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.[1]
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.[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, Harmonic Suppression check.	TEKTRONIX 7L12 Spectrum Analyzer.

[1]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.

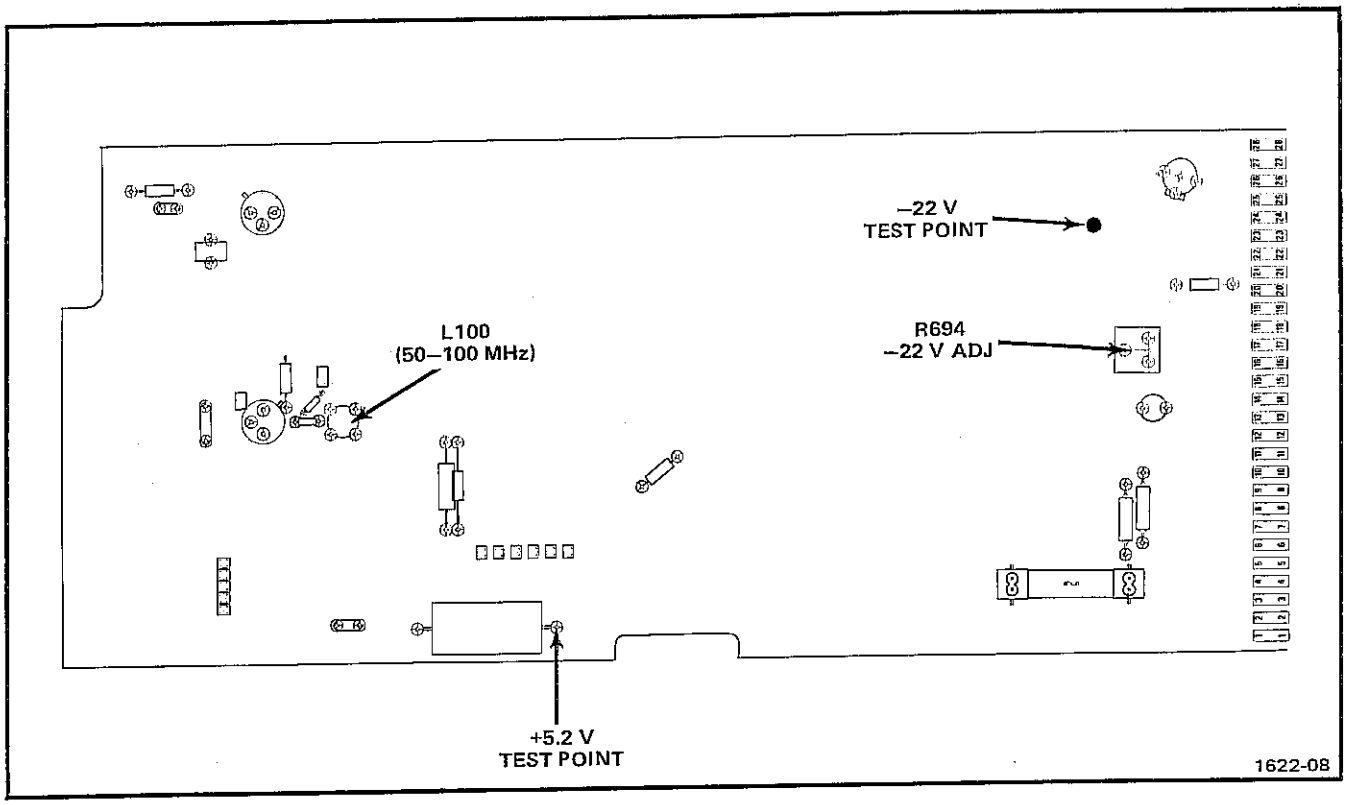

Fig. 3-1. Location of test points, L100, and −22 volt adjustment.

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.

