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FG 503 FUNCTION GENERATOR

INSTRUCTION MANUAL

BEFORE READING

PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL.

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TEKTRONIX®

FG 503 FUNCTION GENERATOR

INSTRUCTION MANUAL

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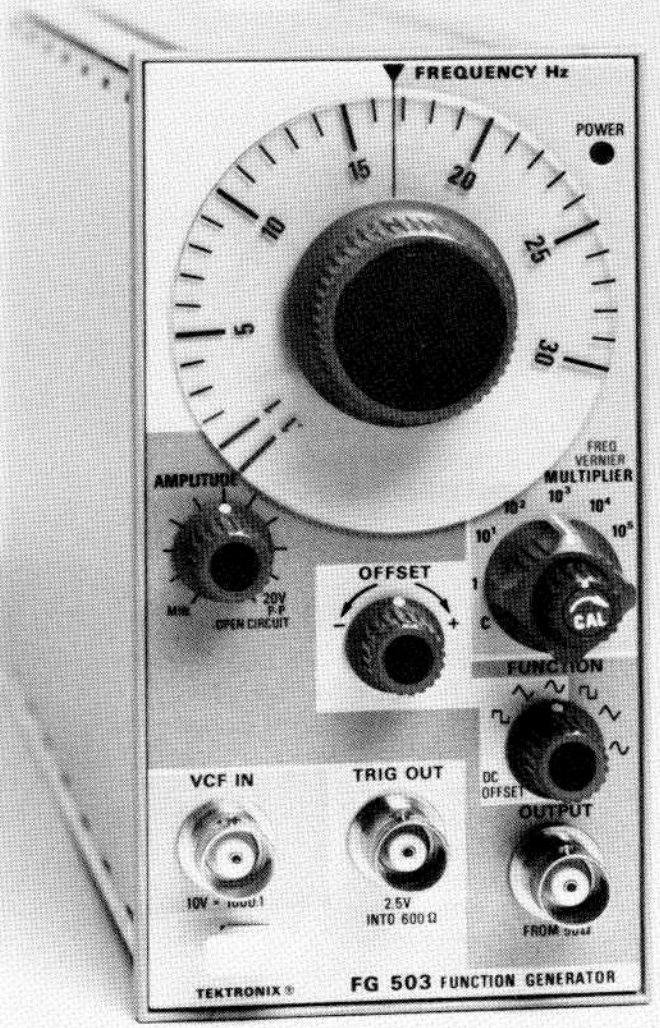

FREQUENCY Hz
POWER
AMPLITUDE
MIN
20V P-P OPEN CIRCUIT
OFFSET
FREQ VERNIER
MULTIPLIER
CAL
FUNCTION
DC OFFSET
VCF IN
TRIG OUT
2.5V INTO 600Ω
OUTPUT
TEKTRONIX ®
FG 503 FUNCTION GENERATOR

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 ±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

CAUTION

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

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

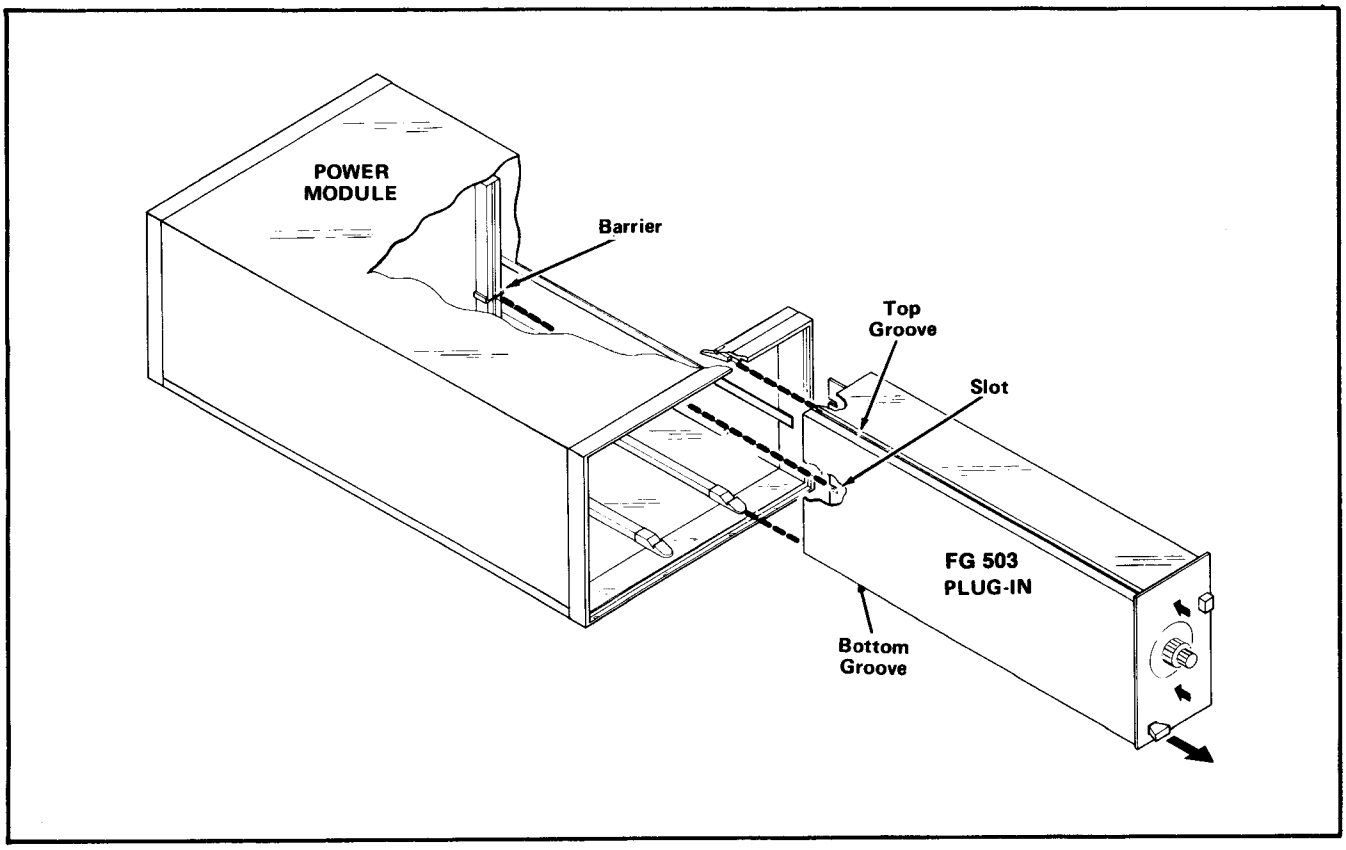


Fig. 1-1. FG 503 installation and removal.

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 Ω voltage source working into a 50 Ω 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 Ω 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 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 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. $R_t = \sqrt{(R_1)^2 + (R_2)^2 + \ldots}$ 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 ±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:

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

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_1 equals 50 Ω and Z_2 equals 125 Ω.

Therefore:

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

and

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

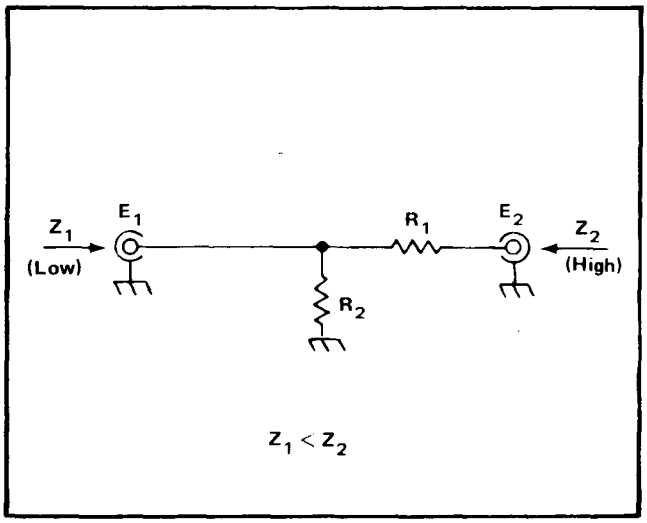


Fig. 1-2. Impedance matching network that provides minimum attenuation.

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,

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

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_1) applied from the lower impedance source encounters a voltage attenuation (A_1) that is greater than 1 and less than 2, as follows:

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

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

$$A_2 = \frac{E_2}{E_1} = \frac{R_1}{R_2} + \frac{R1}{Z_1} + 1.$$

In the example of matching 50 Ω to 125 Ω,

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

and

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

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.

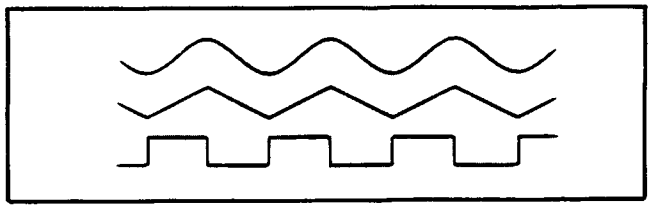


Fig. 1-3. Output waveforms available from the FG 503.

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. 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.

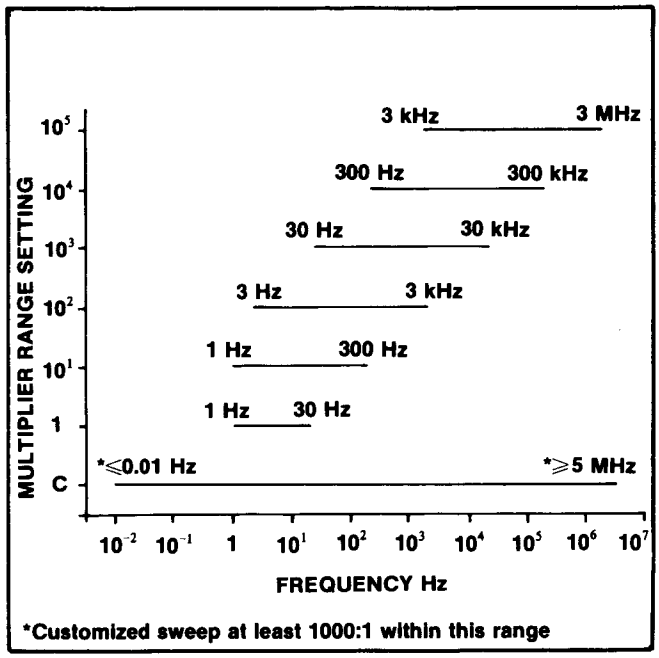


Fig. 1-4. Graph showing range of frequencies for each MULTIPLIER setting that can be swept with a 0 to 10 V signal applied to the VCF input.

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.

CUSTOM TIMING CAPACITOR SELECTION

This feature allows the user to custom select a swept frequency range. For example, assume a swept frequency 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 μF, 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 μF and must have at least a 10 V rating. Ceramic and mylar capacitors work well in this application.

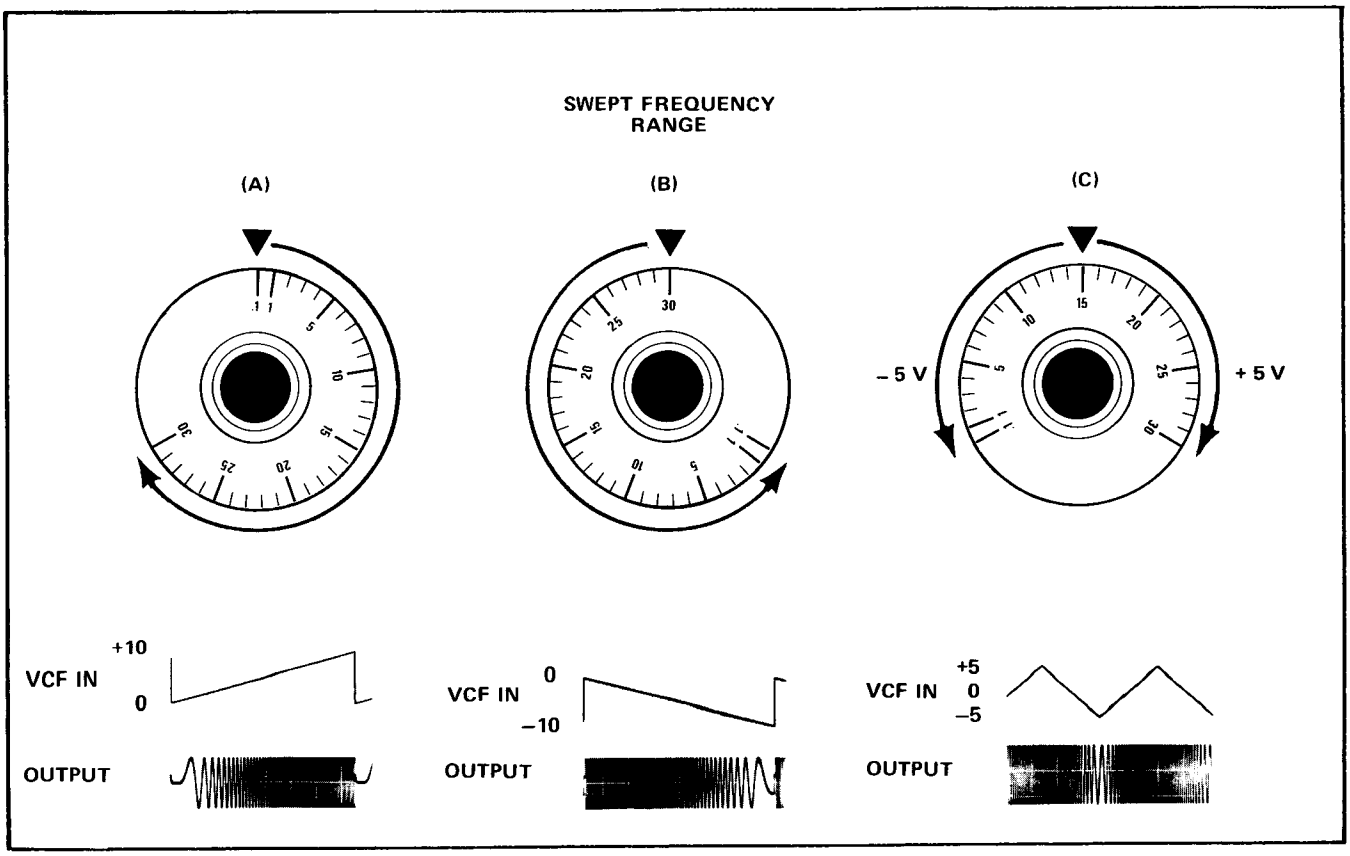


Fig. 1-5. Swept frequency range with 10 V signals applied to VCF IN Connector.

