

485 CALIBRATION PROCEDURE

PRESETS

INTENSITY	CCW
B INTENSITY	CCW
SCALE ILLUM	CCW
BW LIMIT	OFF
CH 1 and CH 2	
VOLTS/DIV	.1V
VARIABLE	CAL
INPUT	CND
POSITION	MIDR
1 M /50	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
HORIZ POSITIONING	MIDR
HORIZ DISPLAY	A
TRACE SEPARATION	MIDR
CAL 5V FREQUENCY	1 MHz
TIME/DIV	1 ms/div
POWER	OFF
DELAY TIME POSITIONS	4.00

101. PRELIMINARY INSPECTION

Visual, IBM cards, boards, front panel, mods, LINE SELECTOR, fuse 3A fast blo.

102. PRESETS

Controls, pots, etc.

103. RESISTANCE CHECK

Check that the ground pin on the power plug is also chassis ground.

104. 230V TURN ON

Line Selector to 230v

Turn instrument on and observe the flash rate of the neon on the inverter board. SW to 115v. The flash rate should increase greatly.

105. CHECK FAN

No dead spots and proper speed.

106. ADJUST 59.4V

±0.1% R1940

107. CHECK 59.4V REGULATION

- a. Increase line voltage to 136V and note reading.
- b. Decrease line voltage to 90V and note reading.
- c. Total change between HI and LO line cannot be greater than 300 mV.

108. ADJUST 50V

±0.1% R2048

109. CHECK 50V REGULATION

- a. Repeat step 7 on 50V supply.
- b. Total change cannot exceed 50 mV.

201. CHECK LOW VOLTAGE POWER SUPPLIES

Check between test point ground and respective test points.

+5 V	± 50 mV	-9 V	±90 mV
+15 V	±225 mV	+9 V	±90 mV
-5 V	± 50 mV	+25 V	±0.5 V
-15 V	±300 mV	+120 V	±2.4 V
-5.5 V	±220 mV	+180 V	±3.6 V
+5.5 V	±220 mV		

202. CHECK LOW VOLTAGE POWER SUPPLY RIPPLE

59.4 V	80 mV max
+15 V	15 mV max
+5.5 V	15 mV max

203. CHECK SHORT PROTECTION

- a. Set test scope to 50 mV/div; 50 ms/div.
- b. Connect X10 probe to TP1926. Should see about 700 mV of signal.
- c. With shorting strap short the 9V supply.
- d. Check for about 20 ms on and 500 ms of off time and 1.5 to 2V of signal. If voltage is larger replace U1910.

204. CHECK ELAPSE TIME METER

1.2 μ A, no separation of the bubble and a reasonable time indication.

205. CHECK LINE STOP OPERATION

- a. While observing DS1824 (neon) on the inverter board ground L.S. TP and turn instrument off. There should be an abnormal rate of change of the flashing neon. (Not necessary when one is familiar with normal rate).
- b. Remove ground strap, turn instrument on and then off.
- c. Observe normal rate of the flashing neon.
- d. Turn POWER on.

301. MONO RAMP SYMMETRY (If 59.4v Ripple is less than 70mv do not check)
- Set test scope to $20\mu\text{s}/\text{div}$.
 - Connect probe to TP1919.
 - Obtain 6 div of vertical deflection.
 - Check peaks to be within 0.4 div of each other.
302. CHECK 13V REGULATION (Generated on A sweep board)
Check for no voltage change while rotating the HORIZ POSITION control.
303. ADJUST CALIBRATOR AMPLITUDE
- Remove Q2114.
 - Measure and record voltage at CAL 5V output.
 - Remove Q2124
 - Adjust R2130 for previous reading and 5V. $\pm 5\text{ mV}$ (typically + 3 mV and +5.003V).
 - Install Q2114 and Q2124.
 - Check 0.5 V into 50Ω , $\pm 0.5\%$; 5V into $1\text{ M}\Omega$ load 0.5%.
 - Check 1Khz duty cycle, half cycles must match within 3 micro sec.
304. ADJUST CALIBRATOR FREQUENCY
- Set TIME/DIV to 1 ms, and apply 1 ms markers to CH 1 input.
 - Connect CAL 5V 1 kHz to CH 2 50Ω input.
 - Adjust R2105 (1 kHz) for one cycle/div.
 - Set trigger to CH 1 and adjust R2105 for no drift. Maximum allowable drift is 2.5 div/sec.
 - Set TIME/DIV to 2 ms/div, trigger to NORM, ADDED MODE, DC coupled. Apply $1\mu\text{s}$ markers.
 - Adjust R2100 (1 MHz) for beat period greater than 2 ms.
305. CHECK CALIBRATOR RISE TIME
- Connect CAL .5 V, 1 MHz to A input on 3S1 using BNC to GR connector and 50Ω GR cable with 2X pad.
 - Set 3S1 to 50 mV/div and adjust for 5 div.
 - Set 3T2 to 500 ps and check risetime 1 ns.

