CALIBRATION

This section provides procedures for calibrating this instrument. These procedures are designed to compare the performance of this instrument with other measurement instruments of known accuracy to detect, correlate, or eliminate by adjustment, any variation from the electrical specifications. These procedures also verify that the controls function properly.

This section is divided into two parts: Part I—Performance Check is provided for those who wish to verify that this instrument meets the applicable electrical specifications in section 1 without making internal adjustments. Part II—Adjustment and Performance Check provides a complete calibration procedure that includes adjustments and performance checks in addition to verifying that the controls function properly. The procedures in Part I and Part II are written so that the entire instrument or any major circuit or part of a circuit can be checked or adjusted.

Table 5-1, Calibration Procedure Electives, lists the choices available and instructions for performing complete or partial calibration procedures. Also refer to page 5-2, Using These Procedures, for more detailed information.

TABLE 5-1
Calibration Procedure Electives

Electives	Procedure
Functional Check	Perform Power-Up Sequence in Part II—Adjustment and Performance Check. Then proceed sequentially through subsections (A, B, C, etc.) to end. If a functional check only is desired, perform the Operators Checkout Procedure in Section 2.
Performance Check Only	Perform Power-Up Sequence in Part I—Performance Check. Then proceed sequentially through subsections (A, B, C, etc.) to end.
Complete Calibration (Part II—Adjustment and Performance Check)	Perform Power-Up Sequence in Part II—Adjustment and Performance Check. Then proceed sequentially through subsections (A, B, C, etc.) to end.
Partial Part I—Performance Check or Part II—Adjustment and Performance Check by Subsection (A, B, C, etc.)	Perform Power-Up Sequence for Part I—Performance Check or Part II—Adjustment and Performance Check. Perform **Before You Begin** and Preliminary Control Settings instructions for subsection (A, B, C, etc.) containing the desired step (A1, A2, B1, B2, etc.). Then proceed through the instructions (a, b, c, etc.) in the desired step. **NOTE** *Although a partial adjustment procedure may be done, we recommend that the entire subsection procedure be performed if any adjustments are made.*

USING THESE PROCEDURES

NOTE

In these procedures, capital letters within the body of the text are used to identify front-panel controls, indicators and connectors on the 7104 (e.g., READOUT). Initial capitalizing is used to identify controls, indicators, and connectors (e.g., Position) on associated test equipment (used in this procedure). Initial capitalizing is also used to identify adjustments internal to the 7104 (e.g., Vert Gain).

These procedures are divided into subsections by major functional circuits (e.g., A. Z-Axis And Display, B. Calibrator And Output Signals, etc.). The order in which the subsections and procedures appear is the recommended sequence for a complete performance check or calibration of the instrument.

Each step contains the Setup Conditions which, if applicable, include control settings for this instrument, a test setup illustration, and test equipment control settings. The Setup Conditions are written so that, if desired, each subsection (A, B, C, etc.) or step (A1, A2, B1, B2, etc.) can be performed separately.

A heading system is provided to readily identify the steps (A1, A2, B1, B2, etc.) that contain performance check and/or adjustment instructions. For example, if CHECK is the first word in the title of a step, an electrical specification is checked. If ADJUST is the first word in the title, the step concerns one or more internal adjustments. And if CHECK/ADJUST appears in the title, the step involves electrical specification checks and related adjustments. If EXAMINE is the first word in the step title, the step concerns measurement limits that indicate whether the instrument is operating properly; these limits are not to be interpreted as electrical specifications.

The alphabetical insructions under each step (a, b, c, etc.) may contain CHECK, EXAMINE, ADJUST, or INTERACTION as the first word of the instruction. These terms are defined as follows:

1. **CHECK**—indicates the instruction accomplishes an electrical specification check. Each electrical specification checked is listed in Table 5-2, Performance Check Summary (see Performance Check Summary discussion for more information).

2. **EXAMINE**—usually precedes an ADJUST instruction and indicates that the instruction determines whether adjustment is necessary. If no ADJUST instruction appears in the same step, the EXAMINE instruction concerns measurement limits that do not have a related adjustment. Measurement limits following the word EXAMINE are not to be interpreted as electrical specifications. They are provided as indicators of a properly functioning instrument and to aid in the adjustment process.

3. **ADJUST**—describes which adjustment to make and the desired result. We recommend that the adjustments not be made if a previous CHECK or EXAMINE instruction indicates that no adjustment is necessary.

4. **INTERACTION**—indicates that the adjustment described in the preceding instruction interacts with other circuits. The nature of the interaction is described and reference is made to the step(s) affected.

PERFORMANCE CHECK SUMMARY

Table 5-2, Performance Check Summary, lists the electrical specifications that are checked in Part I and Part II of this section. Table 5-2 is intended to provide a convenient means for locating the procedures in Part I and Part II that check and/or adjust the instrument to meet the applicable electrical specifications. For example: If the A25 Low-Voltage Regulator board had been repaired or replaced, use Table 5-2 to locate the electrical specifications affected by the repair or replacement. Then, note the title of the procedure in Part I or Part II in which those specifications are checked and/or adjusted. Use the index provided at the front of Part I and Part II to determine the page number of the desired procedures.

ADJUSTMENT INTERVAL

To maintain instrument accuracy, check performance every 1000 hours of operation, or every 6 months if used infrequently. Before complete adjustment, thoroughly clean and inspect this instrument as outlined in the Maintenance section.

TEKTRONIX FIELD SERVICE

Tektronix Field Service Centers and the Factory Service Center provide instrument repair and adjustment services. Contact your Tektronix Field Office or representative for further information.

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TABLE 5-2
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
VERTICAL SYSTEM			
Deflection Factor	Compatible with all 7000-series plug-in units.	Implicitly checked in step E1. Check Vertical Amplifier Gain.	Implicitly checked in step F2. Check/Adjust Vertical Amplifier Gain.
Difference Between Vertical Compartments	1% or less.		
Low-Frequency Linearity	0.1 div or less compression or expansion of a center-screen 2 div signal positioned anywhere vertically within the graticule area.	E2. Check Vertical Low-Frequency Linearity.	F3. Check Vertical Low-Frequency Linearity.
Frequency Response With 7A29 Amplifier Unit	Varies with plug-in unit selected. See 7104 Oscilloscope Vertical System Specification, Table 1-7. 1 GHz at 3 dB down.	Implicitly checked in step E3. Check Vertical Amplifier 1 GHz Gain.	Implicitly checked in step F6. Check Vertical Amplifier 1 GHz Gain.
Step Response Risetime (10 to 90%, with 7A29 Amplifier Unit	350 ps or less.	Does not normally require customer verification. However, risetime can be calculated from the Vertical Bandwidth.	
Isolation Between Vertical Compartments (8 Div Signal) LEFT, RIGHT, ALT Modes	At least 160:1 from dc to 100 MHz and at least 80:1 from 100 MHz to 1 GHz.	E4. Check Vertical Channel Isolation.	F7. Check Vertical Channel Isolation.
Delay Line	Permits viewing the leading edge of triggering signal.	Checked throughout procedure where single pulse is displayed on crt.	
Difference in Signal Delay Between Vertical Compartments	50 ps or less.	Does not normally require customer verification; substantiated at the factory.	
Vertical Display Modes	Selected by front-panel Vertical Mode switch.	E5. Check Vertical Display Modes.	F8. Check Vertical Display Modes.

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Vertical Display Modes (Continued)		E5. Check Vertical Display Modes.	F8. Check Vertical Display Modes.
LEFT	Left vertical unit displayed.		
ALT	Display alternates between Left and Right vertical units at rate determined by Horizontal plug-in units.		
ADD	Display is algebraic sum of Left and Right vertical units.		
CHOP	Display chops between Left and Right vertical units asynchronously to horizontal plug-in unit(s).		
Repetition Rate	1 MHz within 20%.	Does not normally require customer verification. Satisfactory operation is substantiated by other tests.	
RIGHT	Right vertical unit displayed.	E5. Check Vertical Display Modes.	F8. Check Vertical Display Modes.
"SLAVED ALT"	Slaved operation occurs if: (1) VERT MODE switch set to ALT, (2) HORIZ MODE switch set to ALT or CHOP, (3) time-base unit is installed in each horizontal compartment and (4) the A time-base unit operates in INDEPENDENT mode. When in slaved operation the display alternates between: (1) the trace produced by the LEFT VERT unit displayed at the sweep rate of B time-base unit and (2) the trace produced by the RIGHT VERT unit displayed at the sweep rate of A time-base unit. **NOTE** *The VERT TRACE SEPARATION (B) control is inoperative in "Slaved Alt" Mode.*	"SLAVED ALT" is verified in the Operators Checkout Procedure in Section 2, Operating Instructions.	
VERTICAL TRACE SEPARATION (B)	Positions "B" trace at least 4 div above and below "A" trace, when 7104 operates in ALT or CHOP horizontal modes. See note concerning "Slaved Alt" Vertical Mode.	E6. Check Vertical Trace Separation Operation.	F9. Check Vertical Trace Separation Operation.

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TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
TRIGGERING SYSTEM			
A and B TRIGGER SOURCE	Selected by front-panel switches. Lights behind the pushbuttons are illuminated to indicate the trigger source.	C2. Check Trigger Selector Operation.	D4. Check Trigger Selector Operation.
VERT MODE	The trigger source is controlled by the VERT MODE selector. The source (sources) is (are) shown by the illumination of the LEFT and RIGHT trigger source buttons. The source follows (is same as) the Vert Display with the following two exceptions: VERT MODE — Trigger Source CHOP — LEFT "SLAVED ALT" — RIGHT for A TRIG, LEFT for B TRIG See Vertical Display Modes for slaved operation.		
LEFT	Trigger source: LEFT vertical unit; LEFT trigger source button illuminated.		
RIGHT	Trigger source: RIGHT vertical unit; RIGHT trigger source button illuminated.		
HORIZONTAL SYSTEM			
Deflection Factor	Compatible with all 7000-series plug-in units.	D1. Check Horizontal Amplifier Gain.	E1. Check/Adjust Horizontal Amplifier Gain.
Gain Differences Between Horizontal Compartments	1% or less.		
DC Linearity	0.05 division or less error at each graticule line after adjusting for no error at the second and tenth graticule line.		
Fastest Calibrated Sweep Rate	200 ps/division.	D2. Check High-Frequency Timing.	E2. Check/Adjust High-Frequency Timing.

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Horizontal Display Modes	A: A horizontal unit only. ALT: Dual-sweep, alternates between horizontal units. CHOP: Dual-sweep, chops between horizontal units. B: B horizontal unit only.	Checked in Operators Checkout Procedure, in section 2.	
Chopped Mode		Does not normally require customer verification. Satisfactory operation is substantiated by other tests.	
Repetition Rate	200 kHz within 20%.		
Phase Shift Between Vertical and Horizontal Systems	2° or less from dc to at least 50 kHz.	Satisfactory operation substantiated at the factory.	
With Option 2 (B HORIZ Compartment Only)		D3. Check X-Y Compensation (Option 2 only).	E3. Check/Adjust X-Y Compensation (Option 2 only).
With 7A19's or 7A29's at least one of which has the Variable Delay Option	2° or less from dc to 50 MHz after adjusting variable delay for balance at 25 MHz. Phase balance can be obtained at any frequency up to 250 MHz.		
Bandwidth (Option 2 Only)	350 MHz.	D4. Check Horizontal Bandwidth.	E4. Check Horizontal Bandwidth.

CALIBRATOR

Wave Shape	Square wave.	B3. Check Calibrator Rise Time, Fall Time, and Duty Cycle.	C3. Check Calibrator Rise Time, Fall Time, and Duty Cycle.
Polarity	Positive going with base line at 0 volt.		
Output Resistance	450 Ω.	Satisfactory operation substantiated at the factory.	
Output Voltage	Selected by front-panel CALIBRATOR switch.	B1. Check Calibrator Output Voltage.	C1. Check/Adjust Calibrator Output Voltage.
Into 100 kΩ or Greater	40 mV, 0.4 V, 4 V.		
Into 50 Ω	4 mV, 40 mV, 0.4 V.	Satisfactory operation substantiated at the factory.	