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.

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 calbration is not changed in the custom position.

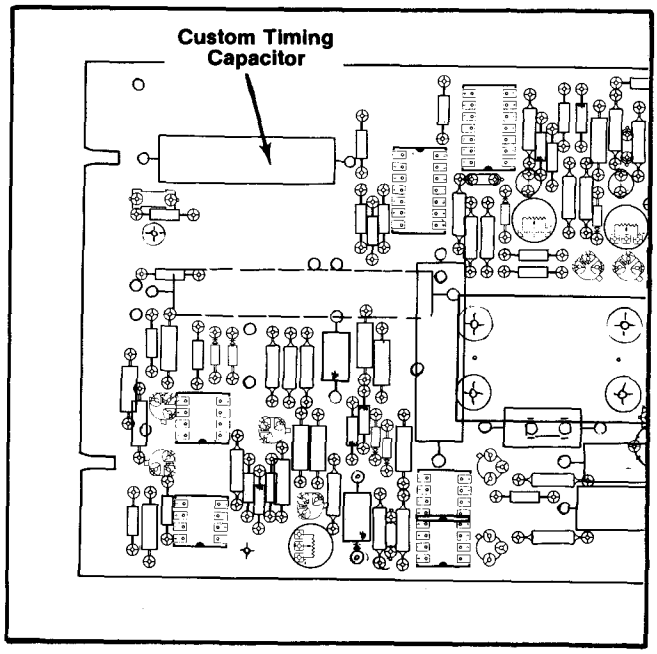


Fig. 1-6. Custom timing capacitor location.

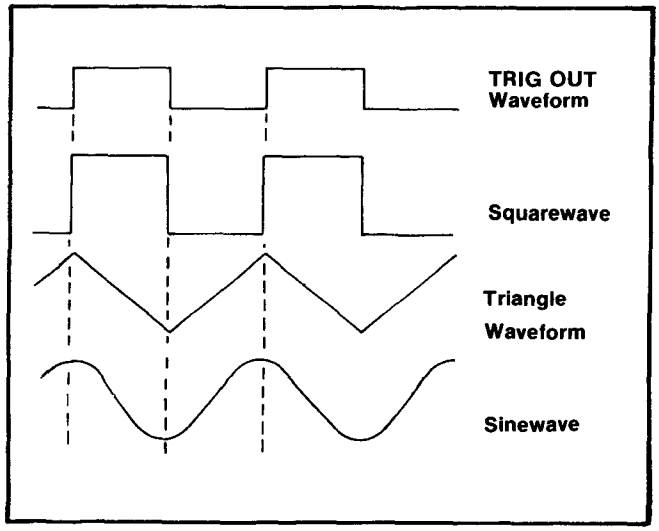


Fig. 1-7. Phase relationships between various OUTPUT waveforms and the TRIG OUT waveform.

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. 1-8.

2. Set the MULTIPLIER selector and FREQUENCY Hz dial for the desired upper or lower frequency limit (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.

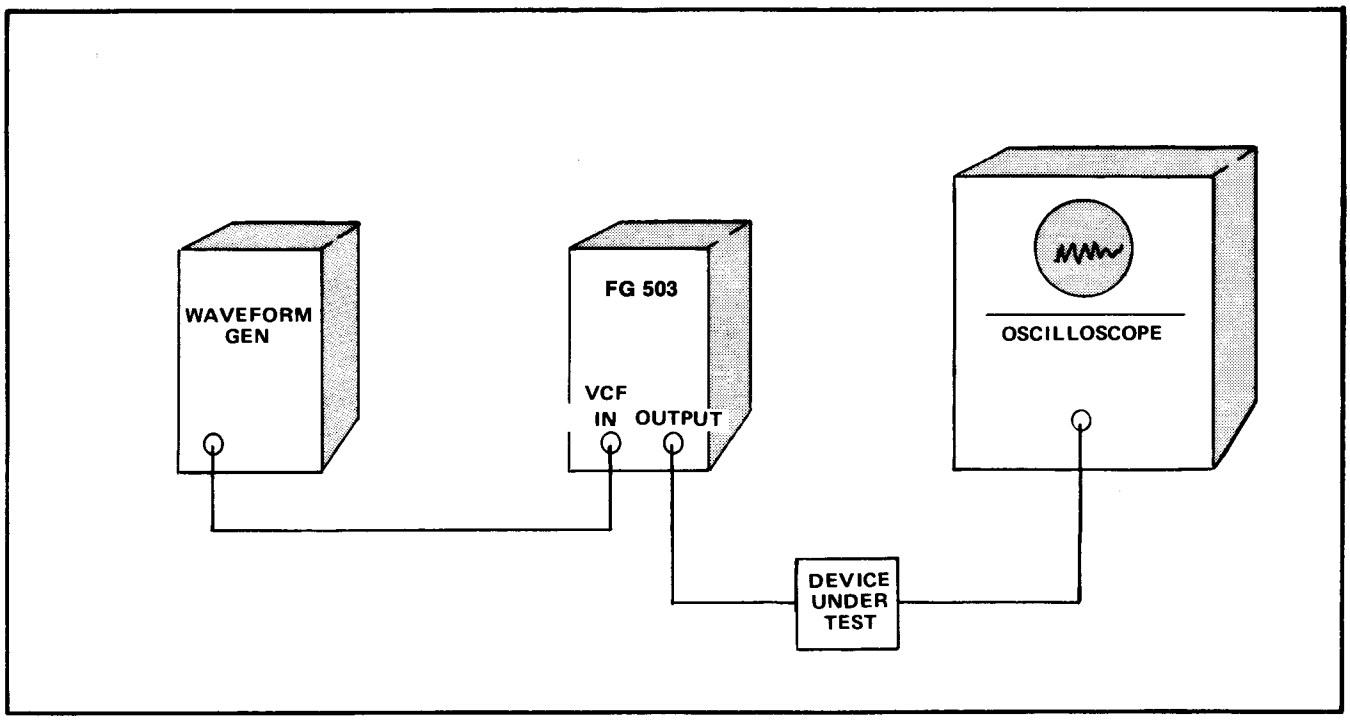


Fig. 1-8. Analyzing circuit or system response.

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: ≤0.01 Hz to ≥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:

≤0.1% of full scale for 1 hour after a 30 minute warmup, ≤0.5% of full scale for 24 hours. Dial must be on calibrated portion and ambient temperature must be 25°C ±5°C.

DIAL ACCURACY:

Within ±5% of full scale from 1 Hz to 3 MHz.

DIAL RANGE:

1 to 30 calibrated, 0.1 to 1 uncalibrated.

OUTPUT AMPLITUDE:

≥20 V p-p open circuit, ≥10 V p-p into a 50 Ω load referenced at 10 kHz and excluding offset.

Variable Amplitude Range: ≥20:1.

AMPLITUDE FLATNESS:

Within 2 db referenced at 10 kHz.

OFFSET RANGE:

At least ±7.5 V open circuit, ≥±3.75 V into a 50 Ω load. Peak signal plus offset at least ±15 V open circuit, ±6 V into 50 Ω load.

SINE WAVE DISTORTION:

≤0.5% from 1 Hz to 30 kHz,
≤1.0% from ≥30 kHz to 300 kHz,
≤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 ±5°C.

TRIANGLE LINEARITY: (From 10% to 90% of the generated ramp.)

Within 1% from 1 Hz to 100 kHz.

Within 5% from 100 kHz to 3 MHz.

SQUAREWAVE:

Risetime: ≤60 ns.

Aberrations: ≤3% p-p at full amplitude into a 50 Ω load.

VOLTAGE CONTROLLED FREQUENCY INPUT:

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

Maximum Slew Rate: Nominally 0.5 V/μs.

TRIGGER OUTPUT:

≥2.5 V into 600 Ω. Leading edge coincides with positive peak of sine and triangle waveforms, and preceeds leading edge of square wave nominally by 50 ns.

POWER CONSUMPTION:

≈15 watts.

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.

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.

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

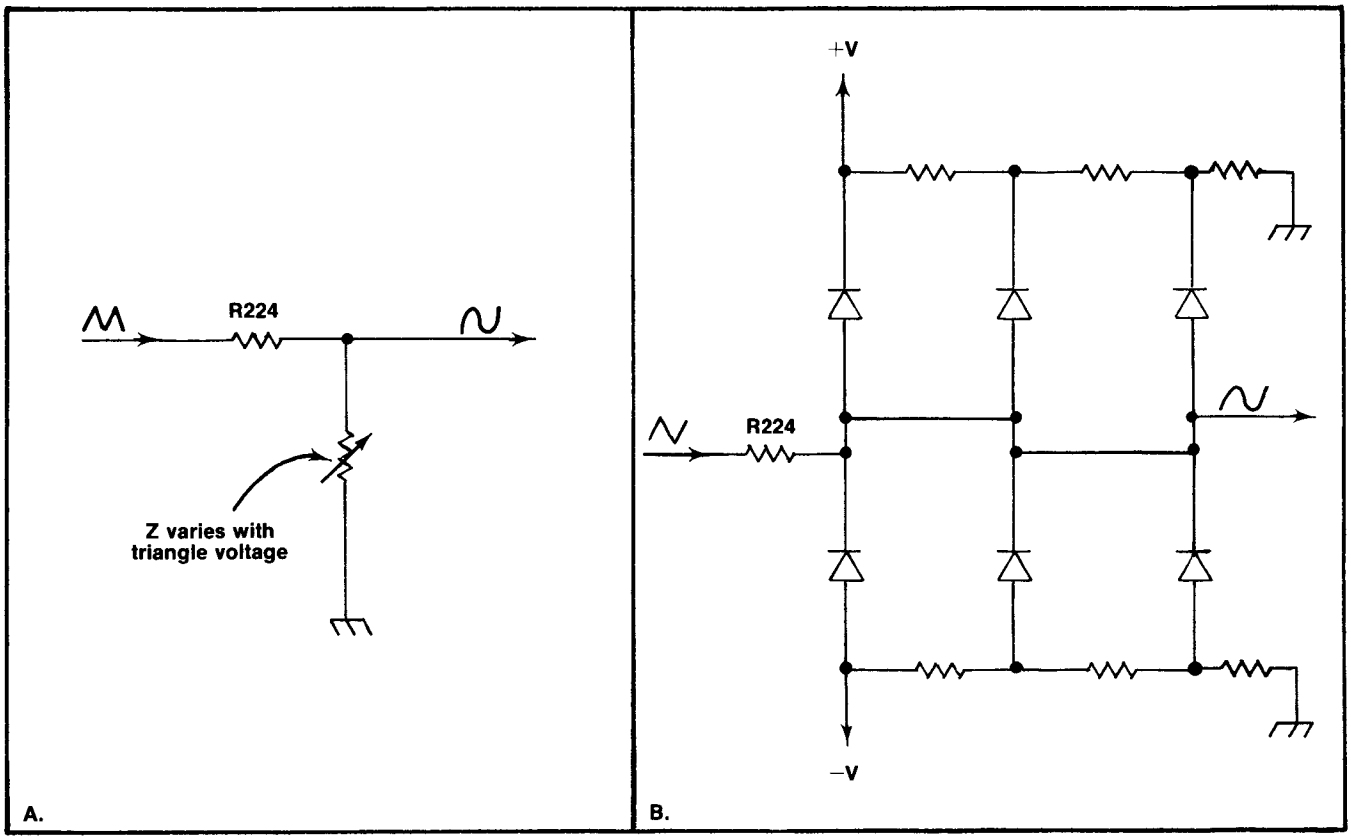


Fig. 2-1. Simplified sine shaper circuits. Part A shows equivalent circuit. Part B shows a three step approximation (actual circuit is a five step approximation). See text.

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.

SERVICE INFORMATION

SYMBOLS AND REFERENCE DESIGNATORS

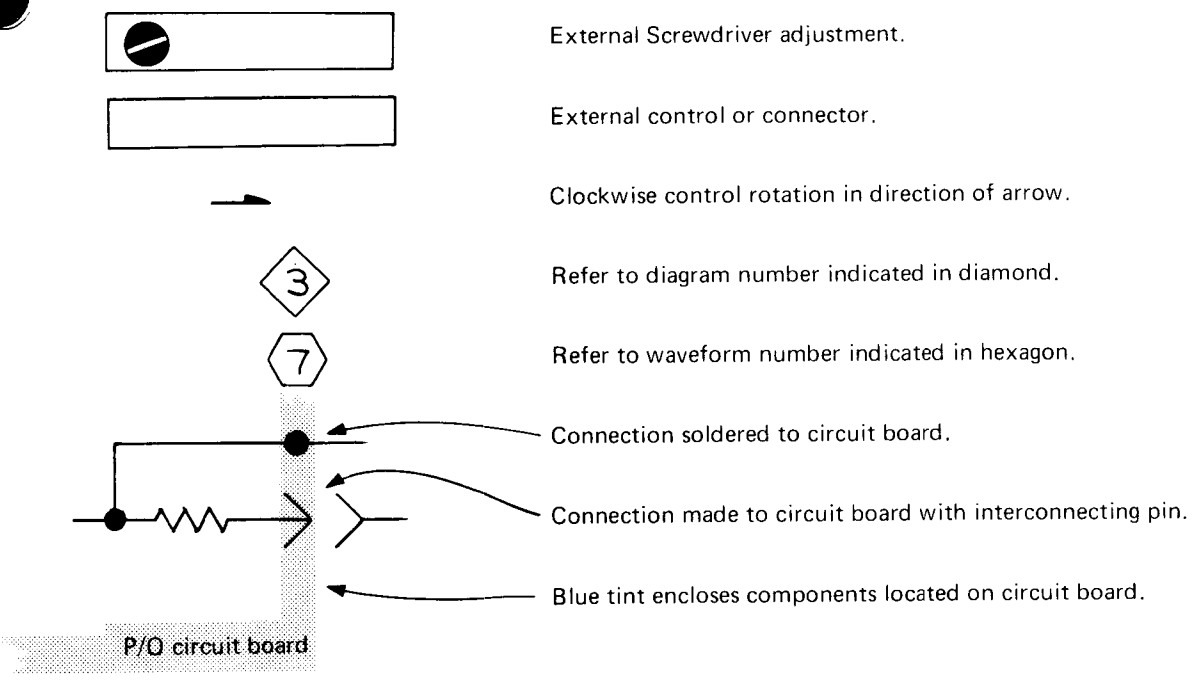
Electrical components shown on the diagrams are in the following units unless noted otherwise:

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

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

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

The following special symbols are used on the diagrams:



External Screwdriver adjustment.

