Tektronix®
COMMITTED TO EXCELLENCE

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

SG 503
LEVELED SINE-WAVE GENERATOR

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Serial Number _____

070-1622-01

First Printing AUG 1974
Revised MAY 1981

TABLE OF CONTENTS

		Page
SECTION 1	OPERATING INSTRUCTIONS	1-1
SECTION 2	SPECIFICATION AND PERFORMANCE CHECK	2-1

WARNING

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

SECTION 3	ADJUSTMENT	3-1
SECTION 4	MAINTENANCE AND INTERFACING INFORMATION	4-1
SECTION 5	CIRCUIT DESCRIPTION	5-1
SECTION 6	OPTIONS	6-1
SECTION 7	REPLACEABLE ELECTRICAL PARTS	7-1
SECTION 8	DIAGRAM AND CIRCUIT BOARD ILLUSTRATION	8-1
SECTION 9	REPLACEABLE MECHANICAL PARTS AND EXPLODED VIEW	9-1

CHANGE INFORMATION

OPERATING INSTRUCTIONS

INTRODUCTION

Description

The SG 503 Leveled Sine-Wave Generator provides a regulated, constant-amplitude versus frequency output into a 50-ohm load. The SG 503 is primarily intended to be used as an oscilloscope calibration device for measuring bandwidths up to 250 megahertz. The SG 503 can also be used as a signal source for general electronics design and development.

Nine overlapping ranges cover the frequency band from 250 kilohertz to 250 megahertz, with an additional range reserved for a 50 kilohertz reference frequency.

A digital counter with automatic ranging and a front panel LED readout is used for frequency indication.

Installation and Removal

CAUTION

Turn the power module off before inserting the plug-in; otherwise, damage may occur to the plug-in circuitry. Because of the high current drawn by the SG 503, it is also recommended that the power module be turned off before removing the SG 503. Refer to Fig. 1-2. Check to see that the plastic barriers on the interconnecting jack of the selected power module compartment match the cut-outs in the SG 503 circuit board edge connector.

Align the SG 503 chassis with the upper and lower guides of the selected compartment. Push the module in and press firmly to seat the circuit board in the interconnecting jack.

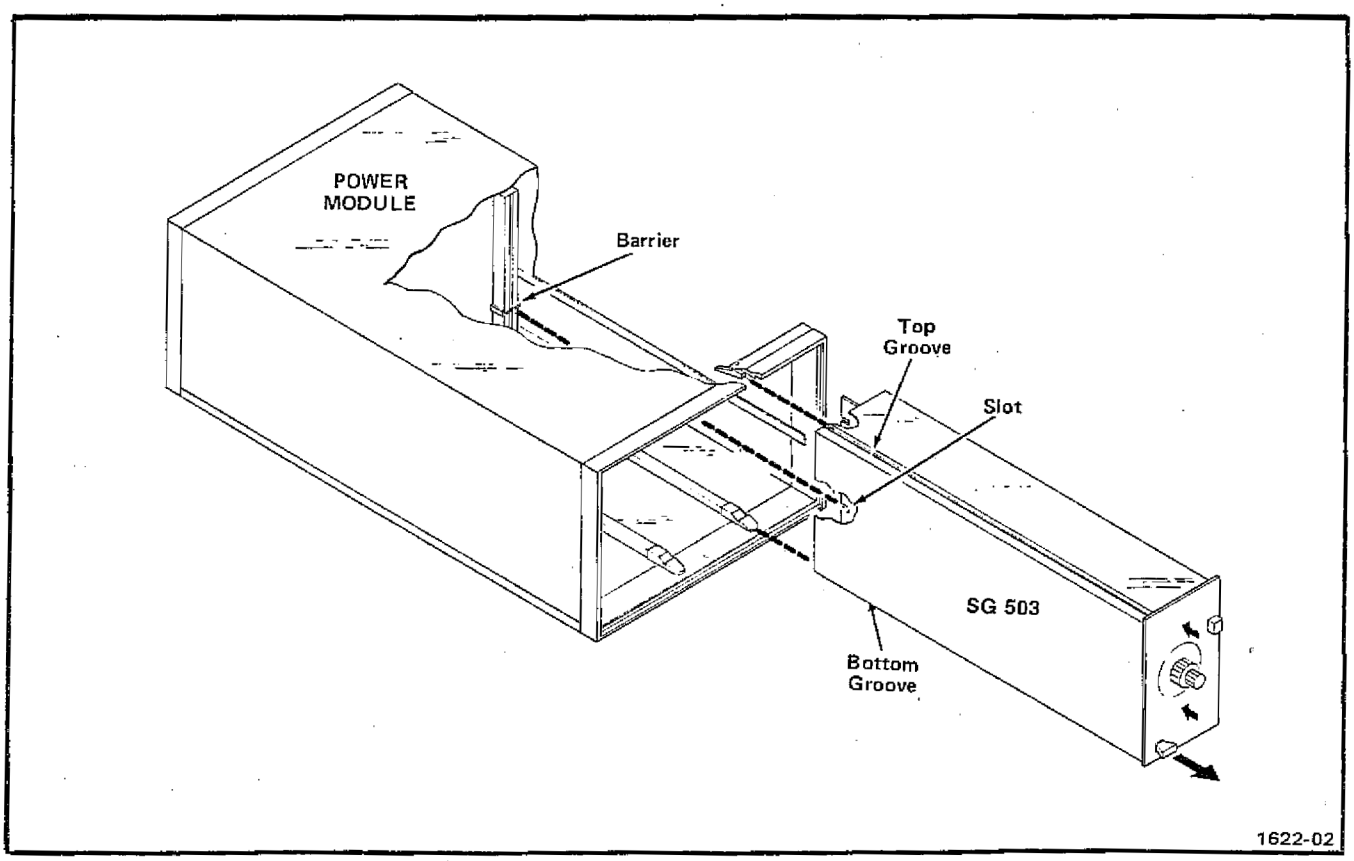


Fig. 1-2. Plug-in installation and removal.

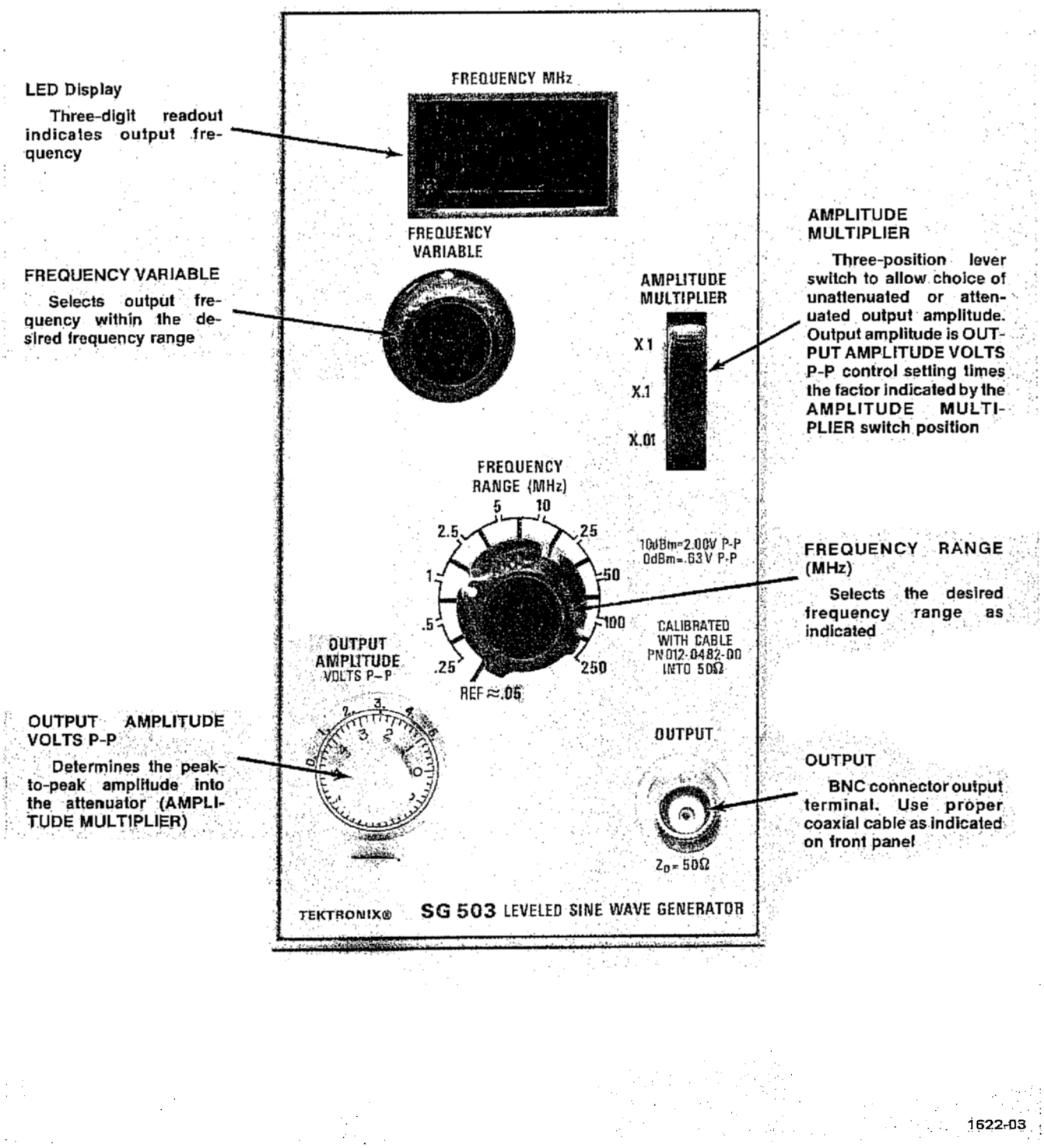


Fig. 1-3. SG 503 controls and connectors.

To remove the SG 503, pull on the release latch located in the lower left corner, until the interconnecting jack disengages and the SG 503 will slide out.

Power application to the SG 503 is indicated by the three-digit LED (Light-Emitting Diode) display being lighted. Turn the FREQUENCY RANGE (MHz) control between the detent positions to test the LED's (888 display). Reset the FREQUENCY RANGE (MHz) control to the desired range. Allow 15 to 20 minutes warmup time for all equipment before using the SG 503.

Overheating

The SG 503 is designed to operate at an ambient temperature from 0°C to +50°C. However, when operating several power supplies in a multi-plug-in power module, especially at low output voltages, or when operating close to other heat-producing equipment, internal temperature may exceed safe limits and actuate a thermal cutout in the power module. Refer to the power module instruction manual for more complete information.

Controls and Connectors

Refer to Fig. 1-3. Even though the SG 503 is fully calibrated and ready to use, the functions and actions of the controls and connectors should be reviewed before attempting to use it.

CAUTION

If the instrument is operated at the extreme limit of, or beyond a band range, the front-panel display may flash a blinking indication, alerting the user to an unleveled output amplitude condition.

OPERATING CONSIDERATIONS

Introduction

The SG 503 has been designed and calibrated with a high quality coaxial cable (Part Number 012-0482-00) to operate as a closely matched system when terminated into a 50-ohm load. See Fig. 1-4A. The absolute amplitude across the load is directly related to its impedance. Part Number 012-0482-00 should be connected directly to the equipment under test if the input impedance of the equipment is 50 ohms. For equipment with an input impedance much greater than 50 ohms, an accurate 50-ohm termination should be connected between the coaxial cable and the equipment. Tee connectors or wire of any type between the 50-ohm termination and the equipment being tested will produce some variation in the calibrated output amplitude at higher frequencies.

Coaxial cables of lesser quality or cables that are longer or shorter than Part Number 012-0482-00 can be used, but the output amplitude flatness specifications are no longer applicable. Cables that are 2 feet longer or 2 feet shorter than Part Number 012-0482-00 can cause amplitude variations that are as much as 4% low or 2% high (respectively) when compared to the calibrated amplitudes at 250 megahertz.

Optimum performance is obtained when the setting of the OUTPUT AMPLITUDE control is in the 1.0 to 5.0 range. For example; when an output amplitude of 0.5 volt peak-to-peak is desired, set OUTPUT AMPLITUDE control to 5.0 and AMPLITUDE MULTIPLIER switch to X.1 instead of 0.5 and X1.

The sine-wave output from the SG 503 may be applied to an external dc level that does not exceed ±1 volt. At higher dc offset levels, couple the output through a dc blocking capacitor. When operating the SG 503 always consider the total load impedance and its effect on the output amplitude.

Open-Circuit Operation

When the SG 503 is operating into an impedance much greater than 50 ohms, up to twice the maximum terminated output amplitude can be obtained. Under open-circuit conditions, the actual output amplitude will be two times the amplitude indicated by the front panel controls.

Open-circuit amplitude flatness is not specified, but is adequate for many applications in the lower frequency bands because the steady state 50-ohm output impedance of the SG 503 reverse-terminates the characteristic impedance of a 50-ohm coaxial cable. The reverse termination keeps the output amplitude constant at the unterminated end of the cable even though standing waves may exist in the coaxial cable.

Capacitive Loads

The input capacitance of the equipment under test will affect the bandwidth. The equivalent circuits shown in Fig. 1-4B and Fig. 1-4C are useful in estimating the amplitude changes caused by reactive loads. Note that as system input capacitance increases, bandwidth decreases. The bandwidth of an oscilloscope with a high input impedance is usually specified using an equivalent 25-ohm source.

When operating the SG 503 on the higher frequency bands with no output attenuation, the front-panel display may flash, indicating an unleveled output amplitude. Switch the AMPLITUDE MULTIPLIER control to the X.1 position and if the display flashing ceases, the problem may be related to an extreme mismatch between the SG 503 and the load. If the SG 503 is operating into a high SWR, a 3-decibel attenuator inserted between the output and the load may improve the operation at full output amplitude (X1 position of the AMPLITUDE MULTIPLIER switch).

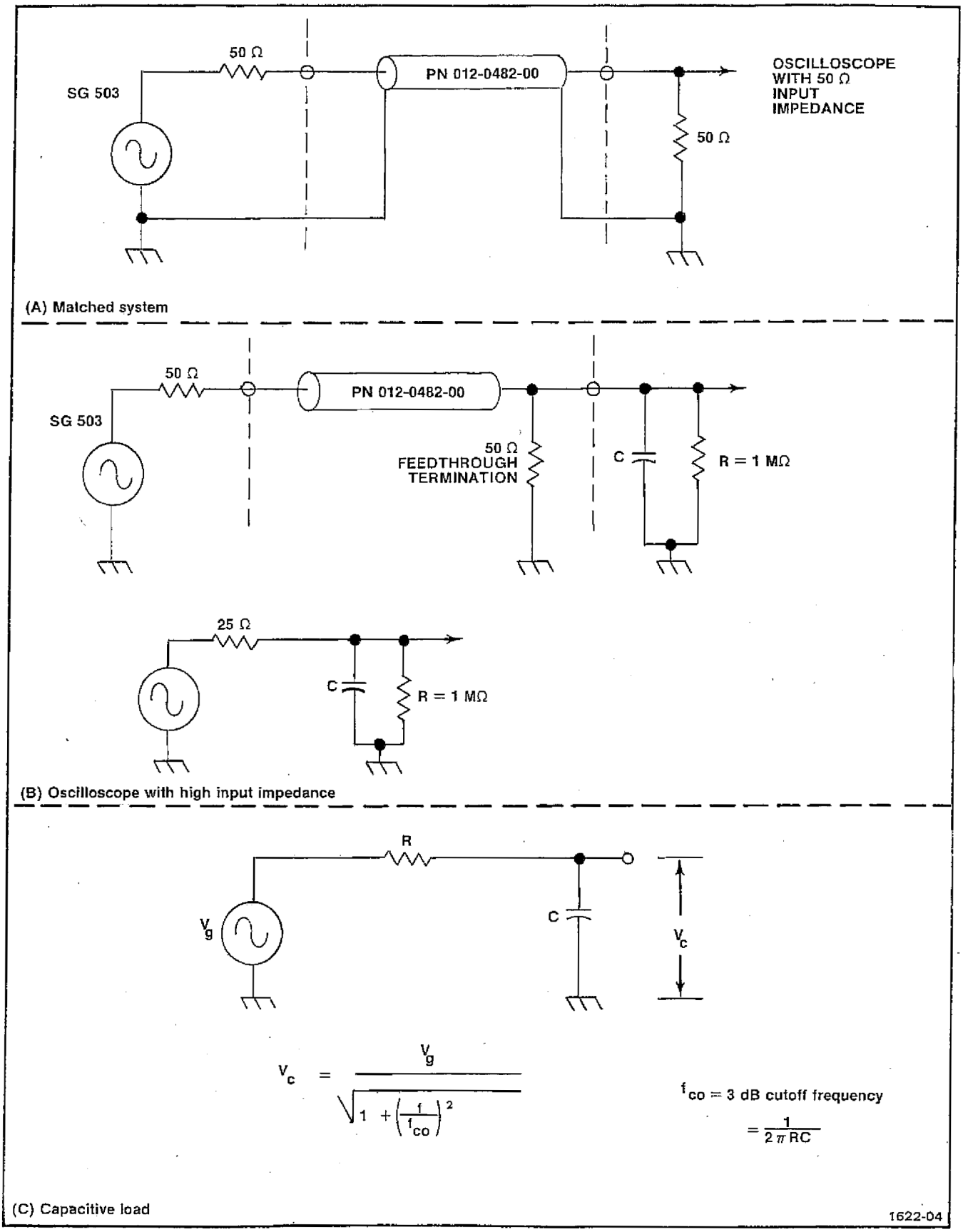


Fig. 1-4. Equivalent circuits for SG 503, 50 ohm coaxial cable and various terminations.

SPECIFICATION AND PERFORMANCE CHECK

SPECIFICATION

Performance Conditions

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

The SG 503 is calibrated for use with a furnished coaxial cable accessory (See Standard Accessories in Replaceable Mechanical Parts list section) terminated into a 50-ohm load.

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

Table 2-1

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information
Frequency Range	250 kHz to 250 MHz, plus 50 kHz reference frequency.	
Output Accuracy	Within ±0.7 of the least significant displayed digit.	
Amplitude Range	5 mV to 5.5 V peak-to-peak over three decade ranges and terminated into a 50-Ω load.	
Accuracy	At 50 kHz reference frequency; within 3% of indicated amplitude on X1 range, 4% on X.1 range, and 5% on X.01 range.	Accuracy must be set to within 0.3% on X1 range and checked to be within 2.0% on X.1 and X.01 ranges.

NOTE

Flatness (Peak-to-Peak) valid only when precision coaxial cable is used. Flatness referenced to NBS corrections of Tektronix standards. NBS uncertainties not included.

Table 2-1 (cont)

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information
Flatness (Peak-to-Peak) Amplitude Multiplier Setting: X1, X.1, X.01	From 250 kHz to 50 MHz output amplitude will not vary more than 1% of the value at 50 kHz. From 100 MHz to 250 MHz amplitude variation is within 3% of the value at 50 kHz.	
Amplitude Multiplier Setting: X1	50 MHz to 100 MHz range; output amplitude will not vary more than 1% of the value at 50 kHz.	
Amplitude Multiplier Setting: X.1 and X.01	50 MHz to 100 MHz range; output amplitude will not vary more than +1.5% and −1.0% of the value at 50 kHz.	
Harmonic Content	Harmonic suppression relative to fundamental: Second harmonic at least 35 dB down. Third and all higher harmonics at least 40 dB down.	

Table 2-2

ENVIRONMENTAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information
Temperature Operating	0° C to +50° C.	
Storage	−40° C to +75° C.	
Altitude Operating	To 15,000 feet maximum operating temperature decreased by 1° C/1000 feet from 5000 to 15000 feet.	
Storage	To 50,000 feet.	
Vibration Operating and Non-operating	With the instrument complete and operating, vibration frequency swept from 10 to 55 to 10 Hz at 1 minute per sweep. Vibrate 15 minutes in each of the three major axes at 0.015 inch total displacement. Hold 10 minutes at any major resonance, or in none, at 55 Hz. Total time, 75 minutes.	
Shock Operating and Non-operating	30 g's 1/2 sine, 11 ms duration, 3 shocks in each direction along 3 major axes, for a total of 18 shocks.	

Table 2-3

PHYSICAL CHARACTERISTICS

Characteristics	Information
Overall Dimensions (measured at maximum points) Height	5.0 inches 12.7 centimeter
Width	2.6 inches 6.6 centimeter
Length	12.2 inches 31.0 centimeter
Net Weight (Instrument Only)	2.25 lbs. 1.02 kilograms

PERFORMANCE CHECK

Introduction

This procedure checks the electrical characteristics of the SG 503 that appear in the Specification section of this manual. If the instrument fails to meet the requirements given in this performance check, the calibration procedure should be performed. This procedure can also be used by an incoming inspection facility to determine acceptability of performance.

The electrical characteristics in Section 2 are valid only if the SG 503 is calibrated at an ambient temperature of +20° C to +30° C and operated at an ambient temperature of 0° C to +50° C. Forced air circulation is required for ambient temperature above +40° C.

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

Test Equipment Required

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

Special test devices are used where necessary to facilitate the procedure. Most of these are available from Tektronix, Inc. and can be ordered through your local Tektronix Field Office or representative.

