

CALIBRATION

Introduction

To ensure instrument accuracy, check the calibration of the 485 after every 1000 hours of operation, or every six months if used infrequently. Before complete calibration, thoroughly clean and inspect the instrument as outlined in the Maintenance Section.

TEKTRONIX Field Service

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

Using This Procedure

Part 1 — Performance Check. Performance of this instrument can be checked without removing the covers or making internal adjustments. This procedure checks the instrument against the SPECIFICATION tolerances (Section 1). Screwdriver adjustments accessible from the outside of the instrument are adjusted in this procedure.

Part 2 — Calibration Procedure. Completion of each step in this procedure ensures that this instrument is correctly adjusted and performing within all listed tolerances.

Partial Calibration. A partial check or adjustment is often desirable after replacing components, or to touch up the adjustment of a portion of the instrument between complete recalibrations. To check or adjust only part of the instrument, set the controls according to Preliminary Control Settings, then start with the major section containing the part to be adjusted (horizontal, vertical, or triggers). To avoid unnecessary recalibration of other parts of the instrument, readjust only if the tolerance given in the CHECK — part of the step is not met. If readjusted, also check the calibration of any other steps listed in the INTERACTION part of this step.

TEST EQUIPMENT REQUIRED

The following test equipment and accessories, or its equivalent, is required for complete calibration of the 485. The equipment specifications given are the minimum necessary for accurate calibration and may be less than those of the listed test equipment. The test equipment must be operating within the listed specifications and correctly calibrated.

Not all of the listed test equipment is required for the Performance Check; those items not required for the Performance Check are indicated by footnote 1.

If equipment substitutes are made, the calibration setup may have to be altered to fit the requirements of that equipment. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the test equipment instruction manual if further instruction is needed.

Special Calibration Fixtures

Special TEKTRONIX calibration fixtures are used in this procedure only where they aid instrument calibration. These special calibration fixtures are available from Tektronix, Inc. Order by part number through your local TEKTRONIX Field Office or representative.

Calibration Equipment Alternatives

All of the test equipment listed is required to completely check and adjust this instrument. Complete checking or adjustment, however, may not always be necessary or desirable. The user may only check selected characteristics, thereby reducing the amount of test equipment actually required. For example, the basic measurement capabilities of this instrument can be verified by checking vertical deflection accuracy using the two Standard Amplitude Calibrators; bandwidth and triggering using the two Constant-Amplitude Signal Generators; and horizontal timing accuracy using the Time-Mark Generator.

TABLE 5-1
TEST EQUIPMENT

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
Precision Multimeter (DVM) ¹	Range 0 to 180 V; accuracy within 0.01%.	Adjust: CAL 5 V. +59.4 and 50 V supplies; Vert Comp Plates; Grid Bias; Auto Focus; Main Vert Gain; 50 Ω Input Impedance. Check: Vert Linearity.	Data Precision Digital Multimeter Model 2400.
DC Voltmeter (VOM) ¹	0 to 4000 V; accuracy within 2%.	High Voltage measurement.	Triplet Model 630-NA or a precision divider with the DVM.
Time-Mark Generator	Marker output 2 ns to 0.5 s within 0.1% accuracy; trigger output 50 ns.	Adjust: Geometry; Horiz Gain; Cal 5 V freq; Y Axis; A timing; B timing; Differential timing; Delay Jitter.	TEKTRONIX Type 184 Time-Mark Generator. TEKTRONIX 2901 Time-Mark Generator.
Medium-Frequency Constant-Amplitude Signal Generator	2 MHz to 50 MHz; reference frequency, 50 kHz; output amplitude, 50 mV to 2 V P-P into 50 Ω ; output accuracy, within 2%.	Adjust: A and B trigger; X-Y phasing. Check: Ext Z Axis blanking; CMR; Ext Trigger; Single Sweep; X-Y Bandwidth; Bandwidth limit.	TEKTRONIX Type 191 Constant Amplitude Signal Generator.
High-Frequency Constant-Amplitude Signal Generator	Frequency, 100 to 350 MHz; output amplitude, 0.5 to 5 V; reference frequency, 3 MHz; accuracy within 1%.	Vertical bandwidth check.	TEKTRONIX 067-0532-01 Calibration Fixture.
Test Oscilloscope	Bandwidth, DC to 100 MHz; deflection factor, 5 mV/div; accurate within 2%.	Adjust: Z Axis Compensation and risetime; Auto Focus; CH 1 Trigger Gain.	TEKTRONIX 465 with P6065 X10 probe.
Amplitude Calibrator and Comparator	Amplitude, 20 mV to 100 V; accurate to 0.25%.	Adjust: 1 M Ω amplifier gain. Check: 1 M Ω deflection factor. Ext Trig Level range.	TEKTRONIX 067-0502-01 Calibration Fixture.
50 Ω Amplitude Calibrator	12 mV to 2 V range.	Adjust: CH 1 and CH 2 Gain; Invert Gain; Added Mode Gain; X-Y Gain. Check: 50 Ω and 1 M Ω Gain match.	TEKTRONIX 067-0508-00 Calibration Fixture.
Tunnel Diode Pulser	Driven by the Type 106 Square-Wave Generator.	Adjust: 50 Ω and 1 M Ω transient response. Check: Ext Trig Delay Match; A Ext Trig response.	TEKTRONIX 067-0681-01 Calibration Fixture.

¹ Not required for Performance Check.

TABLE 5-1
TEST EQUIPMENT (cont)

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
Square-Wave Generator	Frequency Range, 100 Hz to 100 kHz; Amplitude variable 0.5 to 12 V.	Adjust: 50 Ω high frequency transient response; 50 Ω low frequency transient response; 1 M Ω 10 kHz transient response; 1 M Ω input attenuator compensations; Ext Trig indent delay match; A Ext Trig response.	TEKTRONIX Type 106 Square-Wave Generator.
2X Attenuator ¹ (2 required)	Impedance, 50 Ω ; accuracy, 2%; BNC connectors.	Used throughout the procedure for signal attenuation.	TEKTRONIX Part No. 011-0069-02.
5X Attenuator ¹	Impedance, 50 Ω ; accuracy, 2%; BNC connectors.	Used throughout the procedure for signal attenuation.	TEKTRONIX Part No. 011-0060-02.
10X Attenuator	Impedance, 50 Ω ; accuracy, 2%; BNC connector.	Used throughout the procedure for signal attenuation.	TEKTRONIX Part No. 011-0059-02.
T Connector	Connector, BNC.	Ext Trig checks.	TEKTRONIX Part No. 103-0030-00.
Termination (2 required)	Impedance, 50 Ω ; accuracy, 2%; connectors, BNC.	CMR check.	TEKTRONIX Part No. 011-0049-01.
Cable (2 required)	Impedance, 50 Ω ; type RG-58/U; length, 42 inch; connectors, BNC.	Used throughout the procedure for signal interconnection.	TEKTRONIX Part No. 012-0057-01.
GR thru-line termination	Impedance, 50 Ω ; accuracy, 2%; connectors, GR874 to BNC male.	1 M Ω bandwidth check.	TEKTRONIX Part No. 017-0083-00.
Adapter	GR874 to BNC male.	50 Ω vertical bandwidth check.	TEKTRONIX Part No. 017-0064-00.
Screwdriver	Three-Inch shaft, 3/32 inch bit.	Used throughout the procedure to adjust variable resistors.	Xcelite R-3323.
Low Capacitance Screwdriver ¹	1 1/2 inch shaft.	Used throughout the procedure to adjust variable capacitors.	TEKTRONIX Part No. 003-0000-00.
Nylon Tuning Tool ¹	Fits 5/64 inch (ID) hex cores.	X-Y phasing.	Handle and insert TEKTRONIX Part No. 003-0307-00 and 003-0310-00.

TABLE 5-1
TEST EQUIPMENT (cont)

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
Input RC Normalizer ¹	1 MΩ x 20 pF; attenuation, 2X; connector, BNC.	1 MΩ input attenuator compensations.	TEKTRONIX Part No. 067-0538-00.
Cable	Impedance, 50 Ω; type RG-58/U; length, 18 inches; connectors, BNC.	Used throughout the procedure for signal interconnection.	TEKTRONIX Part No. 012-0076-00.
Dual Input Cable, BNC	Dual BNC.	Inserting identical signals into both channels.	TEKTRONIX Part No. 067-0525-00.

TABLE 5-2
TEST EQUIPMENT FOR OPTIONAL CHECK

Characteristic	Performance Requirement	Supplemental Information
VSWR AUTOTESTER with GRATICULE	100 to 350 MHz.	WILTRON COMPANY, Model 67.
561B/2B67/3A9 or 5103N/5B10N/5A22N or 7403N/7B50/7A22	2 μV sensitivity. 20 μV sensitivity. 20 μV sensitivity.	Differential Amplifier. Differential Amplifier. Differential Amplifier.

PART 1 – PERFORMANCE CHECK

Connect the 485 to a power source which meets the specified voltage and frequency requirements. Press the POWER pushbutton to turn the 485 on and allow a 20 minute instrument warmup before commencing the Performance checks. The Performance checks in Part 1 of this section may be performed anywhere within the -15°C to +55°C operating ambient temperature range unless otherwise specified.

1. CHECK EXT Z AXIS BLANKING

a. Apply 0.2 V P-P of 20 MHz from Type 191 Signal Generator to EXT Z AXIS blanking (rear panel) and A EXT TRIG; A SOURCE SW to EXT; HORIZ DISPLAY to A; TIME/DIV to 0.1 μs.

b. Adjust trigger LEVEL for TRIG'D LIGHT.

c. At normal intensity, check for intensity modulation.

d. Change generator to 2 V P-P of 2 MHz; set TIME/DIV to 0.5 μs.

e. Turn INTENSITY higher and check for intensity modulation.