External control or connector.

Clockwise control rotation in direction of arrow.

Refer to diagram number indicated in diamond.

Refer to waveform number indicated in hexagon.

Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

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 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
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
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
15801	FENWAL ELECTRONICS, DIV. OF KIDDE WALTER AND CO., INC.	63 FOUNTAIN ST.	FRAMINGHAM, MA 01701
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.	22 COLUMBIA ROAD	MORRISTOWN, NJ 07960
81483	INTERNATIONAL RECTIFIER CORP.	9220 SUNSET BLVD.	LOS ANGELES, CA 90069
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
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	B010100	B022971	CKT BOARD ASSY:MAIN	80009	670-3302-00
A1	670-3302-01	B022972	B023160	CKT BOARD ASSY:MAIN	80009	670-3302-01
A1	670-3302-02	B023161		CKT BOARD ASSY:MAIN	80009	670-3302-02
C120	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C201	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C226	281-0205-00			CAP.,VAR,PLSTC:4-65PF,100V	80009	281-0205-00
C227	281-0627-00	XB020000		CAP.,FXD,CER DI:1PF,+/-0.25PF,500V	72982	301-000C0K0109C
C230	283-0003-00	B010100	B019999	CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
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	855-558Z5U-103Z
C231	281-0540-00	B020000		CAP.,FXD,CER DI:51PF,5%,500V	72982	301-000U2J0510J
C246	283-0067-00	XB022972	B023161X	CAP.,FXD,CER DI:0.001UF,10%,200V	72982	835-515B102K
C261	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C270[1]						
C271, C273, C275, C276[2]	295-0164-00			CAP.,SET MTCHD:10UF,1UF,0.1UF,0.01UF, 950PF,MTCHD 0.75%	80009	295-0164-00
C277						
C278	281-0629-00			CAP.,FXD,CER DI:33PF,5%,600V	72982	308-000C0G0330J
C279	281-0540-00			CAP.,FXD,CER DI:51PF,5%,500V	72982	301-000U2J0510J
C280	281-0205-00			CAP.,VAR,PLSTC:4-65PF,100V	80009	281-0205-00
C313	290-0572-00			CAP.,FXD,ELCTLT:0.1UF,20%,50V	56289	196D104X0050HA1
C315	290-0572-00			CAP.,FXD,ELCTLT:0.1UF,20%,50V	56289	196D104X0050HA1
C369	281-0202-00			CAP.,VAR,PLSTC:1.5-5.5PF,100V	80031	2222-808-11558
C380	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C405	281-0629-00			CAP.,FXD,CER DI:33PF,5%,600V	72982	308-000C0G0330J
C406	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
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	308-000C0G0330J
C425	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C536	290-0559-00			CAP.,FXD,ELCTLT:22UF,20%,35V	90201	TDC226M035WLG
C539	290-0559-00			CAP.,FXD,ELCTLT:22UF,20%,35V	90201	TDC226M035WLG
C625	290-0559-00			CAP.,FXD,ELCTLT:22UF,20%,35V	90201	TDC226M035WLG
C633	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
CR127	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR130	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR135	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR140	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR313	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR315	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR321	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR323	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR324	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR325	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR327	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR341	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR343	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR344	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR345	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR347	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR410	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152

[1]Optional Timing Capacitor.

[2]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
CR420	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR531	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR533	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR536	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	80009	152-0066-00
CR539	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	80009	152-0066-00
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,W/HARDWARE	05091	31-279
J244	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
J415	131-0255-00			JACK,TIP:FOR 0.08 DIA	98291	SKT-0404
Q121A,B	151-0261-00			TRANSISTOR:SILICON,PNP,DUAL	80009	151-0261-00
Q141	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q145A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q201A,B	151-1054-00			TRANSISTOR:SILICON,JFE,N-CHANNEL,DUAL	80009	151-1054-00
Q211	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q221	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q252	151-0103-00			TRANSISTOR:SILICON,NPN	04713	2N2219A
Q255	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q261	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q320	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q340	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q355	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q360	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q371	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q376	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q380	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q400	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q405	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q410	151-0439-00			TRANSISTOR:SILICON,NPN	80009	151-0439-00
Q420	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q425	151-0440-00			TRANSISTOR:SILICON,PNP	80009	151-0440-00
Q523	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q526	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q566	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q569	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
Q628	151-0103-00			TRANSISTOR:SILICON,NPN	04713	2N2219A
Q640	151-0134-00			TRANSISTOR:SILICON,PNP	80009	151-0134-00
R100	311-1770-00			RES.,VAR,WW: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,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R105	311-0169-00			RES.,VAR,NONWIR:100 OHM,20%,0.50W	01121	W-7564B
R107	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R109	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R111	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R113	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R114	321-0288-00			RES.,FXD,FILM:9.76K OHM,1%,0.125W	91637	MFF1816G97600F
R115	321-0240-00			RES.,FXD,FILM:3.09K OHM,1%,0.125W	91637	MFF1816G30900F
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	91637	MFF1816G12101F
R120	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R121	322-0205-00			RES.,FXD,FILM:1.33K OHM,1%,0.25W	75042	CEBT0-1331F
R123	311-1565-00			RES.,VAR,NONWIR:250 OHM,20%,0.50W	73138	91A-250R0M
R125	322-0205-00			RES.,FXD,FILM:1.33K OHM,1%,0.25W	75042	CEBT0-1331F
R127	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R131	323-0176-00			RES.,FXD,FILM:665 OHM,1%,0.50W	75042	CECT0-6650F
R133	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R140	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R145	322-0209-00			RES.,FXD,FILM:1.47K OHM,1%,0.25W	75042	CEBT0-1471F
R147	322-0209-00			RES.,FXD,FILM:1.47K OHM,1%,0.25W	75042	CEBT0-1471F
R201	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R211	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R214	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R221	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R223	301-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.50W	01121	EB1525
R224	321-0166-00			RES.,FXD,FILM:523 OHM,1%,0.125W	91637	MFF1816G523R0F
R225	321-0168-00			RES.,FXD,FILM:549 OHM,1%,0.125W	91637	MFF1816G549R0F
R226	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R227	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R229	321-0293-00			RES.,FXD,FILM:11K OHM,1%,0.125W	91637	MFF1816G11001F
R230	321-0194-00			RES.,FXD,FILM:1.02K OHM,1%,0.125W	91637	MFF1816G10200F
R231	321-0194-00			RES.,FXD,FILM:1.02K OHM,1%,0.125W	91637	MFF1816G10200F
R232	321-0293-00			RES.,FXD,FILM:11K OHM,1%,0.125W	91637	MFF1816G11001F
R235	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R237	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R239	301-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.50W	01121	EB5115
R241	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R243	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R244	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R246	315-0102-00	B010100	B022971	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R246	315-0221-00	B022972	B023160	RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R246	315-0101-00	B023161		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R250	321-0217-00			RES.,FXD,FILM:1.78K OHM,1%,0.125W	91637	MFF1816G17800F
R251	321-0192-00			RES.,FXD,FILM:976 OHM,1%,0.125W	91637	MFF1816G976R0F
R252	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R253	321-0220-00			RES.,FXD,FILM:1.91K OHM,1%,0.125W	91637	MFF1816G19100F
R255	322-0154-00			RES.,FXD,FILM:392 OHM,1%,0.25W	91637	MFF1421G392R0F
R256	321-0235-00			RES.,FXD,FILM:2.74K OHM,1%,0.125W	91637	MFF1816G27400F
R258	321-0209-00			RES.,FXD,FILM:1.47K OHM,1%,0.125W	91637	MFF1816G14700F
R260	323-0135-00			RES.,FXD,FILM:249 OHM,1%,0.50W	91637	MFF1226G249R0F
R261	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R310	321-0246-00			RES.,FXD,FILM:3.57K OHM,1%,0.125W	91637	MFF1816G35700F
R311	311-1567-00			RES.,VAR,NONWIR:100 OHM,20%,0.50W	73138	91A-100R0M
R313	321-0158-00			RES.,FXD,FILM:432 OHM,1%,0.125W	91637	MFF1816G432R0F
R315	321-0158-00			RES.,FXD,FILM:432 OHM,1%,0.125W	91637	MFF1816G432R0F
R317	311-1567-00			RES.,VAR,NONWIR:100 OHM,20%,0.50W	73138	91A-100R0M
R318	321-0246-00			RES.,FXD,FILM:3.57K OHM,1%,0.125W	91637	MFF1816G35700F
R320	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R321	321-0037-00			RES.,FXD,FILM:23.7 OHM,1%,0.125W	91637	MFF1816G23R70F
R323	321-0063-00			RES.,FXD,FILM:44.2 OHM,1%,0.125W	91637	MFF1816G44R20F
R324	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R325	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R327	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R329	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392R0F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R331	321-0205-00			RES.,FXD,FILM:1.33K OHM,1%,0.125W	91637	MFF1816G13300F
R333	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
R340	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R341	321-0037-00			RES.,FXD,FILM:23.7 OHM,1%,0.125W	91637	MFF1816G23R70F
R343	321-0063-00			RES.,FXD,FILM:44.2 OHM,1%,0.125W	91637	MFF1816G44R20F
R344	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R345	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R347	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R349	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R355	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R357	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R359	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R360	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R361	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R364	315-0510-00			RES.,FXD,CMPSN: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,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R369	321-0223-00			RES.,FXD,FILM:2.05K OHM,1%,0.125W	91637	MFF1816G20500F
R371	321-0283-00			RES.,FXD,FILM:8.66K OHM,1%,0.125W	91637	MFF1816G86600F
R375	311-1568-00			RES.,VAR,NONWIR:50 OHM,20%,0.50W	73138	91A R50
R376	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R377	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R379	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R380	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R381	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R382	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R384	315-0182-00	B010100	B022971	RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R384	315-0162-00	B022972		RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R385	311-1467-00			RES.,VAR,NONWIR:2K OHM,20%,1W	01121	11M040
R386	315-0182-00	B010100	B022971	RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R386	315-0162-00	B022972		RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R389	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R400	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R405	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R406	315-0100-00	B010100	B019999	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R406	303-0100-00	B020000		RES.,FXD,CMPSN:10 OHM,5%,1W	01121	GB1005
R410	315-0100-00	B010100	B019999	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R410	303-0100-00	B020000		RES.,FXD,CMPSN:10 OHM,5%,1W	01121	GB1005
R412	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R415	305-0510-00			RES.,FXD,CMPSN:51 OHM,5%,2W	01121	HB5105
R419	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R420	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R425	315-0100-00	B010100	B019999	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R425	303-0100-00	B020000		RES.,FXD,CMPSN:10 OHM,5%,1W	01121	GB1005
R427	315-0100-00	B010100	B019999	RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R427	303-0100-00	B020000		RES.,FXD,CMPSN:10 OHM,5%,1W	01121	GB1005
R510	307-0093-00			RES.,FXD,CMPSN:1.2 OHM,5%,0.50W	01121	EB12G5
R511	301-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.50W	01121	EB1005
R512	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R517	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R519	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R520	311-1561-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	73138	91A R2500
R522	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R523	308-0685-00			RES.,FXD,WW:1.5 OHM,10%,1W	75042	BW20-1R500J
R525	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R526	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R527	301-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.50W	01121	EB2015
R528	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R530	301-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.50W	01121	EB1525
R560	307-0093-00			RES.,FXD,CMPSN:1.2 OHM,5%,0.50W	01121	EB12G5
R561	301-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.50W	01121	EB1005
R563	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R564	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R566	315-0202-00			RES.,FXD,CMPSN: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,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R600	301-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.50W	01121	EB4315
R603	301-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.50W	01121	EB1525
R625	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R626	321-0312-00			RES.,FXD,FILM:17.4K OHM,1%,0.125W	91637	MFF1816G17401F
R629	321-0289-07			RES.,FXD,FILM:10K OHM,0.1%,0.125W	91637	MFF1816C10001B
R631	301-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.50W	01121	EB1525
R633	321-0289-07			RES.,FXD,FILM:10K OHM,0.1%,0.125W	91637	MFF1816C10001B
R640	315-0512-00			RES.,FXD,CMPSN: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	80009	156-0158-00
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:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U241	156-0180-00	B020000		MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74S00N
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%	80009	152-0217-00
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%	80009	152-0280-00
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%	80009	152-0279-00
VR603	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0279-00

CALIBRATION

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 ±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 Ω termination, bnc connectors, Tektronix Part Number 011-0049-01.

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

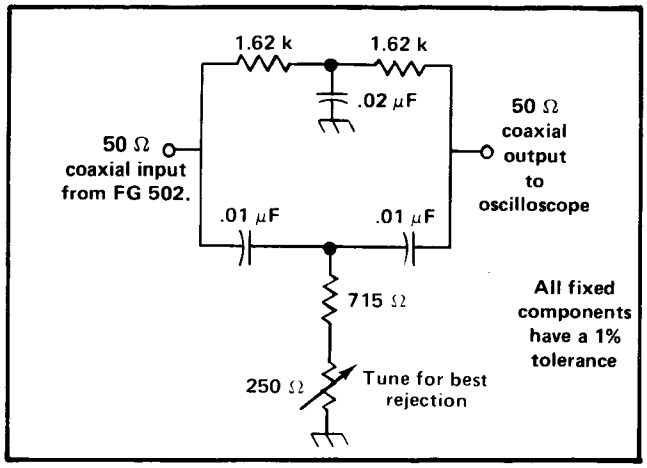


Fig. 3-1. 10 kHz notch filter.

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 ±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 ±1%. Move the negative lead to the −17 TP and check that the reading is 17 V ±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 ±1% of 17 V.

3. ADJUST SYMMETRY

Connect the OUTPUT of the FG 503 through a 50 Ω coaxial cable and a 50 Ω termination, in that order, to the vertical input of the oscilloscope. Set the FG 503 AMPLITUDE control fully cw, the MULTIPLIER control to 10^3, the FREQ VERNIER control fully cw, the FUNCTION switch to ∿ 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 μs/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 division on the crt.

5. ADJUST HIGH FREQUENCY TIMING

Set the FREQUENCY Hz dial to 30 and the oscilloscope sweep speed to 10 μs/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.

)N 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 μs/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 μs/div. Adjust C280, 3 MHz Tmg, for a display of three complete cycles in ten horizontal divisions.

