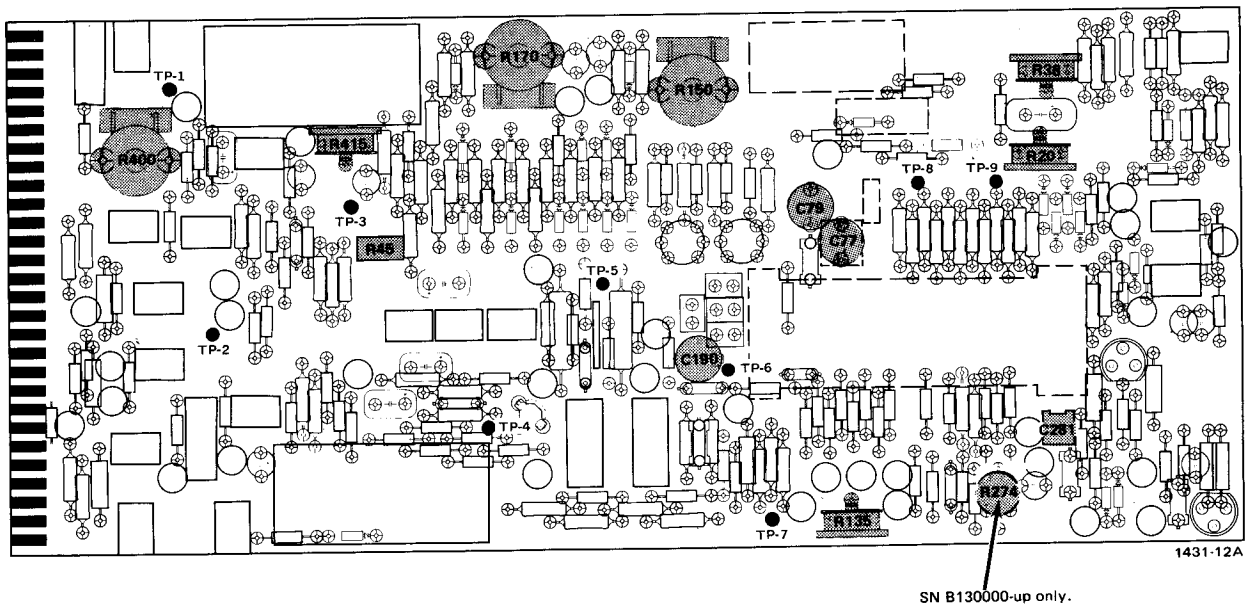


Fig. 3-1. Adjustment and test point locations, SN B020000 & up.

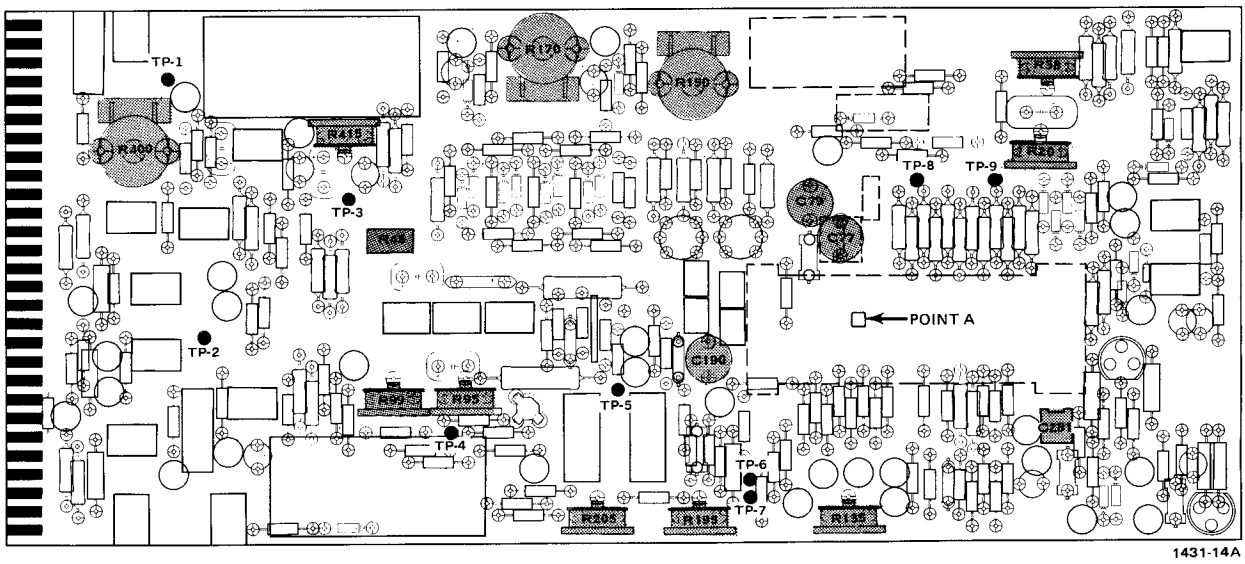


Fig. 3-2. Adjustment and test point locations, below SN B020000.

Initial Control Settings

Set the following controls during warm-up time:

FG 501

FUNCTION	Triangle
AMPL[1]	Fully cw
OFFSET[2]	In (off)
PHASE	Off (pushed in, set to 0°)
FREQ VERNIER	Calibrated (fully cw)
MULTIPLIER	10^4
FREQUENCY Hz	1

DM 501

Range/Function switch	20 DC Volts

PROCEDURE (SN B020000 and up)

1. Reference Current Adjustment (+13.8 V dc)

a. Connect the digital voltmeter Lo input lead to ground (at negative end of C400). Connect the Hi input meter lead to TP1 on the FG 501 (see Fig. 3-1).

b. ADJUST—R400 (Reference Current) for a meter reading of +13.8 V dc.

2. +20 Volt Supply Adjustment

a. Move the 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.

3. +17 Volt Supply Check

a. Move the 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).

4. −17 Volt Supply Check

a. Move the 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 −16.80 V).

c. Disconnect the digital voltmeter leads from the FG 501.

[1]Below SN B130000 AMPL control is labeled OUTPUT.
[2]For SN below B130000 set OFFSET to zero.

5. Adjust Square-Wave High-frequency Compensation and Check Risetime

Control Setting Changes:

FG 501

FUNCTION	Square wave

Oscilloscope

Time/div	2 μs (Mag off)
Volts/div	2 V
Input Coupling	Dc

a. Connect the FG 501 OUTPUT connector through a 50 ΩΩ coaxial cable to a 50 Ω termination at the oscilloscope vertical input connector. Check that the display amplitude is at least 10 V peak-to-peak (SN B130000-up); 7.5 V peak-to-peak for SN below B130000.

b. Set the oscilloscope variable volts/div, triggering, intensity, focus, and position controls for a visible, triggered, vertically-centered five-division display.

c. ADJUST—C281 (square-wave high-frequency compensation) 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).

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

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

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

6. Dial Calibration

Control Settings:

FG 501

FUNCTION	Triangle

Oscilloscope

Time base	10 μs
Triggering	For triggered display

a. Set the FREQUENCY Hz dial just to the point (near 10) where the frequency of the displayed waveform becomes maximum and there is not further change. This will be a few degrees before the waveform disappears (there is no signal output for a part of the area above 10 and below .1). For ease in determining the point of maximum frequency, use the oscilloscope horizontal position control to move the display so that the right end of the sweep can be viewed.

b. CHECK—that the FREQUENCY Hz dial reads 10 at the point where the frequency of the output signal ceases to increase.

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

7. X.1 Symmetry Adjustment

Control Settings:

FG 501

FUNCTION	Square wave
FREQUENCY Hz	Near 1

a. Set the oscilloscope to display one full triggered square-wave cycle over 10 graticule divisions.

b. ADJUST—R45 (X.1 Symmetry) so that the positive-going and negative-going portions of the signal are of equal duration. Switch the oscilloscope triggering slope repeatedly from plus to minus while making final adjustments to R45.

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

8. X10 Calibration

Note

Use of an oscilloscope in this step is optional.

Control Settings:

FG 501

MULTIPLIER	10^3
FREQUENCY Hz	10
FUNCTION	Triangle waveform

Counter

Function	1 Hz
Hold	Fully ccw
Source	Ext
Trigger Level	0

a. Connect the FG 501 output through a 50 Ω coaxial cable and 50 Ω termination to the counter input (if the waveform is also to be displayed on an oscilloscope, insert a tee connector between the 50 Ω termination and the inputs to the counter and oscilloscope).

Oscilloscope

Time base	.1 ms
Triggering	Set for stable, triggered display

b. ADJUST—R20 (X10 Cal) for a counter reading of 10,000 (an oscilloscope display of approximately one cycle per division).

9. X1 Calibration

Control Settings:

FG 501

FREQUENCY Hz	1

Oscilloscope (use of an oscilloscope in this step is optional)

Time base	1 ms

a. Connect the FG 501 through a 50 Ω coaxial cable and 50 Ω termination to a tee connector. Connect the inputs of the counter and oscilloscope to the tee connector.

b. ADJUST—R38 (X1 Cal) for a counter reading of 1.0000 (note an oscilloscope display of about 1 cycle/division).

c. Set the FG 501 FREQUENCY Hz dial to 10 and the oscilloscope time base to .1 ms.

d. CHECK—for a counter reading of 10.000. If neceasary, re-adjust R20 (X10 Cal) for a 10.000 reading (note an oscilloscope display of about 1 cycle/division).

e. Repeat Steps 8 and 9 as necessary.

10. 10^5 Timing Adjustment

Control Settings:

FG 501

MULTIPLIER	10^5
FREQUENCY Hz	10

Oscilloscope (use of an oscilloscope in this step is optional)

Time base	1 μs

Counter

Function	.1 kHz

a. ADJUST—C190 (10^5 X10 Timing) for a counter reading of 1.0000 (note an oscilloscope display of about 1 cycle/division).

11. 10^5 X1 Timing Adjustment

Control Settings:

	FG 501
FREQUENCY Hz	1

	Oscilloscpe (use of an oscilloscope in this step is optional)
Time base	10 μs

a. ADJUST—C79 (10^5 X1 Timing) for a counter reading of .1000 (note an oscilloscope display of about 1 cycle/division).

12. 10^4 X10 Timing Adjustment (Below SN B060000 only)

Control Settings:

	FG 501
MULTIPLIER	10^4
FREQUENCY Hz	10

a. ADJUST—C77 (10^4 Timing) for a counter reading of .1000 (note an oscilloscope display of about 1 cycle/division).

13. Sine-wave Upper and Lower Level Adjustment

Control Settings:

	FG 501
FUNCTION	Sine-wave
MULTIPLIER	10
FREQUENCY Hz	10 (100 Hz)
AMPL[1]	Clockwise
PHASE	In (off)
OFFSET[2]	In (off)

a. Connect the FG 501 to the Distortion Analyzer through a 50 Ω coaxial cable and 50 Ω termination.

b. ADJUST—Upper Level Adjustment R150 and Lower Level adjustment R170 for minimum distortion as read by the Distortion Analyzer.

c. Check the distortion at the frequencies listed in Table 3-2.

[1]Below SN B130000 AMPL control is labeled OUTPUT.
[2]For SN below B130000 set OFFSET to zero.

Table 3-2

FG 501 FREQUENCY	FG 501 MULTIPLIER	FREQUENCY	PERCENT DISTORTION
10	10	100 Hz	0.5%
10	10^3	10 kHz	0.5%
10	10^4	100 kHz	1.0%
5	10^3	5 kHz	0.5%

d. Set the FREQUENCY Hz dial for .1 and the MULTIPLIER switch to 10^3. Place a 50 Ω termination on the VCF INPUT connector. Set the FUNCTION switch to square wave.

e. Disconnect the FG 501 OUTPUT cable and termination from the distortion analyzer and connect them to the input of an oscilloscope. Set the oscilloscope to display one full triggered square-wave cycle over 10 graticule divisions. Switch the oscilloscope triggering slope repeatedly from plus to minus and check the square-wave symmetry. If it is no longer symmetrical, repeat the X.1 Symmetry Adjustment (Step 7 of this procedure).

g. Repeat Step 13 parts c and d as necessary.

14. Triangle DC Level and Phase Range Adjustment

Control Setting:

	FG 501
FUNCTION	Triangle
MULTIPLIER	10^4
FREQUENCY Hz	10

	Pulse Generator
Period	.2 ms
Duration	.1 ms
Amplitude	+2 V into 50 Ω

	Oscilloscope
Time base	.1 ms

a. Connect the pulse generator + output through a 50 Ω coaxial cable and 50 Ω termination to the FG 501 GATE INPUT connector.

b. Pull the FG 501 PHASE control out (on).

c. CHECK—that the display is several bursts of triangle waveforms with a horizontal bar connecting one burst to the next. Rotate the PHASE control 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.

d. ADJUST—R135 (triangle DC Level) if operation is not as described in Step 14 part c above (adjust for equal movement of bar above and below the burst waveforms).

e. Repeat parts c and d above as necessary.

f. Return the PHASE knob to 0° and press it in (off).

g. Disconnect the cable and termination from the pulse generator and FG 501 GATE INPUT.

15. Adjust Output Balance (SN B130000 and up)

Control Settings:

FG 501

AMPL[1]	Minimum Output (ccw)
OFFSET[2]	In (off)

Oscilloscope

Volts/div	.1 V

a. Center the oscilloscope trace.

b. ADJUST—output balance control R274 until the trace is centered on the screen of the oscilloscope.

c. Disconnect all test equipment.

This completes the FG 501 adjustment procedure.

PROCEDURE (SN BELOW B020000)

Steps 1 through 4: perform Steps 1 through 4 as shown for SN B020000-up on page 3-4 except refer to Fig. 3-2.

5. Adjust +4.5 Volts Triangle Amplitude

Control Setting Changes:

FG 501

MULTIPLIER	10^2

Oscilloscope

Volts/Div	0.2 V
Vertical Input Coupling	Dc
Triggering	Auto
Time Base	1 ms
Intensity, Level & Position	For visible, triggered display

[1]**Below SN B130000 AMPL control is labeled OUTPUT.**
[2]**For SN below B130000 set OFFSET to zero.**

a. Connect a 10X probe from the oscilloscope to test point 6 (if TP6 is not present use point A, the circuit board pad below C77 and right of R251). Connect probe ground clip to chassis ground.

b. Set FREQUENCY Hz for maximum frequency as viewed on test oscilloscope.

c. Set oscilloscope vertical input coupling to ground and use Position control to vertically center the trace at the center horizontal graticule line. Return input coupling to dc.

d. ADJUST—R195 (+4.5 volts ∿ Ampl) so the positive peaks on the display extend 2.25 divisions above the graticule center.

e. ADJUST—R205 (−4.5 volts ∿ Ampl) so the negative peaks on the display extend 2.25 divisions below graticule center.

f. Repeat parts d and e as necessary.

6. Triangle DC Level

a. Move probe tip to TP7 (emitter of Q38).

b. ADJUST—R135 (∿ DC Level) so the display extends an equal distance above and below graticule center.

7. Gate Centering

a. Move the 10X probe tip to TP5 (Q85 base).

b. Use vertical position control to center the display on the graticule.

c. Move the probe tip to TP4 (center tap of Gate Centering R95).

d. ADJUST—R95 to re-center the display on the graticule.

e. Disconnect the probe tip and ground clip from the FG 501 and disconnect probe from oscilloscope.

8. Square Wave Amplitude

a. Connect a 50 Ω cable from the FG 501 OUTPUT connector to a 50 Ω termination at the oscilloscope vertical input connector.

b. Set OFFSET and OUTPUT for a 6 division display.

c. Set FUNCTION to ⊓⊔ (square wave).

d. ADJUST—R99 (⊓⊔ Ampl Cal) for a 6-division display. If necessary, adjust OFFSET to keep display vertically centered.

9. Square-Wave High Frequency Compensation

Control Setting Changes:

Oscilloscope

Time Base	2 μs
Triggering & Position	As Required

a. ADJUST—C281 (⊓⊔ HF Comp) for best flat top and square corner on the display.

10. Dial Calibration

Control Setting Changes:

FG 501

FUNCTION	∿ (triangle waveform)
FREQUENCY Hz	Maximum displayed frequency

Oscilloscope

Time base	1 ms/division

a. CHECK—that the FREQUENCY Hz dial reads 10; if not, perform part b.

b. Loosen the two set screws on the brass collar behind the FREQUENCY Hz knob. Hold R25 shaft with pliers to maintain maximum frequency display while rotating dial to read 10, then tighten screws.

11. X10 Calibration

a. ADJUST—R20 (X10 Cal) for 1 triangle waveform/division.

12. X1 Calibration

a. Set FREQUENCY Hz to 1 and oscilloscope time base for 10 ms/division.

b. ADJUST—R38 (X1 Cal) for one triangle waveform/division.

c. Set FREQUENCY Hz to 10 and oscilloscope time base for 1 ms/division.

d. CHECK—for one triangle waveform/division. If not, readjust R20 and repeat parts a through d for best calibration.

13. X1 Symmetry

a. Set MULTIPLIER to 10^3 and FUNCTION to ⊓⊔ (square-wave). Set oscilloscope time base for 10 ms/division.

b. ADJUST—R45 (X.1 Sym) so the upper and lower portions of the displayed square wave are of equal duration.

14. 10^5 X10 Timing

Control Setting Changes:

FG 501

FUNCTION	∿ (triangle)
MULTIPLIER	10^5
FREQUENCY Hz	10

Oscilloscope

Time base	1 μs/division

a. ADJUST—C190 (10^5 X10 Timing) for one triangle waveform/division.

15. 10^5 X1 Timing

a. Set FREQUENCY Hz to 1 and oscilloscope time base for 10 μs/division.

b. ADJUST—C79 (10^5 X1 Timing) for one triangle waveform/division. Repeat steps 14 and 15 as necessary for best calibration.

16. 10^4 X10 Timing

a. Set MULTIPLIER to 10^4, FREQUENCY Hz to 10, and oscilloscope time base for 10 μs/division.

b. ADJUST—C77 (10^4 X10 Timing) for one triangle waveform/division.

c. Disconnect the 50 Ω termination from the oscilloscope input.

17. Upper and Lower Sine-Wave Level

Control Setting Changes:

FG 501

FUNCTION	∿ (sine wave)
MULTIPLIER	10^4
FREQUENCY Hz	1

a. Connect the 50 Ω termination on OUTPUT cable to the distortion analyzer input.

b. ADJUST—R150 (∿ Upper Level) and R170 (∿ Lower Level) for a minimum distortion reading on the analyzer.

MAINTENANCE AND INTERFACING INFORMATION

PREVENTIVE MAINTENANCE

Preventive maintenance steps performed on a regular basis will enhance the reliability of the FG 501. However, checks of the semiconductors in the absence of a malfunction are not recommended as preventive maintenance measures. The recommended time for performing preventive maintenance is just before instrument adjustment.

Cleaning

CAUTION

Do not use acetone, MEK, MIBK, benzene, toluene, carbon tetrachloride, trichloroethylene, methyl alcohol, methylene chloride, sulphuric acid, or Freon compounds for cleaning the FG 501. Use only clean water and a mild detergent.

Exterior. Loose dust may be removed with a soft cloth or dry brush. Water and a mild detergent may be used; however, abrasive cleaners should never be used.

Interior. Cleaning the interior of the unit should precede adjustment since the cleaning process could alter the settings of calibration adjustments. Use low-velocity compressed air to blow off accumulated dust. Hardened dirt can be removed with a soft dry brush, cotton-tipped swab, or a coth dampened in a solution of water and mild detergent.

Adjustment

After cleaning or repairs, do the performance check as described in Section 2 of this manual. If all functions are within specification, no adjustment is needed. If one or more of the specifications are not met, calibrate the instrument as directed in Section 3, Adjustment.

Lubrication

No lubrication is required in the FG 501.

TROUBLESHOOTING AIDS

Circuit Descriptions

Section 5 of this manual explains circuit operation in detail. Used conjointly with the circuit diagrams, the section can be a powerful analytic tool.

Diagrams

A block diagram and detailed circuit diagrams are located on foldout pages in the diagrams section. The circuit diagrams show the component values and assigned circuit reference numbers of each component. The first page of the Diagrams section defines the circuit symbols and reference designators used in the manual. Major circuits are usually identifiable by a series of component numbers. Important waveforms and voltages may be shown within the diagrams, or on adjoining aprons. Those portions of the circuits located on circuit boards are enclosed with gray tint outline.

Cam Switch Charts

Cam switches shown on the diagrams are coded on comprehensive charts to locate the cam number of the switch contact in the complete switch assembly, counting from the front, or knob end, toward the rear of the switch. The charts also indicate with a solid dot when each contact is closed.

Circuit Board Illustrations

Line illustrations showing component locations keyed with a grid locator and table are placed on the back of a foldout page and sequenced as closely as possible to the related circuit diagrams.

To identify electrical components when troubleshooting, turn to the appropriate Parts Location Grid in the Diagrams section. Component values, descriptions, and ordering data are given in the Replaceable Electrical Parts list.

Component and Wiring Color Codes

Colored stripes or dots on electrical components signify electrical values, tolerances, etc. according to EIA standards. Components not color coded usually have information printed on the body. Some wiring coding follows the same EIA standards.

Testing Equipment

Generally, a wide-band oscilloscope, a low-capacitance probe, and a multimeter are all that is needed to perform basic waveform and voltage checks for diagnostic purposes. The calibration procedure and performance check procedure list specific test equipment necessary to adequately check out the instrument.

TROUBLESHOOTING TECHNIQUES

This troubleshooting procedure is arranged in an order that checks the simple trouble possibilities before proceeding to extensive troubleshooting.

Control Settings

Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see the operating instructions in Section 1.

If the FG 501 is operating as part of an interconnected system or test setup, also check control settings of the other instruments in the setup. Check for proper interconnections between the power module and the plug-in modules. Check that the signal is properly connected and that the interconnecting cables and signal source are not defective. Check the power source.

If the power module is suspected, try substituting another FG 501 known to be good into the power module. If the trouble persists after substitution, move the FG 501 to another compartment in the power module to determine if the trouble is confined to one compartment or is common to all of them.

Visual Check

Remove the covers from the FG 501 and look for broken wires, loose or unsoldered connections, damage to the circuit board, and the like. If components damaged from overheating are found, determine the cause of overheating before replacing the component; otherwise, the new component may also be damaged.

Circuit Isolation

Note the symptom. It often identifies the circuit in which the trouble is located. When trouble symptoms appear in more than one circuit, check the affected circuits by making waveform and voltage measurements.

Incorrect operation of all circuits often means trouble in power supplies. Using a multimeter, check first for correct voltages of the individual regulated supplies according to the circuit diagrams and adjustment procedures. Then check the unregualted supplies of the power modules. Defective components elsewhere in the instruments can appear as power supply problems. In these instances, suspected circuits should be disconnected from apparently bad power supplies one at a time to narrow the search.

Voltages and Waveforms

Often defective components can be located by using waveform and voltage indications when they appear on the circuit diagram or in the adjustment procedures. Such waveforms and voltage labels are typical indications and will vary between instruments.

Component Checking

If a component cannot be disconnected from its circuit, the effects of the associated circuitry must be considered when evaluating the measurement. Except for soldered-in transistors and integrated circuits, one end of most components can be unsoldered and lifted from the circuit board.

Transistors and Integrated Circuits (IC). Turn the power switch off before removing or replacing any semiconductor.

A good check of transistor operation is actual performance under operating conditions. A transistor can most effectively be checked by substituting a new component for it (or one which has been checked previously). However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester. Static-type testers are not recommended since they do not check operation under simulated operating conditions. A wick-type desoldering tool can be used to remove soldered-in transistors.

Integrated circuits can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of the circuit description is essential to troubleshooting circuits using integrated circuits. Operating waveforms, logic levels, and other operating information for the integrated circuits are given in the circuit description information. Use care when checking voltages and waveforms around the integrated circuits so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the 14- and 16-pin in-line integrated circuits is with an integrated circuit test clip. This device also doubles as an extraction tool.

Diodes. Do not use an ohmmeter that has a high internal current. High currents may damage the diode, so use the RX1000 scale on the ohmmeter.

Ordinary signal diodes may be checked for an open or shorted condition by measuring the resistance between terminals. With the ohmmeter set to the RX1000 scale, the resistance should be very high in one direction and very low when the leads are reversed.

Resistors. Check resistors with an ohmmeter. Resistor tolerances are given in the Replaceable Electrical Parts list. Resistors do not normally need to be replaced unless the measured value varies widely from the specified value.

Capacitors. A leaky or shorted capacitor can be detected by checking resistance with an ohmmeter on the highest scale. Use an ohmmeter which will not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitor tester, or by checking whether it passes ac signals.

PARTS ORDERING AND REPLACING

Ordering

Standard Parts. Most electrical and mechanical parts can be obtained through your local Tektronix field office or representative. However, you should be able to obtain many of the standard electronic components from a local commercial source in your area. Before you purchase or order a part from a source other than Tektronix, Inc., please check the electrical parts list for the proper value, rating, tolerance, and description. When selecting replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in an instrument. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect the instrument performance.

Special Parts. Some parts are manufactured or selected by Tektronix, Inc., to satisfy particular requirements, or are manufactured for Tektronix, Inc., to our specifications. Most of the mechanical parts used in this system have been manufactured by Tektronix, Inc. Order all special parts directly from the local Tektronix Field Office or representative.

Ordering Procedure. When ordering replacement parts from Tektronix, Inc., please include the following minimum information:

1. Instrument Type (FG 501).
2. Instrument Serial Number (for example, B010251).
3. A description of the part (if electrical, include the circuit number).
4. Tektronix part number.

Please do not return any instruments or parts before receiving directions from Tektronix, Inc.

A listing of Tektronix Field Offices, Service Centers, and Representatives can be found in the Tektronix Product Catalog and Supplements.

Replacing

The exploded view drawings associated with the Replaceable Mechanical Parts list, located at the rear of the manual, may be especially helpful when disassembling or reassembling individual components or subassemblies.

Circuit Boards. If a circuit board is damaged beyond repair, the entire assembly, including all soldered-on components, can be replaced.

To remove or replace a board, proceed as follows:

1. Disconnect all leads connected to the board (both soldered lead connections and solderless pin connections).
2. Remove all screws holding the board to the chassis or other mounting surface. Remove any knobs, etc., that would prevent the board from being lifted out of the instrument.
3. Lift the circuit board out of the unit. Do not force or bend the board.
4. To replace the board, reverse the order of removal. Use care when replacing pin connectors; if forced into place mis-aligned, the pin connectors may be damaged.

Transistors and Integrated Circuits. Transistors and integrated circuits should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement or switching of semiconductor devices may affect the calibration of the instrument. When a transistor is replaced, check the operation of the part of the instrument that may be affected.

Replacement semiconductors should be of the original type or a direct replacement. Figure 4-1 shows the lead configuration of the semiconductors used in this instrument system. When removing soldered-in transistors, use a suction-type de-soldering tool to remove the solder from the holes in the circuit board.

An extracting tool should be used to remove the 14- and 16-pin integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. Order Tektronix Part No. 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the integrated circuit. Try to avoid having one end of the integrated circuit disengage from the socket before the other end.

Cam Switches. Repair of cam-type switches should be undertaken only by experienced maintenance personnel. Switch alignment and spring tension of the contacts must be carefully maintained for proper operation of the switch. For assistance, contact your local Tektronix Field Office or representative.

NOTE

A cam-type switch repair kit including necessary tools, instructions, and replacement contacts is available from Tektronix, Inc. Order Tektronix Part No. 040-0541-00.

The cam-type switches consist of rotating cam drums, which are turned by front-panel knobs, and sets of spring-leaf contacts mounted on adjacent circuit boards. The contacts are actuated by lobes on the cams. These switches can be disassembled for inspection, cleaning, repair, or replacement as follows:

1. Using both thumbs, pull the bottom edges of the metal switch covers apart far enough to where they will slip past the detents and come off. The switch is now open for inspection or cleaning.

2. To completely remove a switch from the circuit board, first remove any knobs or shaft extensions. Loosen the coupling at the potentiometer at the rear of the switch, and pull the long shaft out of the switch assembly.

3. Remove the screws (from the opposite side of the circuit board) which hold the cam drum to the board.

4. To remove the cam drum from the front support block, remove the retaining ring from the shaft on the front of the switch and slide the cam drum out of the support block. Be careful not to lose the small detent roller.

5. To replace defective switch contacts, follow the instructions given in the switch repair kit.

6. To re-install the switch assembly, reverse the above procedure.

Incandescent Bulbs. The POWER light bulb is mounted on the sub-panel using a plastic sleeve. Unsolder the lead wires and pull the bulb out of the sleeve from the rear of the sub-panel.

Customizing the Interface

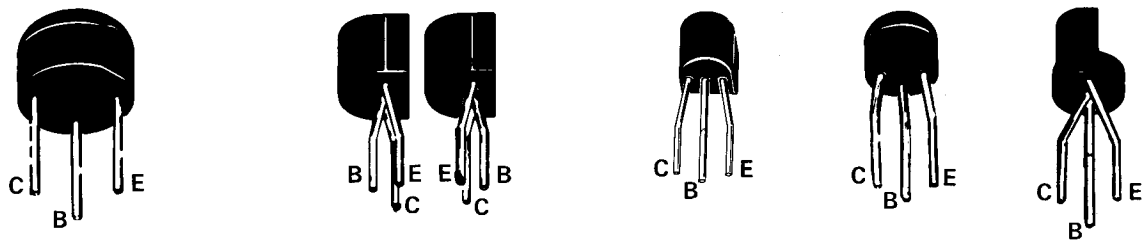
Input and output access to the FG 501 is available at the rear of the main circuit board. Fig. 4-2 identifies the contacts and their respective I/O assignments.

A power module mainframe option (Option 2) is available that provides a rear-panel, multi-pin connector to which I/O lines can be hard-wired for external access. Also possible are intra-compartment connections with other plug-in modules in multiple-compartment mainframes.

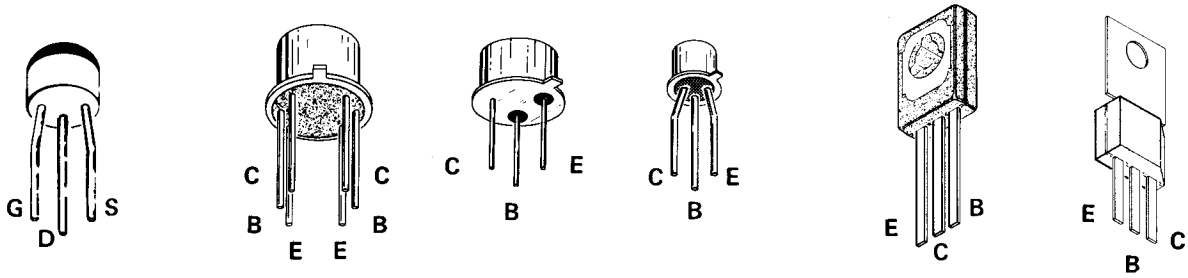
A slot between pins 23 and 24 on the rear connector identifies the FG 501 as a member of the signal source family. If the interface is customized, insert a barrier in the corresponding position of the power module jack to prevent other than signal source plug-ins from being used in that compartment. This protects the plug-in should specialized connections be made to that compartment. Consult the Building A System section of the power module manual for further information.

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. Include complete instrument serial number and a description of the service required.



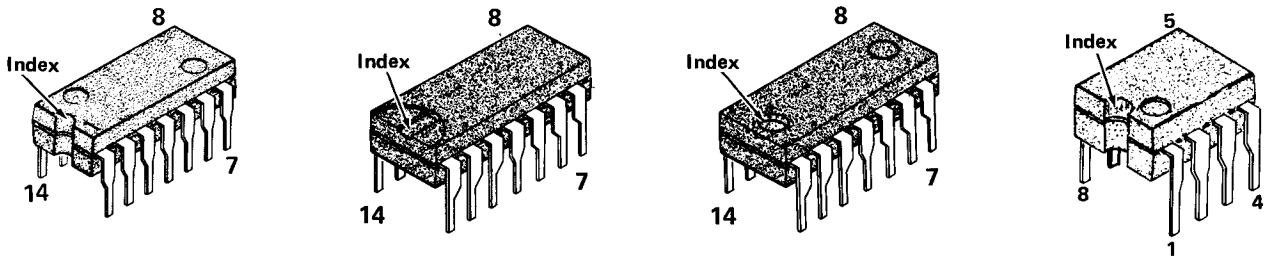
Plastic-Cased Transistors



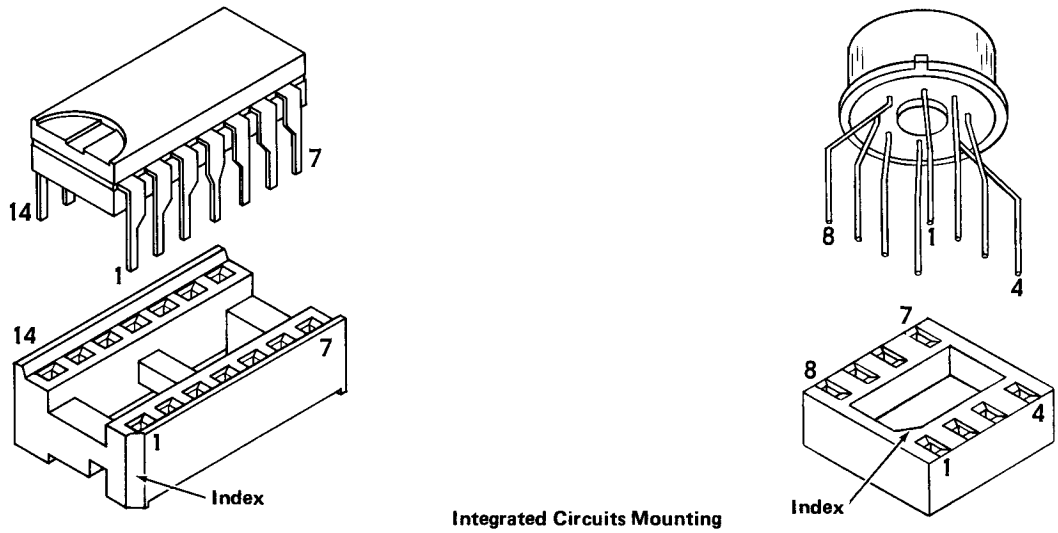
FET'S

Metal-Cased Transistors

Power Transistors



Integrated Circuits Indexing



Integrated Circuits Mounting

1431-20

Fig. 4-1. Semiconductor device lead configurations found in the FG 501.

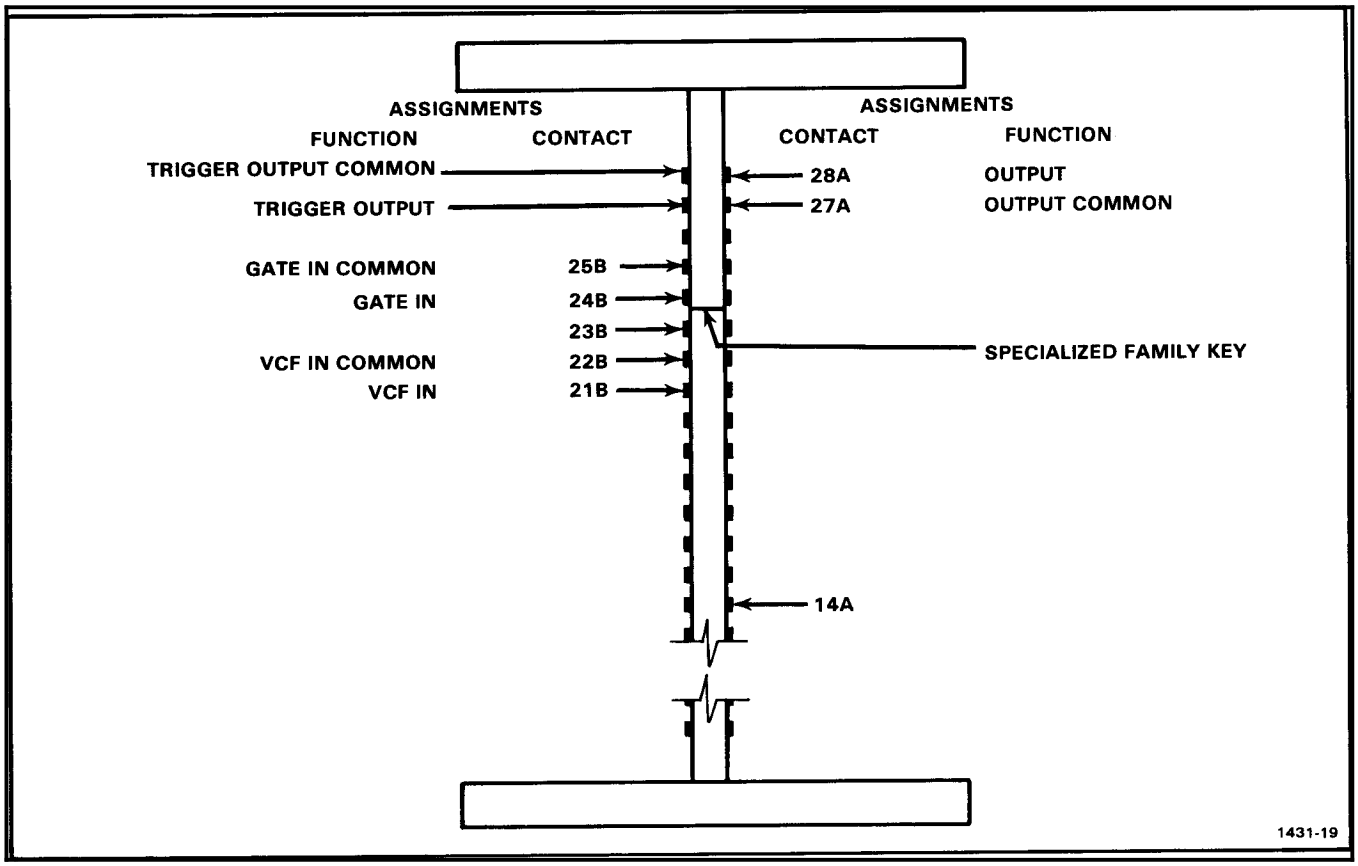


Fig. 4-2. Input/output assignments at rear interface connector, rear view.

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:

Surround the instrument with polyethylene sheeting to protect the finish of the instrument. Obtain a carton of corrugated cardboard of the correct carton strength and having inside dimensions of no less than six inches more than the instrument dimensions. Cushion the instrument by tightly packing three inches of dunnage or urethane foam between carton and instrument, on all sides. Seal carton with shipping tape or industrial stapler.

The carton test strength for your instrument is 200 pounds.

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CIRCUIT DESCRIPTION

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, compose 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 that, together with U48, compose 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 −1.77 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 INPUT) 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 ensures 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 (+7.5 V to −7.5 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 tne 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 INPUT) 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 INPUT), 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 square wave is applied to J215 (GATE INPUT). 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 because the input impedance of the gating input drops to 1 kΩ (R220 vs R81), and turns 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 clampling 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 that offset (via R281 and Q276) 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 current through R268. 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. Potentiometer R274 provides an adjustment for dc balance.

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 compose 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 ensuring 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 compose 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.

OPTIONS

There are no options for the FG 501 at this time.

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
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	B129999	CKT BOARD ASSY:MAIN	80009	670-2105-01
A1	670-2105-02	B130000		CKT BOARD ASSY:MAIN	80009	670-2105-02
A2	670-2248-00	B010100	B129999	CKT BOARD ASSY:FUNCTION	80009	670-2248-00
A2	670-2248-01	B130000		CKT BOARD ASSY:FUNCTION	80009	670-2248-01
C34	290-0519-00			CAP.,FXD,ELCTLT:100UF,20%,20V	90201	TDC107M020WLD
C40	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C72[1] C73 C74 C75 C76	295-0126-00	B010100	B119999	CAP.SET,MTCHD:10,1,0.1,0.01UF,990PF MTCHD	84411	TEK55-0005R5
C72[1] C73 C74 C75 C76	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
C162	281-0519-00	XB130000		CAP.,FXD,CER DI:47PF,+/-4.7PF,500V	72982	308-000C0G0470K
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	B129999X	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	B010100	B129999X	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	B010100	B129999X	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
C286	281-0523-00	XB130000		CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
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

[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
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
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
CR15	152-0141-02	XB130000		SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR16	152-0141-02	XB130000		SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR17	152-0141-02	XB130000		SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR45	152-0141-02	XB130000		SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
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
CR235	152-0141-02	XB130000		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
CR410	152-0141-02	XB130000		SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
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

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
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	B129999X	COIL,RF:1.8UH	80009	108-0105-00
Q45A,B	151-0261-00			TRANSISTOR:SILICON,PNP,DUAL	80009	151-0261-00
Q48A,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
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	80009	151-0188-00
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	80009	151-0188-00
Q250	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q255	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
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	80009	151-0188-00
Q285	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q290	151-0133-00			TRANSISTOR:SILICON,PNP	80009	151-0133-00
Q295	151-0136-00	B010100	B129999	TRANSISTOR:SILICON,NPN	02735	35495
Q295	151-0439-00	B130000		TRANSISTOR:SILICON,NPN	80009	151-0439-00
Q298	151-0322-00	B010100	B129999	TRANSISTOR:SILICON,PNP	80009	151-0322-00
Q298	151-0440-00	B130000		TRANSISTOR:SILICON,PNP	80009	151-0440-00
Q400	151-1066-00			TRANSISTOR:SILICON,FE,P-CHANNEL	80009	151-1066-00
Q410	151-0311-01			TRANSISTOR:SILICON,NPN	80009	151-0311-01
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	80009	151-0311-01
Q447	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q450	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q468	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q472	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q474	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q485	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
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	B010100	B129999	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R11	321-0151-00	B130000		RES.,FXD,FILM:365 OHM,1%,0.125W	91637	MFF1816G365R0F
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	B129999	RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225

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R18	315-0912-00	B130000		RES.,FXD,CMPSN:9.1K,(NOM VALUE),SEL	01121	CB9125
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
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

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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
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

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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
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	B010100	B129999	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R211	315-0151-00	B130000		RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
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	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

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
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	B010100	B129999	RES.,VAR,NONWIR:2 X 1K OHM,20%,0.50W	01121	11M688
R260A,B	311-1950-00	B130000		RES.,VAR,NONWIR:2 X 1K OHM,20%,0.50W	01121	OBD
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
R266	321-0186-00	XB130000		RES.,FXD,FILM:845 OHM,1%,0.125W	91637	MFF1816G845R0F
R267	321-0216-00	B010100	B129999	RES.,FXD,FILM:1.74K OHM,1%,0.125W	91637	MFF1816G17400F
R267	321-0213-00	B130000		RES.,FXD,FILM:1.62K OHM,1%,0.125W	91637	MFF1816G16200F
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	B010100	B129999	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R271	315-0821-00	B130000		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R272	315-0100-00	B010100	B129999X	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R273	315-0100-00	B010100	B129999X	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R274	311-1568-00	XB130000		RES.,VAR,NONWIR:50 OHM,20%,0.50W	73138	91A R50
R275	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R277	315-0102-00	B010100	B129999	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R277	315-0821-00	B130000		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R279	315-0203-00	B010100	B129999	RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R279	321-0213-00	B130000		RES.,FXD,FILM:1.62K OHM,1%,0.125W	91637	MFF1816G16200F
R281	315-0683-00	B010100	B129999	RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R281	321-0276-00	B130000		RES.,FXD,FILM:7.32K OHM,1%,0.125W	91637	MFF1816G73200F
R282	315-0101-00	B010100	B129999	RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R282	315-0821-00	B130000		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R284	315-0512-00	B010100	B129999	RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R284	315-0100-00	B130000		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R285	315-0301-00	B010100	B129999	RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R285	315-0821-00	B130000		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R286	315-0111-00	B010100	B129999	RES.,FXD,CMPSN:110 OHM,5%,0.25W	01121	CB1115
R286	315-0241-00	B130000		RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
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
R293	305-0101-00	XB130000		RES.,FXD,CMPSN:100 OHM,5%,2W	01121	HB1015
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	B129999	RES.,FXD,CMPSN:47 OHM,5%,1W	01121	GB4705
R298	305-0101-00	B130000		RES.,FXD,CMPSN:100 OHM,5%,2W	01121	HB1015
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

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
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
R486	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
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	311-1310-00			RES.,VAR,NONWIR:20K OHM,20%,1W	01121	10M654
S250	105-0378-00			ACTR ASSY,CAM S:	80009	105-0378-00
S260	311-1950-00	XB130000		RES.,VAR,NONWIR:2 X 1K OHM,20%,0.50W	01121	OBD
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

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
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	B129999	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U410	156-0400-00	B130000		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1436CG
U420	156-0067-00	B010100	B010203	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U420	156-0067-06	B010204	B129999	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U420	156-0400-00	B130000		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1436CG
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	B129999	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U470	156-0400-00	B130000		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1436CG
U480	156-0067-00	B010100	B019999	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U480	156-0067-06	B020000	B129999	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U480	156-0400-00	B130000		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	04713	MC1436CG
VR80	152-0243-00	B010100	B019999	SEMICOND DEVICE:ZENER,0.4W,15V,5%	80009	152-0243-00
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%	80009	152-0243-00
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

DIAGRAMS AND CIRCUIT BOARD 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).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it goes to the low state.

Abbreviations are based on ANSI Y1.1-1972.

