

# TEKTRONIX®



## FG 503 FUNCTION GENERATOR

### INSTRUCTION MANUAL

Tektronix, Inc.  
P.O. Box 500  
Beaverton, Oregon 97005

Serial Number \_\_\_\_\_

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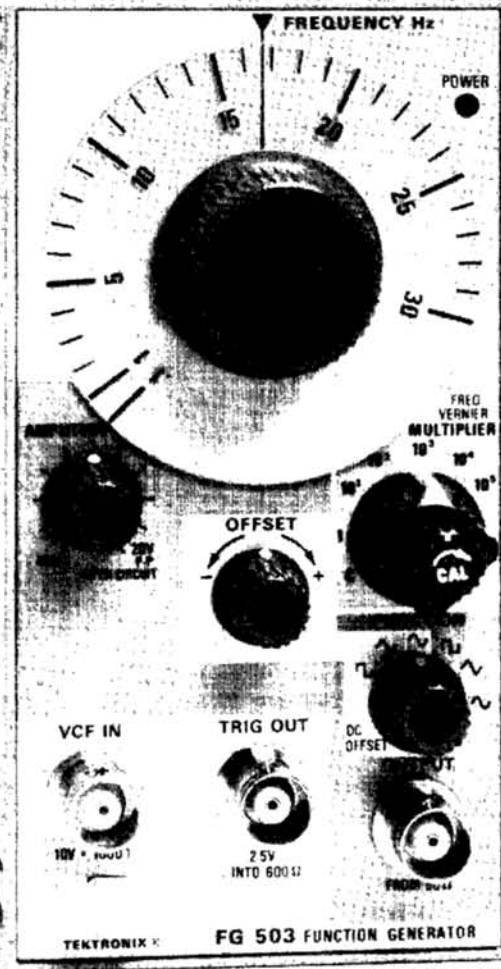
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# OPERATING INSTRUCTIONS

## INTRODUCTION

### INSTRUMENT DESCRIPTION

The FG 503 Function Generator is designed to operate in a TM 500 series power module. Low distortion sine, square and triangle waveforms from 1 Hz to 3 MHz, are available at the front panel. A +2.5 V square wave trigger also is available at the front panel. Variable dc offset of  $\pm 5$  V is provided.

A custom timing switch position is provided. This allows the user to install a timing capacitor for custom tailoring the frequency range of the FG 503.

A voltage-controlled frequency (VCF) input controls 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.

The variety of swept and modulated signals available from the FG 503 make it especially useful for such applications as testing servo-system or amplifier response, distortion and stability. It is also useful for FM generation or as a variable beat-frequency oscillator. The square wave trigger output can be used as a source for TTL logic, or to synchronize an external device such as an oscilloscope or counter.

### INITIAL OPERATION

The FG 503 is calibrated and ready for use when received. It is designed to operate in any compartment of the TM 500 series power module. Refer to the power module instruction manual for line voltage requirements and power module operation. See Fig. 1-1 for installation-removal procedure. Check that the FG 503 is fully inserted in the power module. Pull the PWR switch on the power module. Check that the green POWER light on the FG 503 is on. The Controls, Connectors and Adjustments foldout

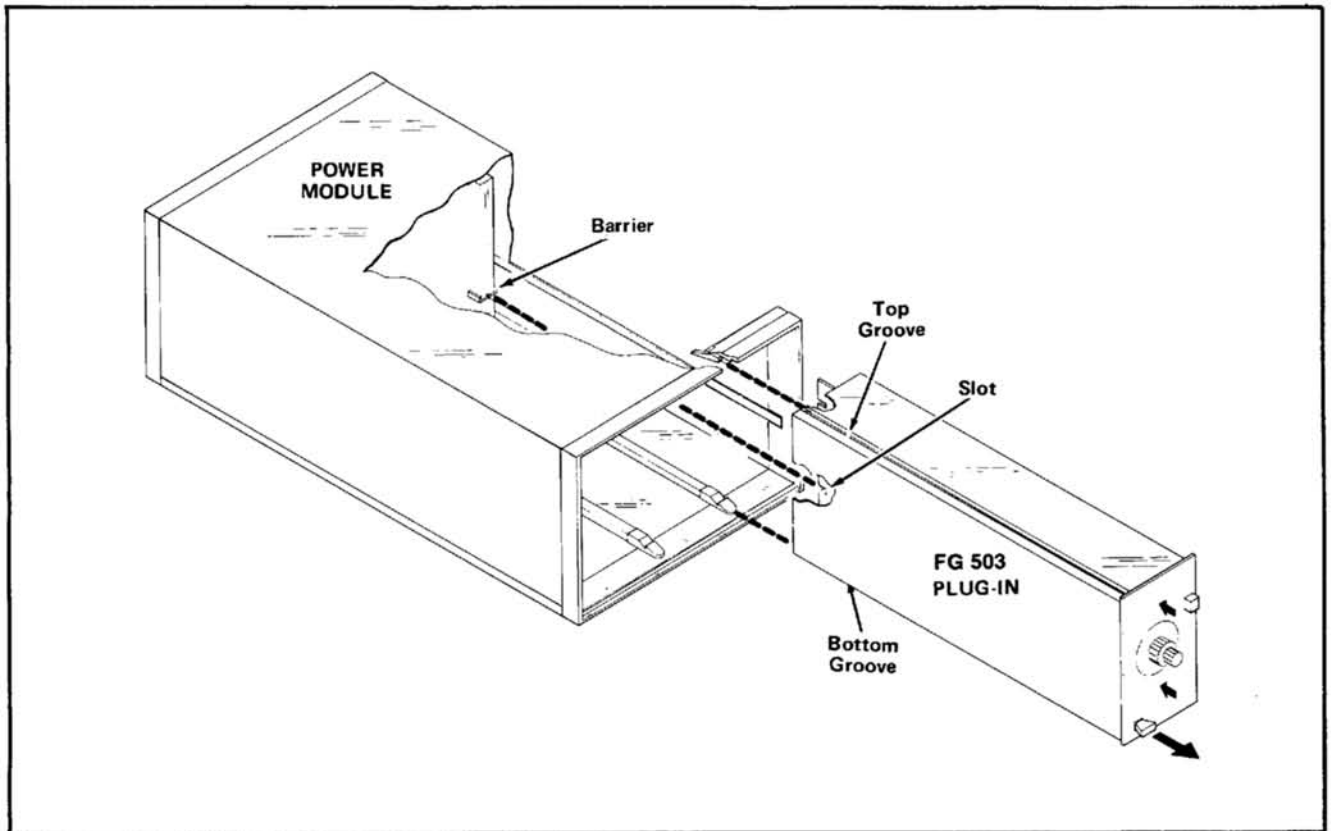


Fig. 1-1. FG 503 installation and removal.

## Operating Instructions—FG 503

page in Section 3 gives a complete description of the front panel controls and connectors.

### FUNCTIONS AVAILABLE AT REAR CONNECTOR

Refer to the rear connector assignment illustration in the Service Section of this manual for pin assignments.

A slot between pins 23 and 24 on the rear connector identifies the FG 503 as a member of the signal source family. A barrier may be inserted 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.

## OPERATING CONSIDERATIONS

### OUTPUT CONNECTIONS

The output of the FG 503 is designed to operate as a 50  $\Omega$  voltage source working into a 50  $\Omega$  load. At higher frequencies, an unterminated or improperly terminated output will cause excessive aberrations on the output waveform (see Impedance Matching discussion). Loads less than 50  $\Omega$  will reduce the waveform amplitude.

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

1. Use good quality 50  $\Omega$  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 to sensitive circuits.
4. Use terminators or impedance-matching devices to avoid reflections when using long cables (six feet or more).
5. Ensure that attenuators, terminations, etc. have adequate power handling capabilities for the output waveform.

### RISETIME AND FALLTIME

If the output pulse from the FG 503 is used to measure the rise or falltime of a device, consider the risetime characteristics of the associated equipment used. If the risetime of the device under test is at least ten times greater than the combined risetimes of the FG 503 plus the monitoring oscilloscope and associated cables, the error

introduced will not exceed 1%. This error can generally be ignored. When the rise or falltime of the test device is less than ten times as long as the combined risetimes of the testing system, the actual risetime of the device must be determined. This is found from the risetime of each component making up the system. The total risetime equals the square root of the sum of the squares of the individual risetimes.  $R_t = \sqrt{(R_1)^2 + (R_2)^2 + \dots}$ . Conversely, the risetime of the device under test can be found, from the same relationship, if the actual risetimes in the system are known.

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

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  $\pm 10$  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.

### IMPEDANCE MATCHING

As a pulse travels down a transmission line, each time it encounters a mismatch, or different impedance than that of 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. If the FG 503 is driving a high impedance such as the 1 MΩ input impedance (paralleled by a stated capacitance) of the vertical input to an oscilloscope, connect the transmission line to a 50 Ω attenuator, 50 Ω termination, and then the oscilloscope input. The attenuator isolates the input capacitance of the device, and the FG 503 is properly terminated.

A simple resistive impedance-matching network, that provides minimum attenuation, is illustrated in Fig. 1-2. To match impedance with the illustrated network, the following conditions must exist:

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

and

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

Therefore:

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

or

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

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<sub>1</sub> equals 50 Ω and Z<sub>2</sub> equals 125 Ω.

Therefore:

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

and

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

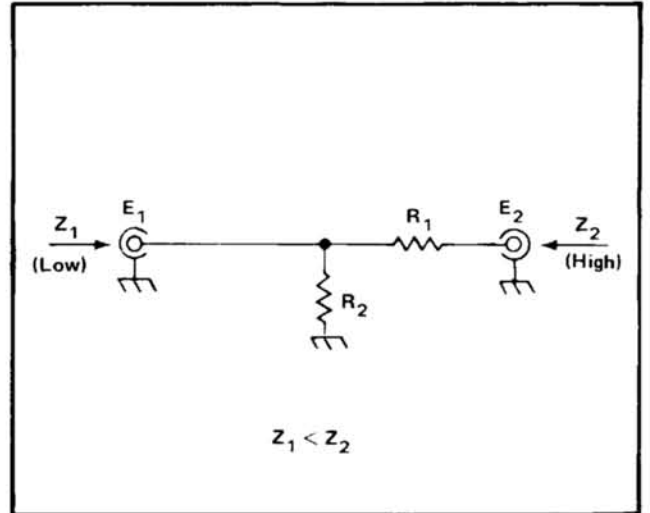


Fig. 1-2. Impedance matching network that provides minimum attenuation.

When constructing such a device, the environment surrounding the components should be designed to provide a transition between the impedances. 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,

$$Z_0 = \frac{138}{\sqrt{\epsilon}} \log_{10} \frac{D}{d}$$

D is the inside diameter of the outer conductor, d is the diameter of the inner conductor, and ε is the dielectric constant (1 in air).

The network shown in Fig. 1-2 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<sub>1</sub>) applied from the lower impedance source encounters a voltage attenuation (A<sub>1</sub>) that is greater than 1 and less than 2, as follows:

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

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A signal ( $E_2$ ) applied from the higher impedance source ( $Z_2$ ) encounters a greater voltage attenuation ( $A_2$ ) that 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  $50 \Omega$  to  $125 \Omega$ ,

$$A_2 = \frac{96.8}{125} + 1 = 1.77$$

and

$$A_2 = \frac{96.8}{64.6} + \frac{96.8}{50} + 1 = 4.43.$$

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  $R_2$ .

# BASIC OPERATION

## FREE-RUNNING OUTPUT

Set the AMPLITUDE control fully clockwise. Notice the two identical sets of waveforms near the FUNCTION selector on the front panel. The three waveforms in the lightly shaded area allow use of the OFFSET control; the other three do not. Select the desired waveform with or without offset. See Fig. 1-3. Select the desired frequency with the MULTIPLIER and FREQUENCY Hz dials. The output frequency is calibrated when the FREQUENCY VERNIER control is in the full clockwise position. Connect the load to the OUTPUT connector and adjust the AMPLITUDE control for the desired output amplitude.

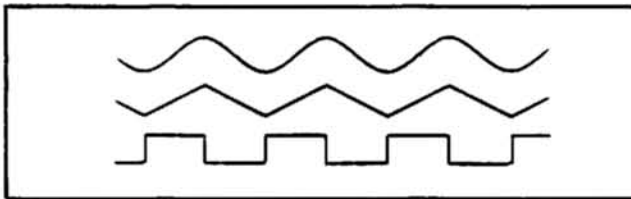


Fig. 1-3. Output waveforms available from the FG 503.

When using the offset feature select the waveform desired in the light shaded area. Now adjust the OFFSET control to position the dc level (baseline) of the output waveform above or below 0 V as desired.

## VOLTAGE-CONTROLLED FREQUENCY (VCF) OUTPUT

The output frequency of the FG 503 can be swept over a frequency range of 1000:1 depending on the

MULTIPLIER setting, by applying a 0 V to 10 V signal to the VCF IN connector. See Fig. 1-4 for maximum VCF range for each MULTIPLIER setting.

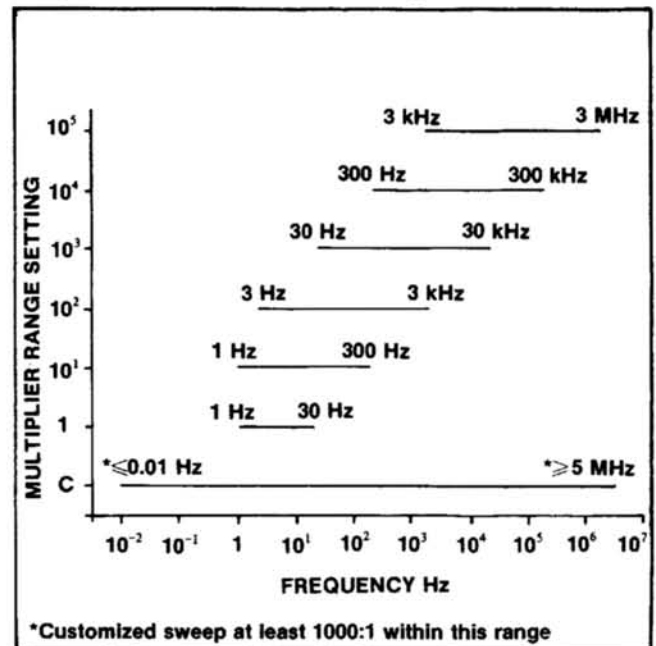


Fig. 1-4. Graph showing range of frequencies for each MULTIPLIER setting that can be swept with a 0 to 10 V signal applied to the VCF input.