401. CHECK ABERRATIONS $\pm 2\%$
- Set 3S1 to 5mV/div.
 - Check for less than 1 div of aberration.
402. ADJUST CATHODE REGULATOR 95V $\pm 1V$ TEST LIMIT $\pm 8V$
403. ADJUST VERTICAL PLATE COMPENSATION
- Center trace.
 - Measure the vertical deflection plate voltage at the CRT neck pins.
(May need 1 k Ω in series to stop vertical oscillation).
 - Average the two readings.
 - Connect DVM to Comp PL TP1746.
 - Adjust R1796 for the average of the readings.
404. ADJUST FOCUS AND ASTIG (X-Y)
- Adjust for a well defined dot.
 - Check for smooth electrical and mechanical operation.
405. ADJUST GRID BIAS
- INTENSITY and B INTENSITY CCW: VERTICAL MODE TO X-Y
 - Connect DVM to TP1781 (Z out DC) and note DC level.
 - With INTENSITY increase DC level 4V.
 - At low ambient light adjust R1660 so the CRT has been cut off.
Test Limit $\pm 1V$
406. ADJUST Z AXIS COMPENSATION
- Set TIME/DIV to .1 μs /div and free run A sweep.
 - Set test scope to .05 μs and 1V sensitivity.
 - Connect probe to TP1782 (Z out HF).
 - Adjust INTENSITY for 4 div of signal.
 - Adjust C1762, C1765 and R1765 for less than 2% of aberration.
407. CHECK Z AXIS RISETIME LESS THAN 15 (If compensation is normal skip this step).

501. CHECK EXT Z AXIS BLANKING

Apply 1Khz from Calibrator to Ext. Input (50 Ω terminator)
Should blank.

502. ADJUST AUTO FOCUS

- a. Preset Max Z cw, Max Focus cw, VARIABLE HOLDOFF to max.
- b. Connect 10X probe to DC Z axis TP and test scope for 10v/div sensitivity.
- c. With 2 div of 3 MHz triggered refocus if necessary with Low Intensity. Set INTENSITY for a 50V step at Z axis TP.
- d. Adjust Focus Gain for best focus.
- e. Adjust INTENSITY for 70V step.
- f. Measure Auto Focus voltage at Auto Focus TP.
- g. Turn INTENSITY to max and adjust for a 70V step with Max Z control.
- h. Set Max Focus control for the voltage measured in Step f.
- i. Set INTENSITY to min; B INTENSITY to max; TIME/DIV to 20ns/div; HORIZ MODE to ALT.
- j. Connect 10X probe to Auto Focus TP. Look for a square wave. If a back to back sawtooth is observed, the I boost circuit is defective.
- k. Return holdoff to normal.

503. CHECK FAST SWEEP BEAM LIMIT

- a. Position off screen; with full INTENSITY; should be 70v step
- b. Center trace and check for 40V to 50V at 1 μ s/div.

CHECK SLOW SWEEP BEAM LIMIT

- a. Set TIME/DIV to 50ms.
- b. Check for 20V to 30V.

CHECK X-Y BEAM LIMIT

- a. Turn INTENSITY ccw; VERT MODE to X-Y
- b. Slowly increase INTENSITY. Should limit before intensity pot reaches 2 o'clock (typically 12:00 o'clock)

504. CHECK B GATE

4V; 0.5V into 50 Ω

601. CHECK A GATE
4V; 0.5V into 50Ω

602. CHECK A HOLDOFF

A SWEEP SPEED	LESS THAN	MORE THAN
10 ns	300 ns	5 μs
.2 μs	1 μs	25 μs
2 μs	4 μs	100 μs
20 μs	40 μs	1 ms
.2 ms	.4 ms	10 ms
2 ms	4 ms	100 ms
20 ms	40 ms	.1 s

603. CHECK A SAWTOOTH
10V; 0.5V into 50Ω

604. ADJUST TRACE ROTATION

- a. Set HORIZ DISPLAY to A
- b. Position trace to graticule center.
- c. Check range of TRACE ROTATION pot. $5.4^\circ = 1 \text{ div.}$
- d. Adjust TRACE ROTATION pot for trace paralleled with graticule center line.

605. ADJUST Y AXIS ALIGNMENT

- a. Apply .1 ms and 1 ms markers to CH 1.
- b. Set TIME/DIV to 1 ms, HORIZ DISPLAY to A.
- c. Adjust VARIABLE TIME/DIV for one major marker/div.
- d. Adjust R1794 for alignment at graticule center $\pm .1 \text{ div.}$

606. ADJUST GEOMETRY

- a. Adjust R1742 for alignment at graticule edges $\pm .1 \text{ div.}$
- b. Note: R1792 and R1794 and TRACE ROTATION may interact.

607. CHECK EDGE FOCUS

No overlap of time marks with 150 markers in 10 div.

608. CHECK CRT DEFECTS

Check for double peaking, flare, grid emission, interface, charging, burns, scan area and mesh defects.

609. CRT LINEARITY

- a. Apply a 2 div. square wave; set $\pm 1 \text{ div.}$ from graticule center; check for less than .1 div. of compression or expansion over the graticule area.