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TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Output Current	40 mA available through CALIBRATOR output with optional bnc to current loop adaptor. CALIBRATOR switch must be set to 4 V for calibrated output.	Satisfactory operation substantiated at the factory.	
Amplitude Accuracy (P-P Voltage)	Within 1%.	B1. Check Calibrator Output Voltage.	C1. Check/Adjust Calibrator Output Voltage.
Repetition Rate Duty Cycle Rise Time and Fall Time	1 kHz within 0.25%. 49.8% to 50.2%. 500 nsec or less into 100 pF or less.	B3. Check Calibrator Rise Time, Fall Time, and Duty Cycle.	C3. Check Calibrator Rise Time, Fall Time, and Duty Cycle.
SIGNAL OUTPUTS			
+ SAWTOOTH OUT		B4. Check A and B Sawtooth Output Signals.	C4. Check A and B Sawtooth Output Signals.
Source	Selected by front panel switch. A: A HORIZ time-base unit. B: B HORIZ time-base unit.		
Polarity	Positive-going with baseline at 0 V within 1 V into 1 MΩ.		
Output Voltage		Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Rate of Rise			
Into 50 Ω	50 mV/unit of time selected by the time-base unit time div switch, within 15%, 100 ns/div maximum sweep rate.		
Into 1 mΩ	1 V/unit of time selected by the time-base unit time div switch, within 10%, 1 μsec/div maximum sweep rate.	B4. Check A and B Sawtooth Output Signals.	C4. Check A and B Sawtooth Output Signals.
Output Resistance	Approximately 950 Ω.	Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
+ GATE OUT		B5. Check A and B Gate Output Signals.	B5. Check A and B Gate Output Signals.
Source	Selected by front-panel switch. A: A Gate, derived from A HORIZ time-base unit main gate. B: B Gate, derived from B HORIZ time-base unit main gate.		
Polarity	Positive-going with baseline at 0 V within 1.0 V into 1 MΩ.		

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
+GATE OUT (cont.)		Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Output Voltage			
Into 50 Ω	0.5 V within 10%.		
Into 1 MΩ	10 V within 10% (up to 1 sec/div sweep rate).		
Rise Time into 50 Ω	5 nsec or less.		
Fall Time into 50 Ω	15 nsec or less.		
Output Resistance	Approximately 950 Ω.		
SIG OUT	Selected by B TRIGGER SOURCE switch.	C2. Check Trigger Selector Operation.	D4. Check Trigger Selector Operation.
Source	Same as B TRIGGER SOURCE.		
Output Voltage		Satisfactory operation substantiated at the factory.	
Into 50 Ω	25 mV/div or vertical deflection within 25%.		
Into 1 MΩ	For a maximum output of ±2 V; 0.5 V/div of vertical deflection within 25%.		
Bandwidth into 50 Ω	Varies with vertical plug-in selected. See 7104 Oscilloscope Vertical System Specification, Table 1-7.		
DC Centering	0 V within 1 V into 1 MΩ.	C1. Check Vertical Signal Out DC Centering.	D3. Check/Adjust Vertical Signal Out DC Centering.
Aberrations	15% or less peak-to-peak within 20 ns of step.	Satisfactory operation substantiated at the factory.	
Output Resistance	Approximately 950 Ω.		

READOUT DISPLAY

Readout Modes		F1. Check Readout Modes.	G4. Check Readout Modes.
Free-Run (Not Labeled)	Continuously displayed.		
PULSED	Single-shot operation.		
Pulse Source	Selected by front-panel switches. + GATE: Triggered by the trailing edge of the + GATE selected by the front-panel switch.		

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Readout Modes (cont.) Pulse Source (Continued)	EXT: Controlled through rear-panel remote control connector. MAN: Manual trigger, independent of other pulse sources.	F1. Check Readout Modes.	G4. Check Readout Modes.
DISPLAY			
Graticule Type	Internal, illuminated with variable edge lighting.	B6. Check Graticule Illumination Operation.	C6. Check Graticule Illumination Operation.
Lighting Normal	Continuously lighted.		
PULSED	Single-shot operation. Lights are pulsed on for approximately 0.5 seconds.		
Pulse Source	Selected by front-panel switches. + GATE: Triggered by the trailing edge of the + GATE selected by the front-panel switch. EXT: Controlled through rear-panel remote control connector. MAN: Manual trigger, independent of other pulse sources.		
Area	8 x 10 div 0.85 cm/div.	Checked at the factory.	
Phosphor	P31.		
Vertical and Horizontal Resolution	17 lines/div.		
Limited Viewing Time Indicator Steady Yellow	Crt display time is limited to ≤ 20 minutes.	Checked in the Operators Checkout Procedure, in section 2.	
Flashing Yellow	Crt display time is limited to 2 minutes or less and Intensity is being limited.		
Geometry	Within 0.1 div of vertical and horizontal graticule lines.	A2. Check Geometry.	B5. Check/Adjust Geometry.
BEAMFINDER	When actuated limits the display within the graticule area and defocuses the display.	Checked in the Operators Checkout Procedure in section 2.	

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Minimum Photographic Writing Speed	20 cm/nsec (without blue filter). Phosphor: Standard P31. Camera: Tektronix C53; f/1.9 1:0.85 lens. Film: Polaroid Type 107; 3000 ASA.	G1. Check Photographic Writing Rate.	H1. Check/Adjust Photographic Writing Rate.
REMOTE CONNECTORS AND SWITCHES			
Control Illumination	High, medium and off. (Three position switch located on rear panel of power supply).	Checked in the Operators Checkout Procedure in section 2.	
Camera Power	3-contact connector compatible with Tektronix C-50 series cameras.	Implicitly checked in step G1. Check Photographic Writing Rate.	Implicitly checked in step H1. Check/Adjust Photographic Writing Rate.
Bottom Pin	Ground.		
Center Pin	Single sweep reset.		
Top Pin	+15 V.		
REMOTE RESET INPUT	Input to reset single-sweep function of time-base units installed in A and B HORIZ compartments.	Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Signal Required	Closure to ground or switching from the high level (+50 V to +10 V; sink less than 40 μA) to the low level (+0.5 V to -5 V; sink less than 12 mA) in less than 1 msec, resets the sweep. Compatible to 15 V open collector TTL source.		
Minimum Pulse Width	10 μsec at 50% amplitude points.		
Maximum Safe Input Voltage	50 V to -5 V (dc + peak ac).		
A SINGLE SWEEP READY	Bnc connector on rear panel. Remote ready indicator for A HORIZ time-base unit.		
Output Signal	Open when not ready. +5 V at 47 Ω source impedance when ready. Output will light a No. 49 bulb.		
B SINGLE SWEEP READY	Bnc connector on rear panel. Remote ready indicator for B HORIZ time-base unit.		
Output Signal	Open when not ready. +5 V at 47 Ω source impedance when ready. Output will light a No. 49 bulb.		

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
GRAT/READOUT SINGLE SHOT	Bnc connector on rear panel. Switching to the low level (+ 1 V) to -5 V; sink less than 2 mA) from the high level (+10 V to +15 V; sink less than 0.3 mA), in less than 1 μsec, triggers the Readout to display one complete readout frame and the GRAT ILLUM (to be displayed for approximately 0.5 sec). Compatible to 15 V open collector TTL Source.	Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Maximum Open Circuit Voltage	+15 V.		
Maximum Safe Input Voltage	+15 V to -5 V (dc plus peak ac).		
Probe Power	Two probe power connectors on rear panel.		
Pin 1	+5 V.		
Pin 2	Chassis Ground.		
Pin 3	-15 V.		
Pin 4	+15 V.		
EXTERNAL Z-AXIS INPUT	Bnc connector on rear panel.	A3. Check External Z-Axis Operation.	B7. Check External Z-Axis Operation.
Polarity and Sensitivity	Positive 2 V provides complete blanking from maximum intensity condition. Negative 2 V provides complete unblanking from minimum intensity condition.		
Low Frequency Limit	Dc.	Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Input Resistance	Approximately 500 ohm.		
Input Capacitance	Less than 50 pF.		
Open Circuit Voltage	0 V.		
Maximum Safe Input Voltage	15 V, dc plus peak ac.		
Maximum Repetition Rate	1 MHz.		

POWER SOURCE

Voltage Range (AC, RMS)	Selected rear-panel LINE VOLTAGE SELECTOR switch.	Does not normally require customer verification. Satisfactory operation substantiated by other tests.
115 V Rated	From 90 V to 132 V.	
230 V Rated	From 180 V to 250 V.	

TABLE 5-2 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Part I Performance Check Procedure Title	Part II Adjustment and Performance Check Procedure Title
Line Frequency	From 48 Hz to 440 Hz.	Does not normally require customer verification. Satisfactory operation substantiated at the factory.	
Maximum Power Consumption	215 W.		
Maximum Current	3.3 A at 60 Hz, 90 V line. 1.7 A at 60 Hz, 180 V line.		
Fuse Data Line (F1200)	4 A fast blow. (For both line voltage selector ranges.)		

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 5-3 is required for a complete Adjustment and Performance Check of the instrument. If only a Performance Check is to be performed, the items required for Adjustment are not required and are indicated by footnote 1. The remaining test equipment is common to both procedures.

The specifications for test equipment, given in Table 5-3 are the minimum required to meet the performance requirements. Detailed operating instructions for test equipment are omitted in these procedures. Refer to the test equipment instruction manual if more information is needed.

SPECIAL FIXTURES

Special fixtures are used only where they facilitate instrument adjustment. These fixtures are available from Tektronix, Inc. Order by part number from Tektronix Field Offices or representatives.

TEST EQUIPMENT ALTERNATIVES

All of the listed test equipment is required to completely calibrate this insrument. However, complete checking or adjusting may not always be necessary or desirable. You may be satisfied with checking only selected characteristics, thereby reducing the amount of test equipment actually required.

The calibration procedures in Part II are based on the first item of equipment given as an example. When other equipment is substituted, control settings or setups may need to be altered. If the exact item of equipment given as an example in Table 5-3 is not available, first check the Minimum Specifications column carefully to see if any other equipment might suffice. Then check the Purpose column to see what this item is used for. If used for a performance check or adjustment that is of little or no importance for your measurement requirements, the item and corresponding step(s) can be deleted.

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TABLE 5-3
Test Equipment

Description	Minimum Specifications	Purpose	Examples of Applicable Test Equipment
1. Test Oscilloscope	Bandwidth, dc to 200 megahertz, minimum deflection factor 10 millivolts/division; accuracy, within 3%. Dual-channel with an inverting input and both added and alternate vertical modes.	Used throughout calibration procedure.	a. TEKTRONIX 7704A Oscilloscope System with 7A18 and 7A29 Amplifier; 7B80 or 7B10 Time Base, and P6053B Probe. b. TEKTRONIX 475 Oscilloscope with P6053B Probe. c. Refer to the Tektronix Products catalog for compatible oscilloscope system.
2. Amplifier Unit (Two Required, One with Variable Delay)	Tektronix 7A-series plug-in unit.	Used throughout procedure to provide vertical input to the instrument under adjustment.	a. TEKTRONIX 7A29 Amplifier, and TEKTRONIX 7A29 AMPLIFIER (Option 4).
3. Amplifier Unit (Dual Trace)	Any 7A-series dual display amplifier unit.	Used to check position and operation of readout display.	a. Any 7A-series dual amplifier unit (may be shared with a 7000-series test oscilloscope).
4. Time-Base Unit (Two Required)	Sweep rate 2 nanoseconds/division.	Used throughout procedure to provide sweep.	a. TEKTRONIX 7B15 Time Base. b. TEKTRONIX 7B10 Time Base.
5. Signal Standardizer (Two Required)	Produces gain-check and pulse-response waveforms.	Used throughout procedure to standardize instrument so plug-in units can be interchanged without complete readjustment and to adjust crt geometry.	a. Tektronix Calibration Fixture 067-0587-02. b. 7000-series plug-in units with suitable signal sources may be substituted if lower performance is acceptable.
6. Plug-In Extender[1] (Rigid Calibration Fixture)	Provides access to power supply voltages.	Power Supply Voltage, Trigger System check and adjustment.	a. Tektronix Part 067-0589-00.
7. Camera	f/1.9, 1:0.85 lens.	Photographic writing rate.	a. TEKTRONIX C-53 Oscilloscope Camera.
8. Precision DC Voltmeter (DVM)	Range, -75 to +200 volts; accuracy, within 0.1%.	Check and adjustment of calibrator output accuracy, power supply voltages and Z-axis display voltages.	a. TEKTRONIX DM 501 Digital Multimeter with power module. b. Fluke Model 825A Differential DC Voltmeter.
9. DC Voltmeter (VOM)	Range, to -2500 volts; accuracy, checked to within 1% at -2265 volts.	High-voltage power supply adjustment and geometry.	a. Triplett Model 630-NA. b. Simpson Model 262.