The polarity of the VCF input signal determines the direction the output frequency is swept from the frequency set by the MULTIPLIER, FREQUENCY Hz, and VER-

NIER controls. A positive-going voltage raises the frequency, while a negative-going voltage lowers the frequency. A voltage that varies symmetrically about 0 V sweeps the output frequency symmetrically about the center frequency determined by the frequency controls. See Fig. 1-5.

Since the VCF input amplitude versus frequency is a linear relationship, the frequency output range may be determined from the VCF input amplitude. Use a fixed dc voltage and frequency counter or other comparison method, to accurately determine the output frequency and VCF voltage relationship. Refer to the test under the heading Response Analysis for a typical application using the VCF feature.

range of 20 Hz to 20 kHz is desired. Fig. 1-4 shows that no fixed multiplier setting includes the desired limits. The value of the capacitor that must be installed is determined by the following formula:

$$C_{cus} = \frac{300}{F_{max}}$$

where  $C_{cus}$  is in  $\mu F$ , and  $F_{max}$ , in Hz, is the maximum frequency required. Apply the formula to the example;

$$C_{cus} = \frac{300}{20 \times 10^3} = 0.015 \mu F.$$

The capacitor selected must be a low leakage non-polarized type within the range of 100 pF to 100  $\mu F$  and must have at least a 10 V rating. Ceramic and mylar capacitors work well in this application.

### CUSTOM TIMING CAPACITOR SELECTION

This feature allows the user to custom select a swept frequency range. For example, assume a swept frequency

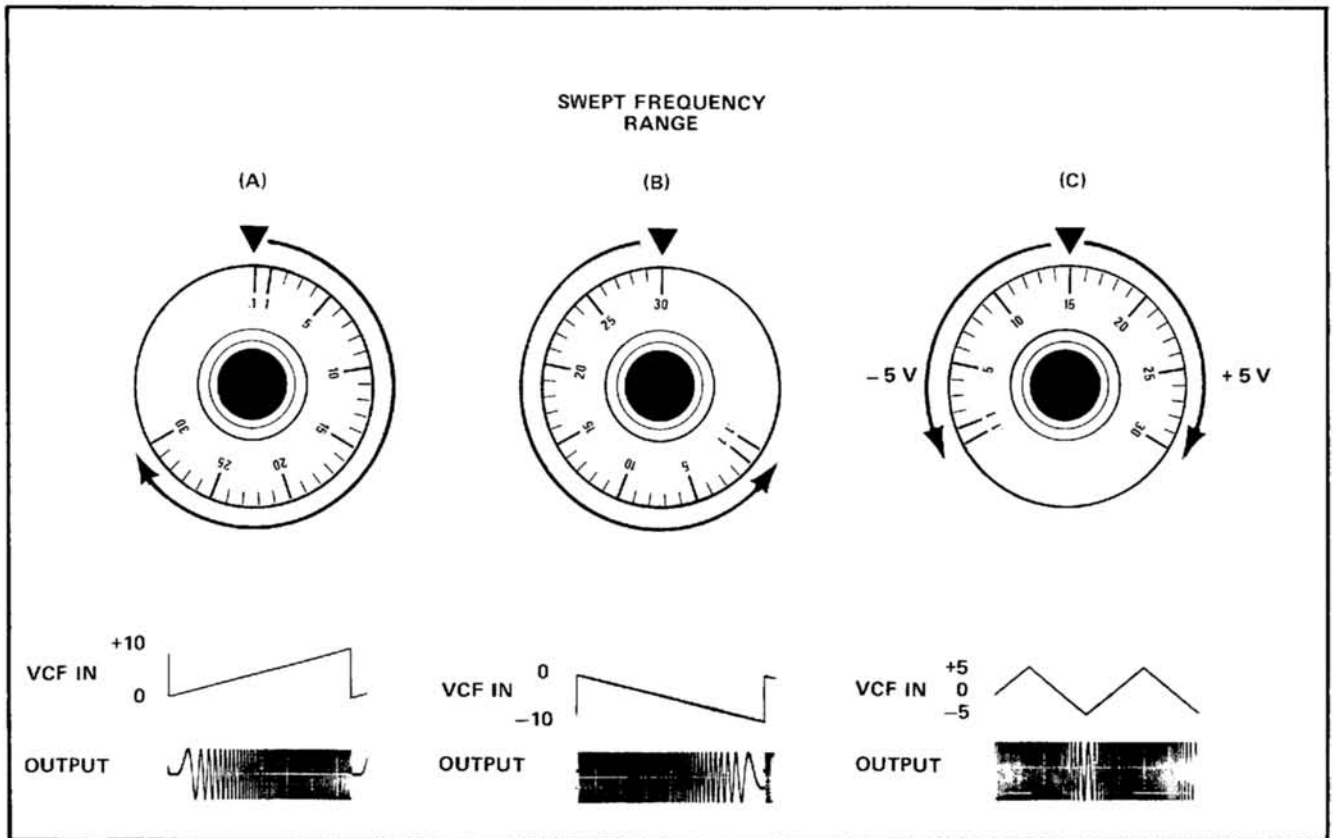


Fig. 1-5. Swept frequency range with 10 V signals applied to VCF IN Connector.

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Remove the left side cover of the FG 503. Refer to Fig. 1-6 for capacitor location. Solder the capacitor to the test points located on the left rear side of the circuit board as shown in Fig. 1-6. Finally, set the MULTIPLIER control to the C position, and apply the correct voltage to the VCF IN connector. Set the FREQUENCY Hz and FREQ VERNIER dials for the desired swept frequency range.

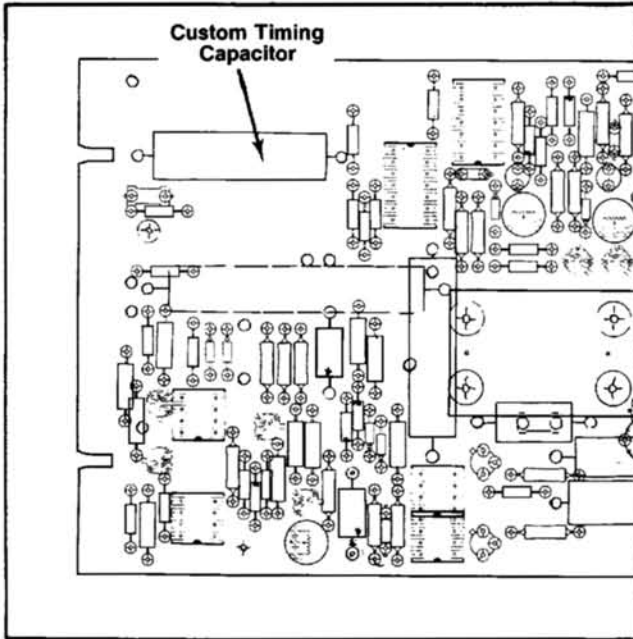


Fig. 1-6. Custom timing capacitor location.

The calibration marks on the FREQUENCY Hz dial are not appropriate for use directly in determining frequency in the custom range position. It is possible however, to custom calibrate the dial, since the linearity of the FREQUENCY Hz dial calibration is not changed in the custom position.

### TYPICAL VCF APPLICATION

The FG 503 is particularly suited for determining response characteristics of circuits or systems. This application utilizes the VCF input of the FG 503 to sweep the generator over a range of frequencies. By applying the desired waveform from the FG 503 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 503. Refer to the Voltage-Controlled Frequency (VCF) Output discussion for additional information.

1. Connect the equipment as shown in Fig. 1-7.
2. Set the MULTIPLIER selector and FREQUENCY Hz dial for the desired upper or lower frequency limit

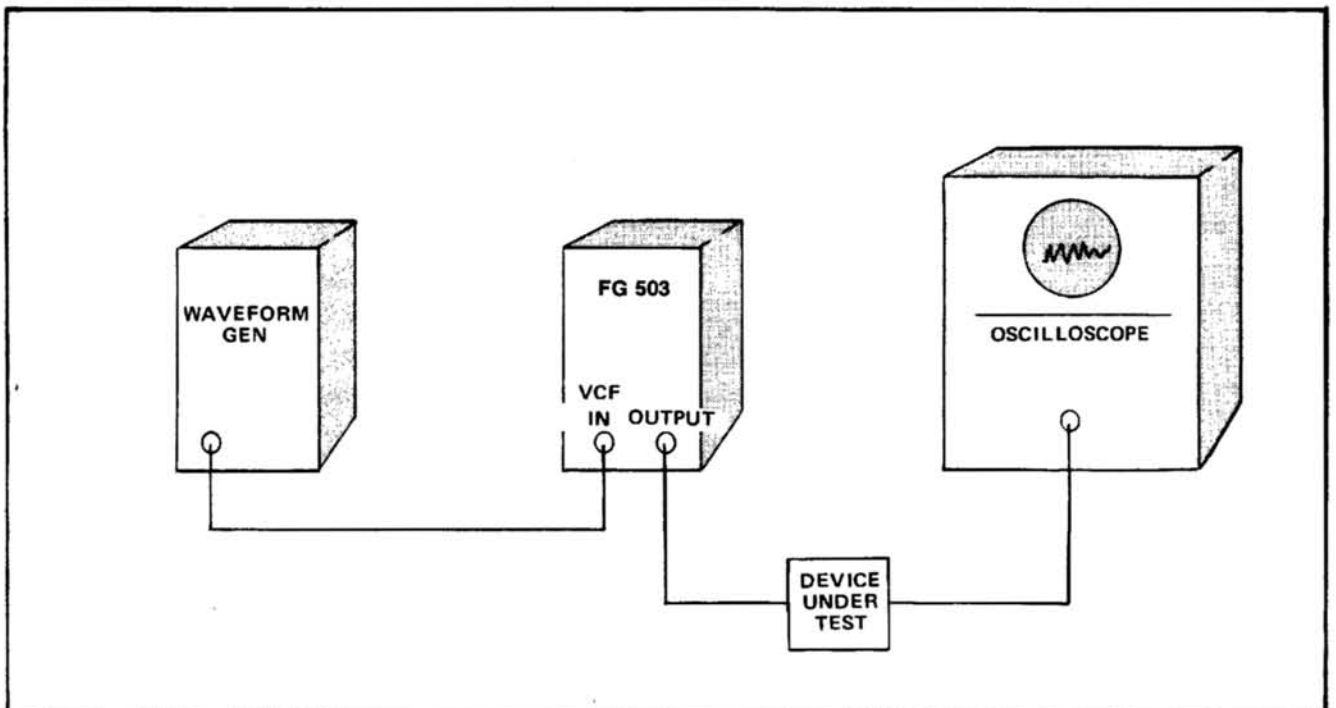


Fig. 1-7. Analyzing circuit or system response.

(depending on the direction you may wish to sweep). See Fig. 1-4 for VCF ranges and MULTIPLIER settings.

3. Apply the desired waveform to the VCF IN connector.

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. Then read the frequency on the FREQUENCY Hz dial.

## ELECTRICAL CHARACTERISTICS

### PERFORMANCE CONDITIONS

The electrical characteristics are valid only if the FG 503 is calibrated at an ambient temperature between +20°C and +30°C, and operated between 0°C and +50°C, unless otherwise noted.

#### WAVEFORMS:

Sine, square, and triangle.

#### FREQUENCY RANGE:

Calibrated Range: 1 Hz to 3 MHz.

Usable Range:  $\leq 0.01$  Hz to  $\geq 5$  MHz.

Custom Range: Switch selectable on front panel. Frequency range determined by user-installed timing capacitor.

#### FREQUENCY RESOLUTION:

1 part in  $10^5$  of full scale setting using FREQUENCY VERNIER control.

#### FREQUENCY STABILITY:

$\leq 0.1\%$  of full scale for 1 hour after a 30 minute warmup,  
 $\leq 0.5\%$  of full scale for 24 hours. Dial must be on calibrated portion and ambient temperature must be 25°C  $\pm 5^\circ$ C.

#### DIAL ACCURACY:

Within  $\pm 5\%$  of full scale from 1 Hz to 3 MHz.

#### DIAL RANGE:

1 to 30 calibrated, 0.1 to 1 uncalibrated.

#### OUTPUT AMPLITUDE:

$\geq 20$  V p-p open circuit,  $\geq 10$  V p-p into a 50  $\Omega$  load referenced at 10 kHz and excluding offset.

Variable Amplitude Range:  $\geq 20:1$ .

#### AMPLITUDE FLATNESS:

Within 2 db referenced at 10 kHz.

#### OFFSET RANGE:

At least  $\pm 5$  V open circuit,  $\geq \pm 2.5$  V into a 50  $\Omega$  load.  
 Peak signal plus offset at least  $\pm 10$  V open circuit,  $\pm 5$  V into 50  $\Omega$  load.

#### SINE WAVE DISTORTION:

$\leq 0.5\%$  from 1 Hz to 30 kHz,  
 $\leq 1.0\%$  from  $>30$  kHz to 300 kHz,  
 $\leq 2.5\%$  from  $>300$  kHz to 3 MHz. Valid for calibrated frequencies only.

#### TRIANGLE SYMMETRY:

Within 1% from 1 Hz to 100 kHz; within 5% from 100 kHz to 3.0 MHz using  $10^5$  MULTIPLIER setting. Dial must be on calibrated portion, and ambient temperature must be 25°C  $\pm 5^\circ$ C.

#### TRIANGLE LINEARITY:

Within 1% from 1 Hz to 100 kHz.

Within 5% from 100 kHz to 3 MHz.

#### SQUAREWAVE:

Risetime:  $\leq 60$  ns.

Aberrations:  $\leq 3\%$  p-p at full amplitude into a 50  $\Omega$  load.



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### VOLTAGE CONTROLLED FREQUENCY INPUT:

Range: A 10 V signal shifts frequency  $\geq 1000:1$  where freq (max) is  $\leq 30X$  MULTIPLIER setting and freq (min) is  $\geq 0.03X$  MULTIPLIER setting.

Slew Rate:  $\geq 0.5$  V/ $\mu$ s.