701. ADJUST HORIZONTAL GAIN

- a. Set HORIZ DISPLAY to B; TIME/DIV to .1ms/div.
- b. Apply .1ms markers.
- c. Adjust R1366 for 1 marker/div.
- d. Check linearity for less than or = .05 div. error.

702. ADJUST A SWEEP CAL

- a. Set HORIZ DISPLAY to A.
- b. Adjust R1308 for 1 marker/div.

703. ADJUST B REGISTER

- a. Set HORIZ DISPLAY to ALT.
- b. Set DTP to 0 and trigger display A and B.
- c. Adjust R1325 for 1 marker/div.

704. ADJUST HORIZONTAL CENTERING

- a. Set HORIZ DISPLAY to A.
- b. Rotate HORIZ. POSITION to both extremes.
- c. Adjust R1150 for equal spacing from vertical graticule center line.

705. CHECK A SWEEP LENGTH

10.3 to 11.3 div.

706. HORIZONTAL GAIN RANGE

- a. Go to X-Y and set 5 div of signal.
- b. Adj. horizontal gain to max. Look for ≥ 6 div. or 20v P-P.
- c. Go to min. gain. Look for ≤ 4 div or 16.4v P-P.
- d. Reset Horiz. gain.

801. PRESET $.1\mu s$, A and B
- Set TIME/DIV to $.1\mu s$; HORIZ DISPLAY to ALT.
 - Adjust C882 for 1 marker/div on A sweep.
 - Adjust C1248 for 1 marker/div on B sweep.
802. PRESET $1\mu s$, A and B
- Set TIME/DIV to $1\mu s$; HORIZ DISPLAY to ALT.
 - Preset C877 for 1 marker/div on A sweep.
 - Preset C1242 for 1 marker/div on B sweep.
803. ADJUST START AND STOP +3 MINOR -2 MINOR LIMIT. SET FOR 0 ERROR
- Set A TIME/DIV to $.1ms$; B TIME/DIV to $1\mu s$; HORIZ DISPLAY to ALT; DTP to 1; B SOURCE to RUNS AFTER DELAY TIME.
 - Adjust start R915 to get intensified portion on the second marker, and the pulse on B trace to just start positive at the front of B trace.
 - Set DTP to 9.
 - Adjust stop R925 for intensified portion on the 10th marker, and pulse on B trace to just start positive at the start of B trace.
 - Recheck 1 and 9 for interaction.
 - DTP Linearity from 0.5 to 9.5 check at each half turn ($50\mu s$ markers) not to exceed 2 minors anywhere or 1 minor over any 1 turn or half turn.
804. ADJUST $.1\mu s$, A and B
- Set A TIME/DIV to $.1\mu s$; B TIME/DIV to $10ns$; HORIZ DISPLAY to ALT
 - Adjust C882 for DTP 9 to match DTP 1.
 - Set B TIME/DIV to $.1\mu s$.
 - Adjust C1248 for B to match A (do not use ALT).

901. ADJUST $1\mu s$, A and B
- Set TIME/DIV to $1\mu s$; B TIME/DIV to $.1\mu s$; HORIZ DISPLAY to ALT
 - Adjust C877 for DTP 9 to match DTP 1.
 - Set B TIME/DIV to $1\mu s$.
 - Adjust C1242 for B to match A (do not use ALT)
902. ADJUST START LINEARITY
- Connect probe to TP872
 - Set TIME/DIV to 20ns/div; A free running, max. holdoff.
 - Adjust R863 for minimum ringing at the start of the +ramp.
 - Go to 10ns/div, may need to compromise between 10ns/div and 20 ns/div.
903. ADJUST 5ns
- Connect 5ns from 184 HF selector to vertical input CH 1.
 - Connect 50ns markers to CH 2; TRIG MODE to CH 2; TIME/DIV to 5ns.
 - Adjust C1190 for 1 marker/div.
904. ADJUST 2ns
- Set TIME/DIV to 2ns and 184 HF selector to 2ns.
 - Adjust C1364 for linearity
 - Recheck 5ns for 1-9 timing.
 - Adjust R1226 for 1 marker/div.
905. ADJUST 1ns
- Set TIME/DIV to 1ns.
 - Adjust R1228 for 1 marker/2 div.
906. LINEARITY
- 1, 2, 5ns/div .1 minor div. over any two div. or any Graticule Line with zero error at 1 and 9.
907. CHECK ALL B SWEEP SPEEDS TO THE GRATICULE
- | | |
|---------------------|------------------------------|
| a. 10ns and 20ns | $\pm 2\%$ = 0.8 minor div |
| b. 50ns | $\pm 1.25\%$ = .5 minor div. |
| $.1\mu s$ | " " |
| $.2\mu s$ | " " |
| $.5\mu s$ | " " |
| 20 μs | " " |
| 2ms | " " |
| .2 sec. and .5 sec. | $\pm 2\%$ = .8 div |

1001. CHECK ALL A SWEEP SPEEDS TO THE GRATICULE

1ns 20ns ±2% = .8 minor div.