2. CHECK OUTPUT WAVEFORMS (With Sweeps Running at 1 ms/div)

a. With test oscilloscope, check the following outputs (located on the rear panel).

b. A and B GATES, approximate amplitude 4 V (0.5 V into 50 Ω).

c. A SAWTOOTH, approximate amplitude to 10 V (0.5 V into 50 Ω).

3. ADJUST TRACE ROTATION

- a. Position trace to graticule center.
- b. Adjust TRACE ROTATION (rear panel) so trace parallels the center graticule line.

4. CHECK B SWEEP TIMING ACCURACY

- a. Check timing over center eight graticule divisions.
- b. Position one time mark to 1 and read error at 9.

NOTE

<i>+15°C to +35°C</i>	<i>-15°C to +55°C</i>
<i>1 ns to 20 ns; within 0.24 division (3%)</i>	<i>0.4 div (5%)</i>
<i>50 ns to 0.1 s; within 0.16 division (2%)</i>	<i>0.32 div (4%)</i>
<i>0.2 s and 0.5 s; within 0.24 division (3%)</i>	<i>0.4 div (5%)</i>

5. CHECK A SWEEP TIMING ACCURACY

NOTE

<i>+15°C to +35°C</i>	<i>-15°C to +55°C</i>
<i>1 ns to 20 ns; within 0.24 division (3%)</i>	<i>0.4 div (5%)</i>
<i>50 ns to 0.1 s; within 0.16 division (2%)</i>	<i>0.32 div (4%)</i>
<i>0.2 s to 0.5 s; within 0.24 division (3%)</i>	<i>0.4 div (5%)</i>

6. CHECK DELAY TIME ACCURACY, 10 ns/div to 0.5 s/div (+15°C to +35°C only)

- a. Use time marks that give 1 to 5 markers/div on the A display. Use B TIME/DIV of 1 ns for A TIME/DIV settings of 10 ns through 0.1 μ s. For A TIME/DIV setting of 0.2 μ s and slower, maintain an A:B ratio of 100:1.
- b. Set the DELAY TIME POSITION (DTP) dial exactly to the reference position (1.0 except as shown in table below). Use the horizontal POSITION control to move the marker on the B display to a reference position.
- c. Rotate the DTP to 9.0 and then slightly from 9.0 to place the B display marker to the same screen reference position. Read the error from (9.00) in minor dial divisions on the DTP dial.

TABLE 5-3

A Time/Div	Reference DTP Position	Maximum DTP Dial Error at Setting near 9.0 (minor divisions)
10 ns	4.0	7
20 ns	2.0	9
50 ns to 1 ms	1.0	5
2 ms to 0.5 s	1.0	9

7. CHECK B ENDS A OPERATION

a. HORIZ DISPLAY to INTEN; A TIME/DIV to 1 ms; B TIME/DIV to 0.1 ms; A TRIGGER HOLDOFF to B ENDS A; SWEEP MODE to AUTO.

b. Rotate DTP; check that sweep ends after the intensified zone.

8. CHECK CH 1 LIGHT EMITTING DIODES (LED'S)

a. Check that the probe lights the corresponding LED, e.g., X10 probe lights X10 LED.

b. Check that CH 2 LED'S are off with VERT MODE in CH 1.

c. Check that CH 1 LED'S are on in CH 1, ALT, CHOP, ADD, and X-Y.

d. If probes are not available: an 11 k Ω resistor to ground from the code ring (around each input BNC) lights the X10 LED. A 6.8 k Ω resistor lights the X100 LED and a short circuit causes trace ident.

9. CHECK CH 2 LED'S

a. Check that the probe lights the corresponding LED.

b. Check that CH 1 LED'S are off with VERT MODE in CH 2.

c. Check that CH 2 LED'S are on in CH 2, ALT, CHOP, ADD, and X-Y.

10. CHECK TRACE IDENT FUNCTION CH 1 and CH 2

a. Check TRACE IDENT function on the probe, shifts the trace approximately 0.2 div up.

- b. Check that the LED for that channel turns off.

11. CHECK INPUT LIGHTS CH 1 and CH 2

- a. Check that 50 Ω is lit when 50 Ω /1 M Ω pushbutton is out.
- b. Check that 1 M Ω is lit when 50 Ω /1 M Ω pushbutton is in.

12. CHECK BEAM FINDER

- a. Check that trace remains within the graticule area with BEAM FINDER depressed.
- b. Check beam finder operation under all combinations of HORIZONTAL, CH 1 and CH 2 POSITION controls.

13. CHECK 50 Ω DEFLECTION FACTOR ACCURACY, $\pm 2\%$, CH 1 and CH 2

- a. Use the 50 Ω Amplitude Calibrator square wave as the signal source. Use 6 division display except at 0.5 V/div and above, where 2 V signal must be used.
- b. Adjust GAIN for zero error in 20 mV/div position.
- c. Check for $\pm 2\%$ deflection factor accuracy of all VOLTS/DIV positions.

14. CHECK 1 M Ω DEFLECTION FACTOR ACCURACY, $\pm 2\%$, CH 1 and CH 2

- a. Use the Standard Amplitude Calibrator square wave as the signal source. Use 4 or 5 division display.
- b. Adjust GAIN for zero error in 20 mV/div position.
- c. Check for $\pm 2\%$ deflection factor accuracy of all VOLTS/DIV positions.

15. CHECK COMMON MODE REJECTION, 50 Ω and 1 M Ω

- a. Connect the Type 191 Signal Generator to CH 1 and CH 2 thru the 10X attenuator and dual BNC input cable (TEKTRONIX Part No. 067-0525-00).

- b. CH 1 and CH 2 inputs 50 Ω , DC; VOLTS/DIV to 20 mV; VERT MODE to CH 1. Apply 8 divisions of 50 kHz signal.

- c. Set VERT MODE to ADD; CH 2 INVERTED. Push to release CH 2 VARIABLE GAIN and adjust for minimum deflection.

- d. Set Type 191 Signal Generator to 50 MHz and check for 0.8 div or less of vertical deflection.

- e. Change generator to 50 kHz, and inputs to 1 M Ω . Add 50 Ω BNC terminations at inputs.

- f. Readjust CH 2 VARIABLE GAIN for minimum deflection.

- g. Change generator to 50 MHz and check for 0.8 div or less of vertical deflection.

- h. Push CH 2 VARIABLE GAIN to CAL.

16. CHECK BANDWIDTH 50 Ω and 1 M Ω , CH 1 and CH 2

- a. Use 6 div of 3 MHz from the High-Frequency Constant-Amplitude Sine-Wave Generator (TEKTRONIX Part No. 067-0532-01) as reference.
- b. Check for a minimum of 4.2 divisions of signal at 350 MHz in the 50 Ω input mode. (4.2 divisions at 300 MHz $+35^{\circ}\text{C}$ to $+55^{\circ}\text{C}$.)
- c. Select the 1 M Ω impedance; terminate the Sine-Wave Generator into the GR 50 Ω thru-line termination.
- d. Use 6 div of 3 MHz from the Sine-Wave Generator as reference.
- e. Check for a minimum of 4.2 divisions of signal at 250 MHz. (4.2 divisions at 200 MHz $+35^{\circ}\text{C}$ to $+55^{\circ}\text{C}$.)

17. CHECK TRIGGER SENSITIVITY A and B

- a. Check in AC, LF REJ, and DC with source switch in INT, that triggering occurs on 0.3 div of 3 MHz, 0.3 div of 50 MHz and 1.5 div of 350 MHz.

b. Set SOURCE switch to EXT; signal applied to vertical input and EXT TRIG.

c. Check that the instrument triggers on 20 mV of 50 MHz and 100 mV of 350 MHz signal.

18. CHECK SINGLE SWEEP

a. Trigger on 0.5 div of 50 MHz.

b. Remove signal and go to SINGLE SWEEP.

c. READY lamp should light.

d. Apply signal; one sweep should occur and READY lamp should go off.

e. Remove signal and reset. The READY lamp should light.

19. CHECK X-Y PHASING

a. Connect CH 1 and CH 2 to Type 191 Signal Generator by the dual BNC input cable connector. Set CH 1 to 50 mV and CH 2 VOLTS/DIV to 20 mV/div, VERT MODE to X-Y, and ground CH 1 input.

b. Apply 10 div of 50 kHz.

c. Set CH 1 input to DC.

d. Switch Type 191 Signal Generator to 4 MHz.

e. Check for less than 0.52 div of vertical opening at center of lissajous figure (3%).

20. CHECK X-Y BANDWIDTH

a. GND CH 1, then apply 6 div of 50 kHz to CH 2.

b. Check for at least 4.2 div at 4 MHz.

21. CHECK CALIBRATOR AMPLITUDE

a. Set CH 1 VOLTS/DIV to 1 V; CH 1 input to 1 M Ω ; apply 5 V of Amplitude Calibrator and Comparator signal to CH 1; adjust CH 1 VARIABLE volts/div for 5 divisions of deflection. Use separate 1 M Ω test oscilloscope for 485-2.

b. Connect CAL 5 V to CH 1 input.

c. Check for 5 divisions of signal ± 0.025 div (0.5%). (Outside +15°C to +35°C range check for 0.05 div 1%.)

d. Set input impedance to 50 Ω ; apply 0.6 V from 50 Ω Amplitude Calibrator. Set VOLTS/DIV to 0.1 V; adjust VARIABLE for 6 divisions of deflection: Connect CAL 5 V to CH 1 input.

e. Check for 5 divisions of signal, ± 0.05 div (1.0%). (Outside +15°C to +35°C range check for 0.25 div 1.5%.)

