

CALIBRATION

PERFORMANCE CHECK

INTRODUCTION

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

specified performance range. Any value within the specified range, within appropriate limits, may be substituted.

TEST EQUIPMENT REQUIRED

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

Table 4-1
TEST EQUIPMENT REQUIRED

Item	Description	Minimum Specifications	Application		Example
			Perf Check	Adj Proc	
1	Power Module	Five compartments or more.	X	X	TEKTRONIX TM 515 or TM 506
2	Oscilloscope System	Minimum Vertical deflection Sweep Rate .5 μ s.	X	X	TEKTRONIX 7704A/ 7A16A/7B50 AS RQ
3	Differential Comparator Amplifier	Minimum Vertical deflection factor .1 V/div	X	X	TEKTRONIX 7A13
4	Sampling System			X	TEKTRONIX 7704A/7S11/ 7T11/S-1
5	Spectrum Analyzer		X		TEKTRONIX 7L12
6	Distortion Analyzer	Frequency range from 20 Hz to at least 300 kHz. Distortion resolution <0.25%	X	X	TEKTRONIX AA 501 333A
7	Frequency Counter	Frequency range 0.002 Hz to above 2 MHz. Accuracy within one part in $10^4 \pm 1$ count.	X	X	TEKTRONIX DC 504 7260A
8	Digital Multimeter	Range to ± 30 V 5 1/2 digits Accuracy 0.1%	X	X	TEKTRONIX DM 501 348A
9	Pulse Generator	0 to 2 V square wave output into 50 Ω load. Period 2 μ s; Duration .1 μ s	X		TEKTRONIX PG 501
10	Power Supply	0 to 10 V range Accuracy $\pm 10\%$	X		TEKTRONIX PS 501-1

HA!

Table 4-1 (cont)

Item	Description	Minimum Specifications	Application		Example
			Perf Check	Adj Proc	
11	Flexible Extender Cable	Compatible with TM 500-Series		X	Tektronix Part No. 067-0645-02
12	Meter Lead	Black	X	X	Tektronix Part No. 012-0462-01
13	Meter Lead	Red	X	X	Tektronix Part No. 012-0462-00
14	Oscilloscope Probe	X10 10 M Ω	X	X	Tektronix Part No. 010-6053-13
15	Coaxial Cable	50 Ω BNC Connectors	X	X	Tektronix Part No. 012-0057-01
16	Termination	50 Ω BNC Connectors	X	X	Tektronix Part No. 011-0049-01
17	X10 Attenuator	50 Ω (20 dB) BNC		X	Tektronix Part No. 011-0059-02
18	X5 Attenuator	50 Ω (14 dB) BNC		X	Tektronix Part No. 011-0060-02
19	Adapter	BNC Female to Dual Banana	X	X	Tektronix Part No. 103-0090-00
20	AC-Calibrator	1% overall accuracy	X		Fliuke 5101B ★

1. Check Frequency Range

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

b. Press the *FREQ* RUN and 0 dB pushbuttons.

c. Press either the \surd , \square , or \sim pushbuttons.

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

e. Set the FREQUENCY Hz dial to 20 and the MULTIPLIER control to the 10⁵ position.

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

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

h. Activate the VAR SYMM control.

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

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

k. Change the MULTIPLIER to 10³.

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

m. Disable the VAR SYMM control.

n. Change the FREQUENCY Hz dial to 2.

o. CHECK—that the FREQUENCY Hz dial can be adjusted to obtain 0.0002 Hz. NOT TESTED

p. Disconnect the counter for the next step.

Date: 7/14/87

Change Reference: C4/0787

Product: FG 501A

Manual Part No.: 070-2957-00

DESCRIPTION Product Group 75

Effective all serial numbers: please replace Step 5 on page 4-3 with the following text:

5. Check Amplitude Flatness

- a. Press the FREE RUN, 0dB and \sim pushbuttons.
- b. Make certain the OFFSET is off.
- c. Set the FREQUENCY Hz dial to 10, MULTIPLIER to 10^3 , and AMPLITUDE control fully clockwise.
- d. Connect the OUTPUT connector through a 50 Ω cable and 50 Ω termination to the (+) input of the differential oscilloscope plug-in.
- e. Adjust vertical amplifier as follows:

(+) INPUT	DC
(-) INPUT	V _c
VOLT/DIV	.5V
POSITION	Midrange
- f. Adjust vertical amplifier COMPARISON VOLTAGE until the positive peaks of the waveform are on the graticule center line.
- g. Change the output to any frequency from 20 Hz to 20 kHz.
- h. Check that the positive peaks of the waveform stay within 1.7 minor divisions of the graticule center line.
- i. Change the output to any frequency from 20 kHz to 1 MHz.
- j. Check that the positive peaks of the waveform stay within +1.7/-1.6 major divisions of the graticule center line.
- k. Change the output to any frequency from 1 MHz to 2 MHz.
- l. Check that the positive peaks of the waveform stay within +3.6/-3.2 major divisions of the graticule center line.
- m. Set the FREQUENCY Hz dial to 10, MULTIPLIER to 10^3 , and \sim button in.

*n - use T_c or DUAL Trigg
500V INPUT
ADD MODE*

- n. Adjust vertical amplifier COMPARISON VOLTAGE until the positive peaks of the waveform are on the graticule center line.
- o. Change the output to any frequency from 20 Hz to 200 kHz.
- p. Check that the positive peaks of the waveform stay within +1.7/-1.6 major divisions of the graticule center line.
- q. Set the FREQUENCY Hz dial to 10, MULTIPLIER to 10^3 , and the VOLTS/DIV of the vertical amplifier to 1 volt.
- r. Adjust vertical amplifier COMPARISON VOLTAGE until the positive peaks of the waveform are on the graticule center line.
- s. Change the output to any frequency from 200 kHz to 2 MHz.
- t. Check that the positive peaks of the waveform stay within +3.8/-3.0 major divisions of the graticule center line.
- u. Set the FREQUENCY Hz dial to 10, MULTIPLIER to 10^3 , and \square button in.
- v. Set the VOLTS/DIV of the vertical amplifier to 2V and the (-) INPUT to GND.
- w. Adjust the AMPLITUDE control for a display of exactly 6.0 major divisions peak to peak.
- x. Change the output to any frequency from 20 Hz to 2 MHz.
- y. Check that the peak to peak voltage on the scope remains between 5.7 and 6.3 major divisions.
- z. Disconnect the oscilloscope for the next step.

On page 4-2: Delete item 20 (AC Calibrator) from Table 4-1.

*7A13 Diff. Comp. is
1 Good if ONE IS AVAILABLE*

2. Check Variable Symmetry Duty Cycle

- a. Press the FREE RUN, 0 dB and \square pushbuttons.
- b. Set the MULTIPLIER to 10^3 and the FREQUENCY dial to 10.
- c. Release the VAR SYMM pushbutton.
- d. Connect the OUTPUT connector through a 50Ω coaxial cable to the oscilloscope vertical input.
- e. Adjust the ~~AMPLITUDE~~ ^{FREQ} and oscilloscope controls to display a waveform that occupies exactly 10 major divisions for one cycle.
- f. Rotate the VAR SYMM control from fully cw to fully ccw.
- g. Readjust the oscilloscope controls as needed at each extreme to display one cycle for 10 major divisions.
- h. CHECK—that the oscilloscope varies each waveform half cycle from ≤ 0.5 major divisions to ≥ 9.5 major divisions.
- i. Leave these connections for the next step.

3. Check Output Amplitude

- a. Using the same setup as in the previous step, turn the AMPLITUDE control fully cw.
- b. CHECK—that the waveform on the oscilloscope display is ≥ 30 V peak to peak. *w/o a 50 Ω load !!*
- c. Remove the coaxial cable from the oscilloscope vertical input and connect a 50Ω termination in series with the cable.
- d. CHECK—that the oscilloscope display is ≥ 15 V peak to peak.
- e. Disconnect the 50Ω cable and remove the 50Ω termination from the oscilloscope for the next step.

4. Check Offset Range

- a. Press the TRIG-0 dB, and \sim pushbuttons.
- b. Make certain the VAR SYMM pushbutton is in.

