ADJUSTMENT PROCEDURE

INTRODUCTION

IMPORTANT—PLEASE READ BEFORE USING THIS PROCEDURE

This procedure is used to return the instrument to conformance with its "Performance Requirements" as listed in the "Specification" (Section 1). It can also be used to optimize the performance of the instrument. As a general rule, these adjustments should be performed every 2000 hours of operation or once a year if used infrequently.

The Adjustment Procedure consists of three subsections. The first subsection is "Internal Adjustments." Step 1 of this subsection, "Display Adjustments," uses display test patterns generated internally by the instrument. Steps 2 through 6 require external generators to provide signals for the test displays. In all steps of the "Internal Adjustments" internal controls must be adjusted (cabinet removal is required). An internal jumper must also be pulled off to enable the menu choices for the Extended Calibration menu. This menu must be enabled to perform "Display Adjustments" as well as the Attenuators and Triggers adjustments called out in the "External Calibration" subsection of this procedure.

The second subsection is "Self Calibration." SELF CAL is a fully automatic procedure initiated by the user from the front panel. No external signals or internal adjustments are required, and beyond starting the procedure, no further action is needed for the user to do a SELF CAL. The instrument cabinet must be installed to obtain a proper SELF CAL, and the Self Calibration subsection must be done and passed before going on to the third subsection of the Adjustment Procedure.

Subsection three is "External Calibration." Here, the user inputs test signals for the Attenuator and Trigger calibration and initiates the semiautomatic routines that use those signals. The internal jumper disabling the Extended Calibration (EXT CAL) menu must be removed to enable the EXT CAL menu choices (as was necessary for the Display Adjustments in "Internal Adjustments" subsection). The instrument cabinet must be installed and the instrument operating at an ambient temperature between +20°C and +30°C for valid calibration of the Attenuators and Trigger circuits.

CALIBRATION SEQUENCE AND PARTIAL PROCEDURES

To completely calibrate this instrument, all steps of this procedure should be performed, completely and in sequence. Individual steps in either the Internal Adjustments or External Calibration subsections can be omitted if a complete calibration is not needed. Individual substeps (parts) in "Display Adjustments" (Internal Adjustments subsection) can be skipped by advancing to the next display.

While a Self Calibration must be performed before doing the External Adjustments, it can also be performed any time the instrument is installed in its cabinet, optimizing the instrument's performance for the existing environment. The internal jumper removed for performance of the Internal Adjustments and External Calibration does not affect Self Calibration.

WARM-UP TIME REQUIREMENTS

This oscilloscope requires adequate warm-up time in a 20°C to 30°C environment before performing the calibration routines and adjustments in this procedure. Calibration performed before the operating temperature has stabilized may cause an erroneous calibration. The adjustment procedure indicates the duration of the warm-up periods and the points in the procedure at which they should be allowed.

PRESERVATION OF INSTRUMENT CALIBRATION

Both the Internal Adjustments and External Calibration subsections require enabling the EXTENDED CALIBRATION menu. Since the internal calibration constants stored can be altered by the user if the EXTENDED CALIBRATION menu is enabled, this menu is disabled by the installation of an internal jumper. REINSTALLATION OF THE INTERNAL JUMPER TO PREVENT INADVERTENT ALTERING OF INTERNAL CALIBRATION CONSTANTS BY USERS IS RECOMMENDED. Performance of a Self Calibration only, without performance of either of the other two subsections, does not require the removal of the jumper or cabinet.

NOTE

The Extended Calibration menu can also be accessed via the GPIB (General Purpose Interface Bus). See "Extended Calibration" in Appendix A of the Operators Manual for further information.

INTERNAL ADJUSTMENTS

Equipment Required (See Table 4-1):

- Primary Leveled Sine-Wave Generator (Item 1)
- Secondary Leveled Sine-Wave Generator (Item 2)
- Calibration Generator (Item 3)
- Coaxial Cable (Item 10)
- Precision Coaxial Cable (Item 11)
- 50 Ω Termination (Item 12)
- 10X Attenuator (Item 13)
- 5X Attenuator (Item 14)
- Dual-Input Coupler (Item 18)
- Alignment Tool (Item 25)
- Normalizer (Item 26)
- Tunnel-Diode Pulser (Item 27)

1. Display Adjustments.

a. Remove the cabinet from the instrument (see "Removal and Replacement Procedure" in the "Maintenance" section of this manual). Remove jumper J156 from P156 on the Side Board (on right side of instrument near the front).

NOTE

Operation (for more than a few minutes) of the scope without its cabinet installed requires that cooling be provided for the components on the Main board. Use a small fan to direct air across the finned heatsinks on that board. The fan used should have the same airflow capability as the fan used in the scope. The CFM (cubic feet per minute) specification for the instrument's fan is 35 CFM at 0 H_20 (essentially, open air). Do NOT remove the fan from the scope for use in cooling the Main board, as critical components in other sections of the instrument may overheat.

b. Connect the instrument to a suitable power source and power it ON. Allow a 10 minute warm up before performing the rest of this subsection.

c. Press the MENU OFF/EXTENDED FUNCTIONS button once or twice (two presses are necessary if any menu is presently displayed, one press if no menu is displayed) to display the EXT FUNCT Functions menu.

d. Press the menu button labeled CAL/DIAG (menu will change).

e. Press the menu button labeled EXT CAL to display the EXT CAL menu.

f. Press the menu button labeled ADJUSTS (Display 1 will appear).

g. ADJUST—The ASTIG and FOCUS front panel controls for best definition of the displayed dot.

h. Press any menu button to advance to Display 2.

NOTE

All adjustment controls associated with Displays 2 and 3 that are not designated front panel controls are located between the fan and the high-voltage shield on the left side board of the instrument.

i. ADJUST—R100 (Grid Bias control) as necessary to display two dots. Continue to adjust R100 just until one dot disappears, leaving the other dot displayed.

j. Press any menu button to advance to Display 3.

k. ADJUST—The ASTIG and FOCUS front panel controls and R300 (Edge Focus control) for most uniform focus over the entire displayed pattern.

l. ADJUST—The TRACE ROTATION front panel control to align the horizontal lines of the displayed pattern parallel to the horizontal graticule lines.

m. ADJUST—R305 (the Y-AXIS control) to align the vertical lines of the displayed pattern parallel to the vertical graticule lines.

n. REPEAT—Parts l and m to obtain best overall alignment.

o. ADJUST—R200 (Geometry control) for the least curvature overall of the display lines at the vertical and horizontal edges of the crt screen.

p. ADJUST—R300 (Edge Focus control) for best focus along the edges of the crt screen.

q. Set the INTENSITY control (front panel) for maximum brightness of the display. ADJUST—R400 (Hi-Drive Focus) for best overall focus of the displayed pattern.

r. Return the INTENSITY control to approximately the same setting in effect prior to part p and repeat parts p and q for best focus compromise between the two intensity settings.

s. Press any menu button to advance to Display 4. Note that all adjustment controls associated with this display are located on the top circuit board near the rear of the instrument (see Figure 5-1).

t. ADJUST—R583 (Vertical Spot-wobble control) and R584 (Horizontal Spot-wobble control) for maximum overall definition of the displayed dot pattern (only one dot visible at each graticule line intersection where a dot is displayed).

NOTE

When the Spot-wobble compensation is badly out of adjustment, three dots will be visible at each of the 33 dot locations. ADJUST—R583 or R584 to align the dots in either a vertically or horizontally oriented line, then use the other control to adjust for only one dot at each dot location (all three dots superimposed).

u. Press any menu button to advance to Display 5. Note that all adjustment controls associated with this display are located on the top circuit board near the rear of the instrument (see Figure 5-1).

NOTE

The display generated by performing part s is composed of a "rectangle" of dots, a small "cross" of 5 dots, and a large "cross" of 2 vectors. Calibration for this display consists of aligning the small cross to the large one (parts v and w), then aligning both crosses to the center graticule lines (parts x and y), and finally, adjusting the horizontal sides of the rectangle for 6 divisions of separation and the vertical sides for 8 divisions of separation (parts z and aa). See Figure 5-2 (a and b).

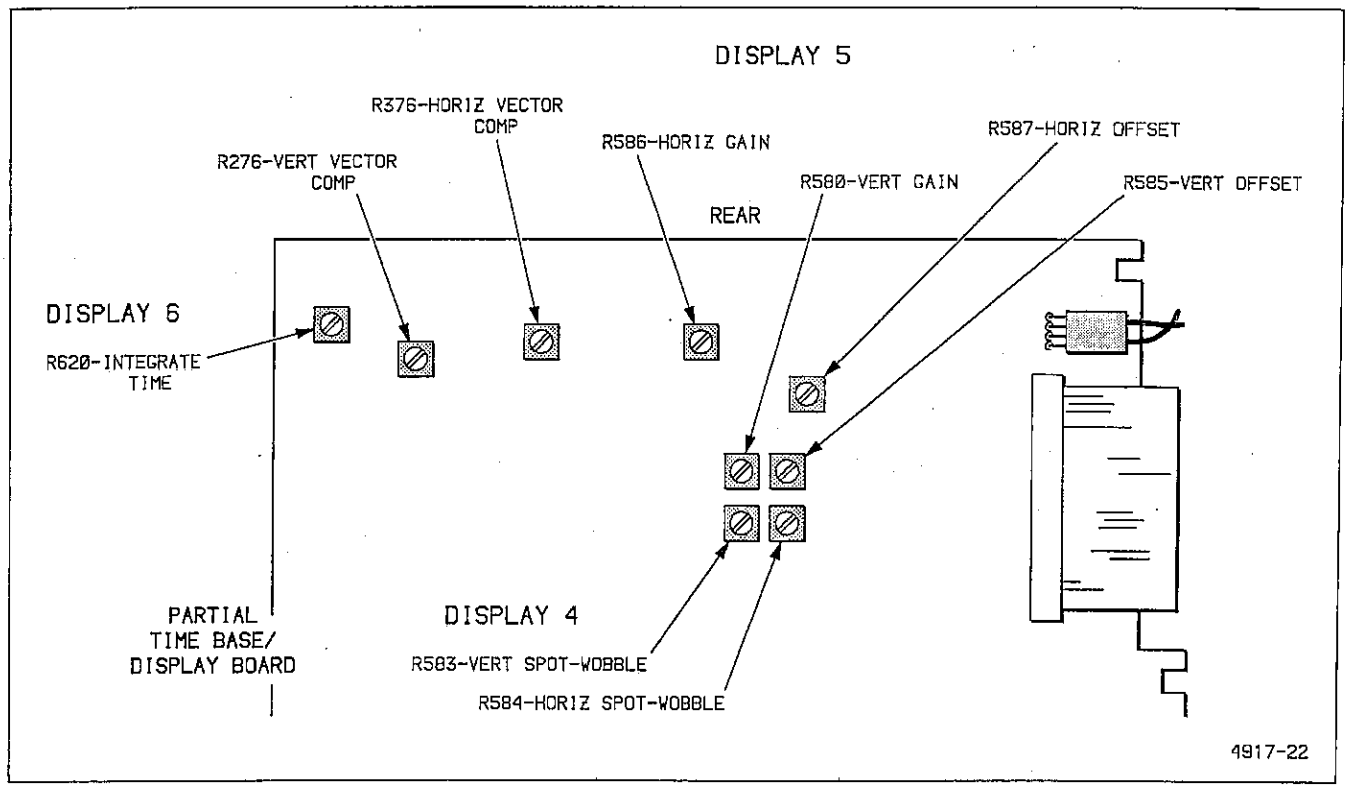
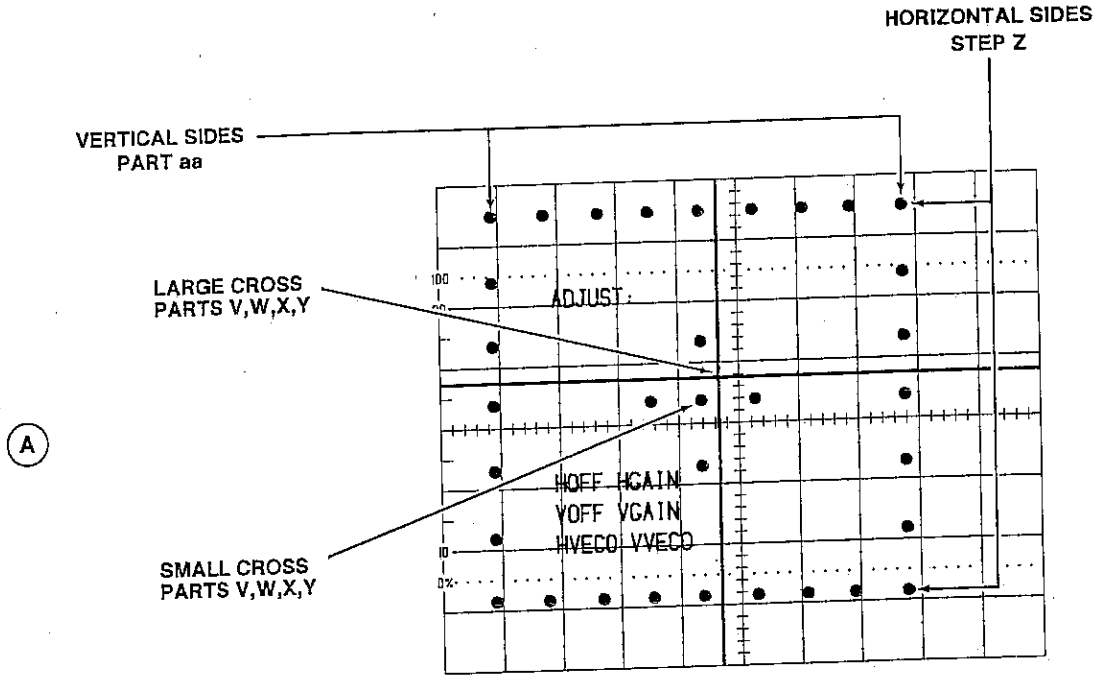
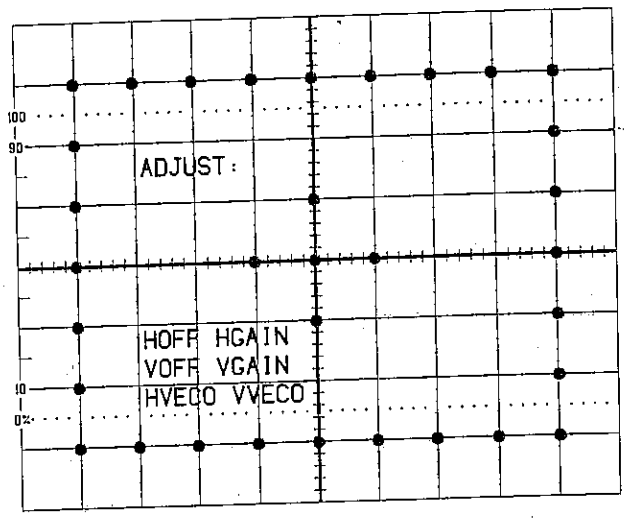