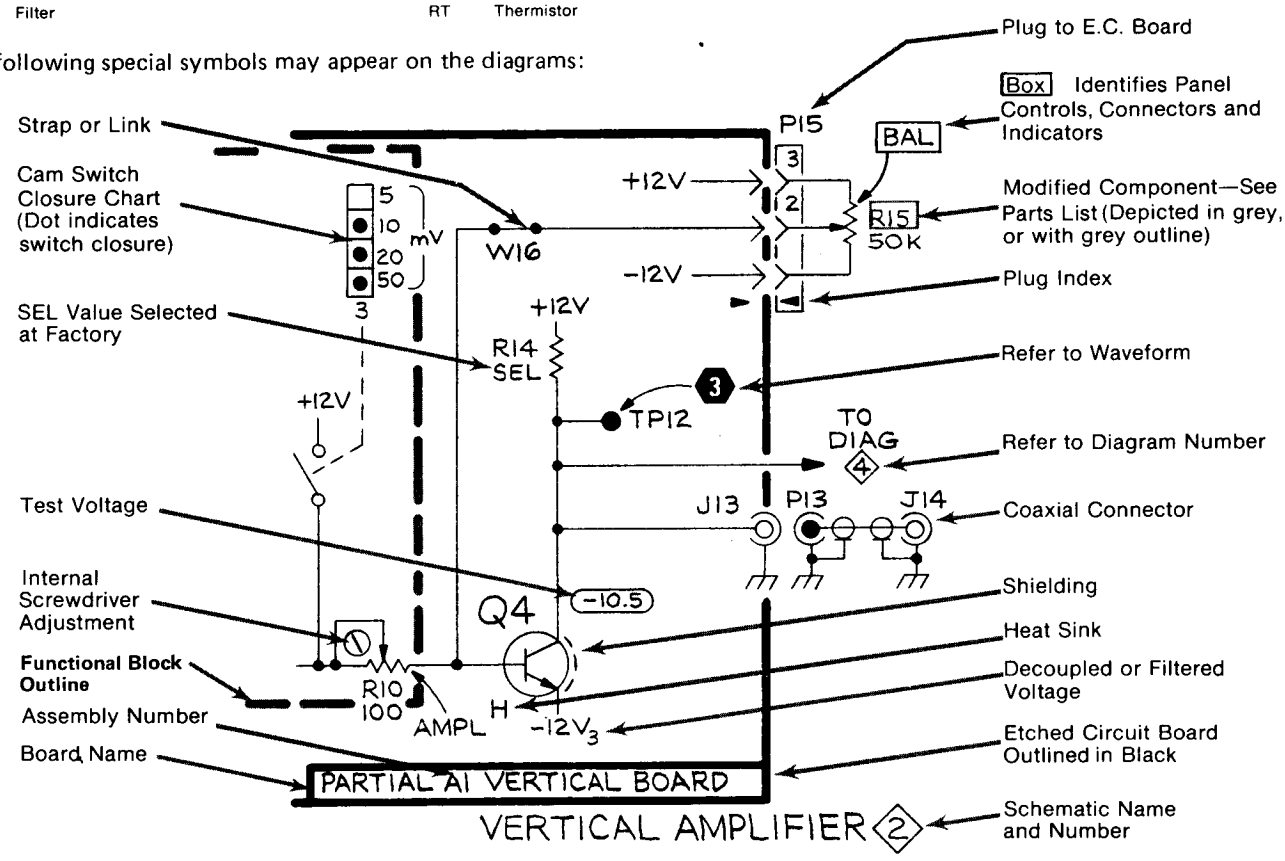
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc)	H	Heat dissipating device (heat sink, heat radiator, etc)	S	Switch or contactor
AT	Attenuator, fixed or variable	HR	Heater	T	Transformer
B	Motor	HY	Hybrid circuit	TC	Thermocouple
BT	Battery	J	Connector, stationary portion	TP	Test point
C	Capacitor, fixed or variable	K	Relay	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CB	Circuit breaker	L	Inductor, fixed or variable	V	Electron tube
CR	Diode, signal or rectifier	M	Meter	VR	Voltage regulator (zener diode, etc.)
DL	Delay line	P	Connector, movable portion	W	Wirestrap or cable
DS	Indicating device (lamp)	Q	Transistor or silicon-controlled rectifier	Y	Crystal
E	Spark Gap, Ferrite bead	R	Resistor, fixed or variable	Z	Phase shifter
F	Fuse	RT	Thermistor		
FL	Filter				

The following special symbols may appear on the diagrams:



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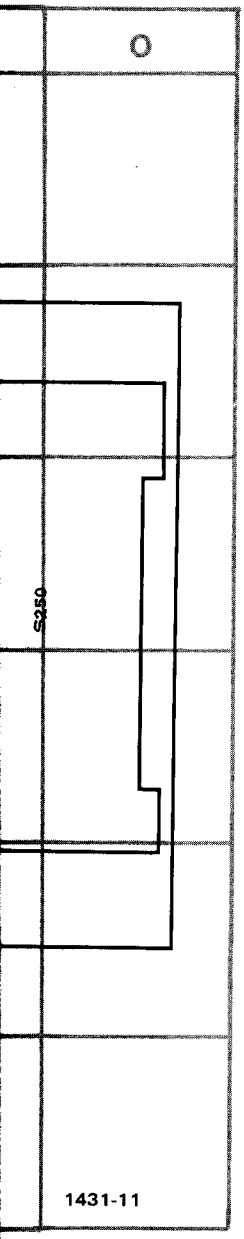
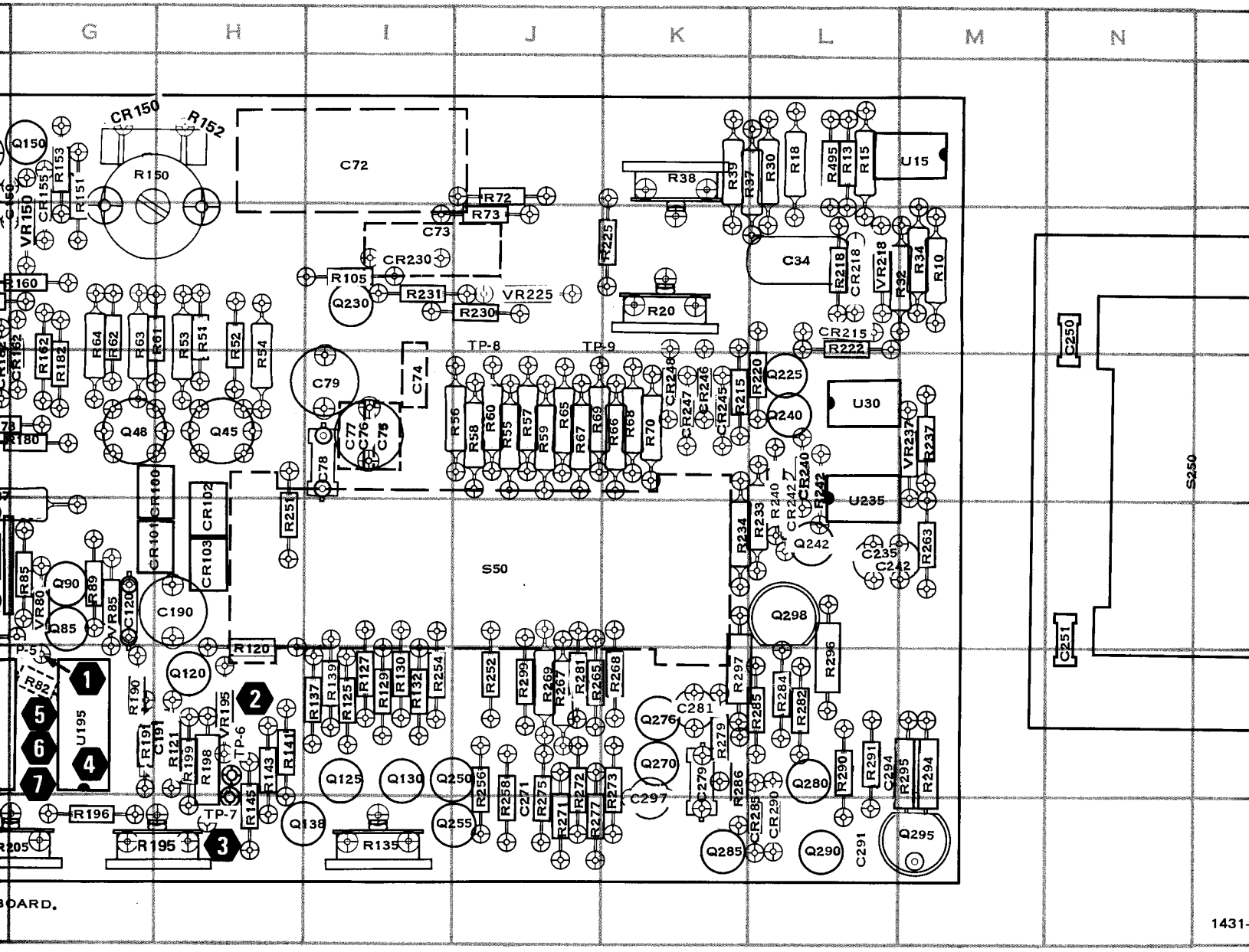


GRID LOCATION CHART
(SN B020000-BELOW)

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C34	L2	CR230	I2	R34	M2	R158	F2	R294	M5	VR80	G4
C40	E3	CR240	L3	R37	L1	R159	F3	R295	M5	VR85	G4
C72†	I1	CR242	L4	R38	K1	R160	G2	R296	L5	VR150	G2
C73†	I2	CR245	K3	R39	K1	R161	F3	R297	K5	VR170	E2
C74†	I3	CR246	K3	R41	E3	R162	G3	R299	J5	VR195	H5
C75†	I3	CR247	K3	R42	D3	R163	F3	R400	B2	VR205	E5
C76†	I3	CR248	K3	R44	D3	R170	F1	R403	A2	VR218	L2
C77	I3	CR285	L6	R45	D3	R171	E1	R405	C2	VR225	J2
C78	I3	CR290	L6	R46	D3	R172	F2	R406	C2	VR237	M3
C79	I3	CR400	B1	R51	H2	R173	E1	R410	E2	VR405	B2
C80	F4	CR450	D6	R52	H2	R175	F3	R411	C2		
C89	F3	CR490	C5	R53	H2	R176	F3	R412	D2		
C95	F5			R54	H3	R178	F3	R415	D2		
C120	G4			R55	J3	R180	G3	R417	E2		
C150	G1	J81	F5	R56	J3	R182	G3	R420	B4		
C170	E1			R57	J3	R190	G5	R422	A4		
C190	H4			R58	J3	R191	G5	R424	B4		
C191	H5	Q45	H3	R59	J3	R194	F6	R430	C3		
C235	L4	Q48	G3	R60	J3	R195	H6	R431	C3		
C242	M4	Q80	F5	R61	H2	R196	G6	R434	C4		
C250	N2	Q85	G4	R62	G2	R198	H5	R441	A5		
C251	N4	Q90	G4	R63	G2	R199	H5	R442	A5		
C271	J6	Q120	H5	R64	G2	R204	F6	R445	B5		
C279	K5	Q125	I5	R65	J3	R205	G6	R446	B5		
C281	K5	Q130	I5	R66	K3	R206	F6	R450	D5		
C291	L6	Q138	I6	R67	J3	R208	E5	R452	C6		
C294	L5	Q150	G1	R68	K3	R210	E5	R455	D5		
C297	K6	Q170	E1	R69	K3	R211	D3	R461	B3		
C400	D1	Q225	L3	R70	K3	R212	E5	R464	B3		
C406	C2	Q230	I2	R72	J1	R215	L3	R465	A3		
C410	D2	Q240	L3	R73	J2	R216	C3	R468	C4		
C415	D2	Q242	L4	R80	F5	R218	L2	R471	B4		
C455	D2	Q250	J5	R81	F5	R220	L3	R473	A4		
C482†	D5	Q255	J6	R82*†	G5	R222	L2	R475	B4		
C485	C5	Q270	K5	R85	G4	R225	K2	R481	D5		
C490	D6	Q276	K5	R87	F3	R230	J2	R482	D5		
C495	E4	Q280	L5	R88	F4	R231	I2	R485	C5		
		Q285	K6	R89	G4	R233	L4	R486	C5		
		Q290	L6	R94	F4	R234	L4	R487	D4		
		Q295	M6	R95	E5	R237	M3	R493	A5		
		Q298	L4	R96	F4	R240	L3	R495	L1		
		Q400	B2	R99	D5	R242	L3				
		Q410	B1	R100	E5	R251	H4				
		Q415	D2	R102	F4	R252	J5	S50†	J4		
		Q420	A5	R105	I2	R254	I5	S250	O3		
		Q424	B5	R120	H5	R256	J5				
		Q430	C3	R121	H5	R258	J6	U15	M1		
CR100	H3	Q445	B6	R125	I5	R263	M4	U30	L3		
CR101	H4	Q447	B5	R127	I5	R265	K5	U40	E4		
CR102	H4	Q450	D5	R129	I5	R267	J5	U45	F4		
CR103	H4	Q468	C4	R130	I5	R268	K5	U48	E4		
CR150	G1	Q472	B4	R132	I5	R269	J5	U80	F5		
CR155	G1	Q474	A4	R135	I6	R271	J6	U195	G5		
CR156	G2	Q485	C5	R137	I5	R272	J5	U235	L3		
CR158	F3	Q488	C6	R139	I5	R273	K5	U410	C2		
CR160	F3			R141	H5	R275	J6	U420	B4		
CR162	G3			R143	H5	R277	K6	U430	C3		
CR170	F2	R10	M2	R145	H6	R279	K5	U440	B5		
CR175	E2	R11	C3	R150	H1	R281	J5	U460	B3		
CR176	E3	R13	L1	R151	G1	R282	L5	U470	B4		
CR178	F3	R15	L1	R152	G1	R284	L5	U480	C5		
CR180	F3	R18	L1	R153	G1	R285	L5				
CR182	F3	R20	K2	R155	F2	R286	K5				
CR215	L2	R30	L1	R156	F2	R290	L5				
CR218	L2	R32	M2	R157	E2	R291	L5				

OMPONENT LOCATION GRID

Below SN B020000



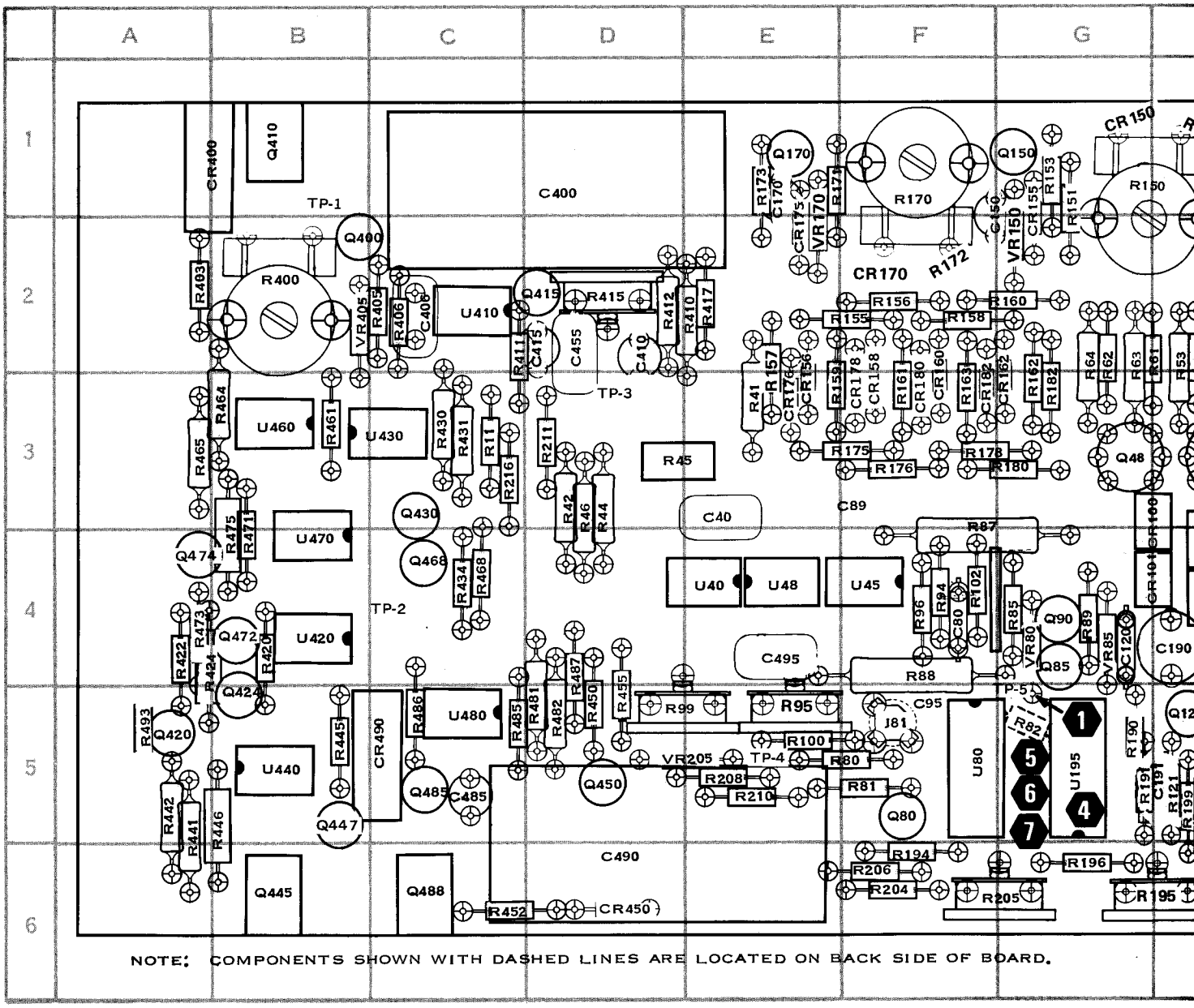
*** See Parts List for serial number ranges.**

† Located on back of board.

PARTS LOCATION GRID
BELOW SN B020000

COMPONENT

Below SN B02



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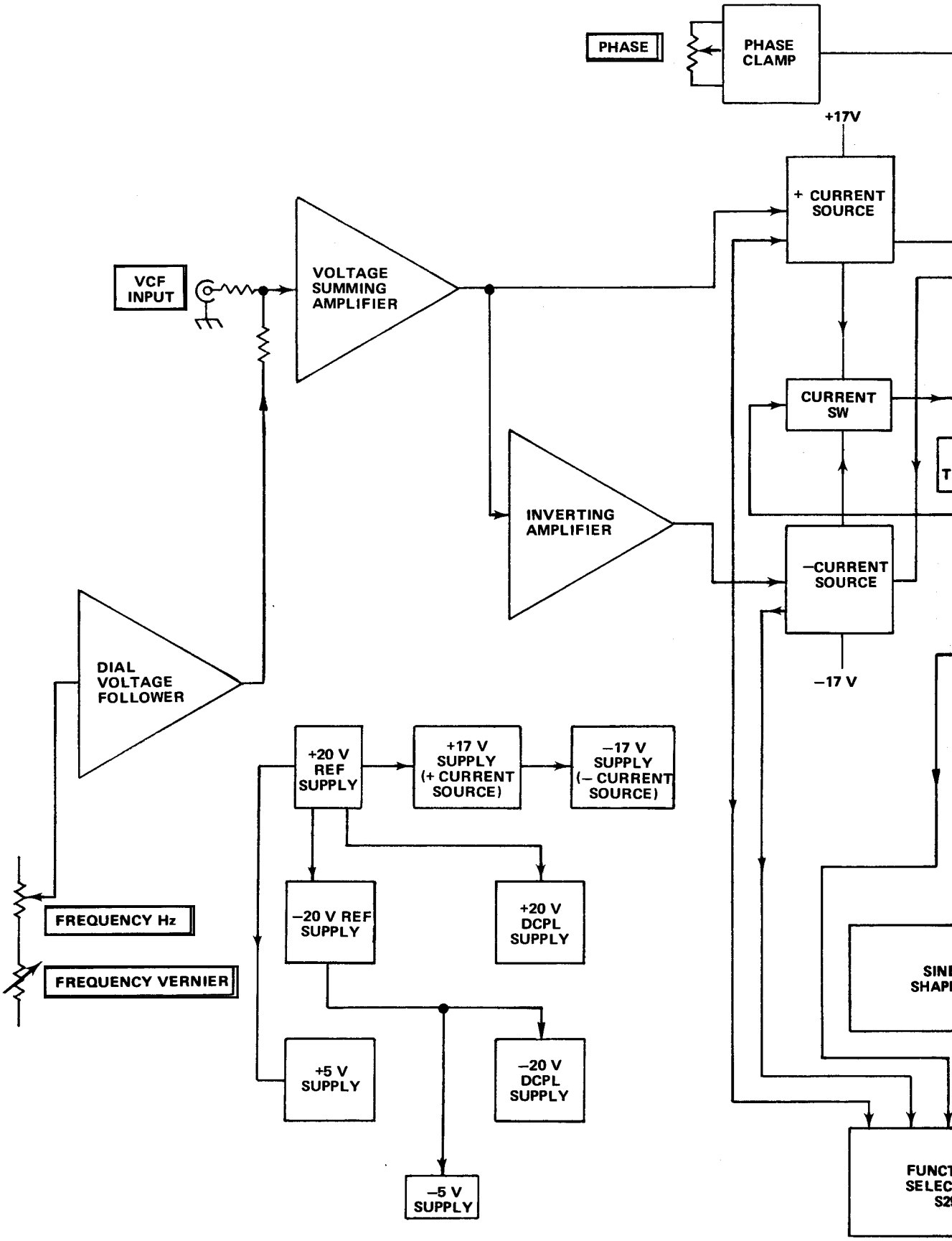
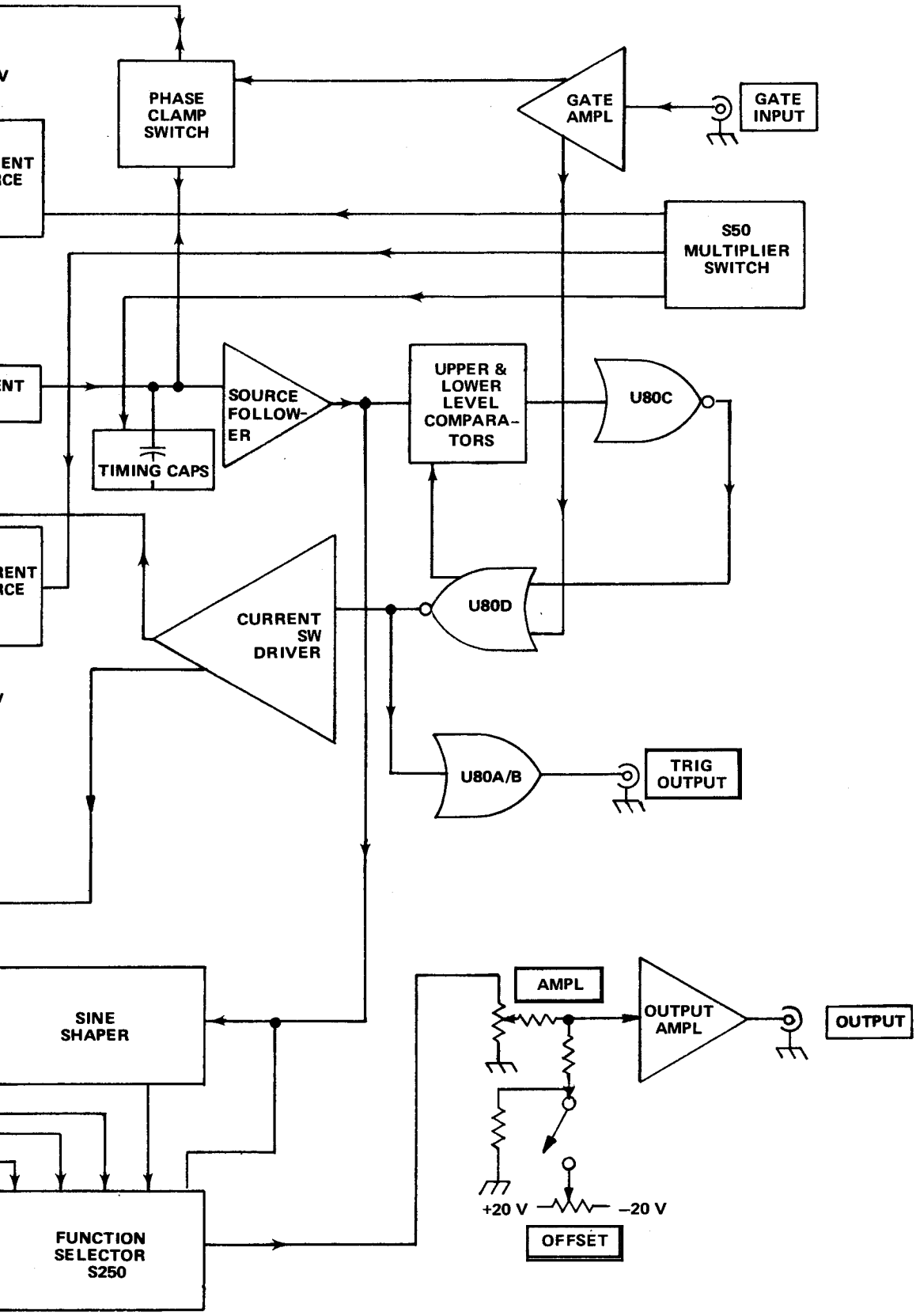

PHASE
PHASE CLAMP
+17V
+ CURRENT SOURCE
VCF INPUT
VOLTAGE SUMMING AMPLIFIER
CURRENT SW
INVERTING AMPLIFIER
–CURRENT SOURCE
–17 V
DIAL VOLTAGE FOLLOWER
+20 V REF SUPPLY
+17 V SUPPLY (+ CURRENT SOURCE)
–17 V SUPPLY (– CURRENT SOURCE)
FREQUENCY Hz
FREQUENCY VERNIER
–20 V REF SUPPLY
+20 V DCPL SUPPLY
+5 V SUPPLY
–20 V DCPL SUPPLY
–5 V SUPPLY

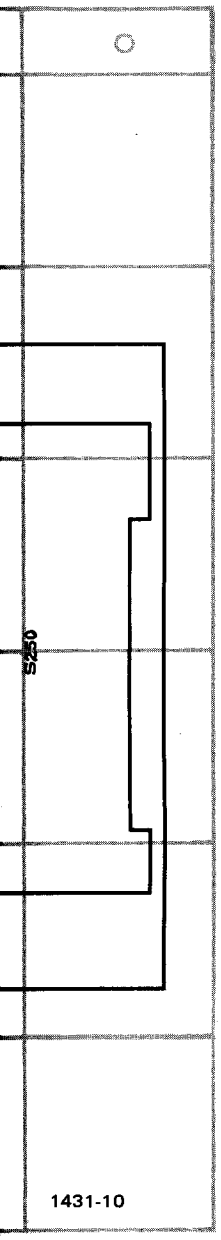
@

FG 501 BLOCK DIAGRAM



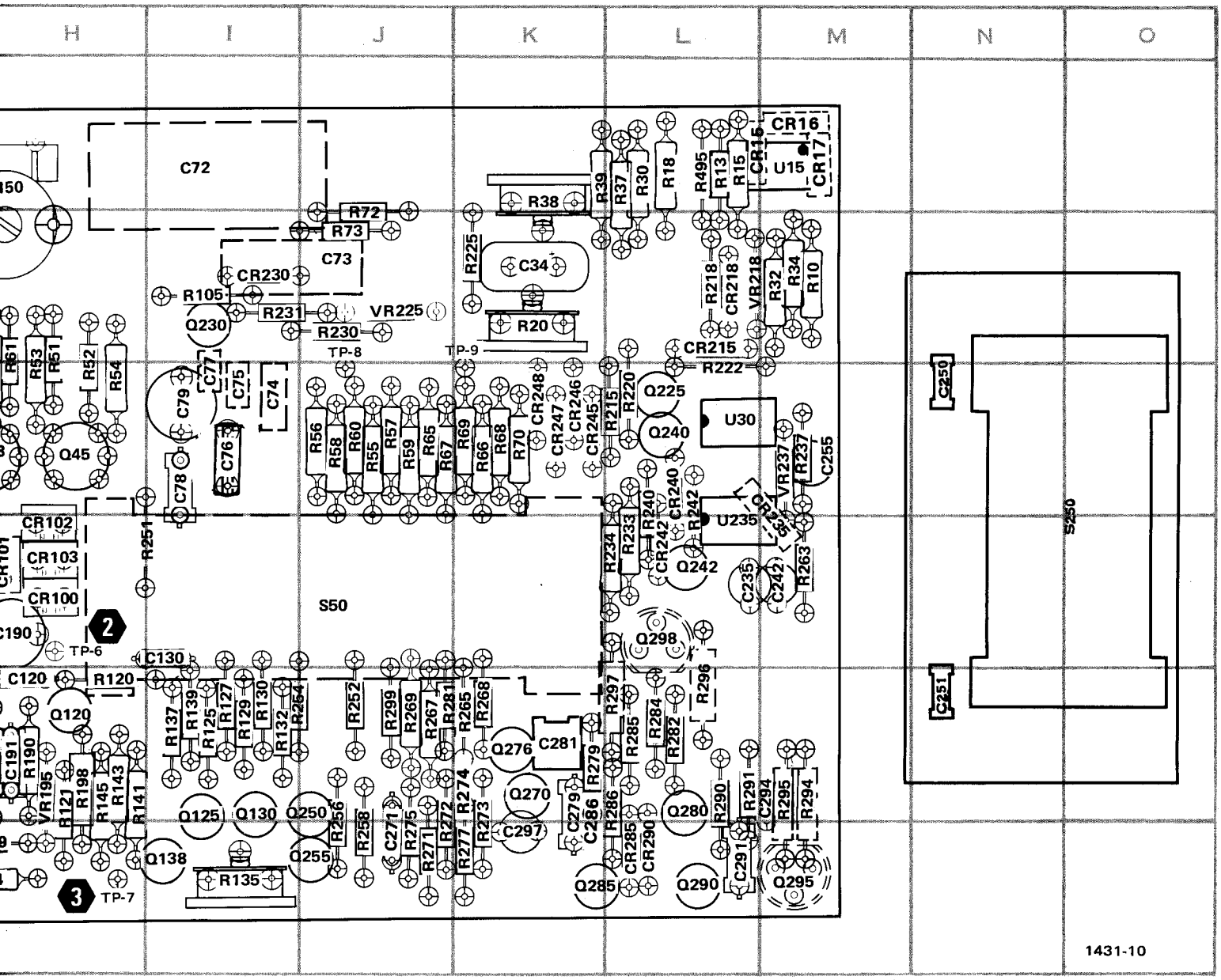
1431-09

GRID LOCATION CHART
(SN B020000-UP)



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C34	K2	CR178	F3	R11	C3	R150	H1	R281	J5	U460	B3
C40	E3	CR180	F3	R13	L1	R151	G1	R282	L5	U470	B4
C72†	I1	CR182	E3	R15	L1	R152	G1	R284	L5	U480	C5
C73†	J2	CR215	L2	R18	L1	R153	G2	R285	L5		
C74†	I3	CR218	L2	R20	K2	R155	G2	R286	L5		
C75†	I3	CR230	I2	R27	F4	R156	F2	R290	L5	VR80	G4
C76†	I3	CR235*	L3	R30	L1	R158	F2	R291	L5	VR85	G4
C77*	I3	CR240	L3	R32	M2	R159	F3	R294	M5	VR195	H5
C78	I3	CR242	L4	R34	M2	R160	E2	R295	M5	VR205	E5
C79	I3	CR245	K3	R37	L1	R161	F3	R296	L5	VR218	L2
C80	F4	CR246	K3	R38	K1	R162	E2	R297	L5	VR225	J2
C85	F3	CR247	K3	R39	K1	R163	E3	R299	J5	VR237	M3
C85'	G4	CR248	K3	R41	E3	R170	F1	R400	B2	VR405	C2
C89	G4	CR285	L6	R42	D3	R171	E1	R403	A2		
C95	E5	CR290	L6	R44	D3	R172	E1	R405	C2		
C120	H5	CR400	B1	R45	D3	R173	F2	R406	C2		
C130	I4	CR410*	C2	R46	D3	R175	E2	R410	E2		
C150	G1	CR450	D6	R51	H2	R176	F2	R411	D2		
C162*	F3	CR490	C5	R52	H2	R178	F2	R412	D2		
C170	F1			R53	H2	R180	E2	R415	D2		
C190	H4	J81	F5	R54	H3	R182	E2	R417	E2		
C191*	H5			R55	J3	R190	H5	R420	B4		
C196*	G6	Q45	H3	R56	J3	R191	G5	R422	A4		
C204*	F6	Q48	G3	R57	J3	R194	G6	R424	B4		
C211	D3	Q80	F5	R58	J3	R196	G6	R430	C3		
C235	L3	Q85	G4	R59	J3	R198	H5	R431	C3		
C242	M4	Q90	F4	R60	J3	R199	G6	R434	C4		
C250	N3	Q120	H5	R61	H2	R204	F6	R441	A6		
C251*	N5	Q125	I5	R62	G2	R205	G6	R442	A5		
C255	M3	Q130	I5	R63	G3	R206	F6	R445	B5		
C271	J6	Q138	I6	R64	G3	R208	E5	R446	B5		
C279*	K5	Q150	G2	R65	J3	R210	E5	R450	D5		
C281	K5	Q170	F2	R66	K3	R211	D3	R452	C6		
C286*	K6	Q225	L3	R67	J3	R212	E5	R455	D5		
C291	L6	Q230	I2	R68	K3	R215	L3	R461	B3		
C294	M5	Q240	L3	R69	K3	R216	C3	R464	A3		
C297	K6	Q242	L4	R70	K3	R218	L2	R465	A3		
C400	D1	Q250	J5	R72	J1	R220	L3	R468	C4		
C406	C2	Q255	J6	R73	J2	R222	L3	R471	B4		
C410	D2	Q270	K5	R80	E5	R225	K2	R473	A4		
C415	D2	Q276	K5	R81	F5	R230	J2	R475	B4		
C455	E4	Q280	L5	R82	F4	R231	I2	R481	D5		
C482*†	D5	Q285	K6	R85	F4	R233	L4	R482	D5		
C485	C5	Q290	L6	R87	G4	R234	L4	R485	D5		
C490	D6	Q295	M6	R88	F4	R237	M3	R486	C5		
C495	E5	Q298	L4	R89	G4	R240	L3	R487	D4		
		Q400	C2	R94	E5	R242	L3	R493	A5		
		Q410	B1	R96	E5	R251	I4	R495	L1		
CR15*	M1	Q415	B2	R99	F4	R252	J5				
CR16*	M1	Q420	A5	R100	E4	R254	I5				
CR17*	M1	Q424	B5	R102	F4	R256	J6	S50†	J4		
CR45*	E4	Q430	C3	R105	I2	R258	J6	S250	O3		
CR100	H4	Q445	B6	R120	H5	R263	M4				
CR101	H4	Q447	B5	R121	H5	R265	K5	U15	M1		
CR102	H4	Q450	D4	R125	I5	R267	J5	U30	L3		
CR103	H4	Q468	C4	R127	I5	R268	K5	U40	E4		
CR150	G1	Q472	B4	R129	I5	R269	J5	U45	F4		
CR155	G2	Q474	A4	R130	I5	R271	J6	U48	E4		
CR156	G3	Q485	C5	R132	I5	R272*	J6	U80	F5		
CR158	F2	Q488	C6	R135	I6	R273*	K6	U195	G5		
CR160	F2			R137	I5	R274*	K5	U235	L4		
CR162	E2			R139	I5	R275	J6	U410	C2		
CR170	E1			R141	H5	R277	K6	U420	B4		
CR175	G3			R143	H5	R279	K5	U430	C3		
CR176	F3	R10	M2	R145	H5			U440	B5		

OCATION GRID



* See Parts List for serial number ranges.

† Located on back of board.

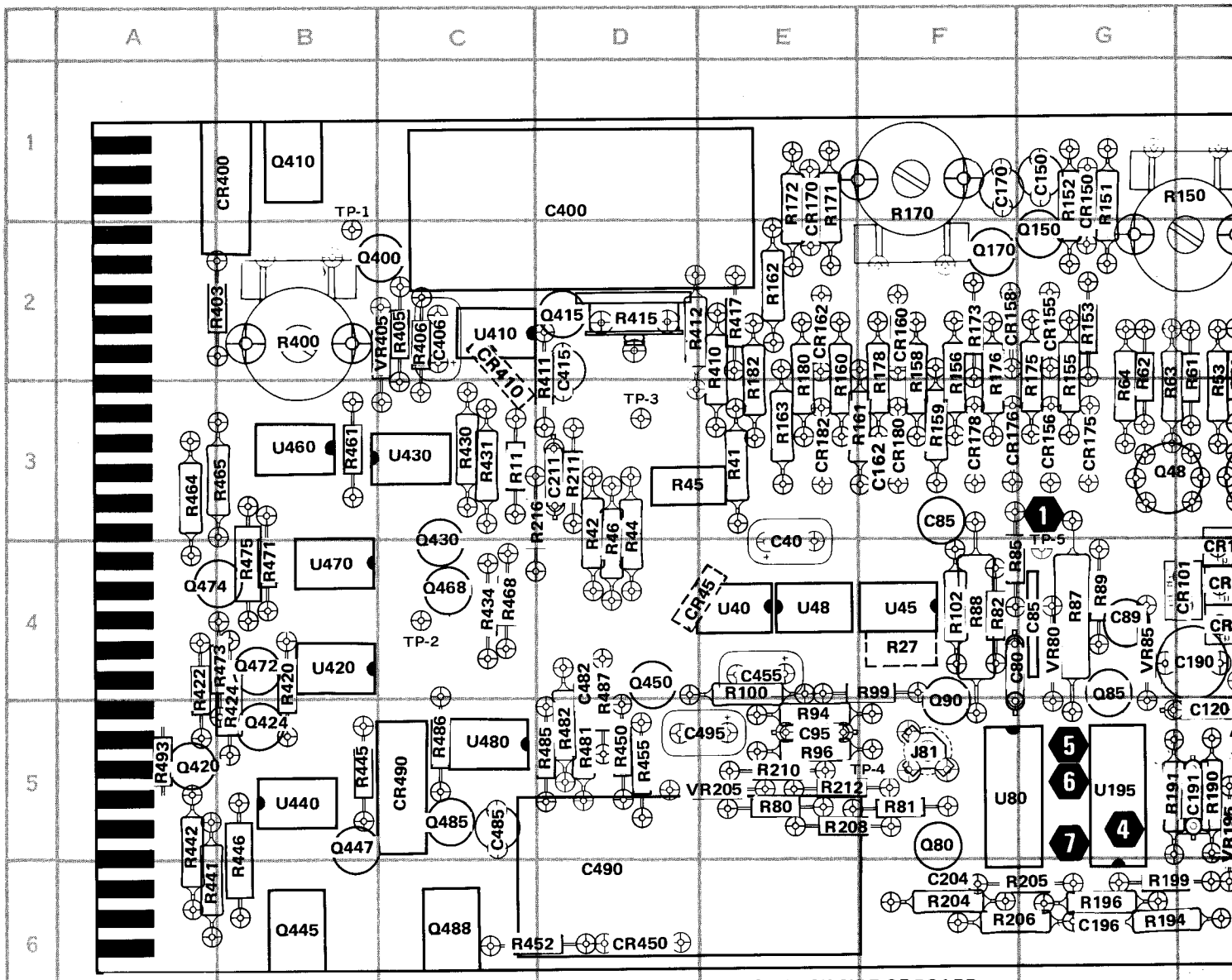
[1]Alternate location.

CKT NO
C34
C40
C72†
C73†
C74†
C75†
C76†
C77*
C78
C79
C80
C85
C85[1]
C89
C95
C120
C130
C150
C162*
C170
C190
C191*
C196*
C204*
C211
C235
C242
C250
C251*
C255
C271
C279*
C281
C286*
C291
C294
C297
C400
C406
C410
C415
C455
C482*
C485
C490
C495
CR15*
CR16
CR17*
CR45*
CR100
CR101
CR102
CR103
CR150
CR155
CR156
CR158
CR160
CR162
CR170
CR175
CR176

COMPONENT LOC

SN B020000-up

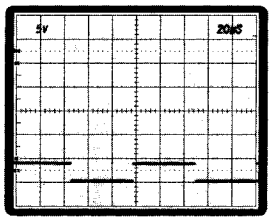
PARTS LOCATION GRID
SN B020000–UP



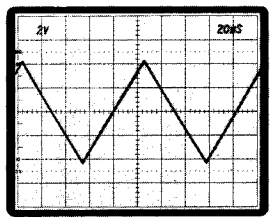
NOTE: COMPONENTS SHOWN WITH DASHED LINES ARE LOCATED ON BACK SIDE OF BOARD.