- c. Connect a dmm set to read ± 15 V to the output connector.
- d. Adjust the VAR \emptyset control for a 0 V reading on the dmm.
- e. Pull and turn the OFFSET control fully cw to fully ccw.

f. CHECK—that the dmm reads $\geq \pm 13$ V at the appropriate stops for the OFFSET control. *NO 50 Ω load*

≥ 14 V

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

h. CHECK—that the dmm reads at least ± 6.5 V at the appropriate stops of the OFFSET control. *≥ 7 V*

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

5. Check Amplitude Flatness *See Change Rec*

- a. Press the FREE RUN, 0 dB and \sim pushbuttons. *PAGE*
- b. Make certain the OFFSET is off.
- c. Set the START dial to 10 and the MULTIPLIER to 10^3 .
- d. Set the AC Calibrator amplitude to 5.000 V rms. Set the AC Calibrator frequency to 10 kHz.
- e. Connect the AC Calibrator through a 50Ω bnc cable and 50Ω bnc termination to the DMM input and note the reading.
- f. Disconnect the AC Calibrator and connect the FG501A OUTPUT to the DMM input through the 50Ω cable and 50Ω bnc termination.
- g. Adjust the FG501A AMPLITUDE to match the reading noted in step e.
- h. Set the AC Calibrator frequency to 20 Hz. Set the START dial to 2 and the MULTIPLIER to 10.
- i. Disconnect the FG501A and reconnect the AC Calibrator to the DMM through the 50Ω cable and termination. Note the DMM reading.
- j. Disconnect the AC Calibrator and reconnect the FG501A OUTPUT to the DMM input through the 50Ω cable and termination.
- k. CHECK—that the reading is between .9886 and 1.0114 times the reading noted in step i.

- l. Set the AC Calibrator frequency to 20 kHz. Set the START dial to 20 and the MULTIPLIER to 10^3 . Repeat steps i through k.
- m. Set the AC Calibrator and the FG501A to any other frequency between 20 Hz and 20 kHz and repeat steps i through k.
- n. Set the FREQUENCY Hz dial to 10 and the MULTIPLIER to 10^3 .
- o. Connect the OUTPUT connector through a 50 Ω cable and 50 Ω termination to the vertical input of the differential oscilloscope plug-in.
- p. Adjust the AMPLITUDE control and the gain of the vertical amplifier for an 8 major division peak to peak display.
- q. Increase the vertical amplifier gain by a factor of 10.
- r. Adjust the vertical amplifier plug-in offset voltage so that the waveform peaks are on the oscilloscope graticule center line.
- s. Change the output to any frequency from 20 kHz to 1 MHz.
- t. CHECK—that the display is within 2.37 major divisions from graticule center.
- u. Decrease the vertical gain of the oscilloscope by a factor of 10 and adjust the offset voltage to 0.
- v. Adjust the output frequency to 10 kHz.
- w. Adjust the oscilloscope vertical gain and the AMPLITUDE control for a 6 major division peak to peak display.
- x. Change the output to any frequency from 1 MHz to 2 MHz.
- y. CHECK—that the peak to peak display amplitude is from 5.36 to 6.73 major divisions.
- z. Press the \square pushbutton.
- aa. Set the output frequency to 10 kHz.
- ab. Adjust the AMPLITUDE control and the vertical comparator oscilloscope plug-in for an 8 major division peak to peak display.
- ac. Increase the oscilloscope vertical plug-in gain by a factor of 10.
- ad. Adjust the vertical plug-in offset voltage so that the positive peaks of the squarewaves are at graticule center.
- ae. Change the output to any frequency from 20 Hz to 2 MHz.
- af. CHECK—that the positive squarewave peaks are within ± 2.37 major divisions from graticule center.
- ag. Press the \curvearrowright pushbutton.
- ah. Change the output frequency to 10 kHz.
- ai. Decrease the oscilloscope vertical plug-in gain by a factor of 10.
- aj. Adjust the vertical plug-in offset voltage to 0.
- ak. Adjust the AMPLITUDE control and the vertical plug-in gain for an 8 major division oscilloscope display of the triangle waveform.
- al. Increase the plug-in gain by a factor of 10.
- am. Adjust the offset voltage so that the positive peak of the triangle waveform is at graticule center.
- an. Change the output to any frequency from 20 Hz to 200 kHz.
- ao. CHECK—that the positive peak of the triangle waveform is 2.37 major divisions or less from the graticule center.
- ap. Decrease the vertical amplifier gain by a factor of 10.
- aq. Remove the comparison voltage from the vertical plug-in.
- ar. Adjust the AMPLITUDE control and the vertical plug-in gain for a peak to peak triangle waveform display of 6 major divisions.
- as. Change the output to any frequency from 200 kHz to 2 MHz.
- at. CHECK—that the peak to peak display reads from 4.4 major divisions to 7.6 major divisions in amplitude.
- au. Disconnect the oscilloscope for the next step.