Table 2-4

LIST OF TEST EQUIPMENT REQUIREMENTS

Description	Performance Requirements	Application	Example
Oscilloscope	Bandwidth, dc to 100 MHz; minimum deflection factor, 1 mV/div with differential comparator; sweep rate, 10 ms/div to 1 μs/div; accuracy, within 3%.	Used throughout procedure to provide display.	TEKTRONIX 7603, 7A13, 7B70 Oscilloscope System.
Digital Voltmeter	Range, 0 to 50 V; accuracy, within 0.1%.	Output voltage flatness check.	TEKTRONIX DM 501 Digital Multimeter.
Digital Counter	Range, 50 kHz to 250 MHz.	Output accuracy	TEKTRONIX DC508 Digital Counter.[1]
Power Module	Three compartments or more.	All tests.	TEKTRONIX TM 503 or TM 504.
Calibration Generator	Amplitude calibration, 5 mV to 5 V; accuracy, ±0.25% into 1 MΩ; output, square wave at approximately 1 kHz.	Amplitude Set check.	TEKTRONIX PG 506 Calibration Generator.[1]
Spectrum Analyzer	Range, 100 kHz to 300 MHz; calibrated levels in decade steps from −45 dB to −35 dB; impedance, 50 Ω; accuracy, linear display, within 10%.	Buffer Distortion, Harmon-Suppression check.	TEKTRONIX 7L12 Spectrum Analyzer.
Peak-to-Peak Detector	Frequency range, 50 Hz to 500 MHz; requires 1.2 V p-p input voltage.	Output voltage flatness check.	Tektronix 067-0625-00 Calibration Fixture.
Coaxial cable	Impedance, 50 Ω; length, 36 inches; connectors, bnc; (precision coaxial cable).	Provides signal interconnection.	Tektronix Part No. 012-0482-00 (supplied with SG 503).
Patch cord (2 required)	Bnc to banana plug-jack, 18 inch.	Provides signal interconnection.	Tektronix Part No. 012-0090-00 (black) 012-0091-00 (red)
Coaxial cable (2 required)	Impedance, 50 Ω; length, 42 inches; connectors, bnc.	Provides signal interconnection.	Tektronix Part No. 012-0057-01.
Attenuator, 2X (2 required).	Impedance, 50 Ω; connectors, bnc.	Output voltage flatness check.	Tektronix Part No. 011-0069-02.
Tee connector	Connectors, bnc.	Reference amplitude check.	Tektronix Part No. 103-0030-00.
Adapter	GR to bnc female.	Output voltage flatness check.	Tektronix Part No. 017-0063-00.
Termination	Impedance, 50 Ω; connectors, bnc.	Output termination for signal generator.	Tektronix Part No. 011-0049-01.
Resistor	Fixed, 2.4 M Ω, 1/2 W, 5%.	Output voltage flatness check.	Tektronix Part No. 301-0245-00.

[1]Requires TM 500-Series Power Module.

Preliminary Procedure

1. Ensure that all power switches are off.

2. Ensure that all test equipment and the SG 503 under test are suitably adapted to the line voltage to be applied.

3. Install the SG 503 into the power module, and if applicable, install all other TM 500-series test equipment into the power module.

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

Initial Control Settings

Set the following controls during warm-up time:

SG 503

AMPLITUDE MULTIPLIER	X1
FREQUENCY VARIABLE	Midrange
FREQUENCY RANGE (MHz)	REF ≈ .05
OUTPUT AMPLITUDE	5.0

Oscilloscope

Intensity, Focus	Set for well-defined trace and normal brightness.

Differential Comparator

Volts/Div	.1 V
Variable	fully clockwise (cal)
+Input	ac
−Input	ac
Bandwidth Limit	5 MHz

Time Base Plug-In

Time/Div	.2 ms
Variable	(cal in)
Triggering	
+Slope	selected
Mode	P-P Auto
Coupling	ac hf rej
Source	Ext
Position	Set so trace starts at left side of graticule.
Magnifier	X1

PERFORMANCE CHECK PROCEDURE

NOTE

The SG 503 must be terminated into an accurate 50-ohm load for all checks. Measure the 50-ohm termination to determine percent of error. A 2% error in the termination (1 ohm) will cause amplitude errors of 1%. For example, a 51-ohm termination causes an amplitude error that is 1% high at 50 kilohertz.

1. Check Reference Amplitude Accuracy at 0.05 megahertz.

a. Connect a 1 kilohertz, 5 volt square-wave signal from the calibration generator, through a bnc tee connector, to the + input of the differential comparator, using a 42-inch cable. Connect a 42-inch cable from the tee connector to the time-base unit external trigger input.

b. Connect the precision 50-ohm cable (supplied with SG 503) to the SG 503 OUTPUT connector.

c. Connect a 50-ohm termination to the remaining end of the precision 50-ohm cable; connect the other end of the 50-ohm termination to the − input of the differential comparator.

d. Set the time-base triggering controls for a stable display; a crt display similar to Fig. 2-1 is obtained.

e. Check—that the corners of the idealized waveform are aligned as illustrated in Fig. 2-1, within 1.5 vertical divisions. Disregard waveform tilt.

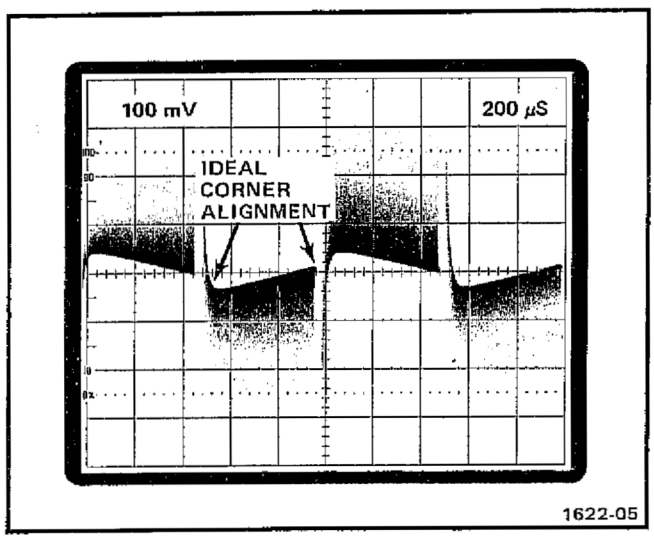


Fig. 2-1. Representation of complex waveform (idealized) with 5 volt reference amplitude at 0.05 MHz, properly set.

f. Set the SG 503 OUTPUT AMPLITUDE control to 0.5; set the calibration generator for a 0.5 volt, 1 kilohertz square-wave signal.

g. Set the differential-comparator deflection factor for 10 mV/div.

h. Check—that the waveform is similar as illustrated in Fig. 2-2, (within 1.5 vertical divisions).

i. Disconnect all cables.

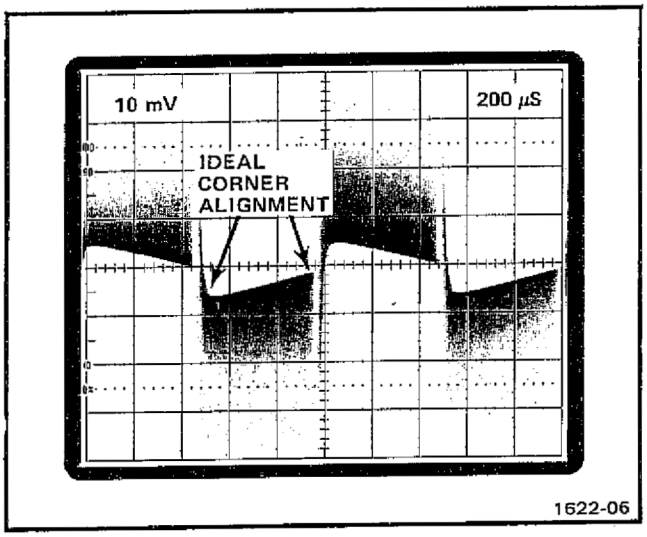


Fig. 2-2. Display of complex waveform (idealized) with 0.5 volt reference amplitude of 0.05 MHz, properly set.

2. Check Harmonic Suppression and Leveling

a. Connect the SG 503 output to the spectrum analyzer input, using the precision 50-ohm cable (supplied with SG 503).

b. Set the SG 503 OUTPUT AMPLITUDE control to 5.5 and the AMPLITUDE MULTIPLIER switch to the X1 position.

c. Set the SG 503 FREQUENCY RANGE (MHz) switch to the 100-250 range.

d. Position the fundamental display to the top graticule line with the spectrum analyzer position control. See Fig. 2-3 for reference.

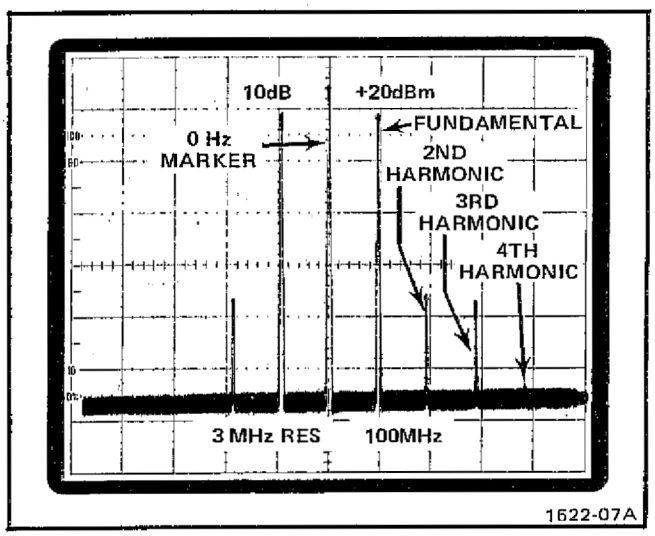


Fig. 2-3. Display of 100 MHz signal and harmonics.

NOTE

It will be necessary to change the spectrum analyzer input attenuation (sensitivity) to maintain a reasonable display on screen, with harmonics above the baseline noise level and within the graticule area.

e. Slowly adjust the SG 503 FREQUENCY VARIABLE control over its entire range and check that the vertical distance (suppression) between the top of the fundamental and second harmonic display is at least 3.5 divisions; the tops of the remaining harmonics are separated at least 4.0 divisions. (Adjust the spectrum analyzer Frequency Span/Div control as necessary to maintain the harmonic display on screen.) See Fig. 2-3.

f. Set the SG 503 FREQUENCY RANGE (MHz) switch to the 50-100 range.

g. Repeat part e of this step for the remaining frequency ranges, using Table 2-5 as reference. (Suppression limit of 45 decibels down corresponds to 4.5 divisions on the display.)

NOTE

All coil adjustments have been adjusted for minimum harmonic amplitude at the high end of the associated range (worst case harmonic conditions). Check that the output remains leveled (display will blink if unleveled condition occurs) as the SG 503 FREQUENCY VARIABLE control is slowly rotated over its associated frequency range.

Table 2-5

SG 503 FREQUENCY (RANGE (MHz)	SG 503 FREQUENCY VARIABLE Typical Displayed Count (Frequency Range)*	Typical Harmonic Suppression (2nd and all higher harmonics, relative to fundamental)
100-250	97.5-260	≥40 dB down
50-100	41.0-109	≥40 dB down
25-50	23.7-52.5	≥40 dB down
10-25	9.09-27.3	≥45 dB down
5-10	4.70-11.1	≥45 dB down
2.5-5	2.30-5.50	≥45 dB down
1-2.5	.950-2.55	≥45 dB down
.5-1	.480-1.05	≥45 dB down
.25-.5	.240-.520	≥45 dB down
REF≈.05	.049-.051	≥45 dB down

***The minimum and maximum displayed count on each range will vary slightly between instruments.**

h. Disconnect the cable from the spectrum analyzer.

3. Readout Accuracy

a. Connect the SG 503 output to the frequency counter using the 50 Ω coax. (Set the counter to 50 Ω.)

b. Set the SG 503 OUTPUT AMPLITUDE to a level that stabilizes the frequency counter display.

c. Slowly adjust the SG 503 FREQUENCY VARIABLE control over its entire range at each of the frequency range positions of the FREQUENCY RANGE (MHz) switch.

d. Check that the frequency counter display is within ±0.7 of the least significant displayed digit on the SG 503.

4. Check Flatness (Peak-to-Peak Amplitude Regulation)

a. Set the SG 503 controls as follows: FREQUENCY RANGE (MHz) switch to REF ≈ .05 position, and the AMPLITUDE MULTIPLIER switch to X1.

b. Connect a 2.4 megohm, 5% resistor across the digital voltmeter floating input terminals. Connect the SG 503 via the precision cable (012-0482-00) and the bnc female-to-GR adapter to the input of the peak-to-peak detector. Use two bnc to banana-plug-jack patch cords to connect the output of the peak-to-peak detector to the floating input terminals on the digital voltmeter; maintain correct polarity, HI to + and LO to −. Set the digital voltmeter to the 20 volts dc range.

c. Slowly adjust the SG 503 OUTPUT AMPLITUDE VOLTS P-P control until the digital voltmeter display indicates ±.000. Output amplitude from the SG 503 should be about 1.1 to 1.2 volts; this establishes a 0.0% reference setting at .050 megahertz.

d. Slowly adjust the SG 503 FREQUENCY VARIABLE control over its entire range at each of the frequency range positions of the FREQUENCY RANGE (MHz) switch.

e. Check—the flatness deviation from 0.25 megahertz to 50 megahertz, must be within 1% of the value at .050 megahertz. The total percentage deviation calculation must include the digital voltmeter reading and the calibration factor of the peak-to-peak detector. For example, a reading of +.008 volt on the digital voltmeter is equivalent to +0.8% deviation. Applying a correction factor of −0.3% results in a total percentage deviation of +0.5%.

f. Check—the flatness deviation from 50 megahertz to 100 megahertz, must be within 1% of the value at .050 megahertz. The same calculation must be considered for this deviation reading as described in part e of this step.

NOTE

A 1% total percentage deviation ensures flatness specification when the SG 503 is operating at the X.1 and X.01 AMPLITUDE MULTIPLIER switch positions.

g. Check—the flatness deviation from 100 megahertz to 250 megahertz, must be within 3% of the value at .050 megahertz. The same calculation must be considered for this deviation reading as described in part e and f of this step.

h. To check the flatness deviation at a higher voltage output from the SG 503, insert two 2X attenuators between the SG 503 cable and the peak-to-peak detector. Repeat part c of this step to obtain another 0.0% reference reading of about 4.7 volts output from the SG 503.

i. After obtaining the new 0.0% reference indication on the digital voltmeter, repeat parts e and f of this step to check flatness deviation for about 4.7 volts output from the SG 503. Tolerance limits are the same as in parts e and f of this step.

j. Disconnect all cables from the SG 503.

This completes the Performance Check procedure of the SG 503 Leveled Sine Wave Generator.

ADJUSTMENT

Introduction

This adjustment procedure is to be used to restore the SG 503 to original performance specifications. Adjustment need not be performed unless the instrument fails to meet the Performance Requirements of the Electrical Characteristics listed in the Specification section, or the Performance Check cannot be completed satisfactorily.

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

Services Available

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

Test Equipment Required

The test equipment listed in Table 3-1, or equivalent, is required for adjustment of the SG 503. Specifications given for the test equipment are the minimum necessary for accurate adjustment and measurement. All test equipment is assumed to be correctly calibrated and operating within specification.

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

A flexible plug-in extender, Tektronix Part No. 067-0645-02, is useful for troubleshooting or adjusting the SG 503; however, the complete Adjustment Procedure can be performed without use of the extender.

Table 3-1

LIST OF TEST EQUIPMENT REQUIREMENTS

Description	Performance Requirements	Application	Example
Oscilloscope	Bandwidth, dc to 100 MHz; minimum deflection factor, 1 mV/div; sweep rate, 10 ms/div to 1 μs/div; accuracy, within 3%.	Used throughout procedure to provide display.	TEKTRONIX 7603, 7A13, 7B70 Oscilloscope System.
Digital Voltmeter	Range, 0 to 50 V; accuracy, within 0.1%.	Voltage measurements. Output voltage flatness check.	TEKTRONIX DM 501 Digital Multimeter.*
Power Module	Three compartments or more.	All tests.	TEKTRONIX TM 503 or TM 504.
Calibration Generator	Amplitude calibration, 50 mV to 5 V; accuracy, ±0.25% into 1 MΩ; output, square wave at approximately 1 kHz.	Amplitude Set check and adjustment.	TEKTRONIX PG 506 Calibration Generator.*
Spectrum Analyzer	Range, 100 kHz to 300 MHz; calibrated levels in decade steps from −45 db to −35 db; impedance, 50 Ω; accuracy, linear display, within 10%.	Buffer Distortion, Harmonic Suppression check.	TEKTRONIX 7L12 Spectrum Analyzer.

*Requires TM 500-Series Power Module.

Table 3-1 (cont)

LIST OF TEST EQUIPMENT REQUIREMENTS

Description	Performance Requirements	Application	Example
Peak-to-Peak Detector	Frequency range, 50 Hz to 500 MHz; requires 1.2 V p-p input voltage.	Output voltage flatness check.	Tektronix 067-0625-00 Calibration Fixture.
Autotransformer with ac voltmeter	Capable of supplying an output voltage from 90 to 132 V, ac; 120 watts of power at the upper limit.	Power supply check.	General Radio W10MTR3W Variac Autotransformer.
Coaxial cable	Impedance, 50 Ω; length, 36 inches; connectors, bnc; (precision coaxial cable).	Provides signal interconnection.	Tektronix Part No. 012-0482-00 (supplied with SG 503).
Patch cord (2 required)	Bnc to banana-plug-jack, 18 inch.	Provides signal interconnection.	Tektronix Part No. 012-0090-00 (black) 012-0091-00 (red)
Coaxial cable (2 required)	Impedance, 50 Ω; length, 42 inches; connectors, bnc.	Provides signal interconnection.	Tektronix Part No. 012-0057-01.
Attenuator, 2X (2 required)	Impedance, 50 Ω; connectors, bnc.	Output voltage flatness check.	Tektronix Part No. 011-0069-02.
Tee connector	Connectors, bnc.	Reference amplitude check.	Tektronix Part No. 103-0030-00.
Adapter	GR to bnc female.	Output voltage flatness	Tektronix Part No. 017-0063-00.
Termination	Impedance, 50 Ω connectors, bnc.	Output termination for signal generator.	Tektronix Part No. 011-0049-01.
Resistor	Fixed, 2.4 MΩ, 1/2 W, 5%.	Output voltage flatness	Tektronix Part No. 301-0245-00.
Screwdriver	Three-inch shaft, 3/32 inch bit.	Used to adjust variable resistors.	Xcelite R-3323.
Alignment tool	Fits 5/64-inch (ID) hex cores.	Used to adjust coils in harmonic suppression check.	Tektronix Part No. 003-0307-00 (handle) 003-0310-00 (insert)
Alignment tool	Five-inch, for slotted cores.	Used to adjust coils in harmonic suppression check.	Tektronix Part No. 003-0301-00.

Preparation

a. Remove the left and right side covers of the SG 503 to gain access to the component side of the circuit boards. Pull the rear end of the side cover outward from the side of the instrument (the cover snaps into place).

b. Install the SG 503 into the left power module compartment, or if appropriate, connect the SG 503 to the power module by means of the flexible plug-in extender.

c. Set the power module for the line voltage to be applied (see power module manual) and connect it to the variable autotransformer; connect the autotransformer to the line voltage source. Be sure that the power switch is off.

d. Install the TM 500-series equipment, including the SG 503 into the power module.

e. Connect all test equipment to a suitable line voltage source.

f. Turn on all test equipment and allow at least 20 minutes for the equipment to warm up and stabilize.

Initial Control Settings

Set the following controls during warm-up time:

SG 503

AMPLITUDE MULTIPLIER	X1
FREQUENCY VARIABLE	Midrange
FREQUENCY RANGE (MHz)	REF ≈ .05
OUTPUT AMPLITUDE	5.0

Oscilloscope

Intensity, Focus	Set for well-defined trace and normal brightness.

Differential Comparator

Volts/div	.1 V
Variable	fully clockwise (cal)
+Input	ac
−Input	ac
Bandwidth Limit	5 MHz

Time Base Plug-In

Time/Div	.2 ms
Variable	(cal in)
Triggering	
+Slope	selected
Mode	P-P Auto
Coupling	ac hf rej
Source	Ext
Position	Set so trace starts at left side of graticule.
Magnifier	X1

7L12 Spectrum Analyzer

Frequency	
Center	selected
Coarse	0000
Fine	midrange
10 dB/div	selected
Triggering	
P-P auto	selected
Free Run	selected
Level	midrange
Slope	+
RF dB	50 (on knob)
Reference level	20
Variable	CAL (ccw)
Time/Div	SPECTRUM
Variable	in
Base Line Clipper	ccw
Horiz Pos	midrange
Video Filters	30 kHz
Video Processor	not selected
Auto Phase Locked	on (up)
Freq Span/Div	100 MHz
Hz Resolution	3 MHz (3M)
Variable	Cal
Vert Pos	midrange

ADJUSTMENT PROCEDURE

NOTE

The SG 503 must be terminated into an accurate 50-ohm load for all checks and adjustments. Measure the 50-ohm termination to determine percent of error. A 2% error in termination (1 ohm) will cause amplitude errors of 1%. For example, a 51-ohm termination causes an amplitude error that is 1% high at 50 kilohertz.