9. ADJUST SQUARE WAVE COMPENSATION

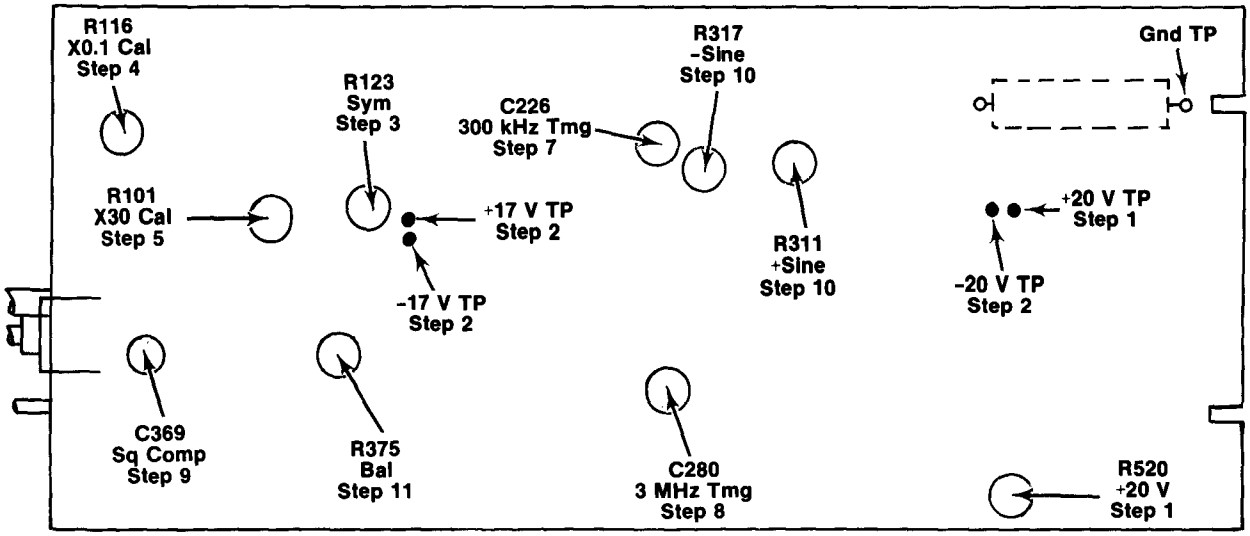
Set the FREQUENCY Hz dial to 10 (1.0 MHz). Adjust C369, Sq Comp, for the squarest front corner on the waveform. Check that the risetime of the square wave is within specification.

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

Set the FUNCTION switch to ∿ in the shaded portion (no offset), MULTIPLIER to 10^3, and FREQUENCY Hz to 10. Set the oscilloscope sweep speed to 50 μs/div. Connect the distortion analyzer to the FG 503 output, or the notch filter (constructed as shown in Fig. 3-1) to the 50 Ω 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.

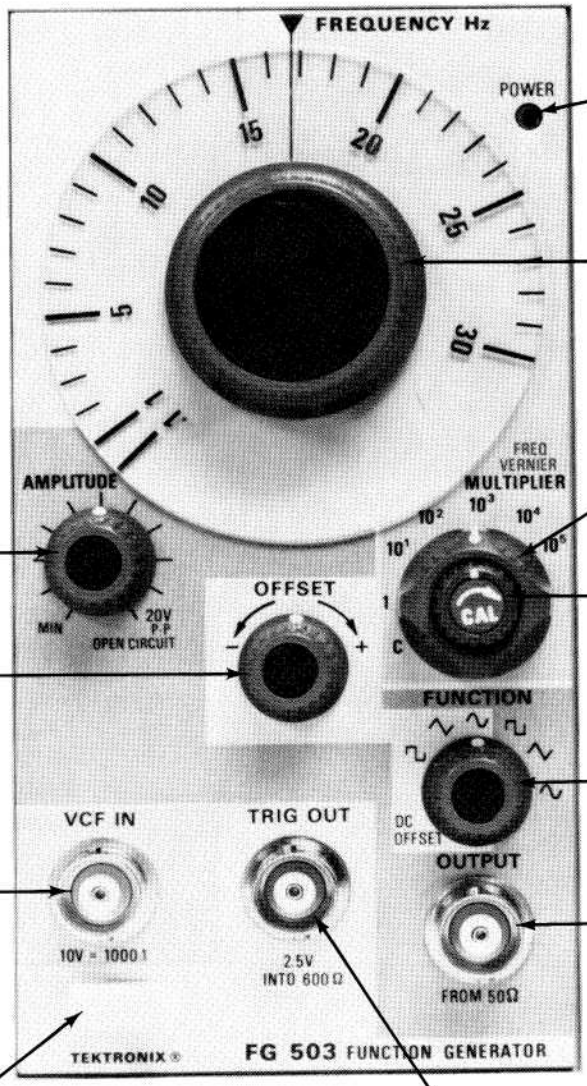
11. ADJUST OUTPUT DC BALANCE

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



POWER On Pilot Light

Illuminated when power is applied to unit.

FREQUENCY Hz Dial

Multiply dial reading by MULTIPLIER setting for frequency out.

MULTIPLIER Switch

Sets basic frequency range. C is custom position.

FREQ VERNIER Control

Allows fine adjustment of output frequency.

FUNCTION Switch

Selects output waveform. Shaded portion is without offset.

OUTPUT Connector

BNC connector for waveform output.

AMPLITUDE Control

Adjusts amplitude of output waveform.

OFFSET Control

Adjust for output waveform DC offset when FUNCTION switch is in unshaded portion.

VCF IN Connector

Applied external voltage changes output waveform frequency.

LATCH

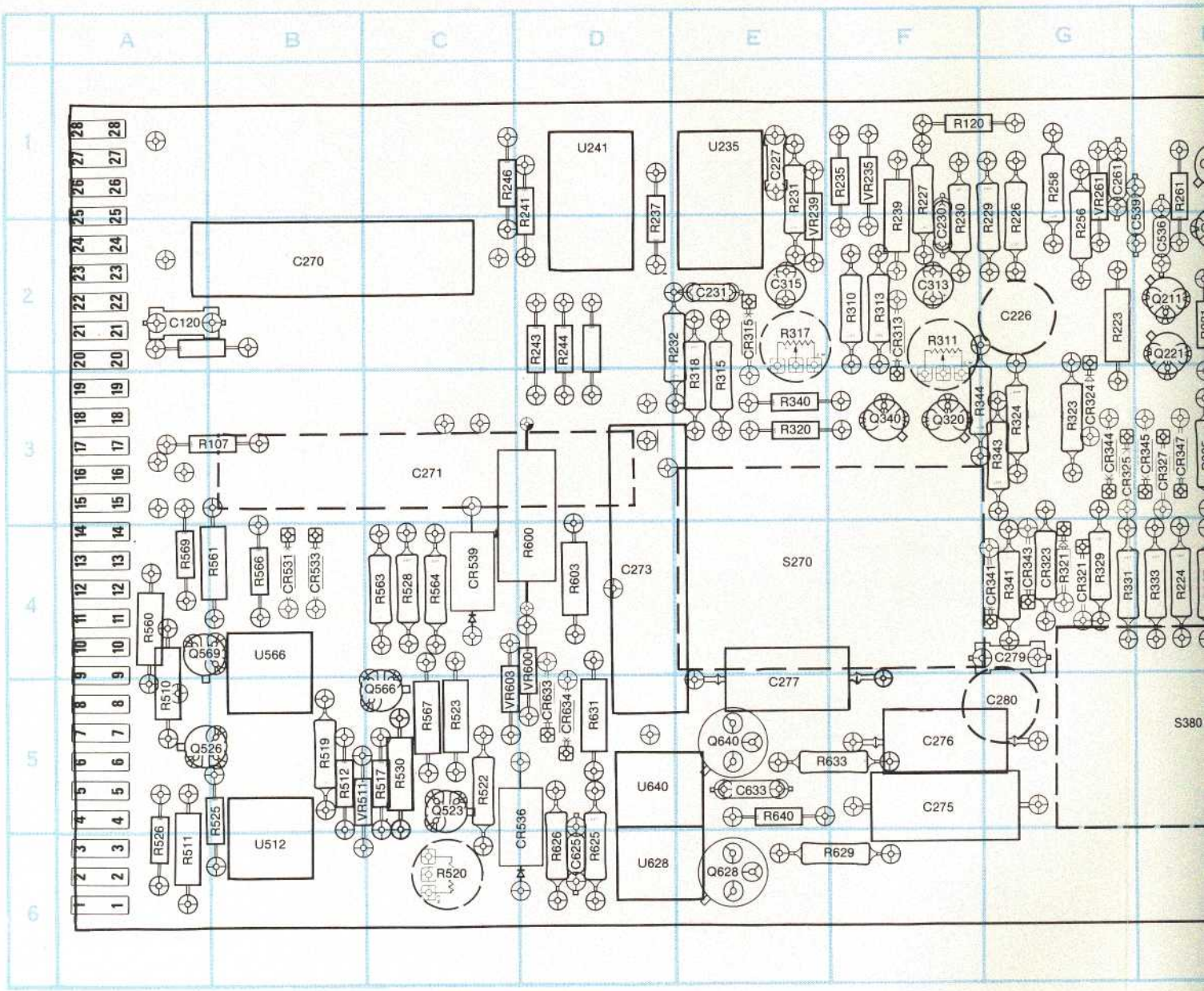
Pull to remove plug-in.

TRIG OUT Connector

Square-wave output for applications requiring an external trigger.

PARTS LOCATION GR

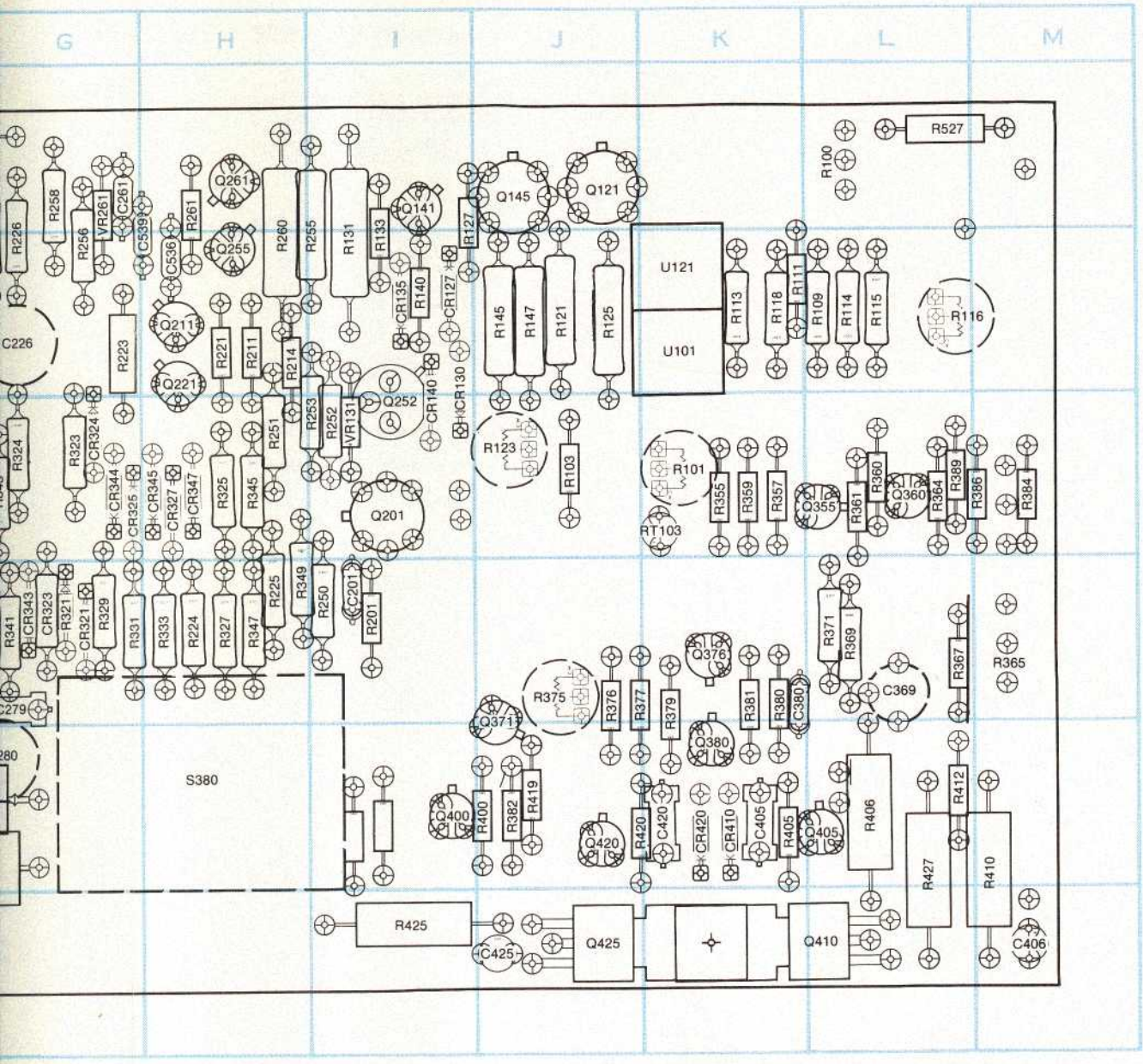
SN B010649-UP



DASHED COMPONENTS LOCATED ON BACK SIDE OF BOARD.

CATION GRID

10649-UP



[1] OPTIONAL CUSTOM TIMING CAPACITOR.

† LOCATED ON BACK OF BOARD.