[1]**Used for calibration only; NOT used for performance check.**

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TABLE 5-3 (CONT.)
Test Equipment

Description	Minimum Specifications	Purpose	Examples of Applicable Test Equipment
10. Time-Mark Generator	Marker outputs, 1 nanosecond to 0.1 second; marker accuracy, within 0.1%; trigger output, 1 millisecond.	Check and adjustment of horizontal timing, and calibrator frequency.	a. TEKTRONIX TG 501 Time-Mark Generator with power module.
11. Low-Frequency Sine-Wave Generator	Frequency, 250 kilohertz to 250 megahertz; output amplitude, variable from 50 millivolts to 3 volts into 50 ohms.	Check and adjust horizontal bandwidth and external Z-axis input.	a. TEKTRONIX SG 503 Leveled Sine-Wave Generator with power module. b. General Radio 1310-B Oscillator.
12. High-Frequency Sine-Wave Generator	Frequency 245 megahertz to 1 gigahertz; reference frequency, 20 megahertz or lower; output amplitude, variable from 0.5 to 4 volts into 50 ohms; amplitude accuracy, constant within 1% of reference as output frequency changes.	Check and adjustment of vertical bandwidth and vertical channel isolation.	a. TEKTRONIX SG 504 Leveled Sine-Wave Generator. b. Wiltron Model 610C Swept Frequency Generator with Model 61083C, 10 to 1220 megahertz plug-in.
13. 10X Passive Probe[1]	Compatible with test oscilloscope to be used.	Used to check signals out, calibrator and Z-axis adjustment.	a. TEKTRONIX P6053B or P6054A Probe.
14. 100X Probe	Compatible with test oscilloscope to be used; impedance, 5 kilohms.	Used to check Z-axis adjustment.	a. TEKTRONIX P6057 Probe.
15. Coaxial Cable (Two of Each Length Required)	Impedance, 50 ohms; type, RG-58/U; length, 18 and 42 inches; connectors, bnc.	Signal interconnection.	a. Tektronix Part 012-0076-00 (18 inches) and Tektronix Part 012-0057-01 (42 inches).
16. 2X Attenuator	Impedance, 50 ohms; 2X accuracy, within 2%, connectors, bnc.	Output termination for signal generators, if amplifier unit is not 50-ohm input impedance.	a. Tektronix Part 011-0069-02.
17. T Connector	Bnc-to-bnc.	Used to check external Z-axis operation and X-Y compensation.	a. Tektronix Part 103-0030-00.
18. Nylon Tuning Tool[1]	1-inch shaft.	Vertical high-frequency compensation.	a. Tektronix Part 003-0675-00.
19. Low-Capacitance Screwdriver[1]	1-inch shaft.	Used throughout adjustment procedure to adjust variable components.	a. Tektronix Part 003-0000-00.
20. Screwdriver[1]	Three-inch shaft, 3/32-inch bit.	Used throughout procedure to adjust variable resistors.	a. Xcelite R-3323.

[1] Used for calibration only; NOT used for performance check.

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PART I—PERFORMANCE CHECK

The following procedure (Part I—Performance Check) verifies electrical specifications without removing instrument covers or making internal adjustments. All tolerances given are as specified in the Specification tables (section 1) in this manual.

Part II—Adjustment and Performance Check provides the information necessary to: (1) verify that the instrument meets the electrical specifications, (2) verify that all controls function properly, and (3) perform all internal adjustments.

A separate Operators Checkout Procedure is provided in section 2 for familiarization with the instrument and also to verify that all controls, indicators and connectors function properly.

INDEX TO PERFORMANCE CHECK PROCEDURE

PERFORMANCE CHECK POWER-UP SEQUENCE

NOTE

The performance of this instrument can be checked at any ambient temperature from 0° to +50° C unless otherwise stated. Adjustments must be performed at an ambient temperature from +20° to +30° C for specified accuracies.

1. Check that the LINE VOLTAGE SELECTOR switch is set for the correct input line voltage.

2. Connect the instrument power cord to the power source.

3. Turn the instrument POWER switch on and allow at least 20 minutes before proceeding.

A. Z-AXIS AND DISPLAY

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
4. Time-base unit
15. 50-ohm cables (two required)
17. T connector (bnc)

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

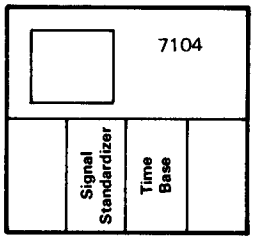
Z-AXIS AND DISPLAY PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Fully counterclockwise
HORIZONTAL MODE ..... A
B INTENSITY ..... Fully counterclockwise
B TRIGGER SOURCE ..... VERT MODE
FOCUS ..... Midrange
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... Midrange
BEAMFINDER ..... Pushbutton out

A1. CHECK TRACE ALIGNMENT

A1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Signal Standardizer
Test Selector Switch ..... Vert or Horiz Aux In

Time Base
Triggering ..... Auto, AC, Internal
Sweep Rate ..... 1 ms/div
Magnifier X1

a. Set the A INTENSITY control for a visible trace. Set the FOCUS and ASTIG controls for a well-defined trace.

b. Position the trace to the center graticule line.

c. **CHECK**—Trace parallels the center graticule line within 0.1 division.

d. **ADJUST**—TRACE ROTATION adjustment to align the trace with the vertical center graticule line.

@

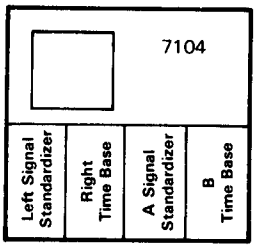
A2. CHECK GEOMETRY

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

A2. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE ..... ALT
HORIZONTAL MODE ..... ALT



Test Equipment Controls:
Left Signal Standardizer
Test Selector Switch ..... Vert or Horiz Gain
Rep Rate ..... 100 kHz

A Signal Standardizer
Test Selector Switch ..... Vert or Horiz Gain
Rep Rate ..... 100 kHz

Right Time Base
Sweep Rate ..... 2 μs/div
Triggering ..... Auto, AC, External

B Time Base
Sweep Rate ..... 2 μs/div
Triggering ..... Auto, AC, External

a. Set the B INTENSITY control for a visible display.

b. Set the FOCUS and ASTIG controls for a well defined display.

c. **CHECK**—For crosshatch pattern lines that parallel the graticule lines within 0.1 division.

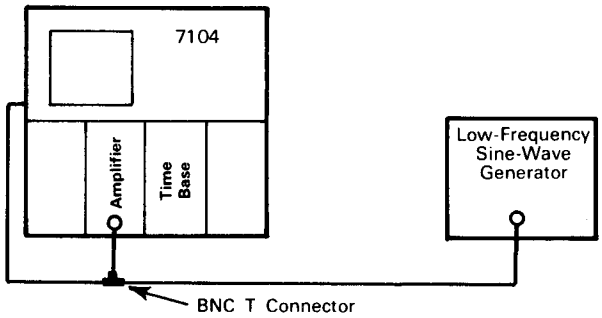
A3. CHECK EXTERNAL Z-AXIS OPERATION

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

A3. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE ..... A
VERTICAL MODE ..... RIGHT



Test Equipment Controls:
Amplifier Unit
Deflection Factor ..... 0.5 V/div
Time Base
Sweep Rate ..... 20 μs/div
Triggering ..... Auto, AC, Internal

a. Set the A INTENSITY control for a dim display.

b. Connect the output of the low-frequency sine-wave generator to the amplifier unit input (use a T connector, bnc, at the amplifier input).

c. Set the low-frequency sine-wave generator for a four-division display at 50 kilohertz (one volt above and below ground).

d. Connect the signal from the output of the T connector at the amplifier input to the Z-AXIS INPUT connector on the rear panel.

e. **CHECK**—Positive portion of the displayed waveform is blanked out.

B. CALIBRATOR AND OUTPUT SIGNALS

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
4. Time-base unit
10. Time-mark generator
15. Coaxial cable (one 18-inch, two 42-inch required)
17. T connector

BEFORE YOU BEGIN:

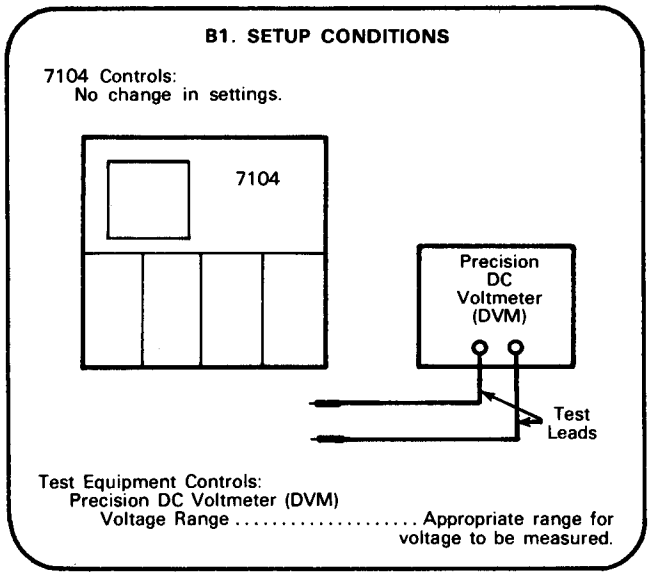
(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

CALIBRATOR AND OUTPUT SIGNALS PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Fully counterclockwise
HORIZONTAL MODE ..... A
B INTENSITY ..... Fully counterclockwise
B TRIGGER SOURCE ..... VERT MODE
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... Midrange
BEAMFINDER ..... Pushbutton out
CALIBRATOR ..... 4 V pushbutton in

B1. CHECK CALIBRATOR OUTPUT VOLTAGE



a. Set both the 4 V and 0.4 V CALIBRATOR pushbuttons to the depressed position.

b. Connect the precision dc voltmeter to the CALIBRATOR output connector.

c. **CHECK**—Meter reading for 0.4008 volt within the limits of 0.4004 to 0.4012 volt.

@

B2. CHECK CALIBRATOR 1 kHz REPETITION RATE

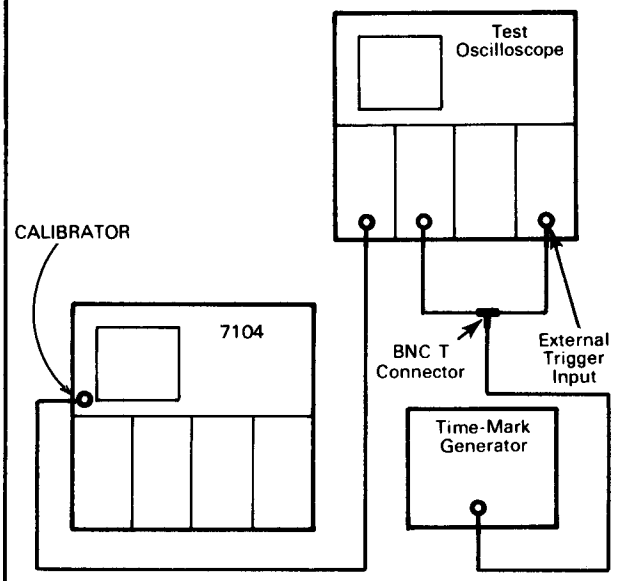
NOTE

A frequency counter with an accuracy of at least 0.1% may be used to adjust the calibrator repetition rate.

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

B2. SETUP CONDITIONS

7104 Controls:
CALIBRATOR ..... 4 V pushbutton in



Test Equipment Controls:
Time-Mark Generator ..... 1 ms markers

Test Oscilloscope
Triggering ..... Auto, AC, External
Input Coupling ..... DC
Sweep Rate ..... 1 ms/div
Vertical Mode ..... Add

a. Connect 1-millisecond time-markers to the test oscilloscope external trigger input and to the noninverting vertical channel of the test oscilloscope (use a T connector). Connect the 7104 CALIBRATOR output to the inverting input of the test oscilloscope.

b. Set the test oscilloscope triggering level for a stable time-mark display.

c. Set the test oscilloscope vertical deflection factors to display 2 divisions of CALIBRATOR signal and 1 division of time-marker signal.

d. Set the test oscilloscope sweep rate for 0.2 second/division.

e. **CHECK**—The time required for the 1-millisecond time marks to drift from the positive level of the CALIBRATOR signal to the negative level, and back to the positive level must be more than 0.4 second (2 divisions). This time can be measured directly from the display by observing the number of divisions that the markers move across the display area before it returns to the positive level.