Waveform conditions:

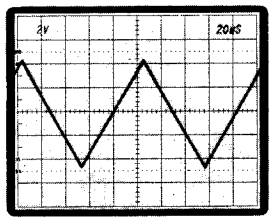
FREQUENCY Hz dial	**10**
Variable	**Cal**
MULTIPLIER	**10^3**
PHASE	**in (off)**
OFFSET	**in (off)**
FUNCTION	**sinewave**
AMPL	**fully clockwise**



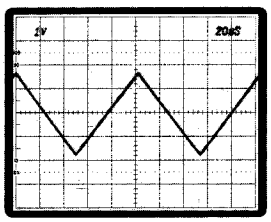
1 **TP 5**



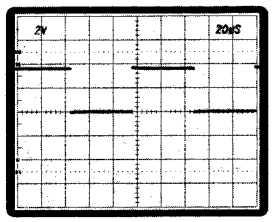
2 **TP 6**



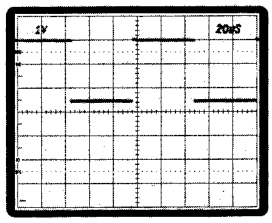
3 **TP 7**



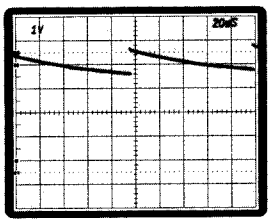
4 **U195-3**



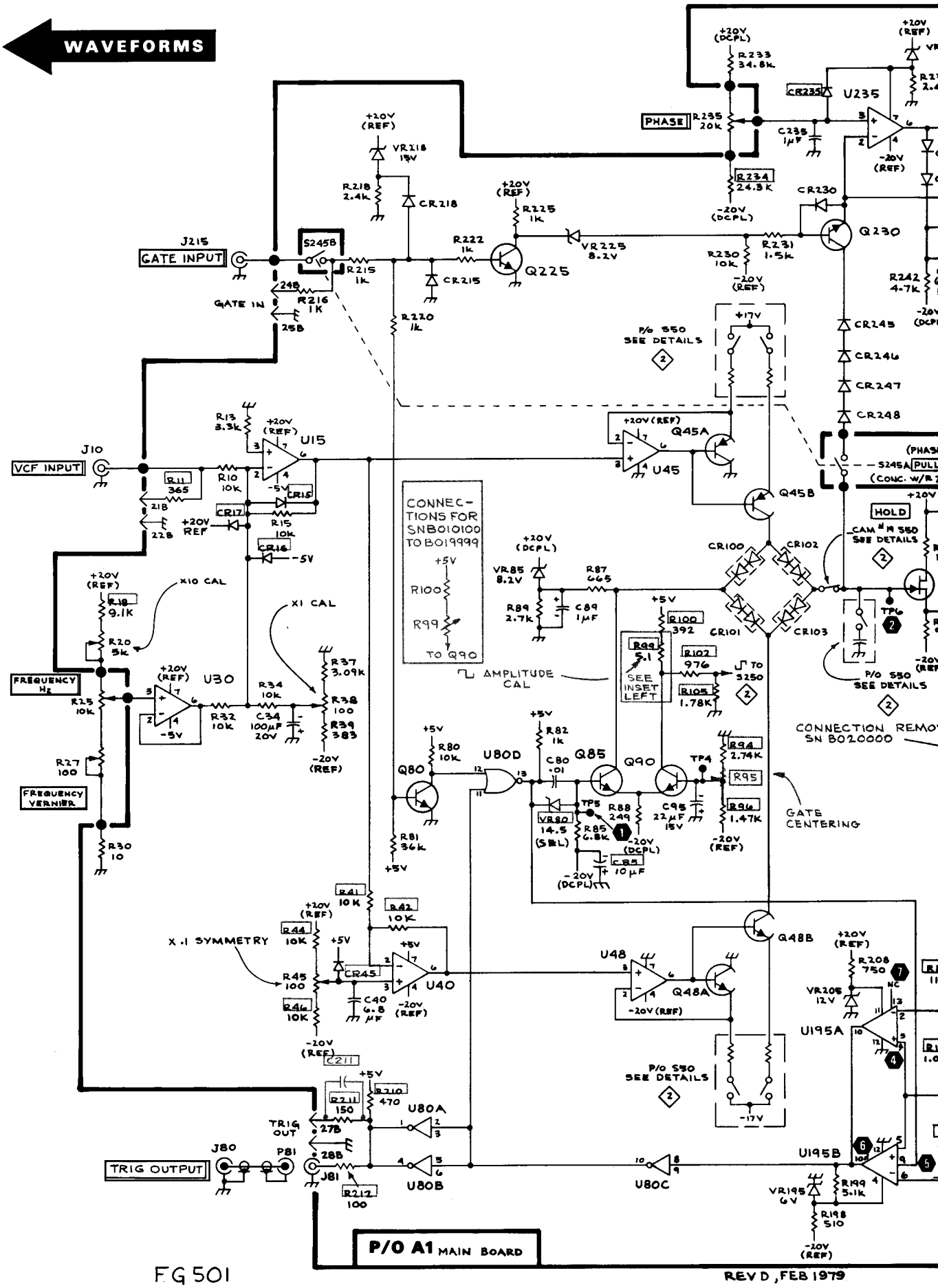
5 **U195-9**



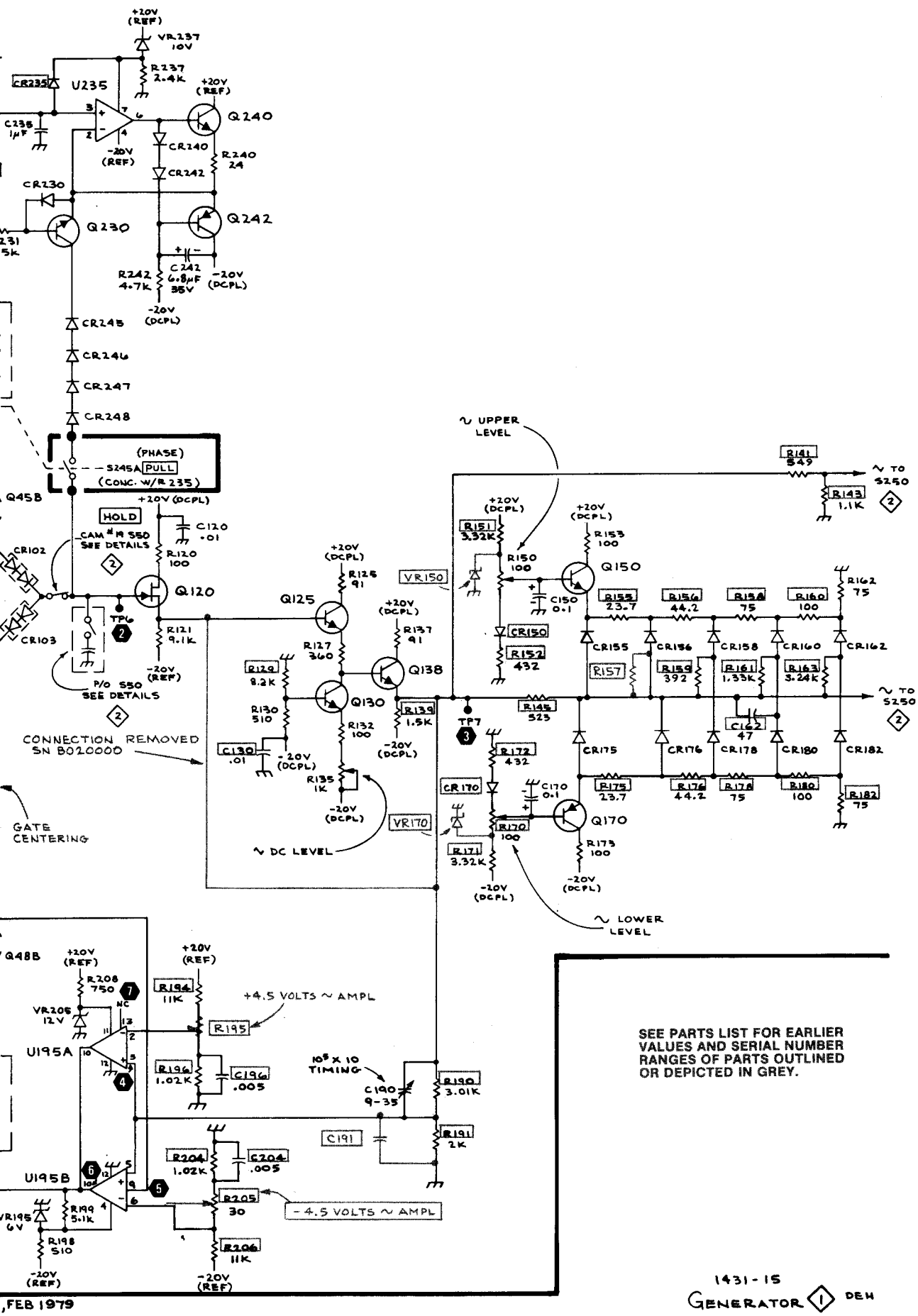
6 **U195-10**



7 **U195-13**


WAVEFORMS
J215
GATE INPUT
S245B
GATE IN
R216 1K
R215 1K
R222 1K
Q225
R225 1K
VR225 8.2V
R231 1.5K
R230 10K
-20V (REF)
R220 1K
CR215
VR218 15V
R218 2.4K
CR218
+20V (REF)
PHASE
R235 20K
R233 34.8K
R234 24.5K
-20V (DCPL)
U235
C235 1μF
CR235
CR230
Q230
R242 4.7K
CR245
CR246
CR247
CR248
P/O S50 SEE DETAILS
+17V
-17V
J10
VCF INPUT
R11 365
R10 10K
R13 3.3K
U15
CR15
CR17
R15 10K
CR16
-5V
+20V REF
Q45A
U45
Q45B
(PHASE
S245A PULL
(CONC. W/R
HOLD
CAM IN S50 SEE DETAILS
CONNECTIONS FOR SN B010100 TO B019999
R100
R99
TO Q90
AMPLITUDE CAL
VR85 8.2V
R87 665
R89 2.7K
C89 1μF
CR100
CR102
CR101
CR103
R100 392
R99 5.1
SEE INSET LEFT
R102 976
R105 1.78K
TO S250
TP6
P/O S50 SEE DETAILS
CONNECTION REMOVED SN B020000
FREQUENCY Hz
R18 9.1K
R20 5K
X10 CAL
X1 CAL
U30
R34 10K
R32 10K
C34 100μF 20V
R37 3.09K
R38 100
R39 383
R25 10K
R27 100
FREQUENCY VERNIER
R30 10
Q80
R80 10K
U80D
R82 1K
C80 .01
Q85
Q90
TP4
R94 2.74K
R95
R96 1.47K
GATE CENTERING
VR90 14.5 (SEL)
R85 6.8K
R88 249
C95 22μF 15V
C85 10μF
R81 36K
X.1 SYMMETRY
R41 10K
R42 10K
R44 10K
R45 100
R46 10K
CR45
U40
C40 6.8 μF
C211
R211 150
R210 470
U80A
U80B
U80C
TRIG OUT
TRIG OUTPUT
J80
P81
J81
R212 100
Q48B
Q48A
U48
-20V (REF)
R208 750
VR206 12V
U195A
U195B
R199 5.1K
R198 510
VR195 6V
P/O A1 MAIN BOARD
REV D, FEB 1979

FG 501



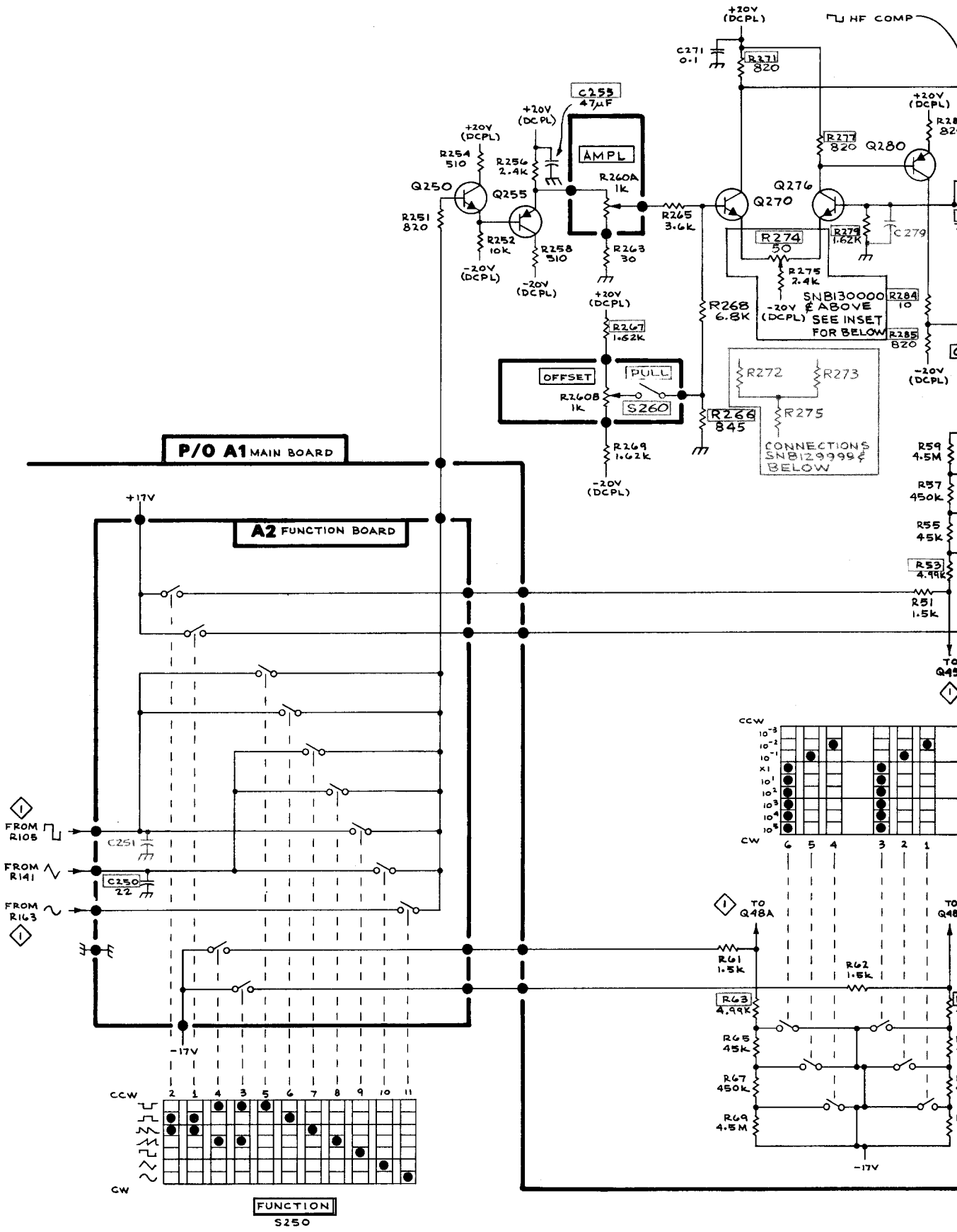
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

1431-15
GENERATOR ◇1 DEH

,FEB 1979

GENERATOR

◇1

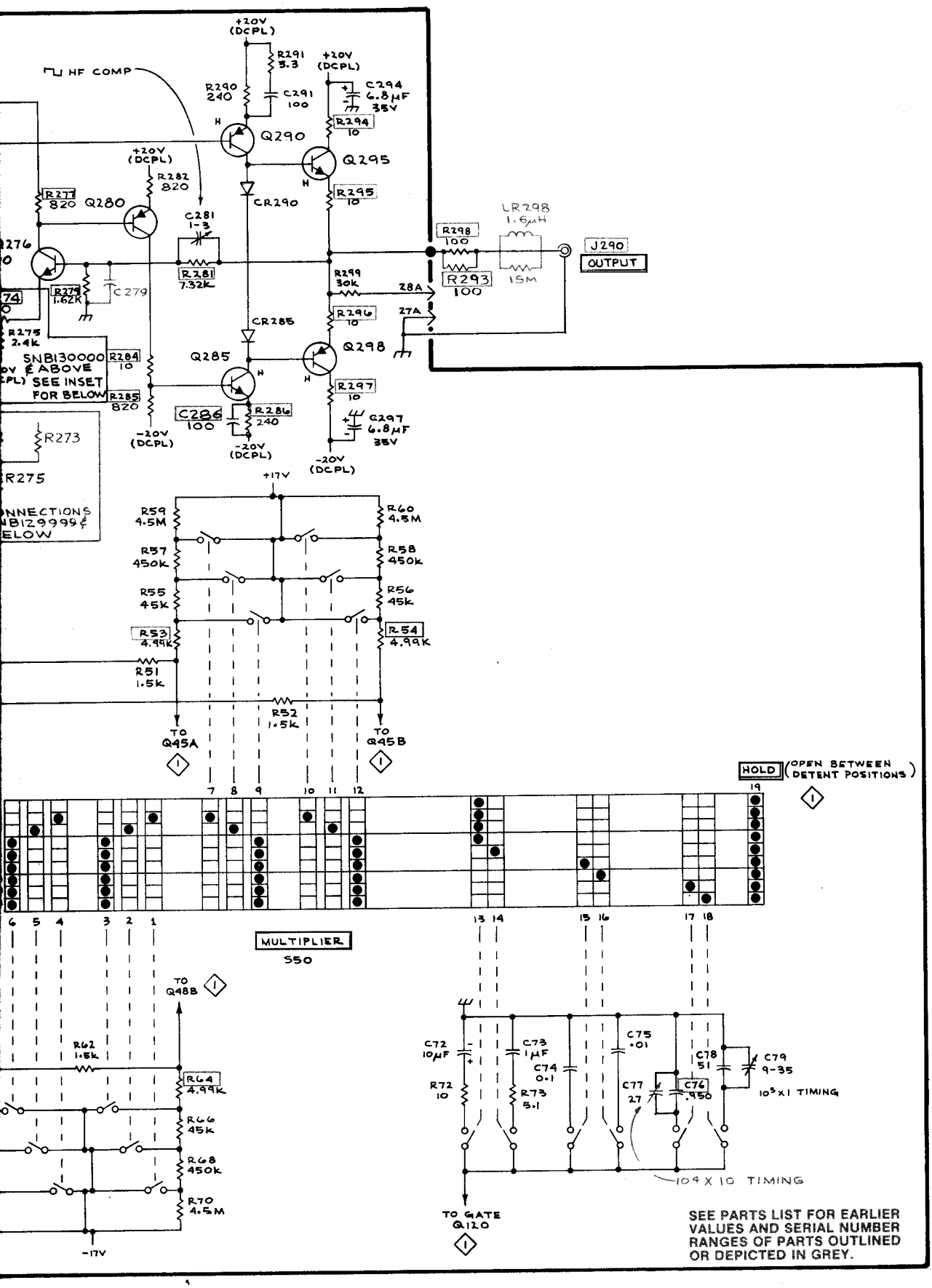


FG 501

REV H, JUL 1978

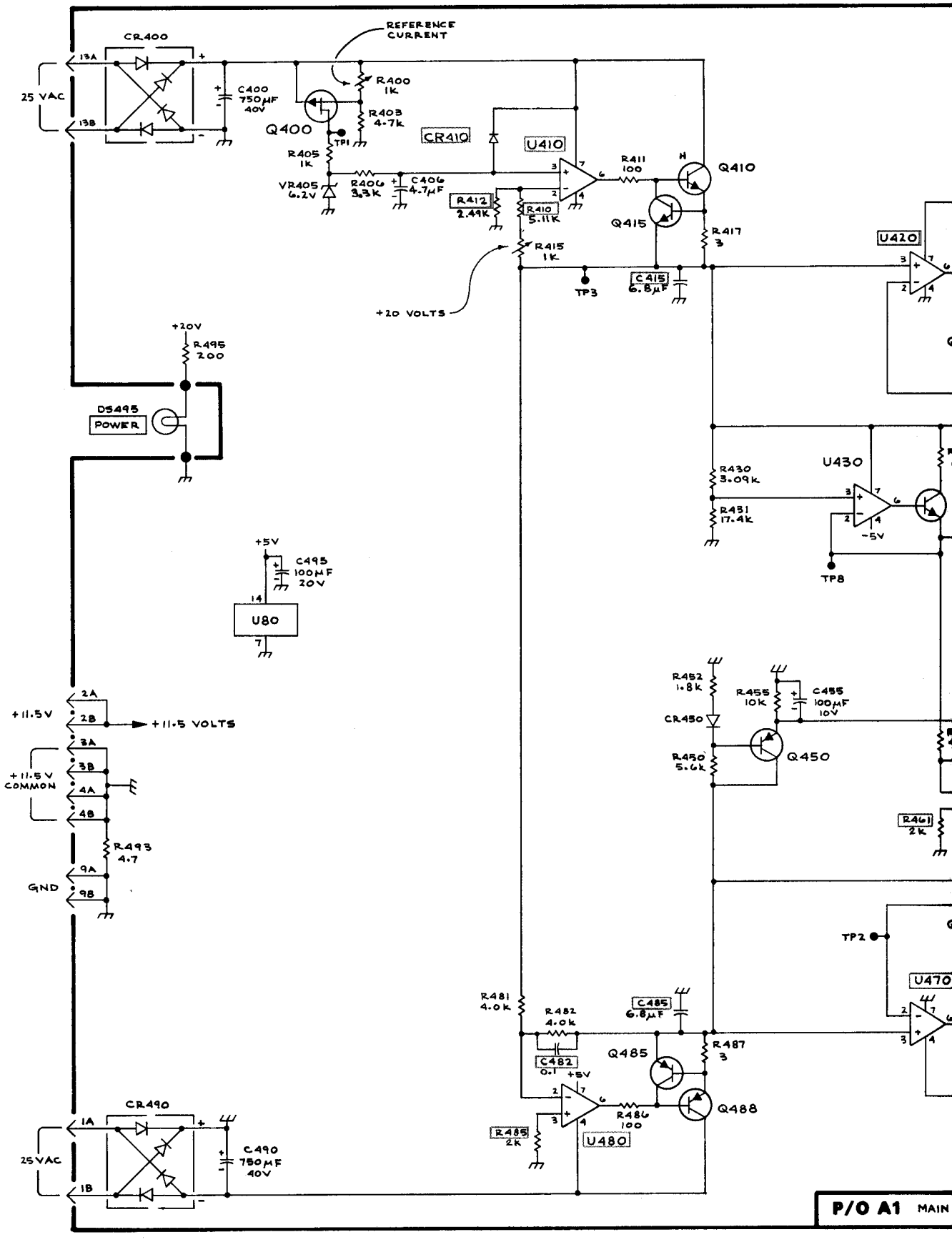
1431-16

OUTPUT AM



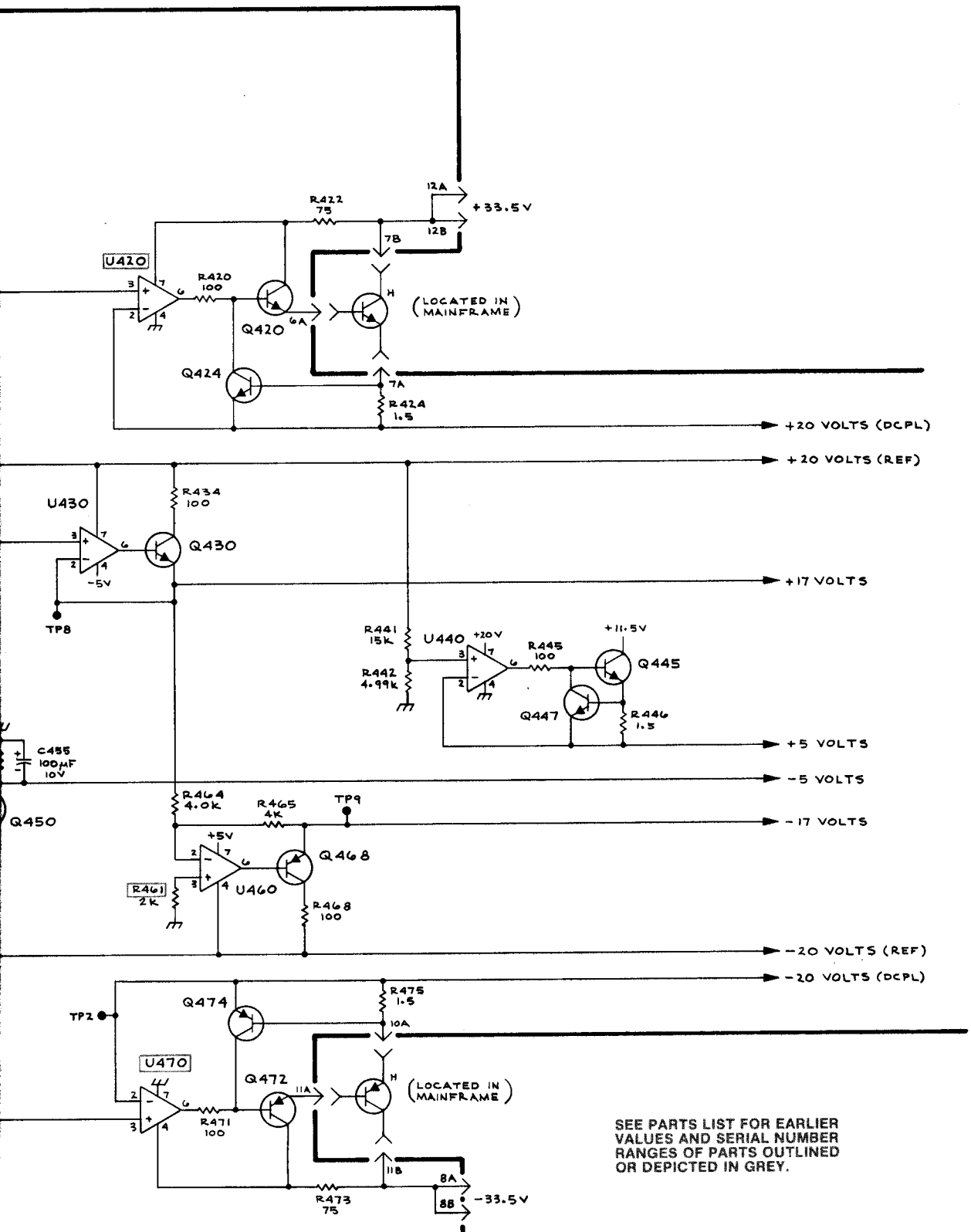
1431-16

OUTPUT AMPLIFIER AND SWITCH DETAILS ◇2 DEH



FG 501

REV G, JUL1978



SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

P/O A1 MAIN BOARD

1451-17

POWER SUPPLY 3 DEH 273

JUL1978

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

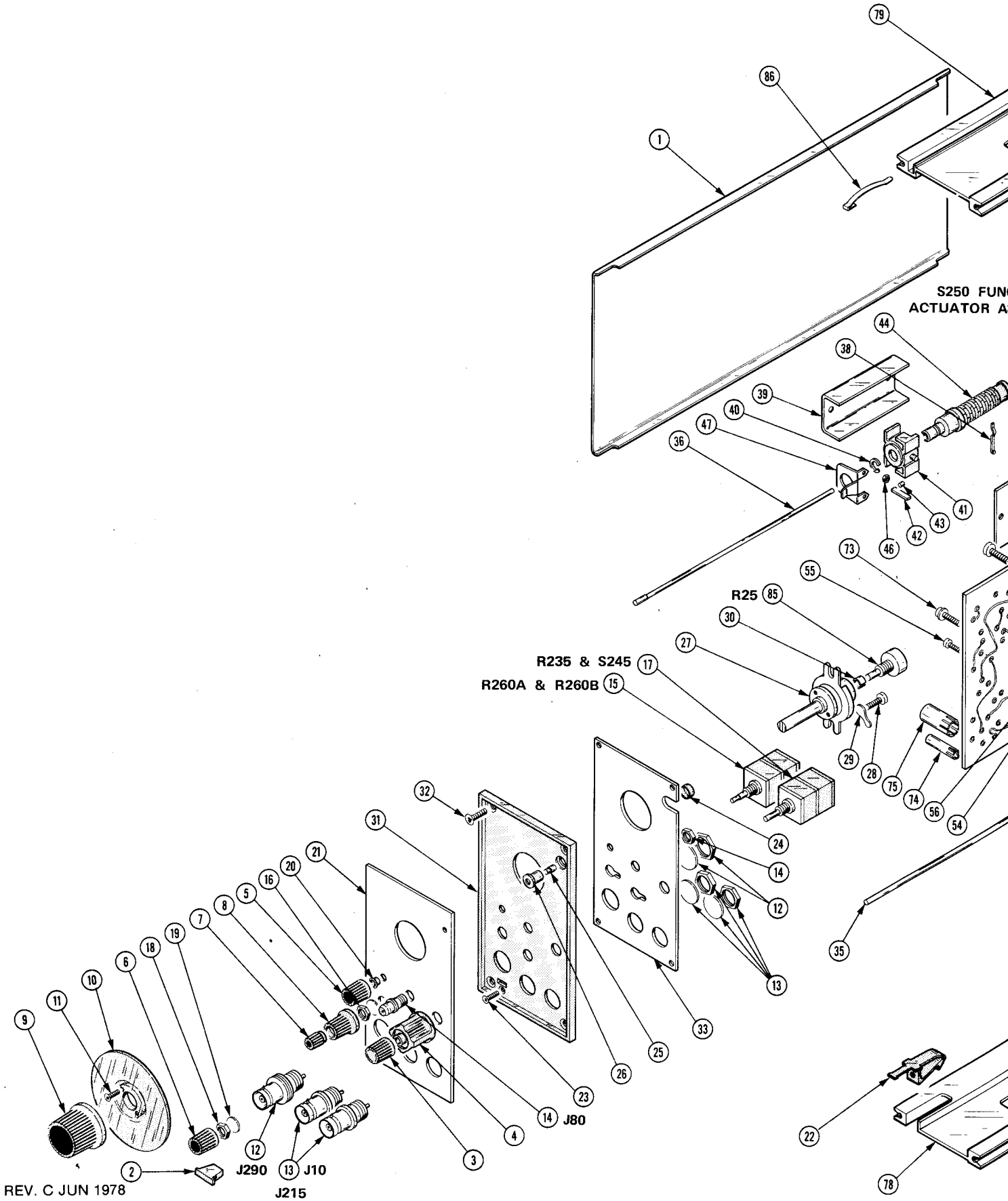
Mfr. Code	Manufacturer	Address	City, State, Zip
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
05091	TRI-ORDINATE CORPORATION	343 SNYDER AVENUE	BERKELEY HEIGHTS, NJ 07922
08261	SPECTRA-STRIP 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
78584	STEWART STAMPING CORP.	630 CENTRAL PARK AVE.	YONKERS, NY 10704
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
93907	CAMCAR SCREW AND MFG. CO.	600 18TH AVE.	ROCKFORD, IL 61101
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:	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	B010100	B139209	1		KNOB:RED--CAL	80009	366-1031-03
	366-1031-08	B139210		1		KNOB:GY,CAL/W/ARROW,0.127 ID,0.392 OD	80009	366-1031-08
	213-0153-00			1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-4	366-1170-01	B010100	B139209	1		KNOB:GRAY,4 SIDED	80009	366-1170-01
	366-1170-03	B139210		1		KNOB:GRAY,0.25 ID X 0.706 OD,0.6H	80009	366-1170-03
	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	B139209	1		KNOB:GRAY	80009	366-1023-01
	366-1023-07	B139210		1		KNOB:GRAY,0.127 ID,0.392 OD,0.466	80009	366-1023-07
-6	366-1023-03	B060000	B139209	1		KNOB:GRAY--PULL	80009	366-1023-03
	366-1023-08	B139210		1		KNOB:GRAY--PULL	80009	366-1023-08
	213-0153-00			1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-7	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
-8	366-1077-00	B010100	B139209	1		KNOB:GRAY	80009	366-1077-00
	366-1077-01	B139210		1		KNOB:GRAY,0.127 ID,0.5 OD,0.531H	80009	366-1077-01
	213-0153-00			1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-9	366-1004-00	B010100	B089999	1		KNOB:GRAY	80009	366-1004-00
	366-1007-01	B090000	B139209	1		KNOB:GRAY	80009	366-1007-01
	366-1007-05	B139210		1		KNOB:GRAY	80009	366-1007-05
	200-0844-01	B139210		1		CAP,INSERT,KNOB:	80009	200-0844-01
	213-0153-00			2		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-10	354-0437-01	B010100	B139209	1		RING,KNOB SKIRT:	80009	354-0347-01
	354-0557-02	B139210		1		RING,KNOB SKIRT:CLEAR,1 TO 10	80009	354-0557-02
-11	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
-12	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
						- - - * - - -		
-13	131-0955-00			2		CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
-14	131-0282-00			1		CONNECTOR,RCPT,:FEEDTHRU	74868	74300MB
-15	----- -----			1		RESISTOR,VAR:(SEE R206A AND R206B EPL)		
						(ATTACHING PARTS)		
-16	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
-17	----- -----			1		RESISTOR,VAR:(SEE R235 AND R245 EPL)		
						(ATTACHING PARTS)		
-18	210-0583-00			1		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-19	210-0940-00			1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
						- - - * - - -		
-20	358-0378-00			1		BUSHING,SLEEVE:PRESS MOUNT	80009	358-0378-00
-21	333-1644-00	B010100	B109999	1		PANEL,FRONT:	80009	333-1644-00
	333-1644-01	B110000	B139209	1		PANEL,FRONT:	80009	333-1644-01
	333-1644-02	B139210		1		PANEL,FRONT:	80009	333-1644-02
-22	214-1513-00	B010100	B019999	1		LCH,PL-IN RTNG:PLASTIC	80009	214-1513-00
	214-1513-01	B020000		1		LCH,PLUG-IN RET:	80009	214-1513-01
						(ATTACHING PARTS)		
-23	213-0254-00			1		SCR,TPG,THD CTG:2-32 X 0.250,100 DEG,FLH	45722	OBD
						- - - * - - -		
-24	200-0935-00			1		BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-25	378-0602-00			1		LENS,LIGHT:GREEN	80009	378-0602-00
-26	352-0157-00			1		LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-27	401-0206-00			1		GR ASSY,SP RDCN:	10539	4511/DAF
						(ATTACHING PARTS)		
-28	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
-29	210-0201-00			1		TERMINAL,LUG:SE #4	78189	2104-04-00-2520N
						- - - * - - -		
-30	358-0481-00			1		BUSHING,SLEEVE:SPLIT,0.128 ID X 0.25 INCH OD	80009	358-0481-00
-31	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)		
-32	213-0229-00			4		SCR,TPG,THD FOR:6-20 X0.375"100 DEG,FLH STL	93907	OBD
						- - - * - - -		
-33	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
-34	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
-35	384-0209-00			1		EXTENSION SHAFT:0.125 OD X 6.064 INCH LONG	80009	384-0209-00
-36	384-0406-00			1		EXTENSION SHAFT:0.125 OD X 5.937 INCH LONG	80009	384-0406-00
-37	----- -----			1		CKT BOARD ASSY:SECONDARY(SEE A2 EPL)		
-38	131-0604-00			11		. CONTACT,ELEC:CKT BD SW,SPR	80009	131-0604-00
	105-0378-00			1		. ACTR ASSY,CAM S:(S250)	80009	105-0378-00
-39	200-1435-00			1		. . COVER,CAM SW:	80009	200-1435-00
-40	354-0219-00			1		. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
-41	401-0155-00			1		. . BEARING,CAM SW:FRONT	80009	401-0155-00
-42	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
-43	214-1127-00			1		. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-44	105-0377-00			1		. . ACTUATOR,CAM SW:	80009	105-0377-00
-45	401-0156-00			1		. . BEARING,CAM SW:REAR	80009	401-0156-00
-46	210-0406-00			4		. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-47	131-1248-00			1		. . CONTACT,ELEC:GROUND	80009	131-1248-00
						(ATTACHING PARTS FOR ACTR ASSY)		
-48	211-0116-00			4		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
						- - - * - - -		
						(ATTACHING PARTS FOR CKT BD ASSY)		
-49	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
-50	129-0080-00			2		POST,ELEC-MECH:0.875 INCH LONG	80009	129-0080-00
						- - - * - - -		
-51	----- -----			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
-52	131-0604-00			19		. CONTACT,ELEC:CKT BD SW,SPR	80009	131-0604-00
-53	131-1003-00			1		. CONNECTOR BODY,:CKT BD MT,3 PRONG	80009	131-1003-00
-54	337-1418-01			1		. SHIELD,ELEC:CAM SWITCH	80009	337-1418-01
						(ATTACHING PARTS)		
-55	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
-56	342-0167-00			1		. INSULATOR,PLATE:2.45 INCH LONG	80009	342-0167-00
						- - - * - - -		
-57	----- -----			1		. RESISTOR,VAR:(SEE R27 EPL)		
						(ATTACHING PARTS)		
-58	210-0583-00			1		. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-59	210-0046-00			1		. WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
-60	407-0579-00			1		. BRKT,RES.MTG:	80009	407-0579-00
						- - - * - - -		
-61	211-0008-00			3		. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-62	210-0921-00			3		. WASHER,MICA:0.50 X 0.141 X0.005 INCH THK	80009	210-0921-00

[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
1-63	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
-64	200-1434-00			1	. . COVER,CAM SW:	80009	200-1434-00
-65	354-0219-00			1	. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
-66	401-0155-00			1	. . BEARING,CAM SW:FRONT	80009	401-0155-00
-67	214-1704-00			1	. . SPRING,FLAT:CAM SW DETENT,0.006 INCH THK	80009	214-1704-00
	214-1704-01			1	. . SPRING,FLAT:CAM SW DETENT,0.008 INCH THK	80009	214-1704-01
	214-1704-02			1	. . SPRING,FLAT:CAM SW DETENT,0.010 INCH THICK	80009	214-1704-02
-68	214-1127-00			1	. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-69	105-0375-00			1	. . ACTUATOR,CAM SW:	80009	105-0375-00
-70	401-0156-00			1	. . BEARING,CAM SW:REAR	80009	401-0156-00
-71	210-0406-00			4	. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-72	131-1248-00			1	. . CONTACT,ELEC:GROUND	80009	131-1248-00
					(ATTACHING PARTS FOR ACTR ASSY)		
-73	211-0116-00			4	. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
	210-0269-00	XB139210		1	. TERMINAL,LUG:NON LOCKING,0.257" MTG HOLE	78584	OBD
					- - - * - - -		
-74	214-0269-00	B010100	B129999X	2	. HEAT SINK,XSTR:0.312 DIA X 0.75 L	98978	TXD-032-75
-75	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
	214-2733-00	XB139210		1	HEAT SINK,XSTR:(2) TO -202,AL	80009	214-2733-00
					(ATTACHING PARTS)		
	211-0004-00	XB139210		2	SCREW,MACHINE:3-48 X 0.125,PNH,STL,CD PL POZ		
	342-0202-00	XB139219		2	INSULATOR,PLATE:TRANSISTOR	01295	10-21-023-106
					- - - * - - -		
-76	136-0252-00			209	. SOCKET,PIN TERM:0.145 INCH LONG	00779	2-330808-7
					(ATTACHING PARTS FOR CKT BD ASSY)		
-77	213-0146-00			4	SCR,TPG,THD FOR:6-20 X 0.313 INCH,PNH STL	83385	OBD
					- - - * - - -		
	210-1270-00	XB128340		2	WASHER,FLAT:0.141 ID X .04THK,AL,.21 9 OD	80009	210-1270-00
	386-3657-00	XB128340		2	SUPPORT,PLUG-IN:	80009	386-3657-00
-78	426-0724-00			1	FR SECT,PLUG-IN:BOTTOM	80009	426-0724-00
-79	426-0725-00			1	FR SECT,PLUG-IN:TOP	80009	426-0725-00
-80	175-0825-00			FT	WIRE,ELECTRICAL:2 WIRE RIBBON,0.531 FT LONG	08261	OBD
-81	175-0828-00			FT	WIRE,ELECTRICAL:5 WIRE RIBBON,0.334 FT LONG	08261	SS-0526-710610C
-82	175-0829-00			FT	WIRE,ELECTRICAL:6 WIRE RIBBON,0.334 FT LONG	08261	SS-0626-710610C
-83	210-0774-00			1	EYELET,METALLIC:0.152 OD X 0.245 INCH L,BRS	80009	210-0774-00
-84	210-0775-00			1	EYELET,METALLIC:0.126 OD X 0.23 INCH L,BRS	80009	210-0775-00
-85	-----	-----		1	RESISTOR,VAR:(SEE R25 EPL)		
-86	214-1061-00	XB050297		1	SPRING,GROUND:FLAT	80009	214-1061-00



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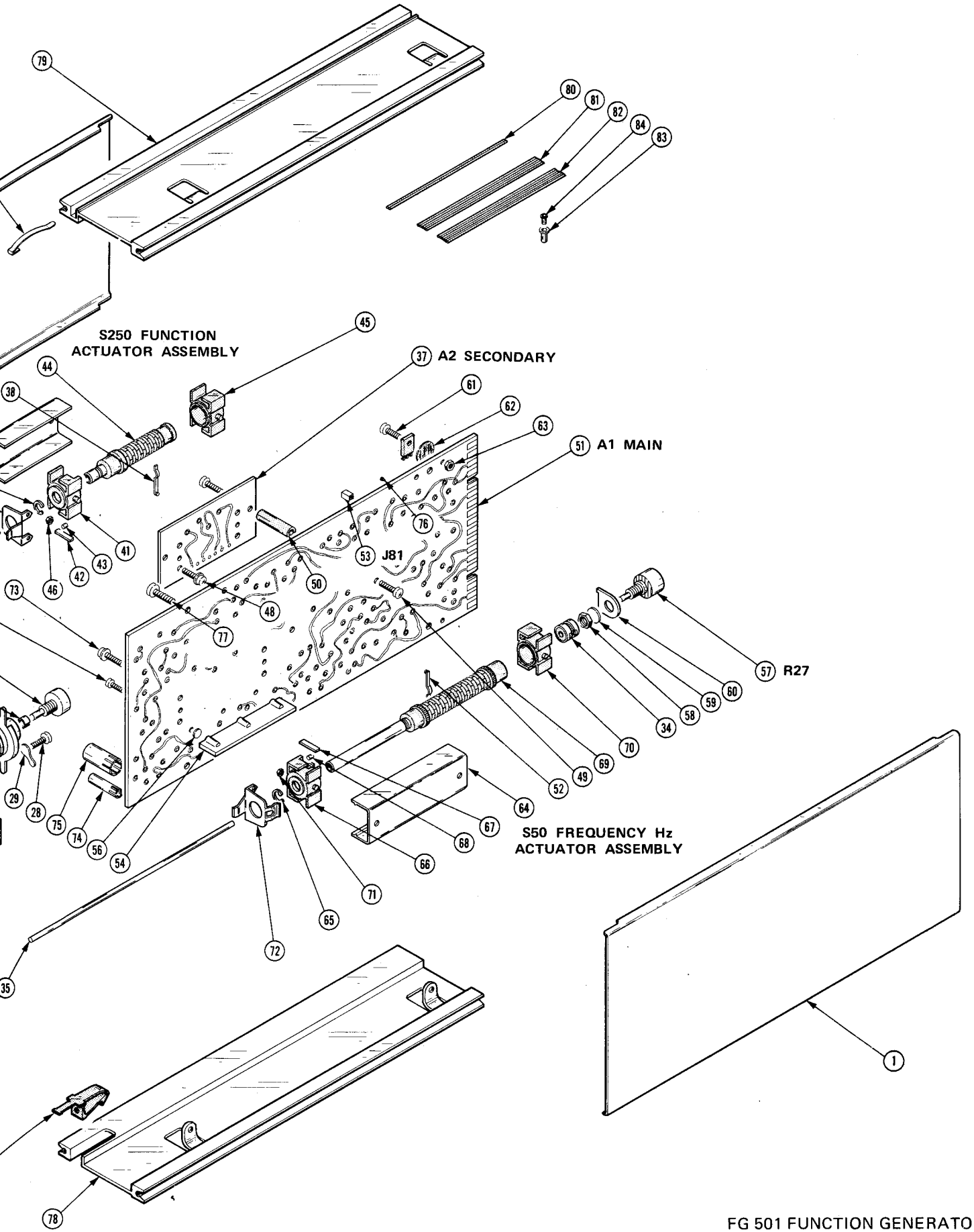


FG 501 FUNCTION GENERATOR

ACCESSORIES

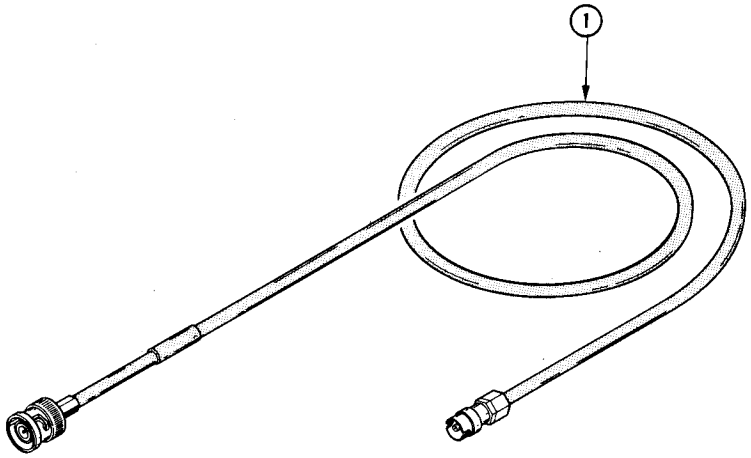


FIG. 2 ACCESSORIES

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- 1	012-0127-00			1		CABLE ASSY,RF:18.50 INCHES LONG	80009	012-0127-00
	070-1431-01			1		MANUAL,TECH:INSTRUCTION	80009	070-1431-01

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
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
PG 508 replaces 114	Performance of replacement equipment is the same or better than equipment being replaced.	
115		
2101		
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		
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
SG 504 replaces 067-0532-01	SG 504 - Frequency range 245 MHz to 1050 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
067-0650-00		
TG 501 replaces 180, 180A	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181		181 - Multiple time-marks
184	TG 501 - Trigger output-slaved to market output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μs.
2901	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - 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.

MANUAL CHANGE INFORMATION

Tektronix® COMMITTED TO EXCELLENCE

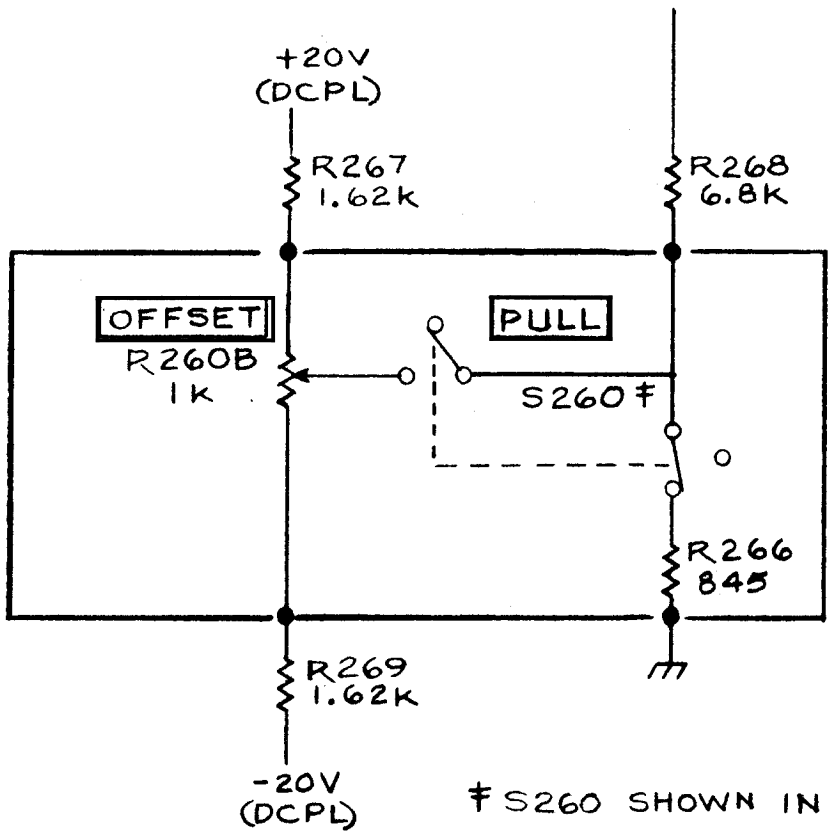
Change Reference: C6/479 Date: 4-3-79

Product: FG 501 070-1431-01

CHANGE	DESCRIPTION

SCHEMATIC CORRECTION

DIAGRAM ◇2◇ OUTPUT AMPL & SWITCH DETAILS- Partial



TEXT CORRECTION

Page 2-2 Table 2-1, Performance Requirement

CHANGE TO:

Offset
Amplitude
Into 50 ohm Load SN B130000-up: + or - 3.75 V

Nachfolgend ist das Service-Manual abgebildet, welches die US-Army für dieses Gerät herausgegeben hat.

Möglicherweise sind hier zusätzliche Informationen verfügbar.

TM 9-6625-474-14&P-2

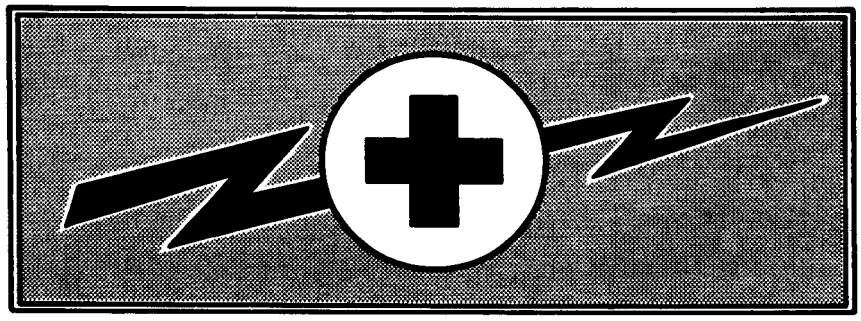
TECHNICAL MANUAL

**OPERATOR, ORGANIZATIONAL,
DIRECT SUPPORT, AND GENERAL SUPPORT
MAINTENANCE MANUAL
(INCLUDING REPAIR PARTS)
FOR**

FUNCTION GENERATOR
TEKTRONIX, MODEL FG 501A
(6625-01-106-9873)

DEPARTMENT OF THE ARMY 27 DECEMBER 1984

WARNING



RA PD 404264

DANGEROUS VOLTAGE

is used in the operation of this equipment

DEATH ON CONTACT

may result if personnel fail to observe safety precautions

Never work on electronic equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid. When the technician is aided by operators, he must warn them about dangerous areas.

Whenever possible, the power supply to the equipment must be shut off before beginning work on the equipment. Take particular care to ground every capacitor likely to hold a dangerous potential. When working inside the equipment, after the power has been turned off, always ground every part before touching it.

Be careful not to contact high-voltage connections when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through vital organs of the body.

WARNING

Do not be misled by the term “low voltage.” Potentials as low as 50 volts may cause death under adverse conditions.

COMMON and probe ground straps are electrically connected. Herefore, an elevated reference applied to any is present on each - as indicated by the yellow warning bands under the probe retractable hook tips.

For Artificial Respiration, refer to FM 21-11,

Power Source

This product is intended to operate in a power module connected to a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

TECHNICAL MANUAL)
)
No. 9-6625-474-14&P-2)

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., *27 December 1984*

OPERATOR, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS)

FOR

FUNCTION GENERATOR TEKTRONIX, MODEL FG 501A (6625-01-106-9873)

REPORTING OF ERRORS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms), direct to: Commander, US Army Missile Command, ATTN: DRSMI-SNPM, Redstone Arsenal, AL 35898-5238. A reply will be furnished to you.

TABLE OF CONTENTS

This manual is, in part, authenticated manufacturer's commercial literature. Recommended Spare Parts List has been added to supplement the commercial literature, The format of this manual has not been structured to consider levels of maintenance.

TABLE OF CONTENTS (CONT)

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION 0

GENERAL INFORMATION

0-1. Scope. This manual contains instructions for the operator, organizational, direct support, and general support maintenance of and calibration procedures for Tektronix Function Generator, Model FG 501A. Throughout this manual, Tektronix Function Generator, Model FG 501A is referred to as the FG 501A.

0-2. Indexes of publications. *a. DA Pam 310-4.* Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to Tektronix Function Generator, Model FG 501A.

b. DA Pam 310-7. Refer to the latest issue of DA Pam 310-7 to determine whether there are modification work orders (MWO'S) pertaining to Tektronix Function Generator, Model FG 501A.

0-3. Forms, Records, and Reports. Department of Army forms and procedures used for equipment maintenance and calibration are those prescribed by TM 38-750, The Army Maintenance Management System. Accidents involving injury to personnel or damage to materiel will be reported on DA Form 285, Accident Report, in accordance with AR 385-40.