22. CHECK CALIBRATOR FREQUENCY (+15°C to +35°C, 0.25%; -15°C to +55°C, 0.5%)

a. Set TIME/DIV to 0.2 ms/div; INT TRIG to CH 1; VERT MODE to ALT.

b. Apply 1 ms markers from the Time-Mark Generator to CH 1 50 Ω input; connect CAL FREQ 1 kHz to CH 2 50 Ω input.

c. Set VOLTS/DIV to obtain about 2 div of signal, for CH 1 and CH 2.

d. Trigger display (markers).

e. Check for less than 2.5 cycles (10 div) of drift in one second. (Outside +15°C to +35°C range check for same drift in one-half second.)

f. Set TIME/DIV to 1 ms/div; INT TRIG to NORM; CAL FREQ to 1 MHz; change markers to 1 μ s.

g. Trigger at top of waveform from the CW end of trigger LEVEL. Use A TRIGGER HOLDOFF to obtain display showing the beat frequency.

h. Check for beat period greater than 400 μ s. (Outside +15°C to +35°C range check for beat period greater than 200 μ s.)

23. CHECK CALIBRATOR 1 kHz DUTY CYCLE (49.8 to 50.2%)

a. Connect 1 kHz of CAL 5 V to CH 1 input. CH 1 impedance to 50 Ω ; CH 1 VOLTS/DIV to 0.1 V; INT TRIG to NORM; A TIME/DIV to 0.1 ms; B TIME/DIV to 1 μ s;

HORIZ DISPLAY to INTEN; B TRIGGER SOURCE to B RUNS AFTER DELAY TIME.

b. Trigger A on + SLOPE. Use DELAY TIME POSITION control to position the intensified portion of the negative step near center screen.

c. Switch HORIZ DISPLAY to B and position the negative step to center screen.

d. Switch A SLOPE polarity and check that the transition changes less than 3 divisions horizontally.

24. CHECK DELAY JITTER

a. Set A TIME/DIV to 1 ms; B trigger source to B RUNS AFTER DELAY TIME. Set B TIME/DIV to 1 μ s and Time-Mark generator to 1 ms. Set HORIZ DISPLAY to ALT; use A trigger LEVEL to obtain a stable display.

b. Set HORIZ DISPLAY to B. Rotate DELAY TIME POSITION dial from 1 to 9, checking for 0.5 div of jitter or less on B display.

25. CHECK INPUT PROTECTION TRIP LEVELS for CH 1 and CH 2

a. Set Type 106 High Amplitude control to minimum; Frequency to 1 kHz and Symmetry for 50% duty cycle. Set CH 1 and CH 2 inputs to DC; VOLTS/DIV to 2 V; position trace to top graticule line; input impedance to 50 Ω .

b. Connect Type 106 High Amplitude to CH 1 input; slowly increase Type 106 amplitude.

c. Check that the input disconnects (trace returns to top graticule line) and reset lamp lights after the trace crosses the 2.8 graticule division point and before it reaches the 4.25 division point. Return Type 106 amplitude to minimum and repeat for CH 2.

PART 2 — 485 CALIBRATION PROCEDURE

Remove the wrap-around cover as described in the Maintenance Section.

Connect the 485 to a power source which meets specified voltage and frequency requirements. Press the POWER pushbutton to turn the 485 on and allow it to warmup for at least 20 minutes before commencing Part 2 Calibration procedure. This instrument should be adjusted at an ambient temperature of +25°C ($\pm 5^\circ$ C) for best overall accuracy.

Preliminary Control Settings

CONTROL	
INTENSITY	CCW
B INTENSITY	CCW

SCALE ILLUM	CCW
BW LIMIT	OFF
CH 1 and CH 2	
VOLTS/DIV	0.1 V
VARIABLE	CAL
INPUT	GND
POSITION	MIDR
1 M Ω /50 Ω	50 Ω
VERT MODE	CH 1
INT TRIG	NORM
CH 2 POLARITY	+ UP
SWEEP MODE	NORM TRIG
A and B TRIGGER	
COUPLING	AC
LEVEL	MIDR
SLOPE	+
A TRIGGER SOURCE	INT
B TRIGGER SOURCE	B RUNS AFTER DELAY TIME
POSITION (HORIZ)	MIDR
HORIZ DISPLAY	A
TRACE SEPARATION	MIDR
CAL 5 V FREQ	1 MHz
TIME/DIV	1 ms
DELAY TIME POSITION	4.00

1. CHECK +59.4 V SUPPLY (± 0.06 V)

a. Using DVM measure at +59.4 V test point on Power Supply board.

b. If necessary adjust +59.4 (R1940).

c. INTERACTION will affect the operation of most circuits in the 485.

2. CHECK +50 V SUPPLY (± 0.05 V)

a. Measure at +50 V test point on Power Supply board.

b. If necessary adjust +50 V (R2048).

c. INTERACTION will affect the operation of most circuits in the 485.

3. CHECK LOW VOLTAGE SUPPLIES (Use Ground Reference Test Point on Power Supply Board)

5 V ± 0.1 V	-9 V ± 0.15 V
+15 V ± 0.25 V	+9 V ± 0.15 V
-5 V ± 0.1 V	+25 V ± 0.6 V
-15 V ± 0.3 V	+120 V ± 2.4 V
-5.5 V ± 0.25 V	+180 V ± 3.6 V
+5.5 V ± 0.25 V	

4. CHECK CALIBRATOR AMPLITUDE

- a. Remove Q2114 located on Sweep board near Calibrator output.
- b. Using DVM measure voltage at CAL 5 V output on front panel. Record the voltage.
- c. Remove Q2124.
- d. Check that CAL 5 V output is 5 V more positive (± 5 mV) than the voltage recorded in step b.
- e. If necessary adjust CAL 5 V (R2130).
- f. Replace Q2114 and Q2124.

5. ADJUST CALIBRATOR FREQUENCY

- a. Set TIME/DIV to 0.2 ms; INT TRIG to CH 1; VERT MODE to ADD.
- b. Apply 1 ms markers from the Time-Mark Generator to CH 1 50 Ω input; connect CAL 5 V, FREQ 1 kHz to CH 2.
- c. Set VOLTS/DIV to obtain about 2 div of signal.
- d. Trigger display (markers).
- e. Adjust 1 kHz (R2105) for less than 0.5 cycles (2.5 div) of square wave (calibrator) drift in 1 second. (0.5 Hz/1 kHz = 0.0005 or 0.05%).
- f. Set TIME/DIV to 2 ms; INT TRIG to NORM; coupling to DC; CAL 5 V frequency to 1 MHz; Time-Mark Generator to 1 μ s; VERT MODE to ADD.
- g. Trigger at top of waveform from the CW end of trigger LEVEL. Use A TRIGGER HOLDOFF to obtain display showing the beat frequency.
- h. Adjust 1 MHz (R2100) for beat period greater than 2 ms. (0.5 kHz/1 MHz = 0.0005 or 0.05%).

6. CHECK CALIBRATOR 1 kHz DUTY CYCLE (49.8 to 50.2%)

- a. Connect 1 kHz of CAL 5 V to CH 1 input; CH 1 impedance to 50 Ω ; CH 1 VOLTS/DIV to 0.1 V; INT TRIG to NORM; A TIME/DIV to 0.1 ms; B TIME/DIV to 1 μ s; HORIZ DISPLAY to INTEN; B TRIGGER SOURCE to B RUNS AFTER DELAY TIME.
- b. Trigger A on + SLOPE; use DELAY TIME POSITION control to position the intensified portion of the negative step near center screen.
- c. Switch HORIZ DISPLAY to B and position the negative step to center screen.
- d. Switch A SLOPE polarity and check that the transition changes less than 3 divisions horizontally.

7. CHECK CATHODE REGULATOR +95 V (± 8 V)

- a. Set INTENSITY controls CCW.
- b. Measure at CATH REG test point on rear of Horizontal Amp board.
- c. If necessary adjust R1625 located next to CATH REG test point.

8. CHECK -3000 V for ± 50 V; or ± 500 V With VOM Accurate to 2% (this voltage is marked -2950 in some instruments)

- a. Make this measurement using the precision divider in conjunction with the precision DC voltmeter, or use high voltage scale of 2% VOM.
- b. Measure through hole in plastic cover at rear of Horizontal Amp board.
- c. This voltage should be within the -2950 to -3050 V range because of correct adjustments performed in steps 1, 2, and 7.

9. CHECK COMPENSATION PLATE VOLTAGE**NOTE**

Adjustments and test points are accessible from the top of the instrument.

- a. Set SWEEP MODE to AUTO TRIG.
- b. With vertical POSITION control center the trace.
- c. With DVM measure the two vertical deflection plate voltages at the CRT neck pins fed from the output of U660. (May need 1 k Ω resistor in series with the test leads to prevent vertical oscillations.)
- d. Calculate the average of two voltages.
- e. Connect DVM to COMP PL test point located next to the COMP PL potentiometer at rear of Horizontal Amp board.
- f. Check for the calculated voltage, ± 0.3 V.
- g. If necessary adjust COMP PL (R1796).

10. ADJUST GRID BIAS

- a. With low intensity level, set VERT MODE to X-Y.
- b. Adjust FOCUS and ASTIG (rear panel) for optimum spot size.
- c. Set INTENSITY and B INTENSITY CCW.
- d. Connect DVM to Z OUT DC test point (at rear of Power Supply board) and note the DC voltage (normally in the +7 to +11 V range).
- e. With the INTENSITY control, increase the DVM reading by 4 V.
- f. Adjust GRID (R1660), located at rear of Horizontal Amp board, so that the CRT spot is at the threshold of visibility in low ambient light.

11. CHECK Z AXIS COMPENSATION and RISE-TIME

NOTE

Adjustments and test points are located at the rear of the Power Supply board.