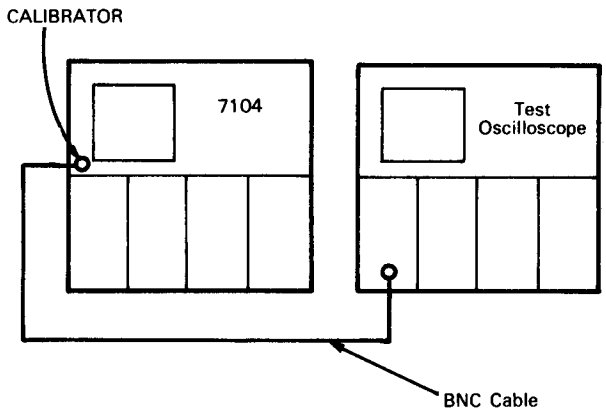
B3. CHECK CALIBRATOR RISE TIME, FALL TIME, AND DUTY CYCLE

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

B3. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Test Oscilloscope
Sweep Rate ..... 0.1 μs/div
Triggering ..... Auto, AC, Internal

a. Connect the CALIBRATOR output to the inverting vertical input of the test oscilloscope.

b. Set the test oscilloscope vertical deflection to display 4 divisions of CALIBRATOR signal.

c. Set the test oscilloscope for a stable display, triggered on the rising portion of the CALIBRATOR signal.

d. **CHECK**—Displayed waveform for not more than 5 divisions horizontally between the 10% to 90% points of the waveform (rise time, 0.5 microsecond or less).

e. Set the test oscilloscope for a stable display triggered on the falling portion of the waveform.

f. **CHECK**—Displayed waveform for not more than 5 divisions between the 90% and 10% points (fall time, 0.5 microsecond or less).

g. Set the test oscilloscope triggering for positive slope and auto mode with ac coupling from the internal source at a sweep rate of 0.1 millisecond/division. Set the triggering controls so that the display starts at the 50% point on the rising edge of the waveform.

h. Set the test oscilloscope sweep magnifier to X10. Then, position the display horizontally so the falling edge of the waveform aligns with the center vertical graticule line.

i. Set the test oscilloscope vertical to invert the display.

NOTE

The display is triggered on the opposite slope, even though the display appears the same.

j. **CHECK**—The 50% point on the falling edge of the waveform now displayed is within 0.2 divisions horizontally of the center line. (Indicates duty cycle of 50% within 0.2%.)

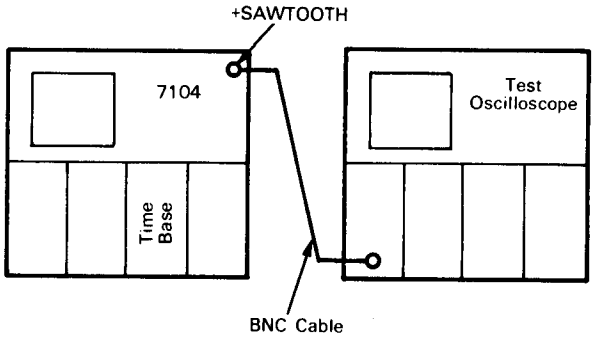
B4. CHECK A AND B SAWTOOTH OUTPUT SIGNALS

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

B4. SETUP CONDITIONS

7104 Controls:
+SAWTOOTH A or B switch ..... A



Test Equipment Controls:
Test Oscilloscope
Sweep Rate ..... 2 ms/div
Vertical Deflection ..... 2 V/div

Time Base
Sweep Rate ..... 0.1 ms/div
Triggering ..... Auto

a. Connect the +SAWTOOTH output connector to the test oscilloscope channel 1 vertical input (1 megohm input).

b. **CHECK**—That the slope of the test oscilloscope display is 2 volts/division within 10% (10 volt sawtooth display for 10 division sweep on 7104 crt screen) and that the sawtooth baseline is within one volt of ground.

c. Move the time-base unit to the B HORIZ compartment.

d. Set the +SAWTOOTH selector switch to the B position.

e. **CHECK**—Test oscilloscope display for 2 volts/division of sweep within 10% (10 volt sawtooth display for 10 division sweep on the 7104 crt screen) and that the sawtooth baseline is within one volt of ground.

@

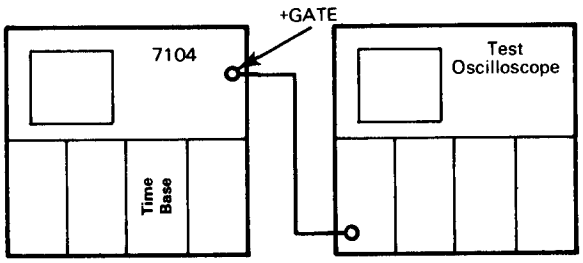
B5. CHECK A AND B GATE OUTPUT SIGNALS

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

B5. SETUP CONDITIONS

7104 Controls:
+GATE A or B Switch ..... A



Test Equipment Controls:
Test Oscilloscope
Vertical Deflection Factor ..... 2 V/div
Sweep Rate ..... 2 ms/div

Time-Base
Mode ..... Delaying
Triggering ..... Auto, AC, Internal
Sweep Rate ..... 0.5 ms/div

a. **CHECK**—Test oscilloscope display for a gate waveform 5 divisions in amplitude within 10% and a baseline at zero volts within one volt.

b. Move the time-base unit to the B HORIZ compartment.

c. Set the +GATE selector switch to the B position.

d. **CHECK**—Test oscilloscope display for a gate waveform 5 divisions in amplitude within 10% and a baseline at zero volts within one volt.

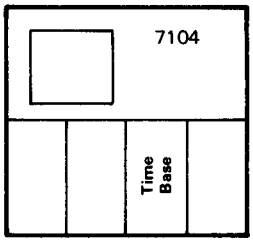
B6. CHECK GRATICULE ILLUMINATION OPERATION

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

B6. SETUP CONDITIONS

7104 Controls:
GRAT ILLUM +GATE or EXT switch ..... +GATE
+GATE A or B switch ..... A
HORIZONTAL MODE ..... A



Test Equipment Controls:
Time Base
Sweep Rate ..... 0.2 s
Triggering ..... Auto, AC, Internal

a. **CHECK**—Rotate the GRAT ILLUM control throughout its range and notice that the illumination of the graticule varies.

b. Set the GRAT ILLUM control fully clockwise to the PULSED detent position.

c. Set the A INTENSITY control for a visible display.

d. **CHECK**—Graticule illumination occurs only after the time-base unit has completed a sweep (adjust GRAT ILLUM PRESET, if necessary).

e. Set the GRAT ILLUM +GATE or EXT switch to EXT.

f. **CHECK**—Press the GRAT ILLUM MAN pushbutton and check for one momentary illumination of the graticule.

g. Set the GRAT ILLUM control to midrange (out of the PULSED detent position).

C. TRIGGER SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
3. Amplifier unit (dual trace)
4. Time-base unit (two required)
5. Signal standardizer
15. Coaxial cable (one 18-inch, two 42-inch required)

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

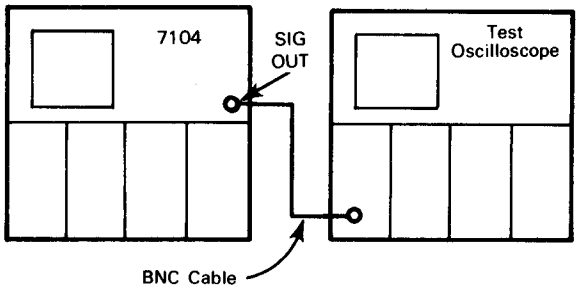
TRIGGER SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Fully counterclockwise
HORIZONTAL MODE ..... A
B INTENSITY ..... Fully counterclockwise
B TRIGGER SOURCE ..... VERT MODE
FOCUS ..... Midrange
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... Midrange
BEAMFINDER ..... Pushbutton out

C1. CHECK VERTICAL SIGNAL OUT DC CENTERING

C1. SETUP CONDITIONS

7104 Controls:
No change in setting.



Test Equipment Controls:
Test Oscilloscope
Input Coupling ..... Gnd or Off
Vertical Deflection ..... 1 V/div
Sweep Rate ..... 1 ms/div

a. Establish a ground reference for the test oscilloscope by positioning the trace to the graticule center line. Do not change the test oscilloscope position control after setting this ground reference.

b. Connect the front-panel SIG OUT connector to the vertical input of the test oscilloscope with the 42-inch, 50-ohm bnc cable.

c. Set the test oscilloscope input coupling switch to dc.

d. **CHECK**—Test oscilloscope display for a dc level within 1 division of the ground reference established in part a.

@

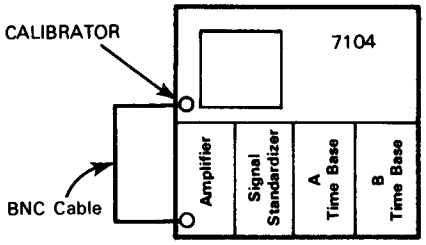
C2. CHECK TRIGGER SELECTOR OPERATION

NOTE

If the preceding step was not performed, first refer to the Trigger System Preliminary Control Settings, then proceed with the following instructions.

C2. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE ..... LEFT
HORIZONTAL MODE ..... A
A TRIGGER SOURCE ..... VERT MODE
B TRIGGER SOURCE ..... VERT MODE



Test Equipment Controls:
Signal Standardizer
Test Selector Switch ..... Vert or Horiz +Step Resp
Rep Rate ..... 10 kHz

A Time Base
Sweep Rate ..... 0.2 ms/div
Triggering ..... Auto, AC, Internal
Magnifier X1
Mode ..... Independent

B Time Base
Sweep Rate ..... 0.2 ms/div
Triggering ..... Auto, AC, Internal
Magnifier X1
Mode ..... Independent

a. Connect the CALIBRATOR 4 V output to the amplifier unit (use 18-inch bnc cable). Set the A INTENSITY control for a visible display. Set the amplifier for a 2-division display in the upper half of the graticule area. Use the A time-base unit trigger level to trigger the display.

b. Set the VERTICAL MODE switch to RIGHT.

c. Set the signal standardizer Amplitude and Position controls for a 2-division display in the lower half of the graticule area.

d. Set the VERTICAL MODE switch to ALT.

e. **CHECK**—The crt display for 1-kHz and 10-kHz triggered waveforms (adjust the time-base unit trigger level controls as necessary).

f. Set the VERTICAL MODE switch to ADD.

g. **CHECK**—For a triggered waveform.

h. Set the VERTICAL MODE switch to CHOP.

i. **CHECK**—For a stable display of only the 1-kHz waveform.

j. Set the A TRIGGER SOURCE switch to LEFT VERT.

k. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 1-kHz waveform.

l. Set the A TRIGGER SOURCE switch to RIGHT VERT.

m. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 10-kHz waveform.

n. Set the VERTICAL MODE switch to ALT, the HORIZONTAL MODE switch to B, and the B INTENSITY control for a visible display.

o. **CHECK**—Crt display for 1-kHz and 10-kHz triggered waveforms.

p. Set the VERTICAL MODE switch to ADD.

q. **CHECK**—For a stable display.

r. Set the VERTICAL MODE switch to CHOP.

s. **CHECK**—For a stable display of only the 1-kHz waveform.

t. Set the B TRIGGER SOURCE switch to LEFT VERT.

u. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 1-kHz waveform.

v. Set the B TRIGGER SOURCE switch to RIGHT VERT.

w. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 10-kHz waveform.

x. Set the VERTICAL MODE switch to ALT, the HORIZONTAL MODE switch to ALT, and the A and B TRIGGER SOURCE switches to VERT MODE.

y. **CHECK**—Vary the time-base unit's Trigger Level control. The B HORIZ time-base unit should be triggered on the 1-kHz waveform; the A HORIZ time-base unit should be triggered on the 10-kHz waveform.

D. HORIZONTAL SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit (two required, one with variable delay)
4. Time-base unit
5. Signal standardizer
10. Time-mark generator
11. Low-frequency sine-wave generator
15. Coaxial cable (one 18-inch, one 42-inch)
17. T connector

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

HORIZONTAL SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
VERT TRACE SEPARATION (B) ..... Midrange
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Fully counterclockwise
HORIZONTAL MODE ..... A
B INTENSITY ..... Fully counterclockwise
B TRIGGER SOURCE ..... VERT MODE
FOCUS ..... Midrange
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... As desired
BEAMFINDER ..... Pushbutton out
X-Y Z-Axis ..... X-Y DC Controlled Z-Axis (see note below)

NOTE

The X-Y Z-Axis Selector is an internal switch located on the Logic board (A13). Refer to Figure 8-29, Test Point and Adjustment Locations E, in section 8 of this manual. When the X-Y Z-Axis Selector switch is set to the X-Y DC Controlled Z-Axis position, control of the Z-Axis drive signal to the crt is determined by the horizontal plug-in unit selected by the HORIZONTAL MODE switch. When the X-Y Z-Axis Selector is set to the X-Y Time Base Controlled Z-Axis position, and an amplifier unit is installed in one of the horizontal compartments, control of the Z-Axis drive signal to the crt is determined by a time-base unit installed in the other horizontal compartment. Return the X-Y Z-Axis Selector to the X-Y Time Base Controlled Z-Axis position after performing all or part of the D. Horizontal System procedure.