Figure 5-1. Adjustment locations for Displays 4 through 6.



A

Typical display (No. 5) needing adjustment. Arrows designate display components and procedure steps affecting those components.



B

Typical display (No. 5) when horizontal and vertical offsets, gains and vector compensations are correctly adjusted.

4917-16

Figure 5-2 (a and b). Display 5—Vertical and Horizontal Gain, Offset, and Vector Compensation adjustments pattern.

v. ADJUST—R276 (Vertical Vector Compensation control) to align the 3 vertically oriented dots of the small cross pattern to the vertical vector of the large cross pattern.

w. ADJUST—R376 (Horizontal Vector Compensation control) to align the 3 horizontally oriented dots of the small cross pattern to the horizontal vector of the large cross pattern.

x. ADJUST—R585 (Vertical Offset control) to precisely align the horizontal vector of the displayed pattern to the center horizontal graticule line.

y. ADJUST—R587 (Horizontal Offset control) to precisely align the vertical vector of the displayed pattern to the center vertical graticule line.

z. ADJUST—R580 (Vertical Gain control) to space the horizontal sides of the rectangle exactly 6 divisions apart.

aa. ADJUST—R586 (Horizontal Gain control) to space the vertical sides of the rectangle exactly 8 divisions apart.

ab. Press any menu button to advance to Display 6. Note that the adjustment control associated with this display is located on the top circuit board near the left rear corner of the instrument (see Figure 5-1).

ac. ADJUST—R620 (Integrator Time control) for best front corner (minimum roll-up or roll-off) of the high-frequency (filled) portion of the display. See Figure 5-3 for further detail.

ad. Push any menu button to exit display 6.

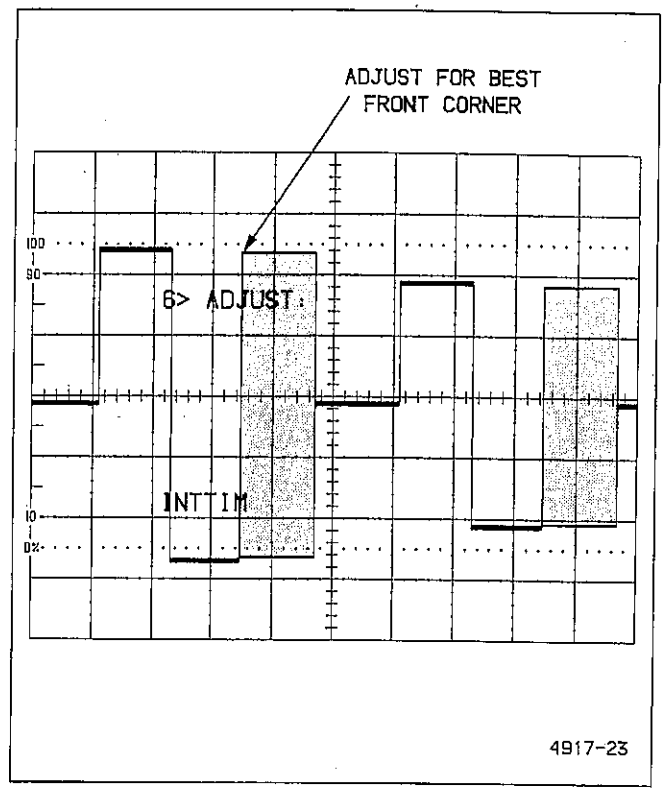


Figure 5-3. Display 6—Integrator Time adjustment pattern.

2. CCD Clocks Adjustment.

a. **Determine if CCD clocks need adjustment:**

- If doing this adjustment procedure after a repair that required replacing either or both CCD's (U450 and U350 on schematic diagram 10) or Peak Detectors (U440 and U340, also on diagram 10) or the CCD Phase Clock Generator (U470 on schematic diagram 11), the CCD clocks will need adjustment; skip to part b and continue this procedure.

- If doing this adjustment procedure as part of routine maintenance, or after a repair that did *not* require replacing the components just mentioned, do the following to determine if clock adjustment is adequate: perform part c to preset the instrument's front-panel controls (skip making the TRIGGER SOURCE setting). Next do part h and subparts 1-3 of part i to set up the instrument and the test generator for checking clock adjustments. Now, do part r, subparts 1-3. If part r is passed for both channels, CCD clock calibration is good; skip to step 3, "CH 1 and CH 2 Input Capacitance Adjustment". If part r is not passed, continue this procedure at part b.

b. **Preset clock adjustments:** Center all adjustment controls shown in Figure 5-4 so they are halfway between full clockwise and full counter-clockwise rotation.

c. **Initialize front-panel controls:** Push the SETUP PRGM front-panel button; then push the menu button labeled INIT. Push the TRIGGER SOURCE front-panel button and set LINE on (underline it) in the menu.

NOTE

This procedure for adjusting clocks assumes front-panel settings set by the PRGM INIT feature; change those settings only when directed to by this procedure.

d. **Preset Common-Mode counts:**

1. **Display GN-DAC counts:** Set CH 1 VOLTS/DIV control to 50 mV, and set the SEC/DIV to 500 ns. Rotate the CH 1 POSITION knob to move the display up off screen. Push MENU OFF/EXTENDED FUNCTIONS twice; then push the SPECIAL menu button, and, when the menu changes, push CCD ADJ. Now, push the ADJ T1 A2 menu button to display the A and T clock adjustment numbers (T1 A2 will be underlined).

2. **Display menu for adjusting CM counts:** Push MENU OFF/EXTENDED FUNCTIONS twice; then push the SPECIAL menu button, and, when the menu changes, push FORCE DAC. The menu for adjusting the CM counts should now be at the bottom of the screen, with the various CCD counts for the four CH 1 CCD sides and the message "TESTING CHANNEL 1" displayed above that menu. (See Figure 5-5.)

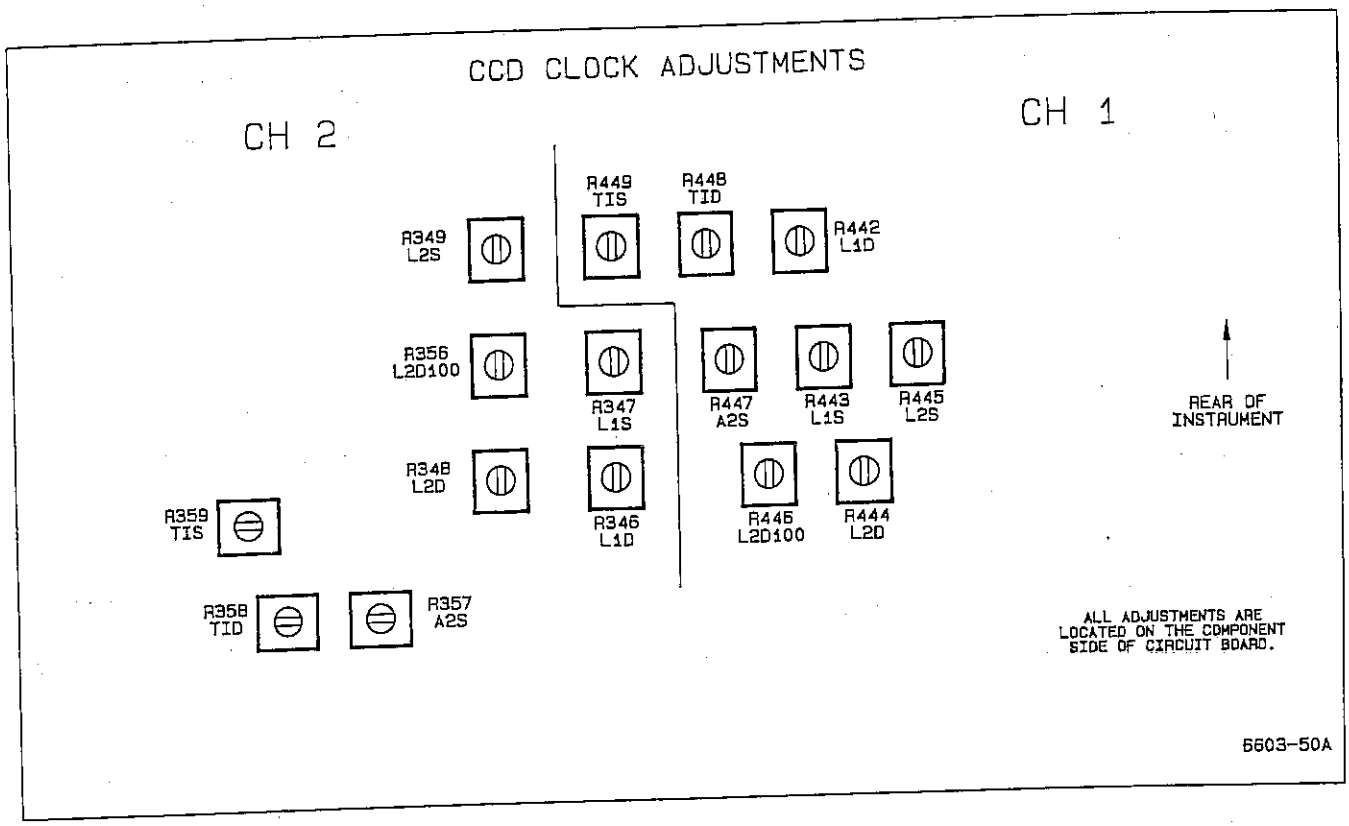


Figure 5-4 (SN B010250 & Above). CH 1 and CH 2 CCD Clock Adjustments (shown centered, as after doing part b).