0-4. Reporting Equipment Improvement Recommendations (EIR). If your FG 501A needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Tell us why a procedure is hard to perform. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, U.S. Army Missile Command, ATTN: DRSM1-CIMD, Redstone Arsenal, AL 35898-5290. We'll send you a reply.

0-5. Administrative Storage. To prepare the Tektronix Function Generator, Model FG 501A for placement into and removal from administrative storage, refer to Section 3, Chapter 4, AR 750-25-1, Maintenance of Equipment and Supplies. Temporary storage should be accomplished in accordance with TB 750-25-1, Section 2, Maintenance of Supplies and Equipment.

0-6. Destruction of Army Electronics Materiel. Destruction of Tektronix Function Generator, Model FG 501A to prevent enemy use shall be in accordance with TM 750-244-2.

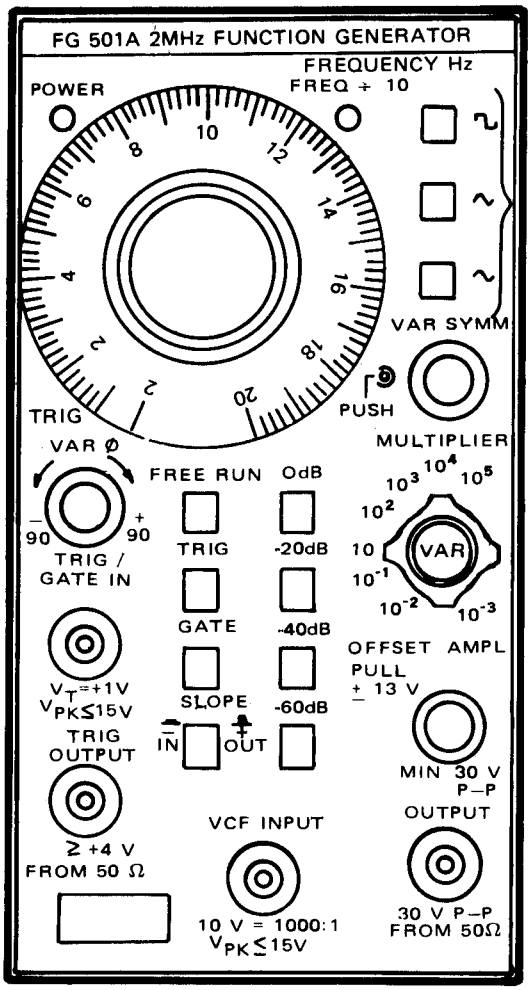


FIG.0-1. FG 501A 2MHz FUNCTION GENERATOR

SECTION 1

SPECIFICATION

INTRODUCTION

This section of the manual contains a general description of the FG 501A and complete electrical, environmental, and physical specifications. Standard accessories are also listed. Instrument option information is located in the back of this manual in a separate section.

INSTRUMENT DESCRIPTION

The FG 501A Function Generator provides low distortion sine, square, triangle, ramp, and pulse waveforms over the frequency range 0.002 Hz to 2 MHz in eight decade steps. Dc offset up to ±13 V is available. Waveform triggering and gating functions, in addition to being slope (+ or –) selectable, are provided with variable phase control capable of up to ±90° phase shift. The symmetry of the output waveform may also be varied from 5 to 95%. Step attenuators provide up to 60 dB of attenuation in 20 dB steps. A variable amplitude control provides an additional 20 dB attenuation.

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 and below the selected frequency to a maximum of 1000:1 depending on the polarity and amplitude of the VCF input signal and the selected output frequency.

ACCESSORIES

The only accessory shipped with the FG 501A is the Instruction Manual.

PERFORMANCE CONDITIONS

The electrical characteristics are valid with the following conditions:

1. The instrument must have been adjusted at an ambient temperature between +20° C and +30° C and operating at an ambient temperature between 0° C and +50° C.

2. The instrument must be in a non-condensing environment whose limits are described under Environmental.

3. Allow twenty minutes warm-up time for operation to specified accuracy; sixty minutes after exposure to or storage in high humidity (condensing) environment.

Items listed in the Performance Requirements column of the Electrical Characteristics are verified by completing the Performance Check in this manual. Items listed in the Supplemental Information column may not be verified in this manual; they are either explanatory notes or performance characteristics for which no limits are specified.

Table 1-1

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information
Frequency		Provided in eight decade steps plus variable, with overlap on all ranges.
Range		
Sine-wave, square-wave, and triangle	.002 Hz to 2 MHz	Calibrated portion of dial extends from 20 to 2. Portion of dial from 2 to .2 is uncalibrated .0002 Hz to .002 Hz uncalibrated portion of dial.
Ramp and Pulse	.002 Hz to 200 kHz ± 10% calibrated portion of dial.	Measured at 50% duty cycle. .0002 Hz to .002 Hz uncalibrated portion of dial.
Variable Symmetry		
Duty Cycle	≤5% to ≥95%.	Activation of Symmetry control divides output frequency by ≈10.
Output Amplitude	At least 30 V P-P into an open circuit, at least 15 V p-p into 50 Ω. (Front panel only.)	Offset control off.
Output Impedance		Front panel z_o = 50 Ω ±10% ATTEN in 0 dB position. Rear interface z_o = 600 Ω –10%.
Offset Range	At least ±13 V into open circuit, at least ±6.5 V into 50 Ω. Maximum peak signal plus offset cannot exceed ±15 V into an open circuit, or ±7.5 into 50 Ω. (Front panel only,) Offset reduced by attenuators.	
Frequency Resolution		1 part in 10^4 of full scale with frequency vernier control.
Stability (Frequency)		
Time		≤0.1% for 1 hour, ≤0.5% for 24 hours.
Temperature		Within 2% from .2 Hz to 2 MHz, and within 10% from .002 Hz to .2 Hz. The FREQUENCY Hz dial must be on the calibrated portion. The instrument must be in a temperature between 0° C and +50° C and checked after a 1 hour warmup. VAR SYMM control disabled,

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
Amplitude Flatness	Measured with 0 dB ATTEN button "IN" and output driving 50 Ω load. (Front panel only.)	
Sinewave (10 kHz Sinewave Ref)	±0.1 dB 20 Hz to 20 kHz ±0.5 dB 20 kHz to 1 MHz ±1 dB 1 MHz to 2 MHz	Typically ±.5 dB .002 Hz to 20 Hz
Squarewave (10 kHz Squarewave Ref)	Peak to peak amplitude within ±0.5 dB of squarewave reference amplitude 20 Hz to 2 MHz.	Typically within ±.5 dB .002 Hz to 20 Hz.
Triangle (10 kHz Triangle Ref)	Peak to peak amplitude within ±0.5 dB of triangle wave reference amplitude 20 Hz to 200 kHz. Within 2 dB 200 kHz to 2 MHz.	Typically within ±.5 dB .002 Hz to 20 Hz.
Sinewave Distortion	≤0.25% 20 Hz to 20 kHz on 10^3 range and below. ≤0.5% 20 kHz to 100 kHz. All harmonics at least 30 dB below fundamental from 100 kHz to 2 MHz	20° to 30° C. Measured with with average responding THD meter. Measurement bandwidth limited to approximately 300 kHz. Verified at 15 V p-p into 50 Ω load. Must be on calibrated portion of dial. VAR SYMM control off, Offset control off. Trig output driving open circuit.
Squarewave Output Risetime and Falltime Aberrations (p-p)	Step ATTEN in 0 dB position. ≤25 ns at 15 V p-p into 50 Ω. ≤3% (Front panel only.)	
Pulse Output Risetime and Falltime Aberrations (p-p)	Step ATTEN in 0 dB position. ≤25 ns at 15 V p-p into 50 Ω. ≤3% (Front panel only.)	
VCF Input	10 V ≥1000:1	Positive going voltage increases frequency. Maximum Slew Rate = 0.5 V/μs. VCF must not exceed range limits, Maximum input ≤15 V pk.
Ext Trig/Gate Input Impedance		≈2 kΩ
Threshold Level	+1 V ±20%.	Maximum input ≤ 15 V pk.
Trigger Output	≥ +4 V into open circuit ≥ +2 V into 50 Ω.	
Variable Phase Range	At least ±90°	Sine and Triangle only.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
Attenuators		60 dB in 20 dB steps. >20 dB additional attenuation with amplitude control.
Accuracy	±1 dB.	Verified at 20 kHz.
Dial Accuracy	Within 3% of full scale 20 to 2.	2 to .2 Uncal.
Triangle		
Linearity		Greater than or equal to 99% 20 Hz to 200 kHz. 97% 200 kHz to 2 MHz (calibrated). Measured from 10% to 90% of waveform.
Time Symmetry	Better than 1% 20 Hz to 200 kHz. 5% 200 kHz to 2 MHz (calibrated).	

Table 1-2

MISCELLANEOUS

Characteristics	Description
Power Consumption	12 W or less. (plug-in only)
Recommended Adjustment Interval	1000 hours or 6 months, whichever occurs first.
Warm-up Time	20 minutes.

Table 1-3

ENVIRONMENTAL'

Characteristics	Description	
Temperature		Meets MIL-T-28800B, class 5.
Operating	0° C to +50° C	
Non-operating	–55° C to +75° C	
Humidity	95% RH, 0° C to 30° C 75% RH to 40° C 45% RH to 50° C	Exceeds MIL-T-28800B, class 5.
Altitude		Exceeds MIL-T-28800B, class 5.
Operating	4.6 Km (15,000 ft)	
Non-operating	15 Km (50,000 ft)	
Vibration	0.38 mm (0.015") peak to peak, 5 Hz to 55 Hz, 75 minutes.	Exceeds MIL-T-28800B, class 5, when installed in qualified power modules.[b]

Table 1-3 (cont)

Characteristics	Description	
Shock	30 G's (1/2 sine), 11 ms duration, 3 shocks in each direction along 3 major axes, 18 total shocks.	Meets MIL-T-28800B, class 5, when installed in qualified power modules.[b]
Bench Handling[c]	12 drops from 45°, 4" or equilibrium, whichever occurs first.	Meets MIL-T-28800B, class 5.
Transportation[c]	Qualified under National Safe Transit Association Preshipment Test Procedures 1A-B-1, and 1A-B-2.	
EMC	Within limits of MIL-461A, and F.C.C. Regulations, Part 15, Subpart J, Class A.	
Electrical Discharge	20 kV maximum charge applied to instrument case.	

[a] **With power module.**

[b] **Refer to TM 500 power module specifications.**

[c] **Without power module.**

Table 1-4

PHYSICAL CHARACTERISTICS

Characteristics	Description
Finish	Plastic/aluminum laminate front panel. Anodized aluminum chassis.
Net Weight	1.88 lbs (.85 kg)
Overall Dimensions	Height 5 in (126mm) Width 2.6 in (67mm) Length 11.9 in (303mm)

SECTION 2

OPERATING INSTRUCTIONS

INTRODUCTION

This section of the manual provides operating information required to obtain the most effective performance from the FG 501A. Included are installation and removal instructions, a functional description of the front panel controls, and a general description of the operating modes. Some basic applications of the instrument are also briefly discussed.

INSTALLATION AND REMOVAL

The FG 501A is calibrated and ready to use when received. It operates in one compartment of any TM 500-series power module. Refer to the power module instruction manual for line voltage requirements and power module operation.

CAUTION

To prevent damage to the FG 501A, turn the power module off before installation or removal of the instrument from the mainframe. Do not use excessive force to install or remove.

Check to see that the plastic barriers on the interconnecting jack of the selected power module compartment match the cutouts in the FG 501 A circuit board edge connector. If they do not match, do not insert the instrument until the reason is found. When the units are properly matched, align the FG 501A chassis with the upper and lower guides of the selected compartment (see Fig. 2-1). Insert the FG 501A into the compartment and press firmly to seat the circuit board edge connector in the power module interconnecting jack. Apply power to the FG 501A by operating the power switch on the power module.

To remove the FG 501A from the power module, pull the release latch (located in the lower left corner) until the interconnecting jack disengages. The FG 501A will now slide straight out.

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. Include complete instrument serial number and a description of the service required.

If the original package is not fit for use or not available, repackage the instrument as follows:

Surround the instrument with polyethylene sheeting, or other suitable material, to protect the exterior finish. Obtain a carton of corrugated cardboard of adequate strength and having inside dimensions no less than six inches more than the instrument dimensions. Cushion the instrument by tightly packing dunnage or urethane foam between the carton and the instrument, on all sides. Seal the carton with shipping tape or an industrial stapler.

The carton test strength for your instrument is 200 pounds.

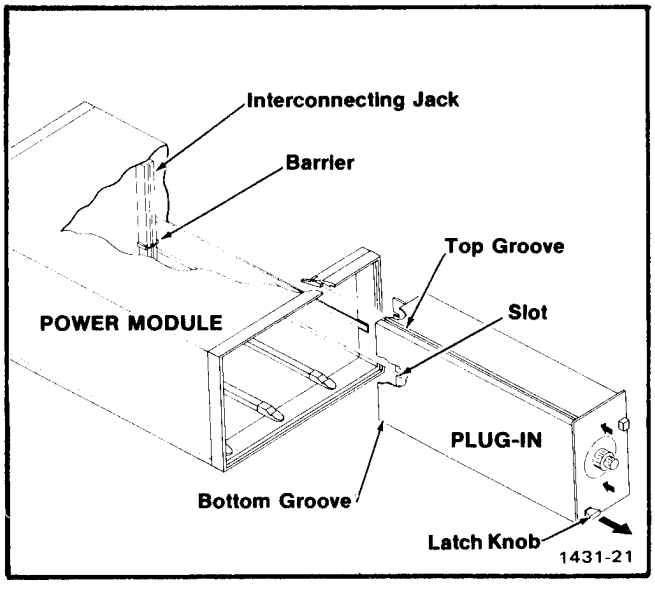


Fig. 2-1. Plug-in installation and removal.

CONTROLS AND CONNECTORS

Although the FG 501A is calibrated and ready to use, the functions and actions of the controls and connectors should be reviewed before attempting to use it. All controls necessary for operation of the instrument are located on the front panel. A brief description of these controls follows. Refer to Fig. 2-2.

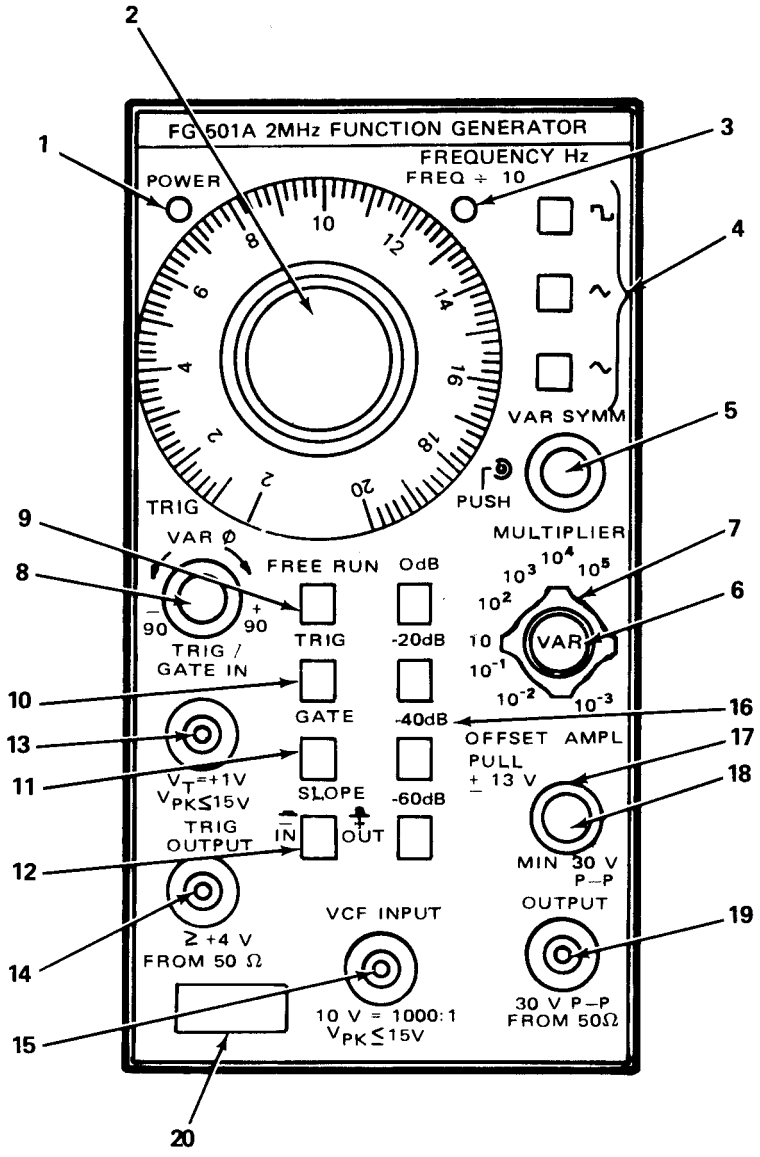


Fig. 2-2. Controls and connectors.

(1) **POWER -** Illuminated when power is applied to the FG 501A.

FREQUENCY CONTROL AND FUNCTION SELECTION

(2) **FREQUENCY Hz** - Selects the frequency of the output waveform in conjunction with the MULTIPLIER control.

(3) **FREQ** + 10 - Illuminated when the variable symmetry function is activated.

(4) **FUNCTION BUTTONS** - Select square, triangle, and sine waveforms.

(5) **VAR SYMM** - (push to enable) adjusts time-based symmetry of the selected output waveform. Reduces the frequency of the output waveform by a factor = 10 and illuminates the FREQ + 10 indicator.

(6) **FREQUENCY VERNIER** - For fine adjustment of output frequency to at least 1 part in 10^4 of full scale.

(7) **MULTIPLIER** - Selects the output frequency in eight decade steps in conjunction with the FREQUENCY Hz control.

TRIGGER AND GATE CONTROLS

(8) **VAR Ø—Selects** - Selects phase lead or lag, up to ±90°, relative to input trigger or gate waveform.

(9) **FREE RUN** - When pressed causes continuous waveform output.

(10) **TRIG** - When pressed causes output of one cycle of selected waveform for each trigger pulse applied to the TRIG/GATE IN connector.

(11) **GATE** - When pressed causes continuous output of the selected waveform for the duration of the gating pulse.

(12) **SLOPE** - Button selects, in TRIG mode, the slope of the input signal which will trigger the selected output waveform. In GATE mode, whether output gating will occur when the level of the input signal is above or below the threshold level of +1 V.

(13) **TRIG/GATE IN** - Bnc connector used to apply the external trigger or gating signal.

(14) **VCF INPUT** - Bnc connector for applying an external voltage for controlling the output frequency of the generator.

(15) **TRIGGER OUTPUT** - Bnc connector which outputs one positive pulse for each cycle of the selected output waveform.

OUTPUT CONTROLS

(16) **ATTENUATOR BUTTONS** - Attenuate the amplitude of the selected output waveform in 20 dB steps to a maximum of 60 dB when pressed.

(17) **AMPL** - Varies the amplitude of the selected output waveform, between steps of the attenuator buttons.

(18) **OFFSET** - Pull and turn control, concentric with the AMPL control, provides up to ±13 V dc offset of the output waveform.

(19) **OUTPUT** - Bnc connector for output of the selected waveform.

(20) **RELEASE LATCH** - Pull to disengage the FG 501A from the power module.

OPERATING CONSIDERATIONS

OUTPUT CONNECTIONS

The output of the FG 501A is designed to operate as a 50 Ω voltage source working into a 50 Ω load. At higher frequencies, an unterminated or improperly terminated output will cause aberrations on the output waveform. Loads less than 50 Ω will reduce the waveform amplitude.

Excessive distortion or aberrations, due to improper termination, are less noticeable at the lower frequencies (especially with sine and square waveforms). To ensure waveform purity, observe the following precautions:

1. Use good quality 50 Ω coaxial cables and connectors.

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

3. Use good quality attenuators if it is necessary to reduce waveform amplitude applied to sensitive circuits.

4. Use terminations orimpedance matching devices to avoid reflections when using long cables (6 feet or more).

5. Ensure that attenuators, terminations, etc. have adequate power handling capabilities for the output waveform.

If there is a dc voltage across the output load, use a coupling capacitor in series with the load. The time constant of the coupling capacitor and load must be long enough to maintain pulse flatness.

RISETIME AND FALLTIME

If the FG 501A is used to measure the rise or falltime of a device, the riestime characteristics of associated equipment should be considered. If the risetime of the device under test is at least 10 times greater than the combined risetimes of the FG 501A and associated equipment, the error introduced will not exceed 1%, and generally can be ignored. When the rise or falltime of the test device is less than 10 times as long as the combined risetimes of the testing system, the actual risetime of the system must be calculated. The risetime of the device under test can be determined once the risetime of the system is known.

IMPEDANCE MATCHING

If the FG 501A is driving a high impedance such as the 1 MΩ input impedance (paralleled by a stated capacitance) of the vertical input of an oscilloscope, connect the transmission line to a 50 Ω attenuator, 50 Ω termination, and then to the oscilloscope input. The attenuator isolates the input capacitance of the device, and the FG 501A is properly terminated.

FIRST TIME OPERATION

The Controls and Connectors pages give a description of the front panel controls and connectors, The waveform selection and frequency determining control sareoutlined in blue, the trigger function controls and inputs are outlined in green, and the output controls are outlined in black.

The following exercise will familiarize the operator with most functions of the FG 501A.

NOTE

If any discrepancies are encountered during the exercise, refer the condition to qualified service personnel,

Preset the controls as follows:

Blue section:

FREQUENCY Hz	10
MULTIPLIER	10
FREQUENCY VERNIER	Fully cw
WAVEFORM—SINE	in
VAR SYMM	off

Green section:

FREE RUN	in

Black section:

ATTENUATOR	-20 dB
AMPL (variable)	Centered
OFFSET	off

Connect a 50 Ω bnc coaxial cable terminated in 50 Ω to the vertical input of an oscilloscope. Set the oscilloscope controls to:

Vertical	1 V/Div DC Coupled
Horizontal (Time Base)	1 ms/Div

The oscilloscope should display 1 complete cycle per division of the sine waveform (approximately 10 cycles across the graticule),

1. Alternately press the square, triangle and sine buttons and observe the different waveshapes. Return to the preset condition.

2. Alternately press the four attenuator buttons and rotate the AMPL (variable) control to verify that the waveform amplitude changes. Return these controls to the preset condition.

3. Pull the OFFSET knob out and rotate it. Notice the change in dc level of the displayed waveform. Return the OFFSET knob to the in position.

4. Push the VAR SYMM button to release it to the out position. Observe that the FREQ ÷ 10 indicator is illuminated and only one cycle of the output waveform is displayed. Rotate the VAR SYMM control through its range and notice the change in shape of the square, triangle, and sine waveforms (with the appropriate buttons pushed in). Return the controls to the preset condition.

5. Rotate the FREQUENCY control and the MULTIPLIER switch while observing the change in frequency of the displayed waveform, Return these controls to the preset condition,

OPERATING MODES

FREE-RUNNING OUTPUT

The following procedure will provide a free-running output with variable frequency and amplitude.

1. Select the desired waveform.

2. Set the AMPL control fully counterclockwise. Check that the VAR SYMM and OFFSET controls are in the off (in) position.

3. Select the desired frequency with the FREQUENCY Hz dial and MULTIPLIER switch. Frequency equals dial setting times multiplier setting.

4. Connect the load to the FG 501A output connector and adjust the AMPL control for the desired output amplitude.

TRIGGERED OR GATED (BURST) OPERATION

With the FG 501A set for free-running operation, as described in previous paragraphs, apply the triggering or gating signal to the TRIG/GATE IN connector.

If only one cycle of the output waveform per trigger is desired, push the TRIG button and select + or – slope. One output cycle will now be generated for each input trigger cycle.

If more than one cycle of the output waveform is desired, push the GATE button. The output will now be continuous for the duration of the gating waveform. The number of cycles per burst can be approximated by dividing the gating signal duration by the period of FG 501A output frequency,

In triggered or gated operation the PHASE control varies the start of the output waveform by ±90°. This phase change is measured from the 0 V, 0° point on the output waveform.

VOLTAGE CONTROLLED FREQUENCY (VCF) OPERATION

The output frequency of any selected waveform can be swept within a range of 1000:1 by applying an external voltage to the VCF INPUT connector. The polarity of the VCF input signal determines which direction the output frequency sweeps from the selected frequency, A positive (+) going signal increases the frequency while a negative (–) going signal decreases the frequency. The amplitude and polarity of the input voltage can be selected within a range of ±10 V depending on the FREQUENCY Hz dial setting.

The maximum swept frequency range of 1000:1 encompasses the uncalibrated portion of the FREQUENCY Hz dial (<.2 to 2). To ensure that the frequency does sweep at least a range of 1000:1, it is recommended that the FREQUENCY Hz dial be set at .2 and a 0 to +10 V signal be applied to the VCF INPUT connector. It may be necessary

to vary the FREQUENCY VERNIER control to obtain the full 1000:1 swept range or the lowest swept frequency desired.

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

TRIGGER OUTPUT

A +4 V square wave is available from the TRIG OUTPUT connector. The frequency of the trigger output is determined by the frequency of the selected output waveform. One trigger pulse is generated for each positive cycle of the output signal except when square waves are selected. When generating square waves, one trigger pulse is generated for each negative cycle of the output signal. Trigger output impedance is 50 Ω.

BASIC WAVEFORM CAPABILITIES

The following photographs illustrate the basic waveform capabilities of the FG 501A.

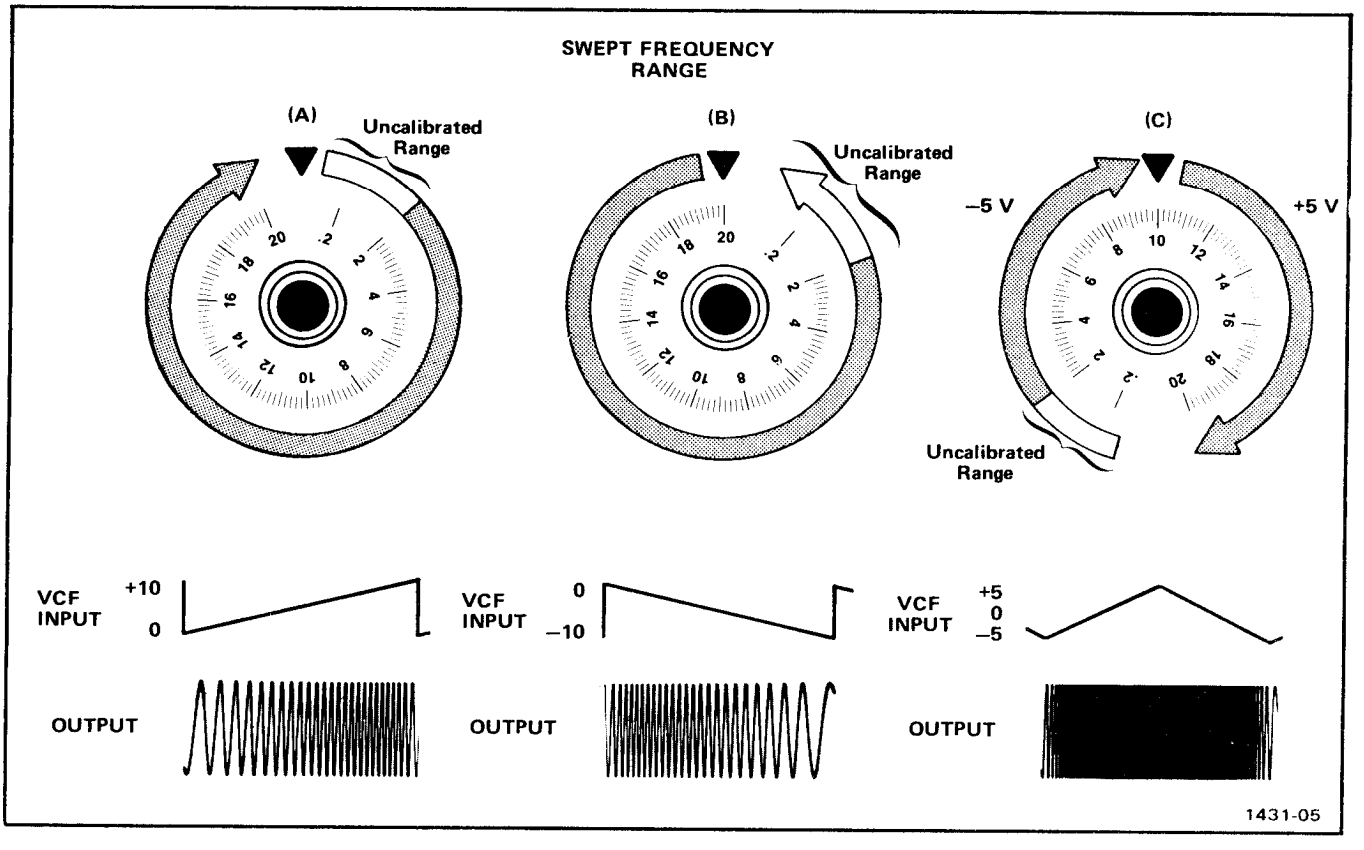


Fig. 2-3. Swept Frequency range with 10 V signals applied to VCF IN connector.

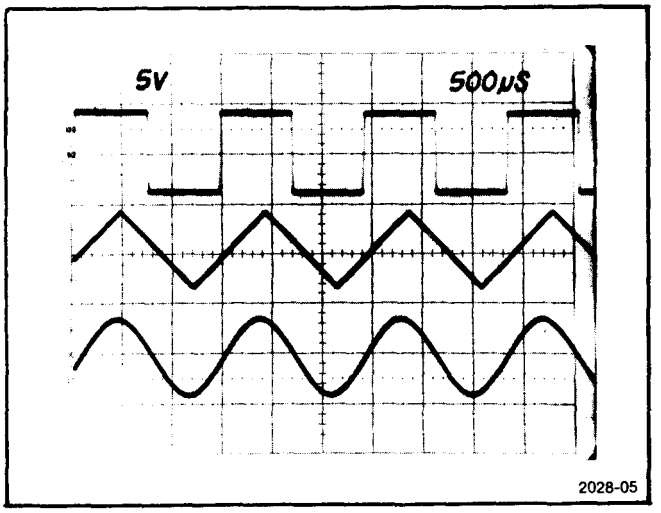


Fig. 2-4. BASIC FUNCTIONS. Square, triangle, and sine waveforms selected by front panel pushbuttons.

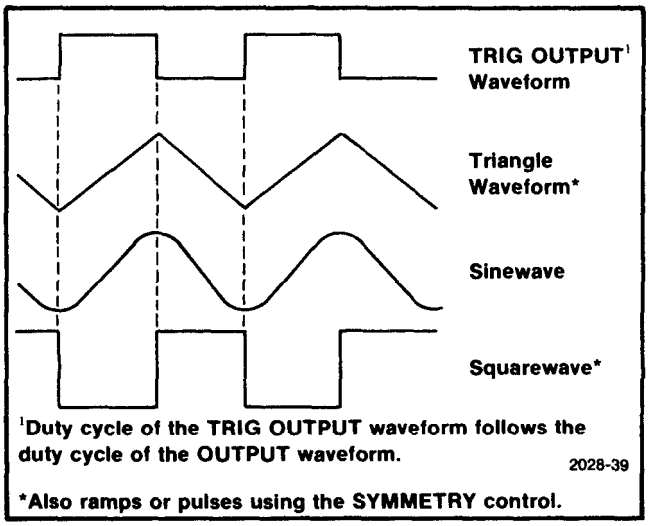


Fig. 2-6. Phase relationships between OUTPUT waveforms and the TRIG OUT waveform.

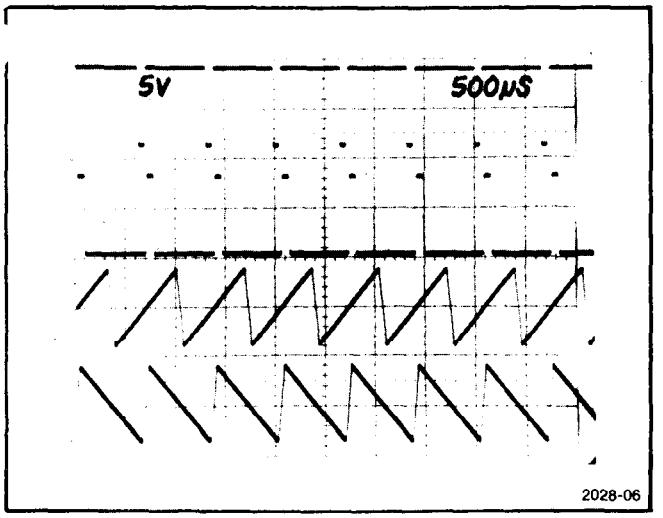


Fig. 2-5. RAMPS AND PULSES. These are obtained from the basic waveforms by using the SYMMETRY control.

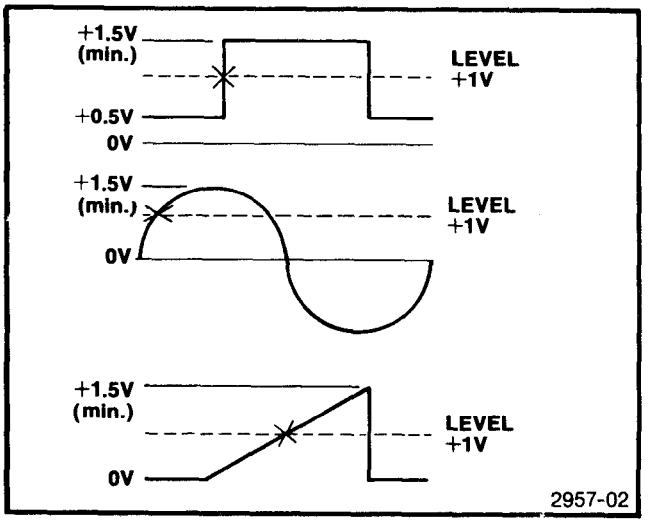


Fig. 2-7. Trigger Signal amplitude requirements and triggering points.

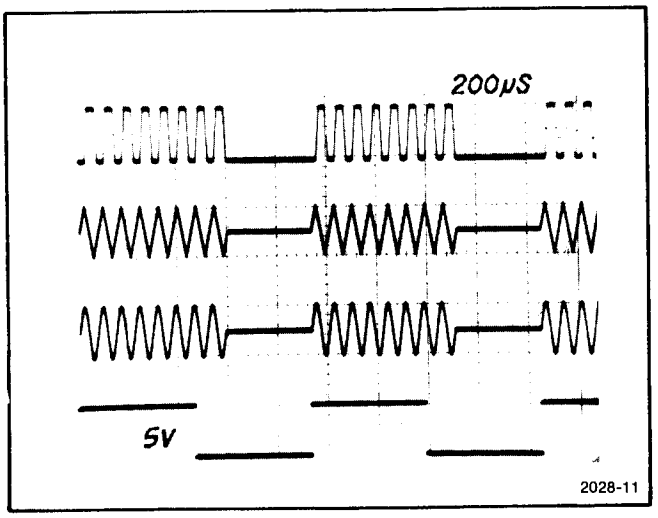


Fig. 2-8. GATED OPERATION. The top three traces are various output waveforms and the bottom trace is the gating waveform applied to the trigger INPUT connector with the GATE pushbutton pressed in. Note the additional cycle completed after the waveforms are gated off.

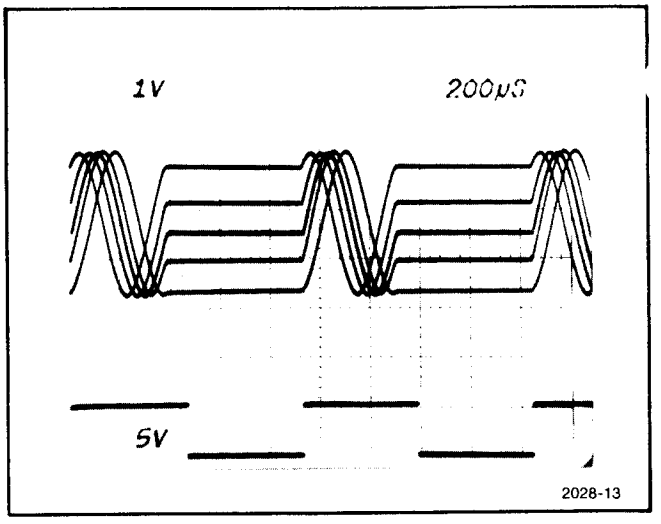


Fig. 2-10. PHASE CONTROL OPERATION. This photograph illustrates PHASE control usage in the triggered mode. The five super-imposed traces illustrate the effect of the phase control. This control provides ±90° of shift. The bottom trace is the triggering waveform.

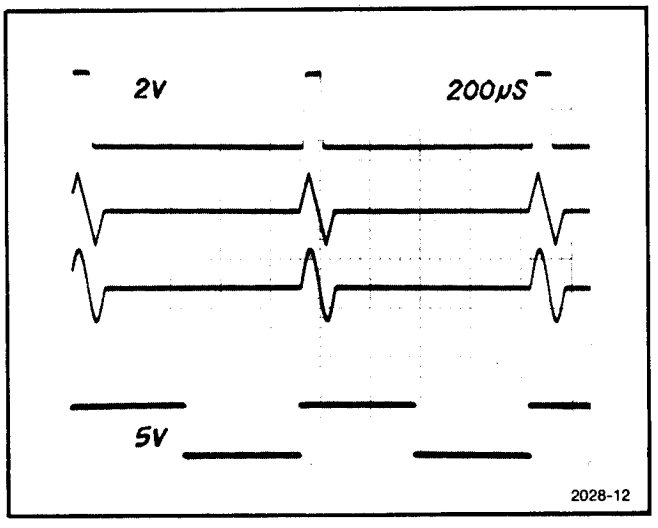


Fig. 2-9. TRIGGERED OPERATION. The top three traces are the various out put traces selected. The bottom trace is the triggering waveform applied to the trigger INPUT connector with the TRIG mode selected. Note that only one cycle of the output waveforms is completed.

APPLICATIONS

RESPONSE ANALYSIS

The FG 501A is particularly suited for determining resIponse characteristics of circuits or systems. This application utilizes the VCF input of the FG 501 Ato sweep the generator over a range of frequencies. Refer to the Voltage Controlled Frequency (VCF) Operation discussion under Operating Modes for additional information.

1. Connect the equipment as shown in Fig. 2-11.

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 INPUT connector. (A positive-going waveform will increase the frequency while a negative-going waveform will decrease it.)

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.

TONE-BURST GENERATION OR STEPPED FREQUENCY MULTIPLICATION

The FG 501A can be used as atone-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

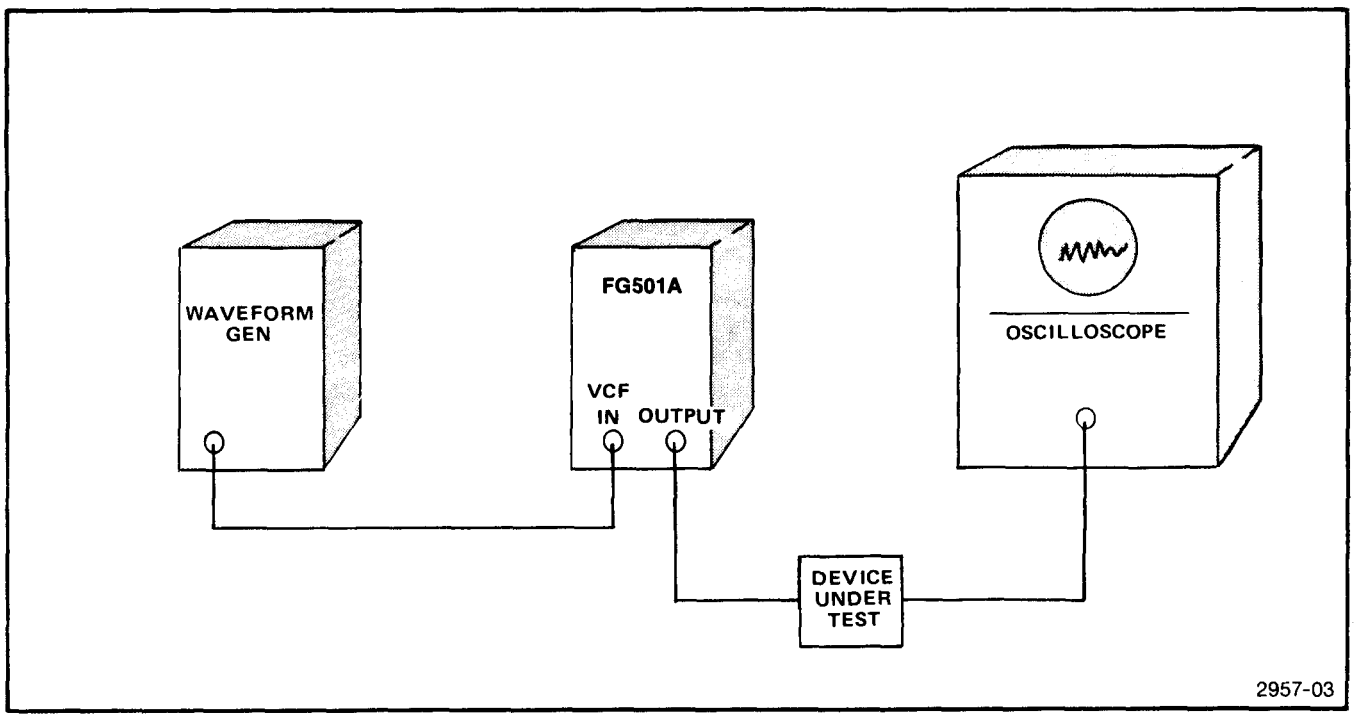


Fig. 2-11. Analyzing circuit or system response.

from the FG 501A. 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. 2-12.

2. Push the GATE button in and set the PHASE control to the desired phase.

3. Set the ramp generator for the desired ramp duration and polarity.

4. 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.

5. Select the sweep frequency range by adjusting the FREQUENCY Hz dial for one end of the sweep 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.

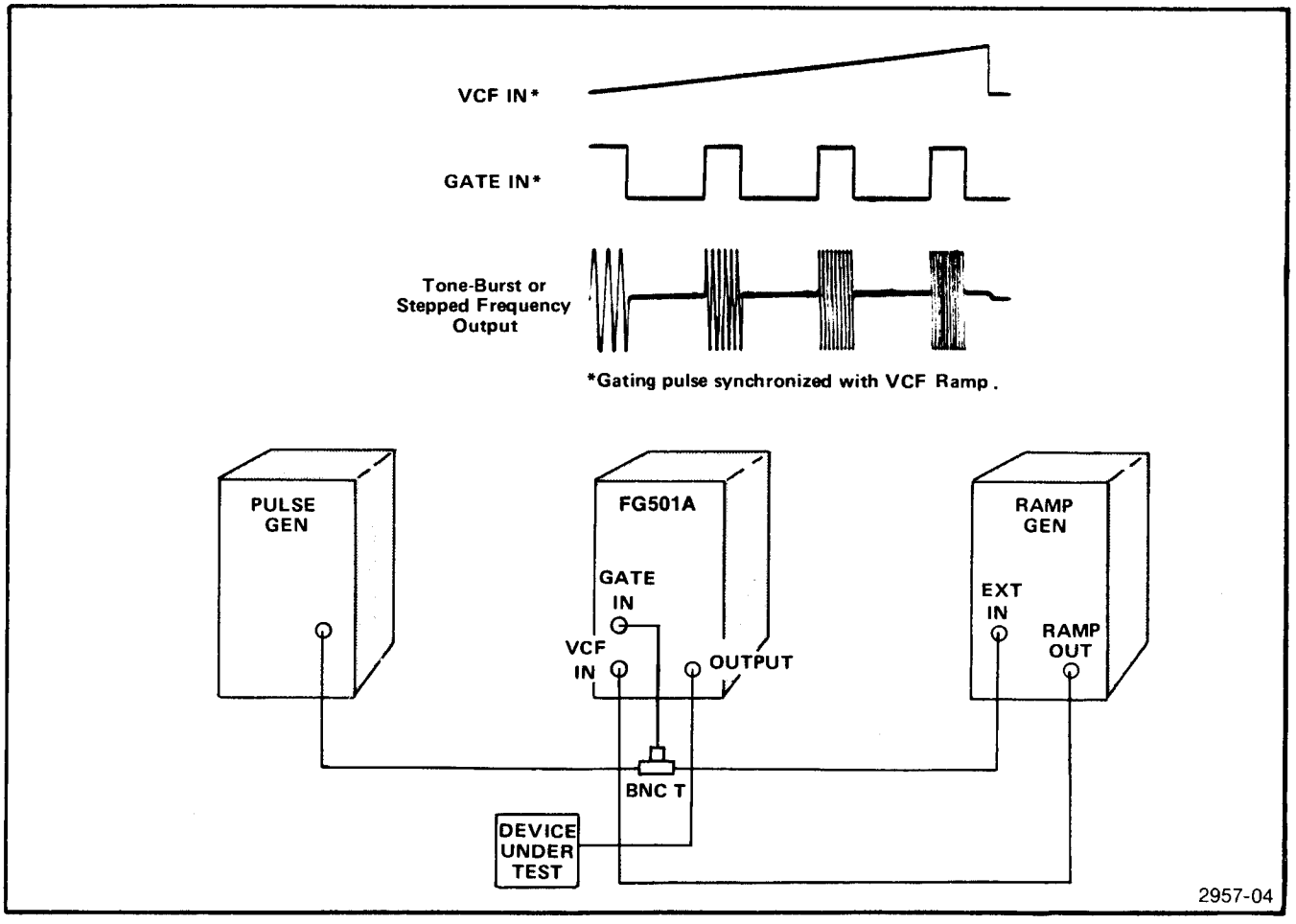


Fig. 2-12. Tone-burst generation or stepped frequency multiplication.

SECTION 3

THEORY OF OPERATION

INTRODUCTION

This section of the manual contains a description of the electrical circuits in the FG 501A. Refer to the block diagram and schematic diagrams on the fold out pages in the back of the manual to aid in understanding this description. Diamond enclosed numbers appearing throughout this section refer to the schematic diagram on which the circuit being discussed is located.

LOOP ①

FREQUENCY CONTROL AND SUMMING AMPLIFIER

The voltage developed across the frequency control divider string, R1429, R1321, R500 and R510, is applied to pin 5 of operational amplifier U1540B. This voltage is buffered by the amplifier and. a current is developed through R1551. This current is applied top in 2 of summing amplifier U1540A where it is summed with any currents developed by a voltage applied tothe VCF inputs. The VCF inputs are J510 (front panel) through R1553, and pin 21B (rear interface) through R1103. These summed currents are buffered by Q1445 and flow through R1543. The voltage developed across R1543 is proportional to the frequency.