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

PARTS LOCATION GRID
SN B010649 – UP

CKT NO	GRID LOC
C120	A2
C201	I4
C226 †	
C227 *	E1
C230	F2
C231	E2
C246 *	
C261	G1
C270 [1]	B2
C271 †	
C273	D4
C275	F5
C276	F5
C277	E5
C278 †	
C279	G4
C280 †	
C313	F2
C315	E2
C369 †	
C380	K4
C405	K5
C406	M6
C415 †	
C420	K5
C425	J6
C536	H2
C539	H2
C625	D6
C633	E5
CR127	I2
CR130	I3
CR135	I2
CR140	I3
CR313	F2
CR315	E2
CR321	G4
CR324	G3
CR325	G3
CR327	H3
CR341	G4
CR343	G4
CR344	G3
CR345	H3
CR347	H3
CR410	K5
CR420	K5
CR531	B4
CR533	B4
CR536	D6
CR539	C4
CR633	D5
CR634	D5

CKT NO	GRID LOC
Q121	J1
Q141	I1
Q145	J1
Q201	I3
Q211	H2
Q221	H2
Q252	I3
Q255	H2
Q261	H1
Q320	F3
Q340	F3
Q355	L3
Q360	L3
Q371	J5
Q376	K4
Q380	K5
Q400	I5
Q405	L5
Q410	L6
Q420	J5
Q425	J6
Q523	C5
Q526	A5
Q566	C5
Q569	A4
Q628	E6
Q640	E5
R100	L1
R101 †	
R103	J3
R105 †	
R107	B3
R109	L2
R111	K2
R113	K2
R114	L2
R115	L2
R116 †	
R118	K2
R120	F1
R121	J2
R123 †	
R125	J2
R127	I2
R131	I2
R133	I2
R140	I2
R145	J2
R147	J2
R201	I4
R211	H2
R214	H2
R221	H2
R223	G2

CKT NO	GRID LOC
R224	H4
R225	H4
R226	G2
R227	F1
R229	G2
R230	F2
R231	E1
R232	E2
R235	F1
R237	D2
R239	F2
R241	D2
R243	D2
R244	D2
R246	C1
R250	I4
R251	H3
R252	I3
R253	I3
R255	I2
R256	G2
R258	G1
R260	H2
R261	H1
R310	F2
R311 †	
R313	F2
R315	E3
R317 †	
R318	E3
R320	E3
R321	G4
R323	G3
R324	G3
R325	H3
R327	H4
R329	G4
R331	G4
R333	G5
R340	E3
R341	G4
R343	G3
R344	G3
R345	H3
R347	H4
R349	H4
R355	K3
R357	K3
R359	K3
R360	L3
R361	L3
R364	L3
R365	M4
R367	L4

CKT NO	GRID LOC
R369	L4
R371	L4
R375 †	
R376	J4
R377	J4
R379	K4
R380	K4
R381	K4
R382	J5
R384	M3
R386	M3
R389	L3
R400	J5
R405	K5
R406	L5
R410	M5
R412	L5
R415 †	
R419	J5
R420	J5
R425	I6
R427	L5
R510	A5
R511	A6
R512	B5
R517	C5
R519	B5
R520 †	
R522	C5
R523	C5
R525	B5
R526	A6
R527	L1
R528	C4
R530	C5
R560	A4
R561	B4
R563	C4
R564	C4
R566	B4
R567	C5
R569	A4
R600	D4
R603	D4
R625	D6
R626	D6
R629	E6
R631	D5
R633	E5
R640	E5
RT103	K3
S270 †	
S380 †	

CKT NO	GRID LOC
U101	K2
U121	K2
U235	E1
U241	D1
U512	B6
U566	B4
U628	D6
U640	D5
VR131	I3
VR235	F1
VR239	E2
VR261	G1
VR511	B5
VR600	D5
VR603	C5

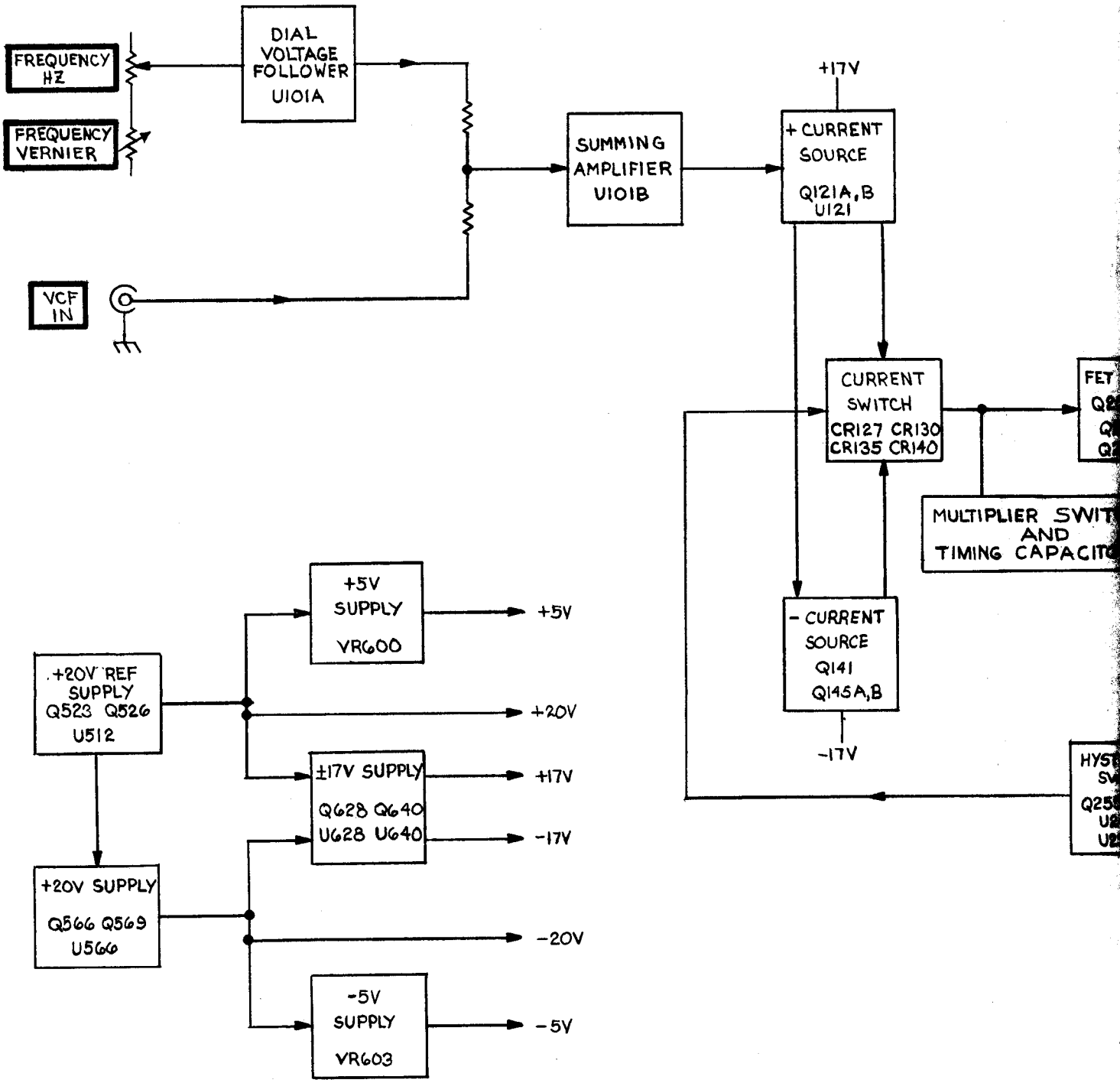
REAR CONNECTOR PIN ASSIGNMENTS

TABLE 2-1

	B		A	
Trigger Output Common	28		28	Output
Trigger Output	27		27	Output Common
	26	Signal Source plug-in barrier slot	26	
	25		25	
	24		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 barrier slot	8	* −33.5 V Filtered DC
* Collector lead of NPN Series-Pass Transistor	7		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	

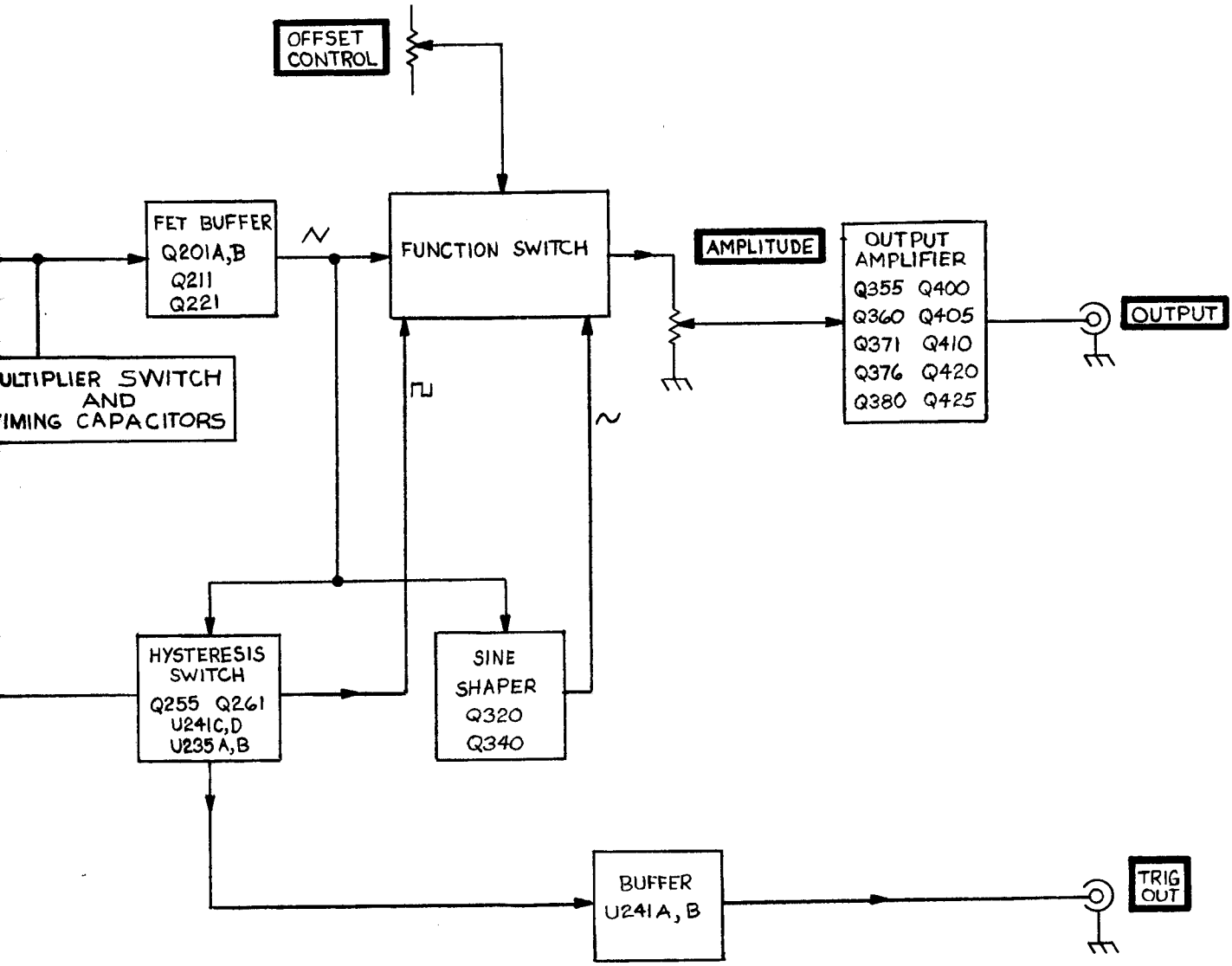
Rear-view of plug-in

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.