- a. Set TIME/DIV to 0.1 μ s; HORIZ DISPLAY to A, and VERT MODE to CH 1 (make sure SWEEP MODE is in AUTO TRIGGER).
- b. Set test oscilloscope to 0.05 μ s/div and 0.1 volt/div.
- c. Connect 10X probe (1 V/div at probe tip) to Z OUT HF test point.
- d. Adjust INTENSITY for 4 div of signal.
- e. Check aberrations for 2% or less.
- f. If necessary adjust Z COMP (C1762, C1765, and R1865).
- g. Check Z AXIS RISE TIME for 15 ns or less.

12. CHECK EXT Z AXIS BLANKING

- a. Apply 0.2 V P-P of 20 MHz from Type 191 Signal Generator to EXT Z AXIS blanking (rear panel) and A EXT TRIG.
- b. Adjust trigger LEVEL for TRIG'D LIGHT.
- c. At normal intensity check for intensity modulation.
- d. Change Type 191 to 2 V P-P and 2 MHz to EXT Z AXIS blanking and A EXT TRIG; set TIME/DIV to 0.5 μ s.
- e. Turn INTENSITY up and check for intensity modulation.

13. CHECK AUTO FOCUS

NOTE

Adjustments and test points are located at the rear of the Power Supply board.

- a. Apply 2 div amplitude of 3 MHz to CH 1 input.
- b. Trigger CH 1, set TIME/DIV to 0.2 μ s/div, HORIZ DISPLAY to A.
- c. With low intensity adjust the FOCUS and ASTIG (rear panel) for the best defined 3 MHz trace.

d. Set A TRIGGER HOLDOFF to max; test oscilloscope to 1 V/div (10 V/div at probe tip) and connect 10X test probe to Z OUT DC test point.

e. Set INTENSITY for 50 V step.

f. Connect the DVM to the AUTO FOC test point. Measure and record the DC voltage.

g. Observe the 485 display and adjust FOC GAIN (R1710) for optimum focus. If the original setting cannot be improved, reset FOC GAIN to the voltage recorded in step f and continue to step 13.

h. If focus was improved by adjusting FOC GAIN, preset MAX Z (R1560) CW and MAX FOC (R1700) CW.

i. Set A TRIGGER HOLDOFF to NORM.

j. Set FOCUS and ASTIG for optimum focus at low display intensity.

k. Set A TRIGGER HOLDOFF to max and adjust INTENSITY for a 70 V step at Z OUT DC test point.

l. Adjust FOC GAIN for best focus.

m. Record the new DC voltage at the AUTO FOC test point.

n. Turn INTENSITY to max and adjust MAX Z (R1560) for a 72 V step on the test oscilloscope.

o. Set MAX FOC for the voltage recorded in step 12m.

p. Set A TRIGGER HOLDOFF to NORM.

14. CHECK OUTPUT WAVEFORMS (With Sweeps Running at 1 ms/div)

a. With test oscilloscope check the following outputs (located on the rear panel).

b. A and B GATES, approximate amplitude 4 V; 0.5 V into 50 Ω .

c. A SAWTOOTH, approximate amplitude 10 V; 0.5 V into 50 Ω .

15. ADJUST TRACE ROTATION

a. Position trace to graticule center.

b. Adjust TRACE ROTATION (rear panel) so trace parallels center graticule line.

16. ADJUST Y AXIS ALIGNMENT

a. Apply 1 ms and 0.1 ms markers of full screen amplitude to CH 1.

b. Set TIME/DIV to 1 ms.

c. Adjust A VARIABLE TIME/DIV for two markers per div.

d. Adjust Y AXIS (R1794), located towards rear of B Trigger board, for vertical alignment at the graticule center.

17. ADJUST GEOMETRY

Adjust GEOM, (R1792), located towards rear of B Trigger board, for least bowing of the vertical lines at the graticule edges.

18. ADJUST HORIZONTAL GAIN

a. Set HORIZ DISPLAY to B; TIME/DIV to 0.1 ms/div, A VARIABLE TIME/DIV to CAL.

b. Apply 0.1 ms markers.

c. Use POSITION (HORIZ) control to keep markers aligned with graticule lines.

d. Adjust H GAIN (R1366), upper rear of Sweep board, for one marker/div and for exact alignment of markers at 1 and 9 (center 8 divisions).

19. ADJUST A SWEEP CAL

a. Set HORIZ DISPLAY to A.

b. Use POSITION (HORIZ) control to keep markers aligned with graticule lines.

c. Adjust A CAL (R1308), located near center rear of Sweep board, for one marker/div and for exact alignment of markers at 1 and 9 (center 8 divisions).

20. CHECK A VARIABLE TIME/DIV

a. Set Time-Mark Generator to 1 ms markers; TIME ON to 0.1 ms.

b. Push and release VARIABLE TIME/DIV to CCW end.

c. Check for 4 divisions or less between markers.

d. Push VARIABLE TIME/DIV into CAL.

21. ADJUST B REGISTER

a. Set HORIZ DISPLAY to ALT; B TRIGGERING SOURCE to INT; DELAY TIME POSITION (DTP) to 0.

b. Trigger A and B sweeps on the 0.1 ms markers.

c. Adjust B REGIS (R1325), located next to the B REGIS test point on Sweep board, for coincidence of the markers at the beginning of the A and B sweeps.

22. CHECK HORIZONTAL CENTERING

a. Set HORIZ DISPLAY to A.

b. While rotating POSITION (HORIZ) control to extremes, observe both ends of the sweep cross the graticule center line.

c. If necessary adjust HORIZ CENT (R1150), located on the center of the B Trigger board.

23. CHECK A SWEEP LENGTH

Greater than 10 but less than 11.5 divisions.

24. ADJUST DELAY START and DELAY STOP (Located on Sweep Board)

a. Set A TIME/DIV to 0.1 ms; B TIME/DIV to 1 μ s; HORIZ DISPLAY to ALT; DELAY TIME POSITION (DTP) dial to exactly 1.0; B SOURCE to RUNS AFTER DELAY TIME; Trigger A on the + SLOPE of the 0.1 ms time mark.

b. Adjust DELAY START (R918) to get intensified portion on the second time mark and the pulse on B trace to just start positive at the front of B trace.

c. Set the DTP dial to exactly 9.0.

d. Adjust DELAY STOP (R925) for the intensified portion on the tenth time mark and the pulse on B trace to just start positive at the front of B trace.

e. Repeat steps b through d for identical B displays at the two DTP dial settings.

25. CHECK 0.1 ms DELAY LINEARITY

a. Same setup as in step 24, except change time marks to 50 μ s.

b. Turn DTP dial fully CCW. The first marker should be displayed on B display.

c. Set DTP dial to exactly 0.95. A marker should be near the middle of B display. Adjust POSITION (HORIZ) to put B display at midscreen reference position.

d. Set DTP dial to exactly 8.95. The marker should be within 0.2 div of being at the same midscreen reference. If necessary make a slight readjustment of DELAY STOP to get the screen position for a DTP dial reading of 8.95 to agree with that for a DTP dial reading 0.95. Note that in this setup one minor DTP dial division corresponds to one screen division, and these procedures require careful settings for repeat reading.

e. Set the DTP dial to settings of exactly 0.45, 0.95, 1.45, 1.95, 2.45, through to 9.45. At each setting observe the marker position on the B display, noting the maximum + and - excursions from the center screen reference position. The total excursion from most negative to most positive, should not exceed 1.4 screen divisions (1 div spec plus ± 0.2 div for operator setting of the dial).

26. ADJUST 0.1 μ s TIMING, A and B

a. Set A TIME/DIV to 0.1 μ s; B TIME/DIV to 10 ns; HORIZ DISPLAY to ALT; apply 0.1 μ s markers.

b. Set the DTP to 1.00 and align the marker to a reference point, then turn the DTP to 9.00 and adjust C882, (behind relay on A Sweep) for zero error at the reference point.

c. Set B TIME/DIV to $0.1 \mu\text{s}$, and set DTP to approximately 0.00 to align the beginning of the A and B sweeps.

d. Adjust C1248 (above the relay in B Sweep) so that B Sweep matches A Sweep timing on screen.

27. ADJUST $1 \mu\text{s}$ TIMING A and B, CHECK $1 \mu\text{s}$ DELAY LINEARITY

a. Set A and B TIME/DIV to $1 \mu\text{s}$ and $0.1 \mu\text{s}$; time marks to $1 \mu\text{s}$; HORIZ DISPLAY to ALT.

b. Trigger A on the + SLOPE of the time marks.

c. Set the DTP dial to exactly 0.95. With the POSITION (HORIZ), set the leading edge of the B display to a reference position while keeping the first 10 markers of A display on the screen. The intensified zone of A must start on the second time mark.

d. Set the DTP to exactly 8.95.

e. Adjust C877 (located in front of the relay on the lower half of the Sweep board) to move the B display to the reference position of step b. The intensified zone of A must start on the tenth time mark.

f. Repeat steps b through e for identical B display at the two DTP dial settings.

g. Check the delay linearity by setting dial to exactly 4.95. The marker on the B display must be within 0.15 div of the reference position.

h. Set B TIME/DIV to $1 \mu\text{s}$; HORIZ DISPLAY to B and the DTP dial to 0.00.

i. Adjust C1242 (located below the relay on the upper half of the Sweep board) for one time mark per division and for exactly 1 to 9 timing (center 8 divisions).