50ns)
 .2μs) 1.25% = .5 minor div.
 20μs)
 2ms)

.2 sec) ±2% = .8 minor div.
 .5 sec)

1002. AUTO REPETITION RATE

A Sweep to 50μs/div Auto trig.

Will trigger on 50ms markers; will not trigger on .1s markers.

1003. CHECK A SWEEP SPEEDS TO THE GRATICULE IN ALT.

10ns, 20ns, 50ns, .2μs, 20μs, 2ms

1004. DELAY TIMING

<u>Sweep Speed</u>	<u>Check</u>	<u>% Error</u>
10ns/div	4 and 9	± 6 minor
20ns/div	2 and 9	± 6 minor
50ns/div	1 and 9	± 3 minor
20μs/div		
.2ms/div		
2ms/div	1 and 9	± 4 minor div.

<u>A TIME/DIV</u>	<u>DIAL SETTING REFERENCE</u>	<u>READ ERROR AT</u>	<u>MAX. ERROR IN MINOR DTP DIAL DIVS.</u>
50ns	0.8	1.8	1
0.1μs	0.4	1.4	1
0.2μs	0.2	1.2	1
.2ms and 2ms	0.2	1.2	1.5

1101. CHECK ALL DIFFERENTIAL TIMING

A Sweep	B Sweep	Markers	Measure	% Error
.1ms	5μs	50μs	0.5 thru 9.5	Not to exceed 2 minors anywhere and 1 minor over any 1/2 or 1 turn.
50ns	2ns	50ns	1 thru 5 5 thru 9	Not to exceed 2 minors anywhere and 1 minor/turn.
20ns	1ns	10ns	2 thru 6 5 thru 9	Not to exceed 4 minors anywhere. 2 minors over any 1 div.
10ns	1ns	10ns	4 thru 7 6 thru 9	

Check Error at Each Marker Past a Dial

1102.

A Sweep	B Sweep	Display	Markers	Turn Dial CW From CW End	Setting of	% Error
10ns	1ns	B	10ns	5 Div. Read Dial	1, 2, 3, 4	±10 minors
20ns	1ns	B	10ns	5 Div. Read Dial	1, 2	±10 minors
50ns	5ns	B	10ns	1 Div. Read Dial	0.4, 0.8	±8 minors
0.2μs	50ns	B	10ns	1 Div. Read Dial	0.2	±3 minors
20μs	50ns	B	1μs	.1 Div. Read Dial	0.2	±3 minors
2ms	20μs	B	0.1ms	.1 Div. Read Dial	0.2	±3 minors

1201. CHECK POSITION RANGE

1ns/div and 2ns/div
.1ms

30ns to 40ns
Past center screen each way

1202. CHECK DELAY JITTER

<u>A Sweep</u>	<u>B Sweep</u>	<u>184 Marker Generator</u>	<u>Check</u>
1ms	1 μ s	1ms	0.5 div of jitter 1 thru 9 on DTP
10 μ s	10ns	.5 μ sec.	0.5 div of jitter 1 thru 9 on DTP

1203. B ENDS A OPERATION

- Horiz mode to Intensify
- A to 1ms, B to .1ms
- Rotate Variable hold off CW into Detent
- Rotate DTP, the Sweep should end after the intensified zone.

1204. CHECK CH 1 L.E.D's

- Check that each L.E.D lights in sequence.
- Check CH 2 L.E.D's are off.
- Check CH 1 L.E.D's are on in CH 1, ALT, CHOP ADDED AND X-Y.

1205. CHECK CH 2 L.E.D's

- Check that each L.E.D lights in sequence.
- Check that CH 1 L.E.D's are off
- Check CH 2 L.E.D's are on in CH 2, ALT CHOP, ADD AND X-Y.

1206. CHECK TRACE IDENT FUNCTION CH 1 and CH 2

Check TRACE IDENT FUNCTION shifts trace approximately .2 div up.

1207. CHECK INPUT LIGHTS CH 1 and CH 2

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

1301. CHECK PROBE POWER (if applicable)

1302. ADDED MODE SHIFT

Freerun trace, Chop Mode
Center CH 1 and CH 2 go to ADD.
Note where the trace is. Go back to
ADD and adj. vertical balance R600
to same location noted in chopped.
Re-center trace in chopped - go to Add
Added Shift $\pm .2$ div.

1303 ADJUST MAIN VERTICAL GAIN

- a. Use CH 2 POSITIONING to Center Trace. Measure voltage at Pins 5 and 9 of U430. $\pm 15\text{mv}$
- b. Adjust R629 for 4 div of deflection from graticule center line after positioning trace for $200\text{mv} +$ the offset. Example: $+7\text{mv}$ at center move 207mv
- c. Position trace to the other Graticule edge, 200mv -offset $\pm 10\text{mv}$
Example: $+7\text{mv}$ at center $200\text{mv} - 7\text{mv} = 193\text{mv}$ at bottom of Grat. $\pm 10\text{mv}$

1304. ADJUST 50Ω INPUT IMPEDANCE CH 1 and CH 2

- a. Set INPUTS to DC
- b. Connect Input Standardizing bridge to CH 2.
- c. Connect 561 calibrator (.1V P-P to standardizing bridge)
- d. Connect Standardizing bridge to 3A9.
- e. Set 3A9 to $50\mu\text{V}/\text{div}$.
- f. Set VOLTS/DIV to $10\text{mV}/\text{div}$.
- g. Adjust R308 for null.
- h. Check all ranges $\pm 0.25\Omega$ max. = 2 div. on screen.
- i. Repeat on CH 1 adjusting R208.