FG 503

REV. C, SEPT. 19



REV. C, SEPT. 1974

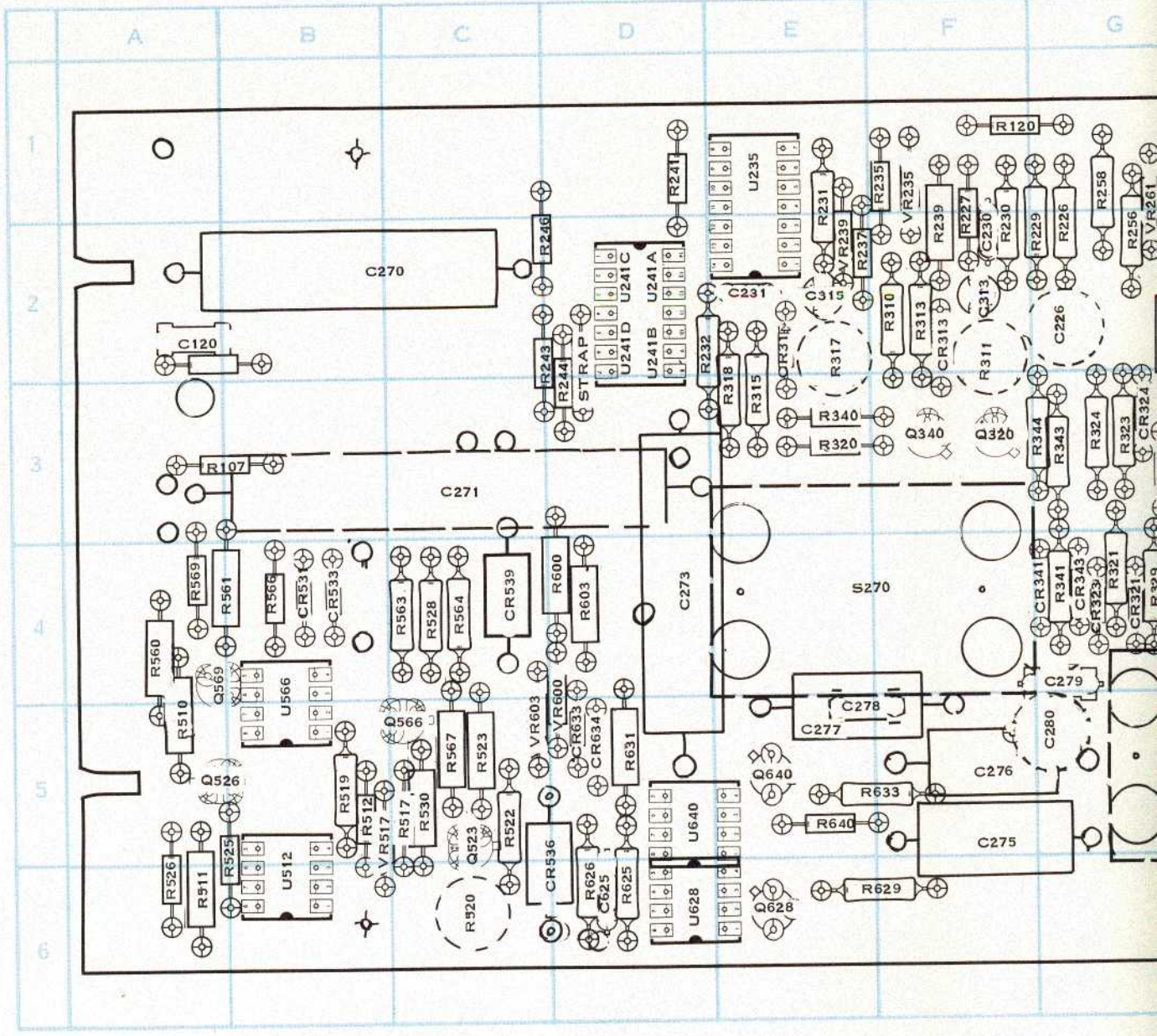
Block Diagram

REAR INTERFACE CONNECTOR ASSIGNMENTS & BLOCK DIAGRAM

FG 503

PARTS LOCATION

SN B010100-B01064



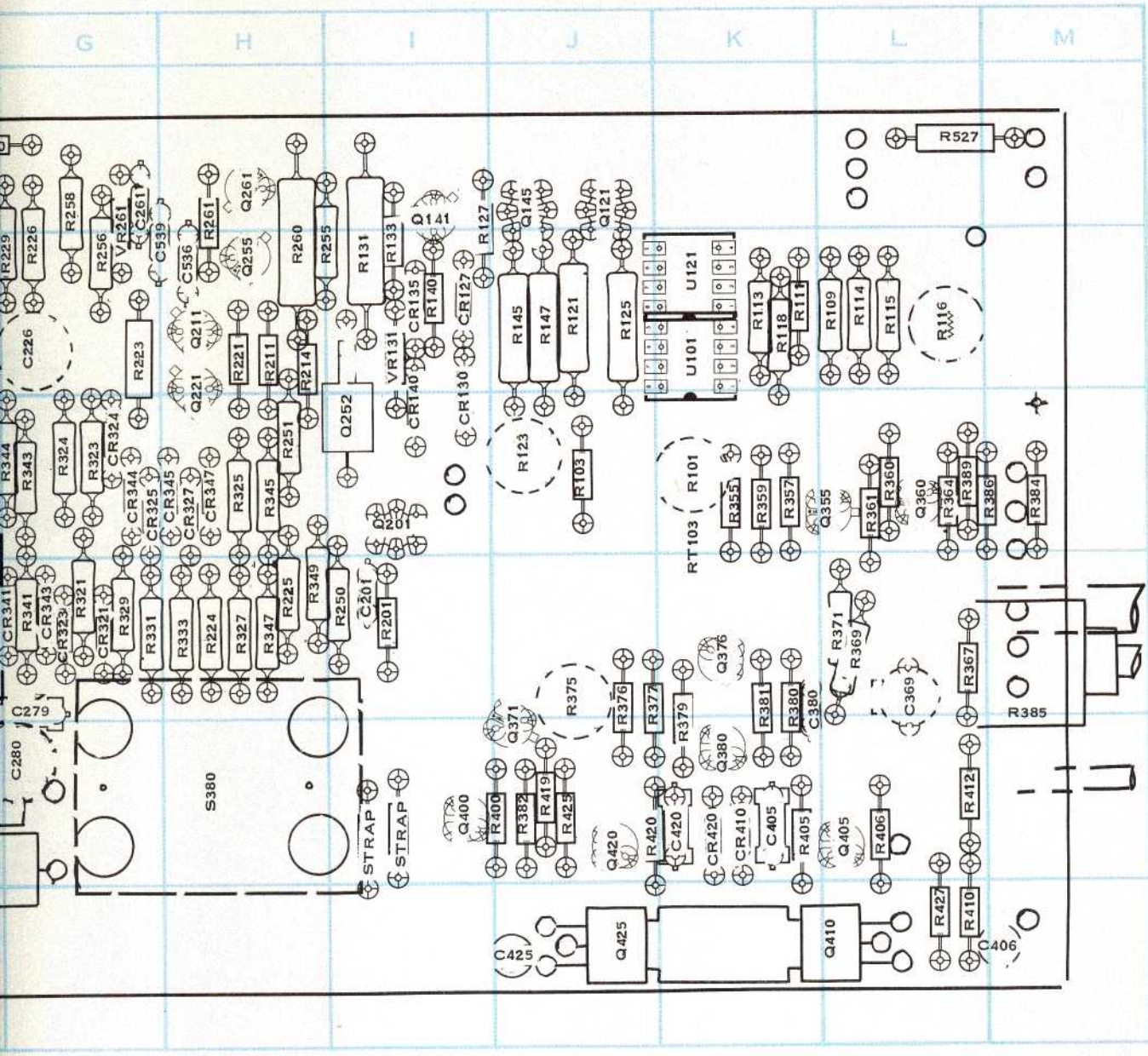
DASHED COMPONENTS LOCATED ON BACK SIDE OF BOARD

PARTS LOCATION GRID
SN B010100 – B010648

@

CATION GRID

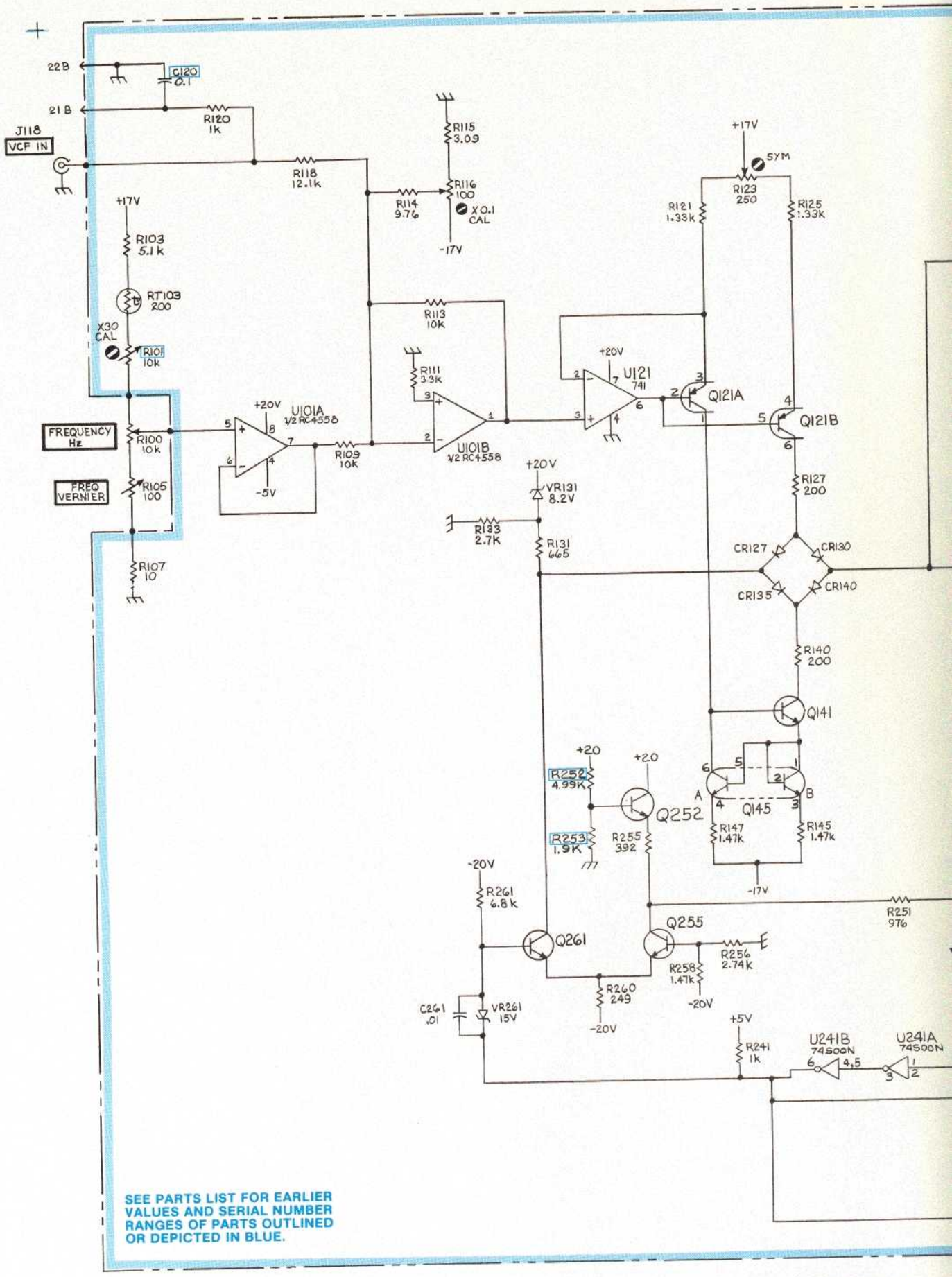
00-B010648



[1] OPTIONAL CUSTOM TIMING CAPACITOR

† LOCATED ON BACK OF BOARD

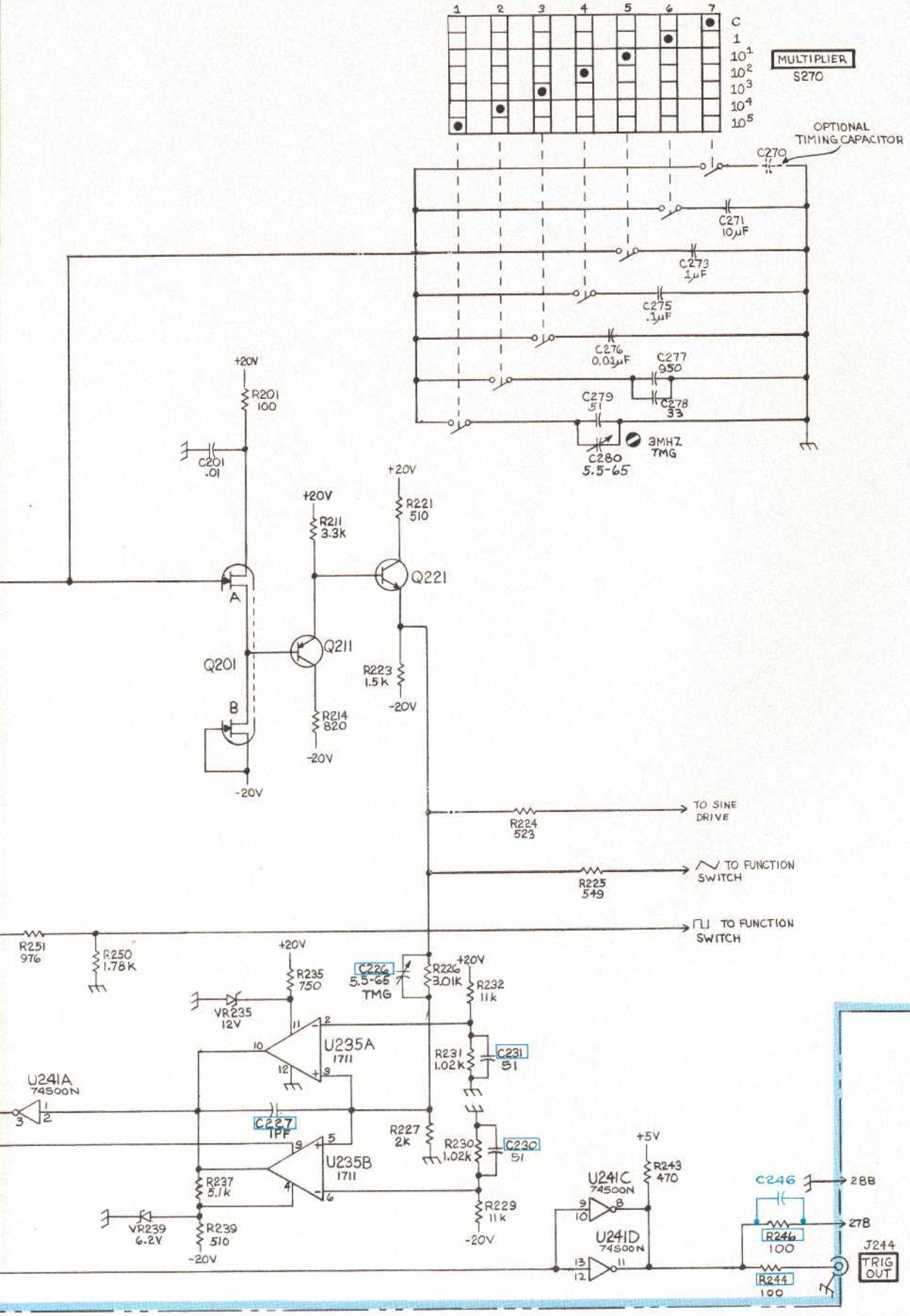
CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C120	A2	Q121	J1	R223	G2	R371	L4	U101	K2
C201	I4	Q141	I1	R224	H4	R375†		U121	K2
C226†		Q145	J1	R225	H4	R376	J4	U235	E1
C230	F2	Q201	I3	R226	G2	R377	J4	U241	D2
C231	E2	Q211	H2	R227	F2	R379	K5		
C261	G1	Q221	H2	R229	G2	R380	K4	U512	B6
C270[1]	B2	Q252	I3	R230	F2	R381	K4	U566	B4
C271†		Q255	H2	R231	E1	R382	J5	U628	D6
C273	D4	Q261	H1	R232	D2	R384	M3	U640	D5
C275	F5	Q320	F3	R235	F1	R385	M4		
C276	F5	Q340	F3	R237	E2	R386	L3	VR131	I2
C277	E5	Q355	L3	R239	F2	R389	L3	VR235	F1
C278†		Q360	L3	R241	D1	R400	J5	VR239	E2
C279	G4	Q371	J5	R243	C2	R405	K5	VR261	G1
C280†		Q376	K4	R244	D3	R406	L5		
C313	F2	Q380	K5	R246	C2	R410	L6	VR517	B5
C315	E2	Q400	I5	R250	I4	R412	L5	VR600	D5
C369†		Q405	L5	R251	H3	R415†		VR603	C5
C380	K4	Q410	L6	R252†		R419	J5		
C406	M6	Q420	J5	R253†		R420	J5		
C415†		Q425	J6	R255	H2	R425	J5		
C420	K5			R256	G2	R427	L6		
C425	J6	Q523	C5	R258	G1	R501	B4		
		Q526	A5	R260	H2	R510	A5		
C536	H2	Q566	C5	R261	H1	R511	A6		
C539	G2	Q569	A4	R310	F2	R512	B5		
C625	D6	Q628	E6	R311†		R517	C5		
C633†		Q640	E5	R313	F2	R519	B5		
				R315	E3	R520†			
CR127	I2	R101†		R317†		R522	C5		
CR130	I3	R103	J3	R318	E3	R523	C5		
CR135	I2	R105†		R320	E3	R525	B5		
CR140	I3	R107	B3	R321	G4	R526	A6		
CR313	F2	R109	L2	R323	G3	R527	L1		
CR315	E2	R111	K2	R324	G3	R528	C4		
CR321	G4	R113	K2	R325	H3	R530	C5		
CR323	G4	R114	L2	R327	H4	R560	A4		
CR324	G3	R115	L2	R329	G4	R561	B4		
CR325	G3	R116†		R331	G4	R563	C4		
CR327	H3	R118	K2	R333	H4	R564	C4		
CR341	G4	R120	F1	R340	E3	R566	B4		
CR343	G4	R121	J2	R341	G4	R567	C5		
CR344	G3	R123†		R343	G3	R569	A4		
CR345	H3	R125	J2	R344	G3	R600	D4		
CR347	H3	R127	I1	R345	H3	R603	D4		
CR410	K5	R131	I2	R347	H4	R625	D6		
CR420	K5	R133	I2	R349	H4	R626	D6		
CR531	B4	R140	I2	R355	K3	R629	F6		
CR533	B4	R145	J2	R357	K3	R631	D5		
CR536	C6	R147	J2	R359	K3	R633	F5		
CR539	C4	R201	I4	R360	L3	R640	E5		
CR633	D5	R211	H2	R361	L3				
CR634	D5	R214	H2	R364	L3	RT103	K3		
		R221	H2	R365	M4				
				R367	L4	S270†			
				R369	L4	S380†			