28. ADJUST A SWEEP LINEARITY (R863)

a. Set the 485 for a 20 ns/div AUTO TRIG Sweep with the A TRIGGER HOLDOFF at max (but not B ENDS A).

b. Connect the 485 A GATE (rear panel) to the Ext Trigger Input of the test oscilloscope using a 50Ω termination at the test oscilloscope. Also, set the test

oscilloscope to 20 ns/div and trigger it on the + SLOPE of the 485 A GATE.

c. Connect the test oscilloscope 10X probe ($10 \text{ M}\Omega$) to the IN test point located near the center of the Sweep board. Make the probe ground connection at one of the GND test points on the Sweep board. Set test oscilloscope Volts/Div for a probe tip deflection factor of 50 mV/div.

d. This display of the A sweep generator input, consists of a positive step having overshoot followed by a positive-going linear ramp.

e. Adjust R863, (located below and in front of the lower relay on the Sweep board) to extend the ramp at the right of the display as linearly as possible back towards the step at the left. Ringing should be minimized, except for one overshoot cycle at the step.

f. Switch the 485 to 10 ns; the step and ramp amplitudes will increase. Make further adjustment if necessary to optimize the "linear ramp" on the two sweep speeds (10 ns/div and 20 ns/div).

29. ADJUST 5 ns TIMING

a. Connect 5 ns time markers from H.F. Selector Output to CH 1 input; connect 50 ns time marks to EXT TRIG INPUT; A TRIG SOURCE to EXT; A TIME/DIV to 5 ns; then center trace (If using a 2901 Time Mark Generator, set Trigger Out for $0.1 \mu\text{s}$).

b. Adjust C1190, (located between Q1168 and Q1172 on B Trigger board) for one time mark per division and for exactly 1 to 9 timing (center 8 divisions).

30. ADJUST 2 ns LINEARITY and TIMING

a. Set A TIME/DIV to 2 ns; select 2 ns time marks from the Time-Mark Generator.

b. With the POSITION (HORIZ) control keep the peak of one time mark positioned to center screen. Adjust C1364, (located in front of H GAIN pot on Sweep board) for most symmetrical timing (best linearity) of the sweep over the center 8 graticule divisions.

c. Adjust R1226, (located above the relay on the lower half of the Sweep board) for one time mark per division and for exactly 1 to 9 timing (center 8 divisions).

d. INTERACTION with 5 ns timing, repeat steps 26 and 27 if necessary.

31. ADJUST 1 ns TIMING

- a. Set TIME/DIV to 1 ns.
- b. Adjust 1 ns (R1228), (located in back of the lower relay on the Sweep board) for exactly 1 to 9 timing (four 2 ns markers over the center 8 divisions).
- c. If exact timing cannot be achieved, a compromise adjustment may be done.

32. CHECK 1, 2, and 5 ns SWEEP LINEARITY

a. Less than 0.1 division of error with timing adjusted on (1 ns through 20 ns). With time marks exactly aligned at 1 and 9 the remaining marks must be no greater than 0.1 div away from their respective graticule lines. The incremental error must not exceed 0.1 div over any one division.

33. CHECK B SWEEP TIMING ACCURACY

- a. Check timing over center 8 graticule divisions; position one time mark to 1 and read error at 9.
- b. 1 ns to 20 ns;—within 0.16 div (2%).
- c. 50 ns to 0.1 s;—within 0.1 div (1.25%).
- d. 0.2 s to 0.5 s;—within 0.16 div (2%).

34. CHECK A SWEEP TIMING ACCURACY

- a. 1 ns to 20 ns;—within 0.16 div (2%).
- b. 50 ns to 0.1 s;—within 0.1 div (1.25%).
- c. 0.2 s to 0.5 s;—within 0.16 div (2%).

35. CHECK AUTO REPETITION RATE

- a. Set A TIME/DIV to 50 μ s; SWEEP MODE to AUTO TRIG.
- b. Check that sweep triggers on 50 ms markers and will not trigger on 0.1 s markers.

36. CHECK DELAY TIME ACCURACY, 10 ns/div to 0.5 s/div

- a. Use time marks that give 1 to 5 markers/div on the A display. Use B TIME/DIV for 1 ns for A TIME/DIV settings of 10 ns through 0.1 μ s. For A TIME/DIV setting of 0.2 μ s and slower maintain an A:B ratio of 100:1.
- b. Set the DTP dial exactly to the reference position (1.0 except at the fastest speeds). Use the POSITION (HORIZ) control to move the marker on the B display to a reference position.
- c. Rotate the DTP to 9.0 and then slightly from 9.0 to place the B display marker to the same screen reference position. Read the error (from 9.00) in the minor dial divisions on the DTP dial.

TABLE 5-4

A Time/Div	Reference DTP Position	Maximum DTP Dial Error at Setting near 9.0 (minor divisions)
10 ns	4.0	6
20 ns	2.0	7
50 ns to 1 ms	1.0	4
2 ms to 0.5 s	1.0	8

37. CHECK INCREMENTAL DELAY ACCURACY 10, 20, and 50 ns/div

NOTE

Check the error at each turn against the requirements given in the chart at the end of this step. Detailed procedure is given for the 10 ns/div.

- a. A and B TIME/DIV of 10 ns and 1 ns; HORIZ DISPLAY to B; A TRIGGER HOLDOFF to NORM; time marks of 10 ns.
- b. Set the DTP dial to exactly 4.0. Adjust the POSITION (HORIZ) for marker leading edge at midscreen. Turn the DTP dial CW one turn at a time and bring a marker to the exact midscreen position.
- c. Check that the dial errors at 5.0, 6.0, and 7.0 are within the allowable limits (at 10 ns/div the change in error over any one turn is not to exceed 2 minor dial divisions, and the total error at any turn is not to exceed 3 minor dial divisions).

d. Set the DTP dial to exactly 6.0. Adjust the POSITION (HORIZ) for marker leading edge at midscreen. Turn the DTP dial CW one turn at a time and bring a marker to the exact midscreen position. Check that the dial errors at 7.0, 8.0, and 9.0 are within the allowable limits.

e. Use the same procedure to check the 20 ns and 50 ns ranges.

TABLE 5-5

Time/ Div	Dial Setting		Max Error in Minor DTP Dial Div	
	Refer- ence	Read Errors At	Change Over Any 1 Turn	Total at Any Turn
10 ns	4.0	5, 6, and 7	2	3
1 ns	6.0	7, 8, and 9	2	3
20 ns	2.0	3, 4, 5, and 6	2	4
1 ns	5.0	6, 7, 8, and 9	2	4
50 ns	1.0	2, 3, 4, and 5	1	2
1 ns	5.0	6, 7, 8, and 9	1	2

38. CHECK DELAY JITTER

a. Set A TIME/DIV to 1 ms; B trigger SOURCE to B RUNS AFTER DELAY TIME; B TIME/DIV to 1 μ s; set Time-Mark Generator to 1 ms markers; set HORIZ DISPLAY to ALT; use A trigger LEVEL to obtain a stable display.

b. Set HORIZ DISPLAY to B; rotate DELAY TIME POSITION from 1 to 9; check for 0.5 div or less of jitter on B display.

39. CHECK B ENDS A OPERATION

a. HORIZ DISPLAY to INTEN; A TIME/DIV to 1 ms; B TIME/DIV to 0.1 ms; A TRIGGER HOLDOFF to B ENDS A.

b. Rotate DTP; check that sweep ends after the intensified zone.

40. CHECK CH 1 LIGHT EMITTING DIODES (LED'S)

a. Check that the probe lights the corresponding LED, e.g., X10 probe lights X10 LED.

b. Check that CH 2 LED'S are off with VERT MODE in CH 1.

c. Check that CH 1 LED'S are on in CH 1, ALT, CHOP, ADD, and X-Y.

d. If probes are not available: an 11 k Ω resistor to ground from the code ring (around each input BNC)light the X10 LED, a 6.8 k Ω resistor lights X100 LED, and a short circuit causes trace ident.

41. CHECK CH 2 LED'S

a. Check that the probe lights the corresponding LED.

b. Check that CH 1 LED's are off with VERT MODE in CH 2.

c. Check CH 2 LED's are on in CH 2, ALT, CHOP, ADD, and X-Y.

42. CHECK TRACE IDENT FUNCTION CH 1 and CH 2

Check TRACE IDENT function on probe shifts trace approximately 0.2 div up, and turns off the LED for that channel.

43. CHECK INPUT LIGHTS CH 1 and CH 2

a. Check that 50 Ω is lit when 50 Ω /1 M Ω pushbutton is out.

b. Check that 1 M Ω is lit when 50 Ω /1 M Ω pushbutton is in.

44. CHECK INPUT PROTECTION TRIP LEVELS for CH 1 and CH 2

a. Set the Type 106 High Amplitude control to minimum, Frequency to 1 kHz, and Symmetry for 50% duty cycle. Set the 485 CH 1 and CH 2 inputs to DC; VOLTS/DIV to 2 V; Position trace to top graticule line; set input impedance selector to 50 Ω (button out).

b. Connect Type 106 High Amplitude to CH 1 input; slowly increase Type 106 amplitude.

c. Check that the input disconnects (trace returns to top graticule line) and reset lamp lights after the trace crosses the 2.8 graticule division point and before it crosses the 4.25 division point. Return Type 106 Amplitude Control to minimum and repeat for CH 2.

45. CHECK PROBE POWER

NOTE

Measure voltages at the respective pins. See Fig. 5-1.

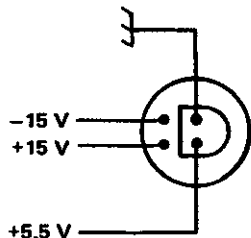


Fig. 5-1. Probe Power Voltages.

46. ADJUST MAIN VERTICAL BALANCE (ADD SHIFT)

- a. Set VERT MODE to CHOP; position CH 1 and CH 2 trace to graticule center.
- b. Push ADD and observe trace position (if less than 0.2 div away from center, proceed to step 47).
- c. Push CHOP and adjust MAIN VERT BAL (R600), (located at the lower rear of Vertical board) for same trace position.
- d. Position CH 1 and CH 2 trace to graticule center.
- e. Push ADD and check for less than 0.2 div shift.