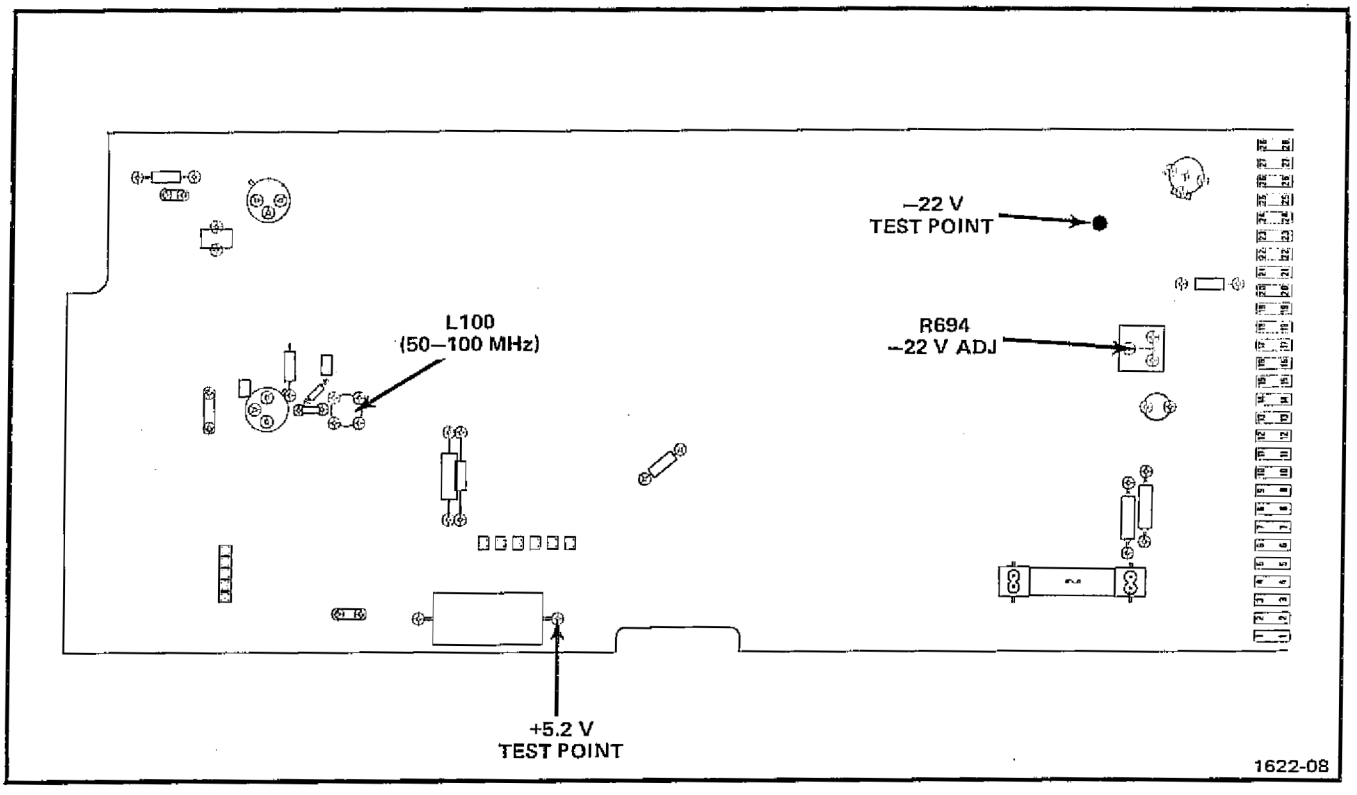


Fig. 3-1. Location of test points, L100, and −22 volt adjustment.

1. Adjust −22 Volt Power Supply

a. Connect the digital voltmeter between the −22 V test point on the Main circuit board, and chassis ground. See Fig. 3-1 for voltage test point location.

b. Check—for a meter reading of −22 volts, ±50 millivolts.

c. Adjust— −22 V adj, R694, for a meter reading of −22 volts. See Fig. 3-1 for adjustment location.

d. Adjust the autotransformer output voltage from the low limit to the high limit as indicated in Table 3-2. Meter reading should not vary more than ±50 millivolts. Return the autotransformer to the nominal line voltage setting.

e. Disconnect the digital voltmeter.

Table 3-2

POWER MODULE UNIVERSAL TRANSFORMER

Line Selector Block Position	Regulating Ranges	
	110-Volts Nominal	220-Volts Nominal
L	90 Vac to 110 Vac	180 Vac to 220 Vac
M	99 Vac to 121 Vac	198 Vac to 242 Vac
H	108 Vac to 132 Vac	216 Vac to 264 Vac
Line Fuse Data	1.6 A slow-blow	0.8 A slow-blow

2. Check +5.2 Volt Supply

a. Connect the digital voltmeter between the +5.2 V test point on the Main circuit board, and chassis ground. See Fig. 3-1 for voltage test point location.

b. Check—for meter reading of +5.0 to +5.4 volts.

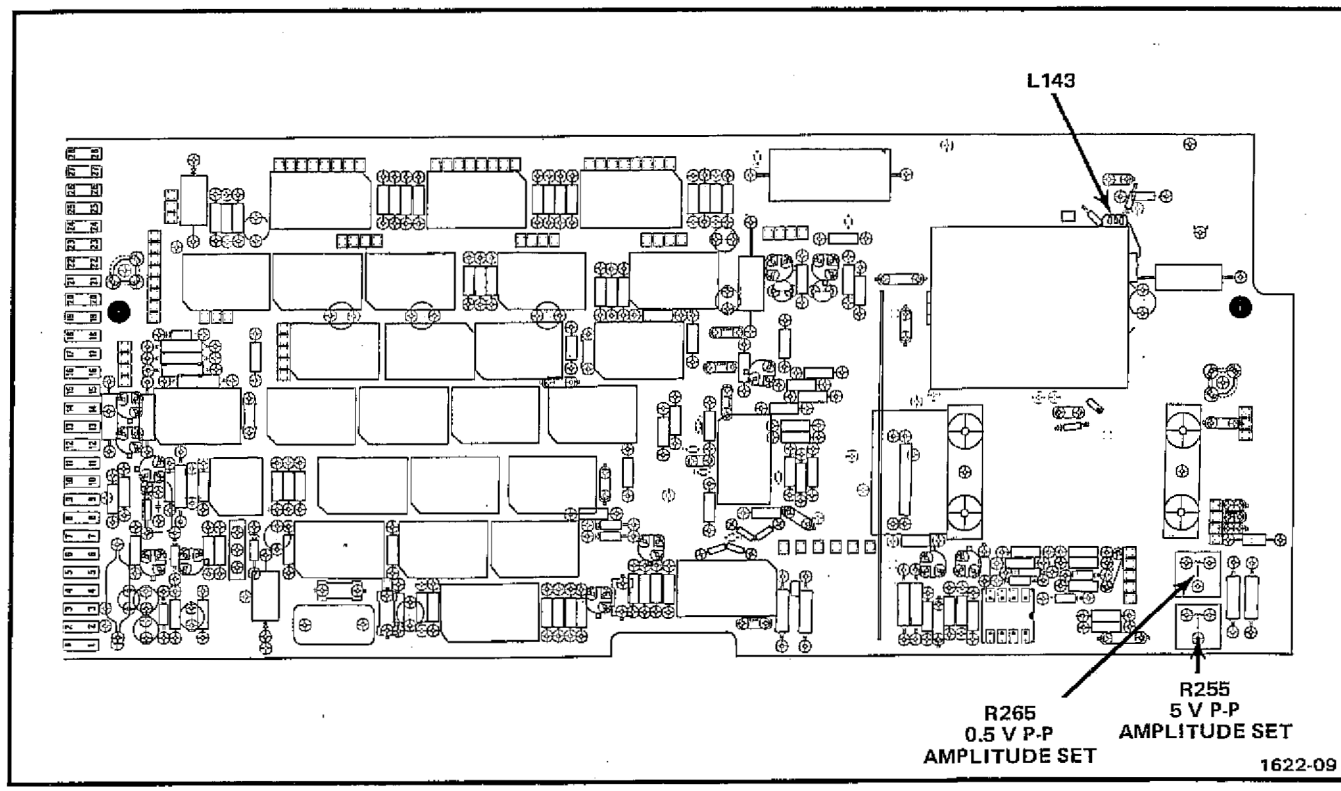


Fig. 3-2. Location of L143, 0.5 V P-P, and 5 V P-P Amplitude Set.

c. Disconnect the digital voltmeter.

3. Adjust .5 V P-P and 5 V P-P Amplitude Set

a. Connect a 1 kilohertz, 5 volt square-wave signal from the Standard Ampl Output of the calibration generator, through a tee connector, to the + input of the differential comparator, using a 42-inch cable. Connect a 42-inch cable from the tee connector to the time-base external trigger input.

b. Connect the precision 50-ohm cable (supplied with SG 503) to the SG 503 OUTPUT connector.

c. Connect a 50-ohm termination to the remaining end of the precision 50-ohm cable; connect the other end of the 50-ohm termination to the − input of the differential comparator.

d. Set the time-base triggering controls for a stable display; a crt display similar to Fig. 3-3 is obtained.

e. Check—that the corners of the idealized waveform are aligned as illustrated in Fig. 3-3. Disregard waveform tilt.

f. Adjust—5.0 P-P Amplitude Set, R255, so the corners of the idealized waveform are aligned as illustrated in Fig. 3-3. See Fig. 3-2 for adjustment location.

g. Set the SG 503 OUTPUT AMPLITUDE control to 0.5; reduce the calibration generator output for a 0.5 V, 1 kHz square-wave signal.

h. Set the differential comparator deflection factor for 10 mV/div.

i. Check—that the waveform is similar as illustrated in Fig. 3-3.

j. Adjust—0.5 V P-P Amplitude Set, R255, so the corners of the idealized waveform are aligned as illustrated in Fig. 3-3. See Fig. 3-2 for adjustment location.

k. Interaction—repeat parts e through j of this step until corners of the idealized waveform are aligned at the 0.5 volt and 5.0 volt settings.

4. Check Amplitude Multiplier Accuracy at 0.05 MHz

a. Set the SG 503 OUTPUT AMPLITUDE control to 5.0 and the AMPLITUDE MULTIPLIER switch to the X.1 position. Note that the FREQUENCY MHz display reads .050.

b. Set the calibration generator for a 0.5 volt, 1 kilohertz square-wave output signal.

c. Check—that the corners of the idealized waveform are not separated by more than 1.5 vertical divisions. See Fig. 3-3 for waveform illustration.

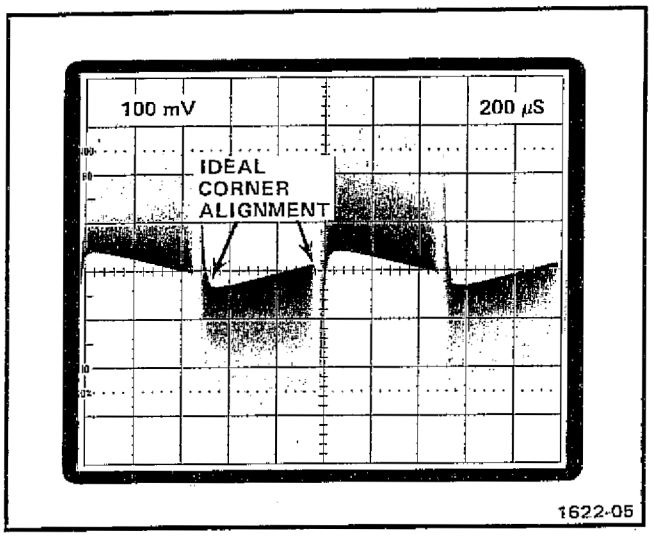


Fig. 3-3. Display of complex waveform (idealized) obtained when the amplitude set controls are properly adjusted at 0.05 MHz.

d. Set the SG 503 AMPLITUDE MULTIPLIER switch to the X.01 position. Do not disturb the SG 503 OUTPUT AMPLITUDE control setting.

e. Set the calibration generator for a 50 millivolt, 1 kilohertz square-wave output signal.

f. Set the differential comparator deflection factor for 1 millivolt/division.

g. Check—that the corners of the idealized waveform are not separated by more than 1.5 vertical divisions. See Fig. 3-3 for waveform illustration.

h. Disconnect all cables and termination.

5. Adjust Output Buffer Current

a. Connect the SG 503 output to the Spectrum Analyzer input, using the precision 50-ohm cable (supplied with the SG 503).

b. Set the SG 503 FREQUENCY RANGE (MHz) switch to the 100-250 range; adjust the FREQUENCY VARIABLE control for a display of 100 megahertz.

c. Position the 0 Hz marker display to the center graticule line with the spectrum analyzer position control. See Fig. 3-5 for reference.

d. Position the fundamental to the top graticule line with the spectrum analyzer vertical position control. See Fig. 3-5 for reference.

e. Slowly adjust the SG 503 OUTPUT AMPLITUDE control over the 0.5 volt to 5.5 volt range in both directions and check for at least 3.5 division vertical separation between the top of the fundamental and the top of the second harmonic display (35 decibels down). See Fig. 3-5 for harmonic reference.

NOTE

It will be necessary to change the spectrum analyzer input attenuation (sensitivity) to maintain a reasonable display on screen, with harmonics above the baseline noise level and within the graticule area.

f. Adjust—Current Adj, R175, for at least 3.5 division vertical separation between the top of the fundamental and the top of the second harmonic display. Repeat part e of this step. See Fig. 3-4 for adjustment location, and Fig. 3-5 for reference.

g. Repeat parts e and f of this step until final adjustment of R175 results in a crt display that shows the vertical separation between the top of the fundamental and second harmonic is at least 3.5 division, and the tops of the remaining harmonics are separated at least 4.0 division.

h. Set the FREQUENCY RANGE (MHz) switch to the 50-100 position; adjust the FREQUENCY VARIABLE control for a display of 100 megahertz.

I. Repeat parts d through g of this step.

6. Check/Adjust Harmonic Suppression

a. Set the SG 503 OUTPUT AMPLITUDE control to 5.5 and the AMPLITUDE MULTIPLIER switch to the X1 position.

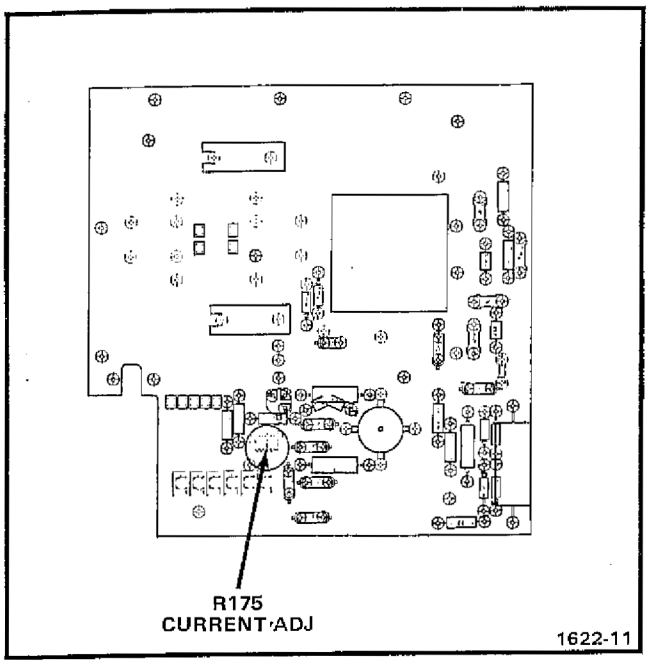


Fig. 3-4. Location of R175 Current Set adjustment.

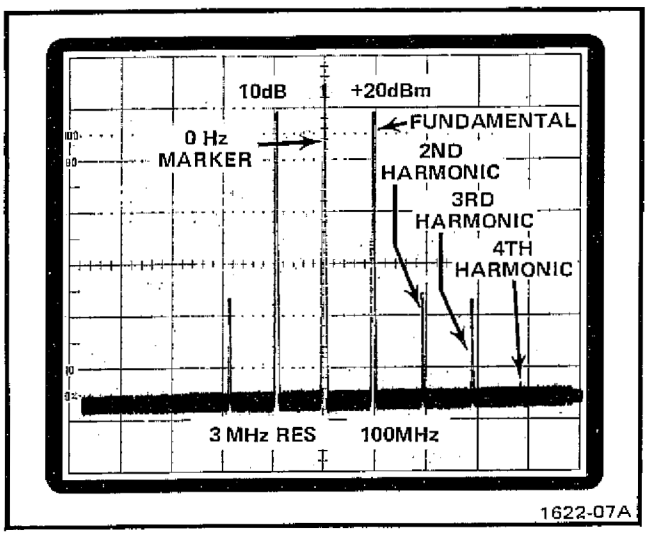


Fig. 3-5. Display of 100 MHz signal and harmonics.

b. Set the SG 503 FREQUENCY RANGE (MHz) switch to the 100-250 range.

NOTE

Adjustment of any coil associated with the oscillator sections is not recommended unless it is definitely proven that the SG 503 does not meet the typical frequency and harmonic suppression requirements as listed in Table 3-1. No coil should be adjusted for more than marginal deviations in frequency range or harmonic suppression. The generation of large harmonic amplitudes or large deviations from the typical frequency range listed in Table 3-1 indicate possible circuit faults, which must be corrected before proceeding further.

c. Position the fundamental to the top graticule line with the spectrum analyzer vertical position control. See Fig. 3-5 for reference.

NOTE

Interaction of the harmonic amplitude display will occur with adjustment of any coil. For example, decreasing the second harmonic amplitude will increase the amplitude of the third harmonic. No attempt should be made to adjust coils to obtain an ideal harmonic display (downward slope from the center frequency); instead, coil adjustments should achieve suppression requirements over the entire over-lapping range.

d. Slowly adjust the SG 503 FREQUENCY VARIABLE control over its entire range and check that the vertical distance (suppression) between the top of the fundamental and second harmonic display is at least 3.5 division, and the tops of the remaining harmonics are separated at least 4.0 division. (Adjust the spectrum analyzer frequency span/div control as necessary to maintain the harmonic display on screen.)

e. Adjust—L143, (physically moving coil), to meet the suppression requirement as given in part d of this step. See Fig. 3-2 for adjustment location.

f. Set the SG 503 FREQUENCY RANGE (MHz) switch to the 50-100 range.

g. Repeat part d of this step for the remaining frequency ranges, using Table 3-3 as reference. (Suppression limit of 45 decibel down corresponds to 4.5 divisions on the display.) See Fig. 3-6 for adjustment location of coils.

NOTE

All coil adjustments should be adjusted for minimum harmonic amplitude at the high end of the associated range (worst case harmonic conditions). Check that the output remains leveled (display will blink if unleveled condition occurs) as the SG 503 FREQUENCY VARIABLE control is slowly rotated over its associated frequency range.

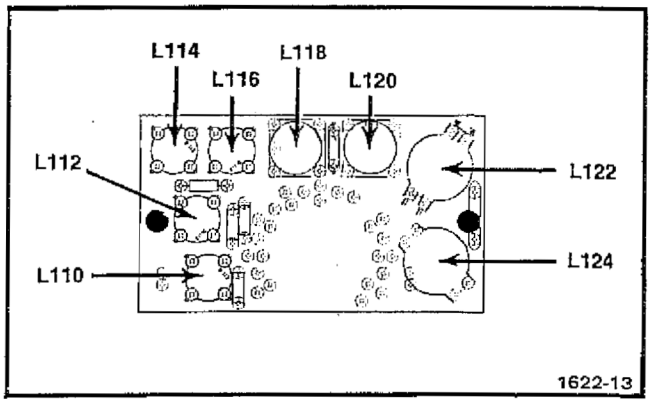


Fig. 3-6. Location of oscillator coils.

Table 3-3

SG 503 FREQUENCY RANGE (MHz)	SG 503 FREQUENCY VARIABLE Typical Displayed Count (Frequency Range)[a]	Typical Harmonic Suppression (2nd and all higher harmonics, relative to fundamental)[b]	SG 503 Coil Adjustment
100-250	97.5-260	≥40 dB down	L143, air core
50-100	41.0-109	≥40 dB down	L100, slug tuned
25-50	23.7-52.5	≥40 dB down	L110, slug tuned
10-25	9.09-27.3	≥45 dB down	L112, slug tuned
5-10	4.70-11.1	≥45 dB down	L114, slug tuned
2.5-5	2.30-5.50	≥45 dB down	L116, slug tuned
1-2.5	.950-2.55	≥45 dB down	L118, pot core, fixed
.5-1	.480-1.05	≥45 dB down	L120, pot core, fixed
.25-.5	.240-.520	≥45 dB down	L122, pot core, fixed
REF≈.05	.049-.051	≥45 dB down	L124, pot core, fixed

[a]**The minimum and maximum displayed count on each range will vary slightly between instruments.**

[b]**Second harmonic minimum is 35 dB down; typically 38 dB down.**

h. Disconnect the cable from the spectrum analyzer.

7. Check Flatness (Peak-to-Peak Amplitude Regulation)

a. Set the SG 503 controls as follows: FREQUENCY RANGE (MHz) switch to REF ≈ .05 position, and the AMPLITUDE MULTIPLIER switch to X1.

b. Connect a 2.4 megohm, 5% resistor across the digital voltmeter floating input terminals. Connect the SG 503 via the precision cable (012-0482-00) and the bnc female-to-GR adapter to the input of the peak-to-peak detector. Use two bnc to banana-plug-jack patch cords to connect the output of the peak-to-peak detector to the floating input terminals on the digital voltmeter; maintain correct polarity, HI to + and LO to −. Set the digital voltmeter to the 20 volts dc range.

c. Slowly adjust the SG 503 OUTPUT AMPLITUDE VOLTS P-P control until the digital voltmeter display indicates ±.000. Output amplitude from the SG 503 should be about 1.1 to 1.2 volts; this establishes a 0.0% reference setting at .050 megahertz.

d. Slowly adjust the SG 503 FREQUENCY VARIABLE control over its entire range at each of the frequency range positions of the FREQUENCY RANGE (MHz) switch.

e. Check—the flatness deviation from 0.25 megahertz to 50 megahertz, must be within 1% of the value at .050 megahertz. The total percentage deviation calcuation must include the digital voltmeter reading and the calibration factor of the peak-to-peak detector. For example, a reading of +.008 volt on the digital voltmeter is equivalent to +0.8% deviation. Applying a correct factor of −0.3% results in a total percentage deviation of +0.5%.

f. Check—the flatness deviation from 50 megahertz to 100 megahertz, must be within 1% of the value at .050 megahertz. The same calculation must be considered for this deviation reading as described in part e of this step.

NOTE

A 1% total percentage deviation ensures flatness performance requirement when the SG 503 is operating at the X.1 and X.01 AMPLITUDE MULTIPLIER switch positions.

g. Check—the flatness deviation from 100 megahertz to 250 megahertz, must be within 3% of the value at .050 megahertz. The same calculation must be considered for this deviation reading as described in part e of this step.

h. To check the flatness deviation at a higher voltage output from the SG 503, insert two 2X attenuators between the SG 503 cable and the peak-to-peak detector. Repeat part c of this step to obtain another 0.0% reference reading for approximately 4.7 volts output from the SG 503.

i. After obtaining the new 0.0% reference indication on the digital voltmeter, repeat parts e and f of this step to check flatness deviation for approximately 4.7 volts output from the SG 503. Tolerance limits are the same as in parts e and f of this step.

j. Disconnect all cables from the SG 503.