### TRIGGER OUTPUT:

$\geq 2.5$  V into 600  $\Omega$ . Leading edge coincides with positive peak of sine and triangle waveforms, and precedes leading edge of square wave nominally by 50 ns.

### POWER CONSUMPTION:

$\approx 15$  watts.



# THEORY OF OPERATION

## INTRODUCTION

The triangle waveform is the basic waveform in the FG 503. The sine wave is derived from the triangle waveform using a five-step approximation. The square waveform is generated by the triangle generator control circuitry.

Refer to the simplified block diagram, and the circuit diagrams in the pullout pages of this manual along with the following discussion, for a complete understanding of the FG 503 operation.

## TRIANGLE GENERATOR

Operational amplifier U121, with Q121, form a positive constant-current source. Q145 and Q141 form a negative constant-current source. These constant current sources supply the current (either positive or negative) to charge the timing capacitor, generating the triangle waveform.

Assume that the junction of CR127 and CR135 is positive (about  $+9$  V) with respect to ground. CR127 is off and CR135 is conducting. CR140 is off, and the timing capacitor is charging from the positive current source through CR130. Q261 is off. Current to hold the junction of CR127 and CR135 positive is supplied via VR131, connected to the  $+20$  V supply.

The ramp, moving in the positive direction, appears in the same polarity at the  $+$  inputs of U235. This is accomplished through the action of source follower Q201A, with its constant current source, Q201B. Q211 and Q221, complementary emitter followers, drive the ac compensated attenuator R226, R227, and C226.

The voltage at pin 2 of U235A rests at about 1.6 V above ground. The voltage at pin 6 of U235B is about the same below ground. Under these conditions, the output of U235A and U235B (pin 10) rests so that the inputs of U241C are at the low TTL level. When the ramp voltage at pins 3 and 5 of U235A and U235B respectively reaches about 1.6 V, the output of these comparators start to go positive. When they reach the high TTL level, pin 10 of U241C goes low, causing the output of U241D to go high. This high level couples through VR261 to the base of Q261, turning Q261 on.

The lowered voltage (about  $-9$  V) at the junction of CR127 and CR135 turns CR140 on, and CR135 and CR130 off. This action disconnects the positive current source from the timing capacitor and connects the negative current source through CR140, causing the ramp to go in the negative direction. The ramp goes negative until the voltage at pins 3 and 5 of U235A and B, respectively, drops to about  $-1.6$  V. At this time the outputs of U235A and U235B go low causing the output of U241C to go high. This action causes the output of U241D to go negative, turning Q261 off, and the cycle repeats.

R123 balances the current between the positive and negative constant current sources so that the charge and discharge times for the capacitor are equal.

The frequency of the triangle waveform is controlled by two factors: (1) the value of the timing capacitor, and (2) the amount of current available to charge it.

When the FREQUENCY Hz dial is turned in the ccw direction, the voltage at pin 5 of U101A goes positive. This causes pin 7 of U101A and pin 2 of U101B to go positive. The voltage at pin 2 of U101B is also controlled by an external voltage applied to the front panel VCF IN connector. Under the above conditions, pin 1 of U101B goes negative, causing pin 6 of U121 to go negative. This increases the current available to charge the ramp generating capacitor. The negative current is also increased through the action of emitter follower Q141.

The waveform at pin 13 of U241D (about 15 V above the base of Q261) drives gates U241A and B, which in turn provide in-phase trigger signals to the front panel and the rear interface connector.

The square wave is taken from the collector of Q255.

## SINE SHAPER

This circuit, by means of a five-step approximation method, develops a sine wave from the applied triangle wave. The circuit is composed of Q320, Q340, and associated components. Although they operate in opposite polarity, each half of the sine shaper functions the

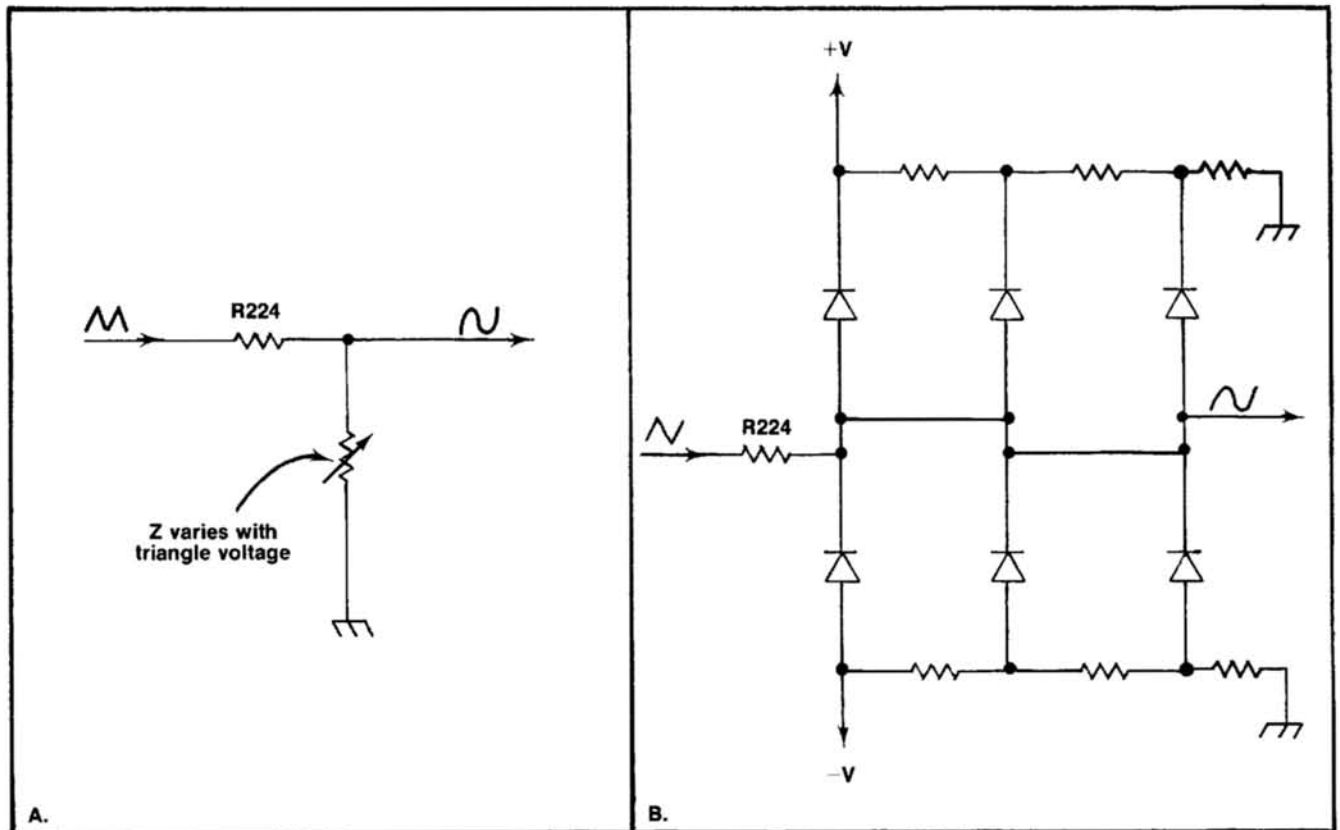


Fig. 2-1. Simplified sine shaper circuits. Part A shows equivalent circuit. Part B shows a three step approximation (actual circuit is a five step approximation). See text.

same, so only the upper half (Q320) is described. See Fig. 2-1 for a simplified version of the sine shaper.

Transistor Q320, controlled by the setting of — sine adjustment R311, establishes a fixed current through the resistive divider chain attached to its emitter. This fixes a different voltage at the cathode of each diode connected to the divider chain. When sine-wave operation is selected, a triangle wave is applied through R224, which forms part of a voltage divider, the other half of which is the diodes and the Q320 resistor chain. The output waveform is taken from the junction of R224 and the Q320 resistor chain.

As the applied triangle waveform rises to the voltage at the cathode of CR327, the diode conducts, changing the divider ratio and thus the slope of the output waveform. The slope is changed each time another diode turns on (as a result of the triangle waveform reaching the turn-on point of the diode), resulting in a waveform of approximate sinusoidal shape. As the input falls, the diodes turn off in succession, until the input waveform reaches zero volts. The changes in slope during this operation would seem to be pronounced; however, the nonlinear characteristics of the diodes tends to round off the changes. The result is a close approximation of a pure sine wave at the output.

## OUTPUT AMPLIFIER

This circuit operates as an inverting operational amplifier.  $R_f$  is R371 and  $R_i$  is R369. The base of Q371 is the negative input and the base of Q380 is the positive input. The overall gain is about four. The selected waveform is applied to the base of Q355. This transistor and Q360 operate as cascaded emitter followers. The waveform is taken from the emitter of Q360, through the AMPLITUDE control to the base of Q371. Q380 and Q371 operate as an emitter-coupled amplifier with Q376 serving as a constant current source. R375, in the emitter circuitry, adjusts for dc unbalance in the output amplifier. The base of Q380 is connected to the OFFSET control when waveform offset capability is required (S380-5 closed). This control also effectively adjusts dc levels in the output amplifier. The in-phase signal is fed from the collector of Q380 to the base of Q405. The out-of-phase signal is fed from the collector of Q371 to the base of inverter Q400. The waveform at the collectors of Q420 and Q405 are in phase. Their collectors drive complementary emitter-follower amplifiers Q425 and Q410. Output and feedback are taken from their common emitters. C369 compensates  $R_f$  for higher frequency components.

## POWER SUPPLIES

VR517 sets the voltage at pin 3 (+ input of an operational amplifier) of U512. U512 has a gain of

approximately three. The output at pin 6, therefore, is about 20 V. Emitter follower Q526 drives the base of the series pass transistor. Should the +20 V load increase, pin 2 of U512 (through R522 and R520) goes negative. This causes pin 6 to go positive, increasing current flow and restoring the +20 V to its previous level. Should the current drawn increase, so the voltage across R523 is sufficient to turn Q523 on, current limiting occurs. Q526 reduces conduction, reducing the current through the series pass transistor to a safe level. CR536 protects the +20 V supply, if it shorts to the minus supply.

U566 is an operational amplifier with a gain of about one. The reference voltage is the +20 V applied at pin 2. The output, at pin 6 (-20 V), drives emitter follower Q569. Q569 drives the series pass transistor located in the power module. Current limiting takes place in conjunction with Q566 and R567. Feedback occurs through R564. The

action of this circuit is similar to the +20 V regulator. CR539 protects this supply, should a short to +20 V occur.

The +17 V is referenced to the +20 V. U628, with a gain of about one, controls Q628, the series pass transistor for this supply. Feedback occurs at pin 2 of U628. Current limiting in the +20 V supply protects this circuit.

The -17 V supply is referenced to +17 V at pin 2 of U640. The gain of U640 is about one. Q640 serves as the series pass transistor for this supply. Feedback occurs through R633. Current limit for this supply is the +20 V supply.

The regulatory action of the +17 V and -17 V supplies is similar to that in the 20 V supplies.

# CALIBRATION PROCEDURE

## SERVICES AVAILABLE

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

## MAINTENANCE

Refer to the TM 500 series power module manual for complete maintenance information.

## TEST EQUIPMENT

For complete calibration, the following equipment is recommended:

Digital voltmeter with ranges greater than  $\pm 20$  V DC, Tektronix DM 501 or equivalent.

At least a 10 MHz oscilloscope system. Tektronix 5403 main frame, 5A45 vertical plug-in, 5B40 time base, or equivalent.

Distortion analyzer or 10 kHz notch filter constructed as shown in Fig. 3-1.

One 50  $\Omega$  termination, bnc connectors, Tektronix Part Number 011-0049-01.

One 50  $\Omega$ , 42-inch coaxial cable, bnc connectors, Tektronix Part Number 012-0057-01 or equivalent.

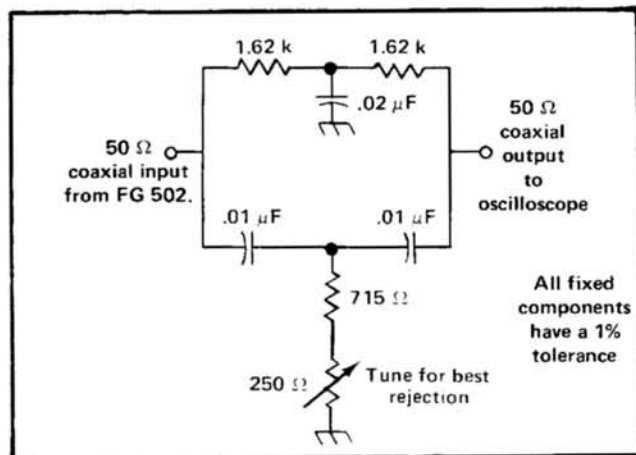


Fig. 3-1. 10 kHz notch filter.

## GENERAL

The FG 503 can be calibrated either fully installed in a TM 500 series power module, or connected to the power module via a flexible plug-in extender (Tektronix Part No. 067-0645-01). Remove the power module cabinet to make adjustments to the FG 503 inside the power module. All adjustments are located on the right side of the circuit board. Make all adjustments at an ambient temperature between 20°C and 30°C (+68°F to +86°F).

### 1. ADJUST +20 V SUPPLY

Connect the positive lead of the voltmeter set to read +20 V to the +20 V TP and the negative lead to the Gnd TP. Adjust R520, +20 V, for a reading of 20 V  $\pm 1\%$ .

### 2. CHECK POWER SUPPLY VOLTAGES

Connect the negative lead of the voltmeter set to read -20 V to the -20 V TP and the positive lead to the Gnd TP. Check that the reading is -20 V  $\pm 1\%$ . Move the negative lead to the -17 V TP and check that the reading is 17 V  $\pm 1\%$ . Now measure the +17 V by switching the negative lead to the Gnd TP and the positive lead to the +17 V TP and check that the reading is within  $\pm 1\%$  of 17 V.