CURRENT SOURCES AND SWITCH

The voltage developed across R1543 is buffered by U1440 and Q1541 which form the negative current source for the main loop timing circuitry. This same voltage is also buffered by U1540C and Q1543 which form a current source identical to U1440 and Q1541. The output current from Q1543 flows through Q1527, Q1525, and Q1421, which form a current mirror that inverts this current to provide the positive current source for the main loop timing circuitry. The current through R1521 is the timing capacitor charging current; the current through R1536 is the discharging current. The Top Dial Symmetry Cal, R1421, adjusts the balance between these two currents so they are equal in magnitude.

In the normal mode of operation (fixed symmetry) R520 and R540 are in the emitter circuit of Q1541 and Q1543. In this condition, equal amounts of current will flow in both the positive and negative current sources. When S500, VAR SYMM, is activated, R530 is switched into the current source emitter circuits. As R530 is varied from one end to the other, unequal amounts of current flow through the positive and negative current sources. In this manner the symmetry of the waveform generated by the loop is varied. These currents are switched into the junction of CR1531 and CR1533 where they alternately charge and discharge the timing capacitor, producing a triangle waveform, The current switch is formed by Q1531, CR1531, Q1433 and CR1533.

TIMING CAPACITORS AND CAPACITANCE MULTIPLIER ②

The timing capacitors provide for triangle generation in the five fastest MULTIPLIER ranges. They are switched into and out of the circuit in decade stepsfrom 10^5 (C1631) down to 10^1 (C1741).

For the four lower MULTIPLIER ranges, 10^0 down to 10^{-3}, C1741 is switched into the feedback loop of U1930 forming an integrator. Current from the current switch is applied to operational amplifier U1940. A voltage is developed at the output of this amplifier that is proportional to the applied current times the value of R1941 (1 kΩ). This voltage is applied, across one of four resistors, to the input of U1930. These resistors, R1831, R1841, R1842, and R1843, are switched into and out of the circuit in decade steps with the MULTIPLIER switch S1731. This arrangement provides very large values of effective capacitance. The output of U1930 is now the triangle that is applied to the buffer stage.

TRIANGLE BUFFER ①

The voltage developed by the timing capacitor or multiplier (U1930) is applied to the triangle buffer. Q1725 and Q1723 form the differential input stage of this circuit. Q1821 serves as a constant current source for the input differential pair. Q1721 and Q1712 complete the feedback for the amplifier such that the voltage at the emitter of Q1712 is equal to the voltage at the Gate of Q1725.

Loop delay compensation is provided by a network comprised of R1712, R1812, C1712, and C1714. The buffered timing capacitor voltage is applied through this network to the level comparators.

LEVEL COMPARATORS

The level comparators detect upper and lower threshold levels. U1700A is the upper level detector and U1700B the lower. The reference level for these comparators is supplied by U1400B and C. As the threshold levels are detected, the respective comparator triggers U1600B.

REFERENCE VOLTAGES

The reference voltage supplies are composed of U1400B (–) and U1400C (+) and associated components. The upper (positive) level threshold voltage is established by adjusting R1412. This resistor is in a voltage divider string from zener diode VR1413. The voltage developed across R1412 is buffered by U1400C and set to approximately +400 mV at the output. This voltage is applied to pin 5 of U1700A as the upper threshold level reference. This same voltage is also applied to pin 9 of inverter U1400B. R1511 is used to adjust the gain of this stage so that the output is nominally –400 mV. This voltage is applied to pin 13 of U1700B as the lower threshold level reference.

LOOP LOGIC

When a rising voltage at pin 6 of U1700A passes through the threshold level set at pin 5, the output (pin 8) goes low pulling pin 10 of U1600Blow. This action sets the flip-flop causing pin 9 (Q) to go high and pin 8 (Q) to go low. Pin 8 of U1600B is tied back, through R1403, to the junction of CR1431 and VR1532. VR1532 serves as a level shifter to change the TTL output gate to the correct level to drive the current switch (Q1531, CR1531, Q1433, CR1533).

As the voltage at the junction of R1532 and R1534 drops, it pulls the bases of Q1531 and Q1433 low. Q1531 is turned on and Q1433 is turned off. Any current from the positive current source, through R1521, now flows through Q1531 and is shunted to the –15 V supply. With Q1433 turned off, any current flow through the negative current source must come from the positively charged timing capacitor through CR1533.

The falling voltage on the timing capacitor is buffered through the triangle buffer and applied to the level comparators U1700A and U1700B. As the voltage at pin 12 of U1700B falls through the threshold level set at pin 13, the output (pin 1) goes low pulling pin 13 of U1600Blow. This action resets the flip-flop causing pin 9 (Q) tonowgo low and pin 8 ($\overline{Q}$) to go high. Taking this high at pin 8 back to the current switch, Q1531 will be turned off and Q1433 turned on. This allows the timing capacitor to charge in the positive direction.

The action just described generates one entire cycle of a triangle wave.

TRIGGER GENERATOR

The square wave output at pin 8 ($\overline{Q}$) of U1600B also drives the trigger output amplifier. This circuit is composed of emitter follower Q1431 and associated components. Q1440, in conjunction with R1440, serves as output short circuit protection. The output of this circuit (at J2043) is a square wave 180° out of phase with the main loop signal. The output amplitude is greater than +4 V into an open circuit, and at least +2 V into a 50 Ω load.

SQUARE WAVE GENERATOR

The output at pin 9 (Q) of U1600B is a square wave, but 180° out of phase with that at pin 8. This signal is used to drive the square wave generator composed of differential pair Q1801, Q1901, and associated components. The base of Q1901 is held at a constant voltage by divider network R1815 and R1818. R1728 and R1816 form a constant current source for the differential pair. The square wave from U1600B alternately switches this constant current to ground through Q1801 or through R1819 and Q1901. In this manner, a square wave voltage is developed with dc levels sufficient to drive the output amplifier for the square wave function.

PHASE CLAMP THRESHOLD DETECTOR

The output of the triangle buffer, in addition to possibly being fed to the Output Amplifier through S1901B, is connected to the base of Q1711. Q1711 and Q1611 form a differential amplifier. Q1621 and associated components provide a constant current source for the differential pair. This amplifier senses the level of the triangle waveform and compares it to the output voltage of U1400A. The output voltage of U1400A is determined by the setting of the VAR 0 control, R550. The voltage range of R550 is established by reference voltage supplies U1400B (–) and U1400C (+). These are the same reference voltages supplied to the Level Comparators. This arrangement permits comparison of the triangle voltage with the maximum possible positive and negative levels, and all levels between.

When the triangle voltage exceeds the reference voltage set by the VAR 0 control, Q1711 turns off. Any current flowing through Q1621 now flows through Q1611.

CURRENT AMPLIFIER

Current flowing through Q1611 also flows through R1622 and is amplified by Q1521. Temperature compensation for this amplifier is provided by CR1621. Differential pair Q1511 and Q1523 serve as a current switch. With Q1511 turned off, any current amplified by Q1521 passes through Q1523 to the junction of CR1531 and CR1533. When the timing capacitor voltage rises to the threshold level set by the VAR 0 control, R550, it is clamped. Q1523 now draws exactly the amount of current that the positive current source supplies. Because the square wave at pin 5 (Q) of U1600A drives the base of Q1511, the clamping action only happens during the positive edge of the triangle wave. On the negative transition, Q1523 is shut off, and Q1511 is on. In this manner, the timing capacitor voltage can be clamped at any desired positive level.

TRIG/GATE AMP AND SINE SHAPER ③

TRIG/GATE AMP AND LOGIC

The input trigger amplifier consists of an emitter coupled differential pair (Q1320 and Q1322), current amplifier Q1324, and the required logic circuitry to control the operation of the main loop phase clamp. Input circuit protection is provided by R1203, R1204, CR1220 and CR1221. Triggering signals are applied either through front panel connector J520 or interface connections on the rear edge of the Main circuit board.

The differential pair, Q1320-Q1322, responds to the input signal when the voltage rises above (+ SLOPE) the reference voltage at the base of Q1320. This reference voltage is established by divider network R1312 and R1314, The position of S1400D, SLOPE switch, determines whether a positive or negative going input will cause the amplifier Q1324 to conduct. When the threshold level is exceeded and conduction starts, current flow through the circuit causes a voltage to be developed across R1322. This voltage is applied to the base of Q1324. The output at the collector of Q1324 is a TTL compatible waveform to drive the logic circuit, U1310. CR1320 provides temperature compensation for Q1324.

Three modes of operation are selectable with S1400; Triggered, Gated, and Free Running.

In the TRIG mode, S1400A and S1400C are positioned such that the output, pin 6, of U1310B is connected to pin 4, set input, of U1600A. In this mode, a very narrow, negative going voltage pulse is developed by U1310B each time the input waveform passes through the trigger threshold. This low sets U1600A, which deactivates the phase clamp until the triangle generator again starts in the positive direction, and allows the generator to complete one full cycle.

In the GATE mode, S1400A and S1400C are positioned such that the output, pin 3, of U1310A is connected to pin 4, set input, of U1600A. In this mode, a low level is produced whenever the input waveform exceeds the threshold if + SLOPE is selected. The generator free runs as long as this condition exists. As soon as the level at the input connector drops below the threshold, the output voltage of U1310A rises. This high level causes the generator to again stop running when the phase clamp reaches its threshold level at the end of the last complete cycle.

In the FREE RUN mode, S1400A is positioned such that pin 4 of U1600A is held low. The generator now outputs continuous waveforms.

SINE SHAPER

The Sine Shaper is composed of three separate circuit functions: a Transconductance Amplifier, the Shaper Circuitry, and an Output Buffer.

Transconductance Amplifier. Emitter coupled transistors Q1210 and Q1212 along with current source Q1200 form the Transconductance Amplifier. The amplifier converts the triangle voltage at the base of Q1212 to a differential current. This current flows through two sets of diode wired transistors, U1120C, U1120D, U1220C, and U1220D, to the input of the shaper.

Shaper. The active portion of the Shaper is formed by two sets of emitter coupled transistors U1220A, U1220B, U1120A and U1120B. These devices have their inputs wired in series and their outputs cross coupled. U1120E and U1220E are current sources for these devices. The circuit operates by generating a power series approximation to the sine function. The devices in U1120 generate the first order term while those in U1220 generate the second order term in the approximation.

Output Buffer. The Output Buffer is an operational amplifier that converts the differential current from Q1010 and U1020D to a single ended voltage that is applied, through the function switch, to the output amplifier. U1020E is a current source for the emitter coupled differential input pair U1020A and U1020B. Q1012 serves as a current mirror for U1020A and as an active load for U1020B. U1020C is the output emitter follower and R1020 is the feedback resistor.

OUTPUT AMPLIFIER & ATTENUATORS 4

The output amplifier is basically a noninverting operational amplifier whose plus input is the base of Q2101 and minus input is the base of Q2113.

The three basic waveforms are selected by S1901 and applied across R560B and R2335 to the input stage of the amplifier. R560B varies the amplitude of the selected waveform. The feedback network consists of R2011 and R2012, connected from the output to the minus input of the amplifier. C2011 provides high frequency compensation for the feedback, and is used to adjust the squarewave front corner. The input pair, Q2101 and Q2113, amplify the difference between the input waveform and the fedback waveform.

An offset current is also summed with the feedback signal at the base of Q2113 when S510A is closed. This allows R560A to control the dc offset of the output signal.

The output of Q2101 is applied directly to Q2111 which is cascoded with Q2011. The output of Q2113 passes through an inverting amplifier, Q2211, before passing to Q2213 cascoded with Q2311. CR2111 provides temperature compensation for Q2211. The two cascodes form drivers for the amplifier output stage.

The output stage consists of Q2013 and Q2123 in parallel with Q2121 for amplification of positive going signals. Q2321 and Q2323 in parallel with Q2325 form the amplifier for negative going signals. The output is taken at the junction of R2026 and R2228. The 50 Ω output impedance is determined by parallel 100 Ω resistors R2033 and R2131. C2121 in this network provides high frequency compensation for the output impedance, The attenuator circuit is a constant impedance resistive divider network, switch selectable in 20 dB steps.

POWER SUPPLY 5

The FG 501A receives its power from the power module via interface connections on the rear edge of the Main circuit board. The power module supplies plus (+) and minus (–) 33.5 Vdc (unregulated) from which the following regulated voltages are generated.

+20 V SUPPLY

The +33.5 V from the power module is filtered and applied to voltage regulator U1210 (pins 11 and 12). This regulator contains its own reference, operational amplifier, and current limiting elements. The output of the regulator is applied to Q1231 which serves as a driver the the series pass transistor located in the power module. The +20 V output is applied across voltage divider R1201, R1301, and R1315. The output level of the supply is set by R1301 (+15 V Adj) which compares the supply output to the internal reference level of the regulator. This supply is current limited through the action of R1121 and the current limiting element in the regulator. When excessive amounts of current are drawn from the supply, the voltage developed across R1121 turns on the current limiting element in the regulator (U1210). This action reduces the base drive, through Q1231, to the series pass transistor causing the supply to reduce output, This supply is the reference for other supplies in the FG 501A.

+15 V SUPPLY

The +15 V supply consists of U1230D and Q1221. U1230D serves as an error amplifier which compares the F15 Voutput of the supply to a +15 Preference developed by divider network R1231, R1232 and R1233 from the +20 V supply. Since this supply is sourced from the +20 V, it is inherently current limited by the +20 V supply.

+5 V SUPPLY

The +5 V supply consists of U1230C and Q1331. U1230C serves as an error amplifier which compares the +5 V output to a +5 V reference developed by divider network R1231, R1232 and R1233 from the +20 V supply. Since this supply is sourced from the +15 V and referenced to the +20 V supply, it is inherently current limited under the same conditions that limit those supplies.

–20 V SUPPLY

The –20 V supply is derived from –33.5 V supplied by the power module. The output of operational amplifier U1230A is applied, through Q1245, to the base of Q1241, which serves as a driver for the series pass transistor located in the power module. This supply is also referenced to the +20 V. The supply is current limited through the action of R1141 and Q1243. When excessive amounts of current are drawn through R1141, a voltage sufficient to turn Q1243 on develops across R1141. This action reduces the base drive to the series pass transistor causing the supply to reduce output.

–15 V SUPPLY

The –15 V supply consists of operational amplifier (U1230B) and a series pass feedback regulator (Q1345), The output of the supply is fed back through divider network R1247, R1341, and R1245. The output level is adjusted by R1341. Because this supply is sourced from the –20 V supply, it is current limited by the –20 V supply.

SECTION 4

CALIBRATION

PERFORMANCE CHECK

INTRODUCTION

This procedure checks the Electrical Performance Requirements as listed in the Specification section in this manual. Perform the internal adjustment procedure if the instrument fails to meet these checks. If recalibration does not correct the discrepancy, circuit troubleshooting is indicated. Also, use this procedure to determine acceptability of performance in an incoming inspection facility, For convenience, many steps in this procedure check the performance of this instrument at only one value in the specified performance range. Any value within the specified range, within appropriate limits, may be substituted.

TEST EQUIPMENT REQUIRED

The test equipment, or equivalent, listed in Table 4-1 is suggested to perform the performance check and the adjust ment procedure.

Table 4-1

TEST EQUIPMENT REQUIRED

Item	Description	Minimum Specifications	Application		Example
			Perf Check	Adj Proc	
1	Power Module	Five compartments or more.	X	X	TEKTRONIX TM 515 or TM 506
2	Oscilloscope System	Minimum Vertical deflection Sweep Rate .5 μs.	X	X	TEKTRONIX 7704/4/ 7A16A/7B50
3	Differential Comparator Amplifier	Minimum Vertical deflection factor .1 V/div	X	X	TEKTRONIX 7A13
4	Sampling System			X	Tektronix 7704/7S11/ 7T11/S-1
5	Spectrum Analyzer		X		TEKTRONIX 7L12
6	Distortion Analyzer	Frequency range from 20 Hz to at least 300 kHz. Distortion resolution <0.25%	X	X	TEKTRONIX AA 501
7	Frequency Counter	Frequency range 0.002 Hz to above 2 MHz. Accuracy within one part in 10^4 ±1 count.	X	X	TEKTRONIX DC 504
8	Digital Multi meter	Range to ±30 V 5 1/2 digits Accuracy 0.1%.	X	X	TEKTRONIX DM 501
9	Pulse Generator	0 to 2 V square wave output into 50 Ω load. Period 2 μs; Duration .1 μs	X		TEKTRONIX PG 501
10	Power Supply	0 to 10 V range Accuracy ±10%	X		TEKTRONIX PS 501-1

Table 4-1 (cont)

Item	Description	Minimum Specifications	Application		Example
			Perf Check	Adj Proc	
11	Flexible Extender Cable	Compatible with TM 500-Series Power Modules		X	Tektronix Part No, 067-0645-02
12	Meter Lead	Black	X	X	Tektronix Part No. 012-0462-00
13	Meter Lead	Red	X	X	Tektronix Part No. 012-0462-01
14	Oscilloscope Probe	X10 10 MΩ	X	X	Tektronix Part No. 010-6053-13
15	Coaxial Cable	50 Ω BNC Connectors	X	X	Tektronix Part No. 012-0057-01
16	Termination	50 Ω BNC Connectors	X	X	Tektronix Part No. 011-0049-01
17	X10 Attenuator	50 Ω (20 dB) BNC		X	Tektronix Part No. 011-0059-02
18	X5 Attenuator	50 Ω (14 dB) BNC		X	Tektronix Part No. 011-0060-02
19	Adapter	BNC Female to Dual Banana	X	X	Tektronix Part No. 103-0090-00

1. Check Frequency Range

a. Connect the OUTPUT connector of the FG 501 to the counter input.

b. Press the FEE RUN and 0 dB pushbuttons.

c. Press either the ∿, ⎍ or ⌇ pushbuttons.

d. Make certain the VAR SYMM and OFFSET controls are off.

e. Set the FREQUENCY Hz dial to 20 and the MULTIPLIER control to the 10^5 position.

f. Adjust the AMPLITUDE control for a stable counter display.

g. CHECK - that the counter reads ≥2 MHz.

h. Activate the VAR SYMM control.

i. Adjust the VAR SYMM control for a 50% duty cycle pulse waveform.

j. CHECK - that the counter reads from 180 kHz to 220 kHz.

k. Change the MULTPLIER to 10^{-3}.

l. CHECK - for an output frequency of between 0.0019 Hz and 0.0021 Hz.

m Disable the VAR SYMM control.

n. Change the FREQUENCY Hz dial to 2.

o. CHECK - that the FREQUENCY Hz dial can be adjusted to obtain 0.0002 Hz.

p. Disconnect the counter for the next step

2. Check Variable Symmetry Duty Cycle

a. Press the FREE RUN, 0 dB and ⊓⊔ pushbuttons.

b. Release the VAR SYMM pushbutton.

c. Connect the OUTPUT connector through a 50 Ω coaxial cable to the oscilloscope vertical input:

d. Adjust the START, MULTIPLIER, AMPLITUDE, and oscilloscope controls to display a squarewave that occupys exactly 10 major divisions for one cycle.

e. Rotate the VAR SYMM control from fully cw to fully CCW.

f. CHECK - that the oscilloscope display varies each squarewave half cycle from ≤1/2 major division to ≥9.5 major divisions.

g. Leave these connections for the next step.

3. Check Output Amplitude

a. Using the same setup as in the previous step, turn the AMPLITUDE control fully cw.

b. CHECK - that the waveform on the oscilloscope display is ≥30 V peak to peak.

c. Remove the coaxial cable from the oscilloscope vertical input and connect a 50 Ω termination in series with the cable.

d. CHECK - that the oscilloscope display is ≥15 V peak to peak.

e. Disconnect the 50 Ω cable and remove the 50 Ω termination from the oscilloscope for the next step.

4. Check Offset Range

a. Press the TRIG 0 dB, and ⊓ pushbuttons.

b. Make certain the VAR SYMM pushbutton is in.

c. Connect a dmm set to read ±15 V to the output connector.

d. Adjust the VAR Ø control for a 0 V reading on the dmm.

e. Pull and turn the OFFSET control fully cw to fully CCW.

f. CHECK - that the dmm reads ≥±13 V at the appropriate stops for the OFFSET control.

g. Remove the coaxial cable from the dmm and insert a 50 Ω termination.

h. CHECK - that the dmm reads at least ±6.5 V at the appropriate stops of the OFFSET control.

i. Remove the connections from the dmm for the next step.

5. Check Amplitude Flatness

a. Press the FREE RUN, 0 dB and ∿ pushbuttons.

b. Make certain the OFFSET is off.

c. Set the FREQUENCY Hz dial to 10 and the MULTIPLIER to 10^3.

d. Connect the OUTPUT connector through a 50 Ω cable and 50 Ω termination to the vertical input of the differential oscilloscope plug-in.

e. Adjust the AMPLITUDE control and the gain of the vertial amplifier for an 8 major division peak to peak display.

f. Increase the vertical amplifier gain by a factor of 10.

g. Adjust the vertical amplifier plug-in offset voltage so that the waveform peaks are on the oscilloscope graticule center line.

h. Change the output to any frequency from 20 Hz to 20 kHz.

i. CHECK - that the display is within 0.46 major divisions from graticule center.

j. Change the output to any frequency from 20 kHz to 1 MHz.

k. CHECK - that the display is within 2.37 major divisions from graticule center.

l. Decrease the vertical gain of the oscilloscope by a factor of 10 and adjust the offset voltage to 0.

m. Adjust the output frequency to 10 kHz.

n. Adjust the oscilloscope vertical gain and the AMPLITUDE control for a 6 major division peak to peak display.

o. Change the output to any frequency from 1 MHz to 2 MHz.

p. CHECK - that the peak to peak display amplitude is from 5.36 to 6.73 major divisions.

q. Press the ⊓⊔ pushbutton.

r. Set the output frequency to 10 kHz.

s. Adjust the AMPLITUDE control and the vertical comparator oscilloscope plug-in for an 8 major division peak to peak display.

t. Increase the oscilloscope vertical plug-in gain by a factor of 10.

u. Adjust the vertical plug-in offset voltage so that the positive peaks of the squarewaves are at graticule center.

v. Change the output to any frequency from 20 Hz to 2 MHz.

w. CHECK—that the positive squarewave peaks are within ±2.37 major divisions from graticule center.

x. Press the ⊿ pushbutton.

y. Change the output frequency to 10 kHz.

z. Decrease the oscilloscope vertical plug-in gain by a factor of 10.

aa. Adjust the vertical plug-in offset voltage to 0.

bb. Adjust the AMPLITUDE control and the vertical plug-in gain for an 8 major division oscilloscope display of the triangle waveform.

cc. Increase the plug-in gain by a factor of 10.

dd. Adjust the offset voltage so that the positive peak of the triangle waveform is at graticule center.

ee. Change the output to any frequency from 20 Hz to 200 kHz.

ff. CHECK - that the positive peak of the triangle waveform is 2.37 major divisions or less from the graticule center.

gg. Decrease the vertical amplifier gain by a factor of 10.

hh. Remove the comparison voltage from the vertical plug-in.

ii. Adjust the AMPLITUDE control and the vertical plug-in gain for a peak to peak triangle waveform display of 6 major divisions.

jj. Change the output to any frequency from 200 kHz to 2 MHz.

kk. CHECK - that the peak to peak display reads from 4.4 major divisions to 7.6 major divisions in amplitude.

ll. Disconnect the oscilloscope for the next step.

6. Check Sinewave Distortion

a. Press the FREE RUN, 0 dB, and ∿ pushbuttons. The VAR SYMM, and OFFSET controls must be off (in).

b. Connect the OUTPUT connector through a 50 Ω coaxial cable and 50 Ω termination to the distortion anal yzer.

c. Set the distortion analyzer to measure total harmonic distortion plus noise with average response.

d. Make certain the function generator is in an ambient temperature from 20° C to 30° C.

e. Select any frequency from 20 Hz to 20 kHz with the FREQUENCY Hz and MULTIPLIER controls. The FREQUENCY Hz control must be on the calibrated portion of the dial and the MULTIPLIER control must be on the 10^3 range or below.

f. Adjust the AMPLITUDE control for a 15 V peak to peak signal at the input of the distortion analyzer.

g. CHECK - that the distortion is $\leq$0.25%.

h. Select any frequency from 20 kHz to 100 kHz. The FREQUENCY Hz control must be on the calibrated portion of the dial.

i. CHECK - that the distortion is $\leq$0.5%.

j. Disconnect the distortion analyzer and the 50 Ω termination from the coaxial cable.

k. Connect the coaxial cable to the input of the spectrum analyzer.

l. Set the FREQUENCY Hz dial at 10 and the MULTIPLIER at 10^4.

m. Adjust the AMPLITUDE control and the spectrum analyzer controls so that amplitudes 30 dB or greater below the fundamental amplitude are easily viewed on the spectrum analyzer.

n. Rotate the FREQUENCY Hz dial to 20, change the MULTIPLER to 10^5, and rotate the FREQUENCY Hz dial from 20 to 2.

o. CHECK - that all harmonics from 100 kHz to 2 MHz are at least 30 dB below the fundamental amplitude.

p. Remove the connections to the spectrum analyzer for the next step.

7. Check Squarewave and Pulse Output

a. Press the FREE RUN, 0 dB and ⎍ pushbuttons. All other pushbuttons out.

b. Set the FREQUENCY Hz dial and the MULTIPLIER control for any calibrated frequency. (For ease, the FREQUENCY Hz dial at 20 and the MULTIPLIER at 10^5 are recommended.)

c. Turn the AMPLITUDE control fully cw.

d. Connect the OUTPUT connector through a 50 Ω coaxial cable and the necessary attenuators to obtain a 5 division display to the 50 Ω vertical input of the sampling oscilloscope.

e. Connect the TRIG OUTPUT connector through a 50 Ω coaxial cable and the necessary attenuators to the external trigger input on the sampling oscilloscope.

f. Obtain a stable rise and fall time display on the oscilloscope.

g. CHECK - that the rise time and fall time is $\leq$25 ns from the 10% to the 90% amplitude points.

h. CHECK - that the peak to peak amplitude of the front corner ringing does not exceed 3% of the total squarewave amplitude. (If the squarewave amplitude is 8 major divisions, maximum aberrations allowed are 0.24 major divisions.)

i. Release the VAR SYMM pushbutton.

j. Adjust the VAR SYMM control for a pulse waveform.

k. Repeat steps f and g.

l. Remove all connections for the next step.

8. Check VCF Input

a. Press the FREE RUN, 0 dB and ∿ pushbuttons. The VAR SYMM and OFFSET pushbuttons should be in. Set the FREQUENCY Hz dial to 20 and the MULTPLIER to 10^5.

b. Connect the OUTPUT connector through a 50 Ω coaxial cable to the input of the frequency counter.

c. Obtain a stable counter display.

d. Apply -10 Vdc to the VCF INPUT connector.

CHECK - that the frequency decreases by a factor of ⩾1000.

f. Remove all connections for the next step.

9. Check External Trigger/Gate Input

a. Press the TRIG, 0 dB, and ∿ pushbuttons.

b. Connect the OUTPUT connector to the vertical input of the oscilloscope.

c. Connect the pulse generator through a 50 Ω coaxial coaxial cable and 50 Ω termination termination to the TRIG/GATE IN connector.

d. Set the pulse generator for a 0 to 1.2 V positive going 50% duty cycle pulse at 1/2 the frequency of the FG 501A.

e. CHECK - for one cycle of a sine waveform for each trigger pulse.

f. Press the GATE pushbutton.

g. CHECK - for an output waveform that lasts for the duration of the gating waveform.

h. Remove all connections for the next step.

10. Check Trigger Out put

a. Press the FREE RUN pushbutton.

b. Connect the TRIG OUTPUT connector through a 50 Ω coaxial coaxial cable to the vertical input of the oscilloscope.

c. CHECK - for a ⩾+4 V waveform on the oscilloscope display.

d. Insert a 50 Ω termination from the coaxial cable to the oscilloscope vertical input.

e. CHECK - for a ⩾+2 V waveform on the oscilloscope display.

f. Remove all connections for the next step.

11. Check Variable Phase Range

a. Press the FREE RUN, 0 dB, and ∿ pushbuttons.

b. Connect the OUTPUT connector to the vertical input of the oscilloscope. Set the oscilloscope for automatic triggering.

c. Obtain a sine waveform on the oscilloscope centered around 0 V. Determine the peak-to-peak amplitude of the waveform.

d. Press the TRIG pushbutton.

e. Rotate the VAR 0 from stop to stop and observe the position of the free running trace on the oscilloscope display.

f. CHECK - that the straight line can be positioned at the peak amplitudes of the sine waveform.

g. Remove all connections for the next step.

12. Check Attenuator Accuracy

a. Press the FREE RUN, 0 dB and ∿ pushbuttons.

b. Set the FREQUENCY Hz dial to 20.

c. Set the MULTIPLIER to the 10^3 position.

d. Set the AMPLITUDE control fully cw.

e. Connect the OUTPUT connector thorugh a 50 Ω coaxial cable and 50 Ω termination to the input of the dB ratio meter (AA 501).

f. Set the AA 501 for automatic level ranging.

g. Push the 0 dB REF button on the AA 501.

h. Push the -20 dB pushbutton.

i. CHECK - that the ratio meter reads from -19 dB to -21 dB.

j. Push the -40 dB pushbutton.

k. CHECK-that the display reads from -39 dB to -41 dB.

l. Push the -60 dB pushbutton.

m. CHECK-that the display reads from -59 dB to -61 dB.

n. Remove all connections for the next step.

12A. Alternate Procedure for Checking Attenuator Accuracy

a. Press the FREE RUN, 0 dB, and ∿ pushbuttons.

b. Set the FREQUENCY Hz dial to 20.

c. Set the MULTIPLIER to 10^3 position. Connect the output through a coaxial cable to the oscilloscope vertical input.

d. Adjust the AMPLITUDE control for exactly a 30 V peak to peak sinewave.

e. Push the -20 dB pushbutton.

f. CHECK-for a waveform amplitude from 2.67 V to 3,37 v.

g. Press the -40 dB pushbutton.

h. CHECK-for a waveform amplitude from 0.267 Vto 0.337 V.

i. Press the -60 dB pushbutton.

j. CHECK-for a waveform amplitude from 0.0267 V to 0.0337 v.

k. Remove all connections for the next step.

13. Check Triangle Time Symmetry

a. Press the FREE RUN pushbutton.

b. Set the FREQUENCY Hz and MULTIPLIER control for any frequency from 20 Hz to 200 kHz in the calibrated portion of the dial. Connect the counter through a coaxial cable to the TRIG OUTPUT connector.

c. Trigger the counter to read the time of the positive-going half cycle of the trigger waveform (+ slope).

d. Record this reading.

e. Trigger the counter to read the negative-going half cycle of the triggering waveform (- slope).

f. Record this reading.

g. CHECK-that the time difference of both readings is ≤ 1

h. Set the FREQUENCY Hz and MULTIPLIER controls for a frequency from 200 kHz to 2 MHz in the calibrated portion of the FREQUENCY Hz dial.

i. Repeat steps c through f.

j. CHECK-that the time difference is $\leq 5\%$.

k. Remove all connections.

ADJUSTMENT PROCEDURE

INTRODUCTION

Use this Adjustment Procedure to restore the FG 501A to original performance requirements. This Adjustment Procedure need not be performed unless the instrument fails to meet the Performance Requirements of the Electrical Characteristics listed in the Specification section, or if the Performance Check procedure cannot be completed satisfactorily. If the instrument has undegone repairs, the Adjustment Procedure is recommended.

Satisfactory completion of all adjustment steps in this procedure assures that the instrument will meet the performance requirements.

SERVICES AVAILABLE

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

RECALIBRATION INTERVAL

Recommended recalibration interval is 2000 hours of operation or six months, whichever occurs first.

TEST EQUIPMENT REQUIRED

The test equipment (or equivalent) listed in Table 4-1 is required for adjustment of the FG 501A. Specifications given for the test equipment are the minimum necessary for accurate adjustment. All test equipment is assumed to be correctly calibrated and operating within specifications.

If other test equipment is used, calibration setup may need to be altered to meet the requirements of the equipment used.

PREPARATION

Access to the internal adjustments is achieved most easily when the FG 501A is connected to the power module with a flexible extender (see equipment list). Removal of the left side cover provides access to all internal adjustments. Refer to the Adjustment Locations in the pullout pages at the rear of the manual.

Make adjustments at an ambient temperature between +20°C and +25°C.

PRELIMINARY SETTINGS

Preset the FG 501A and test equipment controls as follows:

CAUTION

To prevent damage to equipment, be sure the power module and oscilloscope mainframe power is off before inserting or removing plug-in units.

Power Module

LINE SELECTOR	HI

FG 501A

⊓ (pushbutton)	in
FREE RUN (pushbutton)	in
0 dB (pushbutton)	in
FREQUENCY Hz dial	20
VAR SYMM	Mid-range & in
VAR 0	Mid-range
MULTIPLIER	103
VAR (frequency)	cw
OFFSET	Mid-range & in
AMPL	cw

Digital Multimeter (DM 501)

RANGE/FUNCTION	20 DC VOLTS
INPUT	EXT

POWER SUPPLIES

1. Adjust the +15 V ADJ (R1301), ±0.1%

a. Insert the FG 501A and digital multi meter into the power module.

b. Connect the power module power cord to 117 Vac source and turn on the power module.

c. Connect the test leads to the digital multi meter HI and LO INPUTS.

d. Connect the digital multi meter LO test lead to the FG 501A chassis ground. Connect the HI test lead to the FG 501A test point, TP1323 located on the Main board.

e. ADJUST-potentiometer R1301 located on the Main board until the digital multi meter readout indicates between +14.985 and +15.015.

2. Adjust the -15 V ADJ (R1341), ±0.1%

a. Remove the digital multi meter HI test lead from TP1323 and connect to test point, TP1451 (also located on the Main board).

b. ADJUST-potentiometer R1341 located on the Main board until the digital multi meter readout indicates between -14.985 and -15.015.

3. Check the +5 V Supply Accuracy, ±0.5%

a. Remove the digital multi meter HI test lead from TP1451 and connect to test point, TP1331 located on the Main board.

b. The digital multi meter must indicate a readout between +4.975 and +5.025.

4. Check the +20 V Supply Accuracy, ±0.5%

a. Change the digital multimeter RANGE/FUNCTION switch to 200 DC VOLTS.

b. Remove the digital multimeter HI test lead from TP 1331 and connect to test point, TP1321 located on the Main board.

c. The digital multi meter must indicate a readout between +19.90 and +20.10.

5. Check the –20 V Supply Accuracy, ±0.5%

a. Remove the digital multi meter HI test lead from TP1321 and connect to test point, TP1241 located on the Main board.

b. The digital multi meter must indicate a readout between -19.90 and -20.10.

c. Remove all connections

DIAL ALIGNMENT

Refer to Fig. 4-1 test setup and preliminary control settings with the following exceptions.

7000 Series Oscilloscope

POWER	on
FOCUS, INTENSITY	as desired for a well-defined display
VERTICAL MODE	LEFT
HORIZONTAL MODE	B
B TRIGGER SOURCE	VERT MODE

Vertial Plug-in

VOLTS/DIV	5
VARIABLE	in
BANDWIDTH	FULL
POLARITY	+ (UP)
AC-GND-DC	DC
POSITION	centered display

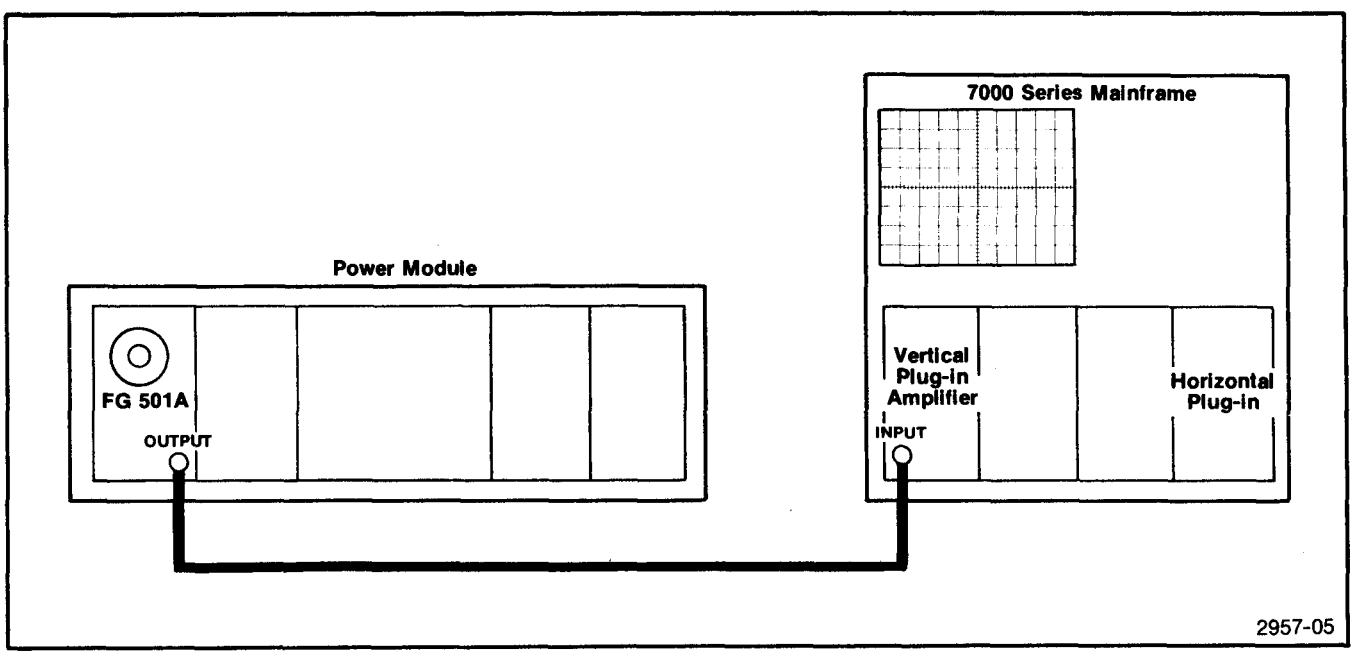


Fig. 4-1. Test setup for DIAL ALIGNMENT and OFFSET adjustment.

Horizontal Plug-in

DISPLAY MODE	TIME BASE
TIME/DIV	50 μs
VARIABLE	in
LEVEL/SLOPE	
MODE	AUTO
COUPLING	AC
SOURCE	INT
MAGNIFIER	X1

6. Frequency Hz Dial Alignment

a. Connect the coaxial cable from the FG 501A OUTPUT to the vertical plug-in INPUT.

b. Adjust the horizontal plug-in LEVEL control for a stable squarewave display on the crt.

c. Locate the coupler holding the FREQUENCY Hz potentiometer extension shaft and loosen the coupler set screw.

d. ADJUST-the FREQUENCY Hz potentiometer counterclockwise until the displayed waveform just stops moving.

e. While holding the potentiometer (coupler), adjust the FREQUENCY Hz dial to 20 (exact).

f. Tighten the coupler set screw (snug only).

g. Adjust the FREQUENCY Hz dial to 18. Then rotate dial slowly counterclockwise until the display crt waveform just stops moving.

h. Check that the FREQUENCY Hz dial is on 20 (±.5 minor graticule division).

i. Tighten the coupler set screw.

ADJUST OFFSET

Refer to Fig. 4-1 test setup and preliminary control settings with the following exceptions.

FG 501A

AMPLITUDE	Ccw
∼ (pushbutton)	in
FREQUENCY Hz	20
MULTIPLIER	102

Vertical Plug-in

VOLTS/DIV	2

7. Adjust the OUTPUT OFFSET (R2201) and SINE OFFSET (R1104)

a. The oscilloscope crt display is a triangle.

b. ADJUST-potentiometer R2201 located on the Main board until the displayed waveform is centered on the vertical graticule line.

c. Press the ∿ (pushbutton) in.

d. The oscilloscope crt display is a sinewave.

e. ADJUST-potentiometer R1104 located on the Aux board until the displayed waveform is centered on the vertical graticule line.

ADJUST SINE DISTORTION

8. Adjust the TRIANGLE AM PLADJ (R1412), TRIANGLE OFFSET (R1511), and TOP DIAL SYMM CAL (R1421)

Refer to Fig. 4-2 check setup and preliminary control settings with the following exceptions.

FG 501A

AMPLITUDE	cw

Audio Analyzer

INPUT LEVEL RANGE	20 V
FUNCTION	THD+N
PERCENT DISTORTION	AUTO
FILTERS	OUT
RESPONSE	AVE

a. Remove the vertical plug-in INPUT connection and re-connect to the audio analyzer using a bnc to banana plug adapter.

b. ADJUST-potentiometers R1412, R1511, and R1421 all located on the Main board for a minimum reading on the audio analyzer. Repeat these adjustments until no further improvement is noted.

9. Adjust the "C" MULT ADJ (R1951)

Refer to Fig. 4-2 test setup and preliminary control settings with the following exceptions.

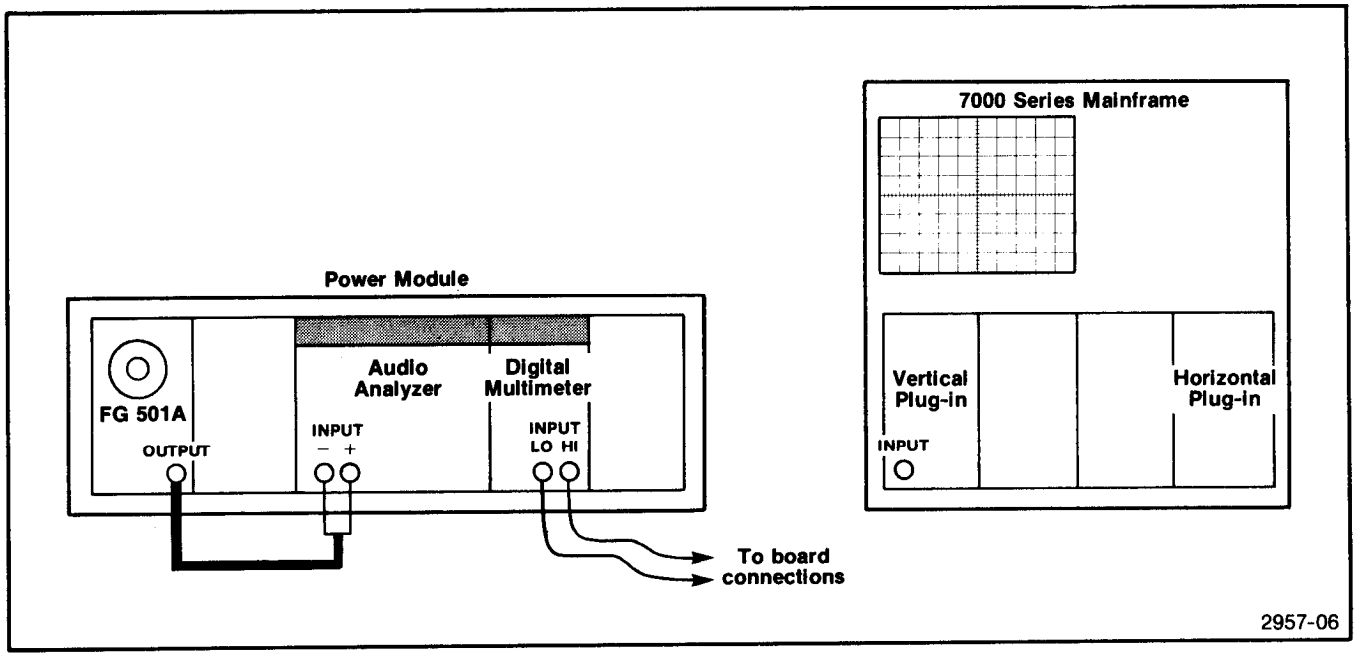


Fig. 4-2. Test setup for SINE DISTORTION adjustment.

Digital Multimeter

RANGE/FUNCTION	2 DC Volts

FG 501A

MULTIPLIER	1

a. Connect the digital mult meter LO INPUT test lead to pin 2 of IC, U1930 located on the Main board.

b. Connect the HI INPUT test lead to pin 2 of IC, U1940 also located on the Main board.

c. ADJUST-potentiometer R1951 located on the Main board for a .0000 digital multimeter readout.

d. Remove digital multimeter test leads.

10. Adjust the BOTTOM DIAL SYMM CAL (R1441)

Refer to Fig. 4-2 test setup.

a. Adjust the FG 501A FREQUENCY Hz dial to 1 and change the MULTIPLIER to 10^2.

b. ADJUST-potentiometer R1441 for a minimum reading on the audio analyzer.

OFFSET ADJUSTS

Refer to Fig. 4-3 test setup and preliminary control settings with the following exceptions:

FG 501A

∿ (pushbutton)	in
MULTIPLIER	102
OUTPUT	ccw

Vertical Plug-in

VOLTS Polarity	+
+ INPUT Coupling	GND
- INPUT Coupling	GND
VOLTS/DIV	.1

11. Adjust OUTPUT OFFSET (R2201)

a. Connect a coaxial cable with 50 Ω termination from the FG 501A OUTPUT to the vertical plug-in + INPUT.

b. Adjust the vertical plug-in POSITION control until the trace lines up on the center horizontal graticule line.

c. Change the vertical plug-in + INPUT coupling to DC.

d. Adjust the vertical plug-in COMPARISON VOLTAGE control until the positive peak of the displayed waveform appears as graticule center.