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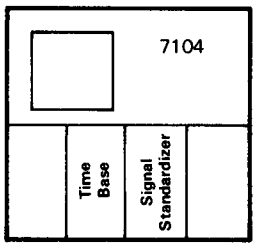
D1. CHECK HORIZONTAL AMPLIFIER GAIN

D1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Signal Standardizer
Test Selector Switch ..... Vert or Horiz Com Mode
Rep Rate ..... 1 MHz

Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal

a. Set the A INTENSITY control for a visible trace.

b. Set the signal standardizer Test Selector switch to Vert or Horiz Gain and the Rep Rate switch to 1 MHz. Align the bright vertical trace with the center vertical graticule line using the signal standardizer Position control.

c. **CHECK**—For 8 divisions of deflection between the center nine traces within 0.08 division. Note the exact error for comparison in part h.

d. **CHECK**—That the other vertical traces align with their respective graticule lines within 0.05 division.

e. Move the signal standardizer to the B HORIZ compartment.

f. Set the HORIZONTAL MODE switch to B.

g. Set the B INTENSITY control for a visible display.

h. **CHECK**—For 8 divisions of deflection between the center nine traces within 0.08 division of the error noted in part c, and that the other vertical traces align with their respective graticule lines within 0.05 division (specified at the center graticule line).

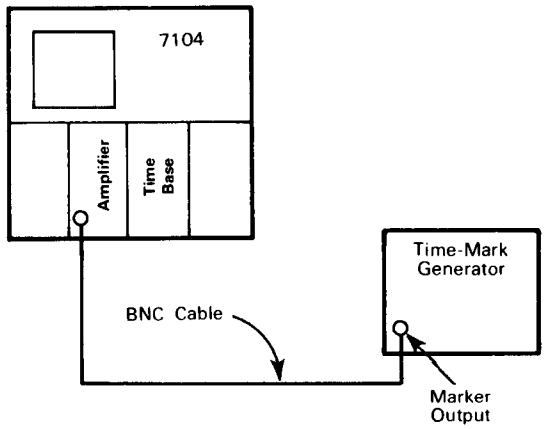
D2. CHECK HIGH-FREQUENCY TIMING

NOTE

If the preceding step was not performed, first refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

D2. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE ..... A



Test Equipment Controls:
Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal
Mode ..... Independent

Amplifier
Deflection Factor ..... 0.5 V/div
Input Coupling ..... DC

Time-Mark Generator ..... 1 ms markers

a. Connect 1-millisecond markers from the time-mark generator to the amplifier unit input and adjust the amplifier unit deflection factor for about 2 divisions of display. Set the A INTENSITY control for a visible display, if necessary.

b. Set the time-base unit triggering controls for a stable display.

c. Position the first marker to the extreme left line on the graticule.

d. Set the time-base unit sweep calibration control for 1 marker at each major graticule division between the second and tenth graticule lines (center 8 divisions).

e. **CHECK**—Refer to the time-base unit instruction manual for performance check or calibration procedures for checking high-frequency timing and linearity.

D3. CHECK X-Y COMPENSATION (OPTION 2)

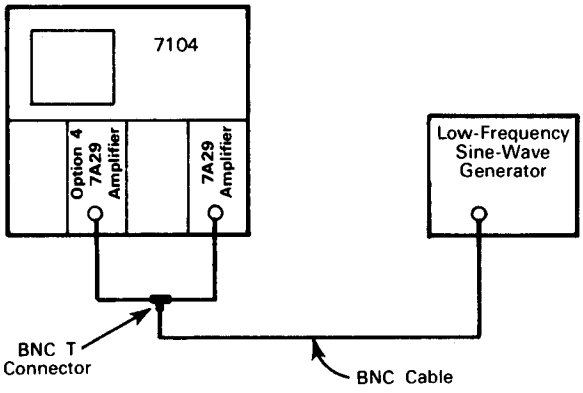
NOTE

If the instrument under test does not contain Option 2, omit the remainder of this step.

If the preceding step was not performed, refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

D3. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE ..... B



Test Equipment Controls:
7A29 Amplifier Option 4
Deflection Factor ..... 0.1 V/div
Input Coupling ..... DC
Polarity ..... + UP

7A29 Amplifier
Deflection Factor ..... 0.1 V/div
Input Coupling ..... DC
Polarity ..... + UP

a. Set the low-frequency sine-wave generator for eight divisions of vertical and horizontal deflection at 25 megahertz.

b. Set the variable delay control on the 7A29 Option 4 Amplifier unit to minimize the separation on the Lissajous display.

c. Set the low-frequency sine-wave generator to 50 megahertz.

d. **CHECK**—Crt Lissajous display for a separation of 0.28 division or less (indicates 2 degrees or less phase shift).

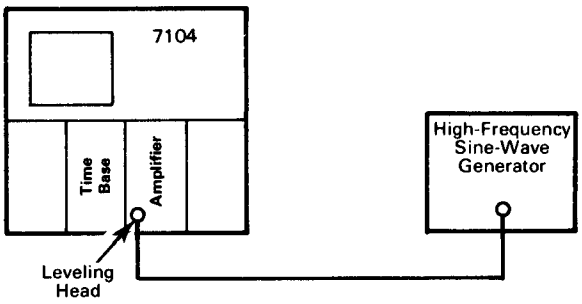
D4. CHECK HORIZONTAL BANDWIDTH

NOTE

If the preceding step was not performed, refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

D4. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE ..... A



Test Equipment Controls:
Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, External

Amplifier
Deflection Factor ..... 0.5 mV
Input Coupling ..... DC

a. Set the high-frequency sine-wave generator for 8 divisions of displayed signal on the 7104 crt at the generator's reference frequency (6 megahertz).

b. Set the high-frequency sine-wave generator output frequency to 350 megahertz.

c. **CHECK**—Displayed 350 MHz amplitude is at least 5.7 divisions.

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E. VERTICAL SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit
4. Time-base unit (two required)
5. Signal standardizer
11. Low-frequency sine-wave generator
12. High-frequency sine-wave generator

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

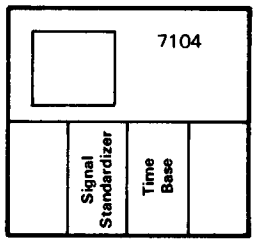
VERTICAL SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
VERT TRACE SEPARATION (B) ..... Midrange
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Midrange
HORIZONTAL MODE ..... A
B INTENSITY ..... Midrange
B TRIGGER SOURCE ..... VERT MODE
FOCUS ..... Midrange
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... As desired
BEAMFINDER ..... Pushbutton out

E1. CHECK VERTICAL AMPLIFIER GAIN

E1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, External

Signal Standardizer
Test Selector Switch ..... Vert or Horiz Gain
Rep Rate ..... 100 kHz

a. Position the signal standardizer display to align the bright center trace with the graticule center line.

b. **CHECK**—For one trace per graticule division within 0.06 division over the center 6 graticule divisions. Note the exact error for comparison in part e.

c. Remove the signal standardizer from the RIGHT VERT compartment and install it in the LEFT VERT compartment.

d. Set the VERTICAL MODE switch to LEFT.

e. **CHECK**—For one trace per graticule division within 0.06 division of the error noted in part b, over the center 6 graticule divisions.

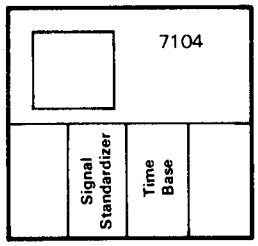
E2. CHECK VERTICAL LOW-FREQUENCY LINEARITY

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

E2. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE ..... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal

Signal Standardizer
Test Selector Switch ..... Vert or Horiz +Step Resp
Rep Rate ..... 1 kHz

a. Set the signal standardizer Amplitude and Position controls so the display is exactly two divisions in amplitude in the center of the graticule area.

b. **CHECK**—Position the two-division display vertically and check for not more than 0.1 division of compression or expansion anywhere within the graticule area.

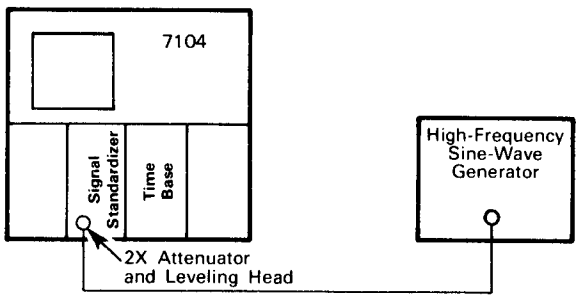
E3. CHECK VERTICAL AMPLIFIER 1 GHz GAIN

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

E3. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE ..... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate ..... 0.1 ms/div
Triggering ..... Auto, AC, External

Signal Standardizer
Test Selector Switch ..... Vert or Horiz Freq Resp

High-Frequency Sine-Wave Generator
Reference Frequency ..... 6 MHz

a. Set the signal standardizer Amplitude control fully clockwise.

b. Connect the high-frequency sine-wave generator to the signal standardizer Aux In CW In (Freq Resp) input with a 2X attenuator.

c. Set the high-frequency sine-wave generator for a 10-division display at the reference frequency (between 6 and 50 megahertz) centered on the graticule. (To obtain a 10-division display, first set for 8 divisions, then vertically position the display 1 division down and set the sine-wave generator to return the top of the display to the top of the graticule.)

d. Set the signal standardizer Amplitude control for a 6-division display, centered on the graticule. (The CW Leveled indicator should be lit.)

e. Without changing the output amplitude, increase the sine-wave generator frequency until the displayed amplitude is reduced to 5 divisions. If the CW Leveled indicator goes off, increase the amplitude of the sine-wave generator signal until the light just turns on.

NOTE

The signal standardizer CW Leveled light must be on and the sine-wave generator must be properly connected for a valid check. Refer to the signal standardizer and high-frequency sine-wave generator manuals.

f. **CHECK**—Sine-wave generator frequency is 1 gigahertz or higher (verifies 1 gigahertz gain).

@

g. Move the signal standardizer to the LEFT VERT compartment (leave signal connected) and set the VERTICAL MODE switch to LEFT.

h. **CHECK**—Repeat parts d through g for the LEFT VERT compartment.

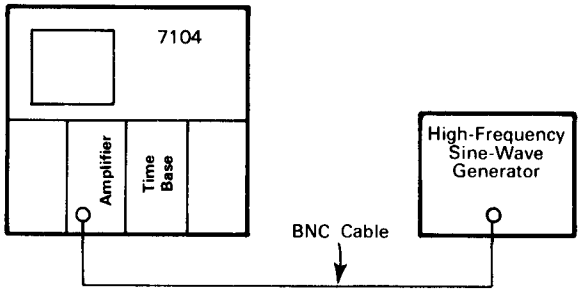
E4. CHECK VERTICAL CHANNEL ISOLATION

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

E4. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE ..... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal

Amplifier
Input Coupling ..... DC

High-Frequency Sine-Wave Generator ..... 1 GHz

a. Connect the output of the high-frequency sine-wave generator to the amplifier unit input.

b. Set the output of the high-frequency sine-wave generator and the amplifier unit deflection factor for 8 divisions of deflection at 1 gigahertz.

c. Set the VERTICAL MODE switch to LEFT.

d. **CHECK**—Crt display amplitude for 0.1 division less of the 1-gigahertz signal (verifies isolation at least 80:1 at 1 gigahertz).

e. Move the amplifier unit to the LEFT VERT compartment without disturbing the set-up.

f. Set the VERTICAL MODE switch to RIGHT.

g. **CHECK**—Crt display amplitude for 0.1 division or less of the 1 gigahertz signal (verifies isolation at least 80:1 at 1 gigahertz).

h. Set the VERTICAL MODE switch to LEFT.

i. Connect the low-frequency sine-wave generator to the amplifier input.

j. Set the low-frequency sine-wave generator for 8 divisions of deflection at 100 megahertz.

k. Set the VERTICAL MODE switch to RIGHT.

l. **CHECK**—Crt display amplitude for 0.05 division or less of 100 megahertz signal (verifies 100 megahertz isolation at least 160:1).

m. Move the amplifier unit to the RIGHT VERT compartment without disturbing the set-up.

n. Set the VERTICAL MODE switch to LEFT.

o. **CHECK**—Crt display amplitude for 0.05 division or less of 100 megahertz signal (verifies isolation at least 60:1 from dc to 100 megahertz).