### 3. ADJUST SYMMETRY

Connect the OUTPUT of the FG 503 through a 50  $\Omega$  coaxial cable and a 50  $\Omega$  termination, in that order, to the vertical input of the oscilloscope. Set the FG 503 AMPLITUDE control fully cw, the MULTIPLIER control to 10<sup>3</sup>, the FREQ VERNIER control fully cw, the FUNCTION switch to  $\square$  in the darkly shaded area (no offset) and the FREQUENCY Hz dial to 10. Set the oscilloscope vertical sensitivity to 2 V/div and the horizontal sweep rate to 10  $\mu$ s/div. Obtain a triggered square wave display on the crt. Adjust the FREQUENCY Hz dial so that only one complete square wave is visible on the crt. Adjust R123, Sym, for a symmetrical square wave. Finally, while switching the sweep triggering on the oscilloscope from positive slope to negative slope, check that the vertical transition of the square wave does not shift in time. Readjust R123, Sym, if necessary to achieve this result.

### 4. ADJUST LOW FREQUENCY TIMING

Set the oscilloscope sweep speed to 1 ms/div. Set the FREQUENCY Hz dial fully cw and make certain the FREQ VERNIER control is fully cw. Now adjust R116, X0.1 Cal, for one complete square wave in ten horizontal divisions on the crt.

### 5. ADJUST HIGH FREQUENCY TIMING

Set the FREQUENCY Hz dial to 30 and the oscilloscope sweep speed to 10  $\mu$ s/div. Adjust R101, X30 Cal, for three complete square wave cycles in ten horizontal divisions. Repeat step four and this step until proper calibration is achieved.

# CALIBRATION PROCEDURE

## 6. CHECK DIAL POSITIONING

Set the oscilloscope sweep rate at 0.1 ms/div. Adjust the FREQUENCY Hz dial so that exactly one complete square wave is displayed over ten horizontal divisions on the crt. The FREQUENCY Hz dial should now read 1. If not, loosen the two set screws on the knob and adjust so the dial reads 1. Go back and repeat steps four and five if adjustment of the FREQUENCY Hz dial was necessary.

## 7. ADJUST 300 kHz TIMING

Set the MULTIPLIER to  $10^4$ , FREQUENCY Hz dial to 30 and the oscilloscope sweep speed to 1  $\mu$ s/div. Adjust C226, 300 kHz Tmg, for a display of three complete cycles in ten horizontal divisions.

## 8. ADJUST 3 MHz TIMING

Set the MULTIPLIER to  $10^5$ , and the oscilloscope sweep speed to 0.1  $\mu$ s/div. Adjust C280, 3 MHz Tmg, for a display of three complete cycles in ten horizontal divisions.

## 9. ADJUST SQUARE WAVE COMPENSATION

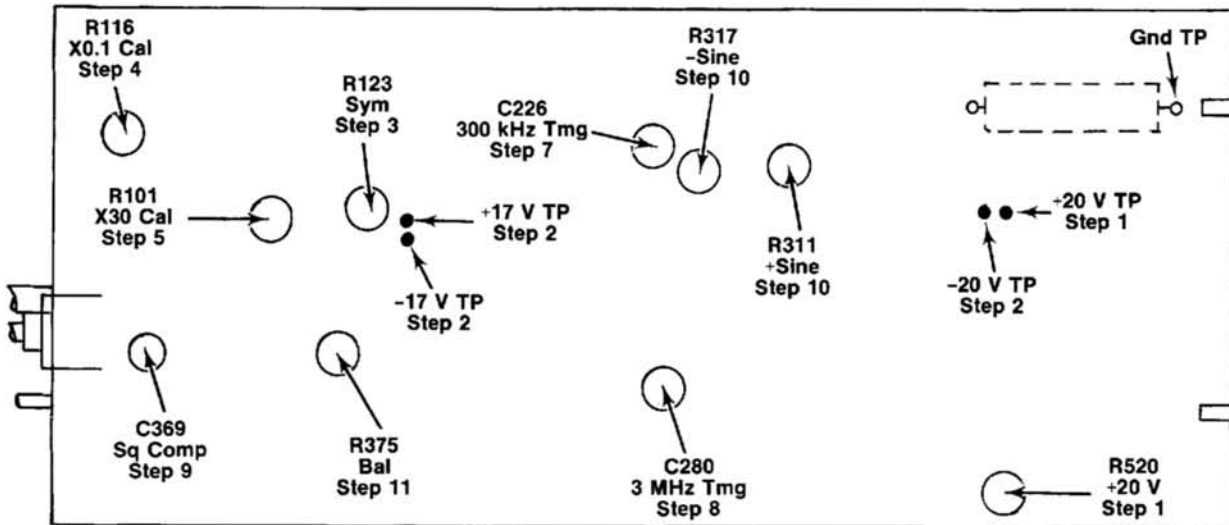
Set the FREQUENCY Hz dial to 10 (1.0 MHz). Adjust C369, Sq Comp, for the squarest front corner on the waveform. Check that the risetime of the square wave is within specification.

## 10. ADJUST SINE WAVE UPPER AND LOWER LEVEL CONTROLS (DISTORTION)

Set the FUNCTION switch to  $\nu$  in the shaded portion (no offset), MULTIPLIER to  $10^3$ , and FREQUENCY Hz to 10. Set the oscilloscope sweep speed to 50  $\mu$ s/div. Connect the distortion analyzer to the FG 503 output, or the notch filter (constructed as shown in Fig. 3-1) to the 50  $\Omega$  terminated end of a coaxial cable from the FG 503. Connect the output of the notch filter to the oscilloscope vertical input. Set the oscilloscope vertical sensitivity for a four-division display and adjust the FREQUENCY Hz dial for minimum display amplitude. Using a four-division display on the oscilloscope, alternately adjust R311, + Sine, R317, - Sine, and the FREQ VERNIER control for minimum display amplitude. If the distortion analyzer is used, adjust for minimum distortion. To arrive at the percent distortion, divide the amplitude of the display, using the notch filter, by the amplitude of the sine wave without the notch filter, and multiply by 100.

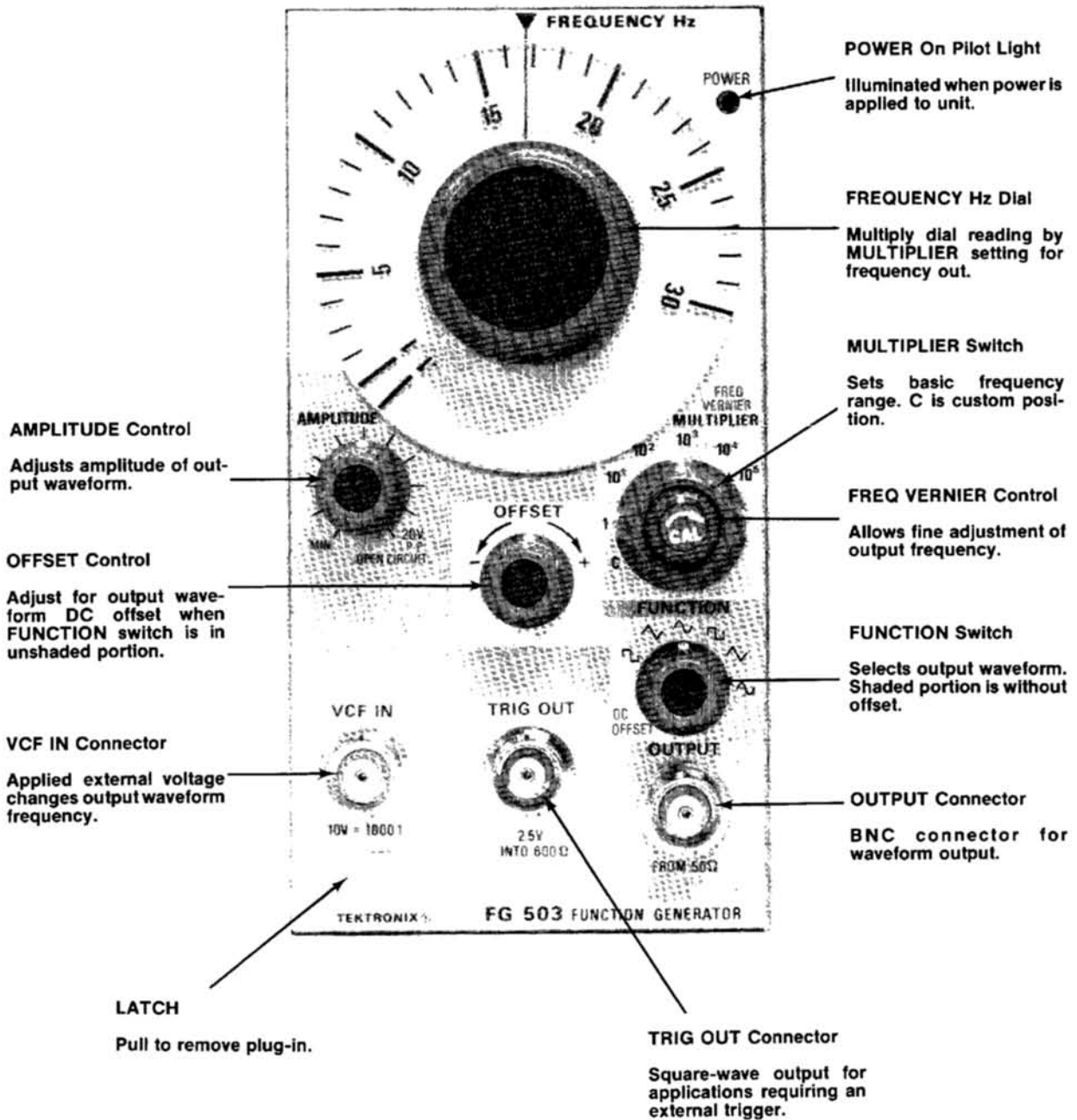
## 11. ADJUST OUTPUT DC BALANCE

Establish the oscilloscope ground reference by grounding the vertical input and position the trace to the graticule center. Connect the output of the FG 503 to the oscilloscope vertical input. Set the vertical deflection at 0.1 V/div. Turn the AMPLITUDE control fully ccw. Now adjust R375, Bal, so that the waveform is centered around the ground reference on the oscilloscope.



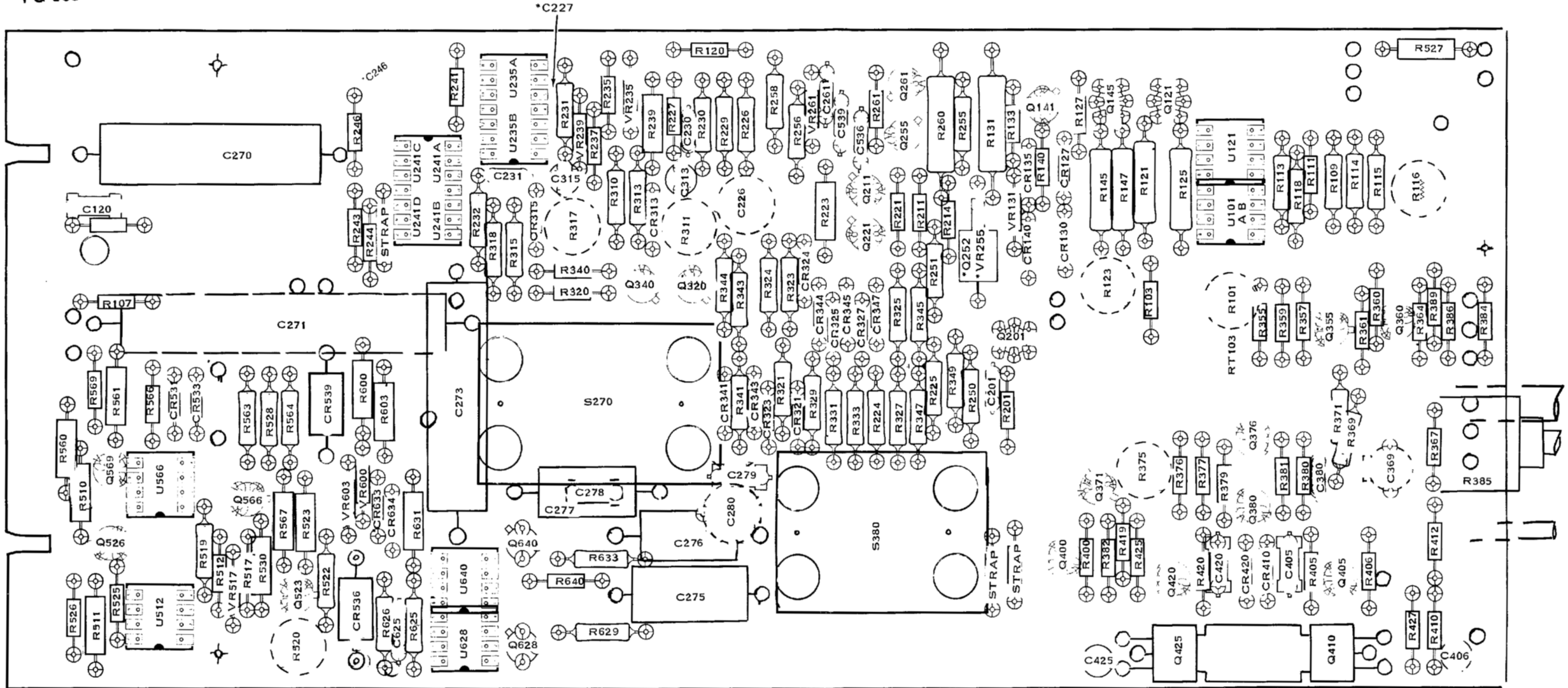
BACK SIDE OF BOARD SHOWN,  
TEST POINTS WILL BE FOUND ON COMPONENT SIDE OF BOARD.

# CONTROLS AND CONNECTORS





# PARTS LOCATION GRID



DASHED COMPONENTS LOCATED ON BACK SIDE OF BOARD

\*See Parts List for serial number ranges.