This completes the Adjustment procedure of the SG 503 Leveled Sine Wave Generator.

MAINTENANCE AND INTERFACING INFORMATION

Preventive Maintenance

There are no special preventive maintenance procedures that apply to the SG 503. Refer to the power module instruction manual for general preventive maintenance procedures and instructions.

Corrective Maintenance

Refer to the power module instruction manual for general corrective maintenance procedures and instructions.

System Maintenance

System maintenance procedures are provided in the power module manual; i.e., preventive maintenance, troubleshooting aids, parts removal and replacement procedures, parts ordering information, etc.

In certain areas in this instrument, it is not recommended to use a suction type desoldering tool when repairing or replacing parts. Use a soldering wick when removing or replacing oscillator coils or the Output Buffer Amplifier (Q190).

Oscillator Maintenance

The oscillator sections can be checked out independent of the leveling circuitry (feedback loop) by removing Q300 and connecting a 500-ohm potentiometer between the socket pins for the collector and emitter.

When replacing components for the oscillator sections be certain that they are as close to the original mechanical layout as possible. Lead length for the transistors, Q130 and Q140, should be 0.2 inch. Replace the heat sinks as originally installed (flush with the top of the transistor case). Do not allow any heat sink to touch any other part or the chassis. Distributed capacity from Q140 heat sinks to surroundings determines the upper frequency limit on the 100-250 megahertz range.

The air-core coil for the 100-250 megahertz range should not need adjustment or repair. If it becomes necessary to perform a repair in this area, use extreme caution and do not break or damage the 50 nanofarad disc capacitor that grounds one end of the coil to the variable capacitor.

Replacing Output Buffer Amplifier

WARNING

The ceramic portions of power transistor Q190 contain BERYLLIUM OXIDE as a major ingredient. Beryllium Oxide heat sinks are safe under most conditions. The only hazard is that a toxic effect may occur if fumes or fine particles are inhaled. Grinding, crushing, or heating above 1800° F can produce fumes or fine particles. Avoidance of such action and subsequent inhalation will assure the absence of any hazard. No hazard is present in normal instrument operation or maintenance.

The Output Buffer Amplifier power transistor (Q190) can be replaced without removing the Attenuator-Output Buffer Amplifier circuit board by unsoldering the leads and removing a 5/16 nut on the mounting stud. Cut the leads of the new transistor to the proper length, keeping note of the position of the collector lead. Apply Dow Corning 4 silicone compound on the under surface of the transistor and about two threads of the mounting stud. Use a very small amount and avoid placing silicone compound on the transistor leads or on the ceramic case. Orient the collector lead toward the rear of the instrument. Seat the transistor to its heat sink and tighten the 5/16 nut on the mounting stud. For efficient heat sinking, the maximum torque for first time replacement should be 6 and 1/2 inch-pounds and 5 inch-pounds for repeated installation of the same transistor. When resoldering the transistor leads to the circuit board, avoid large amounts of solder which may flow through the circuit board holes.

Removal and Replacement of Attenuator-Output Buffer Circuit Board

Remove metal shield cover for the attenuators. The circuit board is held in place by six screws. Four corner screws hold this circuit board to the main board and two counter-sunk screws hold the Output Buffer Amplifier heat sink bracket to the side rail of the chassis. For removal of this board, it may be necessary to loosen the screws holding the main circuit board to the same side rail so that the heat-sink bracket can be withdrawn.

NOTE

Do not loosen the three nuts that hold the heat sink bracket to the circuit board. If it becomes necessary to remove this heat sink from the circuit board it is important to reinstall the three 35-mil washers and plastic insulation between the heat sink and the under side of the board.

When replacing the Attenuator-Output Buffer circuit board, ensure that all pin connections from the main circuit board are aligned and seated properly. Install the six screws, but do not tighten. The two counter-sunk screws on the chassis side rail must be tightened first in order to ensure efficient heat transfer and minimum stress. Tighten the main circuit board screws, and then tighten the four Attenuator-Output Buffer Amplifier circuit board screws last. Replace metal shield.

Alignment of FREQUENCY RANGE (MHz) Control

If it becomes necessary to remove this knob from the front panel, or if it becomes loose on the shaft of the high frequency cam switch, alignment upon reinstallation is accomplished by setting the cam switch on the 50-100 megahertz range. This position can be noted by observing when the three switch contacts on the main circuit board first open when rotating the shaft clockwise.

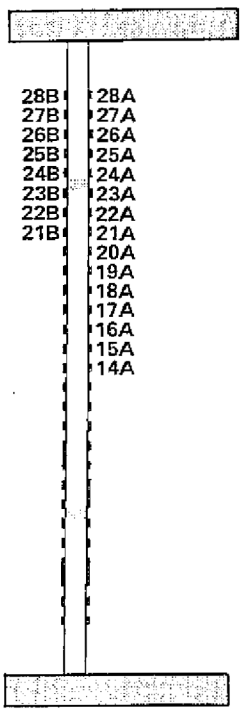
Selected Component Criteria

If the 0.5-1.0 MHz frequency range is outside the specified range, C118 may be selected to raise or lower the frequency range. Optimum value is normally 33 pF, with 20 pF to 47 pF as upper and lower limits. An increase in capacitance will lower the frequency.

Resistor R118 is selected for oscillator stability (e.g., the oscillator may break in and out of oscillation). The nominal value is approximately 470 Ω, with a range of values from 300 Ω to 1 kΩ.

Resistor R116 is also selected for oscillator stability with the same range of values as R118.

Resistor R177 is selected for improved oscillator leveling at 250 MHz. If the oscillator at 250 MHz has an unleveled output, a 10 Ω resistor may be installed between the Main Board (A1) and the Attenuator-Output Buffer Board (A3). The only choice for R177 is either a 10 Ω resistor or no resistor at all.



Rear View

Pin #	Left (B side)	Right (A side)
28	Floating ground for SINE OUT	SINE OUT
27	Decimal .XXX (10^{-1})	Floating ground for SINE OUT
26	Decimal X.XX (10^{0})	Reference Ground for BCD and Decimal Output
25	Floating ground for pin #24B	LSD, BCD, (3D) (8)
24	Signal input referenced to pin #25B	MSD, BCD, (1A) (1)
23	Decimal XX.X (10^{1})	MSD, BCD, (1B) (2)
22	Floating ground for REMOTE Amplitude	MSD, BCD (1C) (4)
21	REMOTE Amplitude input	MSD, BCD, (1D) (8)
20	No connection	MD, BCD (2A) (1)
19	No connection	MD, BCD (2B) (2)
18	No connection	MD, BCD (2C) (4)
17	No connection	MD, BCD (2D) (8)
16	No connection	LSD, BCD (3A) (1)
15	No connection	LSD, BCD (3B) (2)
14	No connection	LSD, BCD (3C) (4)

(1430)1622-14

Fig. 4-1. Input/Output assignments at rear connector.

Troubleshooting

Use the Performance Check, Adjustment Procedure, and Circuit Description as aids to locate trouble in the event of equipment failure. The test equipment listed in the Performance Check and Adjustment Procedure will prove useful in troubleshooting the SG 503.

Functions Available at Rear Connector

A slot between pins 23 and 24 on the rear connector identifies the SG 503 as a member of the signal source family. Insert a barrier in the corresponding position of the power module jack to prevent other than signal source plug-ins from being used in that compartment. This protects the plug-in should specialized connections be made to that compartment. Consult the Building A System section of the power module manual for further information.

Signal outputs, or other specialized connections, may be made to the rear interface connectors as shown in Fig. 4-1. The instrument is not supplied with these connections. If you wish to wire them to the interface connector, consult your local Tektronix Field Office or representative for further information.

REPACKAGING FOR SHIPMENT

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

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.

CIRCUIT DESCRIPTION

Introduction

This section of the manual contains a description of the circuitry used in the SG 503 Leveled Sine Wave Generator. Individual descriptions are separated into the following parts: Oscillator Circuits, Output Buffer Amplifier and Filter, Leveling Circuitry, Display Flash Multivibrator, 50 Ohm Wideband Attenuators, and Power Supplies. Diagrams 1 and 2 are segmented with gray-tint blocks according to circuit function. Circuit block titles correspond to those listed in the Block Diagram. Refer to appropriate diagrams in the Diagrams section of this manual while reading the circuit description.

Oscillator Circuits ◇1◇4

Both oscillator sections, Q130 and Q140, are common-base Hartley configurations with inductive feedback (tapped coils for each frequency range). Amplitude control is accomplished by varying the dc emitter currents. Q300 operates as a variable current source, with its collector current controlled by the output of operational amplifier U280.

The oscillators operate in a non-linear mode (Class C) and the collector current for Q130 or Q140 is a series of pulses at the operating frequency. This series of pulses contain a large number of harmonics and a high Q parallel resonant tank circuit is required to obtain a good sine wave output. The tapped coils allow the highest possible operating Q factor at a given supply voltage and collector-base breakdown rating for the transistors. Spurious oscillations are reduced by the L/R combinations in the collector lead for each transistor.

For those coils that have tuning slugs, the slug position determines the inductance, coupling between windings (leakage inductance) and the Q factor for the oscillating circuit. All of the above factors combine to determine the frequency range, harmonic suppression and maximum available output amplitude.

Output Buffer Amplifier and Filter ◇1

Signals from the oscillator sections are applied via a 100 ohm strip line to the base of Q190. The output of Q190 feeds a low-pass filter which has a cut-off frequency of about 300 megahertz.

Harmonic distortion is generated in the oscillator circuits and also in the Output Buffer Amplifier. At low frequencies, the Output Buffer Amplifier is practically ideal and contributes negligible distortion. However, at higher frequencies distortion increases and becomes more critically dependent on the collector current operating point for Q190. By choosing a frequency where the oscillator signal is fairly clean, most of the observed distortion will be due to the Output Buffer Amplifier. The collector current can then be set for minimum distortion by the adjustment of R175. Distortion is also somewhat dependent on the drive level to Q190. The final adjustment of R175 should result in minimum distortion over the full amplitude range from 0.5 volt to 5.5 volts, establishing a collector current operating point which falls in the 80 to 110 milliamp range.

Leveling Circuitry ◇1

The leveling circuitry is composed of a reference voltage divider, a hybrid peak-to-peak detector, temperature compensation diodes CR216-CR218, and error amplifier U280 with its associated components.

The major components of the hybrid peak-to-peak detector (U225) are diodes CR225A and CR225B with their associated storage capacitors, C225A and C225B, coupling capacitor C225C and output resistor R225A. The peak-to-peak detector produces a dc output across C225A and C225B that is approximately equal to the peak-to-peak voltage at the leveling point (junction of C225C and R225A).

To aid in understanding operation of the peak-to-peak detector, assume perfect diodes, 10 volts peak-to-peak at the leveling point and the reference voltage (set by R260) disconnected. C225A would charge by normal rectifier action to −5 volts dc and C225B to +5 volts dc. If the reference voltage level set by R260 is −10 volts and now applied to C225A (series opposing) the dc levels on C225A, C225B and coupling capacitor C225C will shift by an amount equal to one half the peak-to-peak amplitude at the leveling point. There will now be zero volts dc across C225B, −10 volts dc across C225A, and coupling capacitor C225C will be charged to −5 volts dc. The sinewave at the junction of the two diodes is now centered at −5 volts dc. For an actual complete circuit with non-ideal diodes, the potential difference between C225A and C225B is about equal to the peak-to-peak amplitude at the leveling point.

Because the reference voltage and the dc output of the peak-to-peak detector are connected series opposing, any algebraic difference between these two voltages will be applied to the input of error amplifier U280. When the generator output is leveled, equal dc potentials (about −.7 volt dc) exist at the − and + input terminals of U280 and the system is stabilized.

If the peak-to-peak output amplitude from an oscillator section changes for any reason, a corresponding change in detector output produces an error signal at the − input terminal of U280 which is converted into a collector current change in Q130 or Q140 in such a direction to restore the original peak-to-peak amplitude at the leveling point.

The high-gain leveling system (closed loop) establishes a steady state impedance point at the junction of C225C and R225A which approaches zero ohms. R225A, therefore, sets the generators output impedance and reverse terminates a 50 ohm coaxial cable.

CR200, CR202, VR200 and VR202 reduce transients which can be caused by sudden load changes, while R278, R276, CR276 and CR274 reduce switching transients when changing frequency ranges.

Display Flash Multivibrator ◇1

Q296 and Q290, with their associated components, is a multivibrator circuit that is held in a normally stable state as long as the sine-wave output amplitude is leveled. If the output is not leveled, pin 6 of U280 swings positive with respect to ground and turns on CR280. The multivibrator then operates as an astable circuit with a period of about 2 hertz. The waveform at the collector of Q290 is applied to pins 6 and 7 of U490 (State Generator). This signal causes binary zeros to be supplied to the Display Drivers, which turns off the display. The result is a visible flashing of the front panel LED display.

50 Ohm Wideband Attenuators ◇1

In the X1 position of the AMPLITUDE MULTIPLIER switch, the output signal bypasses the hybrid chip attenuators.

The hybrid chip attenuators (U245 and U240) are labeled on the circuit board as "X.1 & X.01" and "FIRST ÷ 10, X.01".

In the X.1 position of the AMPLITUDE MULTIPLIER switch, U245 divides the generators output by 10.

In the X.01 position of the AMPLITUDE MULTIPLIER switch, U240 divides the generators output by 10 and then U245 divides again by 10 for a total division of 100.

In the X.1 and X.01 positions of the AMPLITUDE MULTIPLIER switch, the 50 ohm attenuators provide additional isolation between the oscillators and a large mismatched load.

Auto-Ranging Counter ◇2 ◇3

(For Instruments SN B060000-above.) The input circuit to the Auto-Ranging Counter is through emitter-follower Q320, which provides a low impedance drive to Q350. Transistors Q350-Q360 and Q330-Q340 is a dual-differential amplifier that provides high gain in two stages. R351-R361 and R332-R334 are the constant-current sources for the respective amplifier, while C340 and C350 serve to stabilize the operating points of the amplifiers. The output signal amplitudes on pins 6 and 7 are constant-amplitude square waves, regardless of the input amplitude to Q320.

A 1-volt peak-to-peak square-wave signal from Q340 is applied to a divide by 8 prescaling circuit consisting of U390, U400A, and U400B (each IC divides by 2) and to the base of Q410. The positive-going edge of the signal at pin 7 of U390 and the negative-going edge of the signal at the base of Q410 are significant to the counting operation. Signal prescaling does not occur for the 50 kilohertz reference frequency or for other frequencies up to and including .999 megahertz.

(For Instruments SN B059999-below.) The input circuit to the Auto-Ranging Counter is through emitter-follower Q320, which provides a low impedance single-ended drive to U350. U350 is a dual-differential amplifier that provides high gain in two stages. R335 and R342 are the constant-current sources for internal emitter connections and the output voltage on pins 6 and 7 start to limit at low input amplitudes. The emitter currents are set for about 8 milliamps, providing symmetrical output signal amplitudes of about 800 millivolts across R358 and R362. L362 is used to boost the high-frequency signal amplitudes to the prescaling circuitry.

Signals from U350 are applied to a divide by 8 prescaling circuit consisting of U390, U400A, and U400B (each IC divides by 2) and to the base of Q410. The positive-going edge of the signal at pin 7 of U390 and the negative-going edge of the signal at the base of Q410 are significant to the counting operation. Signal prescaling does not occur for the 50 kilohertz reference frequency or for other frequencies up to and including .999 megahertz.

A self-biasing arrangement is provided for U390 to ensure that the input bias level on pin 7 is always centered in the hysteresis window. The average of the complementary outputs on pins 2 and 3 is obtained from the junction of R396 and R398 and fed back to pin 7 through L365 and R365 to automatically compensate for any internal temperature drift.

Four counters, U430, U435, U436 and U437 are used for the counting process, but only three decimal digits are displayed on the front panel after the bcd data has been decoded by the bcd-to-Seven Segment Decoder Drivers. U430 frequency divides the input by 10 and its output is used to round off the count held in the remaining counters, allowing a more accurate three-digit display.

The 1 MHz reference clock circuit, U460A and U460B, with inverter U460D, drives U465, which produces two functions. Frequency division by 16 and frequency division by 2 produces a clock signal with a period of 16 microseconds on pin 11 and a clock signal with a period of 2 microseconds on pin 12.

U455B, U455C, U455D, and U460C are positive NAND gates. The logic levels at pin 5 of U455B and pin 10 of U460C determine whether a clock signal with a period of 16 microseconds or 2 microseconds appears at the output of U455D. These logic levels are determined by the output level of positive NAND gate U455C and inverter U455A.

When the FREQUENCY RANGE (MHz) control is in the REF ≈ .05 position, pin 1 of U445A and pin 13 of U445B are held LO (= 0) by the closure of S100-2. This clears U445A and U445B, setting both Q terminals (pin 6 of U445A and pin 8 of U445B) to a HI (= 1) level. A HI level is established on pins 9 and 10 of U455C, setting its output to a LO level. A LO on pin 5 of U455B locks out the clock signal with a 16 microsecond period, while the HI level on pin 10 of U460C allows the 2 microsecond clock to be gated through to the output of U455D.

The HI level on pin 10 of U460C is also transmitted through VR475, reverse biasing CR410 and disabling the divide by 8 signal prescaling circuitry. The 50 kilohertz signal is then processed by Q410 and Q420 with the positive-going edge of the signal at pin 1 of U425A significant to counting operation only during the time that pin 2 of U425A is HI (gating signal).

For 50 kilohertz counting, the 10^{-1} decimal source point (anode of VR475) is always HI and the 2 microsecond clock signal is frequency divided by 1000 by Gate Time Clock Dividers U480, U481, and U482. Positive NAND gates U475A, U475B and U475D are locked out due to the LO levels set at the output of inverting input AND gates U450B, U450C and U450D. With pins 10, 9 and 13 of U485B set to a HI level by the Q terminals of U445A and U445B, a 2000 microsecond clock signal is gated through U485B and U485A to pin 1 of U490.

(Refer to Fig. 5-1 for waveform time relationships involved with the State Generator circuits.) If the leveling circuitry is operating properly, a HI level is set on pins 6 and 7 of U490, allowing it to count. U490 frequency divides by 5 from pin 1 to 11 and frequency divides by 2 from pin 14 to pin 12. This frequency division produces a signal with a period of 10 milliseconds at pin 11 and a square wave with a period of 20 milliseconds at pin 12. The square wave signal (50% duty cycle) on pin 12 is the reference waveform for the counting period, display time and counter reset time.

The square-wave signal on pin 12 of U490 is applied through inverter U432A to pin 2 of positive NAND gate U425A with the positive half of the square wave acting as a gating signal that allows the counters to count for 50% of the total period (10 milliseconds for 50 kilohertz counting).

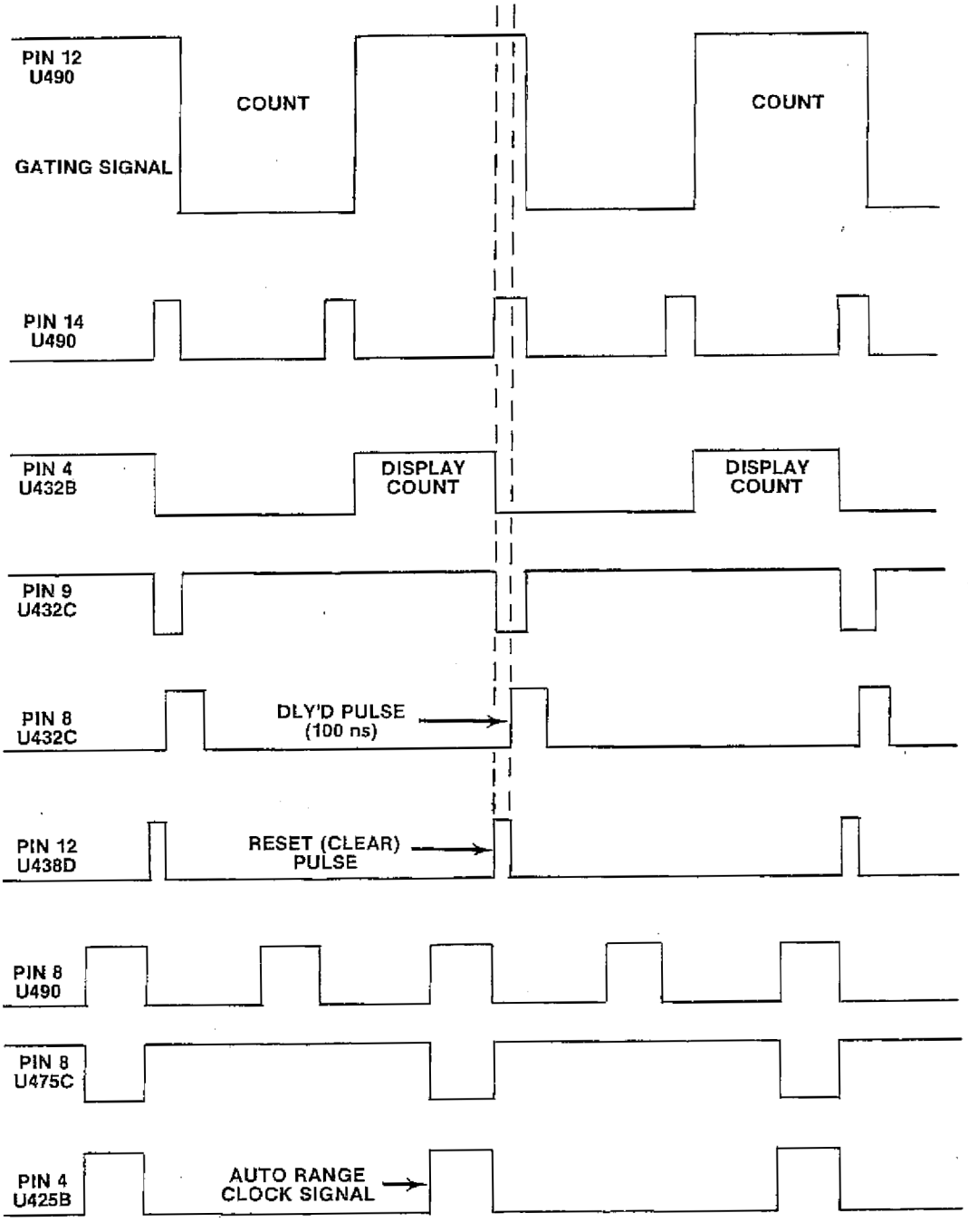
If the sine wave output amplitude from the SG 503 is not leveled, pins 6 and 7 of U490 goes negative at approximately a 2 hertz rate. The result is a blinking front-panel display because U490 is cleared to zero. Zeros supplied to pin 10 of the Display Drivers (U510, U520, and U530) causes them to blank the display for about 0.25 second.