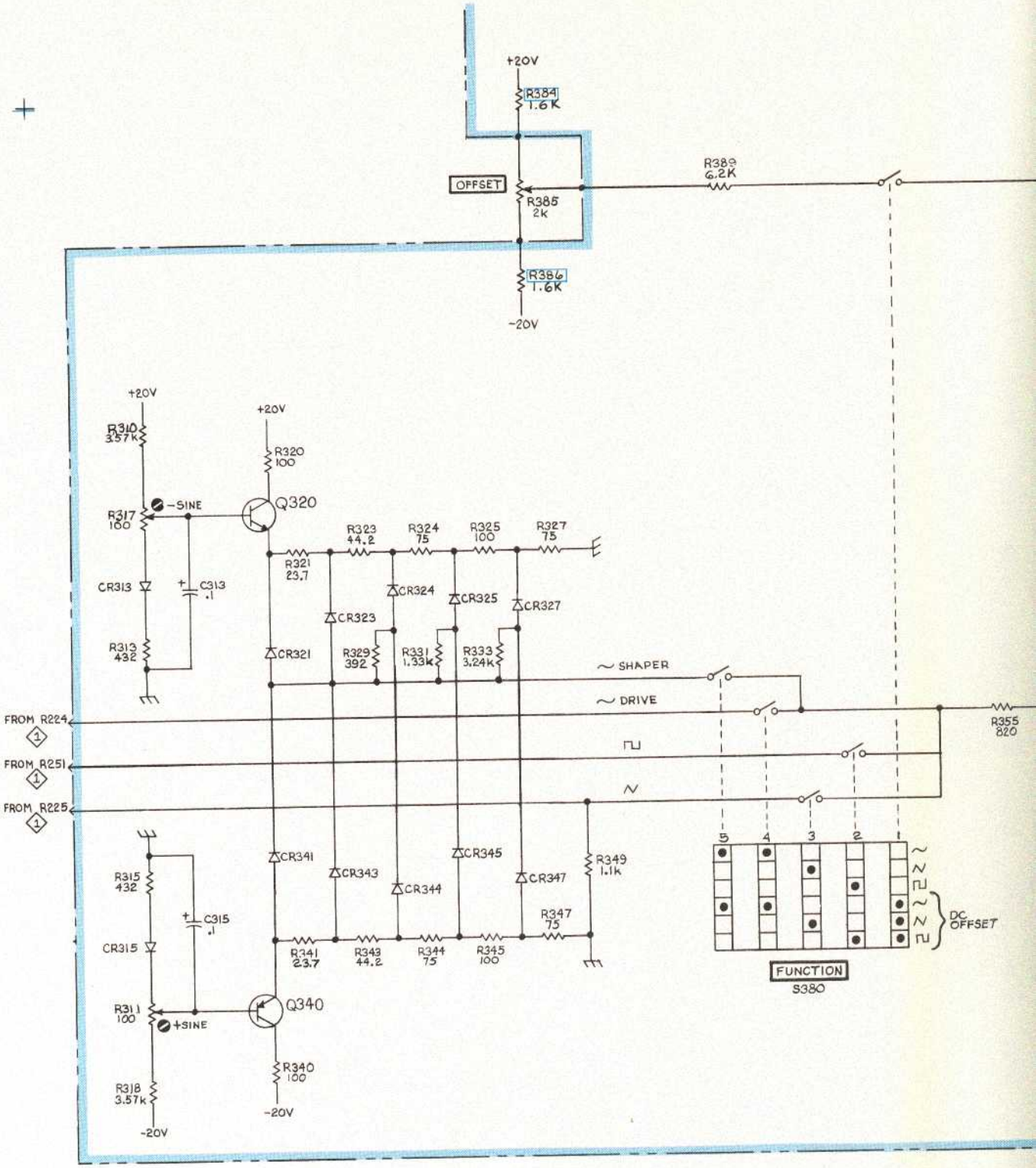


SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN BLUE.

FG 503

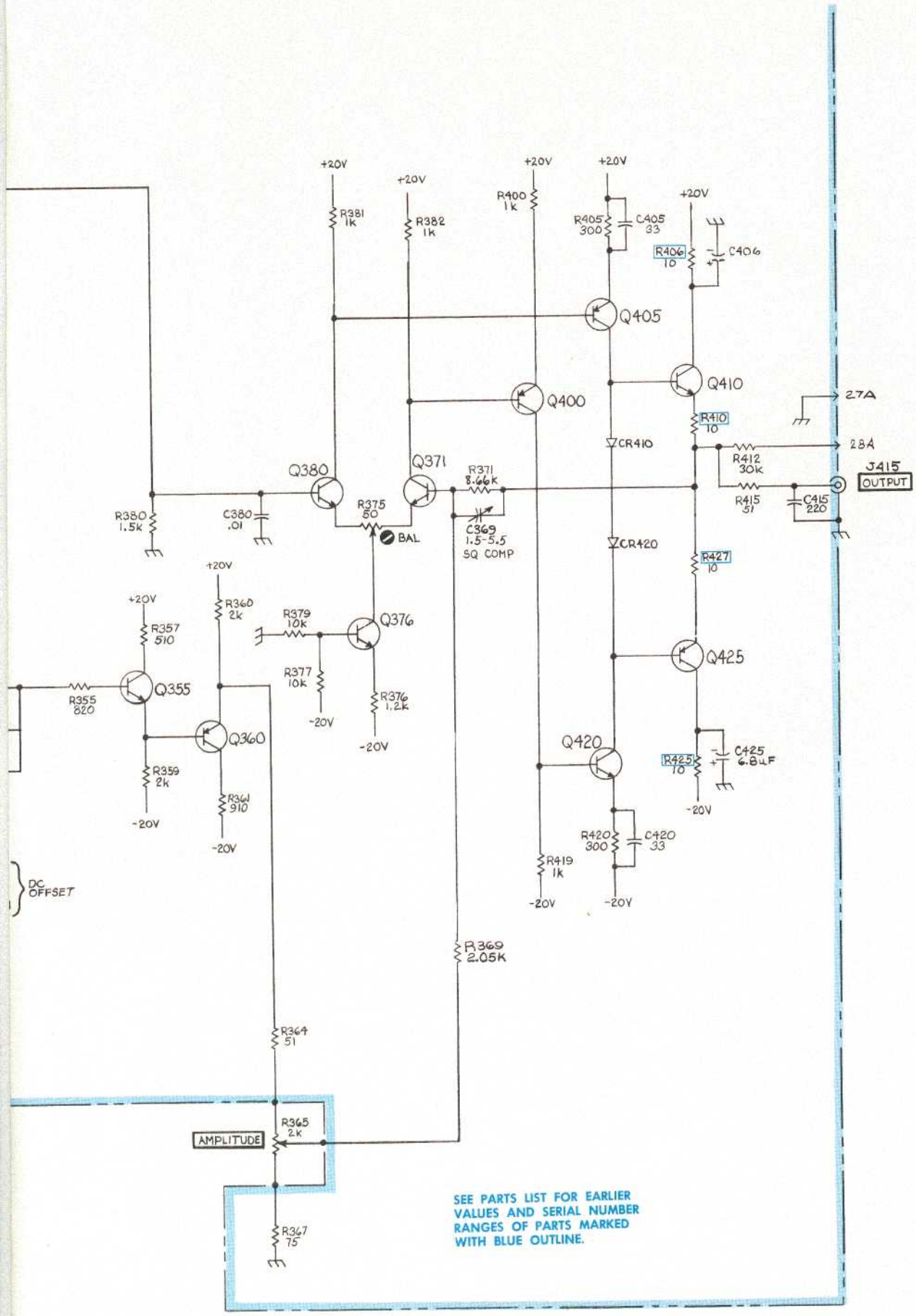
REV. E, FEB 1978

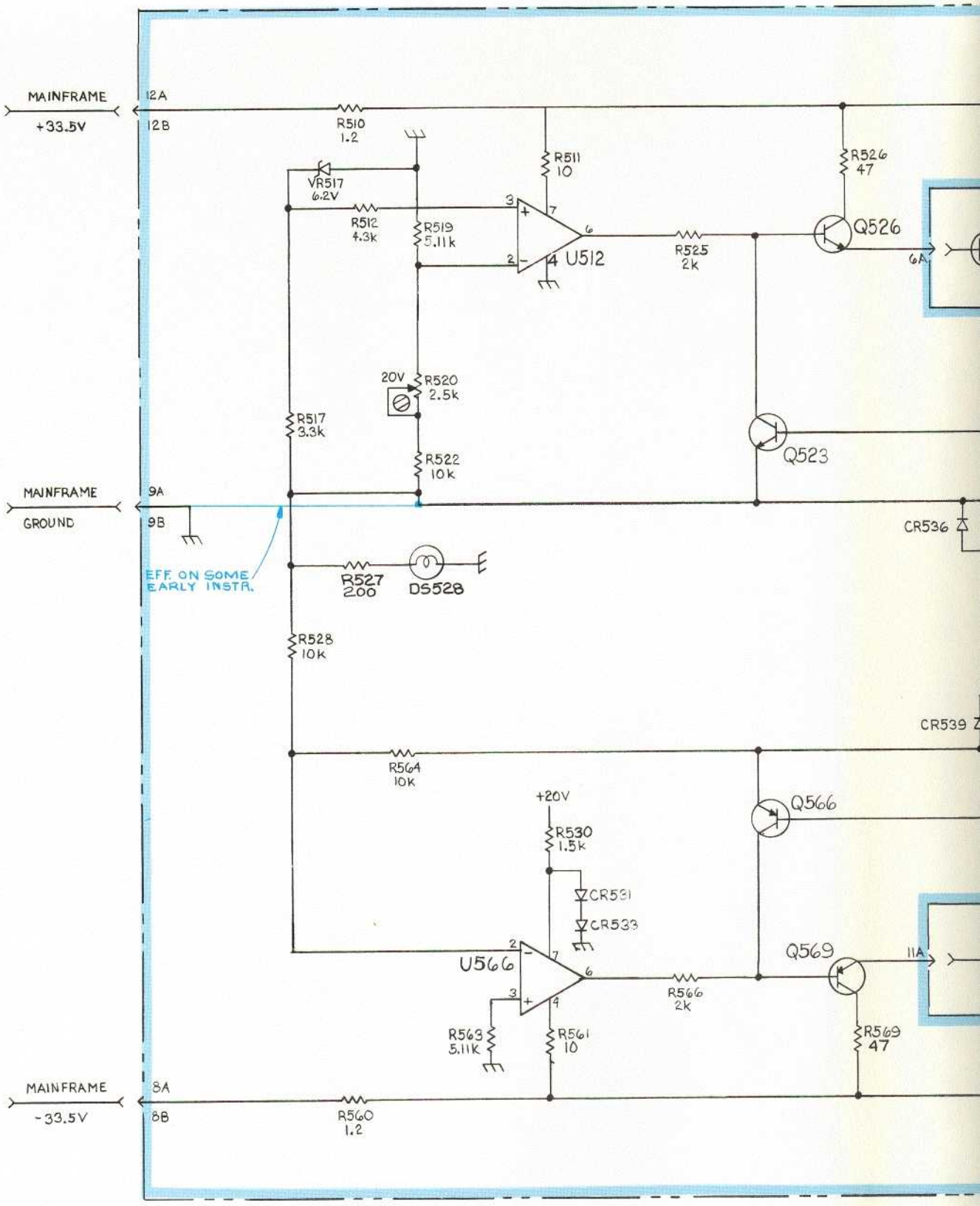

1 2 3 4 5 6 7
C
1
10^1
10^2
10^3
10^4
10^5
MULTIPLIER
S270
OPTIONAL TIMING CAPACITOR
C270
C271 10µF
C273 1µF
C275 .1µF
C276 0.01µF
C277 950
C278 33
C279 51
C280 5.5-65
3MHZ TMG
+20V
R201 100
C201 .01
R211 3.3k
R221 510
Q221
Q211
Q201
A
B
R223 1.5k
R214 820
-20V
TO SINE DRIVE
R224 523
TO FUNCTION SWITCH
R225 549
TO FUNCTION SWITCH
R251 976
R250 1.78K
R235 750
VR235 12V
C226 5.5-65 TMG
R226 3.01K
R232 11k
U235A 1711
R231 1.02k
C231 51
U241A 74S00N
C227 1PF
R227 2k
R230 1.02k
C230 51
U235B 1711
R237 5.1k
VR239 6.2V
R239 510
R229 11k
+5V
R243 470
U241C 74S00N
U241D 74S00N
C246
R246 100
R244 100
J244 TRIG OUT
28B
27B