LOCATED ON BACK BOARD  
 C633  
 \*R252  
 \*R253

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C120	A2	Q121	J1	R223	G2	R371	L4	U101	K2
C201	I4	Q141	I1	R224	H4	R375	J4	U121	K2
C226	G2	Q145	J1	R225	H4	R376	J4	U235A	E1
C227	E1	Q201	I3	R226	G2	R377	J4	E235B	E2
C230	F2	Q211	H2	R227	F2	R379	K5	U241	D2
C231	E2	Q221	H2	R229	G2	R380	K4		
C246	D1	Q252	I3	R230	F2	R381	K4	U512	B6
C261	G1	Q255	H2	R231	E1	R382	J5	U566	B4
C270	B2	Q261	H1	R232	D2	R384	M4	U628	D6
C271	C3	Q320	F3	R235	F1	R385	M4	U640	D5
C273	D4	Q340	F3	R237	E2	R386	L3		
C275	F5	Q355	L3	R239	F2	R389	L3	VR131	I2
C276	F5	Q360	L3	R241	D1	R400	J5	VR235	F1
C277	E5	Q371	J5	R243	C2	R405	K5	VR239	E2
C278	E5	Q376	K4	R244	D3	R406	L5	VR255	I3
C279	G4	Q380	K5	R246	C2	R410	L6	VR261	G1
C280	G5	Q400	I5	R250	I4	R412	L5		
C313	F2	Q405	L5	R251	H3	R419	J5	VR517	B5
C315	E2	Q410	L6	R255	H2	R420	J5	VR600	D5
C369	L4	Q420	J5	R256	G2	R425	J5	VR603	C5
C380	K4	Q425	J6	R258	G1	R427	L6		
C406	M6			R260	H2	R501	B4		
C420	K5	Q523	C5	R261	H1	R510	A5		
C425	J6	Q526	A5	R310	F2	R511	A6		
		Q566	C5	R311	F2	R512	B5		
C536	H2	Q569	A4	R313	F2	R517	C5		
C539	G2	Q628	E6	R315	E3	R519	B5		
C625	D6	Q640	E5	R317	E2	R520	C6		
C633	E5			R318	E3	R522	C5		
				R320	E3	R523	C5		
CR127	I2	R101	K3	R321	G4	R525	B5		
CR130	I3	R103	J3	R323	G3	R526	A6		
CR135	I2	R107	B3	R324	G3	R527	L1		
CR140	I3	R109	L2	R325	H3	R528	C4		
CR313	F2	R111	K2	R327	H4	R530	C5		
CR315	E2	R113	K2	R329	G4	R560	A4		
CR321	G4	R114	L2	R331	G4	R561	B4		
CR323	G4	R115	L2	R333	H4	R563	C4		
CR324	G3	R116	L2	R340	E3	R564	C4		
CR325	G3	R118	K2	R341	G4	R566	B4		
CR327	H3	R120	F1	R343	G3	R567	C5		
CR341	G4	R121	J2	R344	G3	R569	A4		
CR343	G4	R123	J3	R345	H3	R600	D4		
CR344	G3	R125	J2	R347	H4	R603	D4		
CR345	H3	R127	I1	R349	H4	R625	D6		
CR347	H3	R131	I2	R355	K3	R626	D6		
CR410	K5	R133	I2	R357	K3	R629	F6		
CR420	K5	R140	I2	R359	K3	R631	D5		
CR531	B4	R145	J2	R360	L3	R633	F5		
CR533	B4	R147	J2	R361	L3	R640	E5		
CR536	C6	R201	I4	R364	L3				
CR539	C4	R211	H2	R365	M4	RT103	K3		
CR633	D5	R214	H2	R367	L4				
CR634	D5	R221	H2	R369	L4	S270	E4		
						S380	H5		

REV C. OCT 1975



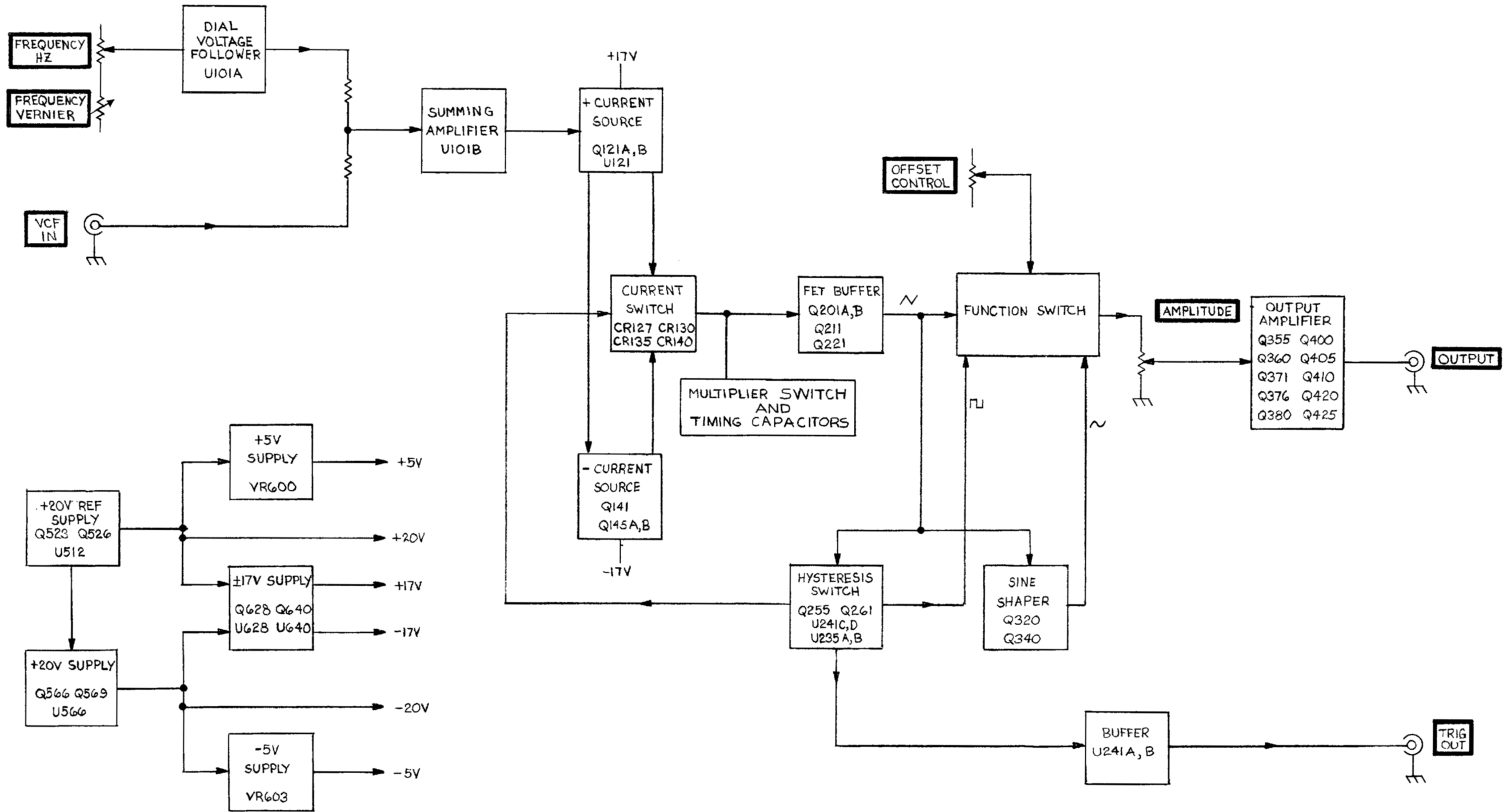
# REAR CONNECTOR PIN ASSIGNMENTS

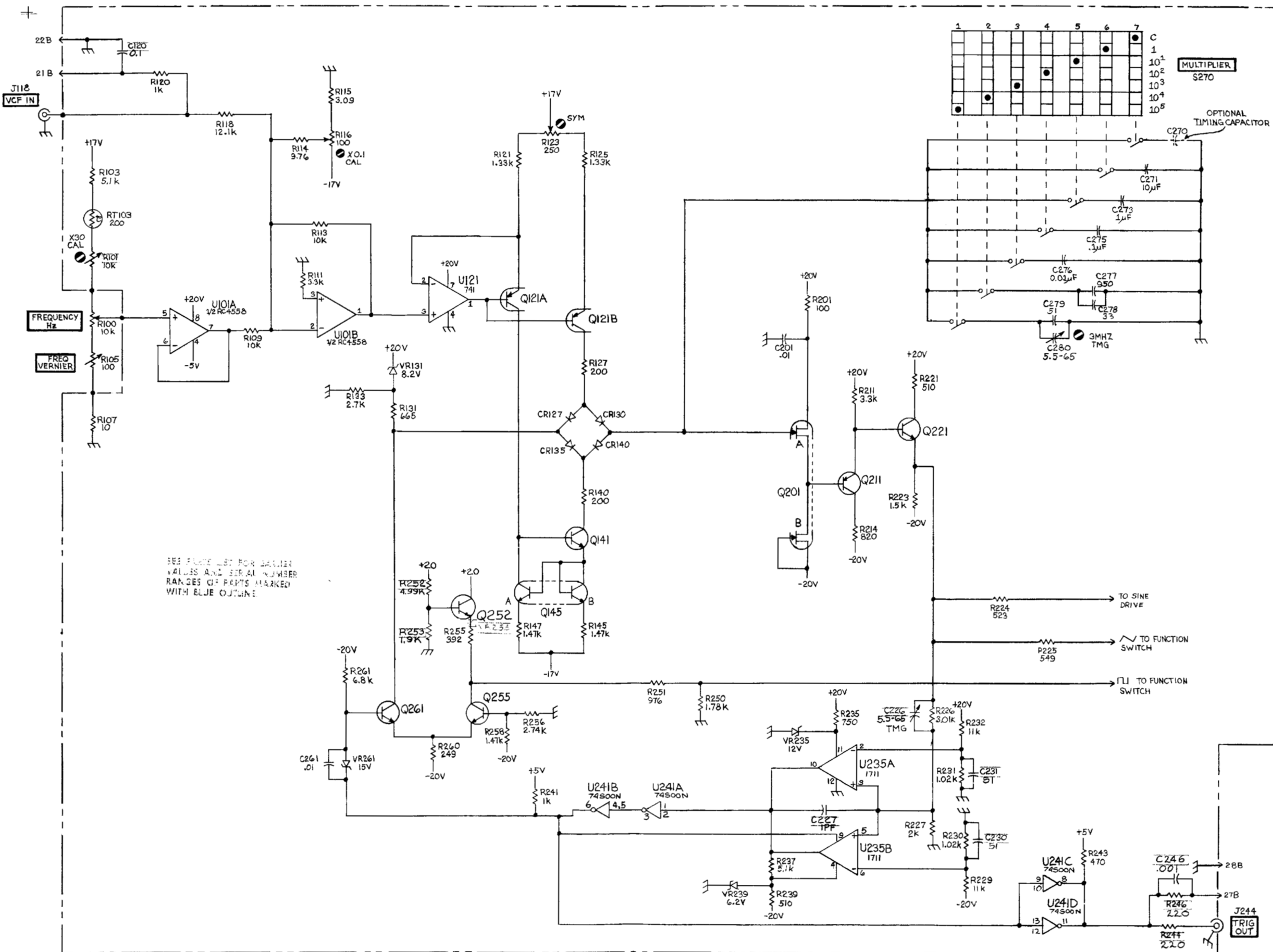
TABLE 2-1

	B		A	
Trigger Output Common	28		28	Output
Trigger Output	27		27	Output Common
	26	Signal Source	26	
	25	plug-in	25	
	24	barrier slot	24	
	23		23	
VCF In Common	22		22	
VCF In	21		21	
	20		20	
	19		19	
	18		18	
	17		17	
	16		16	
	15		15	
	14		14	
25 VAC Winding	13		13	25 VAC Winding
* +33.5 V Filtered DC	12		12	* +33.5 V Filtered DC
* Collector lead of PNP Series-Pass Transistor	11		11	* Base lead of PNP Series-Pass Transistor
Transformer Shield	10		10	* Emitter lead of PNP Series-Pass Transistor
* 33.5 V Common	9		9	* 33.5 V Common
* -33.5 V Filtered DC	8	TM 500	8	* -33.5 V Filtered DC
* Collector lead of NPN Series-Pass Transistor	7	barrier slot	7	* Emitter lead of NPN Series-Pass Transistor
Not Used	6		6	* Base lead of NPN Series-Pass Transistor
17.5 VAC Winding	5		5	17.5 VAC Winding
+11.5 V Common	4		4	+11.5 V Common
+11.5 V Common	3		3	+11.5 V Common
+11.5 V Filtered DC	2		2	+11.5 V Filtered DC
25 VAC Winding	1		1	25 VAC Winding
	B		A	