The Auto Ranging circuits operate when S100-2 is open to change the output levels of U455C, U450B, U450C, and U450D at the proper time to set the decimal point in its proper location and to select the proper gate time intervals for the counting, display, and reset process.

Only one decimal point shift (from .999 megahertz to 1.00 megahertz) will be discussed as the operation is similar for other decimal point shifts. Overflow Detector U440A detects when it is necessary to shift the decimal point as frequency is increased, while U440B detects when it is necessary to shift the decimal point as frequency is decreased.

U445A and U445B operate as a 4-bit shift register (memory). Exclusive—OR gates U438A and U438B act as control devices to determine whether the register shifts right or left to produce the proper output data, thereby speeding up the Auto Ranging process.

Frequencies from .250 megahertz up to and including .999 megahertz do not cause the output data from U445A and U445B to change state. Consequently, the output level of U455C remains LO for these frequencies and the gating signal at pin 12 of U490 is the same as for 50 kilohertz counting.



1622-15

Fig. 5-1. State Generator waveform time relationship.

When U436 and U437 contain binary data equivalent to decimal 99, the next input count to U435 causes pin 11 of U436 to go negative and triggers U440B to force pin 9 of U440B to a HI (= 1). When U435, U436 and U437 contain binary data equivalent to decimal 999, the next input count to U435 causes pin 11 of U437 to go negative and triggers U440A to force pin 13 of U440A to a LO (= 0). At the transition point from .999 megahertz to 1.00 megahertz U440B and U440A have been triggered and set.

A HI on pin 9 of U440B along with a HI on pin 6 of U445A and a LO on pin 9 of U445B results (through the action of U438A and U438B) in a HI (= 1) being transferred to the D input terminal (pin 2) of U445A and a LO (= 0) to the D input terminal (pin 12) of U445B. Pin 5 of U425B (Auto Range Clock Enable) has also been set to a HI through the action of U425D.

On the next Auto Range Clock signal from U450A, pin 6 of U425B goes LO and this negative transition triggers both U445A and U445B, transferring the data from the D terminals to the Q terminals. After data transfer, pin 6 of U445A will be LO (= 0) and pin 5 will be a HI (= 1); pin 9 of U445B will be a LO (= 0) and pin 8 will be a HI (= 1). These logic levels are decoded by U455C, U450B, U450C and U450D to shift the decimal point one place to the right, select the proper gating signal from the Gate Time Clock Dividers, and enables the signal prescaling circuitry.

For the logic levels given, the 2 microsecond clock signal is locked out from U460C and the 16 microsecond clock signal is gated through to the output of U455D. After frequency division by 100, a 1600 microsecond signal is gated through U475D and U485A to appear at pin 1 of U490. U475D is enabled because the output of U450B is HI and all other decoding gate output levels are LO. Although new gate time intervals are selected for Auto Ranging, the waveform time relationships remain the same as illustrated in Fig. 5-1.

Due to the change from a HI to a LO on pin 6 of U445A, the output level of U438B goes HI during the count interval. The output of U440A is now at a HI level because it was reset by the clear pulse and not triggered during count time. This results in a LO level at pin 5 of U425B, which locks out the Auto Ranging clock signal, preventing U445A and U445B from being triggered. U445A and U445B will not change their output data unless it again becomes necessary to change the decimal point location.

For the next decimal point shift (for example, from 9.99 megahertz to 10.0 megahertz), the same sequence of events occur with Exclusive-OR gates U438A and U438B sensing the previous output data of the 4-bit register. The proper binary code is then set at the outputs of U445A and U445B (when triggered by the Auto Ranging clock signal) to shift the decimal point one more place to the right. U475A is enabled by the output level of U450C going HI and a 160 microsecond clock signal is gated through to pin 1 of U490.

Power Supplies ◇3

The −22 V supply is referenced to ground with a reference voltage point established on pin 5 of voltage regulator U695 by the voltage divider action of R697 and R698. The voltage divider composed of R693, R694 and R695 establishes a voltage sensing point at pin 4 of U695. U695 regulates its output by comparing the voltage level on pin 4 with an internal reference. R694 (−22 V ADJ) sets the quiescent level at the base of Q685 which, in turn, sets the quiescent current level through the PNP series-pass transistor located in the power module mainframe. If the −22 volt output level starts to go positive, this change is sensed at pin 4 of U695 and pin 9 of U695 goes negative. This voltage change is transmitted through emitter-follower Q685 to the base of the PNP series-pass transistor, causing it to increase conduction through the load and return the output level to −22 volts. Q690 operates as a load current limiter with R680 acting as the current sensing element.

The +5 V supply is referenced to the −22 V supply with the reference voltage point established at pin 3 of U610 by voltage divider R610-R612. This reference level is about −5 volts. In a quiescent state, the voltage on pin 2 of U610 is also about −5 volts. If the +5 volt output level goes more positive, the voltage change appears at pin 2 of U610 which amplifies and inverts the signal to apply a negative change at the base of Q610. VR610 operates only as a dc level shifter. A positive voltage change at the base of Q600 causes the base of the NPN series-pass transistor located in the power module mainframe to decrease conduction through the load, returning the output level to +5 volts. Q620 is for current over-load protection. If the load current exceeds about 1.8 amps, R624 acts as a current sensing element to turn on Q620. If Q620 turns on, its collector goes positive, turning on CR612. A positive voltage change at pin 2 of U610 turns off the NPN series-pass transistor. The non-polarized connections for C620 and C619 integrate T^2L spikes which may occur on the +5 volt level, preventing them from turning on Q620 and shutting down the power supply during current surges.

CR640 prevents the +5 V supply from going more negative than about −0.7 volt if F620 opens. Q640 protects the load from over-voltage conditions that could occur if the NPN series-pass transistor shorted. If the output level exceeds about 6.2 volts, VR640 conducts, developing a SCR gating signal across R640. This gating signal turns on Q640, clamping the output level to about +0.2 volt.

OPTIONS

OPTION 02 INTERFACE NOTES

General

Pin 26A is the only rear connector pin (from 14 through 28) that is factory wired to internal circuitry. All other inputs and outputs through the rear interface must be user wired when it is desired to interface the SG 503 in a specialized Option 02 Power Module system.

SINE OUT (contact 28A) and GND for SINE OUT (contacts 27A and 28B).

NOTE

Flatness specifications for the SG 503 are invalid when the output signal has been transferred from the front panel to the rear interface, because the insertion loss between the output and the 50 Ω load will be different from that of the precision coaxial cable (Tektronix Part Number 012-0482-00) provided with the instrument.

To transfer the output signal from the front panel to the rear interface, perform the following steps:

1. Remove the short blue cable (with ferrite bead) between the bnc output connector and the Attenuator-Output Buffer Circuit Board (located on the "B" side of the instrument). When this short blue cable is removed, be certain that it is stored in a known location and not misplaced or lost. This cable is mandatory for repairing or recalibrating the instrument.

2. Locate the four holes near pins 27 and 28 on the "B" side of the Main Circuit Board. Install a pin connector socket (Tektronix Part Number 136-0252-01) in the center hole labeled SINE OUT and solder it in place from the "A" side of the board so that connection is made to pin 28A. Install a 3-prong, coaxial-cable receptacle (Tektronix Part Number 131-1003-00) in the remaining three holes and solder it in place from the "A" side of the board so that ground connections are made to pins 27A and 28B.

3. Install a 9.4 inch miniature coaxial cable (blue), with connectors on each end (Tektronix Part Number 175-1554-00), from the output connector on the Attenuator-Output Buffer Circuit Board to the newly installed receptacle for SINE OUT. Dress the blue coaxial cable underneath the lower rear corner of the Attenuator-Output Buffer Circuit Board. Be certain that the center conductor of the blue coaxial cable mates with the center socket pins at each end.

4. Place a tag to the left of the OUTPUT connector on the front panel, labeled: OUTPUT AT REAR CONNECTOR PIN 28A.

NOTE

To prevent ground loop currents, GND for SINE OUT (pins 27A and 28B) should not be tied to any other grounds at the rear interface.

REMOTE Amplitude Controls (Contacts 21A and 22B)

To transfer the OUTPUT AMPLITUDE control from the front panel to the rear interface, perform the following steps:

1. On the "A" side of the Main Circuit Board, immediately behind the front panel, locate the unused holes labeled REMOTE. Install a pin connector socket (Tektronix Part Number 136-0252-01) in the center hole, and a 3-prong, coaxial-cable receptacle (Tektronix Part Number 131-1003-00) in the remaining holes and solder in place from the "B" side of the instrument.

2. Locate the unused holes labeled REMOTE near rear connector pins 21 and 22 ("A" side, Main Circuit Board). Install a pin connector socket (Tektronix Part Number 136-0252-01) in the center hole, and a 3-prong, coaxial-cable receptable (Tektronix Part Number 131-1003-00) in the remaining three holes and solder in place from the "B" side of the instrument. Be certain that the center pin socket is connected to pin 21B and that the 3-prong receptacle is providing a ground connection to pin 22B.

3. On the "B" side of the Main Circuit Board, locate W260 (Terminal Link). W260 looks like a solid white dummy resistor and is located immediately behind the front panel. Unsolder both ends of W260 and without bending the leads, move it horizontally to the two unused holes about one-fourth inch closer to the front panel. Resolder W260 (from the "B" side) into the new holes.

4. On the "B" side of the Main Circuit Board add (solder) a resistor; 51 kΩ, 1/4 W, 5%, (Tektronix Part Number 315-0513-00) between the circuit board run connected to pin 21B and the unused hole labeled GND.

5. Install a 12.4 inch minature coaxial cable (white), with connectors on each end (Tektronix Part Number 175-1555-00), between the two newly installed REMOTE receptacles, making sure that the center conductor mates with the center pin sockets at each end. Dress the white

coaxial cable between the Coil Circuit Board and the bottom side rail. Do not dress the white coaxial cable along the top side rail. In some instruments, this operation may require loosening screws for the Main Circuit Board and side mount bracket (used as a heat sink); if so, remember to retighten all loosened screws.

6. Check with an ohmmeter to verify that a complete circuit (zero resistance) exists between rear connector pin 21B and pin 4 of P230. P230 is the flat blue plug attached to the Attenuator-Output Buffer Circuit Board on the "B" side of the instrument. Pin 4 is connected to a yellow coded wire. Refer to schematic number 1 in the SG 503 instruction manual.

7. Place a tag above the OUTPUT AMPLITUDE control on the front panel, labeled: OUTPUT AMPLITUDE REMOTE CONTROLLED AT REAR CONNECTOR PIN 21B.

NOTE

A dc voltage of approximately −1 V to −11 V applied to pin 21B (after modification) will control the output amplitude over the range from 0.5 V to 5.5 V (peak-to-peak). GND for REMOTE (pin 22B) should not be tied to any other ground at the rear interface.

BCD Outputs (Contacts 14A through 26A)

The SG 503 can be user wired to provide this type of output data to the rear interface. Each decimal digit displayed on the front panel has its own 4-bit BCD data available from the counters in the form of unused holes (solder pads) on the "A" side of the Main Circuit Board (between the upper two rows of IC's). Each set of four holes are labeled: 1A through 1D for the Most Significant Digit (MSD), 2A through 2D for the Middle Digit (MD), and 3A through 3D for the Least Significant Digit (LSD). The rear connector pins (14A through 25A) are also labeled in a one-to-one correspondence with 1A through 3D. It is only necessary to use flat ribbon-wire cable (Tektronix Part Number 175-0827-00) of the proper length to interconnect the counter BDC outputs to the proper solder pads (holes) for the rear connector pins. Solder all connections from the "B" side of the instrument.

The BCD output data user positive logic and is TTL compatible. The 4-bit data lines have a fanout of 8. External decoding circuitry depends on the desired application. Pin 26A provides an internal ground for the BCD output data.

Decimal Data Output (Contacts 27B, 26B, and 23B)

To transfer Decimal Data to the rear interface, perform the following steps:

1. On the "A" side of the Main Circuit Board, just below U480, locate three unused holes (solder pads) labeled: 10^{-1}, 10^{1}, and 10^{0}.

2. Use flat ribbon-wire cable (Tektronix Part Number 175-0827-00) to interconnect these pads in a one-to-one correspondence with rear connector solder pads labeled 10^{-1}, 10^{1}, and 10^{0} (just to the left of CR680 and close to rear connector pins 25 and 26). Solder the wire connections to the "B" side of the Main Circuit Board.

Each Decimal Data line will drive only one TTL gate without external buffering. A Decimal Data line goes to an active-high state when the corresponding front-panel decimal point is turned on by the auto-ranging circuitry.

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
K0099	JACKSON BROS (LONDON) LTD.	258 BROADWAY	NEW YORK, NEW YORK 10007
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
02114	FERROXCUBE CORPORATION	PO BOX 359, MARION ROAD	SAUGERTIES, NY 12477
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPARTMENT	NELA PARK	CLEVELAND, OH 44112
14433	ITT SEMICONDUCTORS	3301 ELECTRONICS WAY	
		P O BOX 3049	WEST PALM BEACH, FL 33402
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
31718	FAIRCHILD MICROWAVE AND OPTOELECTRONICS, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	4001 MIRANDA AVE.	PALO ALTO, CA 94304
32159	WEST-CAP ARIZONA	2201 E. ELVIRA ROAD	TUCSON, AZ 85706
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
50347	OPCOA, DIVISION OF IDS	330 TALMADGE ROAD	EDISON, NJ 08817
50434	HEWLETT-PACKARD COMPANY	640 PAGE MILL ROAD	PALO ALTO, CA 94304
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
72136	ELECTRO MOTIVE CORPORATION, SUB OF INTERNATIONAL ELECTRONICS CORPORATION	LAUTER AVE, P O BOX 7600	FLORENCE, SC 29501
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
75378	CTS KNIGHTS, INC.	400 REIMANN AVE.	SANDWICH, IL 60548
76493	BELL INDUSTRIES, INC., MILLER, J. W., DIV.	19070 REYES AVE., P O BOX 5825	COMPTON, CA 90224
78488	STACKPOLE CARBON CO.		ST. MARYS, PA 15857
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80031	ELECTRA-MIDLAND CORP., MEPCO DIV.	22 COLUMBIA ROAD	MORRISTOWN, NJ 07960
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
95275	VITRAMON, INC.	P O BOX 544	BRIDGEPORT, CT 06601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-2978-00	B010100	B029999	CKT BOARD ASSY:MAIN	80009	670-2978-00
A1	670-2978-01	B030000	B039999	CKT BOARD ASSY:MAIN	80009	670-2978-01
A1	670-2978-02	B040000	B051799	CKT BOARD ASSY:MAIN	80009	670-2978-02
A1	670-2978-03	B051800	B059999	CKT BOARD ASSY:MAIN	80009	670-2978-03
A1	670-2978-04	B060000	B064289	CKT BOARD ASSY:MAIN	80009	670-2978-04
A1	670-2978-05	B064290	B066110	CKT BOARD ASSY:MAIN	80009	670-2978-05
A1	670-2978-06	B066111		CKT BOARD ASSY:MAIN	80009	670-2978-06
A2	----- -----			CKT BOARD ASSY:COIL		
	----- -----			(A2, AVAILABLE ONLY AS ASSY 263-1082-00. (S100)		
A3	670-3073-00	B010100	B029999	CKT BOARD ASSY:ATTENUATOR	80009	670-3073-00
A3	670-3073-01	B030000	B039999	CKT BOARD ASSY:ATTENUATOR	80009	670-3073-01
A3	670-3073-02	B040000	B063388	CKT BOARD ASSY:ATTENUATOR	80009	670-3073-02
A3	670-3073-03	B063389		CKT BOARD ASSY:ATTENUATOR	80009	670-3073-03
A4	670-2954-00			CKT BOARD ASSY:DISPLAY	80009	670-2954-00
A5	670-5045-00	XB060000		CKT BOARD ASSY:DUAL H.F. DIFFERENTIAL	80009	670-5045-00
C100A, C100B, C100C	281-0210-00	B010100	B051799	CAP.,VAR,AIR DI:5-60PF,6-80PF,10-40UF,200V	K0099	5318/3/6H/MOD
C100A, C100B, C100C	281-0210-01	B051800		CAP.,VAR,AIR DI:5-60PF/6-80PF/10-410PF,200V	80009	281-0210-01
C102	283-0639-00			CAP.,FXD,MICA D:56PF,1%,100V	00853	D151E560F0
C104	283-0353-00	B010100	B029999X	CAP.,FXD,CER DI:0.1UF,10%,50V	95275	VJ1210Y104K-H
C106	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
C112	283-0597-00			CAP.,FXD,MICA D:470PF,10%,300V	00853	D153E471K0
C118	283-0615-00	B010100	B064289	CAP.,FXD,MICA D:33PF,5%,500V	00853	D155E330J0
C118	283-0615-00	B064290		CAP.,FXD,MICA D:33PF,5%,500V	00853	D155E330J0
	----- -----			(NOMINAL VALUE,SELECTED)		
C124	283-0695-00			CAP.,FXD,MICA D:4440PF,1%,300V	00853	D193F4441F0
C130	283-0353-00			CAP.,FXD,CER DI:0.1UF,10%,50V	95275	VJ1210Y104K-H
C134	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
C140	283-0353-00			CAP.,FXD,CER DI:0.1UF,10%,50V	95275	VJ1210Y104K-H
C145	283-0064-00	B010100	B029999X	CAP.,FXD,CER DI:0.05UF,+80-20%,50V	72982	5855526Y5U00503Z
C146	290-0536-00	B010100	B029999X	CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C150	283-0299-00			CAP.,FXD,CER DI:51PF,5%,500V	72982	8121N501C0G510J
C154	283-0299-00			CAP.,FXD,CER DI:51PF,5%,500V	72982	8121N501C0G510J
C170	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224M
C172	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C180	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C184	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224M
C190	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224M
C192	281-0615-00	XB051230		CAP.,FXD,CER DI:3.9PF,+/-0.5PF,200V	72982	374001C0J0399D
C194	283-0204-00	XB063389		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C200	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224M
C204	281-0730-00			CAP.,FXD,CER DI:10.8PF,1%,500V	72982	301055C0G1089F
C208	281-0730-00			CAP.,FXD,CER DI:10.8PF,1%,500V	72982	301055C0G1089F
C212	281-0604-00			CAP.,FXD,CER DI:2.2PF,+/-0.25PF,500V	72982	301-000C0J0229C
C214	283-0156-00	XB040000		CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
C215	283-0156-00	XB040000		CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
C216	281-0661-00			CAP.,FXD,CER DI:0.8PF,+/-0.1PF,500V	72982	301-000C0K0808B
C218	283-0156-00	B010100	B039999X	CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
C230	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C232	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C260	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C274	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C278	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C280	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8121N083Z5U0224M