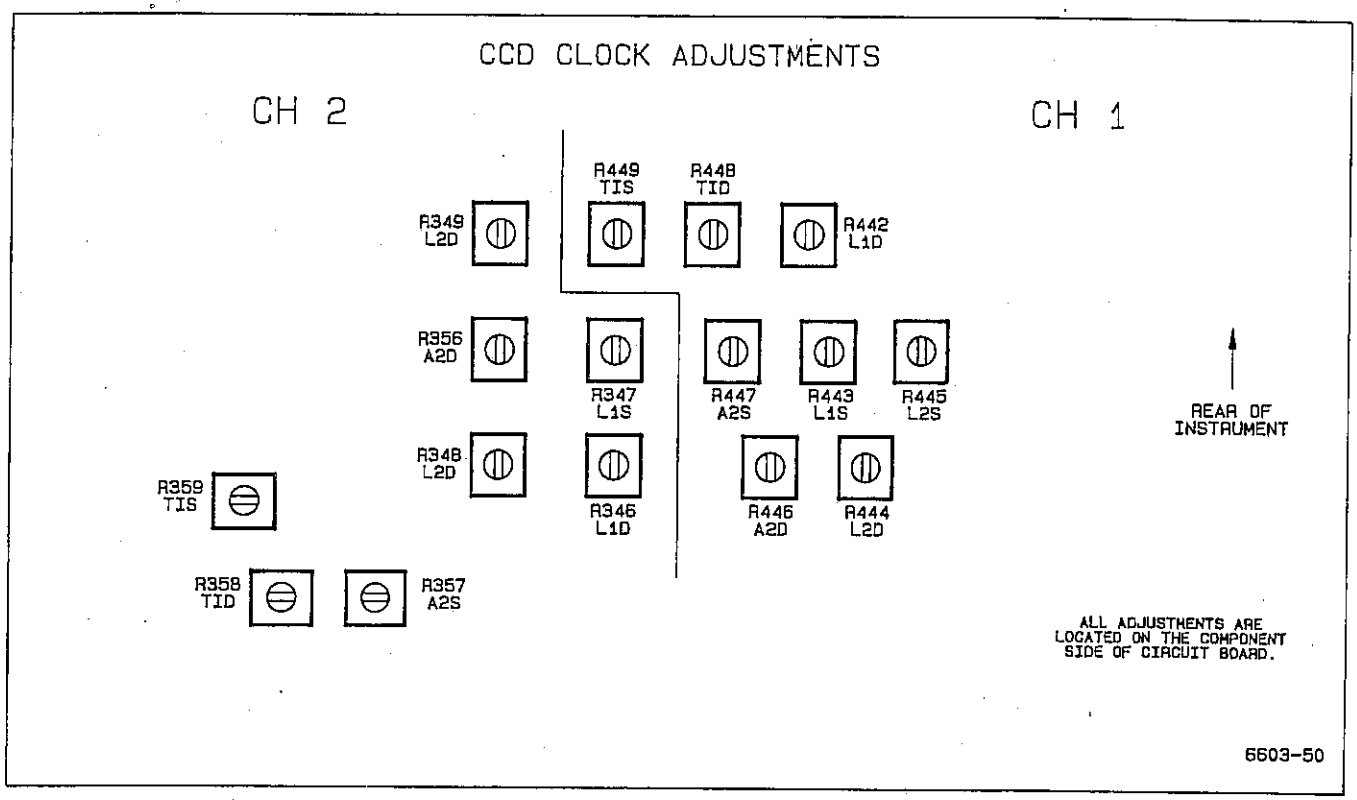


Figure 5-4 (SN B010249 & Below). CH 1 and CH 2 CCD Clock Adjustments (shown centered, as after doing part b).

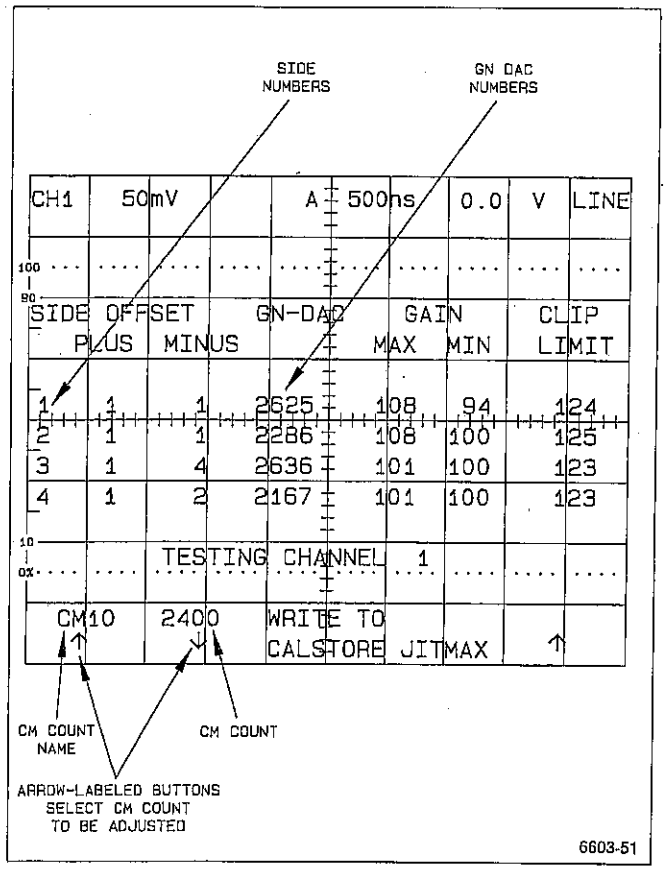


Figure 5-5. CCD counts display and CM adjustment menu.

3. **Set CM/GN-DAC counts, CH 1 sides 1 and 3, at 500 ns:** Repeatedly push the left-most menu button until the common-mode count for CM1O is displayed. Rotate the INTENSITY knob to set the CM1O count to 4095 (maximum count), and then do the following:

- If either GN-DAC counts for side 1 and 3 are below 500, refer the instrument to service personnel for repair.
- If the GN-DAC counts for both side 1 and side 3 are within 500-3200, push WRITE TO CAL STORE and skip to subpart 4.
- If the GN-DAC counts for either or both side 1 and 3 are above 3200 counts, reduce the CM1O count (CM1O stands for Common-Mode count, CH 1, Odd sides) *just enough to bring both counts to ⩽ 3200*, and then push WRITE TO CAL STORE. If CM1O must be reduced to below 1500 counts to bring both GN-DAC counts to within limits, or if both counts cannot be brought to within limits, refer the instrument to service personnel for repair.

4. **Set CM/GN-DAC counts, CH 1 side 2 and 4, at 500 ns:** Push the left-most menu button to move to CM1E (Common-Mode count, CH 1, Even sides); then rotate the INTENSITY knob to set this count to 4095. Now check, and set to within limits if necessary, the GN-DAC counts for sides 2 and 4 as was just done for sides 1 and 3 in subpart 3.

5. **Set CM/GN-DAC counts, CH 2 all sides, at 500 ns:** Rotate the CH 1 POSITION knob to return the CH 1 trace to center screen. Push VERTICAL MODE and set CH 2 on and CH 1 off in the menu. Set CH 2 VOLTS/DIV to 50 mV and rotate the CH 2 POSITION knob to move the CH 2 trace up off screen. Now, return to the CM counts menu: push MENU OFF/EXTENDED FUNCTIONS twice; then push SPECIAL; then push FORCE DAC. The menu for adjusting the CM counts should now be at the bottom of the screen, with the CCD counts for CH 2 CCD sides and the message "TESTING CHANNEL 2" displayed above that menu. Push the left-most menu button until CM20 appears; then repeat subparts 3 and 4, adjusting the CH 2 common-mode counts, CM2O instead of CM1O, and CM2E instead of CM1E.

6. **Turn off CCD counts display:** Vertically position CH 2 back to center screen. Next, push MENU OFF/EXTENDED FUNCTIONS twice; then push SPECIAL; then push CCD ADJ. Now, push the ADJ T1 A2 menu button to turn off the A and T clock adjustment numbers.

7. **Match CH 1 CM counts at 200 ns and 100 ns to 500 ns:** Push VERTICAL MODE and set CH 1 on and CH 2 off. Push MENU OFF/EXTENDED FUNCTIONS twice; then push the SPECIAL menu button, and, when the menu changes, push FORCE DAC. Note the CM1O and CM1E counts obtained in subpart 4. (Use the left- and right-most menu buttons to display CM1O and CM1E.) Now change the SEC/DIV setting to 200 ns, and use the INTENSITY control to set CM1O and CM1E to the values just noted. When finished, push WRITE TO CALSTORE, followed by the A HORIZONTAL MODE button. Change the SEC/DIV to 100 ns and match CM1O and CM2E to the 500 ns values also.

8. **Match CH 2 CM counts at 200 ns and 100 ns to 500 ns:** Push VERTICAL MODE and set CH 2 on and CH 1 off. Return the SEC/DIV to 500 ns. Repeat subpart 7 for CH 2, adjusting CM2O and CM2E, rather than CM1O and CM1E. Remember to push WRITE TO CALSTORE followed by A HORIZONTAL MODE after each CM adjustment.

e. **Do a SELF CAL and verify initial CCD gain:** Skip to, and perform, the procedure found under SELF CALIBRATION in this section. (At this stage of instrument adjustment, SELF CALIBRATION may take several minutes to run rather than the 10 seconds mentioned in the SELF CAL procedure.) If instrument passes the SELF CAL (see NOTE in SELF CAL procedure), skip to part f of this procedure and continue. If, after redoing a SELF CAL as directed in parts e and f of the SELF CAL procedure, any test level except level 7000 has FAIL status, quit this procedure and refer the instrument to service personnel.

If only test level 7000 failed, verify that CCD gain test 7210- 30 passed: repeatedly push the down-arrow menu button to move down the underline pointer at test level 0000 until it is under test level 7000. Push RUN/SEL, and when the menu changes, use the down-arrow button to underline 7200. Push RUN/SEL. Test levels 7210, 7220, and 7230 should all have PASS status (ignore 7240 and 7250); if so, push MENU OFF/EXTENDED FUNCTIONS to remove diagnostic menu and continue with subpart f; if not, quit this procedure and refer the instrument to qualified service personnel for repair.

f. **Check CH 2 and CH 1 LF-linearity and position-effect, and fine-adjust CM counts:**

1. **Set up instrument for check:** Set A SEC/DIV to 50 μs. Next, push COUPLING/INVERT and set 50 Ω ON!OFF to ON for both CH 1 and CH 2. Push ACQUIRE and set REPET ON!OFF to ON. Push TRIGGER SOURCE and set to VERT in the menu. Connect the + FAST RISE output of a Calibration Generator to the CH 2 input connector via a 50-Ω cable. Set the generator output for a 1 ms period and for exactly 2 vertical divisions (discount trace width) of amplitude. Vertically center the display.

2. **Make linearity check:** Rotate the CH 2 POSITION knob to align the bottom of the waveform to the horizontal graticule mark 2.5 divisions above the center horizontal graticule line (the top of the waveform will be off screen). Now push SAVE, vertically reposition the waveform to center screen, and check that the amplitude of the saved waveform is between 1.9 and 2.1 divisions. Push ACQUIRE and repeat the linearity check, this time aligning the *top* of the waveform to the mark 2.5 divisions below the center horizontal graticule line before pushing SAVE. Push ACQUIRE when finished.

3. **Make position-effect check:** Set SEC/DIV to 5 ns. Adjust the amplitude of the calibration generator for 5 divisions, vertically center the pulse, and

horizontally align its rising edge to center screen. Position the top of the waveform to 3.5 divisions below center graticule. Push ACQUIRE and set ENVELOPE to CONTinuous. Check that the vertical width of the trace between 5 ns and 15 ns after the step transition is less than 0.4 division. (Push MENU OFF/EXTENDED FUNCTIONS to turn off menu so the waveform can be easily seen.) Set A SEC/DIV to 500 ns. Push ACQUIRE and set back to NORMAL.

4. **Fine-adjust CM counts:** If both LF-linearity checks in subpart 2, as well as the position-effect check in subpart 3, were passed, skip to subpart 5. If either of the LF-linearity checks *and* the position-effect check failed, refer the instrument to qualified service personnel for repair. Otherwise, display the menu for adjusting the CM counts: Push MENU OFF/EXTENDED FUNCTIONS twice; then SPECIAL; then push FORCE DAC. Then, do the following:

- If either of the LF-linearity checks failed but the position-effect check passed, rotate the INTENSITY control to reduce CM2E by about 150 counts; then push WRITE TO CALSTORE; then push the A HORIZONTAL MODE front-panel button. Next, push the downward arrow menu button to display CM2O and reduce it by about 150 counts also; then push WRITE TO CALSTORE, followed by the A HORIZONTAL MODE button.