1401. ADJUST 50Ω INPUT OFFSET CURRENT CH 1 and CH 2
- Set INPUTS to GND; VOLTS/DIV to 10mV.
 - Switch INPUT to DC and back to GND.
 - Adjust R206 (CH 1) and R306) CH 2 for no trace shift.
1402. ADJUST VARIABLE BALANCE CH 1 and CH 2
- Set VOLTS/DIV to 10mV/div, INPUT to GND.
 - Rotate Variable V/div fully CCW. Adj. R215 for less than .1 div of shift while switching from uncal. to calibrated.
 - Rotate from CW to CCW end while uncalibrated .2 div shift max.
1403. 10MV - 100MV SHIFT
- Switch input coupling to AC. Rotate from 10mv/div to 100mv/div. The maximum allowable shift is .2 div.
1404. ADJUST 5mV BALANCE CH 1 and CH 2
- Set INPUT to GND; POLARITY +UP.
 - Adjust R350 for no shift when switching between 10 and 5mV.
 - Recheck VARIABLE Balance.
 - Repeat in CH 1 adjusting R250.
 - POLARITY to INVERT, adjust R310 for no shift while rotating VARIABLE VOLTS/DIV (.2 div or less).
1405. CHECK INVERT VARIABLE BALANCE
- Set VARIABLE VOLTS/DIV to CAL.
 - Center Trace
 - Switch POLARITY TO +UP
 - Check for ±0.5 div of trace shift or less.
1406. BEAM FINDER
- Proper operation - trace remains within Graticule area with any combination of vertical or horizontal controls.

1501. ADJUST THERMAL COMPENSATIONS

- a. 50 Ω INPUT; 106 Hi Amp; 5X GR pad; GR to BNC adapter; VOLTS/DIV to 20mV/div and adjust for 6 div of 100Hz.
- b. Adjust R106 for optimum response.
- c. Set 106 to 1kHz and adjust R107 for optimum response.
- d. Set 106 to 10kHz and adjust R608 and R609 for optimum response. (Note Steps b, c, d interact and should be repeated at least one time)

1502. ADJUST CH 1 and CH 2 50 Ω GAIN

- a. Set VOLTS/DIV to 20mV.
- b. Connect 120 mV from 50 Ω cal fixture to CH 1 and CH 2.
- c. Adjust front panel GAIN for mid-range.
- d. Adjust Channel Gain R358 for CH 2 and R255 for CH 1 for 6 div.
- e. Check that the gain in 20 MHz limit is $\pm 1\%$ of the full bandwidth gain.

1503. CHECK ATTENUATOR ACCURACY

$\pm 1.67\%$ (.1 div. of 6 div)

1504. CHECK VARIABLE RANGE CH 1 and CH 2

2:1 from CAL and 2.5:1 overall

1505. ADJUST INVERT GAIN

- a. Set POLARITY to INVERT.
- b. Connect 120 mV from 50 Ω cal fixture to CH 2
- c. Adjust R318 for 6 div.

1506. CHECK ADDED MODE GAIN

- a. Connect 50 Ω cal fixture to CH 1 and CH 2 using dual input connector.
- b. Adjust each channel for 4 div of deflection.
- c. Set POLARITY to +UP
- d. Switch VERT MODE to ADD.
- e. Check for 8 div $\pm .1$ div. (must have 4 div of signal in both channels)
- f. Switch POLARITY to INVERT.
- g. Check for no deflection with CH 1 and CH 2 centered.

1601. ADJUST CH 1 TRIGGER GAIN

- a. Connect probe to TP 568
- b. Adjust R505 to null signal.
- c. Remove signal and switch to CH 1; Adjust DC TRIG for 0V at TP568.
- d. Switch to chopped and center CH 1 and CH 2. Should not see more than 30mv P-P square wave. Replace defective Trig. Channel Switch IC if you have excess signal.

1602. POSITION CENTER AND RANGE

- a. CH 1 and CH 2 20mv/div apply 8 div. of 50 Khz, Switch to 10mv/div.
- b. Adjust Centering Pots. R275 (CH1) and R375 (CH 2) so the top and bottom are equal distance from the Graticule Center when positioning from CCW to CW ± 1.2 div.
- c. Center Position controls (dot to 12:00 o'clock) trace ± 1.5 div from Graticule Center.