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C282	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
C290	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C296	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C322	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C323	283-0299-00	XB060000		CAP.,FXD,CER DI:51PF,5%,500V	72982	8121N501C0G510J
C324	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C328	283-0111-00	B010100	B059999X	CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C335	283-0204-00	B010100	B059999X	CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C336	283-0204-00	XB060000		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C340	283-0249-00	XB060000		CAP.,FXD,CER DI:0.068UF,10%,50V	72982	8131N075 C 683K
C342	283-0204-00	B010100	B059999X	CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C345	283-0204-00	B010100	B059999X	CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C350	283-0249-00	XB060000		CAP.,FXD,CER DI:0.068UF,10%,50V	72982	8131N075 C 683K
C358	283-0175-00			CAP.,FXD,CER DI:10PF,5%,200V	72982	8101B210C0G0100J
C360	283-0197-00	B010100	B059999X	CAP.,FXD,CER DI:470PF,5%,100V	72982	8121N075C0G0471J
C365	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C390	283-0353-00			CAP.,FXD,CER DI:0.1UF,10%,50V	95275	VJ1210Y104K-H
C422	281-0629-00			CAP.,FXD,CER DI:33PF,5%,600V	72982	308-000C0G0330J
C435	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C436	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C445	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
C448	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C462	281-0511-00			CAP.,FXD,CER DI:22PF,+/-2.2PF,500V	72982	301-000C0G0220K
C465	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	72982	301-055C0G0100F
C480	290-0531-00			CAP.,FXD,ELCTLT:100UF,20%,10V	90201	TDC107M010WLC
C481	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C490	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C495	281-0536-00			CAP.,FXD,CER DI:1000PF,10%,500V	72982	301000 X5P0 102K
C540	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C542	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
C600	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C610	281-0523-00	B010100	B051229	CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C610	281-0204-00	B051230	B066110X	CAP.,VAR,PLSTC:2-22PF,100V	80031	287C00222MJ02
C618	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C619	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C620	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C630	290-0531-00			CAP.,FXD,ELCTLT:100UF,20%,10V	90201	TDC107M010WLC
C635	283-0154-00	XB030000		CAP.,FXD,CER DI:22PF,5%,50V	72982	8111B061C0G220J
C640	290-0531-00			CAP.,FXD,ELCTLT:100UF,20%,10V	90201	TDC107M010WLC
C642	290-0531-00			CAP.,FXD,ELCTLT:100UF,20%,10V	90201	TDC107M010WLC
C650	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
C655	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
C660	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C662	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C665	290-0559-00			CAP.,FXD,ELCTLT:22UF,20%,35V	90201	TDC226M035WLC
C675	290-0559-00			CAP.,FXD,ELCTLT:22UF,20%,35V	90201	TDC226M035WLC
C677	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N061Z5U0103M
C680	290-0559-00			CAP.,FXD,ELCTLT:22UF,20%,35V	90201	TDC226M035WLC
C694	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C697	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
CR130	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR200	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
CR202	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
CR216	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
CR218	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
CR274	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR276	152-0246-00			SEMICOND DEVICE:SW,SI,40V,200MA	03508	DE140
CR278	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR280	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR410	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
CR600	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR612	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR640	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
CR680	152-0066-00			SEMICOND DEVICE:SILICON,400V,750MA	14433	LG4016
CR694	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR697	152-0333-00	XB064290		SEMICOND DEVICE:SILICON,55V,200MA	07263	FDH-6012
DS500	150-1004-00	B010100	B052649	LAMP,LED:RED,2.5V,15MA	08806	SSL-12
DS500	150-1040-00	B052650		LAMP,LED:RED,5MA,2.0V	50347	LLL-7A
DS510	150-1011-00	B010100	B052549	LAMP,LED:RED,7-SEQUENCE	31718	FND70
DS510	150-1011-01	B052550		LAMP,LED,RDOUT:RED SINGLE DIGIT	07263	FND5082
DS520	150-1011-00	B010100	B052549	LAMP,LED:RED,7-SEQUENCE	31718	FND70
DS520	150-1011-01	B052550		LAMP,LED,RDOUT:RED SINGLE DIGIT	07263	FND5082
DS530	150-1011-00	B010100	B052549	LAMP,LED:RED,7-SEQUENCE	31718	FND70
DS530	150-1011-01	B052550		LAMP,LED,RDOUT:RED SINGLE DIGIT	07263	FND5082
F620	159-0021-00			FUSE,CARTRIDGE:3AG,2A,250V,FAST-BLOW	71400	AGC 2
J240	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
J245	131-1315-00			CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-00
L100	120-0939-00			XFMR,RF:VARIABLE	80009	120-0939-00
L110	120-0938-00			XFMR,RF:VARIABLE	80009	120-0938-00
L112	120-0937-00			XFMR,RF:VARIABLE	80009	120-0937-00
L114	120-0936-00			XFMR,RF:VARIABLE,5-10MHZ	80009	120-0936-00
L116	120-0935-00			XFMR,RF:VARIABLE	80009	120-0935-00
L118	120-0934-00			XFMR,RF:VARIABLE	80009	120-0934-00
L120	120-0933-00			XFMR,RF:VARIABLE	80009	120-0933-00
L122	120-0932-00			XFMR,RF:VARIABLE	80009	120-0932-00
L124	120-0931-00			XFMR,RF:POT CORE,50KHZ	80009	120-0931-00
L143	108-0794-00			COIL,RF:44NH,3 TURNS #18 AWG	80009	108-0794-00
L145	108-0472-00	B010100	B039999X	COIL,RF:160UH	80009	108-0472-00
L184	108-0606-00			COIL,RF:37NH	80009	108-0606-00
L190	276-0569-00			CORE,TOROID:	78488	57-9660
L191	276-0569-00			CORE,TOROID:	78488	57-9660
L195	108-0317-00			COIL,RF:FIXED,15UH	32159	71501M
L197	108-0795-00			COIL,RF:FIXED,2NH	80009	108-0795-00
L200	108-0578-00			COIL,RF:FIXED,45NH	80009	108-0578-00
L204	108-0578-00			COIL,RF:FIXED,45NH	80009	108-0578-00
L208	108-0552-00			COIL,RF:80NH	80009	108-0552-00
L212	108-0552-00			COIL,RF:80NH	80009	108-0552-00
L245	276-0647-00			CORE,EM:TOROID,FERRITE	02114	K5-008-81-1Z2
L265	276-0576-00			CORE,EM:TOROID,FERRITE	78488	#57-0047
L270	276-0576-00			CORE,EM:TOROID,FERRITE	78488	#57-0047
L280	276-0576-00			CORE,EM:TOROID,FERRITE	78488	#57-0047
L290	276-0576-00			CORE,EM:TOROID,FERRITE	78488	#57-0047
L320	108-0733-00			COIL,RF:113NH	80009	108-0733-00
L362	108-0606-00	B010100	B059999	COIL,RF:37NH	80009	108-0606-00
L362	108-0733-00	B060000		COIL,RF:113NH	80009	108-0733-00
L365	108-0509-00			COIL,RF:2.45UH	80009	108-0509-00
L630	108-0795-00			COIL,RF:FIXED,2NH	80009	108-0795-00
L660	108-0472-00			COIL,RF:160UH	80009	108-0472-00
L670	108-0205-00			COIL,RF:1MH	76493	8209
L655	120-0342-00			XFMR,TOROID:10 TURNS,SINGLE	80009	120-0342-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
LR110	108-0408-00			COIL,RF:100NH	80009	108-0408-00
LR112	108-0271-00			COIL,RF:0.025UH	80009	108-0271-00
LR114	108-0333-00			COIL,RF:0.9UH	80009	108-0333-00
LR130	108-0595-00			COIL,RF:FIXED,49NH	80009	108-0595-00
LR135	108-0797-00			COIL,RF:2.45UH	80009	108-0797-00
LR140	108-0796-00			COIL,RF:16NH	80009	108-0796-00
LR142	108-0271-00			COIL,RF:0.025UH	80009	108-0271-00
LR150	108-0271-00			COIL,RF:0.025UH	80009	108-0271-00
LR190	108-0797-00			COIL,RF:2.45UH	80009	108-0797-00
Q130	151-0451-00	B010100	B039999	TRANSISTOR:SILICON,NPN	02735	65128
Q130	151-0211-01	B040000		TRANSISTOR:SILICON,NPN	02735	60794
Q140	151-0451-00			TRANSISTOR:SILICON,NPN	02735	65128
Q160	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q180	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q190	151-0474-00	B010100	B051229	TRANSISTOR:SILICON,NPN	04713	MRF511
Q190	151-0614-00	B051230		TRANSISTOR:SILICON,NPN	80009	151-0614-00
Q290	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q296	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q300	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q320	151-0367-00	B010100	B059999	TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	01295	SKA6516
Q320	151-0402-00	B060000		TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0402-00
Q330	151-0402-00	XB060000		TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0402-00
Q340	151-0402-00	XB060000		TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0402-00
Q350	151-0402-00	XB060000		TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0402-00
Q360	151-0402-00	XB060000		TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0402-00
Q410	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	01295	SKA6516
Q420	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
Q600	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
Q610	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q620	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
Q640	151-0515-01			SCR:SILICON	04713	2N4441
Q685	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
Q690	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
R116	315-0471-00	XB040000	B064289	RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R116	315-0471-00	B064290		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
	----- -----			(NOMINAL VALUE, SELECTED)		
R118	315-0471-00	XB051350	B064289	RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R118	315-0471-00	B064290		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
	----- -----			(NOMINAL VALUE, SELECTED)		
R134	317-0131-00			RES.,FXD,CMPSN:130 OHM,5%,0.125W	01121	BB1315
R138	317-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R140	301-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.50W	01121	EB7505
R145	317-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R146	317-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R150	317-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R160	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R162	321-0207-00			RES.,FXD,FILM:1.4K OHM,1%,0.125W	91637	MFF1816G14000F
R164	321-0319-00			RES.,FXD,FILM:20.5K OHM,1%,0.125W	91637	MFF1816G20501F
R166	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R174	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R175	311-1563-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	73138	91-85-0
R176	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R177	SELECTED	XB063389				
R180	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R184	317-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.125W	01121	BB1515
R190	301-0560-00			RES.,FXD,CMPSN:56 OHM,5%,0.50W	01121	EB5605
R192	301-0560-00			RES.,FXD,CMPSN:56 OHM,5%,0.50W	01121	EB5605

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R195	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R197	315-0471-00	B010100	B039999	RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R197	315-0102-00	B040000		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R204	317-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.125W	01121	BB1815
R212	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R216	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R250	315-0275-00			RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
R255	311-1223-00			RES.,VAR,NONWIR:TRMR,250 OHM,0.5W	02111	63M251T602
R257	321-0224-00			RES.,FXD,FILM:2.1K OHM,1%,0.125W	91637	MFF1816G21000F
R260	311-1531-00			RES.,VAR,WW:2K OHM,5%,1.5W	01121	535-9504
R262	321-0114-00	B010100	B066110	RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150ROF
R262	321-0636-00	B066111		RES.,FXD,FILM:100 OHM,0.5%,0.125W	91637	MFF1816D100ROD
R265	311-1221-00	B010100	B066110	RES.,VAR,NONWIR:50 OHM,20%,0.50W	32997	3386F-T04-500
R265	311-1175-00	B066111		RES.,VAR,NONWIR:100 OHM,10%,0.50W	73138	68WR100
R270	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R272	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R274	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R276	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R277	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R278	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R280	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R284	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R290	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R292	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R294	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R296	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R300	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R302	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R315	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R320	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R322	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R323	315-0750-00	XB060000		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R324	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R326	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R328	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R332	317-0821-00	XB060000		RES.,FXD,CMPSN:820 OHM,5%,0.125W	01121	BB8215
R334	317-0821-00	XB060000		RES.,FXD,CMPSN:820 OHM,5%,0.125W	01121	BB8215
R335	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R338	315-0471-00	B010100	B059999X	RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R340	315-0332-00	B010100	B059999X	RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R342	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R345	315-0102-00	B010100	B059999X	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R350	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R351	317-0821-00	XB060000		RES.,FXD,CMPSN:820 OHM,5%,0.125W	01121	BB8215
R352	315-0221-00	B010100	B059999	RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R352	321-0132-00	B060000		RES.,FXD,FILM:232 OHM,1%,0.125W	91637	MFF1816G232ROF
R355	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R358	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R360	315-0510-00	B010100	B059999X	RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R361	317-0821-00	XB060000		RES.,FXD,CMPSN:820 OHM,5%,0.125W	01121	BB8215
R362	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R365	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R376	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R395	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R396	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200ROF
R397	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R398	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200ROF

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R400	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R402	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R404	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R410	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R411	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R412	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R416	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R420	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R422	315-0131-00			RES.,FXD,CMPSN:130 OHM,5%,0.25W	01121	CB1315
R448	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R460	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R465	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R468	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R470	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R475	315-0111-00			RES.,FXD,CMPSN:110 OHM,5%,0.25W	01121	CB1115
R477	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R480	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R481	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R495	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
R510	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R512	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R513	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R514	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R515	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R516	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R517	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R518	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R520	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R522	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R523	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R524	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R525	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R526	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R527	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R528	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R530	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R532	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R533	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R534	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R535	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R536	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R537	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R538	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R600	315-0472-00	B010100	B051229	RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R600	315-0301-00	B051230		RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R601	301-0220-00	XB040000		RES.,FXD,CMPSN:22 OHM,5%,0.50W	01121	EB2205
R602	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R605	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R610	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R611	315-0562-00	XB051230	B066110X	RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R612	321-0358-00			RES.,FXD,FILM:52.3K OHM,1%,0.125W	91637	MFF1816G52301F
R613	315-0242-00	XB066111		RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R615	321-0336-00			RES.,FXD,FILM:30.9K OHM,1%,0.125W	91637	MFF1816G30901F
R616	321-0358-00			RES.,FXD,FILM:52.3K OHM,1%,0.125W	91637	MFF1816G52301F
R620	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R624	308-0702-00			RES.,FXD,WW:0.33 OHM,5%,2W	75042	BWH-R3300J
R626	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R640	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R680	308-0685-00			RES.,FXD,WW:1.5 OHM,5%,1W	75042	BW20-1R500J
R684	315-0560-00			RES.,FXD,CMPSN:56 OHM,5%,0.25W	01121	CB5605
R686	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R690	315-0270-00	B010100	B039999	RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
R690	315-0471-00	B040000		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R693	321-0236-00			RES.,FXD,FILM:2.8K OHM,1%,0.125W	91637	MFF1816G28000F
R694	311-1224-00			RES.,VAR,NONWIR:500 OHM,20%,0.50W	32997	3386F-T04-501
R695	321-0236-00			RES.,FXD,FILM:2.8K OHM,1%,0.125W	91637	MFF1816G28000F
R697	321-0236-00			RES.,FXD,FILM:2.8K OHM,1%,0.125W	91637	MFF1816G28000F
R698	321-0304-00			RES.,FXD,FILM:14.3K OHM,1%,0.125W	91637	MFF1816G14301F
S100	263-1082-00			SW CAM ACTR AS:FREQUENCY RANGE	80009	263-1082-00
S240	105-0588-00			ACTR ASSY,SL SW:OUTPUT ATTEN	80009	105-0588-00
U225	155-0107-00			MICROCIRCUIT,LI:DIODE LEVELER,HYBRID	80009	155-0107-00
U240	307-1024-00			ATTENUATOR,FXD:50 OHM,10X	80009	307-1024-00
U245	307-1024-00			ATTENUATOR,FXD:50 OHM,10X	80009	307-1024-00
U280	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	02735	85145
U350	156-0534-00	B010100	B059999X	MICROCIRCUIT,LI:DUAL DIFF AMPL,14 LD DIP	80009	156-0534-00
U390	156-0228-00			MICROCIRCUIT,DI:MASTER SLAVE TYPE D F-F	80009	156-0228-00
U400	156-0230-00			MICROCIRCUIT,DI:DUAL D MA-SLAVE FLIP-FLOP	80009	156-0230-00
U425	156-0180-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74S00(N OR J)
U430	156-0395-00			MICROCIRCUIT,DI:DECADE COUNTER	80009	156-0395-00
U432	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U435	156-0079-00			MICROCIRCUIT,DI:DECADE COUNTER,TTL	80009	156-0079-00
U436	156-0079-00			MICROCIRCUIT,DI:DECADE COUNTER,TTL	80009	156-0079-00
U437	156-0079-00			MICROCIRCUIT,DI:DECADE COUNTER,TTL	80009	156-0079-00
U438	156-0062-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL-OR GATE	80009	156-0062-00
U440	156-0039-00			MICROCIRCUIT,DI:DUAL J-K FLIP FLOP	80009	156-0039-00
U445	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U450	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U455	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN7400(N OR J)
U460	156-0113-00			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	80009	156-0113-00
U465	156-0032-00			MICROCIRCUIT,DI:4-BIT BINARY COUNTER	80009	156-0032-00
U475	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN7400(N OR J)
U480	156-0079-00			MICROCIRCUIT,DI:DECADE COUNTER,TTL	80009	156-0079-00
U481	156-0079-00			MICROCIRCUIT,DI:DECADE COUNTER,TTL	80009	156-0079-00
U482	156-0079-00			MICROCIRCUIT,DI:DECADE COUNTER,TTL	80009	156-0079-00
U485	156-0034-00			MICROCIRCUIT,DI:DUAL 4-INPUT NAND GATE	80009	156-0034-00
U490	156-0079-00			MICROCIRCUIT,DI:DECADE COUNTER,TTL	80009	156-0079-00
U510	156-0379-00			MICROCIRCUIT,DI:BCD TO 7-SEGMENT DCDR/DRVR	80009	156-0379-00
U520	156-0379-00			MICROCIRCUIT,DI:BCD TO 7-SEGMENT DCDR/DRVR	80009	156-0379-00
U530	156-0379-00			MICROCIRCUIT,DI:BCD TO 7-SEGMENT DCDR/DRVR	80009	156-0379-00
U610	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	02735	85145
U695	156-0071-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	04713	MC1723CL
VR200	152-0280-00	B010100	B029999	SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
VR200	152-0337-00	B030000		SEMICOND DEVICE:ZENER,0.4W,6.3V,3.2%	04713	SZG210K
VR202	152-0280-00	B010100	B029999	SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
VR202	152-0337-00	B030000		SEMICOND DEVICE:ZENER,0.4W,6.3V,3.2%	04713	SZG210K
VR475	152-0278-00			SEMICOND DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
VR610	152-0279-00	B010100	B066110X	SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	04713	SZG35010RL
VR640	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
Y460	158-0014-00			XTAL UNIT,QTZ:1 MHZ,+/-0.005%	75378	TX-004

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

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

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

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

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

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

Abbreviations are based on ANSI Y1.1-1972.

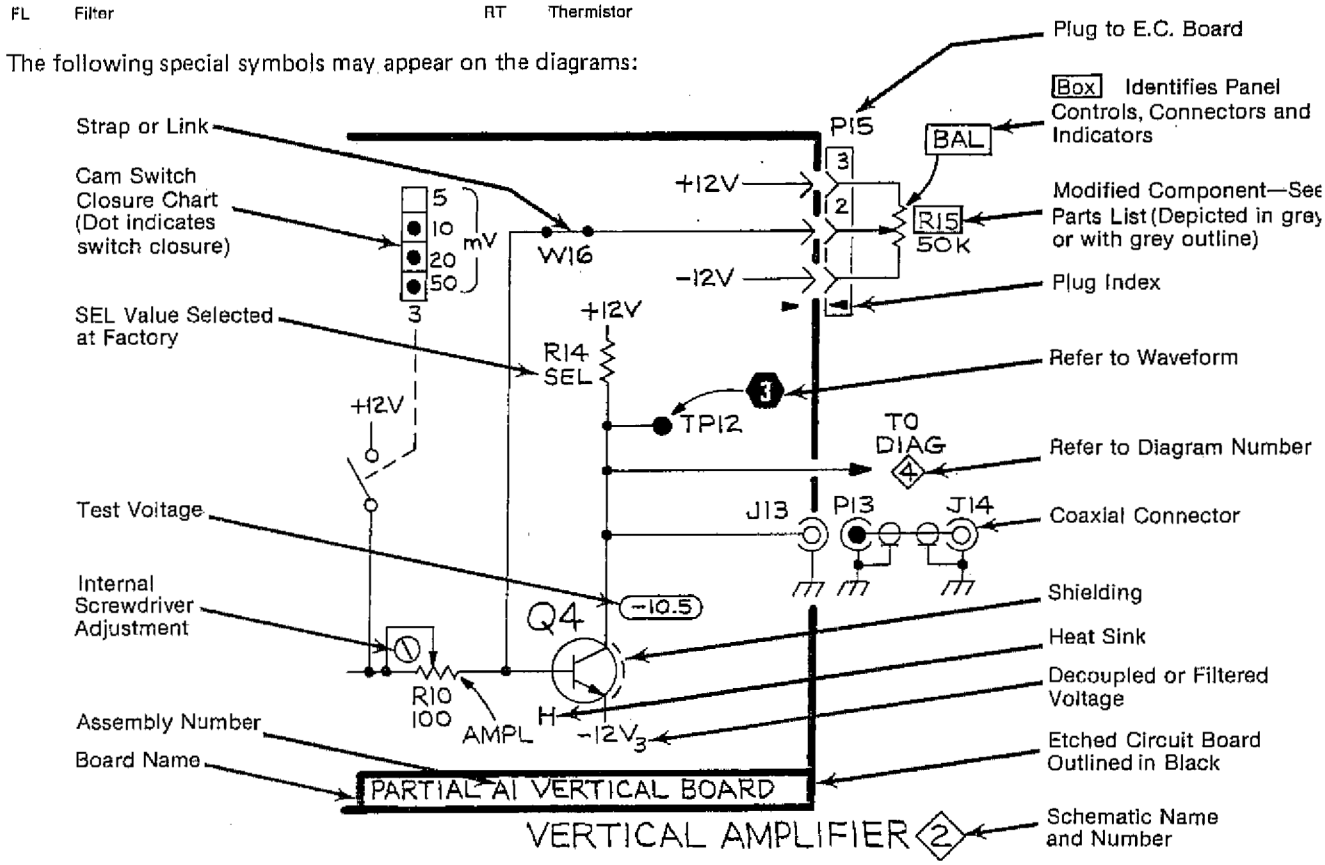
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

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

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

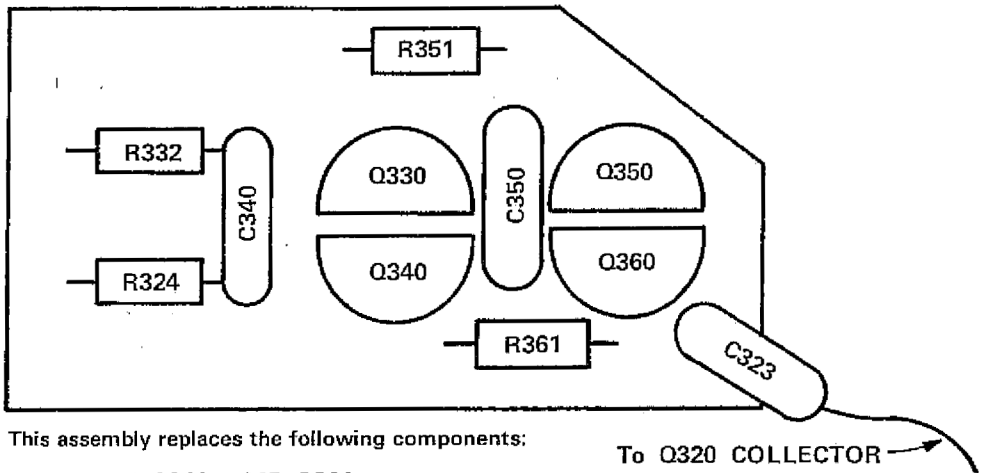
A	Assembly, separable or repairable (circuit board, etc)	H	Heat dissipating device (heat sink, heat radiator, etc)	S	Switch or contactor
AT	Attenuator, fixed or variable	HR	Heater	T	Transformer
B	Motor	HY	Hybrid circuit	TC	Thermocouple
BT	Battery	J	Connector, stationary portion	TP	Test point
C	Capacitor,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

The following special symbols may appear on the diagrams:



A5 Dual differential Amplifier circuit board.