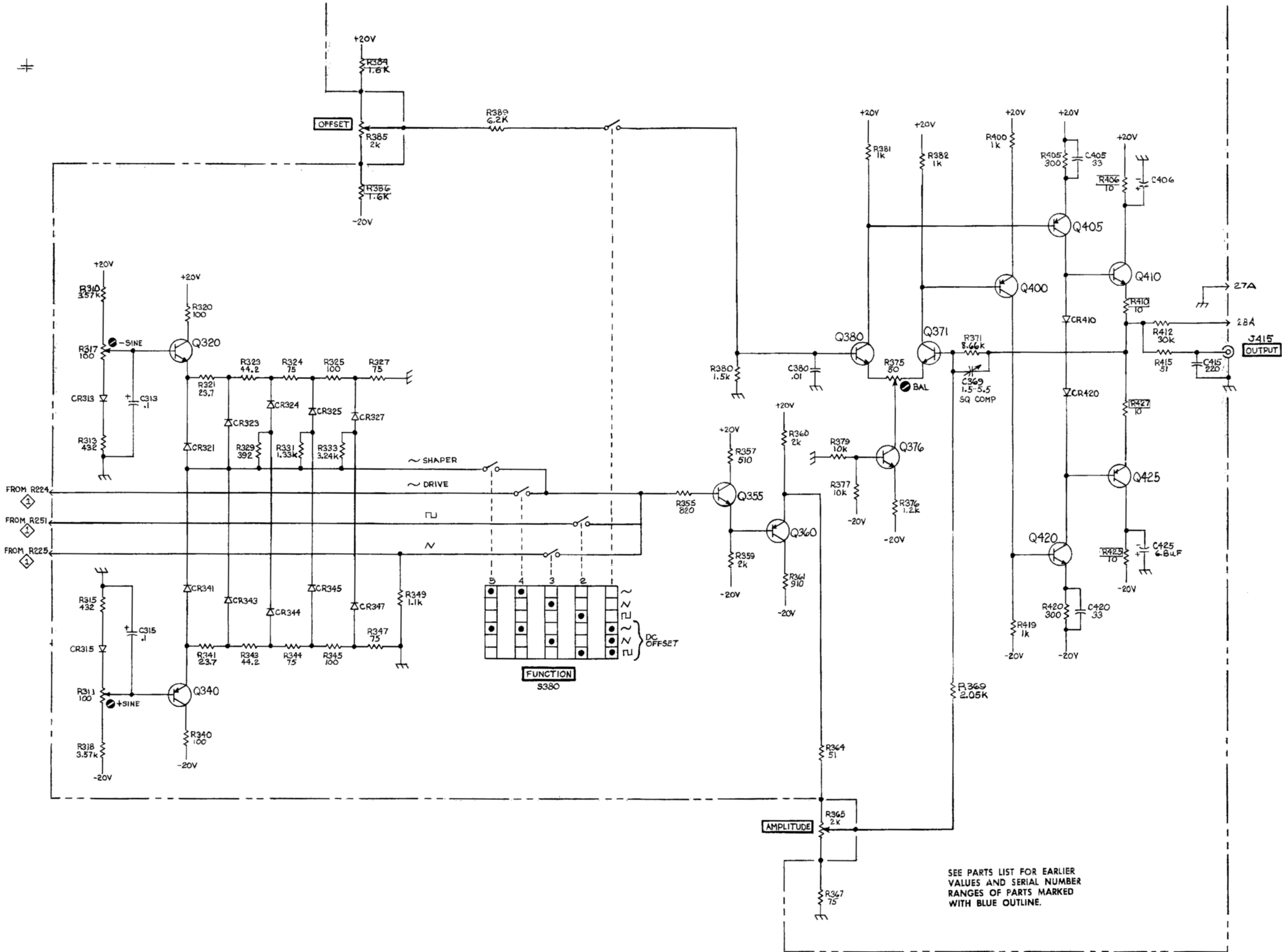
Rear-view of plug-in

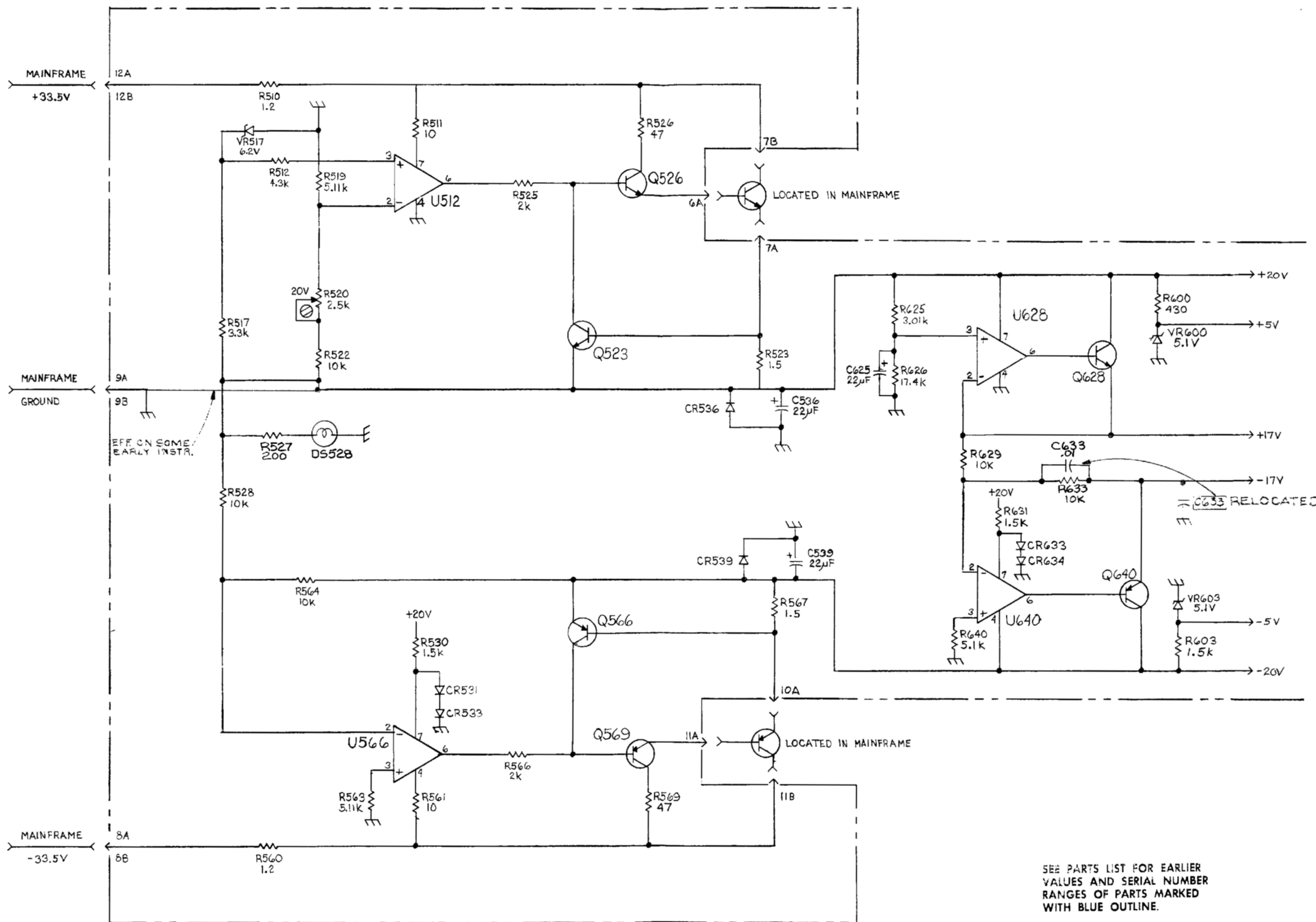
Assignments listed for pins 1A—13A and 1B—13B are available in all power modules; however only those pins marked with an asterisk (\*) are used by the FG 503.





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





# SERVICE INFORMATION

## SYMBOLS AND REFERENCE DESIGNATORS

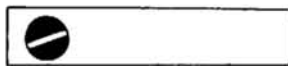
Electrical components shown on the diagrams are in the following units unless noted otherwise:

- Capacitors = Values one or greater are in picofarads (pF).  
 Values less than one are in microfarads ( $\mu$ F).  
 Resistors = Ohms ( $\Omega$ )

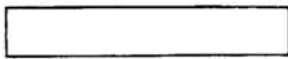
Symbols used on the diagrams are based on ANSI Y32.2 – 1970.

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

The following special symbols are used on the diagrams:



External Screwdriver adjustment.



External control or connector.



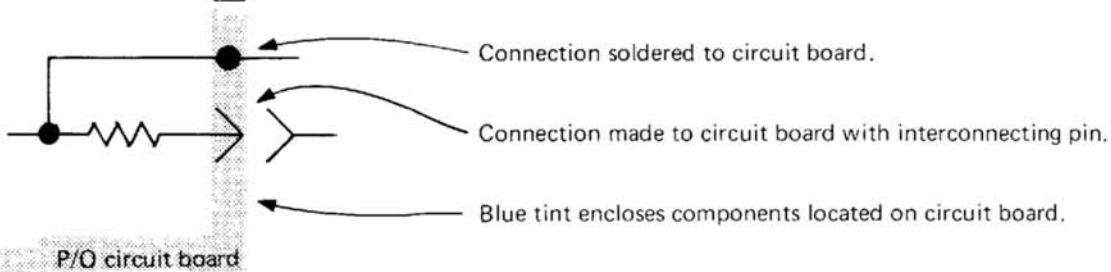
Clockwise control rotation in direction of arrow.



Refer to diagram number indicated in diamond.



Refer to waveform number indicated in hexagon.



# 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
01121	Allen-Bradley Co.	1201 2nd St. South	Milwaukee, WI 53204
01295	Texas Instruments, Inc., Semiconductor Group	P. O. Box 5012	Dallas, TX 75222
02735	RCA Corp., Solid State Division	Route 202	Somerville, NY 08876
03508	General Electric Co., Semi-Conductor Products Dept.	Electronics Park	Syracuse, NY 13201
04713	Motorola, Inc., Semiconductor Products Div.	5005 E. McDowell Rd.	Phoenix, AZ 85036
07910	Teledyne Semiconductor	12515 Chadron Ave.	Hawthorne, CA 90250
12040	National Semiconductor Corp.	Commerce Drive	Danbury, CT 06810
15801	Fenwal Electronics, Div. of Kidde Walter and Co., Inc.	63 Fountain St.	Framingham, MA 01701
18324	Signetics Corp.	811 E. Arques	Sunnyvale, CA 94086
22229	Solitron Devices, Inc., Diodes, Integrated Circuits and CMOS	8808 Balboa Ave.	San Diego, CA 92123
24931	Specialty Connector Co., Inc.	3560 Madison Ave.	Indianapolis, IN 46227
56289	Sprague Electric Co.		North Adams, MA 01247
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
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
80031	Electra-Midland Corp., Mepco Div., A North American Phillips Co.	22 Columbia Rd.	Morristown, NJ 07960
81483	International Rectifier Corp.	9220 Sunset Blvd.	Los Angeles, CA 90069
98291	Sealectro Corp.	225 Hoyt	Mamaroneck, NY 10544



Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-3302-00			CKT BOARD ASSY:MAIN	80009	670-3302-00
C120	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C201	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C226	281-0205-00			CAP.,VAR,PLSTC:5.5-65PF,100V	80031	C010GA/60E
C227	281-0627-00	XB020000		CAP.,FXD,CER DI:1PF,+/-0.25PF,500V	72982	301-000C0G0109C
C230	283-0003-00	B010100	B019999	CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C230	281-0540-00	B020000		CAP.,FXD,CER DI:51PF,5%,500V	72982	301-000U2J0510J
C231	283-0003-00	B010100	B019999	CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C231	281-0540-00	B020000		CAP.,FXD,CER DI:51PF,5%,500V	72982	301-000U2J0510J
C261 <sub>1</sub>	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C270						
C271 <sub>2</sub>						
C273						
C275	295-0164-00			CAP.,SET MTCHD:10UF,1UF,0.1UF,0.01UF, 950PF,MTCHD 0.75%	80009	295-0164-00
C276						
C277						
C278	281-0629-00			CAP.,FXD,CER DI:33PF,5%,600V	72982	308-000C0G0330G
C279	281-0540-00			CAP.,FXD,CER DI:51PF,5%,500V	72982	301-000U2J0510J
C280	281-0205-00			CAP.,VAR,PLSTC:5.5-65PF,100V	80031	C010GA/60E
C313	290-0572-00			CAP.,FXD,ELCTLT:0.1UF,20%,50V	56289	196D104X0050HAL
C315	290-0572-00			CAP.,FXD,ELCTLT:0.1UF,20%,50V	56289	196D104X0050HAL
C369	281-0202-00			CAP.,VAR,PLSTC:1.5-5.5PF,100V	80031	C010EA-5E
C380	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C405	281-0629-00			CAP.,FXD,CER DI:33PF,5%,600V	72982	308-000C0G0330G
C406	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KAL
C415	283-0108-00			CAP.,FXD,CER DI:220PF,10%,200V	56289	272C13
C420	281-0629-00			CAP.,FXD,CER DI:33PF,5%,600V	72982	308-000C0G0330G
C425	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KAL
C536	290-0559-00			CAP.,FXD,ELCTLT:22UF,20%,35V	56289	196D226X0035MAL
C539	290-0559-00			CAP.,FXD,ELCTLT:22UF,20%,35V	56289	196D226X0035MAL
C625	290-0559-00			CAP.,FXD,ELCTLT:22UF,20%,35V	56289	196D226X0035MAL
C633	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
CR127	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR130	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR135	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR140	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR313	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR315	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR321	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR323	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR324	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR325	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR327	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR341	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR343	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR344	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR345	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR347	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR410	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR420	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152
CR531	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	1N4152

<sup>1</sup>Optional Timing Capacitor.

<sup>2</sup>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 tolerance should be the same for all the timing capacitors in the assembly.

EXAMPLE:

285-XXXX-XX F-

# Electrical Parts List—FG 503

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR533	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR536	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	02735	37304
CR539	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	02735	37304
CR633	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR634	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
DS528	150-0109-00			LAMP,INCAND:18V,26MA	71744	CM7220
J118	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE	24931	28JR200-1
J244	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE	24931	28JR200-1
J415	131-0255-00			JACK,TIP:FOR 0.08 DIA	98291	SKT-0404
Q121A,B	151-0261-00			TRANSISTOR:SILICON,PNP,DUAL	12040	NS7410
Q141	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q145A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	12040	NS7348
Q201A,B	151-1054-00			TRANSISTOR:SILICON,JFE,N-CHANNEL,DUAL	22229	FD1644
Q211	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
Q221	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q252	151-0103-00			TRANSISTOR:SILICON,NPN	04713	2N2219A
Q255	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q261	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q320	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q340	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
Q355	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q360	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
Q371	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q376	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q380	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q400	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
Q405	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
Q410	151-0439-00			TRANSISTOR:SILICON,NPN	03508	D40E7
Q420	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q425	151-0440-00			TRANSISTOR:SILICON,PNP	80009	151-0440-00
Q523	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q526	151-0190-00			TRANSISTOR:SILICON,NPN	04713	2N3904
Q566	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
Q569	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
Q628	151-0103-00			TRANSISTOR:SILICON,NPN	04713	2N2219A
Q640	151-0134-00			TRANSISTOR:SILICON,PNP	04713	2N2905A
R100	311-1770-00			RES.,VAR,WV:10K OHM,2W	80009	311-1770-00
R101	311-1559-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	73138	91A-10001M
R103	315-0512-00			RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
R105	311-0169-00			RES.,VAR,NONWIR:100 OHM,20%,0.50W	01121	W7564B
R107	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R109	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R111	315-0332-00			RES.,FXD,COMP:3.3K OHM,5%,0.25W	01121	CB3325
R113	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R114	321-0288-00			RES.,FXD,FILM:9.76K OHM,1%,0.125W	75042	CEAT0-9761F
R115	321-0240-00			RES.,FXD,FILM:3.09K OHM,1%,0.125W	75042	CEAT0-3091F
R116	311-1567-00			RES.,VAR,NONWIR:100 OHM,20%,0.50W	73138	91A-100R0M
R118	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	75042	CEAT0-1212F
R120	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R121	322-0205-00			RES.,FXD,FILM:1.33K OHM,1%,0.25W	75042	CEBTO-1331F
R123	311-1565-00			RES.,VAR,NONWIR:250 OHM,20%,0.50W	73138	91A250R0M