1603. AC COUPLING CAPACITORS

- a. Apply about 2 div. of signal from the 50 Ω cal. fixture (067-508-00)
- b. Switch from AC to DC and observe shift.
- c. Switch input selector to 1 meg Ω and repeat b.

1701. HIGH FREQUENCY COMPENSATION

- a. Set 106 to 100kHz, Tunnel Diode Pulser, 2X GR pad.
 - b. Adjust R613, R614, R615, C615, L654 for optimum response.
 - c. Adjust C214 and R214 for front corner level CH 1.
 - d. Adjust C240 and R240 for fastest risetime CH 1.
 - e. Adjust C315 and R315 for front corner CH 2.
 - f. Adjust C340 and R340 for fastest risetime CH 2.
- NOTE: C617 effects ringing in both channels.
- g. Adjust C617 for minimum ringing and fastest risetime.
 - h. Aberration spec +3%-2%, 4% P-P max.
 - i. Set VOLTS/DIV to 20mV; VERT MODE to ADD.
 - j. Use a six division signal.
 - k. Use opposite channel POSITION to position signal.
 - l. Check for no more than 0.2 div of position when signal is moved 4 div.

1702. ADJUST 1 M Ω DC BAL CH 1 and CH 2

- a. INPUT to 50 Ω ; VOLTS/DIV to 10mV; VERT MODE to CH 1; input to DC.
- b. Switch to 1 M Ω and adjust R45 for no shift.
- c. Switch to 5mv/div., while switching from Gnd to DC., look for less than .1 div shift.

1703. ADJUST 1 M Ω GAIN CH 1 and CH 2

- a. Set VOLTS/DIV to 20 mV.
- b. Apply 100mV from SAC and adjust R78 for 5 div of deflection.
(2%)
- c. Check 50 Ω /1 M Ω match $\pm 0.5\%$ in 20mV/div.
- d. Check Attenuator accuracy to $\pm 2\%$.

1704. 1 M Ω 10 KHz FRONT CORNER CH 1 and CH 2

- a. Connect 106 high amplitude with 6 div of 10 KHz through 2X pad, GR cable, 50 Ω attenuator.
- b. Adjust C46 and R53 for level within .25 minor div.

1705. CHECK 1 MEG Ω DYNAMIC RANGE CH 1 and CH 2

- a. 106, 5X pad, at 50mV/div adjust Hi Amplitude for 4 div of 10KHz.
- b. Switch to 10mV/div and with VARIABLE VOLTS/DIV, adjust for about 7 div.
- c. Switch VOLTS/DIV to 50 mV/div and remove 5X pad.
- d. Check for the same level as seen in Step b ± 0.2 div.

1801. ADJUST 1 M Ω INPUT COMPENSATIONS CH 1 and CH 2 $\pm 2\%$
- Connect 5 div of 1 kHz from 106 high amplitude 2X pad and 20 pf standardizer, VOLTS/DIV to 20 mV.
 - Adjust C12 for front corner level to match 50 Ω input level.
 - Check 5, 10 and 50mV.
 - Set VOLTS/DIV to 100 mV and adjust C24 and C26 for optimum response.
 - Check 200 and 500mV.
 - Set VOLTS/DIV to 1V and adjust C20 and C22 for optimum response.
 - Check 2 and 5V.
 - Check all attenuator positions without 20 pf standardizer.
1802. 1 MEG Ω HF COMPENSATION CH 1 and CH 2.
- Set 106 to 100KHz with Tunnel Diode Pulser; 2X GR pad, and 50 Ω Terminator.
 - 20 mV/div, adjust R55 and C55 for optimum front corner.
 - With a six div Step Response, switch to Add
 - Use opposite channel POSITION to position signal.
 - Check for no more than 0.2 div of front corner change when signal is moved 4 div. (from graticule center).
1803. COMMON MODE REJECTION 50 Ω and 1 MEG Ω
- Connect 191 to 50 Ω input impedance CH 1 and CH 2 thru a 10X GR pad.
 - 20 mv/div CH 1 and CH 2, DC coupled.
 - Select CH 2 invert and adjust for 8 div of 50 MHz.
 - Select ADD and look for .4 div or less.
 - Repeat for 1 Meg Ω but terminate the 532 before dual input coupler.
(If the common mode is good, delete Step 2401.)
1804. NOISE FIGURE (Optional, if you want to, QC procedure checks this)
- Connect 106 fast rise to 50 Ω input through 2 10X pads.
 - Sw input to 5mv/div
 - Adj. 106 to 10Khz and reduce the amplitude until the 2 traces just merge.
 - Select 10mv/div and remove the 2 10X pads.
 - In 50 Ω must have less than 2.5 div. of signal.
 - In 1 Meg Ω must have less than 5 div of signal.

1901. CHECK TRANSIENT RESPONSE CH 1 and CH 2

- a. Set VOLTS/DIV to 20mV; $50\Omega/1\text{ M}\Omega$ to 50Ω
- b. Check transient response using Tunnel Diode Pulser. This is the reference.
- c. After observing % aberrations with the Tunnel Diode Pulser, connect the 109 Pulser to the appropriate channel. The response seen is equivalent to that of the Tunnel Diode Pulser.