- If only position-effect check failed, repeat CM2E/CM2O adjustments as just described for the LF-linearity check failure except increase, rather than reduce, CM2E and CM2O by about 150 counts.

If you had to reduce/increase the CM counts, change the SEC/DIV setting to 200 ns and set CM2O and CM2E to the new values just set for the 500 ns setting. Switch to 100 ns and repeat. (Use the two left-most menu buttons to select between CM2O and CM2E; remember to always push WRITE TO CALSTORE, followed by the A HORIZONTAL MODE button after adjusting any CM count.) When finished, return the SEC/DIV setting to 50 μs and repeat subparts 2, 3, and 4 until the LF-linearity and position-effect checks pass or until CM count is below 1500. (Always match the CM counts at 200 and 100 ns when they are changed at 500 ns.) If any CM count must be reduced below 1500, the instrument should be referred to qualified service personnel for repair.

5. **GN-DAC counts check:** SEC/DIV should be set to 500 ns. Push MENU OFF/EXTENDED FUNCTIONS twice; then SPECIAL; then CCD ADJ. Push ADJ TI A2 to display the GN-DAC counts. ("TESTING CHANNEL 2" should be displayed.) Check that the GN-DAC counts for all four sides (1-4) are within 1000-3200. If one or more GN-DAC counts are outside this range, change test-selectable resistors R690 and R881 (located on Time Base board) to one of the three pairs of values given in Table 5-1. *Resistors must be changed as a pair.* If the out-of-limit GN-DAC counts are greater than 3200, increase R690 and R881 to next higher pair of values listed; if the GN-DAC counts are less than 1000, decrease the resistors to the next lower pair of values. Recheck GN-DAC counts and increase/decrease resistors to the next pair in table as required. If GN-DAC counts cannot be brought to within limits with values pairs given in Table 5-1, refer instrument to qualified service personnel for repair.

Table 5-1
Test Selectable Resistor Values
(R690 and R881)

R690	PART NUMBER	R881	PART NUMBER
100 Ω	321-0097-00	301 Ω	321-0143-00
107 Ω	321-0100-00	348 Ω	321-0149-00
110 Ω	321-0101-00	374 Ω	321-0152-00

6. **Check LF-linearity and position effect, and fine-adjust CM counts for CH 1:** Push the ADJ TI A2 menu button to turn off the GN-DAC counts display. Set the SEC/DIV to 50 μs. Move the 50-Ω cable at CH 2 to the CH 1 input connector. Push VERTICAL MODE, set CH 2 off and CH 1 on in the menu. Adjust the generator for exactly 2 vertical divisions (discount trace width) amplitude, vertically centered on screen. Now do subparts 2-5, using CH 1 controls instead of CH 2 controls and adjusting CM1O/CM1E where CM2O/CM2E are indicated. ("TESTING CHANNEL 1" will be displayed when subpart 5 is performed.) Any time R609 and R881 must be changed to bring either channel's GN-DAC counts within limits, subpart 5 must be reperformed for the other channel. If the resistors must be changed to a higher pair of values for one channel, only to require a lower pair for the other channel, or if both channels cannot be brought to within the GN-DAC count limits, refer this instrument to qualified service personnel for repair.

7. **Remove setup:** Push ACQUIRE and set REPET ON|OFF to OFF. Disconnect the cable from the CH 1 input connector.

g. **Check for correct CCD operation:**

1. **Display GN-DAC counts:** Push MENU OFF/EXTENDED FUNCTIONS twice; then push SPECIAL; then push CCD ADJ. Now, push the ADJ T1 A2 menu button to display the A and T clock adjustment numbers (T1 A2 will be underlined). The various CCD counts for the four CH 1 CCD sides should be on screen, with the message "TESTING CHANNEL 1" displayed near the bottom of the screen.

2. **Verify CH 1 counts are within limits:** Set the SEC/DIV control to 500 ns. Verify that the various counts for each of sides 1-4 are within the limits listed below. If any count is outside the limit listed, refer the instrument to service personnel.

SIDE	OFFSET		GN-DAC		GAIN	CLIP
	PLUS	MINUS	MAX	MIN	LIMIT	
1-4	≤10	≤10	500-3500	≤115	≥80	≥100

3. **Verify CH 2 counts are within limits:** Push VERTICAL MODE and set CH 2 on and CH 1 off in the menu displayed (message will change to "TESTING CHANNEL 2"). Verify that the various counts for each of the CH 2 sides 1-4 are within the limits listed for subpart 2. If any count is outside the limit listed, refer the instrument to service personnel.

4. **Turn off display of GN-DAC counts:** Redo subpart 1, pushing ADJ T1 A2 menu button to remove the display (the underline below T1 A2 is also removed.)

h. **Prepare instrument for adjusting L, TI, and A clocks:**

1. **Turn off display vectors:** Push the front-panel button SELECT, and when the menu changes, push the menu button to set VECTORS ON¦OFF to OFF (OFF should be underlined).

2. **Set input coupling:** Push CH 1 COUPLING/INVERT and set 50 OHMS ON¦OFF to ON (the coupling mode should already be set to DC) in the menu displayed. Push CH 2 COUPLING/INVERT and set 50 OHMS ON¦OFF to ON in that menu.

For SN B010250 & Above

3. **Input test signal:** Connect the output of the secondary Leveled Sine-wave Generator (Item 2) to the CH 1 and CH 2 input connectors via a precision 50-Ω BNC cable and a dual-input coupler.

For SN B010249 & Below

3. **Input test signal:** Connect the output of the primary Leveled Sine-wave Generator (Item 1) to the CH 1 and CH 2 input connectors via a precision 50-Ω BNC cable and a dual-input coupler.

i. **Set up to adjust the L clocks:**

1. **Set up Vertical mode, Trigger source, and acquisition rate:** Push the VERTICAL MODE front-panel button and turn CH 1 on in the menu displayed. Leave CH 1 on also; both channel's VOLTS/DIV setting should be 50 mV. Next, rotate the CH 2 POSITION knob to move the CH 2 trace up off screen. Push TRIGGER SOURCE, and then push the EXT menu button. When the menu changes, set A EXT SOURCE 1¦2 to 2 (underline the "2"). Set the SEC/DIV control to 200 ns.

NOTE

The following two subparts set up an "aliased" display on screen that is used in adjusting the L clocks. At the 200-ns per division setting specified in subpart 2, the acquisition rate will be lower than is required to properly display the 250-MHz sine wave specified in the same subpart. However, by slightly varying the generator output frequency as needed, an "aliased" display is created. The aliased sine wave appears as if it is untriggered and as if its frequency is much lower than the 250-MHz sine wave output by the generator. Use a generator with a highly stable frequency output, such as the TEKTRONIX SG 503.

For SN B010250 & Above

2. **Set up test signal:** Set the generator output level for about a 6-division display at a frequency of 6 MHz, then change the output frequency to 250 MHz. Readjust for a 6 divisions amplitude if necessary, and vertically center the display.

For SN B010249 & Below

2. **Set up test signal:** Set the generator output level for about a 6-division display at a frequency of 1 MHz, then change the output frequency to 250 MHz. Readjust for a 6 divisions amplitude if necessary, and vertically center the display.

3. **Alias display:** Vary the generator output frequency slightly (if required) until only one or two cycles of the untriggered sine wave are displayed (about ±100 kHz).

At this point, the display should appear similar to Figure 5-6 (except "live", not "frozen"); although offset (spacing) between the sides varies from instrument to instrument. Since the instrument is set up to auto-level trigger but given no trigger signal (EXT source), it freezes the display on screen about once every second. This makes it easier to see the results when making a clock adjustment.

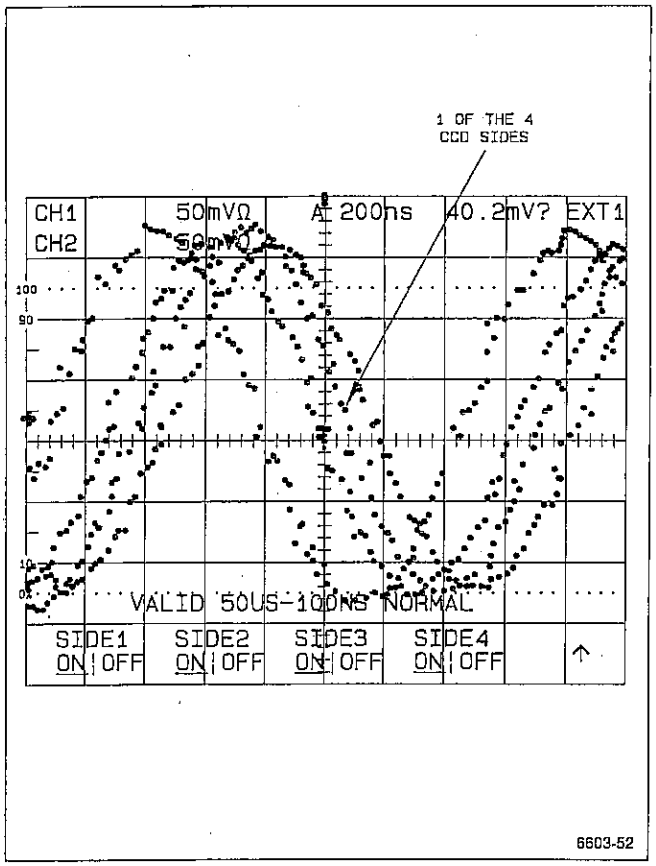


Figure 5-6. CCD sides 1-4 for CH 1 before L-clock adjustment. Note menu shows all sides are ON.

4. **Display CCD sides menu:** Push the MENU OFF/EXTENDED FUNCTIONS button twice to return to the Extended Functions menu; push SPECIAL and, when the menu changes, push CCD sides.

5. **Check/match coarse frequency response between channels:** Set sides 2, 3, and 4 off in the menu, leaving only side 1 on (underlined sides are on). Rotate the CH 2 POSITION knob to move the CH 2 display back on screen. Check that the difference between the amplitudes of the CH 1 and CH 2 displays is no more than 1 division. If mismatched by more than 1 division, adjust R436, C456, and R525 for CH 1 and R263, C257, and R410 for CH 2 until the amplitudes match. (The CH 1 adjustments are located near the front of the instrument on the Main board between the CH 1 Preamp IC, U420, and the shaft to the POWER ON OFF switch; the CH 2 adjustments are located between the CH 1 Preamp IC, U420 and the CH 2 Preamp IC, U320.) Position the CH 2 display off screen and turn back on all four sides when finished.

For SN B010250 & Above

NOTE

When a procedure part or subpart requires an adjustment, pay particular attention to whether CH 1 or CH 2 is to be adjusted. Both CH 1 and CH 2 have an LIS adjustment, an A2S adjustment, etc., so be sure you are setting the adjustment for the channel specified by the part; be sure *you are not setting the equivalent adjustment for the alternate channel. Use Figure 5-4 to locate the adjustments.*

For SN B010249 & Below

NOTE

When a procedure part or subpart requires an adjustment, pay particular attention to whether CH 1 or CH 2 is to be adjusted. Both CH 1 and CH 2 have an LIS adjustment, an A2D adjustment, etc., so be sure you are setting the adjustment for the channel specified by the part; be sure *you are not setting the equivalent adjustment for the alternate channel. Use Figure 5-4 to locate the adjustments.*

j. **Align the odd-numbered CH 1 CCD sides:** Set SIDE 2 and SIDE 4 to OFF in the menu. Set the CH 1 L1S adjustment for the best alignment of the two sides displayed (sides 1 and 3). Push A HORIZONTAL MODE, and readjust if necessary.

"Best Alignment" occurs when both sides are merged into a single side containing twice as many dots or samples. Figure 5-7 (a and b) shows typical "before and after" displays for adjustment of any two CCD sides; here, sides

1 and 3 for CH 1. When setting the L clocks to align any two given sides, set for equal alignment between the rising and falling portions of the sine wave; expect some mismatch of alignment between the peaks of the sides.