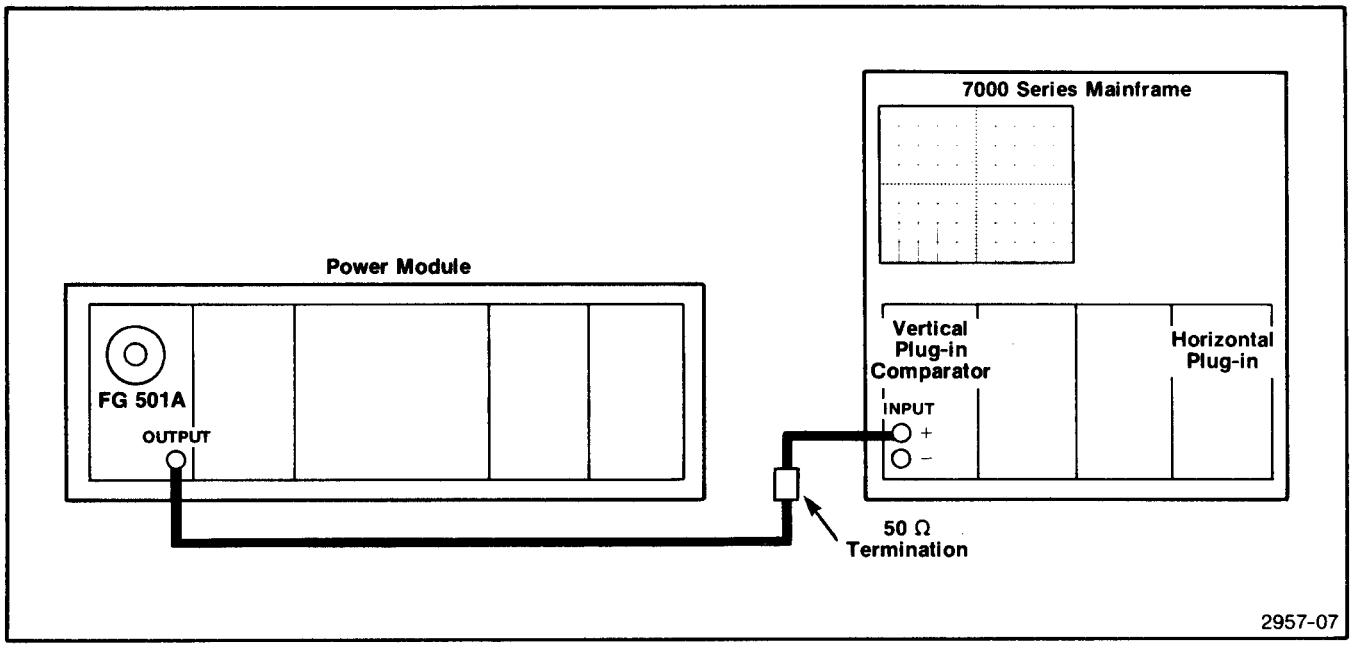


Fig. 4-3. Test setup for OFFSET and SINE/SQUARE AMPLITUDE adjustments.

e. Change the vertical plug-in VOLTS polarity to -.

f. Adjust the vertical plug-in COMPARISON VOLTAGE control until the negative peak of the displayed waveform moves half-way between its present position and the center horizontal graticule line.

g. ADJUST-potentiometer R2201 located on the Main board until the negative peak of the displayed waveform is on the center horizontal graticule line.

12. Adjust the SINE OFFSET (R1104)

a. Change the vertical plug-in VOLTS polarity to + and press the ∿ pushbutton (in).

b. Adjust the vertical plug-in COMPARISON VOLTAGE control until the positive peak of the displayed waveform appears at graticule center.

c. Change the vertical plug-in VOLTS polarity to -.

d. Adjust the vertical plug-in COMPARISON VOLTAGE control until the negative peak of the displayed waveform moves half-way between its present position and the center horizontal graticule line.

e. ADJUST-potentiometer R1104 located on the Aux board until the negative peak of the displayed waveform is on the center horizontal graticule line.

SINE/SQUARE AMPLITUDE ADJUSTS

Refer to Fig. 4-3 test setup and the preliminary controls settings with the following exceptions:

FG 501A

∿ (pushbutton)	in
AMPLITUDE	cw

Vertical Plug-in

VOLTS/DIV	.2
+INPUT Coupling	GND
-INPUT Coupling	GND

13. Adjust the SINE AMPL (R1106)

a. Adjust the vertical plug-in POSITION control until the trace lines up on the center horizontal graticule line.

b. Change the vertical plug-in VOLTS polarity to -.

c. Change the vertical plug-in + INPUT coupling to DC and the - INPUT coupling to VC.

d. Adjust the vertical plug-in COMPARISON VOLTAGE control until the negative peak of the displayed waveform appears at graticule center.

e. Press the FG 501A ∿ pushbutton (in).

f. ADJUST-potentiometer R1106 located on the Aux board until the negative peak of the displayed waveform is on the center horizontal graticule line.

14. Adjust the SQ WAVE AMPL (R1728)

a. Press the FG 501A ⎍ pushbutton (in).

b. Note the position of the negative level of the displayed squarewave.

c. Press the FG 501A ⎍ pushbutton (in).

d. Change the vertical plug-in VOLTS polarity to +.

e. Adjust the vertical plug-in COMPARISON VOLTAGE control until the positive peak of the displayed waveform is on the center horizontal graticule line.

f. Press the FG 501A ⎍ pushbutton (in).

g. ADJUST-potentiometer R1728 located on the Main board until the positive level of the displayed squarewave is off of the center graticule line in the same direction and same amount as the negative level squarewave noted in step 29b.

SQUAREWAVE COMP/RISE AND FALLTIME ADJUSTS

Refer to Fig. 4-4 test setup and the preliminary control settings with the following exceptions.

FG 501A

FREQUENCY Hz	20
MULTIPLIER	105
AMPLITUDE	ccw

Sampling Vertical Plug-in

mVOLTS/DIV	200

Sampling Horizontal Plug-in

SWEEP RANGE	5 μs
TIME/DIV	.1 μs

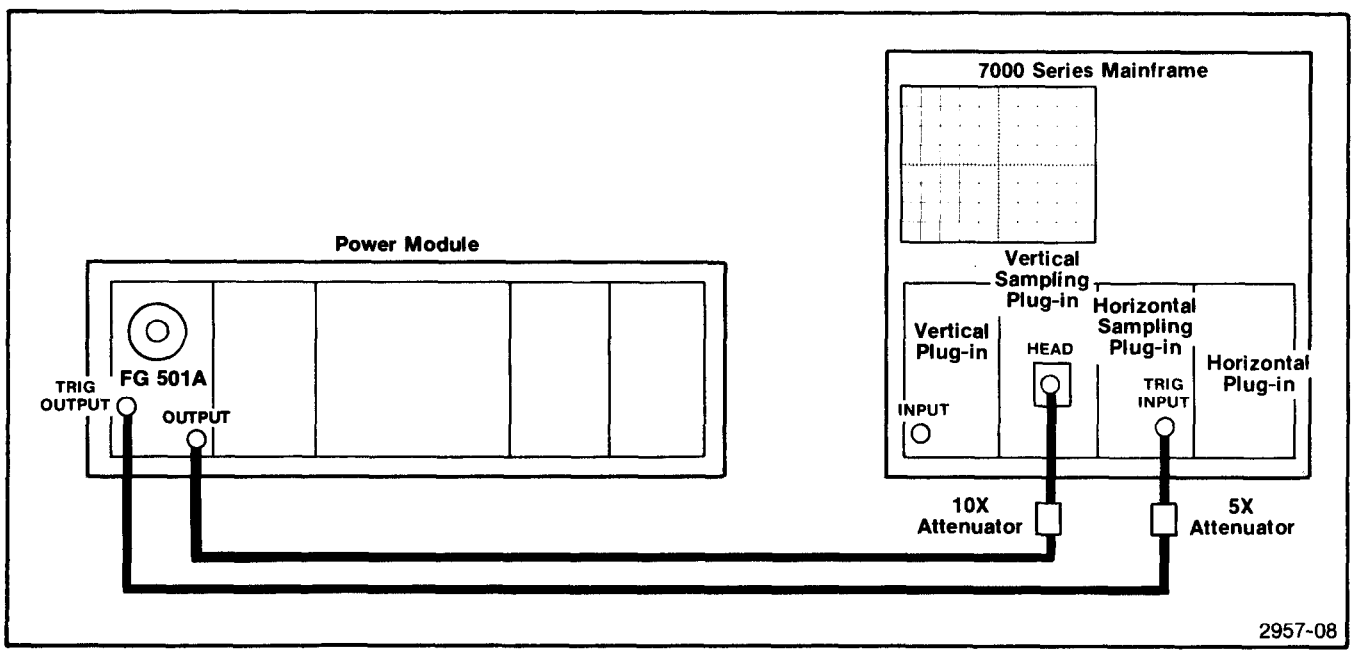


Fig. 4-4. Test setup for SQUAREWAVE COMP/RISE and FALL TIME adjustments.

15. Adjust the SQ WV COMP (C2011)

a. Connect a coaxial cable with a 10X attenuator from the FG 501A OUTPUT to the vertical plug-in sampling head input.

b. Connect a coaxial cable with a 5X attenuator from the FG 501A TRIG OUTPUT to the sampling horizontal plug-in TRIG INPUT.

c. Set the sampling vertical plug-in VARIABLE out and adjust for a displayed waveform amplitude of five major graticule divisions.

d. Change the sampling vertical plug-in mVOLTS/DIV switch to 20.

e. ADJUST-variable capacitor C2011 located on the Main board for a peak-to-peak aberration of 1 major graticule division on the displayed waveform. This aberration will appear at both the top and bottom of the waveform.

DIAL CAL/LOOP DELAY

Refer to Fig. 4-5 test setup and preliminary control setti rigs.

16. Adjust the DIAL CAL (R1321)

a. Connect a 50Ω coaxial cable and terminator from the FG 501A output to the counter input.

b. ADJUST-potentiometer R1321 located on the main board for a counter display of 20.00.

17. Adjust LOOP DELAY (C1714)

a. Change the FG 501A MULTIPLIER to 10^5 and the digital counter FUNCTION to FREQUENCY/.1 kHz.

b. ADJUST-variable capacitor C1714 located on Main board for a digital counter readout of 2.000.

c. Remove all cables and connections.

This completes the Adjustment Procedure for the FG 501A.

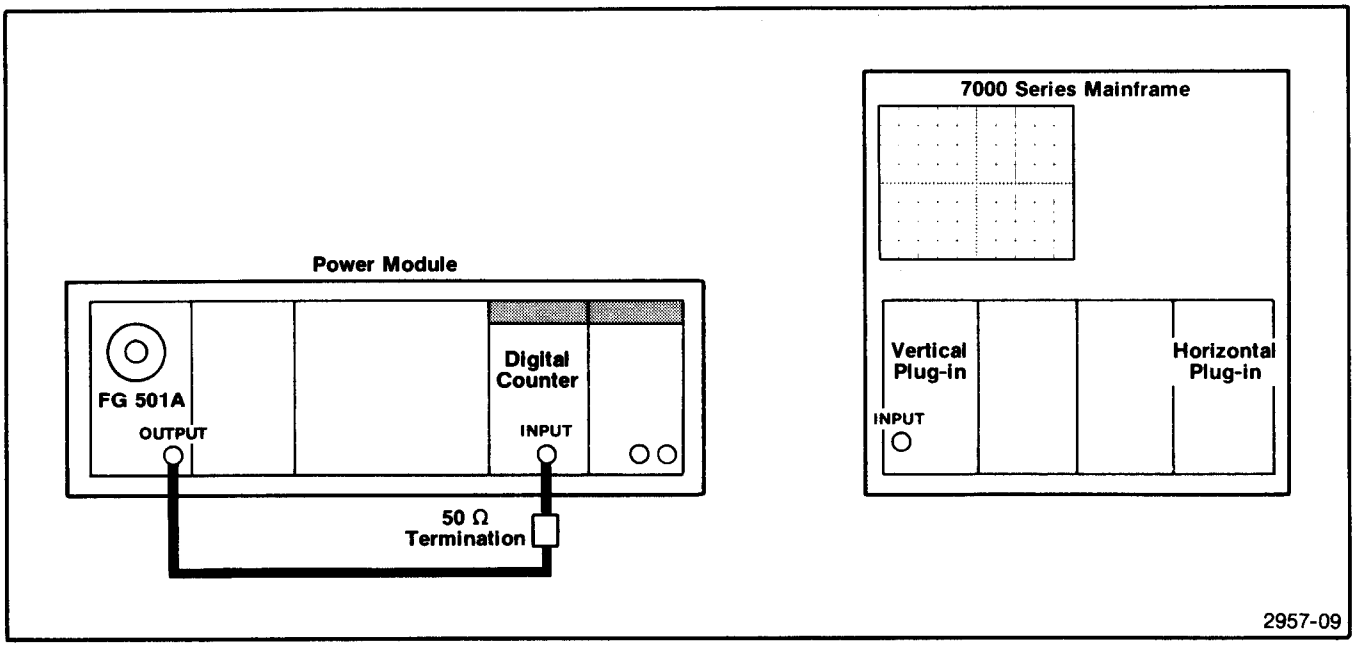


Fig. 4-5. Test setup for DIAL CAL and LOOP DELAY adjustments.

SECTION 5

MAINTENANCE

GENERAL MAINTENANCE INFORMATION

STATIC-SENSITIVE COMPONENTS

CAUTION

Static discharge can damage any semiconductor component in this instrument.

This instrument contains electrical components that are susceptible to damage from static discharge. See Table 5-1 for relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following precautions to avoid damage:

1. Minimize handling of static sensitive components.
2. Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.
3. Discharge the static voltage from your body by wearing a wrist strap while handling these components. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.
4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Keep the component leads shorted together whenever possible.
6. Pick up components by the body, never by the leads.
7. Do not slide the components over any surface.
8. Avoid handling components in areas that have a floor or work surface covering capable of generating a static charge.
9. Use a soldering iron that is connected to earth ground.
10. Use only special antistatic suction type or wick type resoldering tools.

Table 5-1

RELATIVE SUSCEPTIBILITY TO STATIC DISCHARGE DAMAGE

Semiconductor Classes	Relative Susceptibility Levels[a]
MOS or CMOS microcircuits or discretes or linear microcircuits with MOS inputs. (Most Sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETs	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (Least Sensitive)	9

[a] **Voltage equivalent for levels:**

1 = 100 to 500 V
2 = 200 to 500 V
3 = 250 V
4 = 500 V
5 = 400 to 600 V
6 = 600 to 800 V
7 = 400 to 1000 V (est)
8 = 900 V
9 = 1200 V

(Voltage discharged from a 100 pF capacitor through a resistance of 100 ohms.)

CLEANING

This instrument should be cleaned as often as operating conditions require. Loose dust accumulated on the outside of the instrument can be removed with a soft cloth or small brush. Remove dirt that remains with a soft cloth dampened in a mild detergent and water solution. Do not use abrasive cleaners.

CAUTION

To clean the front panel use freon, isopropyl alcohol, or totally denatured ethyl alcohol. Do not use petroleum based cleansing agents. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air (approximately 5 lb/in^2) or use a soft brush or cloth dampened with a mild detergent and water solution.

Hold the board so the cleaning residue runs away from the connectors. Do not scrape or use an eraser to clean the edge connector contacts. Abrasive cleaning can remove the gold plating.

CAUTION

Circuit boards and components must be dry before applying power.

OBTAINING REPLACEMENT PARTS

Electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, it may be possible to obtain many of the standard electronic components from a local commercial source. Before purchasing or ordering a part from a source other than Tektronix, Inc., check the Replaceable Electrical Parts list for the proper value, rating, tolerance, and description.

NOTE

When selecting replacement parts, remember that the physical size and shape of a component may affect its performance in the instrument.

Some parts are manufactured or selected by Tektronix, Inc., to satisfy particular requirements or are manufactured for Tektronix, Inc., to our specifications. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. To determine the manufacturer, refer to the Replaceable Parts list and the Cross Reference index, Mfr. Code Number to Manufacturer.

When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type and option number.
2. Instrument serial number.
3. A description of the part (if electrical, include complete circuit number).
4. Tektronix part number.

SOLDERING TECHNIQUES

WARNING

To avoid electric-shock hazard, disconnect the instrument from the power source before soldering.

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques which apply to maintenance of any precision electronic equipment should be used when working on this instrument. Use only 60/40 rosin-core electronic grade solder. The choice of soldering iron is determined by the reapir to be made.

When soldering on circuit boards or small wiring, use only a 15 watt, pencil type soldering iron. A higher wattage soldering iron can cause the etched circuit wiring to separate from the board base material and melt the insulation from small wiring. Always keep the soldering iron tip properly tinned to ensure the best heat transfer to the solder joint. Apply only enough heat to remove the component or to make a good solder joint. To protect heat sensitive components, hold the component lead with a pair of long-nose pliers between the component body and the solder joint. Use a solder removing wick to remove excess solder from connections or to clean circuit board pads.

SEMICONDUCTORS

To remove in-line integrated circuits use an extracting tool. This tool is available from Tektronix, Inc.; order Tektronix Part Number 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the integrated circuit. Try to avoid disengaging one end before the other end.

INTERCONNECTING PINS

Several methods of interconnection including multi pin and coaxial cable, are used to electrically connect the circuit boards with other boards and components.

COAXIAL CABLES

Replacement of coaxial end lead connectors requires special tools. Damaged cables should be replaced as a unit. For cable part numbers see the Replaceable Mechanical Parts list. Fig, 5-1 shows a coaxial connector assembly.

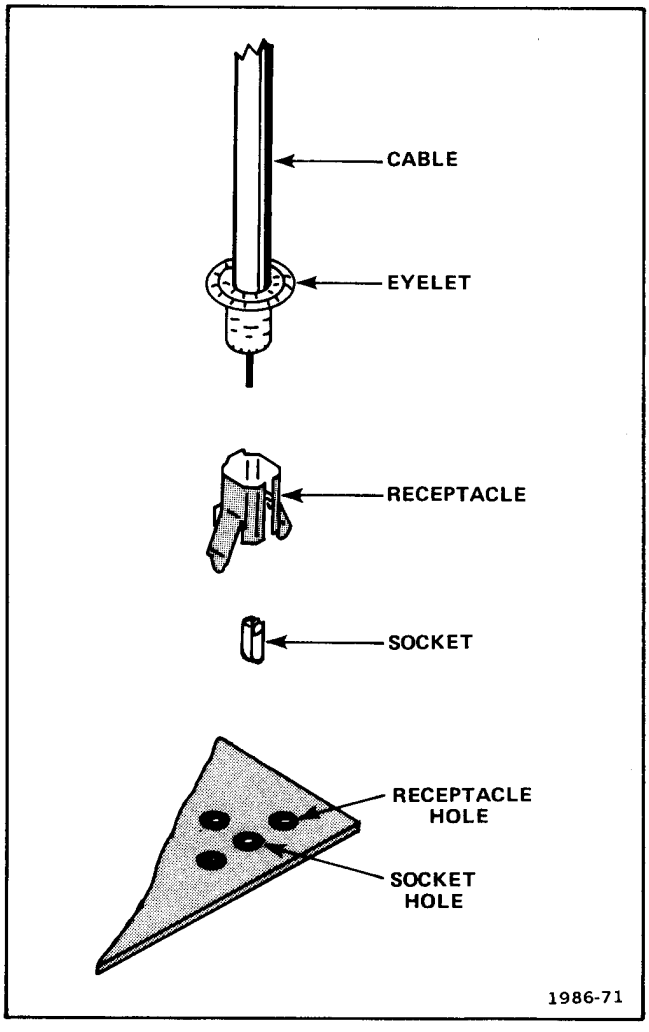


Fig. 5-1. Coaxial end lead connector assembly.

MULTIPIN CONNECTORS

The pin connectors used to connect the wires to the interconnecting pins are clamped to the ends of the wires. To replace damaged multipin connectors, remove the old pin connector from the holder. Do this by inserting a scribe between the connector and the holder and prying the connector from the holder. Clamp the replacement connector to the wire. Reinstall the connector in the holder.

If the individaul end lead pin connectors are removed from the plastic holder, note the order of the individual wires for correct replacement in the holder. For proper replacement see Fig. 5-2.

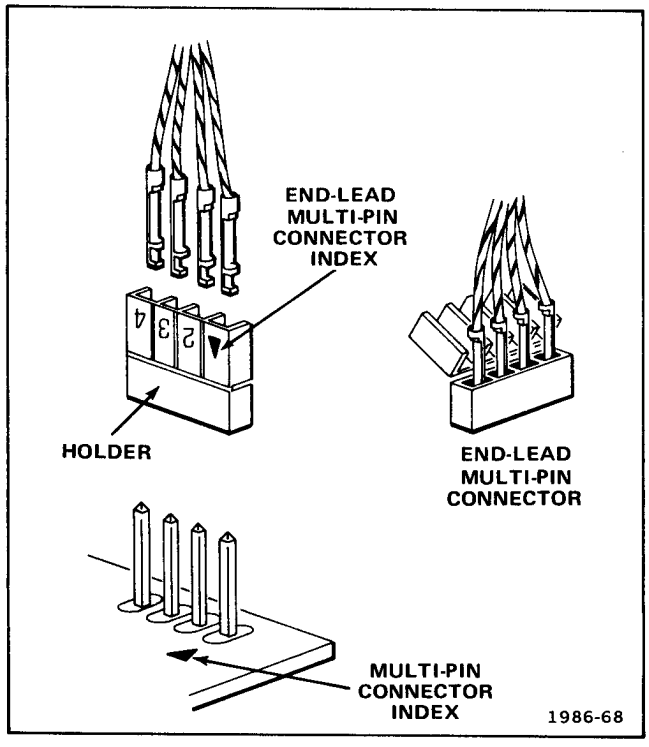


Fig. 5-2. Orientation and disassembly of multipin connectors.

CAM SWITCHES

Use care when cleaning or repairing cam switches. Shaft alignment and spring tension of the contacts must be carefully maintained for proper operation of the switch. For assistance, contact your local Tektronix Field Office or representative.

NOTE

A cam-type switch repair kit including necessary tools, instructions, and replacement contacts is available from Tektronix, Inc. Order Tektronix Part No. 040-0541-00.

The cam switches consist of rotating cam drums which are turned by front-panel knobs, and sets of spri rig-leaf contacts mounted on adjacent circuit boards. The contacts are actuated by lobes on the cams. These switches can be disassembled for inspection, cleaning, repair, or replacement as follows:

1. Pull the metal cover off the switch. The switch is now open for inspection or cleaning.

2. To completely remove a switch from the circuit board, first remove any knobs or shaft extensions. Loosen the coupling at the potentiometer at the rear of the switch, and pull the long shaft out of the switch assembly.

3. Remove the screws (from the opposite side of the circuit board) that hold the cam drum to the board.

4. To remove the cam drum from the front support block, remove the retaining ring from the shaft on the front of the switch and slide the cam drum out of the support block. Be careful not to lose the small detent roller.

5. To replace defective switch contacts, follow the instructions given in the switch repair kit.

6. To reinstall the switch assembly, reverse the above procedure.

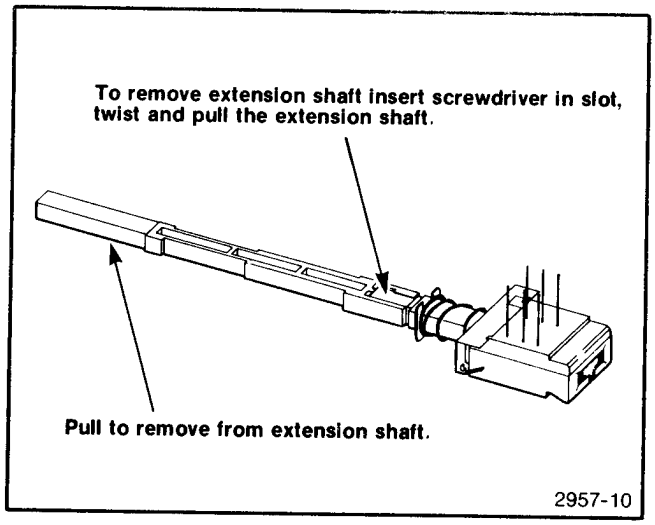


Fig. 5-3. Extension shaft and pushbutton removal.

PUSHBUTTON SWITCHES

See Fig. 5-3 for pushbutton switch disassembly instructions.

FRONT PANEL LATCH REMOVAL

To disassemble the latch, pry up on the pull tab bar attached to the latch assembly. The latch components can now be removed from the instrument.

REAR INTERFACE INFORMATION

FUNCTIONS AVAILABLE AT REAR CONNECTOR

A slot exists between pins 23 and 24 on the rear connector. Insert a barrier in the corresponding position of the power module jack to prevent noncompatible plug-ins from being using in that compartment. Consult the power module manual for further information. Signals for other specialized connections may be made to the rear interface connectors as shown in Fig. 5-4. A description of these connections follows.

Output (From 600 Ω) 28A

The output can be obtained at this terminal by connecting a coax cable from J2141 to J1204 on the A10 Main Board assembly. A 560 Ω resistor is in series with J2141.

Output Common 27A

This is the return connection for the output.

Trigger Output (50 Ω) 27B

This terminal is connected via an internal jumper to the front panel trigger output connector. See the adjustment location illustration for the location of this jumper.

Trigger Out Common 28B

This is the return connection for the trigger output.

Trig/Gate In 24B

This terminal is connected to the trigger amplifier through a 1 KΩ resistor. The output signal is 1 V with an impedance of ≤10 KΩ.

Trig/Gate In Common 25B

This is the return connection for the trig/gate in.

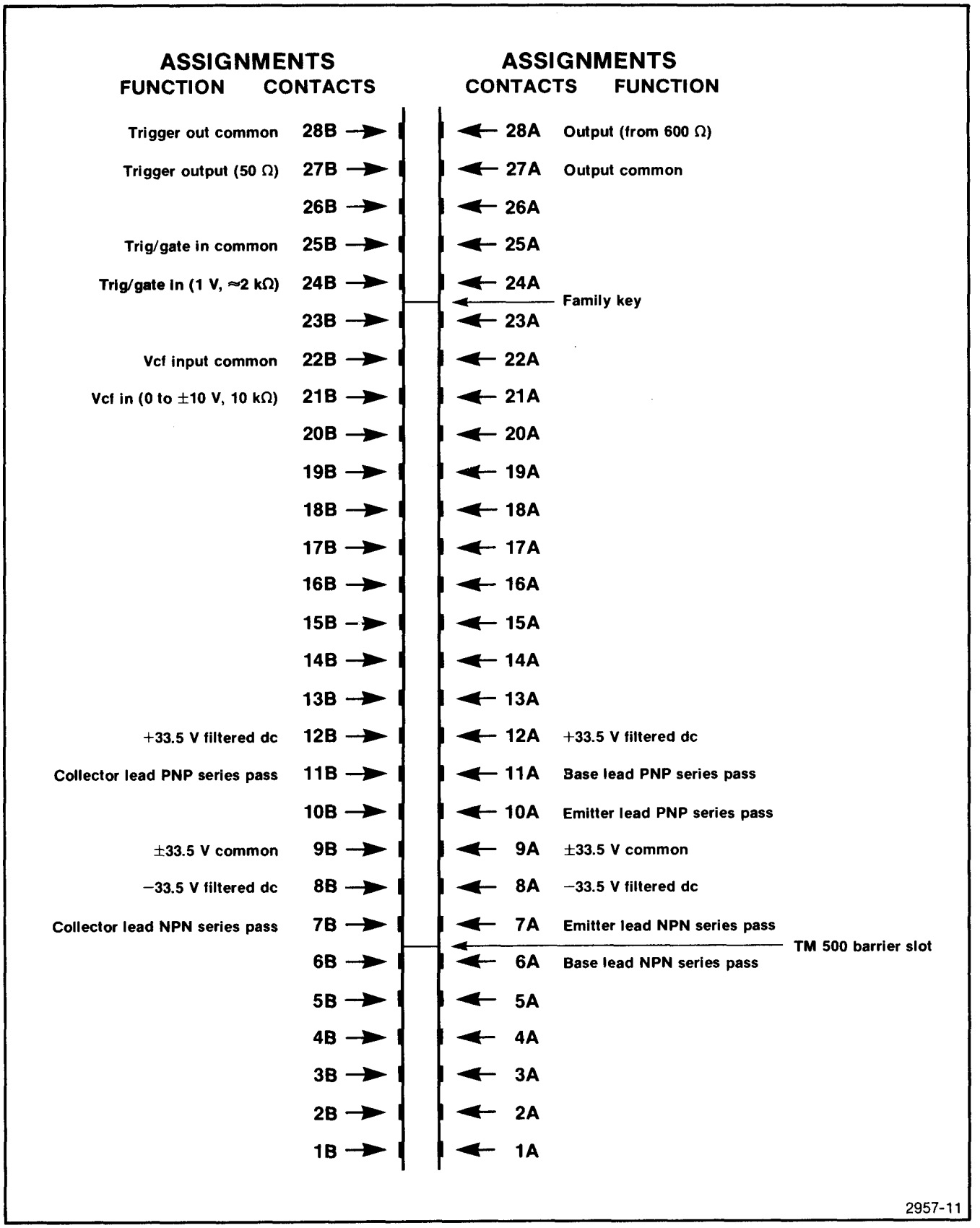


Fig. 5-4. Rear interface connector assignments.

VCF In 21B

This terminal is connected through a 10KΩ resistor via an internal jumper to the virtual ground summing node of operational amplifier U1540A (pin 2). See the Adjustment Location illustration for the location of this jumper.

VCF In Common 22B

This connection is the ground return for the VCF In.

SECTION 6

OPTIONS

There are no options for the FG 501A at the time of this printing.

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, aerial 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.

LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When thecomplete component number of a part is known, this list will identify the assembly in which the part is located.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

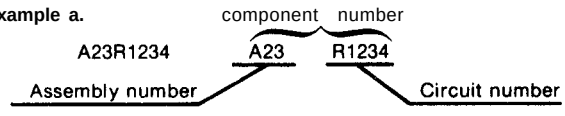
ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

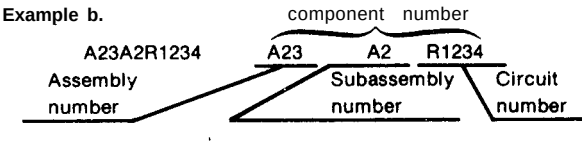
A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

Example a.



Read Resistor 1234 of Assembly 23

Example b.



Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with ita subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

NAME & DESCRIPTION (column five of the Electrical Parts List)

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.

MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
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
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
03888	KDI PYROFILM CORPORATION	60 S JEFFERSON ROAD	WHIPPANY, NJ 07981
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON STREET	DOVER, NH 03820
12969	UNITRODE CORPORATION	580 PLEASANT STREET	WATERTOWN, MA 02172
13511	AMPHENOL CARDRE DIV., BUNKER RAMO CORP.		LOS GATOS, CA 95030
19701	ELECTRA-MIDLAND CORP., MEPCO ELECTRA INC.	P O BOX 760	MINERAL WELLS, TX 76067
22526	BERG ELECTRONICS, INC.	YOUR EXPRESSWAY	NEW CUMBERLAND, PA 17070
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
50434	HEWLETT-PACKARD COMPANY	640 PAGE MILL ROAD	PALO ALTO, CA 94304
53184	XCITON CORPORATION	5 HEMLOCK STREET	LATHAM, NY 12110
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16875
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV	2500 HARBOR BLVD.	FULLERTON, CA 92634
73899	JFD ELECTRONICS COMPONENTS CORP.	PINETREE ROAD	OXFORD, NC 27565
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
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
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

COMPONENT NO.	TEKTRONIX PART NO.	SERIAL/MODEL NO. EFF	DSCONT	NAME & DESCRIPTION	MFR CODE	PART NUMBER
A10				CKT BOARD ASSY:FUNCTION GEN (NOT REPLACEABLE ORDER 672-0924-01)		
A12	670-6694-00	B010100	B020349	CKT BOARD ASSY:AUXILIARY	80009	670-6694-00
A12	670-6694-01	B020350		CKT BOARD ASSY:AUXILIARY	80009	670-6694-01
A10				CKT BOARD ASSY:FUNCTION GEN		
A10C1115	290-0779-00			CAP.,FXD,ELCTLT:10UF,+50-10%,50VDC	56289	502D237
A10C1201	281-0775-00			CAP.,FXD,CER DI:O.1UF,20%,50V	72982	8005D9AABZ5U104M
A10C1203	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A10C1224	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A10C1235	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	72982	8035D9AADC1G470K
A10C1251	290-0779-00			CAP.,FXD,ELCTLT:10UF,+50-10%,50VDC	56289	502D237
A10C1253	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A10C1313	281-0820-00			CAP.,FXD,CER DI:680PF,10%,50V	12969	CGB681KDX
A10C1321	290-0745-00			CAP.,FXD,ELCTLT:2UF,+50-10%,25V	56289	502D225
A10C1323	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A10C1325	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A10C1341	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A10C1431	283-0203-00			CAP.,FXD,CER DI:0.47UF,20%,50V	72982	8131N075E474M
A10C13434	283-0203-00			CAP.,FXD,CER DI:0.47UF,20%,50V	72982	8131N075E474M
A10C1451	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A10C1516	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A10C1532	281-0762-00			CAP.,FXD,CER DI:27PF,20%,100V	72982	8035D9AADC0G270M
A10C1543	281-0823-00	XB020350		CAP.,FXD,CER DI:470PF,10%,50V	12969	CGB471KDN
A10C1601	281-0773-00			CAP.,FXD,CER DI:O.O1UF,10%,100V	04222	GC70-1C103K
A10C1603	281-0773-00			CAP,FXD,CER DI:O.O1UF,10%,100V	04222	GC70-1C103K
A10C1611	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	72982	8035D9AADC1G220K
A10C1613	281-0775-00			CAP.,FXD,CER DI:O.1UF,20%,50V	72982	8005D9AABZ5U104M
A10C1631	295-0164-00			CAP.SET,MTCHD:10,1,O.1,0.01UF,950PF	80009	295-0164-00
A10C1633						
A10C1641						
A10C1711	281-0773-00			CAP.,FXD,CER DI:O.O1UF,10%,100V	04222	GC70-1C103K
A10C1712	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	72982	8035D9AADC1G470K
A10C1714	281-0158-00			CAP.,VAR,CER DI:7-45PF,50V	73899	DVJ-5006
A10C1723	281-0773-00			CAP.,FXD,CER DI:O.O1UF,10%,100V	04222	GC70-1C103K
A10C1724	281-0773-00			CAP.,FXD,CER DI:O.O1UF,10%,100V	04222	GC70-1C103K
A10C1725	281-0810-00			CAP.,FXD,CER DI:5.6PF,0.5%,100V	04222	GC10-1A5R6D
A10C1726	281-0775-00			CAP.,FXD,CER DI:O.1UF,20%,50V	72982	8005D9AABZ5U104M
A10C1741				(PART OF A10C1631)		
A10C1751						
A10C1811	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A10C1812	281-0775-00			CAP.,FXD,CER DI:O.1UF,20%,50V	72982	8005D9AABZ5U104M
A10C1813	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A10C1814	281-0773-00			CAP.,FXD,CER DI:O.O1UF,10%,100V	04222	GC70-1C103K
A10C2006	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
A10C2007	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
A10C2011	281-0064-00			CAP.,VAR,PLSTC:O.25-1.5PF,600V	74970	273-0001-301
A10C2013	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A10C2020	281-0775-00			CAP.,FXD,CER DI:O.1UF,20%,50V	72982	8005D9AABZ5U104M
A10C2031	281-0773-00			CAP.,FXD,CER DI:O.O1UF,10%,100V	04222	GC70-1C103K
A10C2121	281-0764-00			CAP.,FXD,CER DI:82PF,5%,100V	72982	8035D9AADC1G802J
A10C2204	281-0775-00			CAP.,FXD,CER DI:O.1UF,20%.50V	72982	8005D9AABZ5U104M
A10C2217	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A10C2221	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
A10C2224	290-0517-00			CAP,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1

COMPONENT NO.	TEKTRONIX PART NO.	SERIAL/MODEL NO. EFF	DSCONT	NAME & DESCRIPTION	MFR CODE	MFR PART NUMBER
A10C2228	281-0773-00			CAP.,FXD,CER DI:O.O1UF,10%,100V	04222	GC70-1C103K
A10C2229	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
A10C2301	281-0773-00			CAP.,FXD,CER DI:O.O1UF,10%,100V	04222	GC70-1C103K
A10C2302	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
A10CR1431	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A10CR1531	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A10CR1533	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A10CR1621	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A10CR2111	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A10CR2113	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A10CR2213	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A10CR2221	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A10CR2222	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A10F1111	159-0019-00			FUSE,CARTRIDGE:3AG,1A,250V,SLOW BLOW	71400	MDL1
A10F1131	159-0019-00			FUSE,CARTRIDGE:3AG,1A,250V,SLOW BLOW	71400	MDL1
A10J1100	131-0608-00			TERMINAL,PIN:O.365 L X 0.025 PH BRZ GOLD (QTY OF 2)	22526	47357
A10J1121	131-0608-00			TERMINAL,PIN:O.365 L X O.O25 PH BRZ GOLD	22526	47357
A10J1202	131-0608-00			TERMINAL,PIN:O.365 L X O.O25 PH BRZ GOLD (QTY OF 3)	22526	47357
A10J1203	131-0608-00			TERMINAL,PIN:O.365 L X O.O25 PH BRZ GOLD (QTY OF 3)	22526	47357
A10J1301	131-0608-00			TERMINAL,PIN:O.365 L X O.O25 PH BRZ GOLD (QTY OF 3)	22526	47357
A10J1541	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD (QTY OF 4)	22526	47357
A10J1611	131-0608-00			TERMINAL,PIN:0.365 L X O.O25 PH BRZ GOLD (QTY OF 3)	22526	47357
A10J1641	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD (QTY OF 2)	22526	47357
A10J1651	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD (QTY OF 4)	22526	47357
A10J1801	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
A10J1921	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
A10J1923	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
A10J2011	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD (QTY OF 4)	22526	47357
A10J2021	131-0608-00			TERMINAL,PIN:0.365 LM X 0.025 PH BRZ GOLD (QTY OF 2)	22526	47357
A10J2041	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
A10J2043	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
A10L1111	108-0020-00			COIL,RF:7.1UH	80009	108-0020-00
A10L1251	108-0020-00			COIL,RF:7.1UH	80009	108-0020-00
A10Q1221	151-0606-00			TRANSISTOR:SILICON,NPN	04713	SJE375
A10Q1231	151-0464-00			TRANSISTOR:SILICON,NPN	04713	SJE412
A10Q1241	151-0464-00			TRANSISTOR:SILICON,NPN	04713	SJE412
A10Q1243	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1245	151-0350-00			TRANSISTOR:SILICON,PNP	04713	SPS6700
A10Q1331	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1335	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A10Q1345	151-0607-00			TRANSISTOR:SILICON,PNP	04713	SJE376
A10Q1421	153-0586-00			SEMICOND DVD SE:2N3906,MATCHED PAIR (FURNISHED AS A MATCHED PAIR WITH A10Q1527)	80009	153-0586-00
A10Q1431	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1433	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3471TP	01295	SKA6516
A10Q1440	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1445	151-0435-00			TRANSISTOR:SILICON,PNP	04713	SPS8335

COMPONENT NO.	TEKTRONIX PART NO.	SERIAL/MODEL NO. EFF	DSCONT	NAME & DESCRIPTION	MFR CODE	MFR PART NUMBER
A10Q1511	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1521	151-0427-00			TRANSISTOR:SILICON,NPN	80009	151-0427-00
A10Q1523	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1525	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A10Q1527				(PART OF A10Q1421)		
A10Q1531	151-0438-00			TRANSISTOR:SILICON,PNP,SEL FROM SPS6927	80009	151-0438-00
A10Q1541	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
A10Q1543	151-0341-00			TRANSISTOR:SILICON,NPN	07263	S040065
A10Q1611	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A10Q1621	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A10Q1711	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A10Q1712	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1721	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
A10Q1723	151-1042-00			SEMICOND DVC SE:MATCHED PAIR FET	01295	SKA5390
A10Q1725						
A10Q1801	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
A10Q1821	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q1901	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
A10Q2011	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
A10Q2013	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q2101	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q2111	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
A10Q2113	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q2121	151-0440-00			TRANSISTOR:SILICON,PNP	03508	X41E603
A10Q2123	151-0440-00			TRANSISTOR:SILICON,PNP	03508	X41E603
A10Q2211	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
A10Q2213	151-0427-00			TRANSISTOR:SILICON,NPN	80009	151-0427-00
A10Q2311	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A10Q2321	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
A10Q2323	151-0439-00			TRANSISTOR:SILICON,NPN	80009	151-0439-00
A10Q2325	151-0439-00			TRANSISTOR:SILICON,NPN	80009	151-0439-00
A10R500	311-1392-00			RES.,VAR,WW:PNL,10K OHM,2W	02111	140-9504
A10R1103	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A10R1113	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A10R1121	307-0093-00			RES.,FXD,CMPSN:1.2 OHM,5%,0.50W	01121	EB12G5
A10R1131	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
A10R1133	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A10R1135	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A10R1141	307-0093-00			RES.,FXD,CMPSN:1.2 OHM,5%,0.50W	01121	EB12G5
A10R1143	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.025W	01121	CB2025
A10R1201	321-0337-00			RES.,FXD,FILM:31.6K OHM,1%,0.125W	91637	MFF1816G31601F
A10R1203	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A10R1225	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
A10R1226	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
A10R1227	307-0051-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.50W	01121	EB27G5
A10R1228	301-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.50W	01121	EB2015
A10R1229	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1231	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A10R1232	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A10R1233	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A10R1235	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A10R1241	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A10R1242	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A10R1243	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
A10R1245	321-0347-00			RES.,FXD,FILM:40.2K OHM,1%,0.125W	91637	MFF1816G40201F
A10R1247	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	91637	MFF1816G30101F
A10R1301	311-1562-00			RES.,VAR,NONWIR:2K OHM,20%,0.50W	73138	91-84-0

COMPONENT NO.	TEKTRONIX PART NO.	SERIAL/MODEL NO. EFF	DSCONT	NAME & DESCRIPTION	MFR CODE	MFR PART NUMBER
A10R1311	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A10R1315	321-0311-00			RES.,FXD,FILM:16.9K OHM,1%,0.125W	91637	MFF1816G16901F
A10R1321	311-1561-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	73138	91-83-0
A10R1331	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
A10R1333	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A10R1341	311-1563-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	73138	91-85-0
A10R1346	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A10R1401	321-0193-03	B010100	B020339	RES.,FXD,FILM:1K OHM,0.25%,0.125W	91637	MFF1816D10000C
A10R1401	321-0222-00	B020340		RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
A10R1403	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1411	321-0258-09			RES.,FXD,FILM:4.75K OHM,1%,0.125W	91637	MFF1816C47500F
A10R1412	311-1567-00	B010100	B020339	RES.,VAR,NONWIR:TRMR,100 OHM,0.50W	73138	91-89-0
A10R1412	311-1175-00	B020340		RES.,VAR,NONWIR:100 OHM,10%,0.50W	73138	68WR100
A10R1413	321-0916-03			RES.,FXD,FILM:289 OHM,0.25%,0.125W	91637	MFF1816D289R0C
A10R1421	311-0605-00			RES.,VAR,NONWIR:TRMR,200 OHM,0.5W	73138	82-23-2
A10R1423	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
A10R1425	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
A10R1429	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
A10R1431	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
A10R1432	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A10R1433	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
A10R1434	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A10R1435	315-0300-00			RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
A10R1436	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
A10R1440	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A10R1441	311-1559-00			RES.,VAR,NONWIR:10K OHOM,20%,0.50W	73138	91-81-0
A10R1451	307-0051-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.50W	01121	EB27G5
A10R1501	321-0754-07	B010100	B020339	RES.,FXD,FILM:900 OHM,0.1%,0.125W	91637	MFF1816C900R0B
A10R1501	321-0641-00	B020340		RES.,FXD,FILM:1.8K OHM,1%,0.125W	91637	MFF1816G18000F
A10R1511	311-1565-00	B010100	B020339	RES.,VAR,NONWIR:250 OHM,20%,0.50W	73138	91-87-0
A10R1511	311-1307-00	B020340		RES.,VAR,NONWIR:500 OHM,0.50W	32997	3299W-R27-501
A10R1512	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
A10R1513	321-0245-00			RES.,FXD,FILM:3.48K OHM,1%,0.125W	91637	MFF1816G34800F
A10R1514	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A10R1515	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A10R1517	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A10R1518	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1521	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A10R1532	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A10R1533	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
A10R1534	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A10R1536	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A10R1541	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
A10R1543	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	91637	MFF1816G66500F
A10R1545	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
A10R1551	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
A10R1553	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF181G10001F
A10R1603	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1611	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A10R1613	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1615	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1621	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
A10R1622	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A10R1623	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A10R1624	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1625	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
A10R1641	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F

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A10R1711	315-0101-00	B010100	B020349	RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1711	315-0361-00	B020350		RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
A10R1712	321-0172-00			RES.,FXD,FILM:604 OHM,1%,0.125W	91637	MFF1816G604R0F
A10R1713	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A10R1714	315-0472-00	XB020350		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A10R1715	315-0472-00	XB020350		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A10R1721	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A10R1723	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A10R1724	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
A10R1725	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A10R1727	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
A10R1728	311-1566-00			RES.,VAR,NONWIR:200 OHM,20%,0.50W	73138	91-88-0
A10R1801	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1812	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	91637	MFF1816G402R0F
A10R1814	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A10R1815	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
A10R1816	321-0196-00			RES.,FXD,FILM:1.07K OHM,1%,0.125W	91637	MFF1816G10700F
A10R1817	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R1818	321-0313-00			RES.,FXD,FILM:17.8K OHM,1%,0.125W	91637	MFF1816G17801F
A10R1819	321-0236-00			RES.,FXD,FILM:2.8K OHM,1%,0.125W	91637	MFF1816G28000F
A10R1831	321-0289-03			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
A10R1841	321-0645-00			RES.,FXD,FILM:100K OHM,0.5%,0.125W	91637	MFF1816D10002D
A10R1842	307-0465-00			RES.,FXD,FILM:10M OHM,1%,0.5W	03888	FL1/2-105F
A10R1843	321-0481-01			RES.,FXD,FILM:1M OHM,0.5%,0.125W	91637	MFF1816G10003D
A10R1941	321-0193-03			RES.,FXD,FILM:1K OHM,0.25%,0.125W	91637	MFF1816D10000C
A10R1950	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A10R1951	311-1559-00			RES.,CAR,NONWIR:10K OHM,20%,0.50W	73138	91-81-0
A10R2001	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A10R2003	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A10R2004	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
A10R2005	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
A10R2006	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
A10R2011	321-0253-00			RES.,FXD,FILM:4.22K OHM,1%,0.125W	91637	MFF1816G42200F
A10R2012	321-0143-00			RES.,FXD,FILM:301 OHM,1%,0.125W	91637	MFF1816G301R0F
A10R2013	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	91637	MFF1816G60400F
A10R2024	321-0134-00			RES.,FXD,FILM:243 OHM,1%,0.125W	91637	MFF1816G243R0F
A10R2025	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A10R2026	307-0055-00			RES.,FXD,CMPSN:3.9 OHM,5%,0.50W	01121	EB39G5
A10R2031	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
A10R2033	305-0101-00			RES.,FXD,CMPSN:100 OHM,5%,2W	01121	HB1015
A10R2041	315-0125-00			RES.,FXD,CMPSN:1.2M OHM,5%,0.25W	01121	CB1255
A10R2043	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
A10R2045	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
A10R2047	315-0125-00			RES.,FXD,CMPSN:1.2M OHM,5%,0.25W	01121	CB1255
A10R2101	321-0112-00			RES.,FXD,FILM:143 OHM,1%,0.125W	91637	MFF1816G143R0F
A10R2111	321-0151-00			RES.,FXD,FILM:365 OHM,1%,0.125W	91637	MFF1816G365R0F
A10R2113	321-0122-00			RES.,FXD,FILM:182 OHM,1%,0.125W	91637	MFF1816G182R0F
A10R2121	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A10R2122	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A10R2123	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A10R2124	321-0049-00			RES.,FXD,FILM:31.6 OHM,1%,0.125W	91637	MFF1816G31R60F
A10R2131	305-0101-00			RES.,FXD,CMPSN:100 OHM,5%,2W	01121	HB1015
A10R2141	321-0002-00			RES.,FXD,FILM:10.2 OHM,1%,0.125W	91637	MFF1816G10R20F
A10R2143	321-0059-00			RES.,FXD,FILM:40.2 OHM,1%,0.125W	91637	MFF1816G40R20F
A10R2201	311-1560-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	73138	91-82-0
A10R2202	321-0238-00			RES.,FXD,FILM:2.94K OHM,1%,0.125W	91637	MFF1816G29400F
A10R2203	321-0271-00			RES.,FXD,FILM:6.49K OHM,1%,0.125W	91637	MFF1816G64900F