Example: Tunnel Diode Pulser = 3% P-P and viewed 109 response is 4% P-P. The 4% is equivalent to 3% and with a 6% P-P specification, 8% P-P with the 109 is allowable.

- e. Check 50Ω .1V thru 5V to +3% -2%, $\pm 4\%$ P-P
- f. Check 1 Meg Ω .1V thru 5V $\pm 6\%$ P-P using the same method to calibrate the 109 Pulser except calibrate in 1 m Ω 20 mv/div.

1902. CHECK BANDWIDTH 50Ω and 1 M Ω , CH 1 and CH 2

- a. Check for a minimum of 4.50 div of 250 MHz (6 div of 3MHz) in the 1 Meg Ω INPUT IMPEDANCE. Check 5mv, 50mv. At 1v, check for a minimum of 2.9 div (4 div of 3 MHz)
- b. Check for a minimum of 4.5 div of 350 MHz, 6 div of 3 MHz in the 50Ω INPUT IMPEDANCE. Check 5mv and 50mv.

1903. CHECK VSWR

- a. On Type 3A9 Plug-in, Sw CH 2 input to gnd, and connect VSWR out to CH 1, Sensitivity to 20 $\mu\text{V}/\text{div}$, DC coupled, adj. DC offset for VSWR = 1.00
- b. Adj. 532 Amplitude for VSWR = 1.22 (recheck VSWR = 1.00) Remove the 10X pad and connect the VSWR Bridge to the 485 input, DC coupled to the Channel under test. then connect 432 and 5X GR pad to the VSWR Bridge.
- c. Sweep the frequency of the 532 from 100 MHz to 350 MHz. Should not have a VSWR greater than 1.15 from 20mv to 5V and 1.25 in 5mv and 10mv.
- d. Repeat for CH 2.

2001. ADJUST A TRIGGERS

- a. Connect 1 div of 3 MHz to CH 1 input.
- b. HORIZ DISPLAY to A; INT TRIG to NORM; COUPLING to AC; SOURCE to INT. SWEEP MODE TO NORM
- c. Set level ctr to midr, sens ccw, and Arm and Out T.D., cw, LEVEL cw.
- d. Turn Arm T.D. ccw until trace stops free running. Note position of pot.
- e. Adjust LEVEL for a stable display.
- f. Turn Arm T.D. further ccw until trace stops
- g. Adjust Arm T.D. halfway between the two points.
- h. Remove J769
- i. Adjust Out T.D. until the display is not triggered
- j. Reinsert J769
- k. Adjust sens until display is just barely triggered on 0.18 div of signal, and will not trigger on 0.15 div of signal.
- l. Recheck h and i. Using 2 div of 50 KHz centered around the graticule center.
- m. Adjust level center for a stable display with LEVEL at 12:00 o'clock. Test limit within 5° of 12:00 o'clock.
- n. CH 1 switch coupling to DC, adjust +R560 (Internal Trig DC Bal) for stable trigger at graticule center. (If vertical is being done by Line Tuner, skip n and o)
- o. Check in CH 2. Must trigger ± 0.5 div of graticule center both CH 1, CH 2 and ± 1 div of graticule center in ADD.

2002. ADJUST EXTERNAL TRIGGER LEVEL CENTERING (Skip this if vertical is done by Line Tuner)

- a. Set LEVEL to 12:00
- b. Connect 2 div of 50 KHz to A EXT TRIG INPUT
- c. While pushing A EXT TRIG, adjust R830 so trace starts equal distance + and - from graticule center when switching between + and - slope.
- d. SAC to 200mV check for 4 div of deflection at 50mV/div. $\pm 20\%$.

2003. CHECK LINE TRIGGER POLARITY (A ONLY)

2101. ADJUST B TRIGGERS

- a. HORIZ DISPLAY to B; A TIME/DIV to $1\mu\text{s}$; B TIME/DIV to $.2\mu\text{s}$; SOURCE to INT; COUPLING to AC; A and B LEVEL CW; SWEEP MODE to AUTO TRIG.
- b. Adjust as A TRIGGER except pull J1063.
- c. Horiz. to Alt. while triggered, Rotate DTP. The intensified zone of a trace should jump from cycle to cycle but no movement of B trace should be seen.

2102. COUPLING SW WAVEFORMS

- a. Set 485 to A Sweep, Hold off to Max.
- b. Connect a 50Ω cable with 50Ω terminator to A Ext Trig Input from A Gate
- c. Connect a 10X Probe to the $1\text{ m}\Omega$ input of CH 1 and Select 10 mv/div .
- d. Connect 10X Probe to the emitter of Q716 and free run sweep at $10\mu\text{s/div}$.
- e. In DC, look for a step
- f. Switch to AC, Step Function should move downward
- g. Select HF Rej; the 100% Risetime should be about $5\mu\text{s}$.
- h. Select LF Rej. Look for a differentiated step whose fall time to the base line takes about $50\mu\text{s}$ to $70\mu\text{s}$.
- i. Select AC and 10ms/div ; look for a differentiated response with a fall time to the base line of about $50\text{-}70\text{ms}$.