NOTE

Pushing A HORIZONTAL MODE causes the instrument to make firmware corrections based on the new adjustment just made for the L clock. These corrections may change the alignment slightly; in subparts j-n, repeatedly alternate between making the adjustment and pushing A MODE until no change is noted when the button is pushed.

k. **Align the even-numbered CH 1 CCD sides:** Set SIDE 2 and SIDE 4 back on, and set SIDE 1 and SIDE 3 to OFF. Set the CH 1 L2S adjustment for the best alignment of the two sides displayed. Push A HORIZONTAL MODE when finished.

l. **Align CH 2 even sides and odd sides:** Rotate the VERTICAL POSITION knobs to position the CH 1 display up off screen and the CH 2 back on screen. Repeat parts j and k, using the CH 2 L-clock adjustments to align the CH 2 CCD sides. *Be sure to adjust the CH 2 L1S and L2S adjustments and not the equivalent CH 1 L-clock adjustments that were just set.* See Figure 5-4 for adjustment locations.

m. **Align CH 1 sides to CH 2 sides:** Turn on SIDE 2 and turn all remaining sides off. Rotate the CH 1 POSITION knob to return CH 1 on screen positioned so that its ground reference indicator (a small "+" at the left edge of the screen) is on the center horizontal graticule line. Use the CH 2 POSITION knob to superimpose its ground reference indicator on CH 1's. Now, adjust CH 1 L2D for best alignment of the CH 1 and CH 2 sides. You may adjust CH 2 L2D if good alignment is not achieved. (If such is the case, alternate between the CH 1 and CH 2 L1D adjustments until best alignment is achieved.) Remember to push A HORIZONTAL MODE after making each adjustment.

n. **Align an even CH 1 CCD side to an odd:** Set SIDE 1 and SIDE 2 on and all remaining sides OFF. Position the CH 2 display up off screen. Now, adjust CH 1 L1D for best alignment of sides. Push A HORIZONTAL MODE.

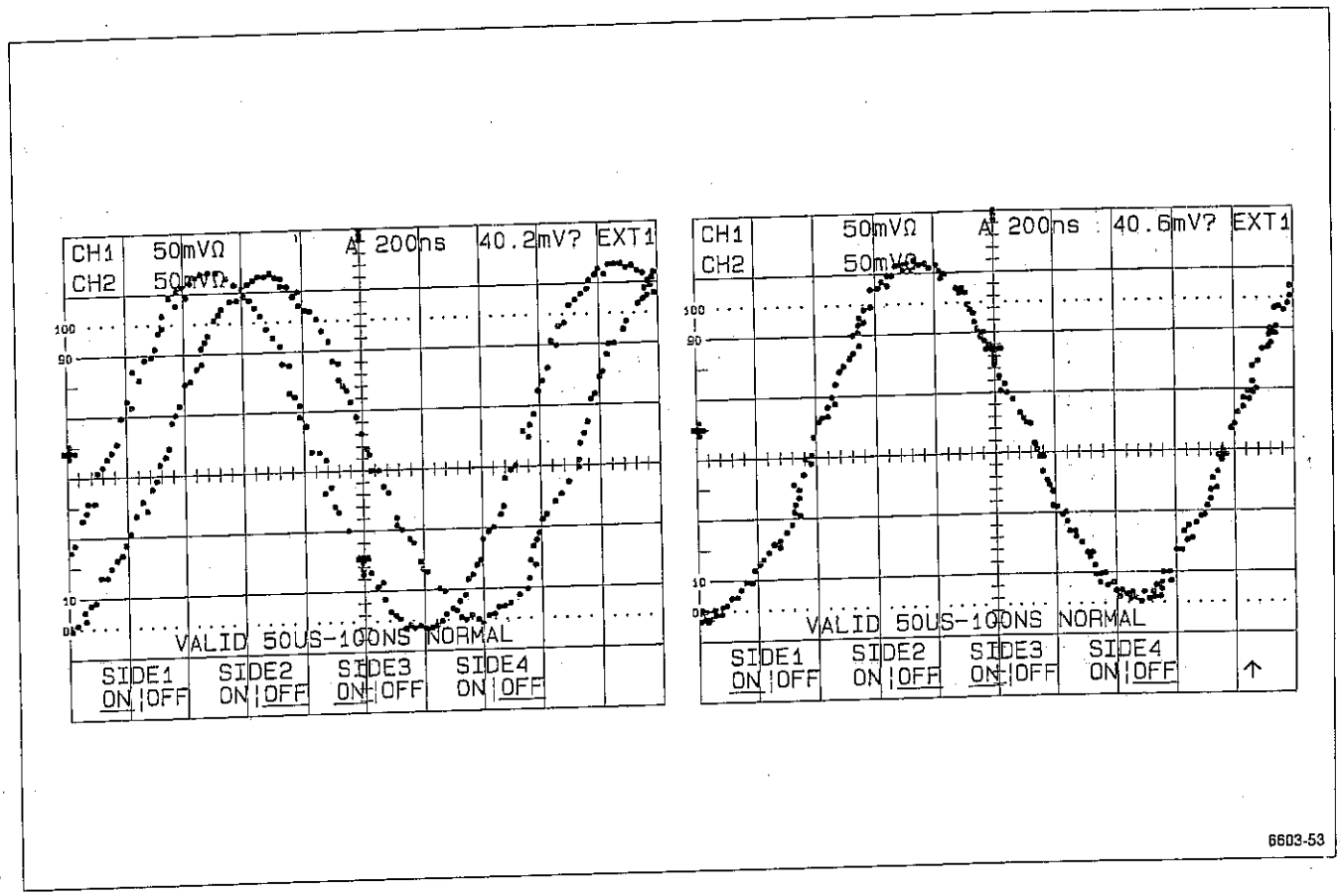


Figure 5-7 (a and b). Sides 1 and 3 before adjustment of L1S and after. Similar results should be obtained when adjusting any pair of sides with the L-clocks adjustments. (Best alignment that can be achieved varies from instrument to instrument.)

o. **Align an even CH 2 CCD side to an odd:** Position CH 1 up off screen and CH 2 on. Adjust the CH 2 L1D for best alignment of SIDE 1 and SIDE 2. Push A HORIZONTAL MODE.

p. **Check CH 1 and CH 2 L-clock adjustment:** Position both channels back on screen, and turn on all four CCD sides. Verify that each channel displays good alignment of its four sides. Repeat parts j through o as necessary to fine-tune the alignment.

q. **Adjust the A and T clocks:**

For SN B010250 & Above

1. **Coarse adjust the CH 1 A and T clocks:** Vertically position the CH 2 display off screen. Look at Figure 5-8 and note the stray samples labeled there. If the CH 1 display has similar "stray samples"—samples obviously offset from the well-aligned samples—adjust the CH 1 A and T clocks to align these stray samples. Begin with TID and TIS, and if necessary you can adjust A2S. Push A HORIZONTAL MODE after making each adjustment, iterating between making the adjustment and pushing A MODE as was done for the L-clock adjustment.

For SN B010249 & Below

1. **Coarse adjust the CH 1 A and T clocks:** Vertically position the CH 2 display off screen. Look at Figure 5-8 and note the stray samples labeled there. If the CH 1 display has similar "stray samples"—samples obviously offset from the well-aligned samples—adjust the CH 1 A and T clocks to align these stray samples. Begin with TID and TIS, and if necessary you can adjust A2D and A2S. Push A HORIZONTAL MODE after making each adjustment, iterating between making the adjustment and pushing A MODE as was done for the L-clock adjustment.

2. **Coarse adjust the CH 2 A and T clocks:** Vertically position the CH 2 display on screen; position the CH 1 display off screen. Repeat subpart 1, but use the CH 2 A and T clock adjustments instead of those for CH 1. See Figure 5-4 for adjustment locations.

3. **Display the A and T clock-adjustment counts:** Set CH 1 on and CH 2 off in the VERTICAL MODE menu. Leave CH 1 vertically positioned off screen. Push the MENU OFF/EXTENDED FUNCTIONS button twice; then push SPECIAL; then push CCD ADJ. Now, push the ADJ T1 A2 menu button to display the A and T clock adjustment numbers (T1 A2 will be underlined).

NOTE

After coarse adjustment performed in subparts 1 and 2, the adjustments outlined in subparts 4 through 7 are often not needed. When performing these subparts, adjust only if the specified check is failed.

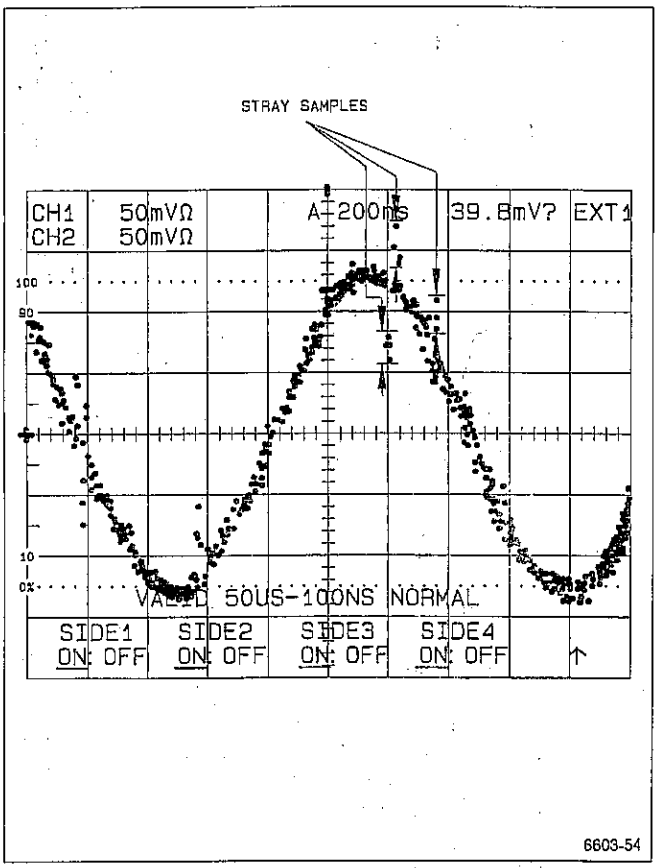


Figure 5-8. CH 1 with L-clocks correctly adjusted, but with stray samples.

For SN B010250 & Above

When making an adjustment after a failed check, start by adjusting TID and then TIS, continuing with A2S only if needed. Adjustment of these controls is best determined by trial: Start with TID and "rock" that adjustment back and forth to see if it improves the out-of-limit number(s), without moving the in-limit numbers out of limit. Continue with TIS and A2S as required; make the minimum number of adjustments that puts all the numbers within limits.

For SN B010249 & Below

When making an adjustment after a failed check, start by adjusting TID and then TIS, continuing with A2S and A2D only if needed. Adjustment of these controls is best determined by trial: Start with TID and "rock" that adjustment back and forth to see if it improves the out-of-limit number(s), without moving the in-limit numbers out of limit. Continue with TIS and the remaining two adjustments as required; make the minimum number of adjustments that puts all the numbers within limits.

For SN B010250 & Above

4. **Check CH 1 clocks at 100 ns and adjust if needed:** Set the SEC/DIV to 100 ns. *If required,* adjust (see NOTE below) the CH1 TIS, TID, and A2S adjustments so that all four sides (numbered 1-4 at extreme left) have GN-DAC counts within 700-3500, GAIN MIN counts greater than 92, and the CLIP LIMIT counts greater than 112 for *any* two sides and greater than 109 for the remaining two sides. (It doesn't matter which two sides are greater than 112 and which are greater than 109, just as long as at least two are greater than 112 and two are greater than 109. Also, all sides can be greater than 112.) See Figure 5-9.