47. CHECK MAIN VERTICAL GAIN

- a. Position CH 2 trace to graticule center.
- b. Connect DVM to test points at output of CH 1 channel switch (test points 418 and 419) and observe reading (must not exceed 15 mV).
- c. Set CH 2 POSITION control for a reading of 200 mV greater than the reading in step b.
- d. Adjust Main Vert Gain (R629) (located on upper rear of Vertical board) for 4 div of deflection from graticule center line.

48. CHECK VERTICAL LINEARITY

- a. With CH 2 POSITION control move trace to opposite edge of graticule.
- b. Check the DVM reading should be within ± 10 mV of being 200 mV away from the reading in 47b.

49. ADJUST 50 Ω INPUT IMPEDANCE CH 1 and CH 2

- a. Set input to 50 Ω ; VOLTS/DIV to 50 mV; VERT MODE to CH 1; position trace to center graticule line.
- b. Set DVM to correct ohms scale and connect to CH 1 input. Note the amount of trace shift caused by the meter current. If the trace has shifted over 2 div (100 mV) the measurement will be invalid, and a lower current ohmmeter must be used.
- c. Set VOLT/DIV to 10 mV.
- d. Short ohmmeter leads together and record first reading.
- e. Connect ohmmeter to CH 1 input and record second reading. Reverse the leads of the ohmmeter and record the third reading.
- f. Input resistance is the average of readings two and three minus the first reading. Note: the first reading is the residual resistance in the ohmmeter leads. The second and third readings are averaged to cancel the effects of any offset current in the 485.
- g. This calculated value of Input R must be within 49.75 to 50.25 Ω .

h. If necessary adjust Input R, R208 CH 1 R308 CH 2, (located at front of Vertical board) for 50 Ω calculated.

i. Repeat procedure for CH 2.

50. ADJUST 50 Ω INPUT OFFSET CURRENT CH 1 and CH 2

- a. Set inputs to GND; VOLTS/DIV to 10 mV.
- b. Switch input to DC then back to GND.

c. Adjust Input I (R206) for CH 1 and Input I (R306) for CH 2, (located on front of Vertical board) for no trace shift.

51. ADJUST VARIABLE BALANCE CH 1 and CH 2

- a. Set VOLTS/DIV to 10 mV; input to GND.
- b. Rotate VARIABLE volts/div fully CCW. Adjust VAR BAL (R215), (located on front of Vertical board) for less than 0.1 div of shift while switching from Uncal to calibrated.
- c. Check for 0.2 div or less of shift while rotating VARIABLE CW to CCW.
- d. Repeat in CH 2 adjusting NVB (R312) (located on front of Vertical board).
- e. Change CH 2 POLARITY to INVERT and repeat in CH 2 adjusting INVB (R310) (located on front of Vertical board).

52. ADJUST 5 mV/DIV BALANCE CH 1 and CH 2

- a. Set input to GND; POLARITY + UP; 10 mV/div.
- b. Adjust R350, (located above U350) for no shift when switching in CH 2 between 10 and 5 mV.
- c. Recheck CH 2 variable balance.
- d. Repeat in CH 1 adjusting R250 (located above U250).

53. CHECK INVERT SHIFT

- a. Set VARIABLE volts/div to cal; VOLTS/DIV to 5 mV; CH 2 to 50 Ω; VERT MODE to CH 2; then center trace.
- b. Switch CH 2 POLARITY between + UP and INVERT.
- c. Check for ±1.0 div of trace shift or less.

54. CHECK BEAM FINDER

- a. Check that trace remains within the graticule area with BEAM FINDER depressed.
- b. Check beam finder operation under all combinations of HORIZONTAL, CH 1, and CH 2 POSITION controls.

55. ADJUST LOW FREQUENCY VERTICAL TRANSIENT RESPONSE

- a. These adjustment (part of MAIN VERT TRANS RESP) are located at the rear of the Vertical board. They are the first four pots above the MAIN VERT BAL adjustment, and are adjusted beginning with the bottom one first.
- b. Input to 50 Ω; DC coupled. Connect the High Amplitude Output of the Type 106 Square-Wave Generator to CH 1 input.
- c. Use a VOLTS/DIV setting of 0.5 V with the Type 106, and an on-screen amplitude of 5 to 6 divisions. Note that the maximum output of this generator will trip the 50 Ω RESET.
- d. The adjustments are to be set for best flatness of the top front corner of the square wave.

TABLE 5-6

	TIME/DIV	SQUARE WAVE
Bottom Adjustment (R606)	5 ms	100 Hz
Next Adjustment (R607)	0.5 ms	1 kHz
Next Adjustment (R608)	20 μs	20 kHz
Next Adjustment (R609)	20 μs	20 kHz

- c. Repeat step d as there may be interaction.

56. ADJUST CH 1 and CH 2 50 Ω GAIN

- a. Located next to second stage IC's towards front of Vertical board.
- b. Set VOLTS/DIV to 20 mV.

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c. Connect 120 mV from 50 Ω Amplitude Calibrator to CH 1 and CH 2.

d. Adjust front panel GAIN for mid-range.

e. Adjust CH 2 GAIN (R358) and CH 1 GAIN (R255) for 6 divisions of deflection.

f. On CH 1 check that the gain in 20 MHz limit is within $\pm 1\%$ of the full bandwidth gain.

57. ADJUST INVERT GAIN (Located Lower Front of Vertical Board)

a. Set POLARITY to INVERT.

b. Connect 120 mV from 50 Ω source to CH 2.

c. Adjust INV Gain (R318) for 6 divisions.

58. CHECK ADDED MODE GAIN

a. Connect 50 Ω Amplitude Calibrator to CH 1 and CH 2 using dual input cable, (067-0525-00); CH 1 and CH 2 DC coupled.

b. Adjust each channel for 4 div of deflection, with VARIABLE VOLTS/DIV.

c. Set POLARITY to + UP.

d. Switch VERT MODE to ADD.

e. Check for 8 div ± 0.1 div.

f. Switch POLARITY to INVERT.

g. Check for < 0.1 div deflection with CH 1 and CH 2 centered.

h. If any deflection was noted in step g, adjust CH 2 VARIABLE VOLTS/DIV for a null (single trace) on the 485 display (do not change this setting unless specified in the following steps).

59. ADJUST CH 1 TRIGGER GAIN (TRIG MODE in NORM)

a. Connect probe to test point (TP568), (located towards rear of Vertical board).

b. Adjust Trig GAIN, (located in middle of Vertical board), to null signal displayed on the test oscilloscope.

60. CHECK 50 Ω ATTENUATOR ACCURACY $\pm 2\%$, CH 1 and CH 2

Check all 50 Ω attenuator positions with a 1 kHz square wave from 50 Ω Amplitude Calibrator.

61. ADJUST POSITION CENTER CH 1 and CH 2

a. CH 1 to 20 mV/div; DC coupled; apply 8 div of 50 kHz from the Type 191 Constant-Amplitude Signal Generator.

b. Switch to 10 mV/div and adjust POS CTR (R275) so the top and bottom are equal spacing from the graticule center, when POSITION control is rotated to both ends of its range.

c. Repeat for CH 2 adjusting POS CTR (R375).

62. ADJUST 50 Ω HIGH FREQUENCY TRANSIENT RESPONSE, CH 1 and CH 2

NOTE

These adjustments are the five remaining adjustments in the MAIN VERT TRANS RESP set, the slug-tuned coil near the output IC, and four adjustments by the input stages of each channel. Total aberrations after adjustment should be within 4% P-P.

a. Signal source is the TU-5, Tunnel Diode Pulser driven by the Type 106 Square-Wave Generator (Set 106 to 100 kHz). The test setup path from the Type 106 to the 485 is as follows:

Type 106 High Amplitude output, 50 Ω input of the cable

Tunnel Diode Pulser, 2X BNC attenuator, 50 Ω input of the 485.

Adjust the Pulser and the Type 106 so that the Pulser just triggers; do not overdrive. A 4 to 7 div step can be used (keep VOLTS/DIV VARIABLE to CAL). The Tunnel Diode Pulser is flat for only 150 ns, so don't use for adjustment of longer time constants.

b. Adjust for best response.

Four of five upper adjustments in the MAIN VERT TRANS RESP set (all but C617 next to the IC).	R613 R614 R615	Adjust for best flat top response.
Slug-tuned coil near the output IC.	L654	Best flat top response.
CH 1 adjustments above U210.	C214 R214	Best front corner level.
CH 1 adjustments behind U210.	C240 R240	Fastest Risetime.
CH 2 adjustments above U310.	C315 R315	Best front corner level.
CH 2 adjustments behind U310.	C340 R340	Fastest Risetime.
Uppermost adjustment in the MAIN VERT TRANS RESP set.	C617	Minimum ringing and fastest risetime for CH 1 and CH 2.

NOTE

U510 and U530 may be raised part way out of their sockets to match the level of the first 3 ns to the remainder of the waveform for CH 1 and CH 2 transient response respectively.

63. ADJUST 1 MΩ DC BAL CH 1 and CH 2

NOTE

These adjustments are accessible at the bottom of the instrument.

a. Input to 50 Ω; VOLTS/DIV to 5 mV; VERT MODE to CH 1; input to GND.

b. Switch to 1 MΩ and adjust R45 for 0 shift between 50 Ω and 1 MΩ.

64. CHECK 1 MΩ GATE CURRENT CH 1 and CH 2

Switch from GND to DC in 5 mV; check for 0.2 div or less of shift.

65. ADJUST 1 MΩ AMPLIFIER GAIN CH 1 and CH 2

NOTE

Adjustments are labeled on the bottom shield of the attenuator compartments.

a. Set VOLTS/DIV to 20 mV.

b. Apply 100 mV from Amplitude Calibrator and Comparator, then adjust R78 for 5 div of deflection.

c. Check 50 Ω/1 MΩ gain match; ±1% in 20 mV/div.

d. Set the 1 MΩ/50Ω switch to 1 MΩ (button in).