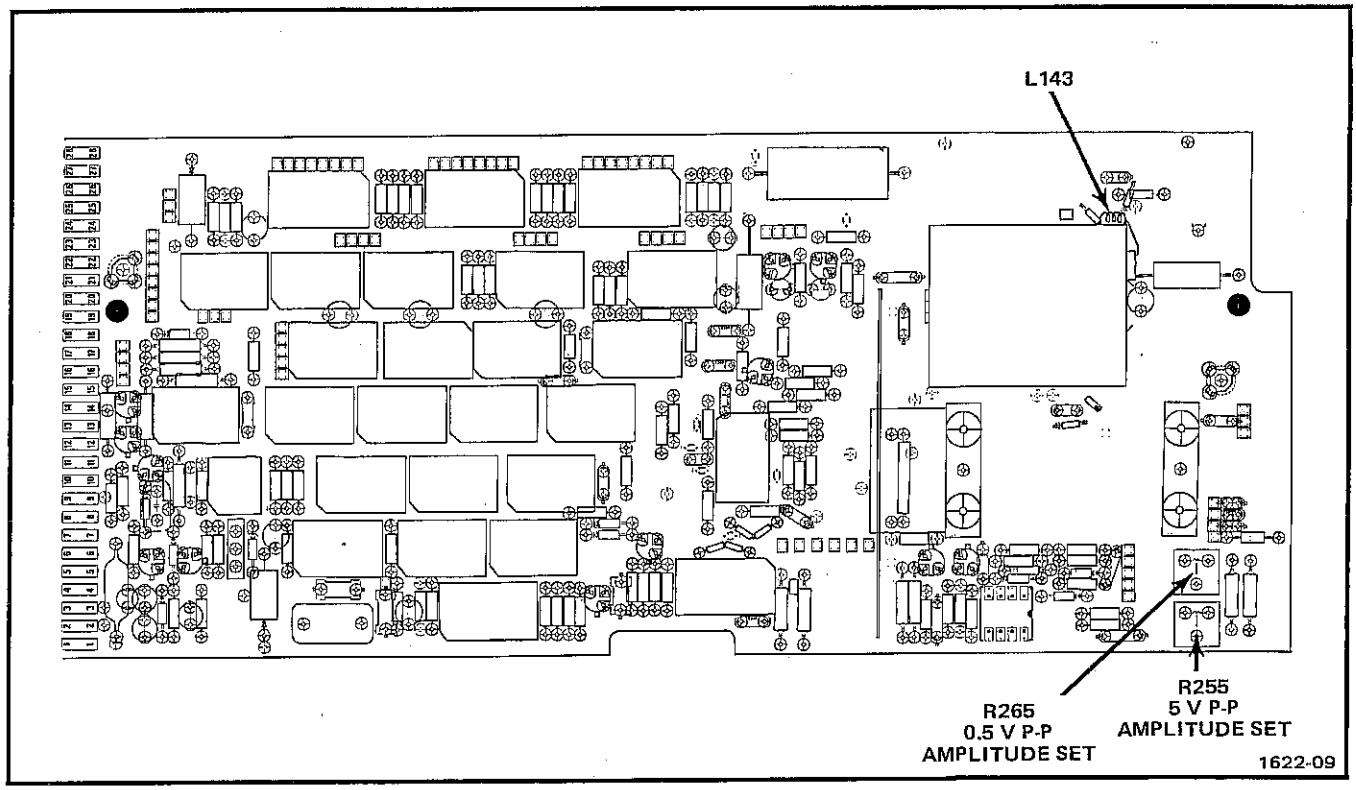

Fig. 3-2. Location of L143, 0.5 V P-P, and 5 V P-P Amplitude Set.

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.

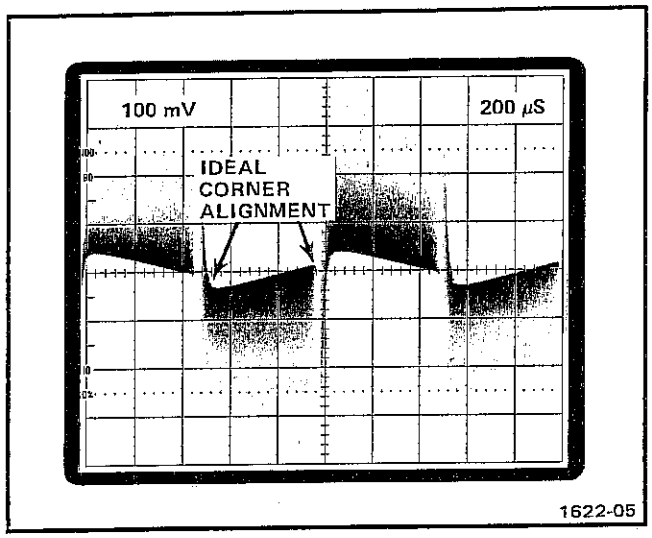

Fig. 3-3. Display of complex waveform (idealized) obtained when the amplitude set controls are properly adjusted at 0.05 MHz.