6. Check Sinewave Distortion

- a. Press the FREE RUN, 0 dB, and \curvearrowright pushbuttons. The VAR SYMM, and OFFSET controls must be off (in).
- b. Connect the OUTPUT connector through a 50 Ω coaxial cable and 50 Ω termination to the distortion analyzer.
- c. Set the distortion analyzer to measure total harmonic distortion plus noise with average response.

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

e. Select any frequency from 20 Hz to 20 kHz with the FREQUENCY Hz and MULTIPLIER controls. The FREQUENCY Hz control must be on the calibrated portion of the dial and the MULTIPLIER control must be on the 10³ range or below.

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

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

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

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

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

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

l. Set the FREQUENCY Hz dial at 10 and the MULTIPLIER at 10⁴.

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

n. Rotate the FREQUENCY Hz dial to 20, change the MULTIPLIER to 10⁵, and rotate the FREQUENCY Hz dial from 20 to 2.

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

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

7. Check Squarewave and Pulse Output

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

b. Set the FREQUENCY Hz dial and the MULTIPLIER control for any calibrated frequency. (For ease, the FREQUENCY Hz dial at 20 and the MULTIPLIER at 10⁵ are recommended.)

c. Turn the AMPLITUDE control fully cw.

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

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

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

g. CHECK—that the rise time and fall time is ≤ 25 ns from the 10% to the 90% amplitude points.

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

i. Release the VAR SYMM pushbutton.

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

k. Repeat steps f and g.

l. Remove all connections for the next step.

8. Check VCF Input

a. Press the FREE RUN, 0 dB and \curvearrowright pushbuttons. The VAR SYMM and OFFSET pushbuttons should be in. Set the FREQUENCY Hz dial to 20 and the MULTIPLIER to 10⁵.

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

c. Obtain a stable counter display.

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

not tested

Time = 25 ns

**Calibration—FG 501A
Performance Check**

e. CHECK—that the frequency decreases by a factor of ≥ 1000 .

f. Remove all connections for the next step.

9. Check External Trigger/Gate Input

a. Press the TRIG, 0 dB, and \surd pushbuttons.

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

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

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

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

f. Press the GATE pushbutton.

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

h. Remove all connections for the next step.

10. Check Trigger Output

a. Press the FREE RUN pushbutton.

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

c. CHECK—for a $\geq +4$ V waveform on the oscilloscope display. (The voltage varies from about +0.7 V to over +4.0 V, TTL logic levels).

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

e. CHECK—for a $\geq +2$ V waveform on the oscilloscope display.

f. Remove all connections for the next step.

11. Check Variable Phase Range

a. Press the FREE RUN, 0 dB, and \surd pushbuttons.

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

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

d. Press the TRIG pushbutton.

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

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

g. Remove all connections for the next step.

340A 12. Check Attenuator Accuracy

a. Press the FREE RUN, 0 dB and \surd pushbuttons.

b. Set the FREQUENCY Hz dial to 20.

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

d. Set the AMPLITUDE control fully cw.

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

f. Set the AA 501 for automatic level ranging.

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

h. Push the -20 dB pushbutton.

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

j. Push the -40 dB pushbutton.

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

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

l. Push the -60 dB pushbutton.

k. Remove all connections for the next step.

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

13. Check Triangle Time Symmetry

n. Remove all connections for the next step.

a. Press the FREE RUN pushbutton.

12A. Alternate Procedure for Checking Attenuator Accuracy

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

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

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

b. Set the FREQUENCY Hz dial to 20.

d. Record this reading.

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

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

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

f. Record this reading. *11.9 us*

e. Push the -20 dB pushbutton.

g. CHECK—that the time difference of both readings is $\leq 1\%$.

f. CHECK—for a waveform amplitude from 2.67 V to 3.37 V.

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

g. Press the -40 dB pushbutton.

i. Repeat steps c through f.

h. CHECK—for a waveform amplitude from 0.267 V to 0.337 V.

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

i. Press the -60 dB pushbutton.

k. Remove all connections.

*Set for 5 volts 3 DIV @ 0 DB
" 5 " " @ -20 DB
" 0.5V " " -40 DB
" 0.05V " " -60 DB*

*0.05 us
0.48 us
47*