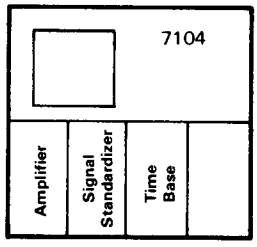
E5. CHECK VERTICAL DISPLAY MODES

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

E5. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE ..... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal

Amplifier
Deflection Factor ..... 0.1 V/div
Input Coupling ..... DC

Signal Standardizer
Test Selector Switch ..... Vert or Horiz Aux In

a. Position the trace to the upper half of the graticule area with the right-vertical unit position control.

b. Set the VERTICAL MODE switch to LEFT and position the trace to the lower half of the graticule area with the left-vertical unit position control.

c. **CHECK**—Crt display for two traces in the ALT and CHOP positions of the VERTICAL MODE switch.

d. Set the VERTICAL MODE switch to ADD.

e. **CHECK**—Crt display for a single trace that can be positioned vertically with either the left or right vertical-unit position control.

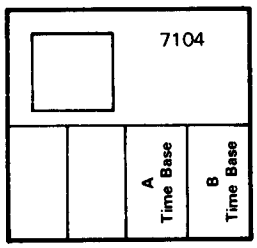
E6. CHECK VERTICAL TRACE SEPARATION OPERATION

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

E6. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE ..... CHOP
VERTICAL MODE ..... ADD



Test Equipment Controls:
A Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal

B Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal

a. **CHECK**—Rotate the VERT TRACE SEPARATION (B) control throughout its range and check that the trace produced by the B time-base unit can be positioned at least 4 divisions above and below the trace produced by the A time-base unit. Also, check with the HORIZONTAL MODE switch set to ALT.

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F. READOUT SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

3. Amplifier unit (dual trace)

4. Time-base unit

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change information at the rear of this manual for any modifications which may affect this procedure.

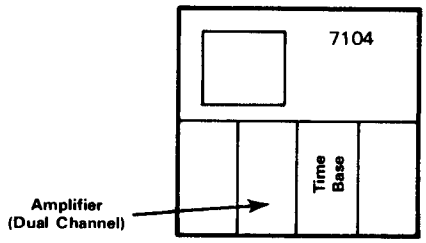
READOUT SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
VERT TRACE SEPARATION (B) ..... Midrange
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Midrange
HORIZONTAL MODE ..... A
B TRIGGER SOURCE ..... VERT MODE
B INTENSITY ..... Midrange
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... Midrange
BEAMFINDER ..... Pushbutton out

F1. CHECK READOUT MODES

F1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal

Amplifier
Mode ..... Dual trace

a. Set the READOUT INTENSITY control for a visible display.

b. **CHECK**—Set the time-base unit to several sweep rates throughout the time/division switch range and check that the readout characters are displayed independently of the sweep.

c. Set the READOUT +GATE or EXT switch to +GATE and the READOUT INTENSITY control to PULSED.

d. Set the +GATE mode switch to A.

e. Set the READOUT PRESET control for a visible readout display.

f. Set the time-base unit for a free-running (not triggered) sweep at a rate of 0.2 second/division.

g. **CHECK**—The readout characters are blanked out while the sweep is running, and are displayed immediately after the end of the sweep; each character encoded by the plug-in units is displayed only once for each sweep.

h. Set the READOUT +GATE or EXT switch to EXT.

i. **CHECK**—Press the READOUT MAN pushbutton and notice that one frame of readout is displayed.

G. PHOTOGRAPHIC WRITING RATE

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit
4. Time-base unit
7. Camera
12. High-frequency sine-wave generator

BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

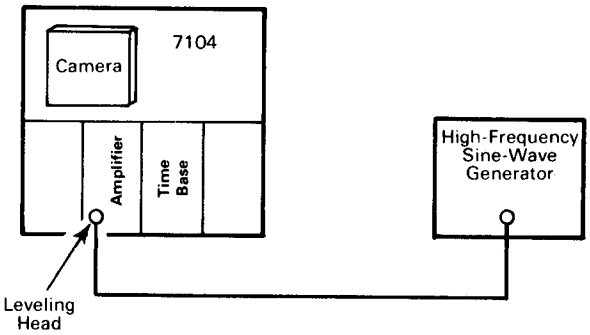
PHOTOGRAPHIC WRITING RATE PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Counterclockwise
HORIZONTAL MODE ..... A
B INTENSITY ..... Counterclockwise
B TRIGGER SOURCE ..... VERT MODE
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... PULSED
BEAMFINDER ..... Pushbutton out

G1. CHECK PHOTOGRAPHIC WRITING RATE

G1. SETUP CONDITIONS

7104 Controls:
GRAT ILLUM +GATE or EXT ..... +GATE
+GATE A or B ..... A



Test Equipment Controls:
Amplifier
Deflection Factor ..... 0.5 V/div
Input Coupling ..... DC

Time Base
Sweep Rate ..... 2 ns
Magnifier X1
Triggering ..... Auto, AC, Internal

High-Frequency Sine-Wave Generator
Frequency ..... 1 GHz

Camera
Mode ..... Time
Aperature f/1.9

NOTE

Section 2, Operating Instructions, contains helpful information on obtaining waveform photographs; see Graticule Illumination, Light Filter, Readout Display and Display Photography.

a. Remove the blue crt filter.

b. Set the A INTENSITY control for a visible display.

c. Set the time-base unit sweep magnifier to X10.

d. Set the high-frequency sine-wave generator output amplitude to display a 7.5 division signal on the 7104 crt.

e. Set the time-base unit triggering controls for a stable display.

f. Set the FOCUS and ASTIG controls for a well-defined display.

g. Set the time-base unit to single-sweep mode.

h. Sequentially press the time-base unit single sweep reset control and set the GRAT ILLUM PRESET control to illuminate the graticule.

i. Focus the camera.

j. Install 3000 ASA film in the camera and close the camera viewing port.

k. Rotate the A INTENSITY control fully clockwise.

l. Press the camera shutter button.

m. Press the time-base single sweep reset button.

n. Press the camera shutter button.

o. Develop film.

p. **CHECK**—Photograph should show the 1 GHz sine-wave signal clearly (see Fig. 5-1 for typical photograph).

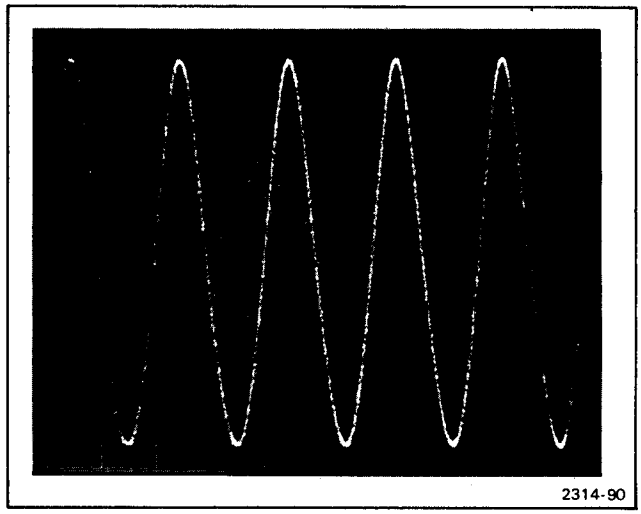


Figure 5-1. Typical 7104 Photographic Writing Rate.

This concludes the Performance Check of the 7104.

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PART II—ADJUSTMENT AND PERFORMANCE CHECK

The following procedure (Part II—Adjustment and Performance Check) provides the information necessary to: (1) verify that the instrument meets the electrical specifications, (2) verify that all controls function properly, and (3) perform all internal adjustments.

Part I—Performance Check verifies electrical specifications without removing instrument covers or making internal adjustments. All tolerances given are as specified in the Specification tables (section 1) in this manual.

A separate Operators Checkout Procedure is provided in the Operators Manual for familiarization with the instrument and also to verify that all controls, indicators, and connectors function properly.

INDEX TO ADJUSTMENT AND PERFORMANCE CHECK PROCEDURE

ADJUSTMENT AND PERFORMANCE CHECK POWER-UP SEQUENCE

NOTE

The performance of this instrument can be checked at any ambient temperature from 0° to +50° C unless otherwise stated. Adjustments must be performed at an ambient temperature from +20° to +30° C for specified accuracies.

1. Check that the LINE VOLTAGE SELECTOR switch is set for the correct input line voltage.

2. Remove cabinet panels to gain access to internal adjustments and test points.

3. Turn the instrument POWER switch on and allow at least 20 minutes warmup before proceeding.

A. POWER SUPPLY

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

8. Precision dc voltmeter (DVM)

20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the **Test Point and Adjustment Locations A** foldout page in Section 8, Diagrams and Circuit Board Illustrations.

WARNING

Extreme caution must be used when operating the 7104 with the power unit removed due to the line voltage, high voltage, and high current potentials present.

NOTE

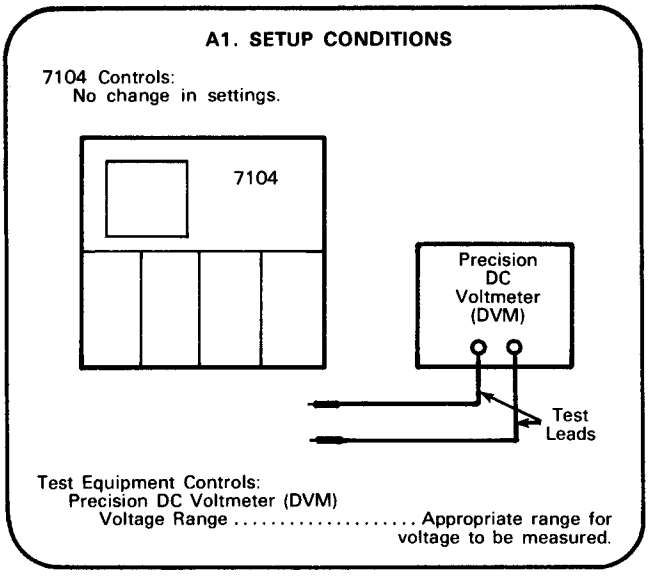
The Power Supply voltages can be checked without removing the power unit by using the 7000-series plug-in extender (rigid), Tektronix part 067-0589-00.

POWER SUPPLY PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... Counterclockwise
BEAMFINDER ..... Pushbutton out
All other controls ..... No change

a. Set POWER switch to OFF and disconnect the line cord from the power source. Remove any plug-in units from the plug-in compartments. Expose the 7104 power supply adjustments and test points by removing the power unit from the rear of the 7104 (interconnecting cables remain connected). See the Maintenance section in this manual for power unit removal instructions.

A1. ADJUST +50 VOLT POWER SUPPLY (R1415)



b. Connect the line cord to the power source and press the POWER button in.

c. Connect the precision dc voltmeter between TP -50 V Sense and TP Ground Sense on the Low-Voltage Regulator circuit board.

d. **EXAMINE**—The meter reading for -50 volts, within the limits of -49.8 to -50.2 volts.

e. **ADJUST**—The +50 V adjustment R1415 for a meter reading of -50 volts within 0.1 volt.

f. **INTERACTION**—Any change in the setting of R1415 may affect the operation of all circuits in the instrument.

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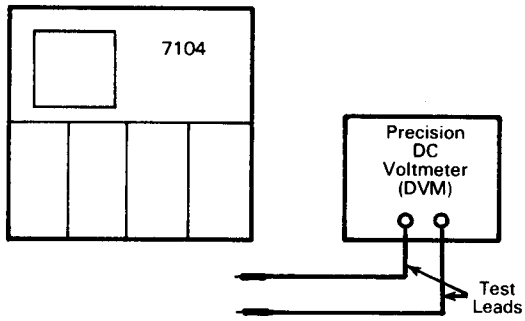
A2. ADJUST INVERTER CONTROL (R1293)

NOTE

If the preceding step was not performed, first refer to the Power Supply Preliminary Control Settings, then proceed with the following instructions.

A2. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Precision DC Voltmeter (DVM)
Voltage Range ..... Appropriate range for voltage to be measured.

a. Connect the precision dc voltmeter between TP1326 and chassis ground.

b. **EXAMINE**—Meter reading for +109 volts within the limits of +108.9 to +109.1 volts. If the meter reading is within the given tolerance, proceed to step A3.

c. **ADJUST**—The Pre Reg Adj, adjustment R1293 for a meter reading of +109 volts within 0.1 volt.

d. **INTERACTION**—Any change in the setting of R1293 may affect the adjustment of R1415 given in step A1.