66. ADJUST 1 MΩ 10 kHz TRANSIENT RESPONSE, CH 1 and CH 2

a. Connect Type 106 High Amplitude with 6 div of 10 kHz through 5X attenuator, GR cable, 50 Ω termination.

b. Adjust C46 and R53 for optimum response.

67. ADJUST 1 MΩ INPUT ATTENUATOR COMPENSATIONS, CH 1 and CH 2

a. Connect the bnc end of a 10X probe (485 Optional Accessory, P6106, P6063B, or equivalent) to the CH 1 input connector. Connect a Probe-tip-to-bnc adapter (Tektronix 013-0084-01) to the probe tip.

b. Set VERT MODE to CH 1 and set CH 1 VOLTS/DIV to .2 V.

NOTE

In the following parts of Step 67, adjust generator Amplitude and add or remove attenuators as required to maintain a 5-vertical-division display. Set sweep controls to display several cycles of the generator waveform.

c. Set High Amplitude Square-wave generator (106 or equivalent) to 1 kHz and connect 2X or 5X or 10X attenuators (as required) in series between the generator output connector and 50Ω termination (see above note). Connect the Probe-tip-to-bnc adapter to the termination.

d. Adjust the CH 1 C12 (only if necessary) to near minimum capacitance (back adjustment screw out toward hole in attenuator shield). CH 1 C12 is set at the factory to provide CH 2 C12 enough range to match the CH 2 input capacitance with the CH 1 input capacitance. Unless there have been extensive circuit repairs, the CH 1 C12 should not require readjustment. When adjusting either C12 or other adjustments, if the low-capacitance screwdriver contains a metal bit, the metal may affect the adjustment. Check adjustment after screwdriver is removed, and re-adjust as necessary.

e. Obtain a 5-vertical-division display and adjust the probe compensation for the best flat-top waveform. Do not re-adjust probe compensation for the remainder of Step 67.

f. Check CH 1 50 mV, .1 V, and .5 V VOLTS/DIV settings for optimum flat-top on a 5-division displayed waveform.

g. Set VOLTS/DIV to 1 V and adjust CH 1 C24 and C26 for best flat-top and best front corner on a 5-division displayed waveform.

h. Check CH 1 2 V and 5 V VOLTS/DIV settings for optimum flat-top and front corner on 5-division displayed waveform.

i. Set CH 1 VOLTS/DIV to 10 V (if necessary, remove the 50Ω termination to maintain a 5-division display). Adjust CH 1 C20 and C22 for best flat-top and best front corner on displayed waveform.

j. Reduce generator output amplitude to minimum. Re-insert attenuators and termination between generator output and Probe-tip-to-bnc adapter. Transfer the bnc end of the probe from the CH 1 input connector to the CH 2 input connector.

k. Set VERT MODE to CH 2, and set CH 2 VOLTS/DIV to .2 V. Set generator Amplitude and add or remove attenuators as necessary to maintain a 5-division display for the remainder of Step 67.

l. Adjust CH 2 C12 for best flat-top waveform.

m. Repeat parts f through i substituting CH 2 adjustments for the CH 1 adjustments.

68. ADJUST 1 MΩ AMPLIFIER HIGH FREQUENCY TRANSIENT RESPONSE

a. Set Type 106 to 100 kHz; TD Pulser 2X attenuator and 50 Ω termination. Set CH 1 and CH 2 VOLTS/DIV to 20 mV.

b. TIME/DIV to 20 ns/div; adjust C55 and R55 for optimum front corner, C70 for best level behind leading edge.

69. CHECK COMMON MODE REJECTION 50 Ω and 1 MΩ

a. Connect Type 191 Signal Generator to 50 Ω input CH 1 and CH 2 thru the 10X attenuator and dual BNC input cable (067-0525-00).

b. CH 1 and CH 2 inputs 50 Ω, DC; VOLTS/DIV to 20 mV; VERT MODE to CH 1. Apply 8 divisions of 50 kHz.

c. Set VERT MODE to ADD; CH 2 INVERTED. Push to release CH 2 VARIABLE GAIN and adjust for minimum deflection; position to center of graticule with CH 2 POSITION control.

d. Set Type 191 to 50 MHz and check for 0.8 div or less of vertical deflection.

e. Set generator to 50 kHz; inputs to 1 MΩ; add 50 Ω BNC terminations at inputs.

f. Readjust CH 2 GAIN for minimum deflection.

g. Set Type 191 to 50 MHz and check for 0.8 div or less of vertical deflection.

h. Push CH 2 VARIABLE GAIN to CAL.

70. CHECK BANDWIDTH 50 Ω and 1 MΩ, CH 1 and CH 2

NOTE

Use 6 div of 3 MHz from the High-Frequency Constant-Amplitude Signal Generator (067-0532-01) as reference.

a. Check for minimum of 4.4 div of signal at 350 MHz in the 50 Ω mode.

b. Check 5, 10, 20, 50 mV, and 0.1 V.

c. Check for minimum of 4.4 div of signal at 250 MHz in the 1 MΩ mode.

d. Check 5, 10, 20, 50 mV, and 0.1 V.

e. Repeat check for 1 V using 4 divisions as reference and 2.9 divisions the minimum deflection.

71. OPTIONAL — CHECK VSWR

NOTE

TEKTRONIX supplies this procedure for a 5000-hour, or as needed, verification of VSWR. Equipment: VSWR AUTOTESTER and Graticule; 561B/3A9/2B67; High-Frequency Constant-Amplitude Signal Generator (067-0532-01).

a. Ground 3A9 CH 2 input; connect VSWR Autotester, VSWR OUT to 3A9 CH 1 input; 3A9 to 20 μV/div; DC coupled; adjust 3A9 DC offset for VSWR = 1.00 on VSWR graticule.

b. Connect Signal Generator to VSWR Autotester RF IN through 10X and 5X attenuators. Set generator frequency to 100 MHz and adjust amplitude for VSWR = 1.22.

c. Disconnect the Signal Generator and recheck VSWR = 1.00.

d. Connect VSWR Autotester to 485 CH 1 input; set 485 input to 50 Ω, DC coupled.

e. Remove the 10X attenuator and reconnect the generator to VSWR Autotester RF IN.

f. Sweep the generator frequency from 100 MHz to 350 MHz. VSWR should be less than 1.25 for deflection factors of 5 mV and 10 mV/div. VSWR should be less than 1.15 for deflection factors of 20 mV/div through 5 V/div.

72. OPTIONAL — CHECK CALIBRATOR OVERSHOOT, RINGING, and RISE TIME

NOTE

These characteristics have been factory verified to specifications. Due to their long term stability (failure to perform is most likely the result of catastrophic failure) only a qualitative check is done here. The Calibrator overshoot and ringing on the 485 is compared to that observed from the Tunnel Diode Pulser.

- a. Set CH 1 input to 50 Ω , DC coupled; TIME/DIV to 1 ns; VOLTS/DIV to 20 mV.
- b. Connect the Type 106/Tunnel Diode Pulser through a 2X BNC attenuator to the CH 1 input (approximately 5 div step). Observe the reference "flat" portion following the positive step.
- c. Connect a 5X BNC attenuator to the CAL 5 V output and connect this signal to CH 1 input (5 div step). Again, observe the "flat" portion following the positive step. This response should be within ± 0.1 div ($\pm 2\%$) of the reference "flat" portion observed in b.
- d. Check positive edge risetime of the Calibrator as observed on the 485. Should be less than 1.4 ns.

73. ADJUST A TRIGGER (Board Next to Atten Shield on Bottom of Oscilloscope)

- a. Set HORIZ DISPLAY to A; A TIME/DIV to 10 $\mu\text{s}/\text{div}$; A COUPLING to AC; A TRIG HOLDOFF to NORM; A SOURCE to INT; A SLOPE to +; SWEEP MODE to NORM.
- b. Set LEV CTR, R725 (R1025)¹, to midrange; A TRIG SENS, R755 (R1055), CCW; ARM TD, R765 (R1075), CW; OUT TD, R775 (R1065), CW; LEVEL, R720, (R1020) CW. Apply one division of 50 kHz reference signal from the Type 191 Signal Generator to the CH 1 input.
- c. Turn ARM TD CCW until trace disappears. Note position of pot.
- d. Adjust LEVEL for a stable display.
- e. Turn ARM TD further CCW until trace disappears. Note position of pot.
- f. Adjust ARM TD pot halfway between positions noted in steps c and e.
- g. Disconnect coax from J763 (J1063 for B trigger). J763 is rear white and brown coax on A trigger board (J1063 is rear white and brown coax on B trigger board).

¹ Circuit numbers in parenthesis pertain to B trigger adjustments, see step 74B.

h. Monitor the voltage at the OUT TD test point (located near the OUT TD control) and adjust the OUT TD control R775 (R1065) until the trace just disappears. Record this voltage.

- i. Reconnect the coax to J763 (J1063).
- j. Adjust the OUT TD control CCW until the trace just disappears again. Record this voltage.
- k. Subtract the voltage in part j from the voltage recorded in part h. Multiply the result by 0.8 and add this quantity to the voltage recorded in part j.
- l. Adjust the OUT TD control to produce a reading that equals the final amount calculated in part k.
- m. Adjust TRIGGER SENS, R755 (R1055) until display cannot be triggered on 0.15 div of signal by rotating the LEVEL control, but can be triggered on 0.18 div of signal by rotating the LEVEL control, (to set signal amplitude to 0.15 or 0.18 div, first adjust the generator amplitude for a display of 1.5 or 1.8 divisions, then increase the VOLTS/DIV setting by a factor of 10). Increase generator signal to produce a two division display.
- n. Adjust LEV CTR for a stable display with LEVEL knob dot positioned at top center (12:00 o'clock).
- o. Switch trigger COUPLING to DC, adjust INT TRIG DC BAL, R560 (located on Vertical Amplifier board), for stable triggering with display vertically centered on graticule.
- p. Apply signal to CH 2 input. Check for triggering within 0.5 divisions of graticule center with SLOPE in + and - positions when VERTICAL MODE is set to CH 1 and CH 2; and within one division of graticule center when VERTICAL MODE is set to ADD. Disconnect signal from 485.