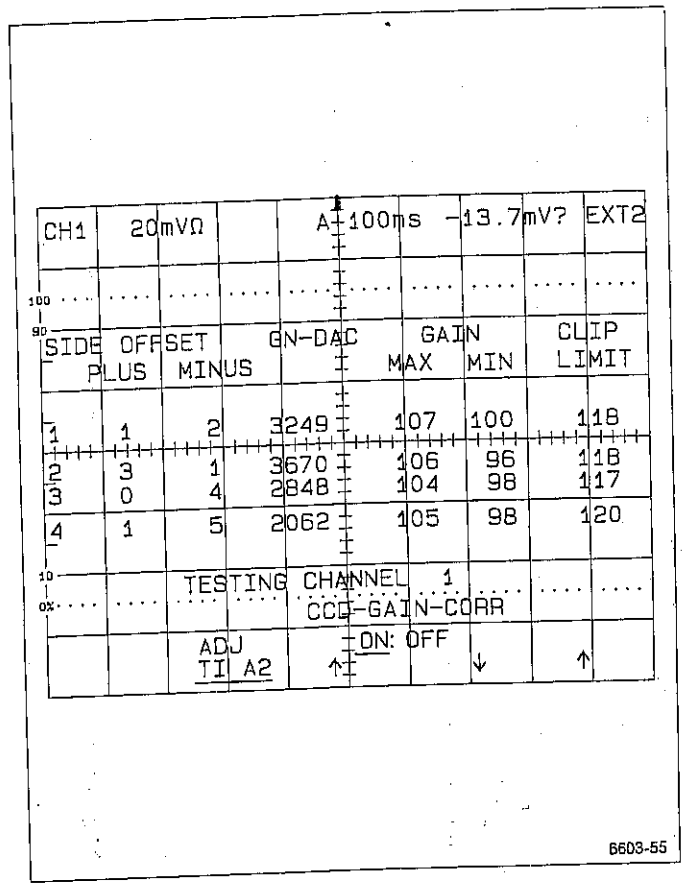


Figure 5-9. Display for adjusting CCD A and T clocks. Note this is the same display for presetting the CM counts, except no CM count adjustment menu is displayed.

For SN B010249 & Below

4. **Check CH 1 clocks at 100 ns and adjust if needed:** Set the SEC/DIV to 100 ns. *If required,* adjust (see NOTE below) the CH1 TIS, TID, A2D, and A2S adjustments so that all four sides (numbered 1-4 at extreme left) have GN-DAC counts within 700-3500, GAIN MIN counts greater than 92, and the CLIP LIMIT counts greater than 112 for *any* two sides and greater than 109 for the remaining two sides. (It doesn't matter which two sides are greater than 112 and which are greater than 109, just as long as at least two are greater than 112 and two are greater than 109. Also, all sides can be greater than 112.) See Figure 5-9.

5. **Check CH 1 clocks at 200 ns and adjust if needed:** Set the SEC/DIV to 200 ns. If required, adjust as for 100 ns setting, except two sides must be greater than 119 and the remaining sides greater than 115 (GN-DAC and CLIP LIMIT requirements are the same as for 100 ns). If adjustment is made, recheck at 100 ns when finished and readjust as necessary.

6. **Check/adjust CH 1 A and T clocks at 500 ns:** Set the SEC/DIV to 500 ns. If required, adjust as for the 100 and 200 ns settings, except two sides must be greater than 122 and the remaining sides greater than 119 (GN-DAC and CLIP LIMIT requirements are the same as for 100 ns). Recheck at 100 ns and 200 ns when finished and readjust as necessary.

For SN B010250 & Above

7. **Check/adjust CH 2 A and T clocks:** Push VERTICAL MODE and set CH 1 off and CH 2 on in the menu displayed. Use the CH 2 POSITION knob to move the CH 2 display up off screen. Now, repeat subparts 2-4 making the CH 2 TIS, TID, and A2S adjustments (only if needed) instead of the CH 1 adjustments (see Figure 5-4).

For SN B010249 & Below

7. **Check/adjust CH 2 A and T clocks:** Push VERTICAL MODE and set CH 1 off and CH 2 on in the menu displayed. Use the CH 2 POSITION knob to move the CH 2 display up off screen. Now, repeat subparts 2-4 making the CH 2 TIS, TID, A2D, and A2S adjustments (only if needed) instead of the CH 1 adjustments (see Figure 5-4).

8. **Turn off display for adjusting A and T clocks:** Set both CH 1 and CH 2 on in the VERTICAL MODE menu. Vertically position both CH 1 and CH 2 waveforms back on screen. Restore the CCD ADJ menu by pushing MENU OFF/EXTENDED FUNCTIONS twice; then SPECIAL; then CCD ADJ. Push ADJ T1 A2 menu button to turn off the display of the A and T clock adjustment numbers (underline is removed).

9. **Do a SELF CAL:** Skip to, and perform, the procedure found under SELF CALIBRATION in this section. (At this stage the instrument may take several minutes to run.) If the instrument passes the SELF CAL (see NOTE in SELF CAL procedure), skip to part r of this procedure and continue. If, after redoing a SELF CAL as directed in parts e and f of the SELF CAL procedure, any test level has FAIL status, quit this procedure and refer the instrument to qualified service personnel for repair.

r. **Check CH 1 and CH 2 A and T clocks' overall adjustment :**

1. **Set up for checking CCD side alignment:** The SEC/DIV control should be set to 200 ns. Adjust generator frequency to display about 2 cycles on screen.

2. **Verify good alignment of, and between, CH 1 and CH 2 waveforms:** Push SAVE and use the CH 1 and CH 2 POSITION controls to position the CH 1 and CH 2 for easy viewing. Check that the four sides of both the CH 1 and CH 2 waveforms are well-aligned and appear as single sine wave in each channel (see Figure 5-10). Now use the VERTICAL POSITION knobs to superimpose the CH 1 and CH 2 waveforms. Check that the CH 1 and CH 2 waveforms are well aligned; i. e., the superimposed sine waves should look like a "fatter" version of the CH 1 and CH 2 sine waves.

NOTE

Mainly check the falling and rising parts of the sine wave, rather than the peaks, since the amplitude may differ somewhat between channels as the instrument has not been completely adjusted.

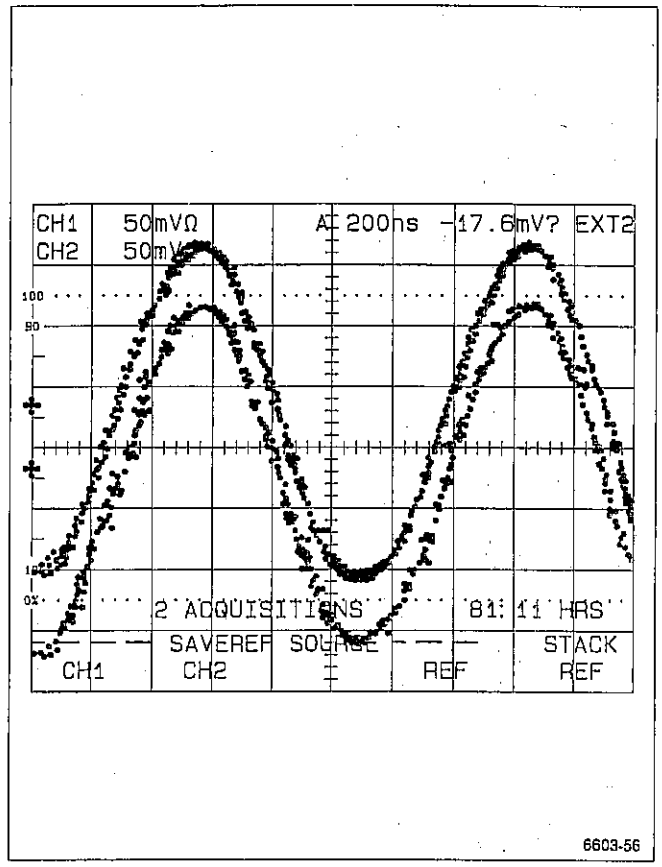


Figure 5-10. Typical CH 1 and CH 2 displays after clock adjustment.

3. **Check sample dispersion:** Now, push STORAGE ACQUIRE and vertically position the CH 1 and CH 2 display about 1 division apart. Adjust the frequency of the test generator for about a third of a cycle display in each channel. Push SAVE to capture a rising or falling portion of the waveform. (Watch the untriggered display until the desired portion is on screen and quickly push SAVE to capture; push ACQUIRE and repeat if unsuccessful.) Check to see that the dispersion of the samples on each section is no greater than one vertical division for each channel, and that there is no more than 1/2 division of difference between the two channels (see Figure 5-11).

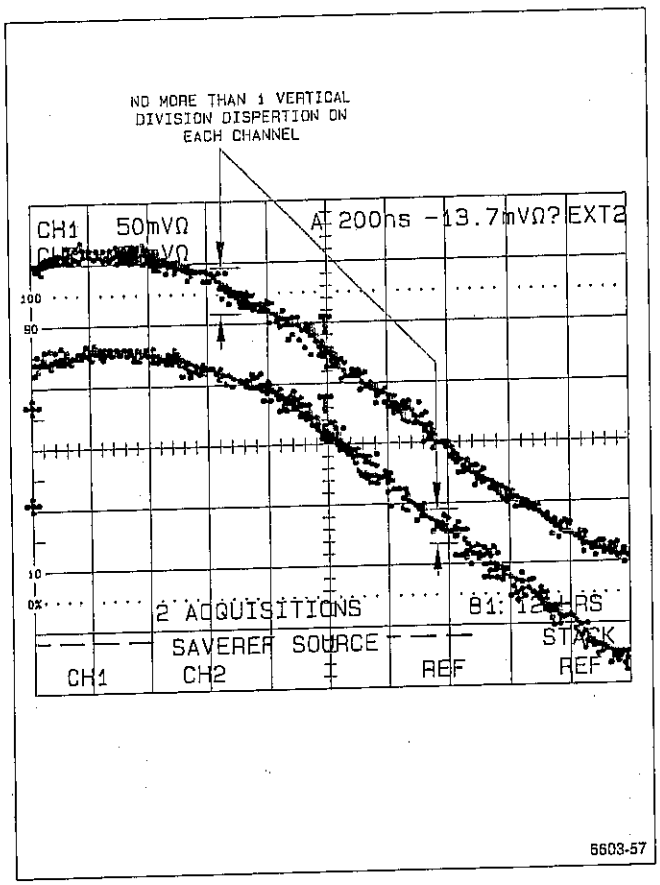


Figure 5-11. Checking sample dispersion.

4. **If either CH 1 or CH 2 fail the checks just performed, redo parts i-q to improve adjustment of L, A, and T clocks to meet checks.** (Push STORAGE ACQUIRE to return to a "live" display.)

For SN B010250 & Above (Step s and subparts only)

s. **Adjust the 100 ns L clocks:**

1. **Set up instrument:** Set the SEC/DIV to 100 ns. Vertically position the CH 2 display up off the screen.

2. **Set up test signal:** Set the generator output level for about a 4-division display at a frequency of 1 MHz, then change the output frequency to 500 MHz. Readjust for a 4 division amplitude if necessary, and vertically center the display.

3. **Alias display:** Vary the generator output frequency slightly (if required) until only one or two cycles of the untriggered sine wave are displayed (about ±100 KHz).

4. **Adjust CH 1 100 ns L clock:** Set the CH 1 L2D100 adjustment for the best alignment of all 4 sides (minimum sample dispersion). Push A HORIZONTAL MODE, and readjust if necessary. Continue to iterate until no change is noted when A HORIZONTAL MODE is pushed.

5. **Adjust CH 2 100 ns L clock:** Vertically position the CH 1 display up off screen, and position the CH 2 display back on screen. Set the CH 2 L2D100 adjustment for the best alignment of all 4 sides (minimum sample dispersion). Push A HORIZONTAL MODE, and readjust if necessary. Continue to iterate until no change is noted when A HORIZONTAL MODE is pushed.

t. Disconnect test setup.

3. CH 1 and CH 2 Input Capacitance Adjustment (C414 and C311).

a. If a menu is displayed, press the MENU OFF/EXTENDED FUNCTIONS button to remove it from the screen. Select SETUP PRGM and press the menu button labeled INIT PANEL. Make the following changes to the front panel setup:

Set:	A SEC/DIV	100 μs

b. Connect the HIGH AMPLITUDE output of the Calibration Generator to the CH 1 input connectors via a precision 50 Ω BNC cable, a 50 Ω terminator, and an adjustable normalizer.

c. Set the generator output level for a 6 division display at a frequency of 1 kHz.

d. Set the normalizer for a square front corner over approximately the first 40 μs (0.4 division) of the positive portion of the waveform.

e. Change the CH 1 VOLTS/DIV control to 50 mV and adjust the generator amplitude for a 6 division display.

f. ADJUST—C414 (near the front edge of the Main board) for the same waveform front corner as noted in part d.

g. Repeat parts c through f until no change is observed in the waveform front corner between the 50 mV and 100 mV settings for the CH 1 VOLTS/DIV control.

h. Move the input signal to CH 2. Select VERTICAL MODE and set CH 2 on and CH 1 off.

i. Repeat parts c through g to adjust the CH 2 input capacitance, adjusting C311 in part f and using the CH 2 VOLTS/DIV control for parts e and g.

j. Disconnect the test setup.