Ckt No.	Tektronix Part No.	Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont			
R125	322-0205-00			RES.,FXD,FILM:1.33K OHM,1%,0.25W	75042	CEBTO-1331F
R127	315-0201-00			RES.,FXD,COMP:200 OHM,5%,0.25W	01121	CB2015
R131	323-0176-00			RES.,FXD,FILM:665 OHM,1%,0.50W	75042	CECTO-6650F
R133	315-0272-00			RES.,FXD,COMP:2.7K OHM,5%,0.25W	01121	CB2725
R140	315-0201-00			RES.,FXD,COMP:200 OHM,5%,0.25W	01121	CB2015
R145	322-0209-00			RES.,FXD,FILM:1.47K OHM,1%,0.25W	75042	CEBTO-1471F
R147	322-0209-00			RES.,FXD,FILM:1.47K OHM,1%,0.25W	75042	CEBTO-1471F
R201	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R211	315-0332-00			RES.,FXD,COMP:3.3K OHM,5%,0.25W	01121	CB3325
R214	315-0821-00			RES.,FXD,COMP:820 OHM,5%,0.25W	01121	CB8215
R221	315-0511-00			RES.,FXD,COMP:510 OHM,5%,0.25W	01121	CB5115
R223	301-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.50W	01121	EB1525
R224	321-0166-00			RES.,FXD,FILM:523 OHM,1%,0.125W	75042	CEATO-5230F
R225	321-0168-00			RES.,FXD,FILM:549 OHM,1%,0.125W	75042	CEATO-5490F
R226	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	75042	CEATO-3011F
R227	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	75042	CEATO-2001F
R229	321-0293-00			RES.,FXD,FILM:11K OHM,1%,0.125W	75042	CEATO-1102F
R230	321-0194-00			RES.,FXD,FILM:1.02K OHM,1%,0.125W	75042	CEATO-1021F
R231	321-0194-00			RES.,FXD,FILM:1.02K OHM,1%,0.125W	75042	CEATO-1021F
R232	321-0293-00			RES.,FXD,FILM:11K OHM,1%,0.125W	75042	CEATO-1102F
R235	315-0751-00			RES.,FXD,COMP:750 OHM,5%,0.25W	01121	CB7515
R237	315-0512-00			RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
R239	301-0511-00			RES.,FXD,COMP:510 OHM,5%,0.50W	01121	EB5115
R241	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R243	315-0471-00			RES.,FXD,COMP:470 OHM,5%,0.25W	01121	CB4715
R244	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R246	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R250	321-0217-00			RES.,FXD,FILM:1.78K OHM,1%,0.125W	75042	CEATO-1781F
R251	321-0192-00			RES.,FXD,FILM:976 OHM,1%,0.125W	75042	CEATO-9760F
R252	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEATO-4991F
R253	321-0220-00			RES.,FXD,FILM:1.91K OHM,1%,0.125W	75042	CEATO-1911F
R255	322-0154-00			RES.,FXD,FILM:392 OHM,1%,0.25W	75042	CEBTO-3920F
R256	321-0235-00			RES.,FXD,FILM:2.74K OHM,1%,0.125W	75042	CEATO-2741F
R258	321-0209-00			RES.,FXD,FILM:1.47K OHM,1%,0.125W	75042	CEATO-1471F
R260	323-0135-00			RES.,FXD,FILM:249 OHM,1%,0.50W	75042	CECTO-2490F
R261	315-0682-00			RES.,FXD,COMP:6.8K OHM,5%,0.25W	01121	CB6825
R310	321-0246-00			RES.,FXD,FILM:3.57K OHM,1%,0.125W	75042	CEATO-3571F
R311	311-1567-00			RES.,VAR,NONWIR:100 OHM,20%,0.50W	73138	91A-100ROM
R313	321-0158-00			RES.,FXD,FILM:432 OHM,1%,0.125W	75042	CEATO-4320F
R315	321-0158-00			RES.,FXD,FILM:432 OHM,1%,0.125W	75042	CEATO-4320F
R317	311-1567-00			RES.,VAR,NONWIR:100 OHM,20%,0.50W	73138	91A-100ROM
R318	321-0246-00			RES.,FXD,FILM:3.57K OHM,1%,0.125W	75042	CEATO-3571F
R320	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R321	321-0037-00			RES.,FXD,FILM:23.7 OHM,1%,0.125W	75042	CEATO-23R70F
R323	321-0063-00			RES.,FXD,FILM:44.2 OHM,1%,0.125W	75042	CEATO-44R2F
R324	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	75042	CEATO-75R00F
R325	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEATO-1000F
R327	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	75042	CEATO-75R00F
R329	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	75042	CEATO-3920F
R331	321-0205-00			RES.,FXD,FILM:1.33K OHM,1%,0.125W	75042	CEATO-1331F
R333	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	75042	CEATO-3241F
R340	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R341	321-0037-00			RES.,FXD,FILM:23.7 OHM,1%,0.125W	75042	CEATO-23R70F

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R343	321-0063-00			RES.,FXD,FILM:44.2 OHM,1%,0.125W	75042	CEAT0-44R2F
R344	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	75042	CEAT0-75R00F
R345	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEAT0-1000F
R347	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	75042	CEAT0-75R00F
R349	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	75042	CEAT0-1101F
R355	315-0821-00			RES.,FXD,COMP:820 OHM,5%,0.25W	01121	CB8215
R357	315-0511-00			RES.,FXD,COMP:510 OHM,5%,0.25W	01121	CB5115
R359	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R360	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R361	315-0911-00			RES.,FXD,COMP:910 OHM,5%,0.25W	01121	CB9115
R364	315-0510-00			RES.,FXD,COMP:51 OHM,5%,0.25W	01121	CB5105
R365	311-1467-00			RES.,VAR,NONWIR:2K OHM,20%,1W	01121	11M040
R367	315-0750-00			RES.,FXD,COMP:75 OHM,5%,0.25W	01121	CB7505
R369	321-0223-00			RES.,FXD,FILM:2.05K OHM,1%,0.125W	75042	CEAT0-2051F
R371	321-0283-00			RES.,FXD,FILM:8.66K OHM,1%,0.125W	75042	CEAT0-8661F
R375	311-1568-00			RES.,VAR,NONWIR:50 OHM,20%,0.50W	73138	91A50R00M
R376	315-0122-00			RES.,FXD,COMP:1.2K OHM,5%,0.25W	01121	CB1225
R377	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R379	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R380	315-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R381	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R382	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R384	315-0182-00			RES.,FXD,COMP:1.8K OHM,5%,0.25W	01121	CB1825
R385	311-1467-00			RES.,VAR,NONWIR:2K OHM,20%,1W	01121	11M040
R386	315-0182-00			RES.,FXD,COMP:1.8K OHM,5%,0.25W	01121	CB1825
R389	315-0622-00			RES.,FXD,COMP:6.2K OHM,5%,0.25W	01121	CB6225
R400	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R405	315-0301-00			RES.,FXD,COMP:300 OHM,5%,0.25W	01121	CB3015
R406	315-0100-00	B010100	B019999	RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R406	303-0100-00	B020000		RES.,FXD,COMP:10 OHM,5%,1W	01121	GB1005
R410	315-0100-00	B010100	B019999	RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R410	303-0100-00	B020000		RES.,FXD,COMP:10 OHM,5%,1W	01121	GB1005
R412	315-0303-00			RES.,FXD,COMP:30K OHM,5%,0.25W	01121	CB3035
R415	305-0510-00			RES.,FXD,COMP:51 OHM,5%,2W	01121	HB5105
R419	315-0102-00			RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R420	315-0301-00			RES.,FXD,COMP:300 OHM,5%,0.25W	01121	CB3015
R425	315-0100-00	B010100	B019999	RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R425	303-0100-00	B020000		RES.,FXD,COMP:10 OHM,5%,1W	01121	GB1005
R427	315-0100-00	B010100	B019999	RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R427	303-0100-00	B020000		RES.,FXD,COMP:10 OHM,5%,1W	01121	GB1005
R510	307-0093-00			RES.,FXD,COMP:1.2 OHM,5%,0.50W	01121	EB12G5
R511	301-0100-00			RES.,FXD,COMP:10 OHM,5%,0.50W	01121	EB1005
R512	315-0432-00			RES.,FXD,COMP:4.3K OHM,5%,0.25W	01121	CB4325
R517	315-0332-00			RES.,FXD,COMP:3.3K OHM,5%,0.25W	01121	CB3325
R519	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	75042	CEAT0-5111F
R520	311-1561-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	73138	91A-25000M
R522	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R523	308-0685-00			RES.,FXD,WW:1.5 OHM,10%,1W	75042	BW20-1R500J
R525	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R526	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R527	301-0201-00			RES.,FXD,COMP:200 OHM,5%,0.50W	01121	EB2015
R528	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEAT0-1002F
R530	301-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.50W	01121	EB1525

Ckt No.	Tektronix Part No.	Serial/Model No.		Name & Description	Mfr	
		Eff	Dscont		Code	Mfr Part Number
R560	307-0093-00			RES.,FXD,COMP:1.2 OHM,5%,0.50W	01121	EB12G5
R561	301-0100-00			RES.,FXD,COMP:10 OHM,5%,0.50W	01121	EB1005
R563	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	75042	CEATO-5111F
R564	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R566	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R567	308-0685-00			RES.,FXD,WW:1.5 OHM,10%,1W	75042	BW20-1R500J
R569	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R600	301-0431-00			RES.,FXD,COMP:430 OHM,5%,0.50W	01121	EB4315
R603	301-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.50W	01121	EB1525
R625	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	75042	CEATO-3011F
R626	321-0312-00			RES.,FXD,FILM:17.4K OHM,1%,0.125W	75042	CEATO-1742F
R629	321-0289-07			RES.,FXD,FILM:10K OHM,0.1%,0.125W	75042	CEAT9-1002B
R631	301-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.50W	01121	EB1525
R633	321-0289-07			RES.,FXD,FILM:10K OHM,0.1%,0.125W	75042	CEAT9-1002B
R640	315-0512-00			RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
RT103	307-0343-00			RES.,THERMAL:200 OHM,10%	15801	2D10
S270	263-1090-00			ACTUATOR ASSY,CAM SW:MULTIPLIER	80009	263-1090-00
S380	263-1038-00			ACTUATOR ASSY,CAM SW:FUNCTION	80009	263-1038-00
U101	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	S5558V
U121	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U235	156-0116-00			MICROCIRCUIT,LI:DUAL COMPARATOR	04713	MC1711CL
U241	156-0043-00	B010100	B019999	MICROCIRCUIT,DI:2-INPUT NOR GATE	01295	SN7402N
U241	156-0180-00	B020000		MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74800N
U512	156-0067-06			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U566	156-0067-06			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-06
U628	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U640	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
VR131	152-0217-00			SEMICOND DEVICE:ZENER,0.4W,8.2V,5%	07910	1N756A
VR235	152-0168-00			SEMICOND DEVICE:ZENER,0.4W,12V,5%	04713	1N963B
VR239	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	1N753A
VR261	152-0243-00			SEMICOND DEVICE:ZENER,0.4W,15V,5%	81483	1N965B
VR517	152-0461-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	1N821
VR600	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	07910	1N751A
VR603	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	07910	1N751A

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



## CROSS INDEX MFR. CODE NUMBER TO MANUFACTURER

MFR.CODE	MANUFACTURER	ADDRESS	CITY,STATE,ZIP
0000C	Gettig Engineering and Manufacturing Co.		Springmill, PA 16875
01295	Texas Instruments, Inc., Semiconductor Group	P. O. Box 5012	Dallas, TX 75222
08261	Spectra-Strip Corp.	7100 Lampson Ave.	Garden Grove, CA 92642
22526	Berg Electronics, Inc.	Youk Expressway	New Cumberland, PA 17070
24931	Specialty Connector Co., Inc.	3560 Madison Ave.	Indianapolis, IN 46227
26365	Gries Reproducer Co., Div. of Coats and Clark Inc.	125 Beechwood Ave.	New Rochelle, NY 10802
45722	USM Corp., Parker-Kalon Fastener Div.	1 Peekay Drive	Clifton, NJ 07014
73743	Fischer Special Mfg. Co.	446 Morgan St.	Cincinnati, OH 45206
74445	Holo-Krome Co.	31 Brook St. West	Hartford, CT 06110
78189	Illinois Tool Works, Inc. Shakeproof Division	St. Charles Road	Elgin, IL 60120
78471	Tilley Mfg. Co.	900 Industrial Rd.	San Carlos, CA 94070
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
82647	Texas Instruments, Inc., Control Products Div.	34 Forest St.	Attleboro, MA 02703
83385	Central Screw Co.	2530 Crescent Dr.	Broadview, IL 60153