SN B060000 - up



NOTE: This assembly replaces the following components:

C328, C335, C342, C345, C360
R338, R340, R345
U350

VOLTAGE AND WAVEFORM CONDITIONS

WARNING

Dangerous potentials exist at several points throughout this instrument. When the instrument is operated with the covers removed, do not touch exposed connections or components. Some transistors have voltages present on their cases. Disconnect the power source before replacing parts.

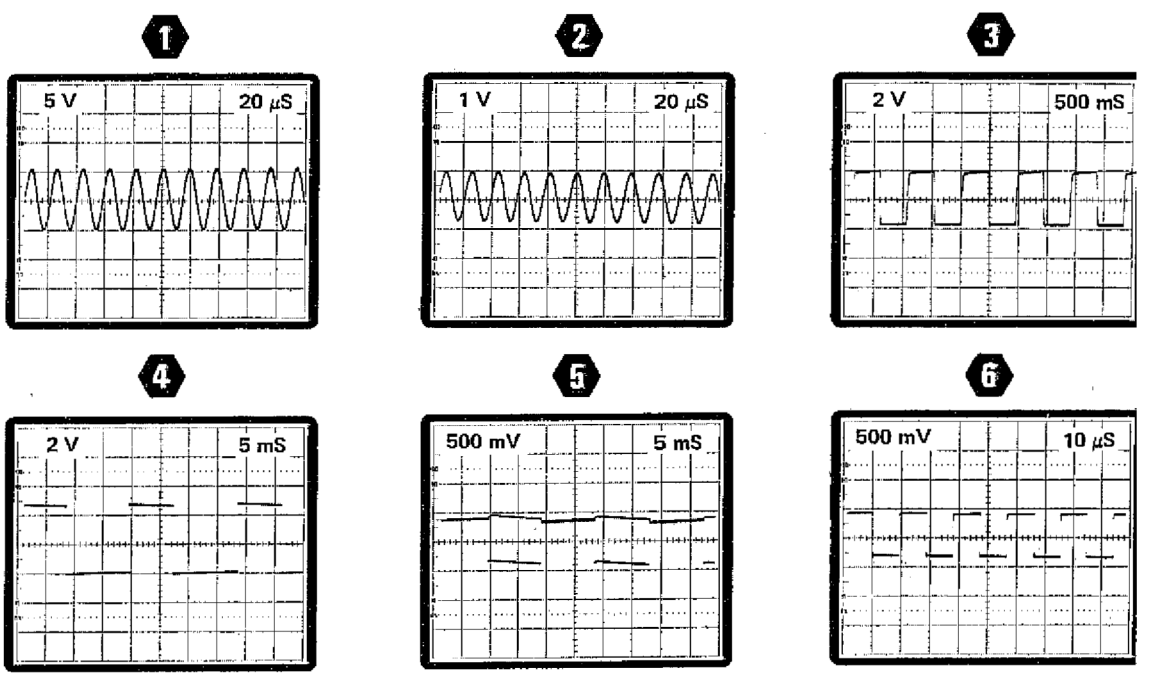
The voltages and waveforms shown on the diagrams were taken with no input signal and the SG 5(front panel controls set as follows:

VOLTAGES		*WAVEFORMS	
AMPLITUDE MULTIPLIER	X1	AMPLITUDE MULTIPLIER	X1
FREQUENCY VARIABLE	Midrange	FREQUENCY VARIABLE	Midrange
FREQUENCY RANGE (MHz)	REF ≈ .05	FREQUENCY RANGE (MHz)	REF ≈ .05
OUTPUT AMPLITUDE	5.5	OUTPUT AMPLITUDE	5.5

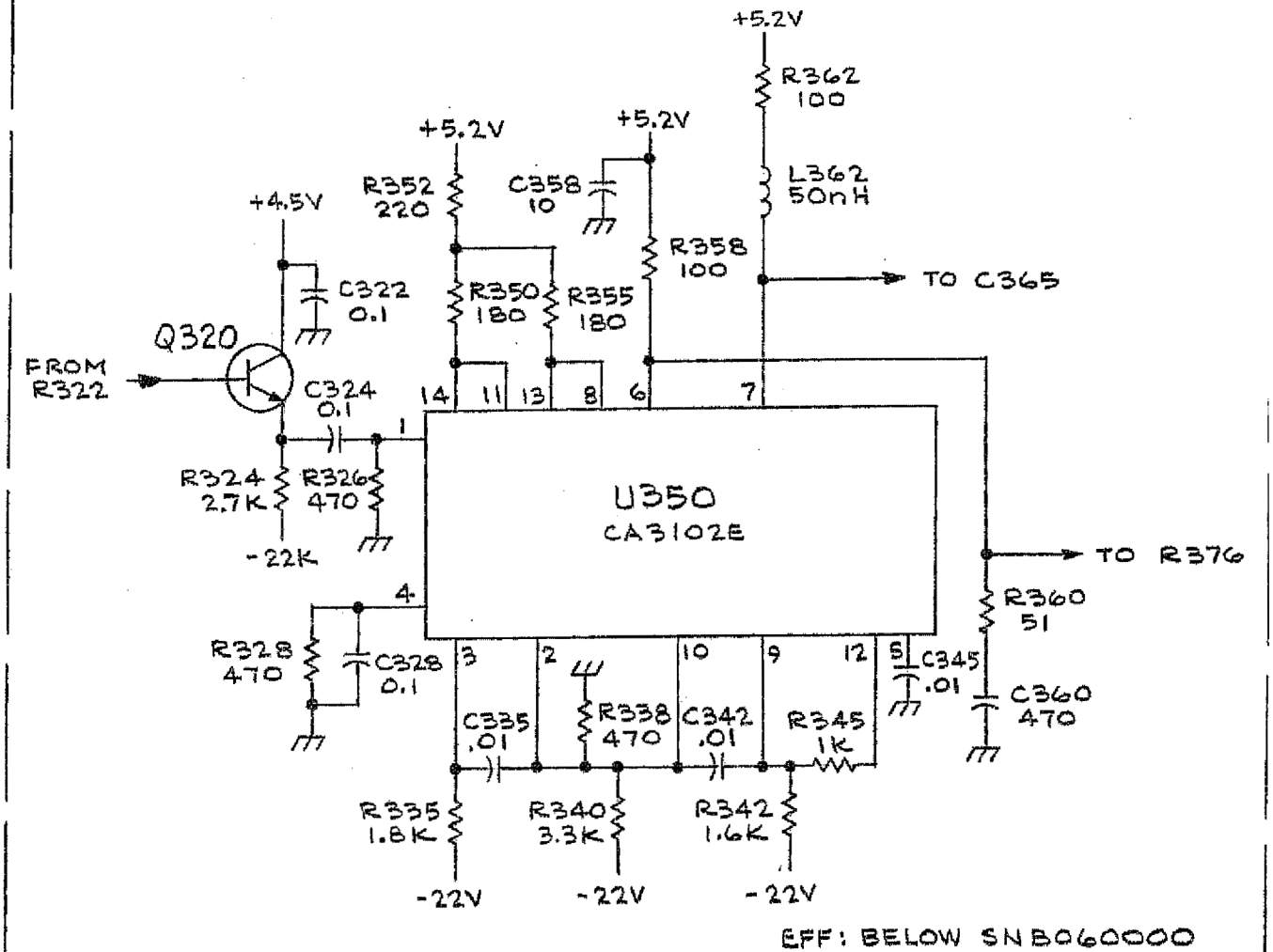
***gnd reference: center horizontal graticule line**

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimete with a 10 MΩ input impedance (Tektronix DM 501 Digital Multimeter or Tektronix 7D13 Digital Multimete used with readout equipped, 7000-series oscilloscope).

Waveform Conditions. The waveforms shown are actual waveform photographs taken with Tektronix Oscilloscope Camera System and Projected Graticule. Vertical deflection factor shown on th waveform is the actual deflection factor from the probe tip. Voltages and waveforms on the diagrams ar not absolute and may vary between instruments because of component tolerances, internal calibratior or front-panel settings. Readouts are simulated in larger-than-normal type.



1622-22

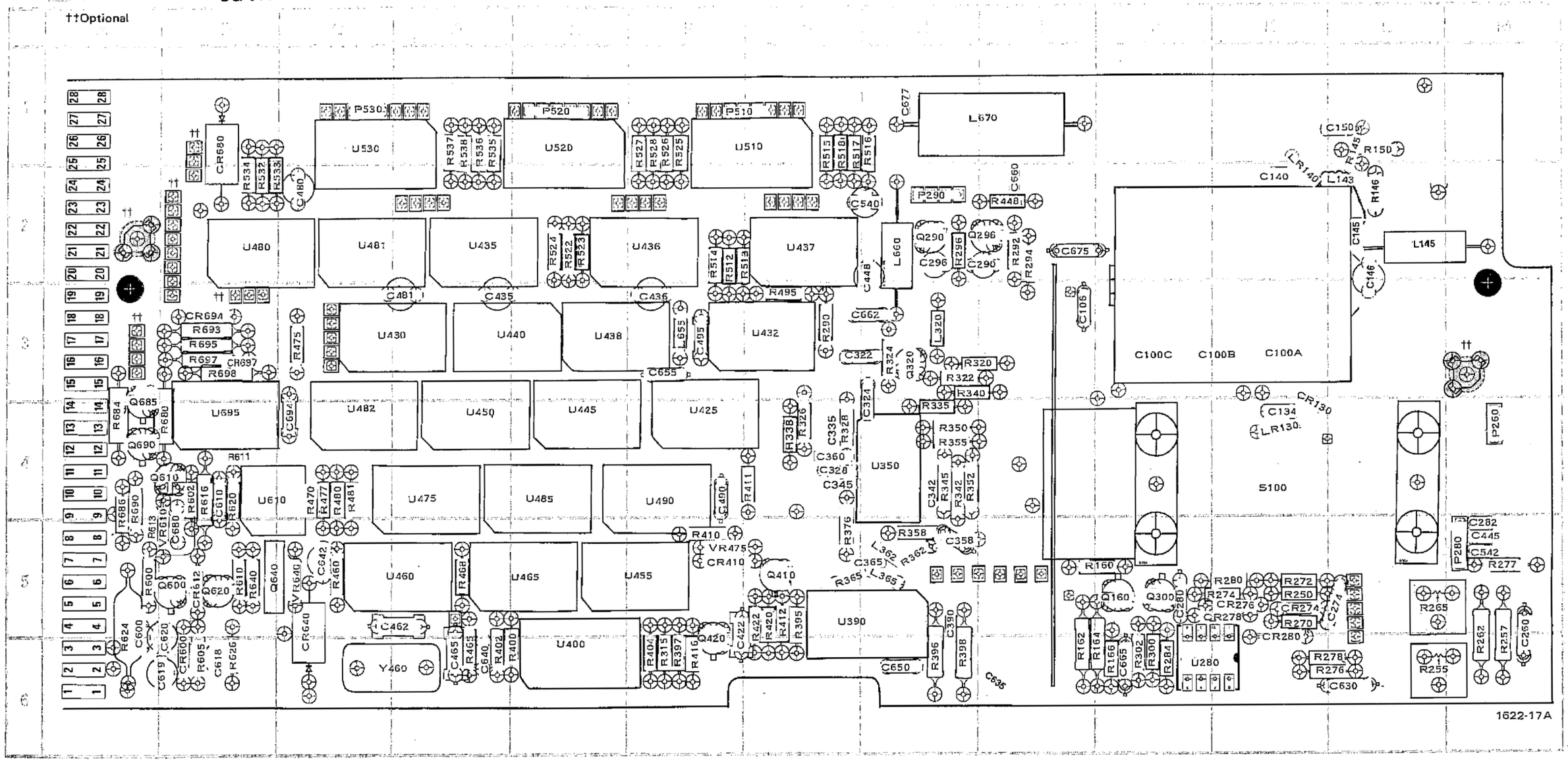

+5.2V
R362
100
L362
50nH
+5.2V
+5.2V
R352
220
C358
10
+4.5V
R358
100
TO C365
C322
0.1
R350
180
R355
180
Q320
FROM
R322
C324
0.1
14
11
13
8
6
7
1
U350
CA3102E
R324
2.7K
R326
470
-22K
TO R376
4
R360
51
R328
470
C328
0.1
3
2
10
9
12
5
C345
.01
C360
470
C335
.01
R338
470
C342
.01
R345
1K
R335
1.8K
R340
3.3K
R342
1.6K
-22V
-22V
-22V
EFF: BELOW SN8060000

+5.2 V
R315
390
PRE-SCALE LOCKOUT
DUAL DIFFERENTIAL AMPLIFIER (U350) Q330, Q340, Q350 Q360
HIGH FREQUENCY ÷8 SIGNAL PRESCALING U390, U400
ECL-TTL TRANSLATOR Q420
GATE U425
CR410
VR475
LOW FREQUENCY BYPASS Q410
BANDSWITCHED OSCILLATORS 50 kHz—250 MHz Q130—Q140
1 MHz CLOCK U460 Y460
CLOCK PRESCALE U465
SELECT CLOCK U455 U460
RANGE DECODERS U450 U455
AUTO-RANGING LOGIC AND MEMORY U445, U438
OVER-FLOW DETECTORS U440 U438
COUNTERS U430 U435 U436 U437
DECODERS DRIVERS U510 U530
DISPLAY DS510 DS520 DS530
AUTO-RANGE CLOCK U475 U450 U425
BUFFER AMPLIFIER
Q180
Q190
GATE TIME CLOCK DIVIDERS U480 U481 U482
LOGIC GATES U475
GATE TIME SELECT U485
STATE GENERATOR U490 U432 U425
LOW-PASS FILTER & MATCHING NETWORK
PEAK-TO-PEAK DETECTOR
50 Ω
R212
10K
50 OHM WIDEBAND ATTENUATORS X1, X.1, X.01
OUTPUT
FROM DISPLAY FLASH MULTIVIBRATOR
CURRENT SOURCE Q160
−22 V
−22 V
OUTPUT AMPLITUDE R260
CURRENT SOURCE Q300
U280
−22 V
DISPLAY FLASH MULTIVIBRATOR Q296—Q290
TO STATE GENERATOR U490

SG 503 BLOCK DIAGRAM

CUSTOMER MOD SG 503

††Optional



A1 Main circuit board "A" side.

NOTE

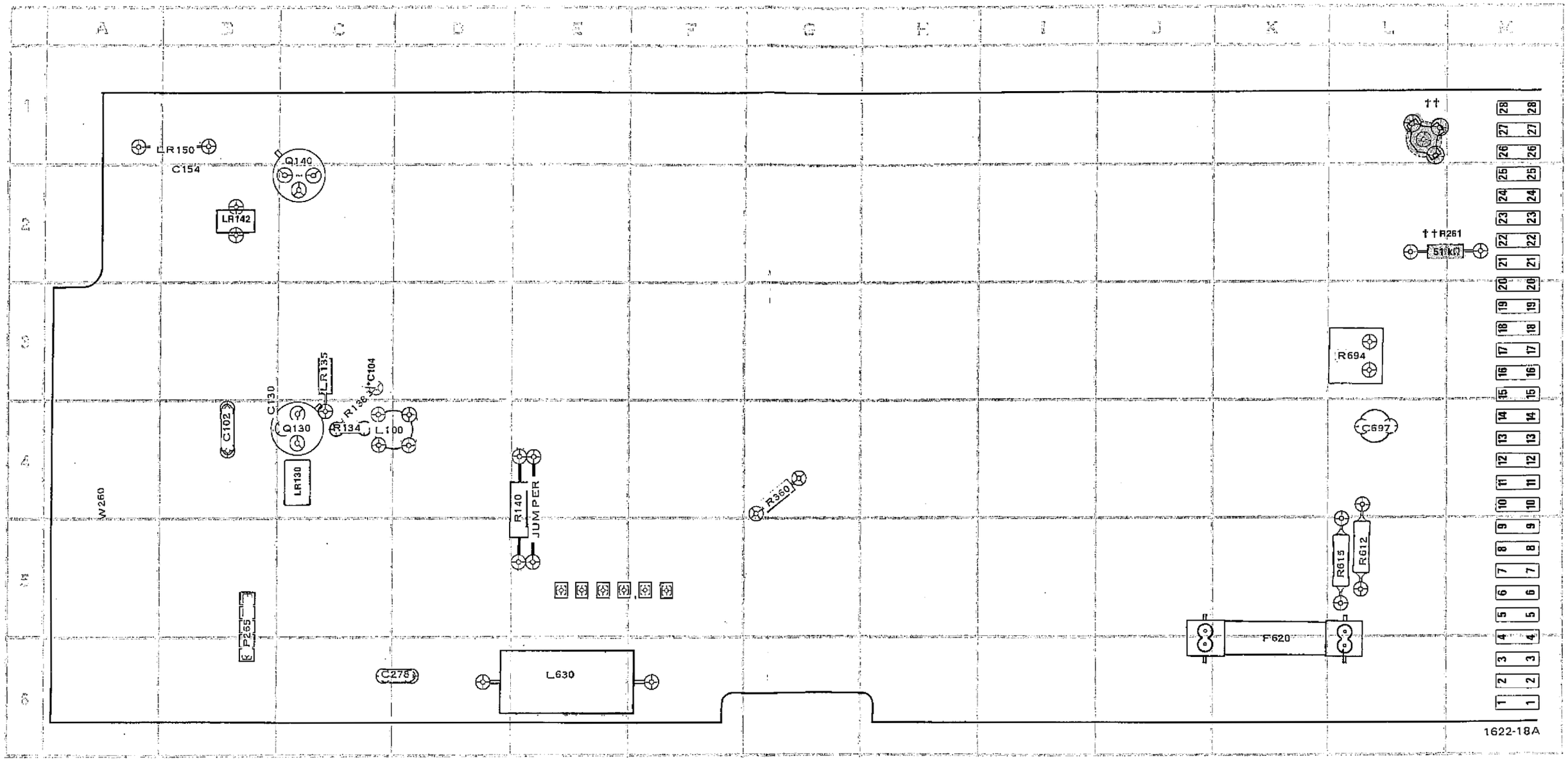
The following CKT NO's are ferrite beads. Refer to schematic diagrams for locations.

L190
L191
L245
L265
L270
L280
L290

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C100A	K3	C324	G4	C480	C2	C655	F3	CR640	C5	P280	M5	Q640	B5	R270	K5	R322	H3	R395	G5	R468	D5	R524	E2	R611*	B4	U350*	H4	U475	D4
C100B	K3	C328*	G4	C481	C3	C660	I2	CR680	B1	P290	H2	Q685	A4	R272	K5	R324	H3	R396	H6	R470	C4	R525	F1	R613	A5	U390	G5	U480	B2
C100C	J3	C335*	G4	C490	F4	C662	G3	CR694	B3	P510	F1	Q690	A4	R274	K5	R326	G4	R397	F6	R475	C3	R526	F1	R616	B4	U400	E6	U481	C2
C106	I3	C342*	H4	C495	F3	C665	J6	CR697*	B3	P520	E1	R145	L1	R276	K6	R328	G4	R398	H6	R477	C4	R527	F1	R620	B4	U425	F4	U482	C4
C134	K4	C345*	G4	C540	G1	C675	I2	L143	L2	P530	C1	R146*	L2	R277	M5	R335	H4	R400	D6	R480	C4	R528	F1	R624	A5	U430	C3	U485	E4
C140	K2	C358	H5	C542	M5	C677	H1	L145*	L2			R145	L1	R278	K6	R338*	G4	R402	D6	R481	C4	R532	B2	R626	B6	U432	G3	U490	F4
C145*	L2	C360*	G4	C600	A5	C680	B5	L320	H3	Q160	J5	R150	L1	R280	K5	R340*	H3	R404	F6	R495	G3	R533	B2	R640	B5	U435	D2	U510	F1
C146*	L2	C365	G5	C610	B4	C694	C4	L362	H5	Q290	H2	R160	J5	R284	J6	R342	H4	R410	F5	R512	F2	R534	B2	R680	A4	U436	F2	U520	E1
C150	L1	C390	H5	C618	B6	CR130	K4	L365	H5	Q296	H2	R162	I6	R290	G3	R345*	H4	R411	F4	R513	F2	R535	D1	R684	A4	U437	G2	U530	C1
C260	M6	C422	F6	C619	A5	CR274	K5	L655	F3	Q300	J5	R164	I6	R292	I2	R350	H4	R412	G5	R514	F2	R536	D1	R686	A4	U438	E3	U610	B4
C274	L5	C435	D3	C620	A5	CR276	K5	L660	H2	Q320	H3	R166	J6	R294	I2	R352	H4	R416	F6	R515	G1	R537	D1	R690	A4	U440	D3	U695	B4
C280	J5	C436	F3	C630	L6	CR278	K5	L670	I1	Q410	G5	R250	K5	R296	H2	R355	H4	R420	G5	R516	G1	R538	D1	R693	B3	U445	E4		
C282	M5	C445	M5	C635*	I6	CR280	K6	LR130	K4	Q420	F6	R255	L6	R300	J6	R358	H5	R422	G5	R517	G1	R600	A5	R695	B3	U450	D4	VR475	F5
C290	H2	C448	G2	C640	D6	CR410	F5	LR140	K2	Q600	B5	R257	M6	R302	J6	R362	H5	R448	I2	R518	G1	R602	B4	R697	B3	U455	F5	VR610	A5
C296	H2	C462	C5	C642	C5	CR600	B6			Q610	A4	R262	M6	R315	F6	R365	G5	R460	C5	R522	E2	R605	B6	R698	B3	U460	D5	VR640	C5
C322	G3	C465	D6	C650	H6	CR612	B5	P260	M4	Q620	B5	R265	L5	R320	H3	R376	G5	R465	D6	R523	E2	R610	B5	U280	J6	U465	E5	Y460	C6

SG503

CUSTOMER MOD



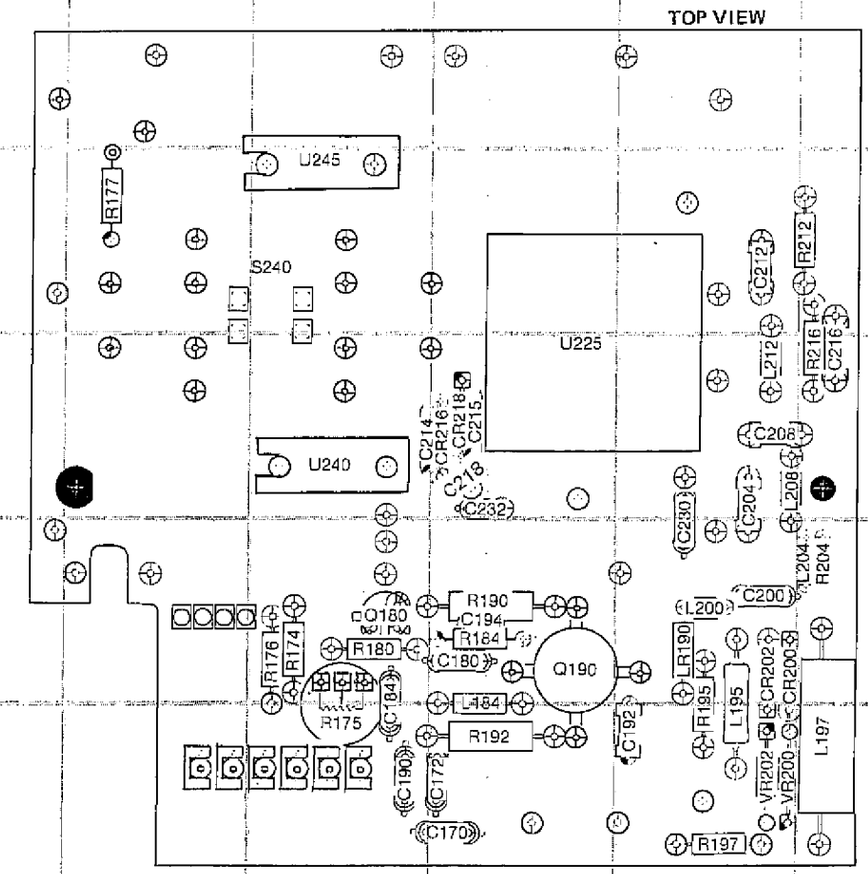
††Optional

A1 Main circuit board "B" side.