4. Transient Response Adjustment.

a. **Set up to adjust transient response:**

1. **Initialize front panel:** Push the SETUP PRGM front-panel button; then push the menu button labeled INIT.

NOTE

Subpart 1 initializes the front-panel controls to known settings. Make only the changes outlined in the following procedure parts to avoid incorrect setups.

2. **Modify initial control settings:** Set CH 1 VOLTS/DIV to 20 mV and the SEC/DIV control to 5 μs. Push the CH 2 COUPLING/INVERT front-panel button and set 50 Ω ON:OFF to ON in the menu. Repeat for CH 1. Now, push STORAGE ACQUIRE and set REPET ON:OFF to ON in the menu.

3. **Set up test signal:** Connect the HI-AMPLitude output of a pulse generator to the CH 1 input through a 50-Ω precision cable, a tunnel-diode pulser, and a 2.5X attenuator. Set the generator's frequency to 100 kHz and the amplitude to maximum. Now, set the Trigger Level control of the TD Pulser to minimum (full counterclockwise rotation); then slowly rotate control clockwise just until a pulse five divisions in amplitude appears on screen. (Use the minimum Trigger Level setting that triggers the pulse.) Vertically center the display. Increase the SEC/DIV setting to 2 ns and push the INIT@50% front-panel button.

b. **Adjust CH 1 transient response:** Adjust R436, C456, and R525 for best front-corner. (These adjustments are located near the front of the instrument on the Main board between the CH 1 Preamp IC, U420, and the shaft to the POWER ON OFF switch.)

c. **Adjust CH 2 transient response:** Disconnect the test signal at the CH 1 input and move to the CH 2 input. Push VERTICAL MODE and set CH 2 on and CH 1 off. Set CH 2 VOLTS/DIV to 20 mV and vertically center the display as required. Now, adjust R263, C257, and R410 for best front-corner. (These adjustments are located near the front of the instrument on the Main board between the CH 1 Preamp IC, U420 and the CH 2 Preamp IC, U320.)

d. **Verify CH 2 and CH 1 bandwidth at 20 mV/division:**

1. **Set up the instrument for bandwidth verifications:** Change the SEC/DIV control to 5 ns. Disconnect the pulse generator output from the CH 2 input. Now, connect the output of the secondary Leveled-sine Wave Generator (Item 2) to the CH 2 input through the output head and a 10X attenuator. Set the test generator for a reference 6-division, 6-MHz signal display vertically centered on screen.

2. **Verify CH 2 bandwidth:** Switch the SEC/DIV control to 2 ns; then increase the test generator frequency until the amplitude decreases to 4.4 divisions on screen. The frequency should be greater than or equal to 310 MHz. Write down the frequency and the channel tested for use in the following subparts.

NOTE

If the frequency at 4.4 division is not greater than or equal to 310 MHz, readjust the transient response for the appropriate channel until the 310 MHz or greater bandwidth is obtained.

3. **Verify CH 1 bandwidth:** Return the SEC/DIV setting to 50 ns; push VERTICAL MODE and set CH 1 on and CH 2 off in the menu displayed. Move the signal from the CH 2 input to the CH 1 input, and set the test generator for a reference 6 division, 6-MHz signal, vertically centered on screen. Switch the SEC/DIV control to 5 ns; then increase the test generator frequency until the amplitude decreases to 4.4 divisions on screen. The frequency should be greater than or equal to 310 MHz (see NOTE for subpart 2). Write down the frequency and the channel tested for use in the following subparts.

e. **Match CH 1 bandwidth at remaining VOLT/DIV settings:**

NOTE

The following subparts attempt to match each channel's frequency response for all other VOLTS/DIV settings to that for the 20 mV setting. In some cases, you may not be able to adjust the number of divisions specified in the subpart (either 3.7 or 4.4 divisions) at the frequency obtained for the 20-mV setting in part f; if this is the case, just adjust as close as possible and check that the number of divisions obtained is ≥ 4.4 (3.7 for subpart 3) up to 310 MHz.

1. **Display menu for matching bandwidth:** Push MENU OFF/EXTENDED FUNCTIONS twice; then push the SPECIAL menu button, and, when the menu changes, push FORCE DAC. Now, push the left-most menu button until TRN1 is displayed near the lower-left corner of the screen.

2. **Set up CH 1 for adjusting 1-V bandwidth:** Set the CH 1 VOLT/DIV to 1 V. Remove the 10X attenuator and connect the generator's leveling head directly to the CH 1 input. Return the SEC/DIV to 50 ns and set the generator for the 5 division, 6-MHz reference signal. Change the SEC/DIV setting to 2 ns and increase the generator frequency to that written down for subpart 3 of part d.

3. **Adjust the 1-V bandwidth:** Rotate the INTENSITY knob to increase or decrease the waveform's amplitude to set to 3.7 divisions. Push WRITE TO CALSTORE menu button when finished.

4. **Set up CH 1 for adjusting 100-mV bandwidth:** Set the CH 1 VOLT/DIV to 100 mV. Return the SEC/DIV to 50 ns and set the generator for the 6-division, 6-MHz reference signal. Change the SEC/DIV setting to 2 ns and increase the generator frequency to that written down for subpart 3 of part d.

5. **Adjust the 100-mV bandwidth:** Rotate the INTENSITY knob to increase or decrease the waveform's amplitude to set to 4.4 divisions. Push WRITE TO CALSTORE menu button when finished.

6. **Set up CH 1 and adjust the 50-mV bandwidth:** Install a 10X attenuator between the generator's leveling head and the CH 1 input, and set the CH 1 VOLT/DIV to 50 mV. Repeat subparts 4 and 5, using the 50 mV VOLTS/DIV setting instead of 100 mV.

7. **Adjust the 10 mV, 5 mV, and 2 mV bandwidth:** Install a 5X attenuator between the 10X attenuator and the CH 1 input. Perform subparts 4 and 5 for the 50-mV, 10-mV, 5-mV, and 2-mV settings to match the bandwidth for each of those settings. Remember to push WRITE TO CALSTORE after making the TRN1 adjustment at each VOLTS/DIV setting.

f. **Match CH 2 bandwidth remaining VOLTS/DIV settings:** Push VERTICAL MODE and set CH 2 on and CH 1 off. Move the test signal from the CH 1 input to the CH 2 input, removing both the 5X and 10X attenuators. Now repeat subparts 1-7 of part e, selecting and setting TRN2 instead of TRN1 in subpart 1, setting the generator to the frequency written down for subpart 2 of part d instead of for subpart 3, and setting the CH 2 VOLTS/DIV control instead of the CH 1 in subparts 2-7.

g. Disconnect the test setup and push MENU/OFF EXTENDED FUNCTIONS to exit the menu.

5. 100 MHz Bandwidth Limit Filter Adjustment (Non-TV Options Only).

a. If a menu is displayed, press the MENU OFF/EXTENDED FUNCTIONS button to remove it from the screen. Select SETUP PRGM and press the menu button labeled INIT PANEL. Make the following changes to the front panel setup:

Set:	A SEC/DIV	50 ns
	CH 1 VOLTS/DIV	10 mV
Select BANDWIDTH		
Set:	50 MHz	On
Select CH 1 COUPLING/INVERT		
Set:	50 Ω ON:OFF	ON
Select STORAGE ACQUIRE		
Set:	REPET ON:OFF	ON
	AVG	On (8)

b. Connect the positive-going, FAST RISE output of the Calibration Generator to the CH 1 input via a precision 50 Ω cable and a 10X attenuator.

c. Set the generator output level for a 5 division display at a frequency of 100 kHz.

d. ADJUST—R431 for as flat a response as possible. This potentiometer is located on the Main circuit board.

e. Move the test setup to the CH 2 input connector.

f. Select VERTICAL MODE and set CH 2 on and CH 1 off.

g. Set CH 2 VOLTS/DIV to 10 mv.

h. Repeat parts c and d, adjusting R233 for part d.

i. Disconnect the test setup.

6. 20 and 100 MHz Bandwidth Limit Filter Adjustment (TV-Option 05 Only)

a. If a menu is displayed, press the MENU OFF/EXTENDED FUNCTIONS button to remove it from the screen. Select SETUP PRGM and press the menu button labeled INIT PANEL. Make the following changes to the front panel setup:

Set:	A SEC/DIV	50 ns
	CH 1 VOLTS/DIV	10 mV
Select BANDWIDTH		
Set:	20 MHz	On
Select CH 1 COUPLING/INVERT		
Set:	50 Ω ON/OFF	ON
Select STORAGE ACQUIRE		
Set:	REPET ON/OFF	ON
	AVG	On (8)

b. Connect the positive-going, FAST RISE output of the Calibration Generator to the CH 1 input via a precision 50 Ω cable and a 10X attenuator.

c. Set the generator output level for a 5 division display at a frequency of 100 kHz.

NOTE

Adjust the coils in the following parts so their slugs are out approximately the same amount.

d. ADJUST—L531 for as flat a response as possible. This coil is located on the Main circuit board.

e. Move the test setup to the CH 2 input connector.

f. Select VERTICAL MODE and set CH 2 on and CH 1 off.

g. Set the CH 2 VOLTS/DIV control to 10 mV.

h. Repeat parts c and d for CH 2, adjusting L431 for part d.

i. Set the A SEC/DIV control to 100 μs.

j. Connect the Leveled Sine-wave Generator output via a 50 Ω precision cable and two 10X attenuators to the CH 2 input connector.

k. Set the generator to produce a 50 kHz, 5 division display.

l. Increase the generator output to 5 MHz and set the SEC/DIV control to 500 ns.

m. Check that the display amplitude is between 4.80 and 5.05 divisions.

n. Select BANDWIDTH and set 100 MHz on. Set the A SEC/DIV control back to 50 ns.

o. Select VERTICAL MODE and set CH 1 on and CH 2 off.

p. Repeat parts b through h to adjust the 100 MHz bandwidth limit, adjusting R431 and R233 in part d (adjust R431 when adjusting for CH 1, R233 for CH 2). These resistors are located on the Main board.

q. Disconnect the test setup.

7. Video Input Gain Adjustment (TV-Option 05 Only)

NOTE

In part a, you will connect the ground lead of a X10 probe to pin 5 of J125 on the processor board. Be sure you are connecting to the correct pin. Pin 1 is marked with a square pad, and all odd-numbered pins are in the same row as pin 1. Pin 5 is the second pin up from pin 1.

a. First, power the scope off. Then, perform subparts b-f of part 3 of the Removal and Replacement procedure in Section 6 to access the processor board of the instrument. Connect a X10 probe to the CH 2 input; then connect the ground lead of that probe to pin 5 of J125 of the processor board and the probe tip to the cathode of CR502. (CR502 is immediately above Q504 on the processor board; see the Processor Board drawing in the Diagrams section to locate CR502.) Power the scope back on.

b. Set up the scope: if a menu is displayed, press the MENU OFF/EXTENDED FUNCTIONS button to remove it from the screen. Select SETUP PRGM, and press the menu button labeled INIT PANEL. Make the following changes to the front-panel setup:

Set:	A SEC/DIV	2 μs
	CH 1 VOLTS/DIV	500 mV
	CH 2 VOLTS/DIV	2 V
	TRIGGER SLOPE	– (minus)
Select BANDWIDTH		
Set:	20 MHz	On
Select TRIGGER MODE		
Set:	AUTO	On

c. Connect the Full-Field Signal output of the video signal generator to the CH 1 input of the scope via a 75 Ω cable and a 75 Ω terminator.

d. Set the generator output for a field square wave producing a 100 IRE pedestal output for all lines. One line of video, with sync tip and color burst, should be displayed on screen in CH 1. (See top waveform in Figure 5-12.)

e. ADJUST—R419 while watching the output signal on the bench scope. First turn R419 all the way clockwise. Now, slowly rotate the adjustment counter-clockwise until the IRE pedestal appears on both the rising and falling edge of the waveform and the bottom of the waveform moves up slightly. Adjustment is correct when the output is not overdriven, with the IRE pedestal missing on the rising and edges, or underdriven, with excessive aberrations on the bottom of the waveform. (See bottom waveform in Figure 5-12.)

f. Disconnect the test setup. Perform, in reverse order, subparts b-f in part 3 of the Removal and Replacement procedure to return the processor board to its normal position.