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscnt	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	366-1007-03			1						KNOB:GRAY WITH SETSCREW	80009	366-1007-03
	213-0153-00			2						. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-3	366-1031-03			1						KNOB:RED--CAL	80009	366-1031-03
	213-0153-00			1						. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-4	366-1170-01			1						KNOB:GRAY,4 SIDED	80009	366-1170-01
	213-0153-00			2						. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-5	366-0494-00			3						KNOB:GRAY	80009	366-0494-00
	213-0153-00			1						. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-6	214-1840-00			1						PIN,KNOB SECRG:	80009	214-1840-00
-7	366-1422-01			1						KNOB:LATCH	80009	366-1422-01
-8	131-0955-00			2						CONNECTOR,RCPT,:BNC,FEMALE	24931	28JR200-1
-9	131-0955-00			1						CONNECTOR,RCPT,:BNC,FEMALE	24931	28JR200-1
										(ATTACHING PARTS)		
-10	210-0255-00			1						TERMINAL,LUG:0.391" ID INT TOOTH	80009	210-0255-00
										- - - * - - -		
-11	-----			2						RES.,VAR:(SEE R365,R385 EPL)		
										(ATTACHING PARTS FOR EACH)		
-12	210-0583-00			1						NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20319-402
-13	210-0940-00			1						WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
										- - - * - - -		
-14	-----			1						RES.,VAR:(SEE R100 EPL)		
										(ATTACHING PARTS)		
-15	210-0413-00			1						NUT,PLAIN,HEX.:0.375-32 X 0.50 INCH,STL	73743	3145-402
-16	210-0978-00			1						WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL	78471	OBD
										- - - * - - -		
-17	358-0378-00			1						BUSHING,SLEEVE:PRESS MOUNT	80009	358-0378-00
-18	333-1828-00			1						PANEL,FRONT:FOR FG503	80009	333-1828-00
-19	214-1513-01			1						LCH,PLUG-IN RET:	80009	214-1513-01
										(ATTACHING PARTS)		
-20	213-0254-00			1						SCR,TPG,THD CTG:2-56X0.25"100 DEG,FLH STL	45722	OBD
										- - - * - - -		
-21	200-0935-00			1						BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-22	378-0602-00			1						LENS,LIGHT:GREEN	80009	378-0602-00
-23	352-0157-00			1						LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-24	386-2555-00	B010100	B010228	1						SUBPANEL,FRONT:PLASTIC	80009	386-2555-00
	386-2555-02	B010229		1						SUBPANEL,FRONT:PLASTIC	80009	386-2555-02
										(ATTACHING PARTS)		
-25	213-0229-00			4						SCR,TPG,THD FOR:6-20 X0.375"100 DEG,FLH STL	83385	OBD
										- - - * - - -		
-26	337-1984-00			1						SHIELD,ELEC:FRONT PANEL	80009	337-1984-00
-27	384-0926-00			1						SHAFT,CAM SW:EXT,2.958 INCH LONG	80009	384-0926-00
-28	384-0260-00			1						ROD,EXT:SHAFT,9.470 INCH LONG	80009	384-0260-00
	672-0449-00			1						CKT BOARD ASSY:	80009	672-0449-00
										(ATTACHING PARTS)		
-29	213-0146-00			3						SCR,TPG,THD FOR:6-20 X 0.313 INCH,PNH STL	83385	OBD
										- - - * - - -		
										. CKT BOARD ASSY W/CAM SWITCH INCLUDES:		
-30	-----			1						. CKT BOARD ASSY:MAIN(SEE A1 EPL)		
										. . . CKT BOARD ASSY INCLUDES:		
-31	131-0566-00			4						. . . LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	0000C	I-2007-1
-32	131-0604-00			12						. . . CONTACT,ELEC:0.025 SQ X 0.365 INCH LONG	80009	131-0604-00
-33	136-0252-04			3						. . . CONTACT,ELEC:0.188 INCH LONG	22526	75060
-34	136-0260-02			2						. . . SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	01295	C931602
-35	136-0269-02			2						. . . SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C931402
-36	136-0514-00			2						. . . SOCKET,PLUG-IN:MICROCIRCUIT,8 CONTACT	82647	C930802
-37	214-0579-00			6						. . . TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-38	376-0051-01			1						. . . CPLG,SHAFT,FLEX:FOR 0.125 INCH DIA SHAFTS	80009	376-0051-01
										. . . COUPLING INCLUDES:		
	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
	213-0048-00			4						. . . SETSCREW:4-40 X 0.125 INCH,HEX SOC STL	74445	OBD



Mechanical Parts List—FG 503

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5					Name & Description	Mfr	
				Code	Mfr Part Number						
1-39	-----	-----	1	.	.	.	.	.	RES.,VAR:(SEE R105 EPL) (ATTACHING PARTS)		
-40	210-0583-00		1	.	.	.	.	.	NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20319-402
-41	210-0046-00		1	.	.	.	.	.	WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
-42	407-0579-00		1	.	.	.	.	.	BRKT,RES.MTG:	80009	407-0579-00
-43	-----	-----	2	.	.	.	.	.	TRANSISTOR:(SEE Q410,Q425 EPL) (ATTACHING PARTS)		
-44	211-0040-00		2	.	.	.	.	.	SCREW,MACHINE:4-40 X 0.25",BDCH PLSTC	26365	NOTE
-45	210-0921-00		2	.	.	.	.	.	WASHER,MICA:0.50 X 0.141 X0.005 INCH THK	80009	210-0921-00
-46	214-2215-00		1	.	.	.	.	.	HEAT SINK,XSTR:2 TAB MTG. (ATTACHING PARTS)	80009	214-2215-00
-47	211-0008-00		2	.	.	.	.	.	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-48	129-0419-00		1	.	.	.	.	.	POST,ELEC-MECH:HEX.,0.588 INCH LONG	80009	129-0419-00
	263-1090-00		1	.	.	.	.	.	ACTR ASSY,CAM S:FUNCT (ATTACHING PARTS)	80009	263-1090-00
-49	211-0116-00		4	.	.	.	.	.	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
-50	200-1441-00		1	.	.	.	.	.	ACTUATOR ASSY INCLUDES: COVER,CAM SW.:7 ELEMENTS	80009	200-1441-00
-51	354-0219-00		1	.	.	.	.	.	RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
-52	214-1127-00		2	.	.	.	.	.	ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-53	214-1704-01		2	.	.	.	.	.	SPRING,FLAT:CAM SW DETENT,0.008 INCH THK	80009	214-1704-01
-54	210-0406-00		4	.	.	.	.	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-55	401-0155-00		1	.	.	.	.	.	BEARING,CAM SW:FRONT	80009	401-0155-00
-56	105-0620-00		1	.	.	.	.	.	ACTUATOR,CAM SW:	80009	105-0620-00
-57	401-0156-00		1	.	.	.	.	.	BEARING,CAM SW:REAR	80009	401-0156-00
	263-1038-00		1	.	.	.	.	.	ACTR ASSY,CAM S:FUNCT (ATTACHING PARTS)	80009	263-1038-00
-58	211-0116-00		4	.	.	.	.	.	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
-59	200-1660-00		1	.	.	.	.	.	ACTUATOR ASSY INCLUDES: COVER,CAM SW.:5 ELEMENTS	80009	200-1660-00
-60	354-0219-00		1	.	.	.	.	.	RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
-61	214-1127-00		1	.	.	.	.	.	ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-62	214-1704-01		2	.	.	.	.	.	SPRING,FLAT:CAM SW DETENT,0.008 INCH THK	80009	214-1704-01
-63	210-0406-00		4	.	.	.	.	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-64	401-0155-00		1	.	.	.	.	.	BEARING,CAM SW:FRONT	80009	401-0155-00
-65	105-0621-00		1	.	.	.	.	.	ACTUATOR,CAM SW:	80009	105-0621-00
-66	401-0156-00		1	.	.	.	.	.	BEARING,CAM SW:REAR	80009	401-0156-00
-67	426-0724-00		1	.	.	.	.	.	FR SECT,PLUG-IN:BOTTM	80009	407-0724-00
-68	214-1061-00		1	.	.	.	.	.	SPRING,GROUND:FLAT	80009	214-1061-00
-69	426-0725-00		1	.	.	.	.	.	FR SECT,PLUG-IN:TOP	80009	407-0725-00
	175-0826-00		FT	.	.	.	.	.	WIRE,ELECTRICAL:3 WIRE RIBBON	08261	TEK-175-0826-00
ACCESSORIES											
	070-1727-00		1	.	.	.	.	.	MANUAL,TECH:INSTRUCTION	80009	070-1727-00

## **MANUAL CHANGE INFORMATION**

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

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

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

## **SERVICE NOTE**

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

# CALIBRATION TEST EQUIPMENT REPLACEMENT

## Calibration Test Equipment Chart

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

### Comparison of Main Characteristics

Comparison of Main Characteristics		
DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 nsec into 50 $\Omega$ .	107 - Risetime less than 3.0 nsec into 50 $\Omega$ .
108	PG 501 - 5 V output pulse; 3.5 nsec Risetime.	108 - 10 V output pulse; 1 nsec Risetime.
111	PG 501 - Risetime less than 3.5 nsec; 8 nsec Pretrigger pulse delay.	111 - Risetime 0.5 nsec; 30 to 250 nsec Pretrigger Pulse delay.
114	PG 501 - $\pm 5$ V output.	114 - $\pm 10$ V output. Short proof output.
115	PG 501 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; $\pm 5$ V dc Offset; short proof output. Has $\pm 5$ V output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; $\pm 10$ V output. Short proof output.
PG 502 replaces 107		
108	PG 502 - 5 V output	108 - 10 V output.
111	PG 502 - Risetime less than 1 nsec; 10 nsec Pretrigger pulse delay.	111 - Risetime 0.5 nsec; 30 to 250 nsec Pretrigger pulse delay.
114	PG 502 - $\pm 5$ V output.	114 - $\pm 10$ V output. Short proof output.
115	PG 502 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; $\pm 5$ V output. Short proof output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; $\pm 10$ V output. Short proof output.
2101	PG 502 - Does not have Paired, Delayed, Undelayed and output locked mode; $\pm 5$ V output.	2101 - Paired, Delayed, Undelayed and output locked on mode; 10 V output.
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude, 60 V output.	106 - Positive and Negative-going trigger output signal. 50 nsec 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, 191, 067-0532-01	SG 503 - Amplitude range 5 mV to 5.5 V p-p. SG 503 - Frequency range 250 kHz to 250 MHz. SG 503 - Frequency range 250 kHz to 250 MHz.	190B - Amplitude range 40 mV to 10 V p-p. 191 - Frequency range 350 kHz to 100 MHz. 0532-01 - Frequency range 65 MHz to 500 MHz.
TG 501 replaces 180, 180A	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. Only one time-mark can be generated.	180A - Marker outputs, 5 sec to 1 $\mu$ s. Sinewave available at 5, 10, and 50 MHz. Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be stacked.
181	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns.	181 - Marker outputs, 1, 10, 100, 1000, and 10,000, plus 10 MHz sinewave.
2901	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. Only one time-mark can be generated.	2901 - Marker outputs, 5 sec to 0.1 $\mu$ s. Sinewave available at 5, 10, and 50 ns. Separate trigger pulses, from 5 sec to 0.1 $\mu$ s. Multiple time-marks can be stacked.



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# MANUAL CHANGE INFORMATION

PRODUCT FG 503

CHANGE REFERENCE C5/376

070-1727-00

DATE 3-19-76

**CHANGE:**

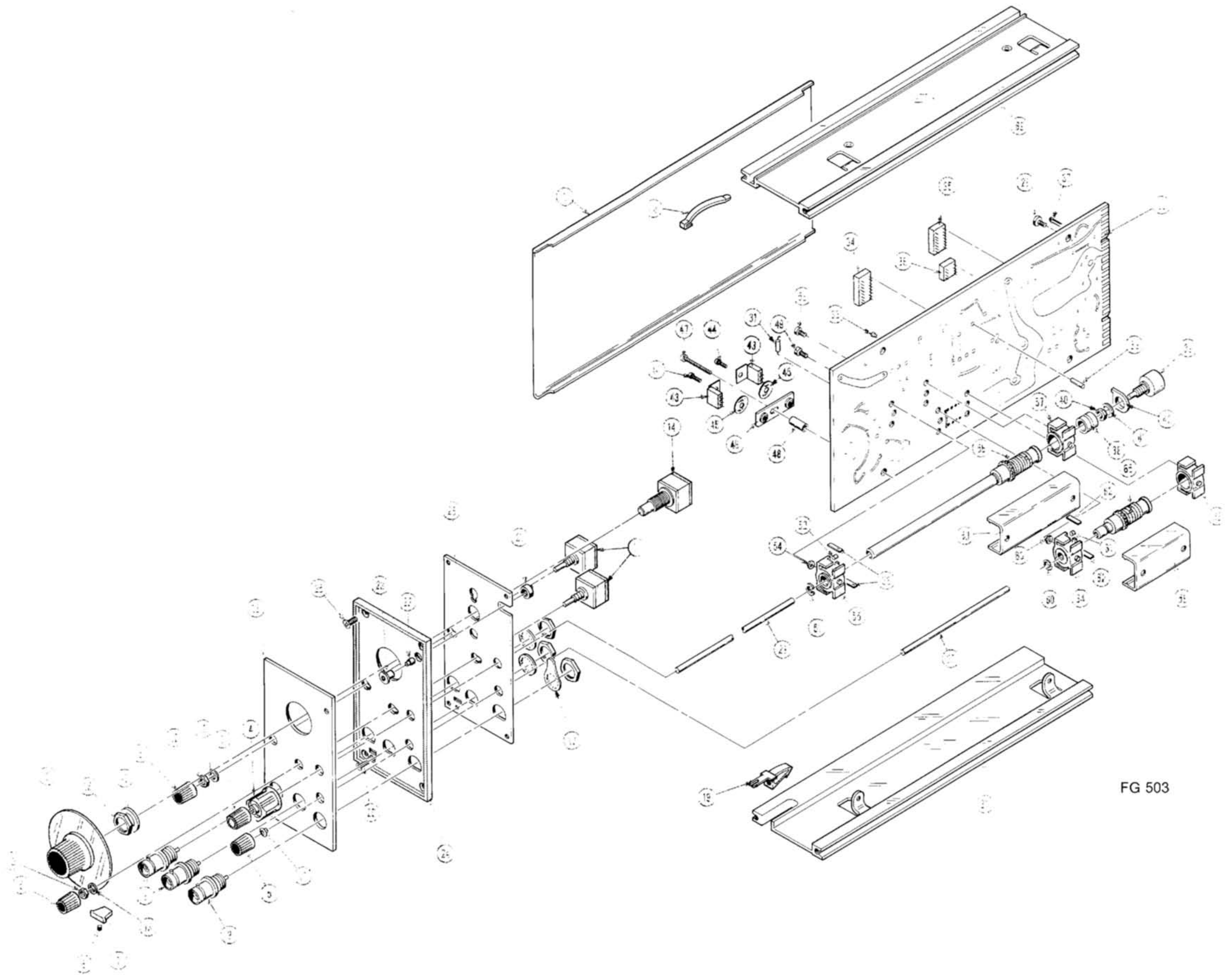
**DESCRIPTION**

## TEXT CORRECTION

Page 1-4, BASIC OPERATION, right column, just above Fig. 1-4

CHANGE: The text should read as follows:

MULTIPLIER setting, by applying a 0 V to 10 V signal to the VCF IN connector. It may be necessary to vary the CAL control to obtain the full 1000:1 swept range or the lowest swept frequency desired. See Fig. 1-4 for maximum VCF range for each MULTIPLIER setting."



## ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty						Name & Description	Mfr Code	Mfr Part Number	
		Eff	Dscont		1	2	3	4	5				
2-	070-1727-00			1						MANUAL,TECH: INSTRUCTION	80009	070-1727-00	