FG 503

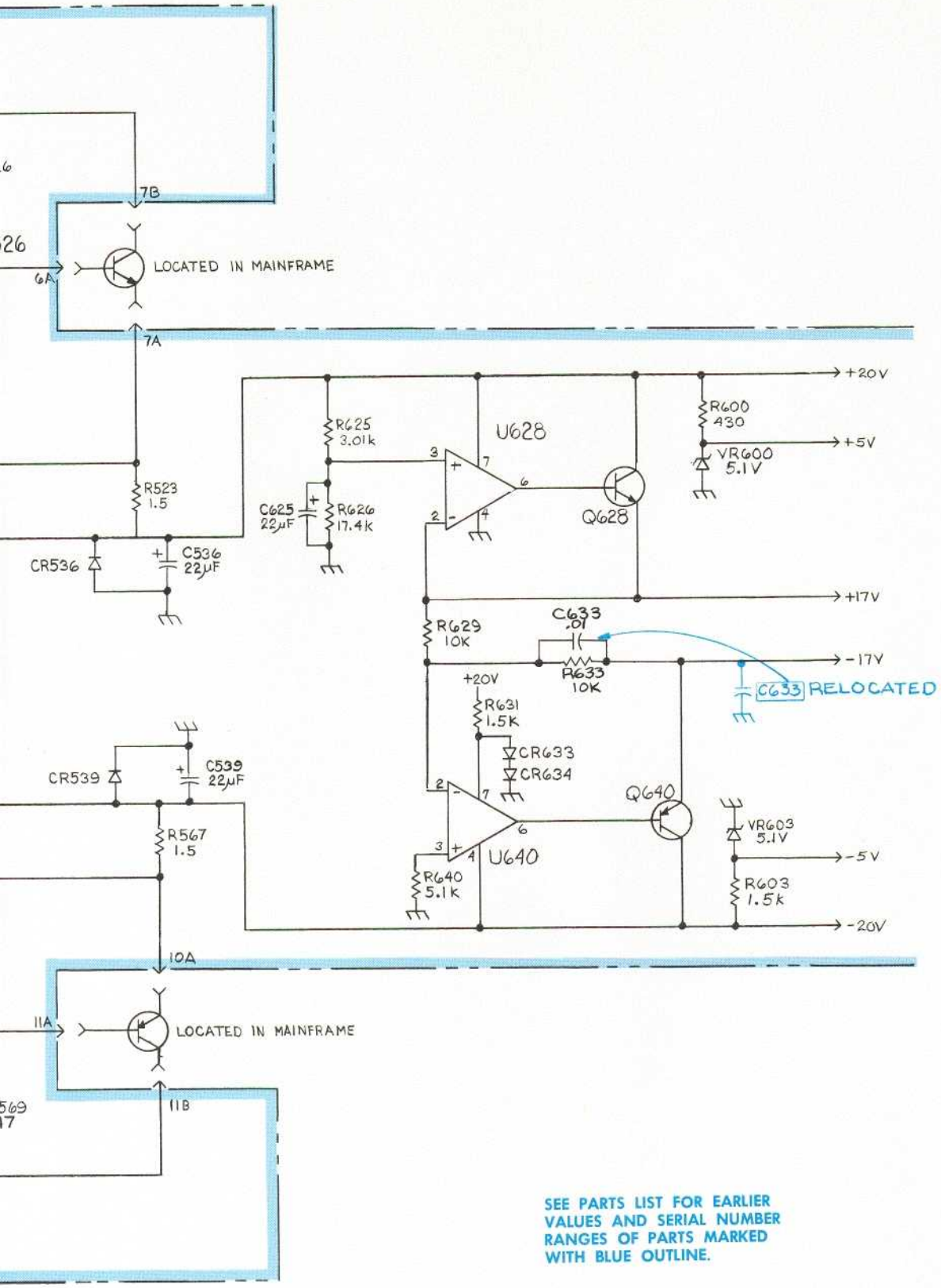
REV.C, SEPT. 1975


+20V
R381 1k
R382 1k
R400 1k
R405 300
C405 33
R406 10
C406
Q405
Q410
Q400
CR410
R410 10
27A
28A
R412 30k
J415 OUTPUT
R415 51
C415 220
Q380
Q371
R371 8.66K
R380 1.5k
C380 .01
R375 50
BAL
C369 1.5-5.5 SQ COMP
CR420
R427 10
R360 2k
R379 10k
Q376
R357 510
Q355
R355 820
R377 10k
R376 1.2k
-20V
Q360
R359 2k
R361 910
Q425
Q420
R425 10
C425 6.8uF
R420 300
C420 33
R419 1k
DC OFFSET
R369 2.05K
R364 51
AMPLITUDE
R365 2k
R367 75
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.



FG 503

REV. C, SEPT. 19



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

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

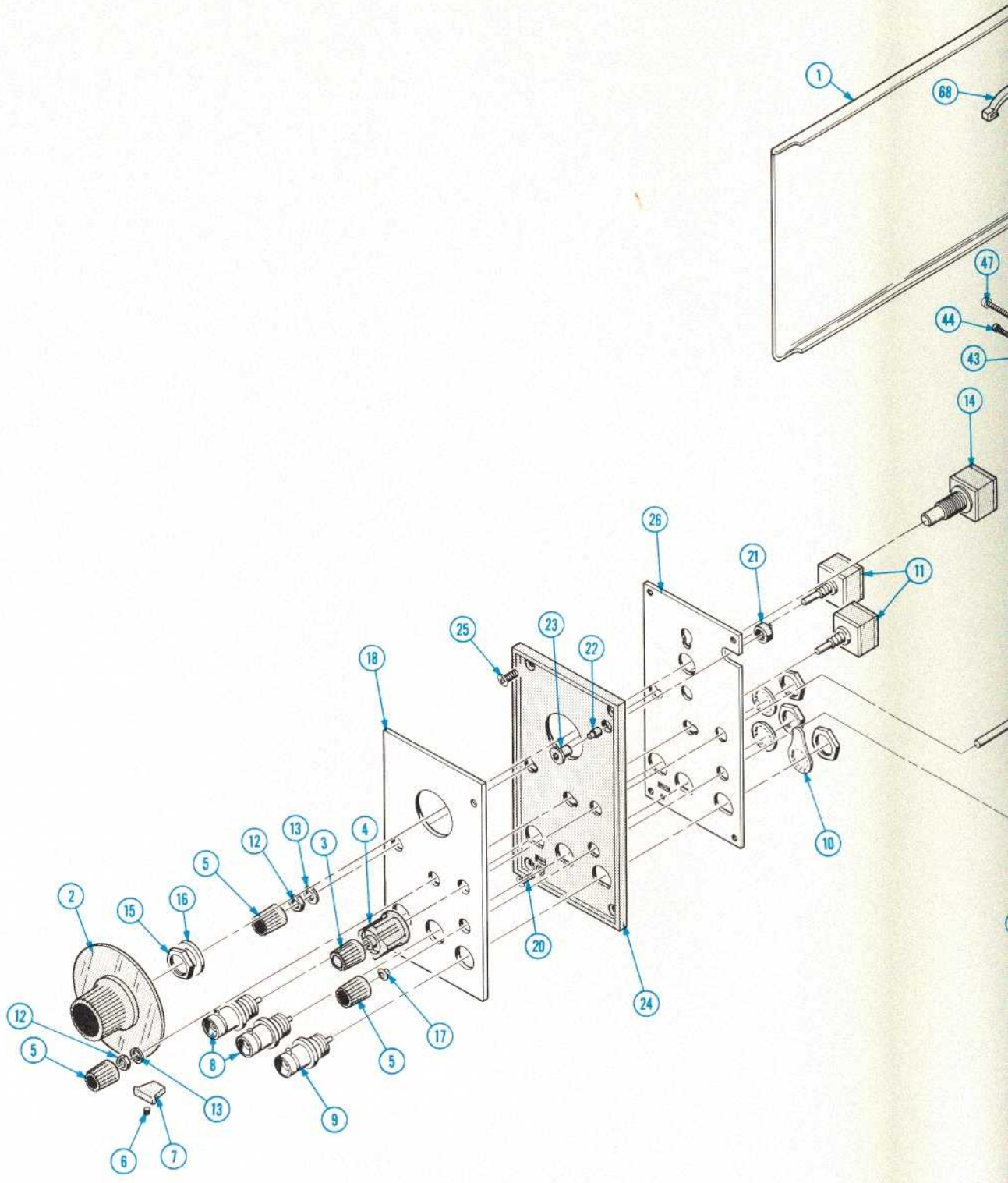
"	INCH
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	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
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
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
26365	GRIES REPRODUCER CO., DIV. OF COATS AND CLARK, INC.	125 BEECHWOOD AVE.	NEW ROCHELLE, NY 10802 CAMPBELLSVILLE, KY 42718
45722	USM CORP., PARKER-KALON FASTENER DIV.	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16875
55210	GETTIG ENG. AND MFG. COMPANY	446 MORGAN ST.	CINCINNATI, OH 45206
73743	FISCHER SPECIAL MFG. CO.		
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
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	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	366-1007-03			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:0.094 OD X 0.120 INCH LONG	80009	214-1840-00
-7	366-1422-01			1		KNOB:LATCH	80009	366-1422-01
-8	131-0955-00			2		CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
-9	131-0955-00			1		CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
						(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	2X20224-402
-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:2-32 X 0.250,100 DEG,FLH	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	384-1334-00			1		ROD,EXT:SHAFT,9.470 INCH LONG	80009	384-1334-00
	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	55210	L-2007-1
-32	131-0604-00			12		. . CONTACT,ELEC:CKT CD SW,SPR	80009	131-0604-00
-33	136-0252-04			18		. . SOCKET,PIN TERM:0.188 INCH LONG	22526	75060
-34	136-0260-02			2		. . SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	82647	C951601
-35	136-0269-02			2		. . SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C951401
-36	136-0514-00			2		. . SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	C950802
-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

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	2X20224-402
-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",BDGH PLSTC	26365	OBD
-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.	80009	214-2215-00
						(ATTACHING PARTS)		
-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	80009	263-1090-00
						(ATTACHING PARTS)		
-49	211-0116-00			4		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
						- - - * - - -		
	----- -----			-		. . ACTUATOR ASSY INCLUDES:		
-50	200-1441-00			1		. . 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	80009	263-1038-00
						(ATTACHING PARTS)		
-58	211-0116-00			4		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
						- - - * - - -		
	----- -----			-		. . ACTUATOR ASSY INCLUDES:		
-59	200-1660-00			1		. . 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
	386-3657-00	XB023140		2		SUPPORT,PLUG-IN:	80009	386-3657-00
	210-1270-00	XB023140		2		WASHER,FLAT:0.141 ID X 0.219 OD	80009	210-1270-00
-67	426-0724-00			1		FR SECT,PLUG-IN:BOTTOM	80009	426-0724-00
-68	214-1061-00			1		SPRING,GROUND:FLAT	80009	214-1061-00
-69	426-0725-00			1		FR SECT,PLUG-IN:TOP	80009	426-0725-00
	175-0826-00			FT		WIRE,ELECTRICAL:3 WIRE RIBBON	08261	175-0826-00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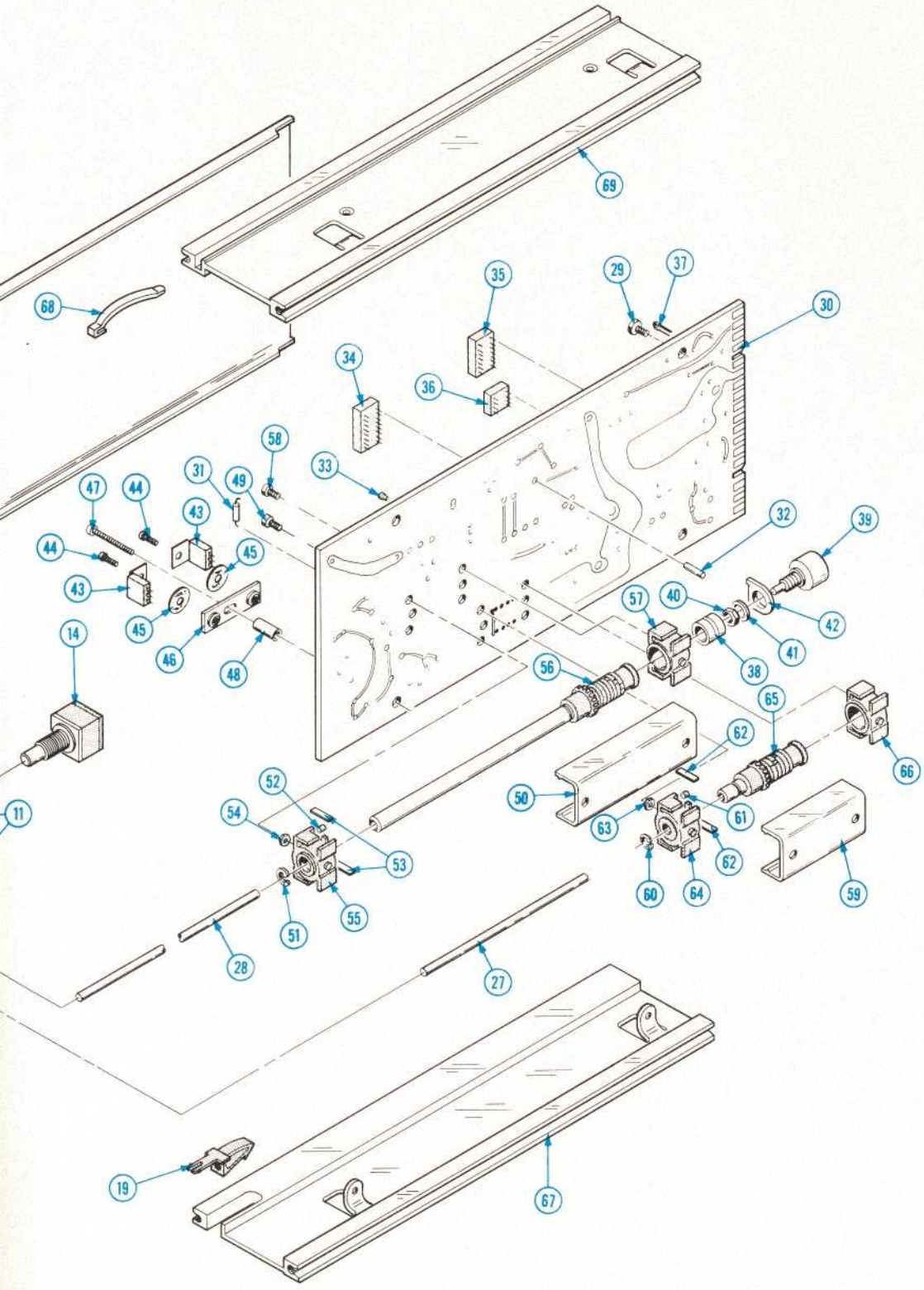

FIG. 1 EXPLODED

FG 503

Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
	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

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

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