74A. ADJUST EXTERNAL TRIGGER LEVEL CENTERING

- a. Set A trigger SOURCE to EXT; A LEVEL knob dot to 12:00 o'clock.
- b. Connect the Type 191 Signal Generator to the A EXT TRIG connector. Hold the A EXT TRIG button in, and adjust the Type 191 for a 2 division display of 50 kHz signal.
- c. Adjust R830 (IDENT) while depressing the A EXT TRIG button, so the trace starts at an equal distance above and below graticule center when switching the A Trigger SLOPE switch from + to -. Release the A EXT TRIG button.
- d. Remove the signal from the A EXT TRIG connector, and apply it to the CH 1 input.

74B. ADJUST B TRIGGERS (Located on Board Behind B Triggering Switches on Top of Oscilloscope)

NOTE

To prevent possible interference from the 1 MHz calibrator signal, set the calibrator *FREQ* pushbutton to 1 kHz position during B Trigger checks and adjustments.

a. Set HORIZ DISPLAY to B; A TIME/DIV to 50 μ s; B TIME/DIV to 10 μ s; B SOURCE to INT; A & B COUPLING to AC; A & B LEVEL CW; SWEEP MODE to AUTO TRIG; VERT MODE to CH 1.

b. Adjust the B triggering by repeating step 73, parts b through n (substitute the J1063 coax for the J763 coax in step 73 parts g and i, and substitute the following adjustment controls; R1055 for R755, R1075 for R765, R1065 for R775, R1025 for R725, R1020 for R720).

c. Use LEVEL controls to trigger the A and B sweeps; set HORIZ DISPLAY to ALT; rotate the DTP and check that the intensified zone of the A trace jumps from cycle to cycle without movement of the B trace. Disconnect the Type 191 from the 485.

75A. CHECK EXTERNAL A and B TRIGGERS

a. Set VERT MODE to CH 2; INT TRIG to NORM; HORIZ DISPLAY to A; SWEEP MODE to NORM TRIG; A Trigger SOURCE to EXT, CH 2 input to 50 Ω .

b. Apply 20 mV of 50 kHz reference signal (as viewed on the CRT) from the 191 through the network shown in Fig. 5-2. Set the 191 to 50 MHz (without changing the Amplitude control). Set the A & B TIME/DIV controls to 20 ns/division. Adjust the LEVEL control and check that stable triggering can be achieved. Disconnect the Type 191 from the Fig. 5-2 network.

c. Connect the High Frequency Constant-Amplitude Signal Generator to the Fig. 5-2 T connector through a GR to BNC adapter. Adjust generator amplitude to provide 100 mV of displayed Reference Frequency signal on the CRT (use external attenuators as necessary between the generator cable and the T connector to obtain the 100 mV displayed signal).

d. Switch the generator to 350 MHz without changing the amplitude setting. Set the A TIME/DIV to one ns/division (for B trigger check, set A TIME/DIV to 10 ns/division and B TIME/DIV to one ns/division).

e. Check that stable triggering can be achieved by adjusting the LEVEL control.

f. Set the SWEEP MODE to AUTO; A trigger SOURCE to INT; HORIZ DISPLAY to B. Remove the connection from the A EXT TRIG input and connect it to the B EXT TRIG input; set B trigger SOURCE to EXT.

g. Repeat Step 75A parts b through e for the B trigger.

h. Disconnect generator and Fig. 5-2 network from the 485.

75B. CHECK INTERNAL A and B 350 MHz TRIGGERING

a. Set VERT MODE to CH 2; INT TRIG to NORM; A Trigger SOURCE to INT; CH 2 input to 50 Ω ; CH 2 VOLTS/DIV to 100 mV/division; A TIME/DIV to one ns.

b. Apply a 350 MHz signal from the High Frequency Constant-Amplitude Signal Generator to the CH 2 input through a GR to BNC adapter and adjust for a 1.5 division CRT display (change CH 2 VOLTS/DIV and generator amplitude control as necessary to produce the 1.5 division display).

c. Check that stable triggering can be achieved by adjusting the LEVEL control.

d. Set the SWEEP MODE to AUTO; HORIZ DISPLAY to B; B trigger SOURCE to INT; A TIME/DIV to 10 ns/division; B TIME/DIV to one ns/division.

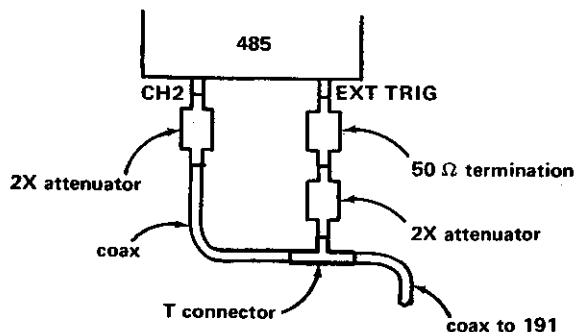
e. Repeat step 75B parts b and c for B sweep 350 MHz internal triggering.

f. Disconnect generator and cables from the 485.

76. CHECK A EXT TRIGGER DELAY MATCH TO CH 2

a. CH 2 50 mV/div; DC coupled; A triggering SOURCE EXT; COUPLING AC; SLOPE +; TIME/DIV 1 ns; CAL 5 FREQ 1 MHz.

b. Connect 50 Ω termination at A EXT TRIG; connect 2X attenuators to 50 Ω termination and CH 2 input; connect Dual Input cable to 2X attenuators; connect CAL 5 V output to Dual Input Connector. See Fig. 5-2.



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Fig. 5-2. External Trigger Check Connection.

c. Use the A LEVEL control to trigger on the larger of the positive steps. This should give a 3.3 div display (167 mV) on CH 2. Use CH 2 POSITION control to center the CH 2 step vertically.

d. Hold the A EXT TRIG pushbutton and use the A LEVEL to center the large step vertically. Use POSITION (HORIZ) to set the 50% amplitude point exactly 0.1 div to the right of center screen (this 0.1 ns offset compensates for the delay through the one 50 Ω BNC termination).

e. Check for 0.5 ns or less delay match of EXT TRIG to CH 2 50 Ω (± 0.5 div).

f. Add a 50 Ω BNC termination at CH 2 input; CH 2 input to 1 M Ω .

g. Repeat step d, but use POSITION (HORIZ) to set 50% amplitude point exactly to center screen.

h. Check for 0.5 ns or less delay match of EXT TRIG to CH 2 1 M Ω (± 0.5 div).

77. CHECK EXTERNAL TRIGGER LEVEL RANGE A and B

a. Connect 1 V from the Amplitude Calibrator to A EXT TRIG; A TRIGGER SOURCE to EXT; SWEEP MODE to NORM.

b. Rotate LEVEL and check that sweep stops running at both ends of the LEVEL range.

c. Amplitude Calibrator to 10 V; A TRIGGER SOURCE to EXT \div 10.

d. Rotate LEVEL and check that sweep stops running at both ends of the LEVEL range.

e. SWEEP MODE to AUTO; HORIZ DISPLAY to B.

f. Repeat for B.

78. CHECK SINGLE SWEEP

a. Trigger A Sweep on 1 div of 50 kHz.

b. Remove signal and switch to SINGLE SWEEP.

c. Reset lamp should light.

d. Apply signal, should have one sweep, READY light should go off.

e. Remove signal and reset. RESET lamp should light.

79. CHECK A EXT TRIG RESPONSE

a. Connect TD Pulser through a 50 Ω termination to the A EXT TRIG input.

b. Depress the A EXT TRIG switch and check risetime to less than 1.6 ns.

80. ADJUST X-Y BALANCE (Located Rear of Sweep Board)

a. Set VERT MODE to ALT; VOLTS/DIV to 20 mV.

b. Center both traces.

c. Set VERT MODE to X-Y.

d. Adjust X-Y center (R1355 located on Sweep board) to center spot.

81. ADJUST X-Y GAIN (Located Rear of Vertical Board)

a. Connect 120 mV from 50 Ω Amplitude Calibrator to CH 2 50 Ω input impedance.

b. Adjust X GAIN (R575) for 6 div, must match CH 2 gain $\pm 1\%$.

c. 5 mV/div to 5 V/div gain accuracy $\pm 2\%$.

82. ADJUST X-Y PHASING (Located Rear of Sweep Board)

a. Connect CH 1 and CH 2 to Type 191 generator through dual input cable.

b. Apply 10 div of 50 kHz; CH 1 to 50 mV, CH 2 to 20 mV.

c. Switch to 4 MHz.

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d. Adjust X-Y L1346 (Sweep board) for a closed lissajous figure.

e. Switch Type 191 to next lower range, adjust X-Y R1348 (Sweep board) for closed lissajous figure.

f. Recheck d and e as they may interact.

g. Switch to 20 MHz limit, compromise phasing adjustments between full and 20 MHz limit for less than 0.2 div opening with 7 div of signal.

83. CHECK X-Y BANDWIDTH

a. Ground CH 1, apply 10 div of 50 kHz to CH 2.

b. Check for at least 4 MHz bandwidth at -3 dB point.

84. CHECK BANDWIDTH LIMIT

a. Set VERT MODE to CH 1 and apply 6 div of 50 kHz.

b. Hold BANDWIDTH pushbutton in.

c. Check for 17 to 23 MHz bandwidth at -3 dB point.