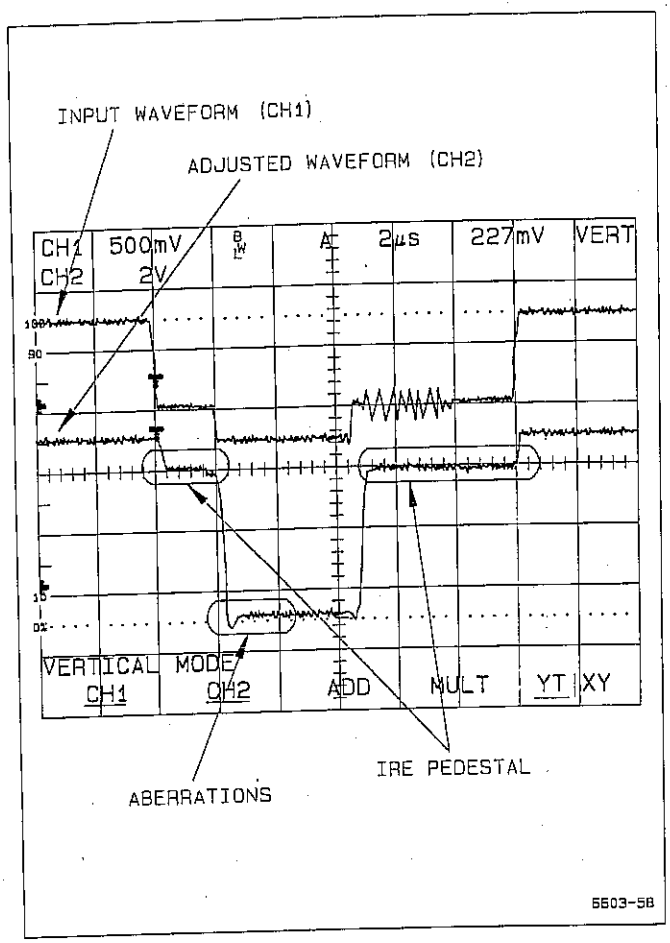


Figure 5.12 Input and output (after adjustment) waveforms.

SELF CALIBRATION

Equipment Required:

None

1. Self Calibration

a. Turn the instrument POWER ON and allow a 10 minute warm-up period. Note that the instrument's cabinet should be in place when performing this subsection of this procedure. (If an Internal Calibration was performed and J156 removed, do not reinstall J156 prior to reinstalling the cabinet unless an External Calibration is NOT to be performed after execution of a Self Calibration.)

b. Press the MENU OFF/EXTENDED FUNCTIONS button once or twice (two presses are necessary if any menu is presently displayed, one press if no menu is displayed) to display the Extended Functions menu.

c. Press the menu button labeled CAL/DIAG (menu will change).

d. Press the menu button labeled SELF CAL. "RUNNING" will be displayed in the lower right corner of the crt screen for approximately 10 seconds as the instrument performs its automatic calibration routine.

NOTE

After successful completion of the automatic calibration routine, "RUNNING" will disappear from the CRT screen and "PASS" will be displayed above the SELF CAL menu button label. Press the MENU OFF/EXTENDED FUNCTIONS button to return the instrument to control settings in effect before the Self Calibration was initiated. If the automatic calibration routine is NOT successful (errors are detected), the EXTENDED DIAGNOSTICS menu will be displayed with accompanying error messages. Perform the following parts only if the instrument fails the Self Calibration; otherwise, Self Calibration has been completed.

e. Press the MENU OFF/EXTENDED FUNCTIONS button to turn off the EXTENDED DIAGNOSTICS menu.

f. Repeat parts b through d. If the instrument displays the EXTENDED DIAGNOSTICS menu again, refer the instrument to qualified personnel for servicing; otherwise, Self Calibration has been successfully completed.

EXTERNAL CALIBRATION

Equipment Required (see Table 4-1):

Calibration Generator (Item 3)

NOTE

J156 must be removed (see step 1, part a of Internal Adjustments) and a Self Calibration executed before this subsection can be performed. After performance (or partial performance) of this subsection, the cabinet should be removed and J156 reinstalled. Installation of this jumper will prevent inadvertent loss of the Calibration constants established by performance of this procedure. See the introduction of this procedure for further detail.

1. Attenuator Gain Adjustments.

a. Press the MENU OFF/EXTENDED FUNCTIONS button—twice, if a menu is presently displayed—to call up the Extended Functions menu.

b. Press the menu button labeled CAL/DIAG. (The menu will change.)

c. Press the menu button labeled EXT CAL to display the EXT CAL menu. Then press the menu button labeled ATTEN.

d. Set the Calibration Generator for a DC output. (See the generator Operators manual.)

NOTE

Do not attempt to calibrate CH 1 and CH 2 simultaneously via a dual-input coupler. The resulting reduction of the scope's input impedance can degrade the calibration-signal amplitude, leading to inaccurate calibration.

e. Connect the STD OUTPUT of the Calibration Generator to the CH 1 input connector through a 50-Ω cable.

f. Press the menu button that is labeled ATTEN GAIN. ("CONNECT CH1 TO 0.2VDC" will appear.) Set the generator output to 0.200 volts.

g. Press the ATTEN GAIN button again. ("RUNNING" will be displayed near the lower right corner of the screen.)

h. When the display changes from "CONNECT CH1 TO 0.2VDC" to "CONNECT CH1 TO 2.0VDC," change the generator output to 2.000 volts and press the ATTEN GAIN button.

i. When the display changes from "CONNECT CH1 TO 2.0VDC" to "CONNECT CH1 TO 20.VDC" change the generator output to 20.00 volts and press the ATTEN GAIN button.

j. When the display changes from "CONNECT CH1 TO 20.VDC" to "CONNECT CH2 TO 0.2VDC" disconnect the STD OUTPUT of the Calibration Generator from CH 1 and connect it to the CH 2 input connector.

k. Change the generator output to 0.2 volts and press the ATTEN GAIN button.

l. Repeat Steps h and i, substituting CH2 for CH1.

NOTE

When the sequence is finished, "RUNNING" will disappear from the CRT screen. If the calibration was successful, the ATTEN GAIN label will be marked "PASS." If the calibration was NOT successful, the label will be marked "FAIL." Perform Steps m and n only if the instrument fails the Attenuator Gain calibration sequence; otherwise, go to Step o.

m. Recheck the test setup and ensure that the Calibration Generator is set for a DC output. Reperform the Self Calibration subsection of this procedure.

n. Repeat parts a through i. If the instrument fails the Attenuator Gain Calibration sequence again, refer the instrument to qualified personnel for servicing; otherwise, Attenuator Gain Calibration has successfully been completed.

o. Disconnect the test setup.

2. Channel Delay Adjustments.

a. Press the MENU OFF/EXTENDED FUNCTIONS button once or twice to display the Extended Functions menu. (Two presses are necessary if any menu is presently displayed, one press if no menu is displayed.)

b. Press the menu button labeled CAL/DIAG (menu will change).

c. Press the menu button labeled EXT CAL to display the EXT CAL menu. Then press the menu button labeled ATTEN.

d. Connect the FAST RISE OUTPUT of a Calibration Generator to the CH 1 and CH 2 input connectors through a 50-Ω cable, a 10X attenuator, and a dual input coupler.

e. Set the Calibration Generator for a FAST RISE output. (See the generator Operators manual).

f. Press the menu button that is labeled ATTEN GAIN. "CONNECT BOTH CHANNELS TO A FAST RISE SIGNAL VIA A TERMINATED COAX AND A DUAL INPUT CONNECTOR" will appear.) Set the generator output to MAX.

g. Press the RUN button. ("RUNNING" will be displayed near the lower right corner of the screen.)

NOTE

After successful completion of the Channel Delay Calibration sequence, "RUNNING" will disappear from the CRT screen and "PASS" will be displayed above the CHAN DLY menu button label. If the calibration routine is NOT successful, "FAIL" will be displayed above the CHAN DLY button label. Perform the following parts only if the instrument fails the Channel Delay Calibration sequence; otherwise, Channel Delay Calibration is complete.

h. Recheck the test setup and ensure that the Calibration Generator is set for a fast rise output. Reperform the Self Calibration subsection of this procedure.

i. Repeat parts a through g. If the instrument fails the Channel Delay Calibration sequence again, refer the instrument to qualified personnel for servicing; otherwise, Channel Delay Calibration has successfully been completed.

j. Disconnect the test setup.

3. Trigger Adjustments.

a. Press the MENU OFF/EXTENDED FUNCTIONS button once or twice (two presses are necessary if any menu is presently displayed, one press if no menu is displayed) to display the Extended Functions menu.

b. Press the menu button labeled CAL/DIAG (menu will change).

c. Press the menu button labeled EXT CAL to display the EXT CAL menu.

d. Connect the STD OUTPUT of a Calibration Generator to the EXT TRIG 1 and EXT TRIG 2 input connectors through a 50 Ω cable and a dual input coupler.

e. Set the Calibration Generator for a DC output (see the generator Operators manual).

f. Press the menu button labeled TRIGGER ("CONNECT TRIGS TO GND" will be displayed) and set the generator output to 0.2 mV (~GND).

g. Press the TRIGGER button again ("RUNNING" will be displayed near the lower right corner of the screen).

h. When the display changes from "CONNECT ... TO GND" to "CONNECT ... TO 0.5V" change the generator output to 0.5 V and press the TRIGGER button.

i. When the display changes from "CONNECT ... TO 0.5V" to "CONNECT ... TO 2.0V" change the generator output to 2 V and press the TRIGGER button.

NOTE

After successful completion of the Trigger Calibration sequence, "RUNNING" will disappear from the CRT screen and "PASS" will be displayed above the TRIGGER menu button label. If the calibration routine is NOT successful, "FAIL" will be displayed above the TRIGGER button label. Perform the following parts only if the instrument fails the Trigger Calibration sequence; otherwise, Trigger Calibration is complete.

j. Recheck the test setup and ensure that the Calibration Generator is set for a DC output. Reperform the Self Calibration subsection of this procedure.

k. Repeat parts a through i. If the instrument fails the Trigger Calibration sequence again, refer the instrument to qualified personnel for servicing; otherwise, Trigger Calibration has been successfully completed.

l. Disconnect the test setup.

4. Ramp (REPET) Calibration.

a. Press the MENU OFF/EXTENDED FUNCTIONS button once or twice (two presses are necessary if any menu is presently displayed, one press if no menu is displayed) to display the Extended Functions menu.

b. Press the menu button labeled CAL/DIAG (menu will change).

c. Press the menu button labeled EXT CAL to display the EXT CAL menu.

d. Press the menu button labeled REPET. The EXT CAL menu will display "RUNNING" momentarily and then display "PASS" or "FAIL." The calibration for REPET is then complete.

5. CTE Calibration.

a. Press the MENU OFF/EXTENDED FUNCTIONS button once or twice to display the Extended Functions menu. (Two presses are necessary if any menu is presently displayed, one press if no menu is displayed.)

b. Press the menu button labeled CAL/DIAG (menu will change).

c. Press the menu button labeled EXT CAL to display the EXT CAL menu. Then press the menu button labeled CTE CAL. A short-synopsis of the next calibration step will be displayed.

NOTE

The message "THIS MUST BE THE LAST STEP" also appears in the menu. It is a reminder that the CTE Calibration must be done after any adjustment of the CCD clocks or Transient response. (See steps 2 and 4 under "Internal Adjustments" in this section).

d. Connect the FAST RISE OUTPUT of a Calibration Generator to the CH 1 and CH 2 input connectors through a 50-Ω cable, a 5X attenuator, and a dual input coupler.

e. Set the Calibration Generator for a FAST RISE output at a 100 kHz frequency. Set the generator amplitude to maximum. (See the generator Operators manual as required).

f. Press the menu button that is labeled EXECUTE. ("RUNNING" will appear in the lower right corner as the calibration executes.)

NOTE

After successful completion of the CTE Calibration sequence, "RUNNING" will disappear from the CRT screen, the instrument will switch to the Extended Calibration menu, and "PASS" will be displayed above the CTE CAL menu button label. If the calibration routine is NOT successful, "FAIL" will be displayed above the CTE CAL button label. Perform the following parts only if the instrument fails the CTE Calibration sequence; otherwise, Channel Delay Calibration is complete.

g. Recheck the test setup and ensure that the Calibration Generator is set for a fast rise output. Reperform the Self Calibration subsection of this procedure.

h. Repeat parts a through f. If the instrument fails the CTE Calibration sequence again, refer the instrument to qualified personnel for servicing; otherwise, CTE Calibration has successfully been completed.

i. Disconnect the test setup.