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.

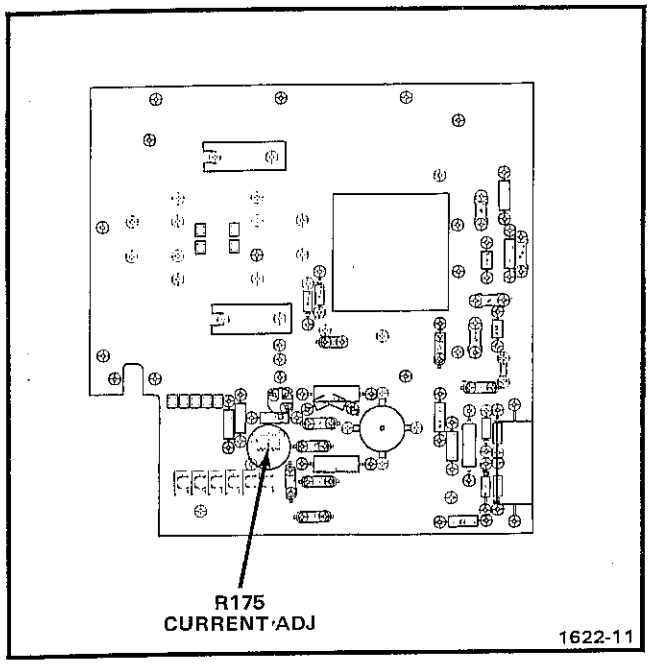

Fig. 3-4. Location of R175 Current Set adjustment.

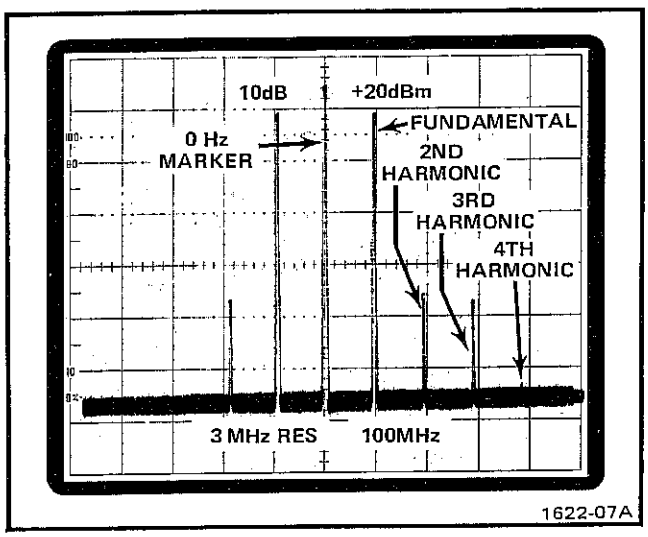

Fig. 3-5. Display of 100 MHz signal and harmonics.

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.

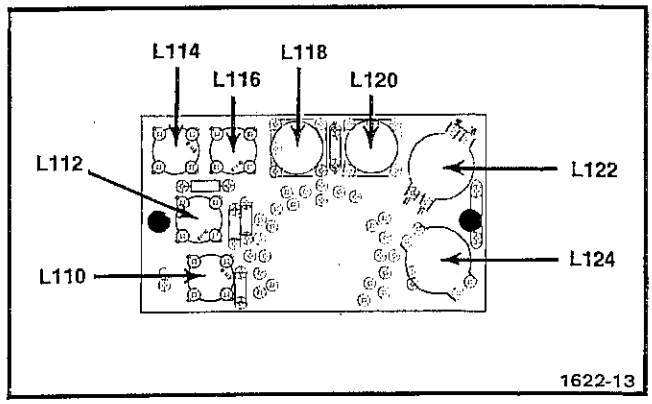

Fig. 3-6. Location of oscillator coils.

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.