2103. CHECK FOLLOWING AMPLITUDES AND FREQUENCIES A AND B.

- a. In AC, LF REJ, and DC
- b. Does trigger on $.3\text{ div}$ of 3 MHz , $.3\text{ div}$ of 50 MHz , and 1.5 div of 350 MHz .
- c. Less than 100 ps jitter at 350 MHz . (If vertical is done by Line Tuner skip c.)

2104. CHECK EXT TRIGGERS A AND B

- a. 20mV at 50 MHz
- b. 100mV at 350 MHz

2105. TRIGGER MODE LOGIC

- a. $5\mu\text{s}$ time marks to CH 1.
- b. Do checks outlined in Table I. (See Table I on following page)

2201.

TABLE I

TRIG. MODE	VERTICAL MODE	INPUT TO CH 1	INPUT TO CH 2	SHOULD TRIGGER	SHOULD NOT TRIGGER
Norm	CH 1	X		X	
CH 1	CH 1	X		X	
CH 1	CH 2	X		X	
CH 2	CH 1	X			X
Norm	CH 2		X	X	
CH 1	CH 2		X		X
CH 2	CH 2		X	X	
CH 2	CH 1		X	X	

2301. CHECK EXT. TRIGGER LEVEL RANGE A and B

- a. Apply .5V of +DC mixed, with the POLARITY switch in the correct mode.
- b. Check for cutoff.
- c. Repeat with .5V of -DC mixed.
- d. With SOURCE in EXT -10 repeat as in a, b and c using $\pm 5V$ mixed.

2302. SINGLE SWEEP

- a. Trigger on .5 div of 50 KHz
- b. Remove signal and go to Single Sweep
- c. Reset lamp should light
- d. Apply signal; should have one trace.
- e. Remove signal and reset. Should light the reset lamp.

2303. EXT. TRIG INDENT DELAY MATCH

- a. Connect Type 109 Pulser through GR "T" with 5X pad and 2ns coax in each leg. Terminate one leg with GR 50 Ω terminator.
- b. Connect 50 Ω terminator to A EXT TRIG and other leg to CH 1 50 Ω input.
- c. Adjust CH 1 sensitivity for the same amplitude as viewed on A EXT TRIG.
- d. Position equal around zero and measure time between 50% points. 500 ps max.

2304. A EXT. TRIG RESPONSE

- a. Connect Type 109 Pulser through a terminated 2X GR pad to the A EXT TRIG input.
- b. Depress the A EXT TRIG sw and check Risetime to less than 1.4 ns and aberrations to +25%, -25% , 30% P-P.

2401. 50 Ω 1M Ω MATCH CH 1 and CH 2 (If CMRR was good, delete this step)

- a. Using Type 109 Pulser, CT-3 with terminated coax on pickoff to A EXT TRIG, trigger A.
- b. Connect CT-3 to vertical input with a GR to BNC adapter.
- c. Adjust sensitivity for 2 div positioned equally around zero.
(Note where 50% occurs)
- d. Remove GR to BNC and terminate with GR 50 Ω terminator.
- e. Switch to 1 M Ω and note where 50% occurs.
- f. 50 Ω and 1M Ω must match within 100ps.

Steps 2402-2502 may be skipped if the Vertical is being calibrated by a Line Tuner.

2402. ADJUST X-Y BALANCE

- a. Set VERT MODE to ALT; VOLTS/DIV to 20mV.
- b. Center both traces.
- c. Set VERT MODE to X-Y.
- d. Adjust R1355 to center dot. (Located on Sweep Board)

2403. ADJUST X-Y GAIN

- a. Connect 120 mV from 50 Ω cal fixture to CH + 50 Ω input impedance.
- b. Adjust R575 for 6 div, must match CH 2 gain $\pm 1\%$.
- c. 5mv/div to 5v/div gain accuracy $\pm 2\%$ (If the attenuator accuracy is well within specs (1 %) skip c)

2404. ADJUST X-Y PHASING

- a. Connect CH 1 and CH 2 to 191 generator through dual input connector.
- b. Apply 10 div of 50 KHz
- c. Switch to 4 MHz.
- d. Adjust L1346 (sweep board) for a closed lissajous pattern.
- e. Switch 191 to next range down, adjust R1348 (sweep board) for closed lissajous pattern.
- f. Recheck d and e as they may interact.
- g. Sw to 20 MHz limit, compromise between full and 20 MHz limit for less than .2 div opening with 7 div of signal.

2501. CHECK X-Y BANDWIDTH

- a. Gnd CH 1, apply 10 div of 50 KHz to CH 2.
- b. Check for at least 4 MHz bandwidth at -3db point.

2502. CHECK BANDWIDTH LIMIT (If vertical is calibrated by Line Tuner, skip this step)

- 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 -3db point.
- d. Set 1 div of 50 MHz, go to bandwidth limit.
- e. Check signal does not trigger.