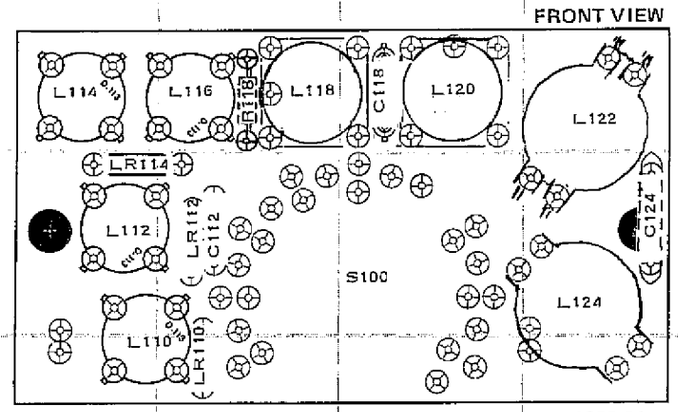
*See Parts List for serial number ranges.

REV D SEP 1979

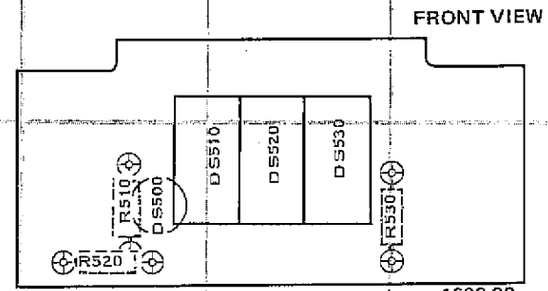
CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C102	B4	LR135	C3	R615	L5
C104 *	C3	LR150	B1	R694	L3
C130	C3				
C154	B2	Q130	C4	W260	A4
C278	D6	Q140	C2		
C697	L4				
		P265	B5		
F620	K5				
		R134	C4		
L100	D4	R138	C4		
L142	B2	R140	E4		
L630	E6	R360	G4		
LR130	C4	R612	L5		



A3 Attenuator circuit board



A2 Coil circuit board



A4 Display circuit board

*See Parts List for serial number ranges.

†Located on back of board.

‡ Selected component, refer to maintenance section.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C112	K2	C214*	C3	DS510	I5	L195	E4	R116*†	L1	R216	F3
C118*	L1	C215*	D3	DS520	I5	L197	F5	R118*†	K1	R510	H5
C124	M2	C216	F3	DS530	I5	L200	E4	R174	C4	R520	H5
C170	D5	C218*	D3			L204	F4	R175	C5	R530	J5
C172	D5	C230	E3	L110	J3	L208	E3	R176	C4		
C180	D4	C232	D3	L112	J2	L212	E3	R177*‡	B2	S100	L2
C184	C4			L114	J1			R180	C4	S240	C2
C190	C5	CR200	E4	L116	K1	LR110	K3	R184	D4		
C192	E5	CR202	E4	L118	K1	LR112	K2	R190	D4	U225	D2
C194*	D4	CR216	C3	L120	L1	LR114	J2	R192	D5	U240	C3
C200	E4	CR218	D3	L122	M1	LR190	E4	R195	E4	U245	C2
C204	E3			L124	M2			R197	E5		
C208	E3	DS500	H5	L184	D4	Q180	C4	R204	F4	VR200	E5
C212	E2					Q190	D4	R212	F2	VR202	E5

REV F JUL 1980

A2 COIL BOARD

FREQUENCY RANGE (MHz)

SEE DETAILS ④

S100

A1 MAIN BOARD

BANDSWITCHED OSCILLATORS 50kHz – 250 MHz

A3 ATTENUATOR – OUTPUT BUFFER BOARD

OUTPUT BUFFER AMP

LOW PASS FILTER

AMPLITUDE MULTIPLIER S240

X1
X0.1
X.01

"●" INDICATES "A" CLOSED "B" OPEN
"A" CONTACTS ON SLIDE SIDE
(SHOWN IN X1 POSITION)

PEAK-PEAK DETECTOR U225

TEMP COMP

50Ω WIDEBAND ATTEN

COUNTER TO R320 ②

J245 OUTPUT

L245 FERRITE BEAD THIS END OF CABLE

FREQUENCY VARIABLE

VOLTAGE REGULATOR

CURRENT SOURCE & REGULATOR

DISPLAY FLASH MULT

TWO FERRITE BEADS L265, L270, ON THIS CABLE

TWO FERRITE BEADS L280, L290 ON CABLE

Q190 2N5947 BASING

CUT AT ANGLE

S100
FREQUENCY RANGE (MHz)
(SHOWN IN 50-100 MHz POS)

REF ≈ .05
▲ 0.25-0.5
▲ 0.5-1
▲ 1-2.5
▲ 2.5-5
▲ 5-10
▲ 10-25
▲ 25-50
▲ 50-100
▲ 250

1 2 3 4 5 6 7 8 9 10 11

▲ – DETENT POS

"●" INDICATES:
1. CONTACT CLOSED
2. "A" CLOSED "B" OPEN
"A" CONTACTS ARE ON CAM SIDE OF BOARD.

TOP VIEW L100

SEE OPTIONS

REMOTE AMPLITUDE 21B → DC INPUT
22B → COM
SINE OUT 28A → SIG
27A → COM
28B

REMOTE

.5V P-P AMPLITUDE SET

OUTPUT AMPLITUDE VOLTS P-P

5V P-P AMPLITUDE SET

* LEADLESS CAPACITOR

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

AUTO RANGING COUNTER AMPLIFIER

+5.2V R315 390

R352 232 C356 10 R358 100 L362 150nH

R362 100

R350 180 +3.0

R355 180

Q330 Q340

R332 820 C340 .068 R334 820 -3V

R342

Q350 Q360 -22V

R328

R351 820 C350 .068 R361 820 -5.5

A5 DUAL DIFFERENTIAL CIRCUIT BD

C336 .01 R335 1.8K -22V

+4.5V C322 .01 R323 75 C323 51

FROM R/C 216 ① 100Ω LINE R322 51 Q320 C324 0.1 +4.5

R320 180 L320 130nH R324 2.7K R326 470 -22V

L365 2.5μH R365 180 C365 .01

U390 1670

R398 200 R396 200 R395 390 R397 390

C390 0.1 +5.2V

÷8 SIGNAL PRESCALING

U400 10131 A B

R402 270 R400 270 R404 270

CR410 R376 470

R410 10K R411 10K +5.2V Q410 +4.5

R412 270

+5.2V R420 15 C422 33 R422 130

Q420 +3.8 R416 100 +1.5

GATE

U425A 74S00 +2.1 +3.5

OVERFLOW DETECTOR

+5.2V U430 7490 COUNTERS

U432D 7402

U435 7490 C435 10μF TO U530 ③

U436 7490 C436 10μF TO U520 TO DISPLAY DRIVERS ③

U437 7490 TO U510 ③

U440B 7473 +4.2 +0.10

U440A 7473 +4.0

U438D 7486 +5.2

(10⁰) 100 PIN 7 DS530 ③

(10¹) 10 PIN 7 DS520 ③

(10²) 1 PIN 7 DS510 ③

(10⁻¹) 0.1 DS500 ③

U425D 74S00

U425B 74S00

P290 P280 ① ③

R448 390 C448 1μF C445 1000 S100-2 ② CLOSED REF ≈ .05 ONLY R276 ①

AUTO RANGE CLOCK ENABLE

U438A 7486 U445B 7474 U438B 7486

U445A 7474

RANGE DECODER

U455C 7400 +0.09 +3.9

U450D 7402 +0.19

U450C 7402 +2.1

U450B 7402 +0.19

SELECT CLOCK

REFERENCE CLOCK

VR475 3V

CLOCK PRESCALE

R460 2.2k U460A 74L00 Y460 1MHz XTAL C462 22 U460B 74L00 U460D 74L00 C465 10 R468 300 R465 2.2k

R475 110

U465 7493 +5.2V

U455B 7400 U455A 7400 U455D 7400 U460C 74L00 R470 510

LOGIC GATES

R477 560 U475B 7400

U480 7490 C480 100μF R480 560 U475A 7400 +0.89

U481 7490 C481 10μF R481 560 U475D 7400

U482 7490 +0.89

GATE TIME CLOCK DIVIDER

GATE TIME SELECT

U485B 7420 U485A 7420 +0.89

(C) Q290 FROM DISPLAY FLASH MULTI ①

U490 7490 C490 0.1

STATE GEN

U432A 7402 +2.1

U432C 7402 +3.3

U425C 74S00 R495 160 C495 .001 U438C 7486 OVERFLOW DETECTOR

U450A 7402 AUTO RANGE CLOCK

U475C 7400 +1.7 +2.1

U432B 7402 PIN 10 DECODER/DRIVERS ③

④

A1 MAIN BOARD

SG 503

1622-24 REV G JULY 1980

AUTO-RANGING COUNTER ②

A1 MAIN BOARD

+11.5V
2A
2B
C600 0.1
+11.5V COMMON
3A
3B
4A
4B
R600 300
R602 1.8k
+10.4
Q600
R601 22
R605 4.7k
CR600
+6.6
6A
7B
LOCATED IN MAINFRAME
7A
+5.8
R624 0.33Ω
Q620
R626 20
Q610
U610
-17.1
C610
-22V
R611
VR610
R613 2.4K
R612 52.3K
R610 15.0K
-4.9
CR612
C620 10µF 25V
C619 10µF 25V
C618 10µF 25V
R620 4.7k
F620 2A
+5V
L630 2.5mH
+4.5 VOLTS
C635 22
C630 100µF 10V
R615 30.9k
R616 52.3k
VR640 6.2V
Q640
R640 1k
C640 100µF 10V
CR640
C642 100µF 10V
+5.2 VOLTS
+5.2V
U438 7486
U445 7474
U450 7402
U455 7400
U460 74L00
U440 7473
U425 74S00
L655
C655 1µF
U390 1670
C650 1µF
U400 MC10131
CR680
C680 22µF 35V
C677 .01
C660 0.01
C662 0.1
C675 22µF 35V
L660 160µH
C665 22µF 35V
-22 VOLTS
-22V
L670 1mH
CR697
R697 2.80k
R698 14.3k
C697 6.84F
U695 -723C
C694 100
R693 2.80k
R694 500
R695 2.80k
CR694
-22V ADJ
Q690
R690 470
R680 1.5Ω
-23.4
Q685
-22.8
R684 56
R686 3.9k
10A
11A
11B
LOCATED IN MAINFRAME
-33.5V COMMON
9A
9B
8A
8B
-33.5V

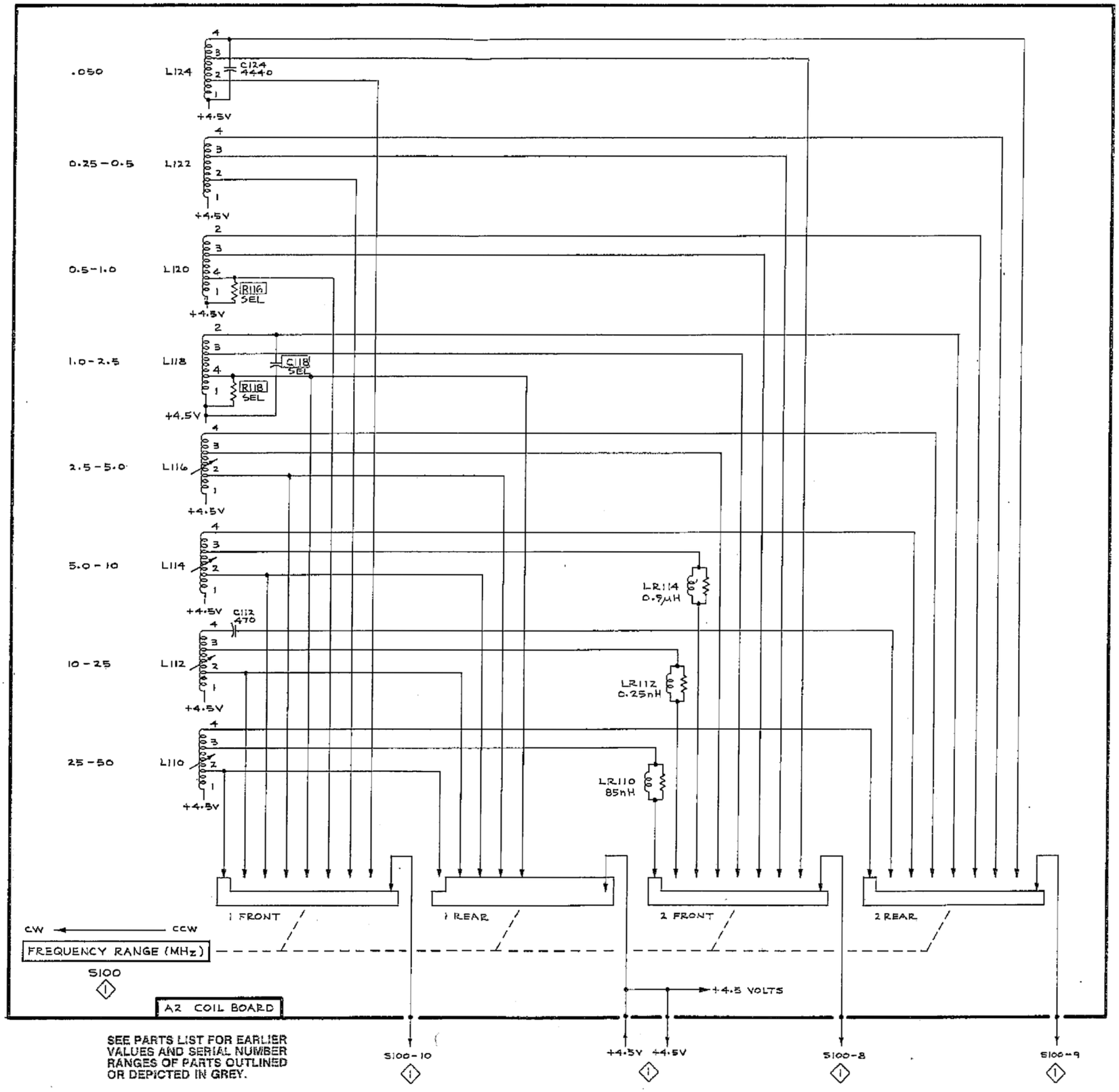
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

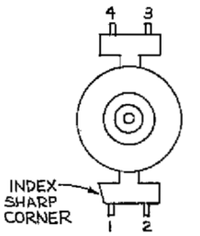
U432B-4
R276
P280-3
P290-3
C542 1000
S100-3
C540 1µF
U435
3A 3B 3C 3D
U530 8T06
+5.2V
R532 270
R533 270
R534 270
R535 270
R536 270
R537 270
R538 270
U450D-18 (100DP)
P500-2
P530
R530 390
DS530 (LSD)
U436
2A 2B 2C 2D
U520 8T06
R522 270
R523 270
R524 270
R525 270
R526 270
R527 270
R528 270
U450C-10 (10 DP)
P500-4
P520
R520 390
DS520
U437
1A 1B 1C 1D
U510 8T06
R512 270
R513 270
R514 270
R515 270
R516 270
R517 270
R518 270
U450B-4 (1.0 DP)
P500-3
P510
R510 390
DS510 (MSD)
U455A-3 (0.1 DP)
P500
DS500
A4 DISPLAY BD.

1622-25
REV F JULY 1980

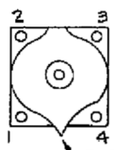
POWER SUPPLY AND DISPLAY 3

DEM 0874

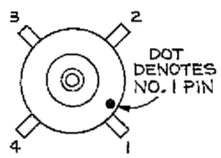




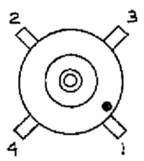
TOP VIEW L122
L124



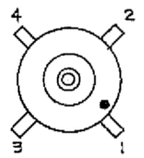
TOP VIEW L118
L120



TOP VIEW L110
L116

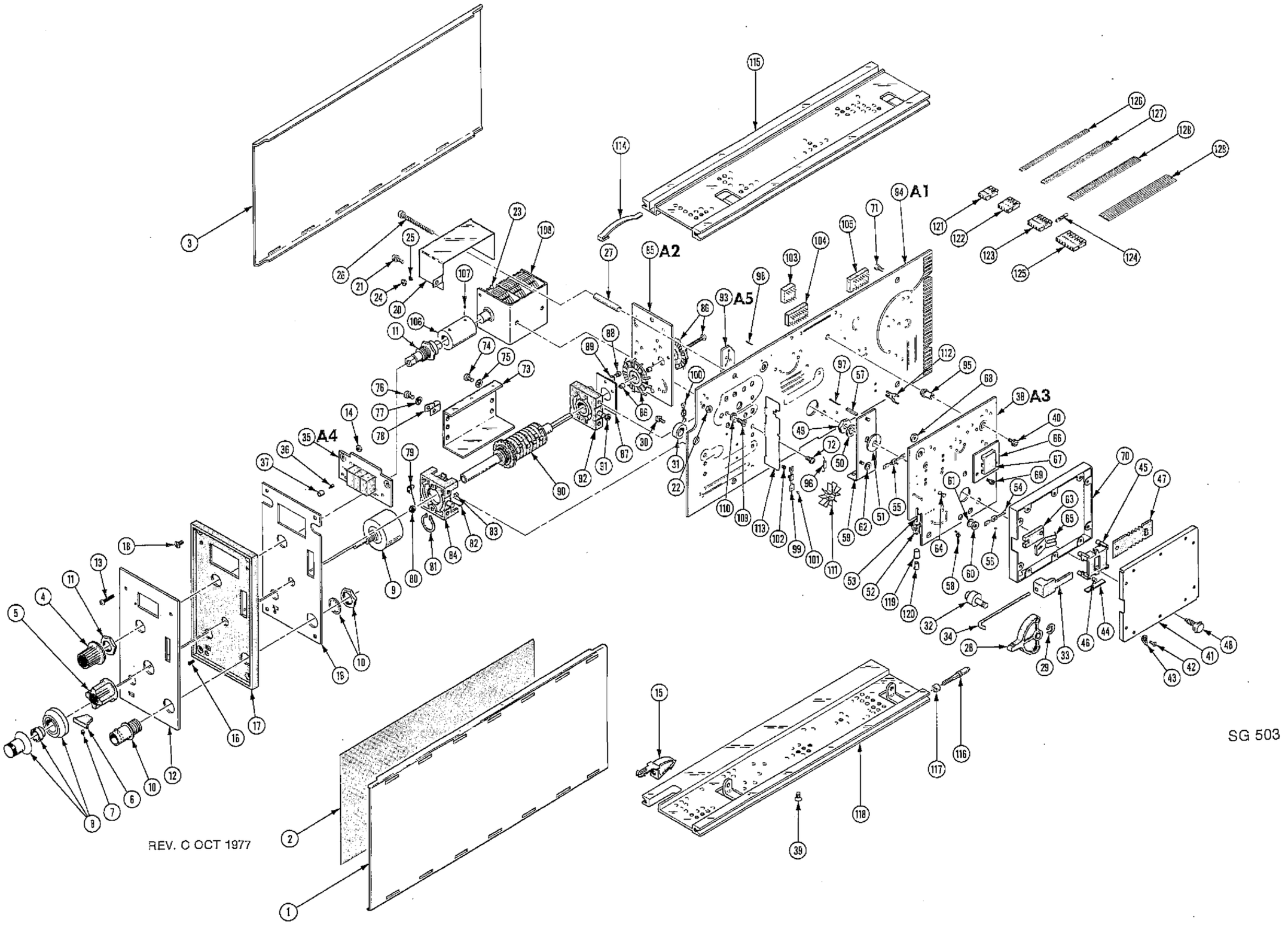


TOP VIEW L114



TOP VIEW L112

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


A1
A2
A3
A4
A5
REV. C OCT 1977
SG 503