COMPONENT NO.	TEKTRONIX PART NO.	SERIAL/MODEL NO. EFF	DSCONT	NAME & DESCRIPTION	MFR CODE	MFR PART NUMBER
A10R2204	321-0238-00			RES.,FXD,FILM:2.94K OHM,1%,0.125W	91637	MFF1816G29400F
A10R2211	321-0122-00			RES.,FXD,FILM:182 OHM,1%,0.125W	91637	MFF1816G182R0F
A10R2213	321-0112-00			RES.,FXD,FILM:143 OHM,1%,0.125W	91637	MFF1816G143R0F
A10R2223	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
A10R2225	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A10R2226	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A10R2227	321-0049-00			RES.,FXD,FILM:31.6 OHM,1%,0.125W	91637	MFF1816G31R60F
A10R2228	307-0055-00			RES.,FXD,CMPSN:3.9 OHM,5%,0.50W	01121	EB39G5
A10R2231	323-0088-00			RES.,FXD,FILM:80.6 OHM,1%,0.50W	75042	CECTO-80R60F
A10R2233	323-0089-00			RES.,FXD,FILM:82.5 OHM,1%,0.50W	19701	MF7CD82R50F
A10R2251	321-0059-00			RES.,FXD,FILM:40.2 OHM,1%,0.125W	91637	MFF1816G40R20F
A10R2253	321-0002-00			RES.,FXD,FILM:10.2 OHM,1%,0.125W	91637	MFF1816G10R20F
A10R2255	321-0089-00			RES.,FXD,FILM:82.5 OHM,1%,0.125W	91637	MFF1816G82R50F
A10R2257	321-0002-00			RES.,FXD,FILM:10.2 OHM,1%,0.125W	91637	MFF1816G10R20F
A10R2301	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
A10R2303	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
A10R2301	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
A10R2335	315-0750-00	B010100	B020709	RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A10R2335	321-0046-00	B020710		RES.,FXD,FILM:29.4 OHM,1%,0.125W	91637	MFF1816G29R40F
A10R2351	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
A10R2353	323-0089-00			RES.,FXD,FILM:82.5 OHM,1%,0.50W	19701	MF7CD82R50F
A10R2355	323-0088-00			RES.,FXD,FILM:80.6 OHM,1%,0.50W	75042	CECTO-80R60F
A10S1901	260-1268-01			SWITCH,PUSH:3 BUTTON,2 POLE,FUNCTION	80009	260-1268-01
A10S2331	260-2020-00			SWITCH,PUSH:4 BUTTON,2 POLE,ATTENUATOR	80009	260-2020-00
A10TP1241	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A10TP1321	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A10TP1323	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A10TP1331	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A10TP1451	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A10U1210	156-0071-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	04713	MC1723CL
A10U1230	156-0495-00			MICROCIRCUIT,LI:OPNL AMPL	27014	LM324N
A10U1400	156-0495-00			MICROCIRCUIT:LI:OPNL AMPL	27014	LM324N
A10U1440	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	02735	85145
A10U1501	156-0991-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	04713	MC78L05ACP
A10U1540	156-0495-00			MICROCIRCUIT,LI:OPNL AMPL	27014	LM324N
A10U1600	156-0331-00			MICROCIRCUIT,DI:DUAL D-TYPE,FLIP-FLOP	80009	156-0331-00
A10U1700	156-1056-00			MICROCIRCUIT,LI:DIFFERENTIAL COMPARATOR	04713	MC1514L
A10U1930	156-1156-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-1156-00
A10U1940	156-1156-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-1156-00
A10VR1241	152-0149-00			SEMICOND DEVICE:ZENER,0.4W,10V,5%	04713	SZG35009K3
A10VR1413	152-0456-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	1N827
A10VR1532	152-0667-00			SEMICOND DEVICE:ZENER,0.4W,3.0V,2%	04713	SZG30025RL
A10VR1811	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
A10VR1813	152-0212-00			SEMICOND DEVICE:ZENER,0.5W,9V,5%	04713	SZ50646RL
A10VR2213	152-0590-00			SEMICOND DEVICE:ZENER,18V,5% AT 7MA	80009	152-0590-00
A10W1411	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A10W1503	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A10W1531	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
A10W1535	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1

COMPONENT NO.	TEKTRONIX PART NO.	SERIAL/MODEL NO. EFF	DSCONT	NAME & DESCRIPTION	MFR CODE	MFR PART NUMBER
A12				CKT BOARD ASSY:AUXILIARY		
A12C1000	290-0301-00			CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2
A12C1002	281-0810-00			CAP.,FXD,CER DI:5.6PF,0.5%,100V	04222	GC10-1A5R6D
A12C1020	281-0810-00			CAP.,FXD,CER DI:5.6PF,0.5%,100V	04222	GC10-1A5R6D
A12C1022	281-0810-00			CAP.,FXD,CER DI:5.6PF,0.5%,100V	04222	GC10-1A5R6D
A12C1100	290-0301-00			CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2
A12C1110	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A12C1112	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A12C1120	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A12C1200	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A12C1202	290-0301-00			CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2
A12C1215	281-0630-00	XB020350		CAP.,FXD,CER DI:390PF,5%,500V	72982	630000Y5D391J
A12C1220	281-0764-00			CAP.,FXD,CER DI:82PF,5%,100V	72982	8035D9AADC1G802
A12C1300	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
A12C1310	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	GC70-1C103K
A12C1320	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
A12CR1000	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1110	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1200	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1220	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1221	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1225	152-0141-02	XB020350		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1226	152-0141-02	XB020350		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1320	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A12J1000	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
A12J1020	131-1425-00			CONTACT SET,ELE:R ANGLE,O.150" L,STR OF 36	22526	65521-136
A12J1220	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
A12J1300	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
A12J1302	131-1003-00			CONN,RCPT,ELEC:CKT BD ;MT,3 PRONG	80009	131-1003-00
A12J1400	131-1425-00			CONTACT SET,ELE:R ANGLE,0.150"L,STR OF 36	22526	65521-136
A12L1010	108-0419-00			COIL,RF:FIXED,1.1UH	80009	108-0419-00
A12Q1010	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A12Q1012	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A12Q1200	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A12Q1210	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
A12Q1212	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
A12Q1320	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A12Q1322	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A12Q1324	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A12R1000	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
A12R1010	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
A12R1012	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
A12R1014	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
A12R1015	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
A12R1016	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A12R1020	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
A12R1022	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A12R1100	321-0269-00			RES.,FXD,FILM:6.19K OHM,1%,0.125W	91637	MFF1816G61900F
A12R1102	321-0269-00			RES.,FXD,FILM:6.19K OHM,1%,0.125W	91637	MFF1816G61900F
A12R1104	311-0634-00			RES.,VAR,NONWIR:TRMR,500 OHM,0.5W	32997	3326H-G48-501
A12R1106	311-0643-00			RES.,VAR,NONWIR:50 OHM,10%,0.50W	73138	82-33-2
A12R1108	321-0216-00			RES.,FXD,FILM:1.74K OHM,1%,0.125W	91637	MFF1816G17400F
A12R1110	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
A12R1111	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A12R1113	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
A12R1115	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A12R1116	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015

COMPONENT NO.	TEKTRONIX PART NO.	SERIAL/MODEL NO. EFF	DSCONT	NAME & DESCRIPTION	MFR CODE	PART NUMBER
A12R1119	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
A12R1120	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A12R1121	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A12R1122	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A12R1123	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A12R1125	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
A12R1200	321-0229-00			RES.,FXD,FILM:2.37K OHM,1%,0.125W	91637	MFF1816G23700F
A12R1202	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
A12R1203	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A12R1204	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A12R1210	321-0224-00			RES.,FXD,FILM:2.1K OHM,1%,0.125W	91637	MFF1816G21000F
A12R1212	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
A12R1215	315-0204-00	XB020350		RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
A12R1216	321-0183-00			RES.,FXD,FILM:787 OHM,1%,0.125W	91637	MFF1816G787R0F
A12R1217	321-0183-00			RES.,FXD,FILM:787 OHM,1%,0.125W	91637	MFF1816G787R0F
A12R1220	315-0101-00			RES.,FXD,CMPSN:100 OHM 5%,0.25W	01121	CB1015
A12R1221	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A12R1225	315-0472-00	XB020350		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A12R1300	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
A12R1310	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
A12R1312	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
A12R1313	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A12R1314	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
A12R1320	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A12R1322	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
A12R1324	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
A12R1325	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
A12S1400	260-2040-00			SWITCH,PUSH:4 BTN 2 POLE,MODE	80009	260-2040-00
A12U1020	156-0048-00			MICROCIRCUIT,LI:FIVE NPN TRANSISTOR ARRAY	02735	CA3046
A12U1120	156-0048-00			MICROCIRCUIT,LI:FIVE NPN TRANSISTOR ARRAY	02735	CA3046
A12U1220	156-0048-00			MICROCIRCUIT,LI:FIVE NPN TRANSISTOR ARRAY	02735	CA3046
A12U1310	156-0382-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74LS00(N OR J)

COMPONENT NO.	TEKTRONIX PART NO.	SERIAL/MODEL NO. EFF	DSCONT	NAME & DESCRIPTION	CODE	MFR MFR PART NUMBER
CR500	150-1033-00			LT EMITTING DIO:YELLOW,585NM,40MA MAX	50434	HLMP 1401
CR510	150-1029-00			LT EMITTING DIO:GREEN,565NM,35MA	53184	XC209G
J500	131-0955-00			CONN,RCPT,ELECT:BNC,FEMALE	13511	31-279
J510	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J520	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J530	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
R510	311-0169-00			RES.,VAR,NONWIR:100 OHM,20%,0.50W	01121	W-7564B
R520	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R530	311-2104-00			RES.,VAR,NONWIR:PNL,15K OHM,10%,0.25W (FURNISHED AS A UNIT WITH S500)	12697	CM41780
R540	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R550	311-1298-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	01121	W-7909
R560	311-2107-00			RES.,VAR,NONWIR:DUAL,PNL,1K X 50K OHM (FURNISHED AS A UNIT WITH S510)	12697	CM41781
S500				(PART OF R530)		
S510				(PART OF R560)		
S1731	263-1189-00			SW CAM ACTR AS:FREQUENCY MULTIPLIER	80009	263-1189-00

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it is in the low state.

Abbreviations are based on ANSI Y1.1-1972.

Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966 Drafting Practices.
Y14.2, 1973 Line Conventions and Lettering.
Y10.5, 1968 Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

American National Standard Institute
1430 Broadway
New York, New York 10018

Component Values

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

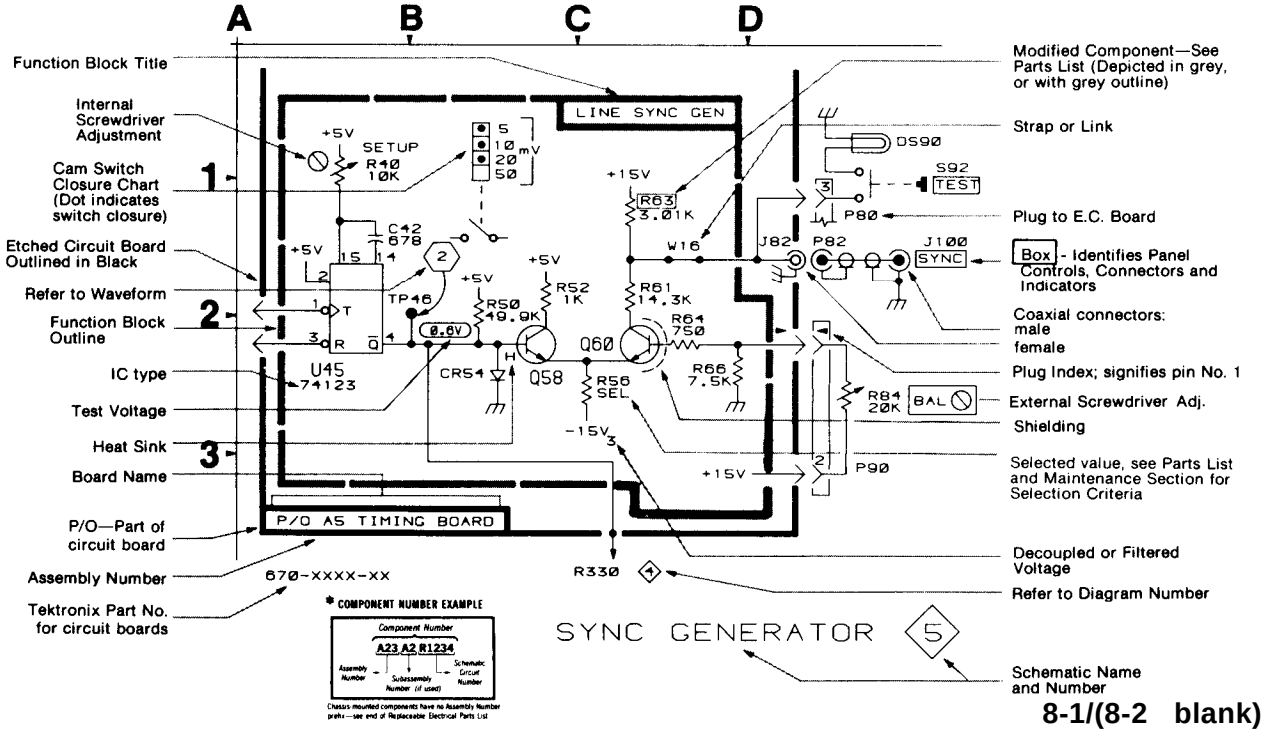
Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

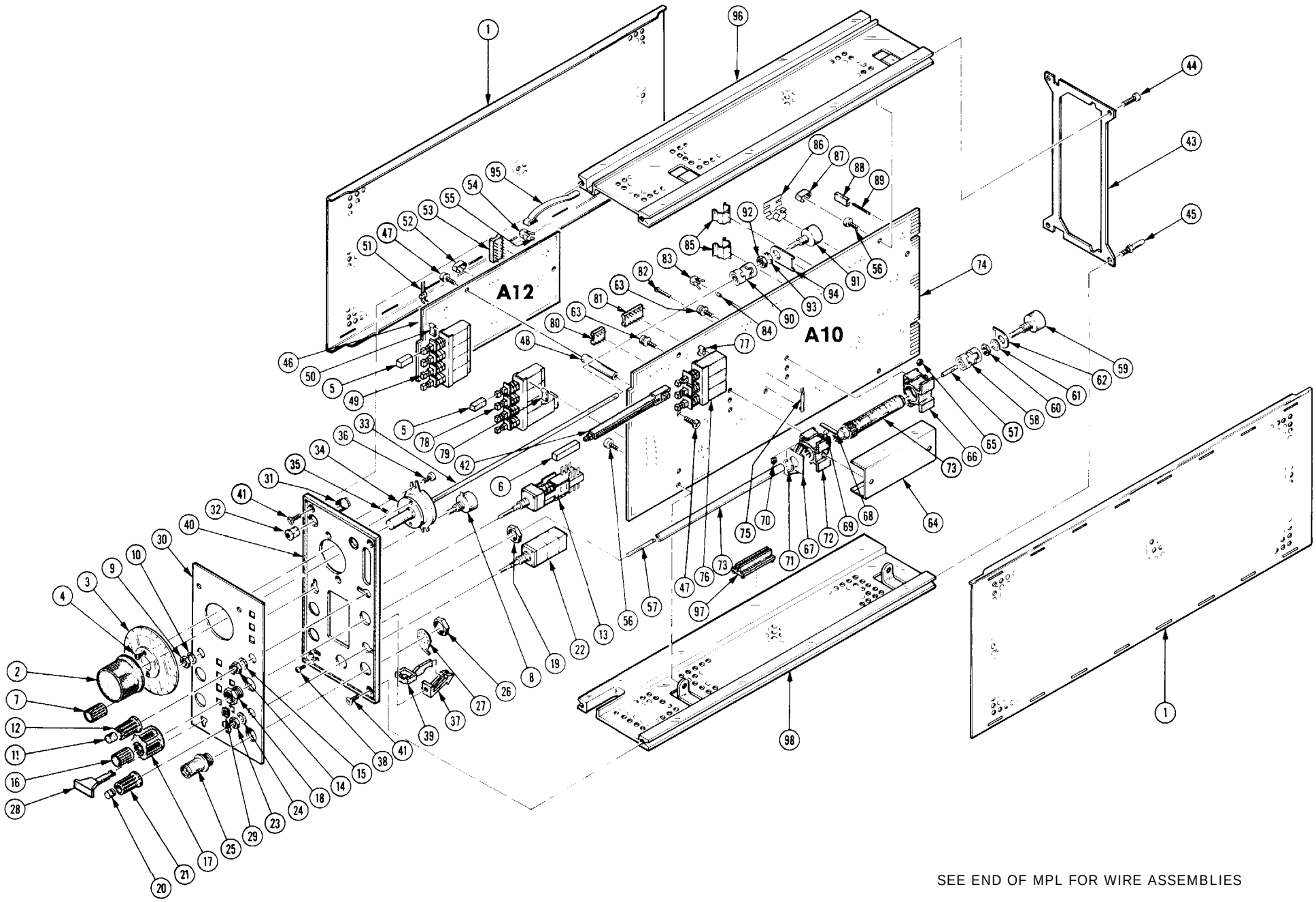
The information and special symbols below may appear in this manual.

Assembly Numbers and Grid Coordinates

Each assembly in the instrument is assigned an assembly number (e.g., A20). The assembly number appears on the circuit board outline on the diagram, in the title for the circuit board component location illustration, and in the lookup table for the schematic diagram and corresponding component locator illustration. The Replaceable Electrical Parts list is arranged by assemblies in numerical sequence; the components are listed by component number *(see following illustration for constructing a component number).

The schematic diagram and circuit board component location illustration have grids. A lookup table with the grid coordinates is provided for ease of locating the component. Only the components illustrated on the facing diagram are listed in the lookup table. When more than one schematic diagram is used to illustrate the circuitry on a circuit board, the circuit board illustration may only appear opposite the first diagram on which it was illustrated; the lookup table will list the diagram number of other diagrams that the circuitry of the circuit board appears on.





SEE END OF MPL FOR WIRE ASSEMBLIES

FG 501A FUNCTION GENERATOR
EXPLODED VIEW

ADJUSTMENT LOCATIONS

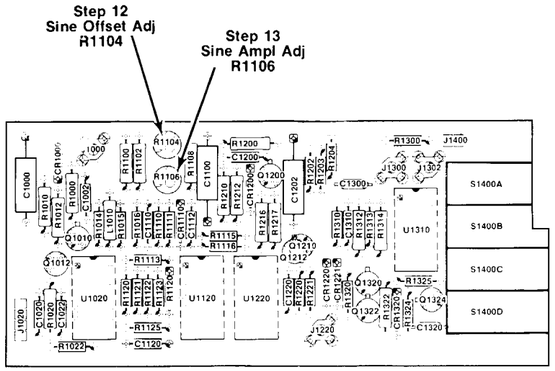


Fig. 8-1. Auxiliary Board.

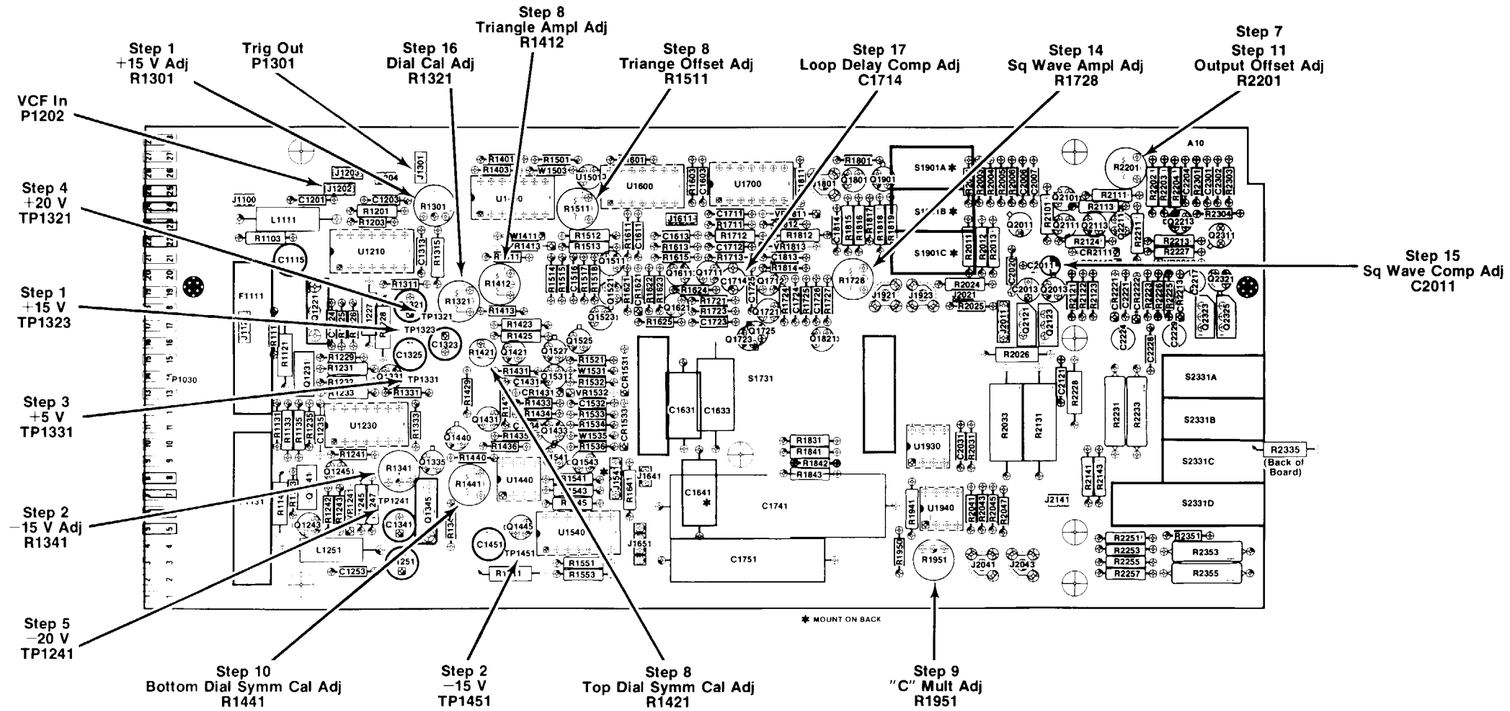


Fig. 8-2. Main Board.

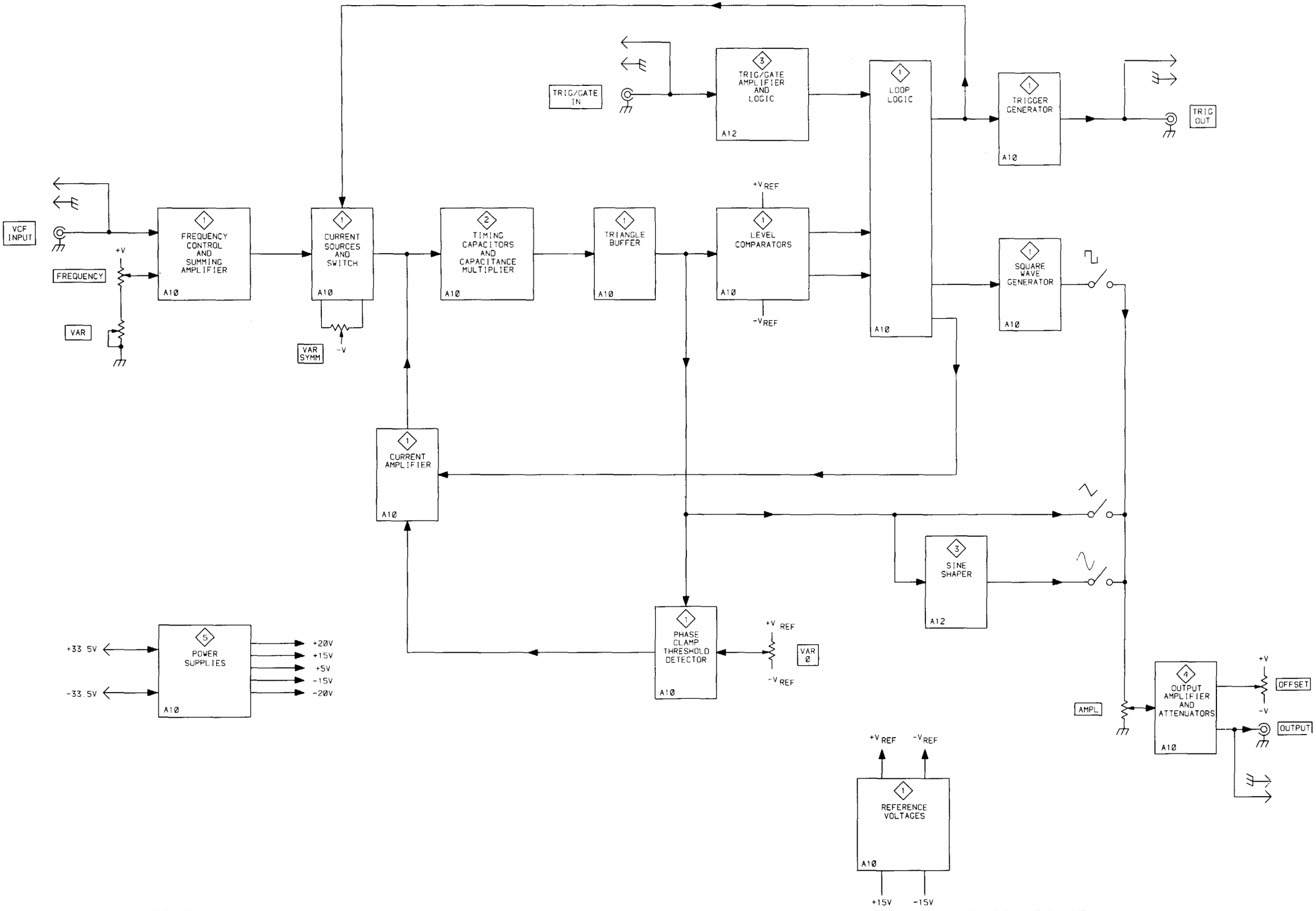


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Fig. 8-3.

BLOCK DIAGRAM

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JS

PARTS LOCATION GRID

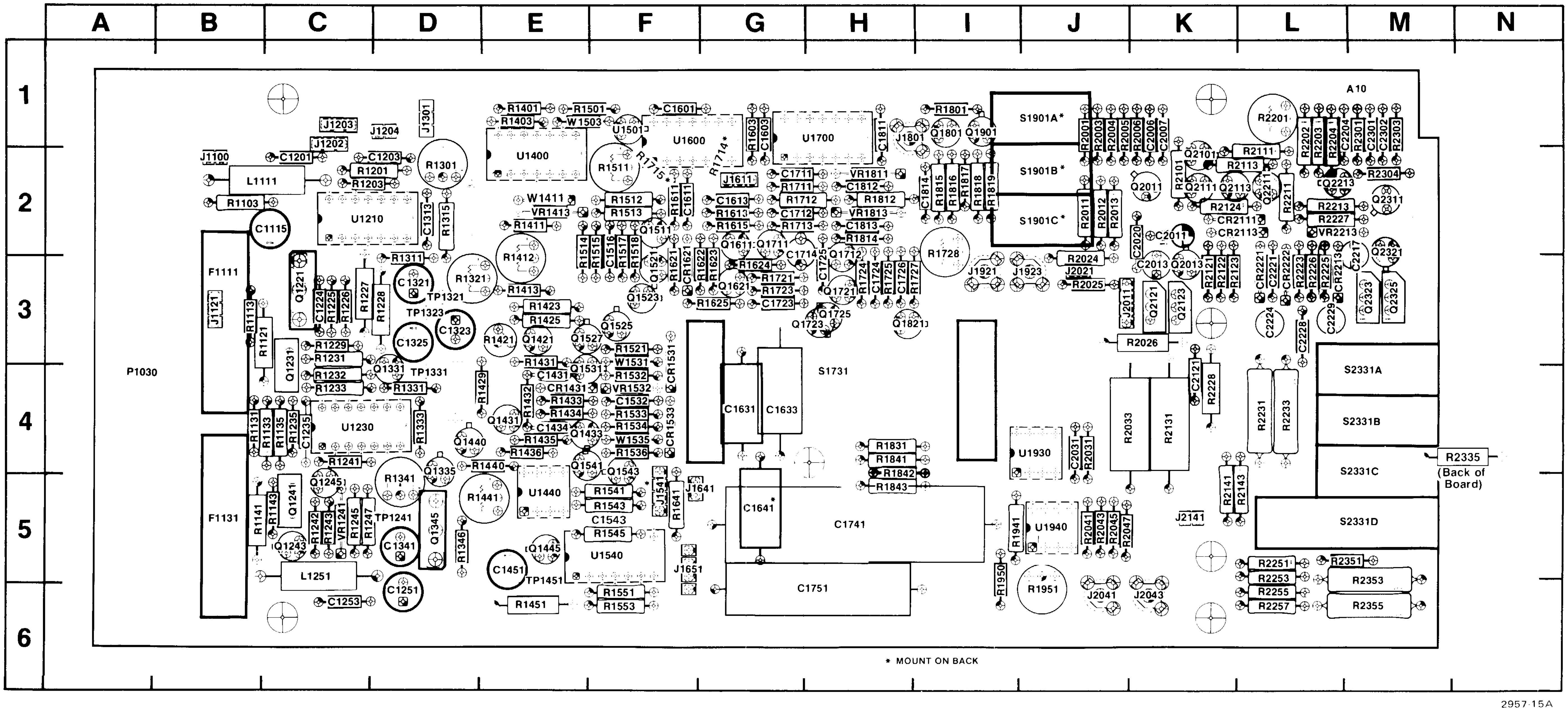
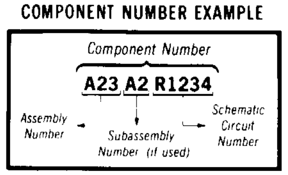


Fig. 8-4. Main Board (A10 Assy).

COMPONENT NUMBER EXAMPLE



Chassis mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

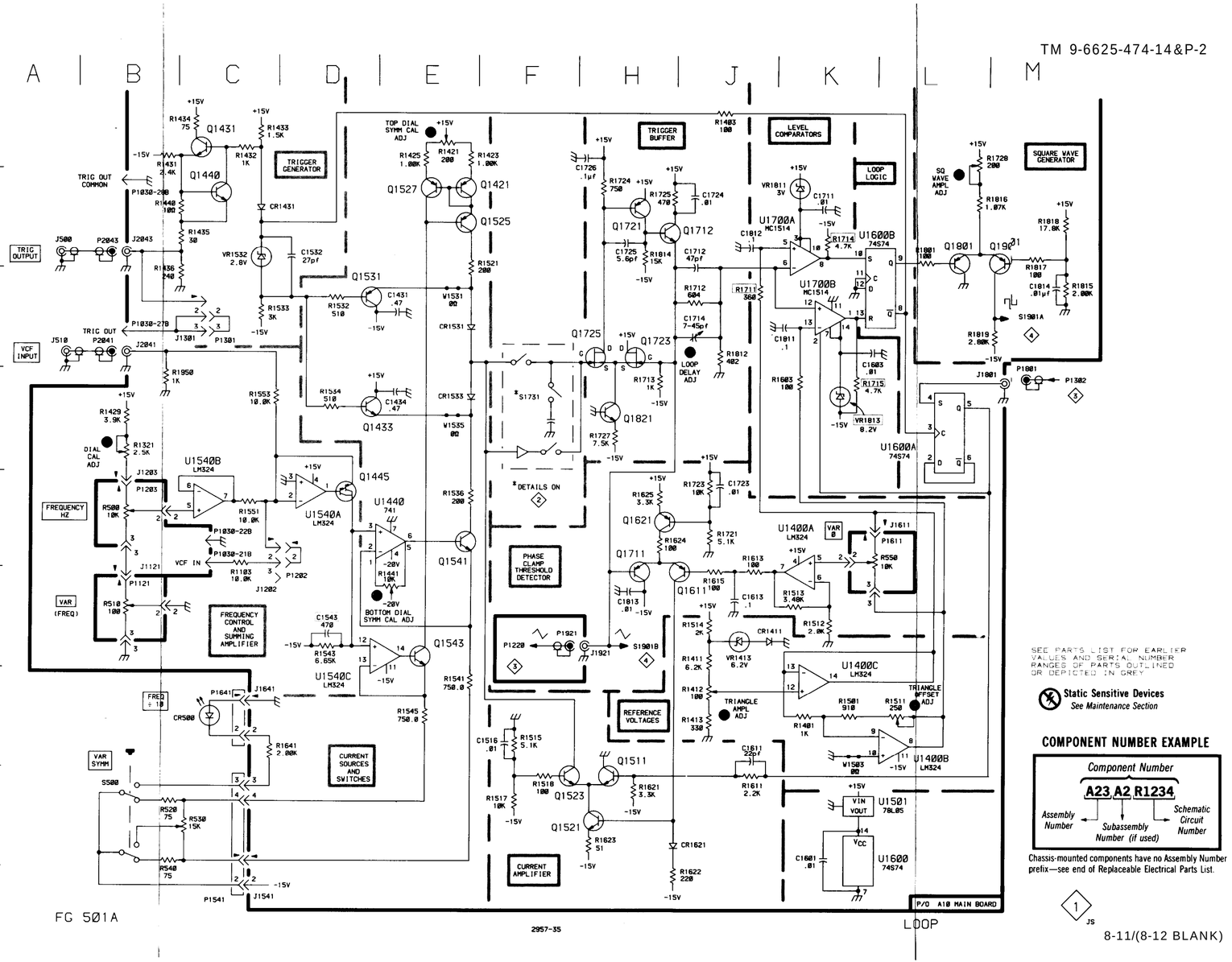
Static Sensitive Devices
See Maintenance Section

TABLE 8-1
COMPONENT REFERENCE CHART

P/O A10 ASSY — MAIN BOARD (1)

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1431	E3	E4
C1434	**E4**	**E4**
C1516	**F7**	**F2**
C1532	D2	F4
C1543	D6	**F5**
C1601	K8	**F1**
CI 603	**K3**	G1
C1611	**J7**	F2
C1613	J6	**G2**
C1711	**K2**	**G2**
C1712	**J2**	G2
C1714	J3	G2
C1723	J5	G3
C1724	J2	H3
C1725	H2	H3
C1726	H1	**H3**
C1811	**K3**	**H1**
C1812	**J2**	H2
C1813	H6	**H2**
C1814	M3	**I2**
CR1431	C2	E4
CR1531	**E3**	F3
CR1533	**E4**	F4
CR1621	H8	F3
J1121	B6	**B3**
J1202	D5	**C1**
J1203	**B5**	C1
J1301	**C3**	**D2**
J1541	C8	**F5**
J1611	**K5**	G2
J1641	**C7**	**F5**
J1801	**M4**	**H1**
J1921	**H6**	I3
J2041	93	J6
J2043	92	K6
P1030	**B3**	A4
P1121	**B6**	93
P1203	**B5**	C1
P1301	**C3**	**D2**
P1541	C8	**F5**
P1611	**K5**	G2
P1641	**C7**	**F5**
P1801	M4	**H1**
P1921	F6	I3
P2041	93	**J6**
Q1421	E2	**E3**
Q1431	c I	**E4**
Q1433	**D4**	E4
Q1440	**C2**	**D4**
Q1445	D5	**E5**
Q1511	H8	F2
Q1521	H8	**F3**
Q1523	**F8**	**F3**
Q1525	E2	F3
Q1527	E2	E3
Q1531	**D3**	E4
Q1541	**E5**	**E4**
Q1543	E6	**F4**
Q1611	**H5**	G2
Q1621	**H5**	**G3**
Q1711	H5	**G2**
Q1712	**H2**	H2
Q1721	**H2**	H3
Q1723	**H3**	**H3**
Q1725	**H3**	**H3**
Q1801	L2	I1
Q1821	**H4**	H3
Q1901	**M2**	I1
R1103	C5	**B2**
R1321	94	**D3**
R1401	**K7**	E1
R1403	**J1**	E1
R1411	J6	E2
R1412	J7	E3
R1413	J7	E3
R1421	E1	E3
R1423	E1	E3
R1425	E1	E3
R1429	**B4**	**E4**
R1431	**B1**	**E3**
R1432	C1	E4
R1433	C1	E4
R1434	C1	E4
R1435	C2	E4
R1436	B3	E4
R1440	**B2**	E4
R1441	**E6**	**E5**
R1501	**K7**	**F1**
R1511	**L7**	F2
R1512	K6	F2
R1513	**K6**	**F2**
R1514	**J6**	**E2**
R1515	**F7**	F2
R1517	**F8**	F2
R1518	F8	F2
R1521	E2	**F3**
R1532	**D3**	**F4**
R1533	**C3**	F4
R1534	**D4**	F4
R1536	**E5**	F4
R1541	E7	**F5**
R1543	**D6**	**F5**
R1545	**E7**	F5
R1551	**C5**	F6
R1553	**C4**	**F6**
R1603	**K4**	**G1**
R1611	**J8**	F2
R1613	**J5**	G2
R1615	J6	G2
R1621	**H8**	**F3**
R1622	**H8**	**G3**
R1623	H8	G3
R1624	H5	G3
R1625	H5	G3
R1641	**C7**	F5
R1711	**J3**	G2
R1712	J3	G2
R1713	H4	G2
R1714	K2	G2
R1715	**K4**	**F2**
R1721	**J5**	**G3**
R1723	J5	G3
R1724	H2	H3
R1725	H2	H3
R1727	**H4**	H3
R1728	**L1**	I2
R1801	**L2**	I1
R1812	**J3**	H2
R1814	**H2**	**H2**
R1815	**M3**	**I2**
R1816	L2	I2
R1817	M2	I2
R1818	**M2**	**I2**
R1819	**M3**	**I2**
R1950	**B4**	**I5**
R2043	**B2**	**J5**
U1400A	K5	E2
U1400B	L5	E2
U1400C	K7	E2
U1501	K8	F1
U1540A	**D5**	F5
U1540B	**C5**	F5
U1540C	**D6**	F5
U1600A	**L4**	F1
U1600B	K2	F1
U1700A	K2	H1
U1700B	**K3**	**H1**
VR1413	**J6**	**E2**
VR1532	C2	F4
VR1811	**K2**	H2
VR1813	**K4**	H2
W1411	J6	E2
w 1503	K7	EI
W1531	**E3**	**F3**
W1535	**E4**	**F4**
CR500	**C7**	Chassis
J500	**A2**	Chassis
J510	A3	Chassis
R500	C8	Chassis
R510	**B6**	Chassis
R520	**C8**	Chassis
R530	C8	Chassis
R540	C8	Chassis
S500	98	Chassis

P/O **A10 ASSY also shown on** (2) (3) (4) (5)



SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE

Component Number: **A23 A2 R1234**
- Assembly Number
- Subassembly Number (if used)
- Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

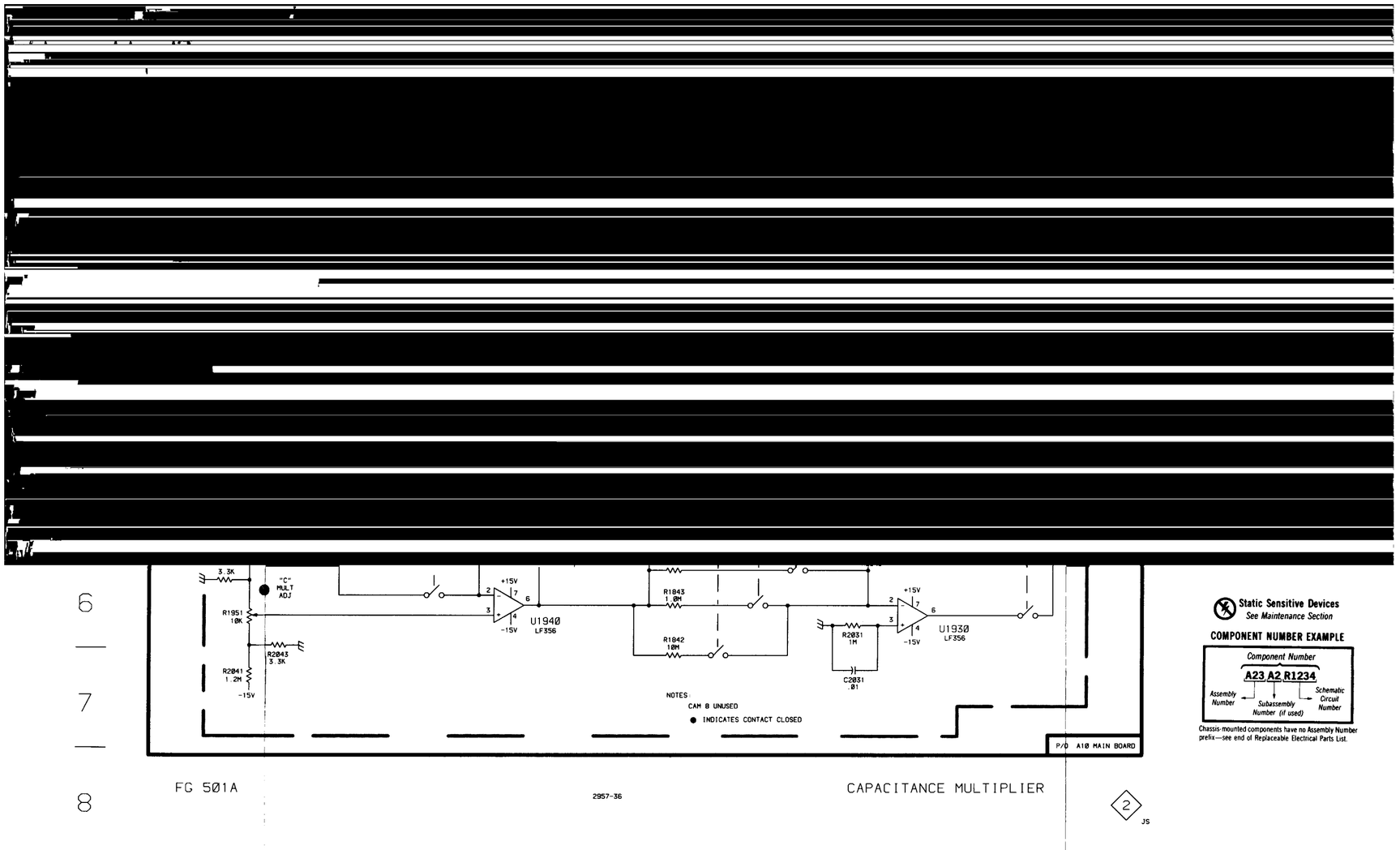
(1) JS

TABLE 8-2
COMPONENT REFERENCE CHART

P/O A10 ASSY — MAIN BOARD ◇2

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1631	**E4**	**G4**
C1633	**F4**	**G4**
C1641	**E4**	**G5**
C1741	**K4**	**H5**
C1751	**F4**	**H6**
C2031	**J7**	**J4**
R1831	F5	H4
R1841	F6	H4
R1842	F7	H4
R1843	F6	**H5**
R1941	E6	**I5**
R1951	**B6**	J6
R2031	**J6**	J4
R2041	**B7**	**J5**
R2043	**B7**	**J5**
R2045	**B6**	J5
R2047	**B6**	J5
S1731	C3	H4
U1930	K6	J4
U1940	E6	J5

P/O A10 ASSY also shown on ◇1 ◇3 ◇4 ◇5



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CAPACITANCE MULTIPLIER ◇2 JS

PARTS LOCATION GRID

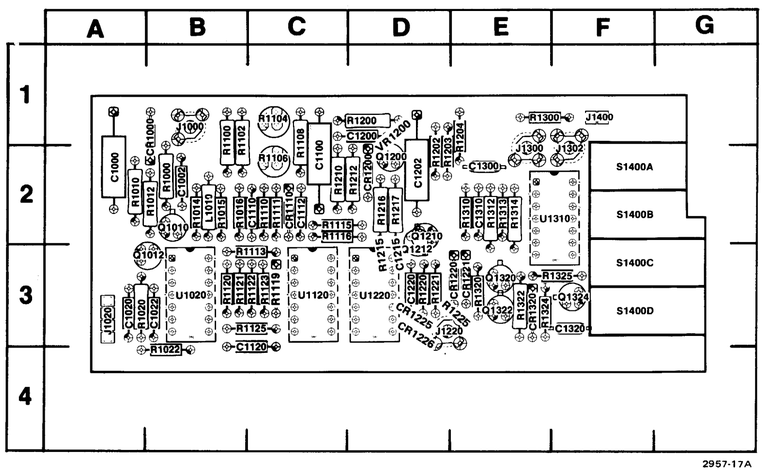


Fig. 8-5. Auxiliary Board (A12 Assy).

COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234
- A23: Assembly Number
- A2: Subassembly Number (if used)
- R1234: Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Static Sensitive Devices
See Maintenance Section

TABLE 8-3
COMPONENT REFERENCE CHART

A12 ASSY — AUXILIARY BOARD ◇3

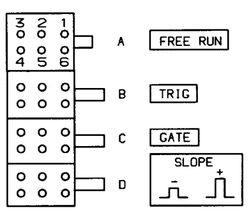
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1000	**J5**	A2
C1002	**F5**	**B2**
C1020	**J6**	**A3**
C1022	**K6**	B3
C1100	**E8**	C2
C1110	**D5**	C2
C1112	**B8**	**C2**
C1120	**B7**	**C3**
C1200	**B4**	**D1**
C1202	**C4**	**D2**
C1215	**C4**	**D3**
C1220	**F4**	**D3**
C1300	**E1**	**E2**
C1310	**C2**	**E2**
C1320	**F4**	**F3**
CR1000	**J6**	**B1**
CR1110	**C8**	**C2**
CR1120	**C7**	**C3**
CR1200	**B4**	**D2**
CR1220	**C3**	E3
CR1221	**C2**	E3
CR1225	**H5**	D3
CR1226	**H5**	**D3**
CR1320	**E4**	**E3**
J1000	**M7**	**B1**
J1020	**B6**	**A3**
J1100	**B3**	B2
J1220	**K4**	D3
J1300	**B2**	E2
J1302	**M2**	F2
J1400	**B1**	F1
L1010	**L7**	B2
P1000	**M7**	**B1**
P1020	**B6**	**A3**
P1030	**A3**	A4
P1220	**K4**	D3
P1300	**B2**	E2
P1302	**M2**	F2
P1400	**B1**	F1
Q1010	**E5**	**B2**
Q1012	**J6**	**A3**
Q1200	**C4**	**D2**
Q1210	**C5**	**D2**
Q1212	**F4**	**D3**
Q1320	**D1**	**E3**
Q1322	**E3**	**E3**
Q1324	**F3**	**F3**
R1000	**H7**	**B2**
R1010	**J6**	**A2**
R1012	**J6**	**B2**
R1014	**L7**	**B2**
R1015	**J8**	**B2**
R1016	**B7**	**B2**
R1020	**K7**	**A3**
R1022	**B6**	**B4**
R1100	**J5**	**B1**
R1102	**J5**	**B1**
R1104	**J5**	**C1**
R1106	**M7**	**C2**
R1108	**C8**	**C1**
R1110	**H8**	**C2**
R1111	**D6**	**C2**
R1113	**E6**	**B3**
R1115	**D8**	**C2**
R1116	**D8**	**C2**
R1119	**C7**	**C3**
R1120	**L6**	**B3**
R1121	**D5**	**B3**
R1122	**D5**	**C3**
R1123	**H7**	**C3**
R1125	**D6**	**C3**
R1200	**C4**	**D1**
R1202	**B4**	**D2**
R1203	**C3**	**C2**
R1204	**C2**	**E1**
R1210	**E8**	**C2**
R1212	**D8**	**D2**
R1215	**C5**	**D3**
R1216	**C5**	**D2**
R1217	**E4**	**D2**
R1220	**H4**	**D3**
R1221	**B5**	D3
R1225	**H4**	D3
R1300	**C1**	E1
R1310	**E1**	E2
R1312	**D2**	E2
R1313	**D1**	E2
R1314	**D1**	E2
R1320	**D3**	E3
R1322	**E4**	E3
R1324	**F3**	E3
R1325	**F2**	**F3**
S1400A	**L2**	**F2**
S1400B	**L2**	F2
S1400C	**L2**	F3
S1400D	**E3**	F3
U1020A	J7	B3
U1020B	J7	B3
U1020C	L6	B3
U1020D	**D5**	B3
U1020E	**J7**	B3
U1020	**J7**	**B3**
U1120A	**E7**	**C3**
U1120B	**E7**	C3
U1120C	**C7**	C3
U1120D	**F7**	C3
U1120E	**E8**	C3
U1220A	**D6**	D3
U1220B	**E7**	D3
U1220C	**C6**	D3
U1220D	**F6**	**D3**
U1220E	**D8**	**D3**
U1310A	**J2**	F2
U1310B	**K3**	F2
U1310C	**J2**	F2
U1310D	**H2**	F2
VR1200 *	B4	D1
CR510	**B1**	Chassis
J520	**B2**	Chassis

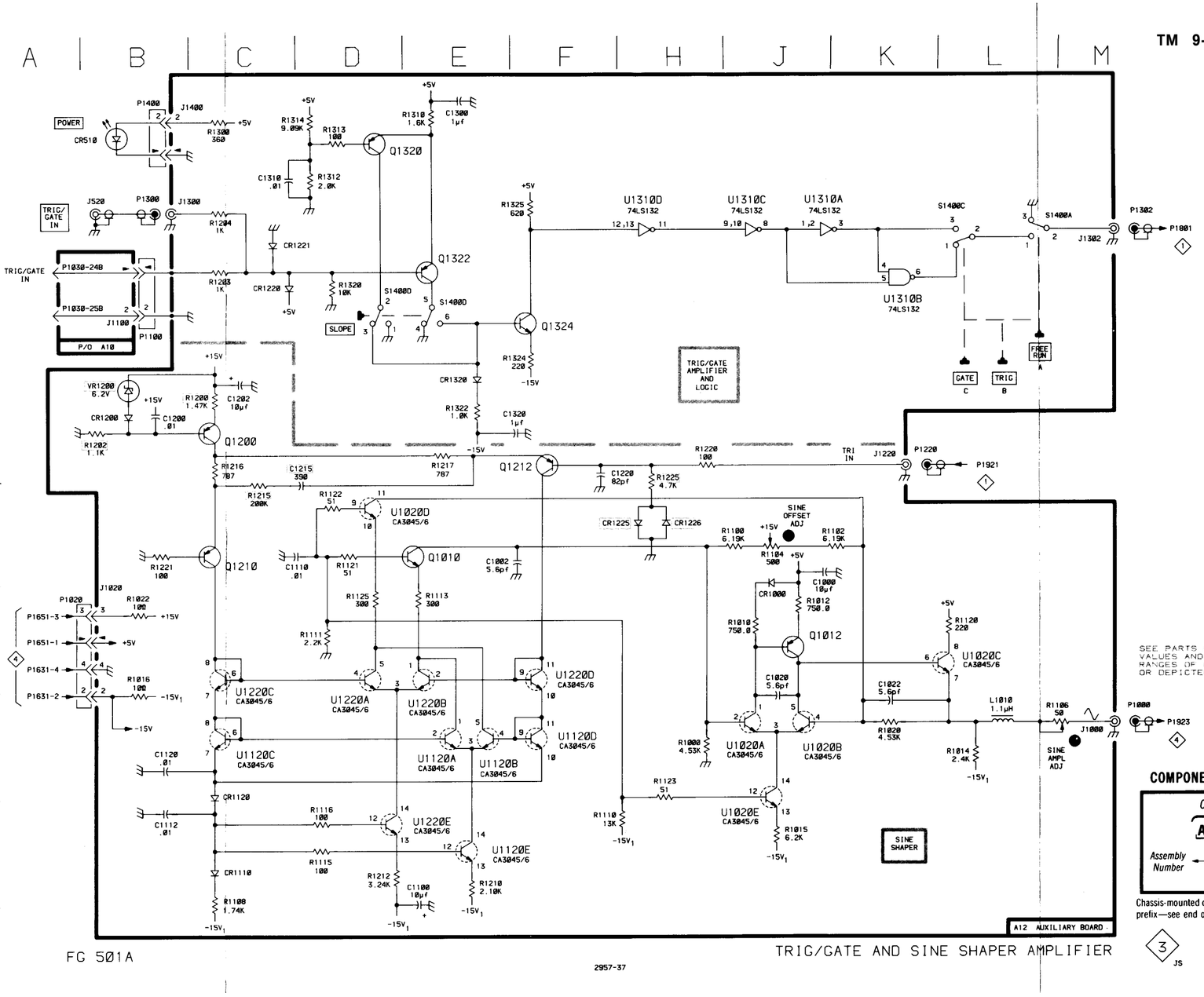
P/O A10 ASSY — MAIN BOARD ◇3

J1100	B3	S2
P1100	B3	B2

P/O **A10 ASSY also shown on** ◇1 ◇2 ◇4 ◇5

S1400

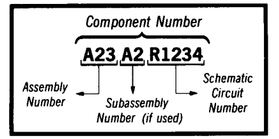




SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

JS

FG 501A

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TRIG/GATE AND SINE SHAPER AMPLIFIER

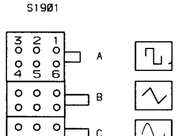
TABLE 8-4
COMPONENT REFERENCE CHART

P/O A10 ASSY — MAIN BOARD ④

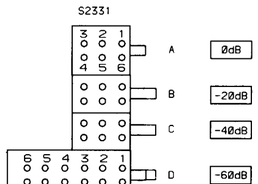
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C2006	H2	K1
C2007	H2	K1
C2011	F4	**K2**
C2013	H1	**K3**
C2020	**H2**	K2
C2121	**H5**	K4
C2204	D6	**L1**
C2217	H7	**M2**
C2221	F5	L3
C2224	**F1**	**L3**
C2228	**F2**	**L3**
C2229	F8	L3
C2301	H8	M1
C2302	H8	M1
CR2111	E4	L2
CR2113	F5	**L2**
CR2213	**F5**	**L3**
CR2221	**F4**	L3
CR2222	H6	L3
J1204	M6	D1
J1651	M1	**F5**
J1923	**B6**	**J3**
J2011	**C1**	J3
J2021	C5	J3
J2141	M6	KS
P1030	M6	**A4**
P1651	M1	**F5**
P1923	**B6**	**J3**
P2011	**C1**	**J3**
P2021	C5	J3
Q2011	F3	K2
Q2013	F4	K3
Q2101	D5	K2
Q2111	F2	K2
Q2113	E5	K2
Q2121	H4	K3
Q2123	H4	K3
Q2211	E4	L2
Q2213	**F8**	**L2**
Q2311	**F7**	**M2**
Q2321	F6	M2
Q2323	H6	M3
Q2325	H6	M3
R2001	C6	**J1**
R2003	D5	**J1**
R2004	**H3**	J1
R2005	**H3**	J1
R2006	H2	**K1**
R2011	**F5**	**J2**
R2012	ES	J2
R2013	F2	J1
R2024	**D4**	J2
R2025	**C7**	J3
R2026	H4	**K3**
R2033	H5	**J4**
R2101	D2	K2
R2111	ES	L1
R2113	E4	L2
R2121	H3	K3
R2122	H3	K3
R2123	F3	K3
R2124	F2	K2
R2131	**H5**	K4
R2141	**J5**	KS
R2143	J4	L5
R2201	E5	L1
R2202	**D6**	L1
R2203	**E6**	L1
R2204	E6	L1
R2211	F4	L2
R2213	F8	**L2**
R2223	H7	**L3**
R2225	**H6**	L3
R2226	**J6**	L3
R2227	F8	L2
R2228	**H5**	K4
R2231	**J4**	L4
R2233	J5	**L4**
R2251	K4	**L5**
R2253	K4	**L5**
R2255	K4	**L6**
R2257	**K4**	L6
R2301	**H7**	M1
R2303	H8	**M1**
R2304	H7	**M2**
R2335	C5	N4
R2351	M6	**L5**
R2353	KS	**M5**
R2355	K4	M6
S1901A	C4	**J1**
S1901B	C5	**J2**
S1901C	**C6**	J2
S2331B	**J4**	M4
S2331C	**K3**	M4
S2331D	K4	MS
VR2213	F7	L2
J530	M5	Chassis
R560A	**B1**	Chassis
R560B	**C5**	Chassis
	B1	Chassis
	B2	Chassis

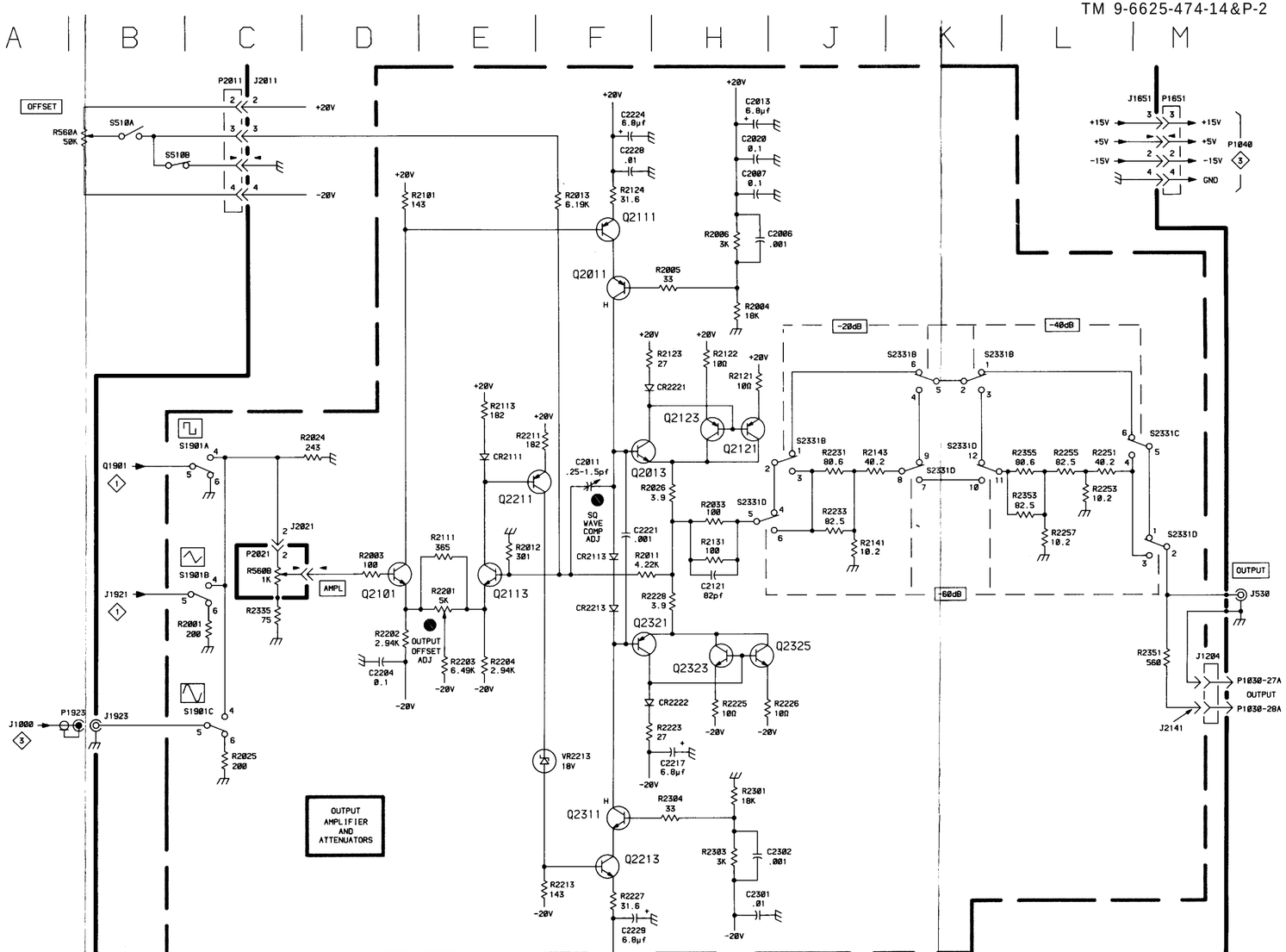
P/O **A10 ASSY also shown on** ① ② ③ ⑤

S1901



S2331





FG 501A

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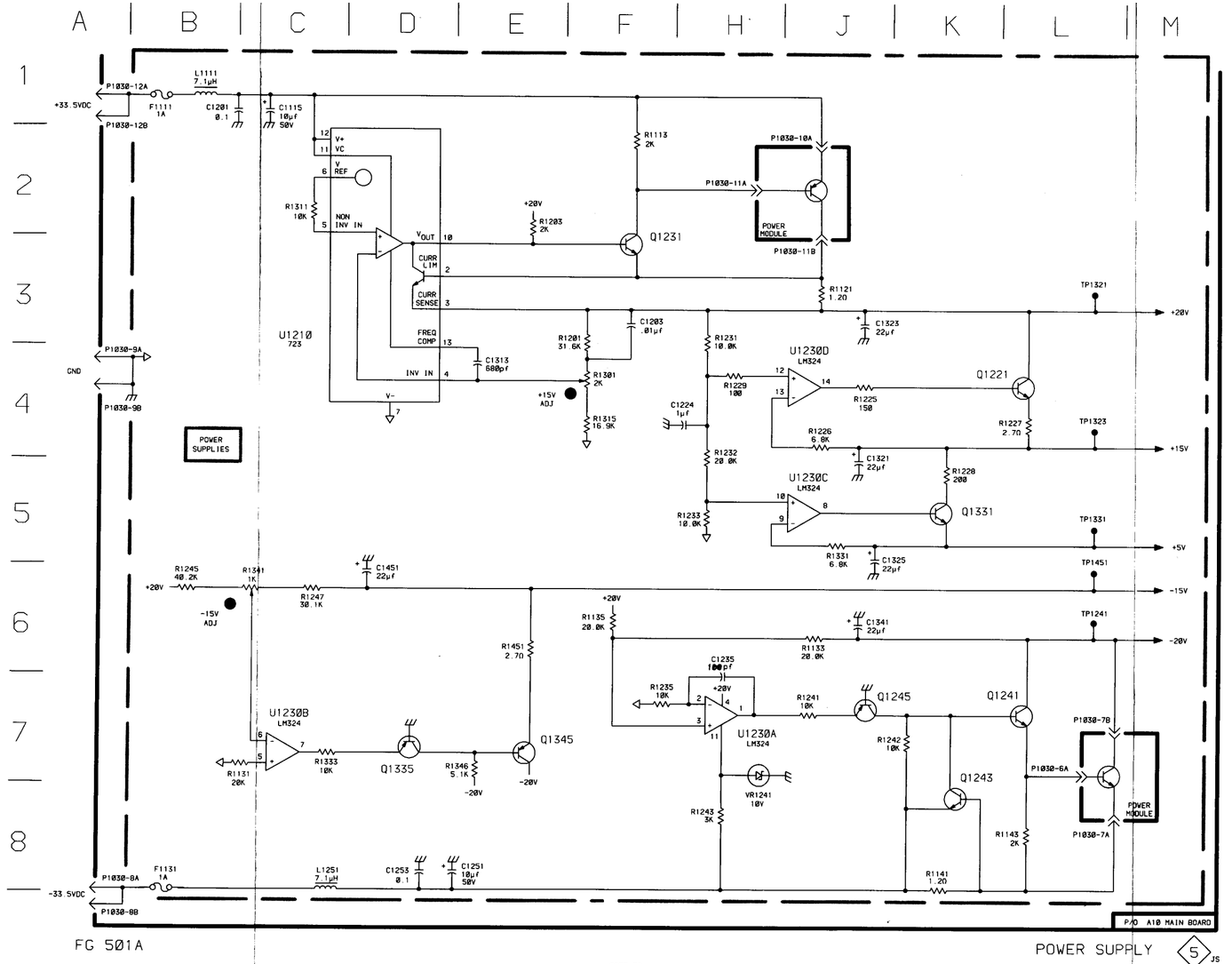
OUTPUT AMPLIFIER AND ATTENUATORS ④

TABLE 8-5
COMPONENT REFERENCE CHART

P/O A10 ASSY — MAIN BOARD ◇5

CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1115	**C1**	**C2**
C1201	**B1**	**C2**
C1203	**F3**	**D2**
C1224	**H4**	**C3**
C1235	**H6**	**C4**
C1251	**D8**	**D6**
C1253	**D8**	**C6**
C1313	**E4**	**D2**
C1321	**J5**	**D3**
C1323	**J3**	**D3**
C1325	**J5**	**D3**
C1341	**J6**	**D5**
C1451	**D6**	**E5**
F1111	**B1**	B3
F1131	**B8**	B5
L1111	**B1**	**B2**
L1251	**C8**	**C5**
P1030	**L8**	**A4**
P1030	**A1**	**A4**
P1030	**A8**	**A4**
P1030	**J2**	**A4**
P1030	**H2**	**A4**
P1030	**L7**	**A4**
P1030	**A4**	**A4**
Q1221	**L4**	**C3**
Q1231	**F3**	**C3**
Q1241	**L7**	**C5**
Q1243	**K8**	**C5**
Q1245	**J7**	**C5**
Q1331	**K5**	**D4**
Q1335	**D7**	**D4**
Q1345	**E7**	**D5**
R1113	**F2**	B3
R1121	**J3**	B3
R1131	**C7**	B4
R1133	**J6**	C4
R1135	**F6**	**C4**
R1141	**K8**	**B5**
R1143	**L8**	**C5**
R1201	**F3**	**C2**
R1203	**E2**	**C2**
R1225	**J4**	**C3**
R1226	**J4**	**C3**
R1227	**L4**	**C3**
R1228	**K5**	**D3**
R1229	**H4**	**C3**
R1231	**H3**	**C3**
R1232	**H4**	**C4**
R1233	**H5**	**C4**
R1235	**F7**	**C4**
R1241	**J7**	**C4**
R1242	**K7**	**C5**
R1243	**H8**	**C5**
R1245	**B6**	**C5**
R1247	**C6**	**C5**
R1301	**F4**	**D2**
R1311	**C2**	**D3**
R1315	**F4**	**D2**
R1331	**J5**	**D4**
R1333	**C7**	**D4**
R1341	**C6**	**D5**
R1346	**E7**	**D5**
R1451	**E6**	**E6**
TP1241	**L6**	**D5**
TP1321	**L3**	**D3**
TP1323	**L4**	**D3**
TP1331	**L5**	**D4**
TP1451	**L6**	**E5**
U1210	**D3**	**C2**
U1230A	**H7**	**C4**
U1230B	**C7**	**C4**
U1230C	**J5**	**C4**
U1230D	**J4**	**C4**
VR1241	H7	C5

P/O **A10 ASSY also shown on** ◇1 ◇2 ◇3 ◇4



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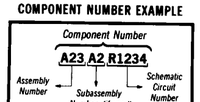
POWER SUPPLY ◇5 JS

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

SECTION 9

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	HANOLE
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
SHLOR	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
K0099	JACKSON BROS (LONDON) LTD.	258 BROADWAY	NEW YORK, NEW YORK 10007
00779	AMP, INC.	P O BOX 3608	HARRISBURG. PA 17105
01536	CAMCAR DIV OF TEXTRON INC. SEMS PRODUCTS UNIT	1818 CHRISTINA ST.	ROCKFORD, IL 61108
13103	THERMALLOY COMPANY, INC.	2021 W VALLEY VIEW LANE P O BOX 34829	DALLAS, TX 75234
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
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
93907	TEXTRON INC. CAMCAR DIV	600 18TH AVE	ROCKFORD, IL 61101

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	337-1399-04			2	SHIELD,ELEC:SIDE	80009	337-1399-04
-2	366-1837-00			1	KNOB:GRAY,0.252 ID X 1.041 OD,0.7	80009	366-1837-00
-3	354-0557-05			1	RING,KNOB SKIRT:CLEAR,1.875 OD (ATTACHING PARTS)	80009	354-0557-05
-4	211-0088-00			2	SCREW,MACHINE:2-56 X 0.281"82 DEG,FLH STL -*-	77250	OBD
-5	366-1559-00			8	PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-6	366-1512-00			3	PUSH BUTTON:GRAY,0.18 SQ X 0.83 INCH LG	80009	366-1512-00
-7	366-1023-07			1	KNOB:GRAY,0.127 ID,0.392 OD,0.466	80009	366-1023-07
-8				1	RES.,VAR,NONWIR:(SEE R550 REPL) (ATTACHING PARTS)		
-9	210-0583-00			1	NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-10	210-0940-00			1	WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL -*-	79807	OBD
-11	366-1059-03			1	PUSH BUTTON:GY W/YEL BND,0.227	80009	366-1059-03
-12	366-1215-01			1	KNOB:GY,0.127 ID X 0.5 OD,0.531	80009	366-1215-01
-13				1	RES.,VAR,NONWIR:(SEE R530,S500 REPL) (ATTACHING PARTS)		
-14	210-0583-00			1	NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-15	210-0940-00			1	WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL -*-	79807	OBD
-16	366-1031-06			1	KNOB:GRAY--VAR	80009	366-1031-06
-17	366-1170-03			1	KNOB:GRAY,0.25 ID X 0.706 OD,0.6H	80009	366-1170-03
-18	358-0029-00			1	BSHG,MACH.THD:HEX,0.375-32 X 0.438"LONG (ATTACHING PARTS)	80009	358-0029-00
-19	210-0413-00			1	NUT,PLAIN,HEX.:0.375-32 X 0.50 INCH,STL -*-	73743	3145-402
-20	366-1319-03			1	KNOB:GY,W/IDX,0.79 ID,0.28 OD,0.32 H	80009	366-1319-03
-21	366-1077-01			1	KNOB:GRAY,0.127 ID,0.5 OD,0.531H	80009	366-1077-01
-22				1	RES.,VAR,NONWIR:(SEE R560,S510 REPL) (ATTACHING PARTS)		
-23	210-0583-00			1	NUT,PLAIN,HEX:0.25-32 X 0.312 INCH BRS	73743	2X20317-402
-24	210-0940-00			1	WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL -*-	79807	OBD
-25				4	CONNECTOR,RCPT:(SEE J500,J510,J520,J530 REPL) (ATTACHING PARTS)		
-26	220-0495-00			1	NUT,PLAIN,HEX.:0.375-32 X 0.438 INCH BRS	73743	OBD
-27	210-0255-00			4	TERMINAL,LUG:0.391 ID,LOCKING,BRS CD PL -*-	80009	210-0255-00
-28	366-1690-00			1	KNOB:SIL GY,0.53 X0.23 X 1.059	80009	366-1690-00
-29	426-1072-00			11	FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
-30	333-2684-00			1	PANEL,FRONT:	80009	333-2684-00
-31	200-0935-00			2	BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-32	352-0157-00			2	LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-33	384-1406-00			1	EXTENSION SHAFT:6.64 L X 0.125 OD,AL,CRM	80009	384-1406-00
-34	401-0206-00			1	GR ASSY,SP RDCN:6 TO 1 (ATTACHING PARTS)	K0099	4511/DAF
-35	213-0022-00			1	SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	OBD
-36	211-0008-00			2	SCREW,MACHINE:4-40 X 0.250,PNH,STL,CD PL -*-	83385	OBD
-37	105-0719-00			1	LATCH,RETAINING:PLUG-IN (ATTACHING PARTS)	80009	105-0719-00
-38	213-0113-00			1	SCR,TPG,THD FOR:2-32 X 0.312 INCH,PNH STL -*-	93907	OBD
-39	105-0718-01			1	BAR,LATCH RLSE:	80009	105-0718-01
-40	386-4469-00			1	SUBPANEL,FRONT: (ATTACHING PARTS)	80009	386-4469-00
-41	213-0229-00			4	SCR,TPG,THD FOR:6-20 X0.375"100 GED,FLH STL -*-	93907	OBD
-42	384-1292-00			3	EXTENSION SHAFT:2.417 INCH LONG,PLASTIC	80009	384-1292-00
-43	386-4278-00			1	SUPPORT,FRAME:REAR,AL (ATTACHING PARTS)	80009	386-4278-00
-44	213-0868-00			2	SCREW,TPG,TF:6-32 X 0.375 L,FILM,STEEL	93907	OBD
-45	386-3657-01			2	SUPPORT,PLUG IN: -*-	93907	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
1-46				1	CKT BOARD ASSY:AUXILIARY(SEE A12 REPL)		
					(ATTACHING PARTS)		
-47	211-0678-00			6	SCR,ASSEM WSHR:4-40 X 0.281 L,PNH STEEL	01536	OBD
-48	129-0251-00			3	INSULATOR,STDF:O.250 OD X 1.125" L,PLSTC	80009	129-0251-00
					-*-		
				-	CKT BOARD ASSY INCLUDES:		
-49				1	.SWITCH,PUSH:(SEE A14S1400 REPL)		
-50	361-0385-00			4	.SPACER,PB SW:0.164 INCH LONG	80009	361-0385-00
-51				1	.TERMINAL,SET PIN:(SEE A12J1020,J1400 REPL)		
-52	214-0973-00			1	.HEAT SINK,ELEC:0.28 X 0.18 OVAL X 0.187"H	80009	214-0973-00
-53	136-0269-02			4	.SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CLE	73803	CS9002-14
-54				4	.CONN,RCPT,ELEC:(SEE A14J1000,J1220,J1300,		
				-	.J1302 REPL)		
-55	136-0252-07			4	.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
	672-0924-00	B010100	B020349	1	CKT BOARD ASSY:FUNCTION GEN 1 WIDE	80009	672-0924-00
	672-0924-01	B020350		1	CKT BOARD ASSY:FUNCTION GEN 1 WIDE	80009	672-0924-01
					(ATTACHING PARTS)		
-56	213-0124-00			4	SCR,TPG,THD FOR:6-20 X 0.250 INCH,PNH STL	83385	OBD
					-*-		
				-	CKT BOARD W/SW ASSY INCLUDES:		
-57	384-1007-00			1	.EXTENSION SHAFT:8.328 L X 0.123 OD	80009	384-1007-00
-58	376-0051-01			1	.CPLG,SHAFT,FLEX:0.127 ID X 0.375 OD	80009	376-0051-01
-59				1	.RES.,VAR,NONWIR:(SEE R510 REPL)		
					(ATTACHING PARTS)		
-60	210-0583-00			1	.NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-61	210-0046-00			1	.WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
					-*-		
-62	407-0579-00			1	.BRACKET,VAR RES:BRASS CD,PL	80009	407-0579-00
				1	.SW,CAM ACTR AS:(SEE S1731 REPL)		
					(ATTACHING PARTS)		
-63	211-0678-00			4	.SCR,ASSEM WSHR:4-40 X 0.281 L,PNH STEEL	01536	OBD
					-*-		
					.ACTR ASSY INCLUDES:		
-64	200-2524-00			1	..COVER,CAM SW:15 ELEMENT,AL	80009	200-2524-00
-65	210-0406-00			2	..NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-66	401-0156-00			1	..BEARING,CAM SW:REAR	80009	401-0156-00
-67	131-1248-00			1	..CONTACT,ELEC:SHAFT GND,NI BE	80009	131-1248-00
-68	214-1704-00			2	..SPRING,FLAT:CAM SW DETENT,0.006 INCH THK	80009	214-1704-00
-69	214-1127-00			2	..ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-70	210-0406-00			2	..NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-71	354-0219-00			1	..RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
-72	401-0155-00			1	..BEARING,CAM SW:FRONT	80009	401-0155-00
-73	105-0856-00			1	..ACTR,CAM SW:FREQUENCY MULTIPLIER	80009	105-0856-00
-74				1	.CKT BOARD ASSY:FUNCTION GEN(SEE A10 REPL)		
-75	131-0604-00			15	..CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-76				1	..SWITCH,PUSH:(SEE A10S1901 REPL)		
-77	361-0385-00			4	..SPACER,PB SW:0.164 INCH LONG	80009	361-0385-00
-78				1	..SWITCH,PUSH:(SEE A10S2331 REPL)		
-79	361-0385-00			4	..SPACER,PB SW:0.164 INCH LONG	80009	361-0385-00
-80	136-0514-00			3	..SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
-81	136-0269-02			6	..SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CLE	73803	CS9002-14
-82	214-0579-02			5	..TERM,TEST POINT:BRASS	80009	214-0579-02
-83				5	..CONN,RCP,ELEC:(A10J1801,J1921,J1923,		
				-	..J2041,J2043 REPL)		
-84	136-0252-07			5	..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-85	344-0326-00			4	..CLIP,ELECTRICAL:FUSE,BRASS	75915	102071
-86	214-3057-00			2	..HEAT SINK,XSTR:TO-5,SIL BRZ PTD,BLACK	13103	6024U SPECIAL
-87	214-0973-00			1	..HEAT SINK,ELEC:0.28 X 0.18 OVAL X 0.187"H	80009	214-0973-00
-88	131-0993-00			1	..BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-89				33	..TERMINAL,PIN:(SEE A10J1100,J1121,J1202,		
				-	..J1203,J1204,J1301,J1541,J1611,J1641,J1651,		
				-	..J2011,J2021,J2141 REPL)		
-90	376-0051-01			1	..CPLG,SHAFT,FLEX:0.127 ID X 0.375 OD	80009	376-0051-01
-91				1	..RES.,VAR,NONWIR:(SEE A10R500 REPL)		
					..(ATTACHING PARTS)		
-92	210-0583-00			1	..NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-93	210-0046-00			1	..WASHER,LOCK 0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
					-*-		

FIG.& INDEX NO.	TEKTRONIX PART NO.	SERIAL/MODEL NO. EFF	DSCONT	QTY	1 2 3 4 5 NAME & DESCRIPTION	MFR CODE	MFR PART NUMBER
1-94	386-4470-00			1	..PLATE,RES MTG:BRASS	80009	386-4470-00
-95	214-1061-00			1	SPRING,GROUND:FLAT	80009	214-1061-00
-96	426-0724-19			1	FR SECT,PLUG-IN:BOTTOM	80009	426-0724-19
-97	351-0612-00			2	GUIDE,CKT BOARD:NYLON,1.0 L	80009	351-0612-00
-98	426-0725-05			1	FR SECT,PLUG-IN:TOP	80009	426-0725-05

FIG.& INDEX NO.	TEKTRONIX PART NO.	SERIAL/MODEL NO. EFF	SERIAL/MODEL NO. DSCONT	QTY	1 2 3 4 5	NAME & DESCRIPTION	MFR CODE	MFR PART NUMBER
						WIRE ASSEMBLIES		
	175-2101-00			1		CA ASSY,SP,ELEC:3,26 AWG,3.5 L	80009	175-2101-00
				-		(FROM A10R500 TO A10J1203)		
	352-0161-03			1		.CONN BODY,PL,EL:3 WIRE ORANGE	80009	352-0161-03
	175-5119-00			1		CA ASSY,SP,ELEC:2,26AWS,8.5L,RIBBON	80009	175-5119-00
						(FROM A10J1100 TO A12J1210)		
	352-0169-02			1		.CONN BODY,PL,EL:2 WIRE RED	80009	352-0169-00
	175-2101-00			1		CA ASSY,SP,ELEC:3,26 AWG,3.5 L,RIBBON	80009	175-2101-00
				-		(FROM A10J1121 TO R510)		
	352-0161-03			1		.CONN BODY,PL,EL:3 WIRE ORANGE	80009	352-0161-03
	175-5124-00			1		CA ASSY,SP,ELEC:4,26 AWG,7.0 L,RIBBON	80009	175-5124-00
				-		(FROM A10J1541 TO R530,S500)		
	352-0162-04			1		.CONN BODY,PL,EL:4 WIRE YELLOW	80009	352-0162-04
	175-5120-00			1		CA ASSY,SP,ELEC:3,26 AWG,7.0 L,RIBBON	80009	175-5120-00
				-		(FROM A10J1611 TO R550)		
	352-0161-03			1		.CONN BODY,PL.EL:3 WIRE ORANGE	80009	352-0161-03
	175-3242-00			1		CA ASSY,SP,ELEC:2,26 AWG,8.0 L,RIBBON	80009	175-3242-00
				-		(FROM A10J1641 TO CR500)		
	352-0169-02			1		.CONN BODY,PL,EL:2 WIRE RED	80009	352-0169-00
	175-5117-00			1		CA ASSY,SP,ELEC:4,26 AWG,3.5 L,RIBBON	80009	175-5117-00
				-		(FROM A10J1651 TO A12J1020)		
	352-0162-04			2		.CONN BODY,PL,EL:4 WIRE YELLOW	80009	352-0162-04
	175-5113-00			1		CABLE ASSY,RF:50 OHM COAX,5.5 L	80009	175-5113-00
				-		(FROM A10J1801 TO A12J1302)		
	175-3073-00			1		CABLE ASSY,RF:50 OHM COAX,4L5 L,9-2	80009	175-3073-00
				-		(FROM A10J1921 TO A12J1220)		
	175-3074-00			1		CA ASSY,RF:50 OHM COAX,3L5 L,9-1	80009	175-3074-00
				-		(FROM A10J1923 TO A12J1000)		
	175-3432-00			1		CA ASSY,SP,ELEC:4,26 AWG,3L5 L,RIBBON	80009	175-3432-00
				-		(FROM A10J2011 TO R560,S510)		
	352-0162-04			1		.CONN BODY,PL,EL:4 WIRE YELLOW	80009	352-0162-04
	175-5122-00			1		CA ASSY,SP,ELEC:2,26 AWG,4.0 L,RIBBON	80009	175-5122-00
				-		(FROM A10J2021 TO R560,S510)		
	352-0169-02			1		.CONN BODY,PL,EL:2 WIRE RED	80009	352-0169-00
	175-3272-00			1		CABLE ASSY,RF:50 OHM COAX,4.0 L	80009	175-3272-00
				-		(FROM A10J2041 TO J510)		
	175-3255-00			1		CABLE ASSY,RF:50 OHM COAX,3.5 L	80009	175-3255-00
				-		(FROM A10J2043 TO J500)		
	175-5115-00			1		CABLE ASSY,RF:50 OHM COAX,3.0 L	80009	175-5115-00
				-		(FROM A12J1300 TO J520)		
	175-3062-00			1		CA ASSY,SP,ELEC:2,26 AWG,3.0 L,RIBBON	80009	175-3062-00
				-		(FROM A12J1400 TO CR510)		
	352-0169-02			1		.CONN BODY,PL,EL:2 WIRE RED	80009	352-0169-00

APPENDIX A

REFERENCES

DA PAM 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders
DA PAM 310-7	Index of US Army Equipment Modification Work Orders
FM 21-11	First Aid for Soldiers
AR 385-40	Accident Reporting and Records
AR 750-1	Army Materiel Maintenance Concept and Policies
TB 750-25-1	Maintenance Supplies and Equipment: Army Metrology and Calibration System
TM 38-750	The Army Maintenance Management System (TAMMS)
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use

APPENDIX B
MAINTENANCE ALLOCATION CHART

Section 1. INTRODUCTION

B-1. GENERAL.

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance categories.

b. The Maintenance Allocation Chart (MAC) in Section II designates overall authority and responsibility for the performance of maintenance functions on the identified end items or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance categories.

c. Section III lists the tools and test equipment (both special and common) required for each maintenance function as referenced from Section II.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

B-2. MAINTENANCE FUNCTIONS. Maintenance Functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

b. Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.

d. Adjust. To maintain or regulate, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. *Aline.* To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Removal/Install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace. To remove an unserviceable item and install a serviceable counterpart in its place.

i. Repair. The application of maintenance services 1, including fault location/troubleshooting 2, removal/ installation, and disassembly/assembly 3, procedures, and maintenance actions 4, to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) prescribed to restore an item to a completely serviceable-operational condition as required by maintenance standard in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like-new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to army equipment and is normally reserved for the depot category of maintenance. The rebuild operation includes the act of returning to zero those age measurements (hours/mile, etc.) considered in classifying army equipment/components.

(1) Services - inspect, test, service, adjust, aline, calibrate, and/or replace.

(2) Fault locate/troubleshoot - the process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or Unit Under Test (UUT).

(3) Disassembly/assembly - encompasses the step-by-step taking apart (or breakdown) of a repairable assembly (group numbered item) to the level of its least componency identified as maintenance significant (i.e., assigned an SMR code) for the category of maintenance under consideration.

(4) Actions - welding, griding, riveting, straightening, facing, remachinery, and/or resurfacing.

B-3. EXPLANATION OF COLUMNS IN THE MAC, SECTION II.

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, *Component/Assembly.* Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Function. Column 3 lists the functions to be performed on the item listed in Column 2 (for detailed explanation of these functions, see paragraph B-2).

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the category of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number of complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate work time figures will be shown for each category. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/fault location time, and quality assurance/ quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance categories are as follows:

C ..... Operator or Crew
O ..... Organizational Maintenance
F ..... Direct Support Maintenance
H ..... General Support Maintenance
L ..... Specialized Repair Activity (SRA)[5]
D ..... Depot Maintenance

5 This maintenance category is not included in Section II, column (4) of the Maintenance Allocation Chart. To identify functions to this category of maintenance, enter a work time figure in the "H" column of Section II, column (4), and use an associated reference code in the Remarks column (6). Key the code to Section IV, Remarks, and explain the SRA complete repair application there. The explanatory remark(s) shall reference the specific Repair Parts and Special Tools LIST (RPSTL) TM which contains additional SRA criteria and the authorized spare/repair parts.

e. Column 5, Tools and Test Equipment. Column 5 specifies, by code, those common tools sets (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function,

f. Column 6, Remarks. This column shall, when applicable, contain a letter code, in alphabetic order, which shall be keyed to the remarks contained in Section IV.

B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III.

a. Colunm 1, Reference Code. The tool and test equipment reference code correlates with a code used in the MAC, Section III, Column 5.

b. Column 2, Maintenance Category. The lowest category of maintenance authorized to use the tool or test equipment.

c. Column 3, Nomenclature. Name or identification of the tool or test equipment.

d. Column 4, National Stock Number. The National Stock Number of the tool or test equipment.

e. Column 5, Tool Number. The manufacturer's part number

B-5. EXPLANATION OF COLUMNS IN REMARKS, SECTION IV.

a. Column 1, Reference Code. The code recorded in Column 6, Section II.

b. Column 2, Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

SECTION II. MAINTENANCE ALLOCATION CHART FOR TEKTRONIC 501A FUNCTION GENERATOR

(1)	(2)	(3)	(4)					(5)	(6)
GROUP NUMBER	COMPONENT/ASSEMBLY	MAINTENANCE FUNCTION	MAINTENANCE CATETORY*					TOOLS AND EQUPT	REMARKS
			C	O	F	H	D		
Fig 1	TEK 501A Function Generator	Insp	0.10						A
		Calibrate				1.00		1-20	B
		Repair				1.50		20	C D
	Circuit Card Assy A-12	Insp				.10			A
		Replace				.50		20	B
	Circuit Card Assy	Insp				.10			A
		Replace				.50		20	B
	Lt. Emitting Diode	Insp				.10			A
		Replace				.50		20	B

*C.operator/crew O.organizational F.direct support H.general support D.depot

SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR TEKTRONIC 501A FUNCTIONAL GENERATOR

TOOL OR TEST EQUIPMENT	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1-14	H	Test Equipment		Ref Table 4-1
20	H	JTK 17LAL, 35H Tool Kit	4931-01-073-3845	

SECTION IV. REMARKS

REFERENCE CODE	REMARKS
A	Organizational maintenance will be accomplished by the organization owning and using the equipment.
B	All special tools and test equipment are called out in Table 4-1.
C	Supply of parts will be through normal supply channels.
D	A recommended repair parts list will be published as part of this manual. Parts that have NSN'S assigned will be requisitioned separately and will not be part of this kit.

APPENDIX C

RECOMMENDED SPARE PARTS LIST
FOR
TEKTRONIX 501A FUNCTIONAL GENERATOR

ITEM NO.	TEKTRONIX PART NO.	ITEM NAME	REC. QTY
1	150-1029-00	LT EMITTING DIO	1
2	150-1033-00	LT EMITTING DIO	1
3	670-6694-02	CIRCUIT BOARD ASSY	1
4	670-6697-05	CIRCUIT BOARD ASSY	1

APPENDIX D

MANUAL CHANGE INFORMATION

DESCRIPTION

EFF SN B022260 (FG 501A) 070-2957-00

EFF SN B020890 (FG 507) 070-2986-00

REPLACEABLE ELECTRICAL PARTS AND SCHEMATIC CHANGES

CHANGE TO:

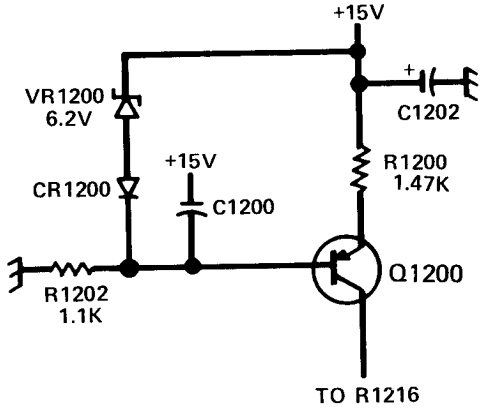
A10	---- ----	CKT BOARD ASSY: FUNCTION GEN
		(NOT REPLACEABLE ORDER 672-0924-03) (FG 501A)
A10	---- ----	CKT BOARD ASSY: FUNCTION GEN
		(NOT REPLACEABLE ORDER 672-0897-03) (FG 507
A12	670-6694-02	CKT BOARD ASSY: AUXILIARY (FG 501A & FG 507)
A10U1400	156-0495-01	MICROCIRCUIT, LI: OPNL AMPL, SEL
A10VR1813	152-0217-00	SEMICOND DEVICE: ZENER, 0.4W, 8.2V, 5%
A12R1200	321-0209-00	RES., FXD, FILM: 1.47K OHM, 1%, 0.125W
A12R1202	315-0112-00	RES., FXD, CMPSN: 1.1K OH, 5%, 0.25W

ADD:

A12VR1200	152-0486-00	SEMICOND DEVICE: ZENER, 0.25W, 6.2V, 2%

U1400 and VR1813 are located on the MAIN circuit board assembly and are shown on diagram 1 LOOP.

DIAGRAM 3 TRIG/GATE AND
SINE SHAPER AMPLIFIER - partial



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THE METRIC SYSTEM AND EQUIVALENTS

'NEAR MEASURE

. Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

'VEIGHTS

Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

TEMPERATURE

5/9(°F - 32) = °C
212° Fahrenheit is evuivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5C° + 32 =°F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
ıts	Liters	0.473
arts	Liters	0.946
allons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
'ers	Gallons	0.264
.ms	Ounces	0.035
.ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
lometers per Liter	Miles per Gallon	2.354
›meters per Hour	Miles per Hour	0.621