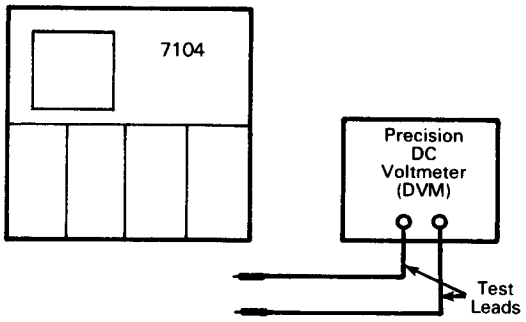
A3. EXAMINE POWER-SUPPLY VOLTAGES

NOTE

If the preceding step was not performed, first refer to the Power Supply Preliminary Control Settings, then proceed with following instructions.

A3. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Precision DC Voltmeter (DVM)
Voltage Range ..... Appropriate range for voltage to be measured.

a. **EXAMINE**—Table 5-4 lists the low-voltage power supplies in this instrument. Check each supply with the precision dc voltmeter for output voltage within the given tolerance. Connect meter common lead to TP Ground Sense.

b. **INTERACTION**—If the power supplies are not within the tolerances given in Table 5-4, repeat steps A1 and A2.

TABLE 5-4
Power Supply Tolerance

Power Supply	Output Voltage Limits
TP -50 V Sense	-49.8 to -50.2 volts
TP -15 V Sense	-14.85 to -15.15 volts
TP +5 V Sense	+4.9 to +5.1 volts
TP +15 V Sense	+14.85 to +15.15 volts
TP +50 V Sense	+49.5 to +50.5 volts

c. Disconnect the precision dc voltmeter.

NOTE

Regulation of the individual power supplies can be checked using the procedure given under Troubleshooting Techniques in the Maintenance section.

d. Disconnect the line cord from the power source.

e. Install the power unit and connect the line cord.

B. Z-AXIS AND DISPLAY

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
2 or 3. Amplifier unit (two required)
4. Time-base unit (two required)
5. Signal standardizer (two required)
8. Precision dc voltmeter (DVM)
9. DC voltmeter (VOM)
11. Low-frequency sine-wave generator
12. High-frequency sine-wave generator
13. 10X passive probe
14. 100X probe
15. Coaxial cable (two 42-inch required)
16. 2X attenuator
17. T connector
19. Low-capacitance screwdriver
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the Test Point and Adjustment Locations B foldout page in Section 8, Diagrams and Circuit Board Illustrations.

(4) Remove the blue rear-panel cabinet cover (secured by 4 screws).

Z-AXIS AND DISPLAY PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
VERT TRACE SEPARATION (B) ..... Midrange
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Fully counterclockwise
HORIZONTAL MODE ..... A
B INTENSITY ..... Fully counterclockwise
B TRIGGER SOURCE ..... VERT MODE
FOCUS ..... Midrange
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... Midrange
BEAMFINDER ..... Pushbutton out
X-Y Z Axis Selector ..... X-Y Time Base Controlled Z-Axis (see following note)

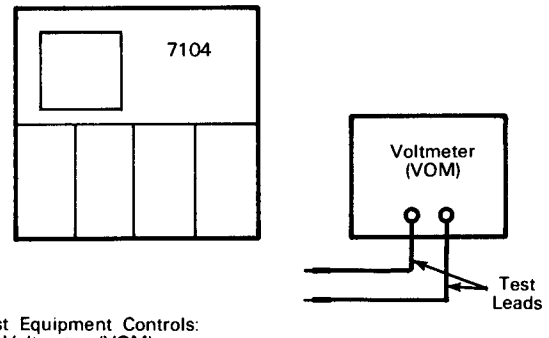
NOTE

The X-Y Z-Axis Selector is an internal switch located on the Logic board (A13). Refer to Figure 8-29, Test Point and Adjustment Locations E, in section 8 of this manual. When the X-Y Z-Axis Selector is set to the X-Y DC Controlled Z-Axis position, control of the Z-Axis drive signal to the crt is determined by the horizontal plug-in unit selected by the HORIZONTAL MODE switch. When the X-Y Z-Axis Selector is set to the X-Y Time Base Controlled Z-Axis position (In) and an amplifier unit is installed in one of the horizontal compartments, control of the Z-Axis drive signal to the crt is determined by a time-base unit installed in the other horizontal compartment. Return the X-Y Z-Axis Selector to the X-Y Time Base Controlled Z-Axis position (In) after performing all or part of this procedure.

B1. ADJUST HV SUPPLY (R1805)

B1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Voltmeter (VOM)
Range ..... Appropriate range for voltage to be measured.

a. Set the POWER switch to OFF.

b. Connect the dc voltmeter (VOM), set to measure at least -2500 volts (accuracy check to within 1%), between TP1846 (-2265 volt test point), and TP1756 (ground). (Test points located on the A22 High Voltage board.)

c. Set the POWER switch to on.

d. **EXAMINE**—Meter reading; -2265 volts within the limits of -2243 to -2287 volts.

e. **ADJUST**—The HV Adjust, adjustment R1805, for a meter reading of -2265 volts.

f. Set the POWER switch to OFF.

WARNING

Shock hazard exists while performing parts g through n; VOM elevated to 2.4 kV.

g. Connect the dc voltmeter (VOM), set to measure 150 volts, between TP1844 (-2400 volts) and TP1846 (-2265 volts).

h. Set the POWER switch to on.

i. **EXAMINE**—Meter reading for 137 volts within the limits of 132 volts to 142 volts. If meter reads outside limits, corrective maintenance is required to prevent deterioration of the crt cathode.

j. Set the POWER switch to OFF and disconnect the voltmeter.

k. Remove the shield from the Z-Axis board.

l. Connect the dc voltmeter (VOM), set to measure 600 millivolts dc, across R1688 on the Z-Axis board A21 (connect VOM common test lead to junction of CR1687 and R1688 and the other lead to pin 6 of P1602).

m. Set the POWER switch to on.

n. **EXAMINE**—Meter reading for a momentary deflection of at least 10 millivolts; if meter reading is less, corrective maintenance is required to prevent deterioration of the crt cathode.

o. Set the POWER switch to OFF and disconnect the dc voltmeter.

p. Replace the shield on the Z-Axis board.

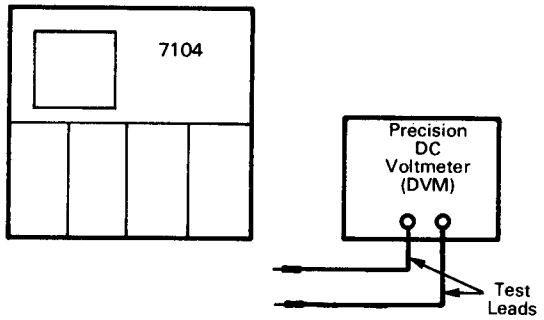
B2. ADJUST CRT GRID BIAS (R1746)

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

B2. SETUP CONDITIONS

7104 Controls:
POWER switch ..... ON



Test Equipment Controls:
Precision DC Voltmeter (DVM)
Range ..... Approprite range for voltage to be measured.

a. Connect the precision dc voltmeter (DVM) between test point TP1678 and chassis ground.

b. **EXAMINE**—The DVM reading for 8 volts within 1 volt.

c. **ADJUST**—Set the Z-Axis Level adjustment R1645 for 8 volts.

d. Install an amplifier unit in the A HORIZ and B HORIZ compartments, and midrange the B HORIZ amplifier unit Position control.

e. Rotate the B INTENSITY control clockwise until the DVM reads 13 volts.

f. **ADJUST**—The Grid Bias adjustment R1746 so that the dot displayed on the crt is just extinguished.

NOTE

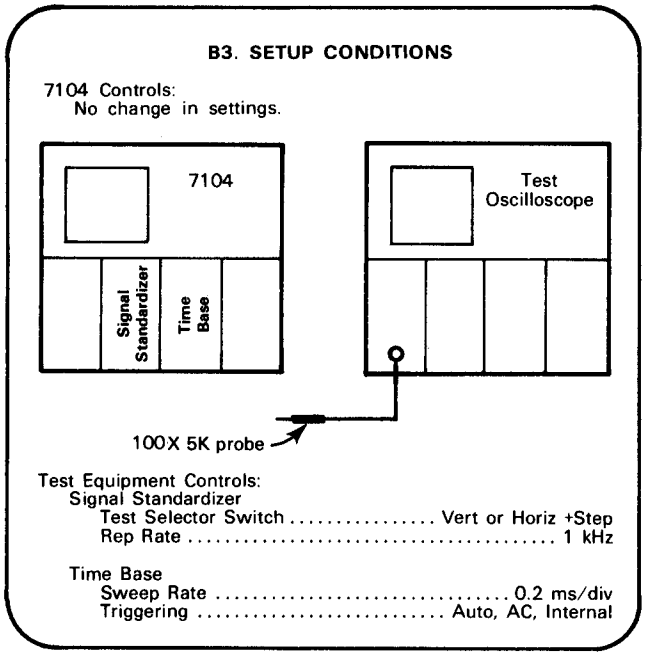
The instrument has to be on for at least 20 minutes to allow for stabilization of the crt grid cutoff voltage.

g. Disconnect the DVM test leads.

B3. ADJUST Z-AXIS AMPLIFIER (R1626, R1637, R1635, C1635, C1651, AND C1663)

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.



a. Set the A INTENSITY control for a visible display.

b. Set the time-base unit triggering controls for a stable display.

c. Rotate the signal standardizer Amplitude and Position controls fully counterclockwise.

d. Connect the 100X 5-kilohm probe to the input of the test oscilloscope. Note that a 50-ohm system is needed for the 100X 5-kilohm probe.

e. Set the test oscilloscope for dc input coupling with a vertical deflection factor of 0.1 volts/division (10 volts/division at the probe tip) and a sweep rate of 1 millisecond/division.

f. Connect the probe tip to TP1678. Connect the probe ground to chassis ground with a short grounding strap.

g. Set the time-base unit sweep rate to 0.1 microsecond/division and the magnifier to X10.

h. Set the test oscilloscope sweep rate to 1 microsecond/division.

i. Set the Clamp Level adjustment R1626 fully clockwise.

j. Set the A INTENSITY control fully clockwise.

k. Set the Z-Axis Gain adjustment R1637 for a pulse amplitude (indicated on the test oscilloscope) of 70 volts above ground.

l. Set the Clamp Level adjustment R1626 for a pulse amplitude of 63 volts above ground.

m. Rotate the A INTENSITY control counterclockwise until the pulse amplitude displayed on the test oscilloscope is 33 volts above ground.

n. Set the time-base unit Time/Div switch to 2 nanoseconds/division and trigger source to External.

o. Set the signal standardizer Rep Rate to 100 kHz.

p. Set the test oscilloscope deflection factor to 50 millivolts/division (5 volts at probe tip), sweep rate to 10 nanoseconds/division and magnifier to X1.

q. **EXAMINE**—The test oscilloscope display for aberrations of less than 4%, rise time of less than 6.5 nanoseconds, and fall time of less than 12 nanoseconds.

NOTE

Use test oscilloscope X1 magnifier for checking aberrations and X10 magnifier for checking rise time.

r. **ADJUST**—Z-Axis compensations #1, #2, #3, and #4 adjustments R1635, C1635, C1651, and C1663 to minimize the aberrations and rise time of the pulse displayed on the test oscilloscope.

NOTE

Use test oscilloscope X1 magnifier for checking aberrations and X10 magnifier for checking rise time.

s. Disconnect the test oscilloscope probe.

@

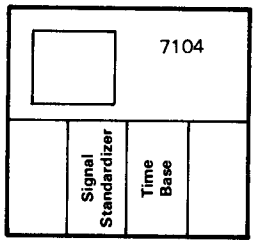
B4. CHECK/ADJUST TRACE ALIGNMENT (R1888)

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

B4. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Signal Standardizer
Test Selector Switch ..... Vert or Horiz Aux In

Time Base
Triggering ..... Auto, AC, Internal
Sweep Rate ..... 1 ms/div
Magnifier X1

a. Set the A INTENSITY control for a visible trace. Set the FOCUS and ASTIG controls for a well-defined trace.

b. Position the trace to the center graticule line.

c. **CHECK**—Trace parallels the center graticule line within 0.1 division.

d. **ADJUST**—TRACE ROTATION adjustment to align the trace with the center graticule line.

e. Move the signal standardizer to the A HORIZ compartment and the time-base unit to the RIGHT VERT compartment.

f. Install an amplifier unit in the B HORIZ compartment.

g. Set the B INTENSITY control for a visible trace and with the signal standardizer Position control, position the trace to the center graticule line.

h. **CHECK**—Trace parallels the center graticule line within 0.1 division.

i. **ADJUST**—Y Alignment (Ortho) adjustment R1888 (on the A22 High-Voltage board) so trace parallels the center graticule line.

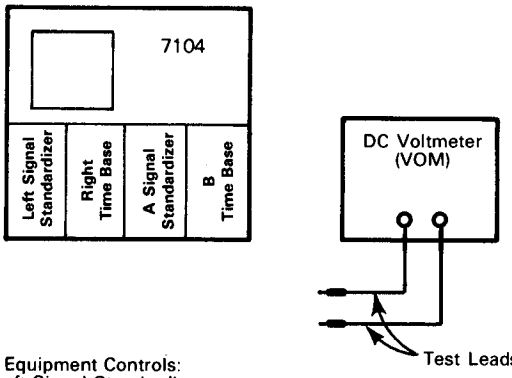
B5. CHECK/ADJUST GEOMETRY (R740, R830, R1030, R1888, R1062, R1853-R1856, R1883, R1825, R1891, R1873-R1876, R1874-R1875, R1894, R1864-R1865, R1863-R1866, R1854-R1855)

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

B5. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE ..... ALT
HORIZONTAL MODE ..... ALT



Test Equipment Controls:
Left Signal Standardizer
Test Selector Switch ..... Vert or Horiz Gain
Rep Rate ..... 100 kHz

A Signal Standardizer
Test Selector Switch ..... Vert or Horiz Gain
Rep Rate ..... 100 kHz

Right Time Base
Sweep Rate ..... 2 μs/div
Triggering ..... Auto, AC, External

B Time Base
Sweep Rate ..... 2 μs/div
Triggering ..... Auto, AC, External

VOM ..... Appropriate range for voltage to be measured.

a. Set the B INTENSITY control for a visible display.

b. Set the FOCUS control to midrange.

c. **ADJUST**—Stigmator adjustment R1894, Focus Preset adjustment R1825 and the front-panel ASTIG control for best overall focus of the crosshatch display.

d. **CHECK**—For crosshatch pattern lines that parallel graticule lines within 0.1 division.

e. **INTERACTION**—Performing the adjustments in the remainder of this procedure (B5) may uncalibrate the vertical and horizontal amplifiers. It will therefore be necessary to perform procedures E. Horizontal System, and F. Vertical System in this section.

f. Set both signal standardizer Test selector switches to Vert or Horiz Com Mode.

g. Move jumper P1062 (on the A19 Horizontal Amplifier board) to short together the two pins nearer the left side of the 7104.

NOTE

Adjustment and Test Point Locations B shows correct position of P1062 located by dotted lines.

h. **EXAMINE**—The displayed trace should align with the center graticule line within 0.1 division.

i. **ADJUST**—Ctr (center) adjustment R1030 (Horizontal board) to position the trace to the graticule center line.

j. Return jumper P1062 to the storage pins.

k. **EXAMINE**—The displayed horizontal trace should align with the center graticule line within 0.I division.

l. **ADJUST**—MVA (main vertical amplifier) Center adjustment R740 to position the horizontal trace to the graticule center line.

m. Set the TRACE ROTATION control so that the horizontal trace is parallel to the center graticule line.

n. **ADJUST**—Y Alignment (Ortho) adjustment R1888 so that the vertical trace is parallel to the center graticule line.

WARNING

Shock hazard exists while performing parts o through y; VOM elevated to 2.4 kV.

o. Connect the test leads of the VOM, set to measure 200 volts dc, between TP1850 and TP1852.

p. Preset the Vertical Differential Linearity adjustment R1854-R1855 so that zero volts is indicated on the VOM.

q. Move the VOM test leads to TP1860 and TP1862.

r. Preset the Differential Geometry adjustment R1864-R1865 so that zero volts is indicated on the VOM.

s. Move the VOM test leads to TP1870 and TP1872.

t. Preset the Horizontal Differential Sensitivity adjustment R1874-R1875 so that zero volts is indicated on the VOM.

u. Disconnect the VOM test leads.

v. Mechanically midrange the Horizontal Bowing adjustment R1883, Vertical Linearity adjustment R1853-R1856, Geometry adjustment R1863-R1866, and Horizontal Sensitivity adjustment R1873-R1876.

NOTE

A DVM equipped with a high-impedance probe (at least 1,000 megohms) can be used to preset the adjustments in part w more effectively, using the voltages listed on the label attached to the crt shield.

w. Connect the VOM between TP1813 and ground.

x. **ADJUST**—D1-D2 Shield adjustment R1891 so that the meter reads the voltage listed for TP1813 on the label attached to the crt shield. (If no label, mechanically midrange R1891.)

y. Disconnect the VOM test leads.

z. Set the Test selector switches of both signal standardizers to Vert or Horiz Gain.

aa. Set the B INTENSITY control for a visible crosshatch display.

bb. **ADJUST**—FOCUS and ASTIG controls, and Stigmator adjustment R1894 for best overall focus of the crosshatch pattern.

cc. **ADJUST**—D1-D2 Shield adjustment R1891 for sharply focused outer vertical traces.

NOTE

As this control is adjusted, the top and bottom portions of the vertical traces become more or less focused. This is the control's primary function. Due to interaction effects, the display will also change height and show vertical pin cushion or barrel distortions. These effects are corrected later.

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dd. **ADJUST**—Vertical Linearity adjustment R1853-R1856 for best overall vertical linearity (expand crosshatch display until best linearity is achieved).

NOTE

There may be some imbalance (i.e., compression at top and expansion at bottom) which should be averaged out so that the errors are of the same magnitude. As the Vertical Linearity adjustment is adjusted, the display will either shrink and become barreled vertically, or expand and become pin-cushioned vertically. These effects will be corrected later.

ee. **ADJUST**—If any vertical linearity imbalance is observed in previous steps, adjust the Vertical Differential Linearity adjustment R1854-R1855 to correct this condition (i.e., place each horizontal line coincident with a graticule line). As this control is adjusted, vertical lines will become keystoned. This effect will be corrected later.

ff. **ADJUST**—Geometry adjustment R1863-R1866 for straight vertical traces (aim for straightness without keystone).

NOTE

As R1863-R1866 is adjusted, the display will also expand or contract horizontally. This effect will be corrected later.

gg. **ADJUST**—If any vertical keystone is present on the display, it should be corrected by adjusting the Differential Geometry adjustment R1864-R1865.

hh. **ADJUST**—Horizontal Bowing adjustment R1883 to obtain straight horizontal lines at the top and bottom of the crt screen.

NOTE

As this control is adjusted, the display will shrink or expand horizontally. This effect will be compensated for later. The line straightening effect of this control is very slight.

ii. Set the signal standardizer installed in the A HORIZ compartment to Aux In.

jj. Set the HORIZONTAL MODE switch to A. Rotate the A HORIZ signal standardizer Position control to align the trace with the third graticule line from the left side of the crt screen.

kk. With a precision dc voltmeter, measure the differential voltage on the crt horizontal deflection plates. Note this voltage.

ll. Rotate the A HORIZ signal standardizer Position control to align the trace with the eighth graticule line from the left side of the crt screen.

mm. With the precision dc voltmeter, measure the differential voltage on the crt horizontal deflection plates. Note this voltage.

nn. **EXAMINE**—The sum of the absolute voltages measured in parts jj and ll should be 9.4 volts within 0.94 volt (1.88 volts/division of deflection within 10%).

oo. **ADJUST**—Horizontal Sensitivity adjustment R1873-R1876 to obtain a crt horizontal sensitivity that is 1.88 volts/division, within 10% (9.4 volts within 0.94 volt for 5 divisions of deflection).

NOTE

If this adjustment is moved an appreciable amount, it may be necessary to readjust the Geometry adjustment R1863-R1866 to compensate for the slight pin cushion or barrel distortion of the vertical lines. If the crt horizontal sensitivity of 1.88 volts/division within 10% cannot be achieved with the Horizontal Sensitivity adjustment R1873-R1876, it may be corrected by adjusting the Horizontal Bowing adjustment R1883 slightly at the expense of minor horizontal line bowing.

pp. Set the HORIZONTAL MODE switch to ALT.

qq. Set the signal standardizer installed in the A HORIZ compartment to Vert or Horiz Gain.

rr. **ADJUST**—If horizontal nonlinearity or nonuniform bowing of vertical lines is observed on the display, adjust the Horizontal Differential Sensitivity adjustment R1874-R1875 to correct the nonlinearity.

ss. **ADJUST**—FOCUS control, ASTIG control and Stigmator adjustment R1894 for best overall focus of crosshatch pattern.

tt. **EXAMINE**—Displayed crosshatch pattern should align with the vertical and horizontal graticule lines within 0.1 division everywhere on the graticule.

uu. **ADJUST**—Vert Gain adjustment R830 (on A17 Vertical Amplifier board) and LF Gain adjustment R1062 (on A19 Horizontal Amplifier board) so that the vertical and horizontal traces of the crosshatch display align with the vertical and horizontal graticule lines within 0.1 division.

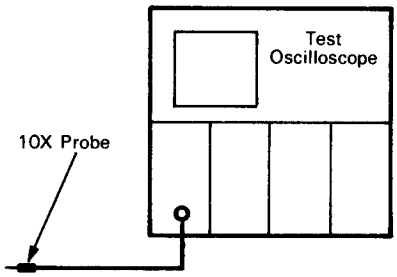
B6. ADJUST AUTO FOCUS (R1622, C1620)

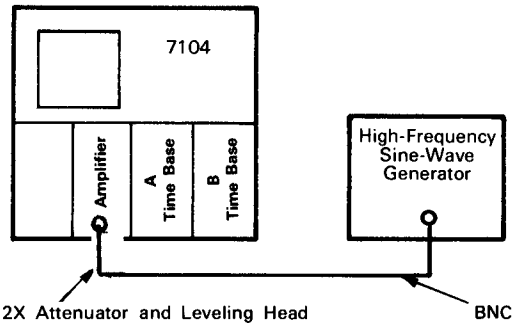
NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

B6. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE ..... RIGHT
HORIZONTAL MODE ..... A





Test Equipment Controls:
Test Oscilloscope
Deflection Factor ..... 0.2 V/div
Sweep Rate ..... 20 ns/div
Triggering ..... Negative slope

High-Frequency Sine-Wave Generator
Frequency ..... 250 MHz

A Time Base
7B15
Sweep Rate ..... 5 μs/div
Triggering ..... Auto, AC, Internal
Magnifier X1
B Delay Mode ..... B Triggerable After Dly
Trace Sep ..... OFF

B Time Base
7B10
Sweep Rate ..... 5 ns/div
Triggering ..... Auto, AC, Internal
Magnifier X1

Amplifier
Deflection Factor ..... 0.2 V/div
Input Coupling ..... DC

a. Connect the high-frequency sine-wave generator to the amplifier input connector.

b. Set the A INTENSITY control as desired.

c. Set the high-frequency sine-wave generator Amplitude control for a 2 division display.

d. Set the HORIZONTAL MODE switch to B.

e. Set both time-base triggering levels for a triggered light.

f. Set the B INTENSITY control for a low-intensity display.

g. Set the FOCUS control and ASTIG adjustment for a well-defined display.

h. Connect the 10X probe from the test oscilloscope to TP1628 on the A21 Z-Axis board.

i. Rotate the amplifier unit Position control to move the displayed waveform off the crt screen.

j. Set the B INTENSITY control fully clockwise.

k. **ADJUST**—The Focus Gain adjustment R1622 for maximum pulse amplitude displayed on the test oscilloscope.

l. **ADJUST**—The Comp #5 adjustment C1620 to minimize aberrations on the negative-going pulse displayed on the test oscilloscope.

m. **EXAMINE**—The pulse displayed on the test oscilloscope should be at least 6 volts with a pulse leading-edge fall time of 20 nanoseconds or less with less than 25% aberrations.

n. Remove test oscilloscope 10X probe.

o. Set the A HORIZ time-base unit sweep rate to 0.1 millisecond/division.

p. Set the READOUT INTENSITY control for a visible readout display.

q. Set the FOCUS control for optimum focus of the readout display.

r. Rotate the amplifier Position control to move the sine wave to the crt screen center.

s. **EXAMINE**—Rotate the FOCUS control and check that the sine wave and readout displays focus at the same point on the FOCUS control.

t. **ADJUST**—The Focus Gain adjustment R1622 for optimum focus of the displayed sine-wave signal.

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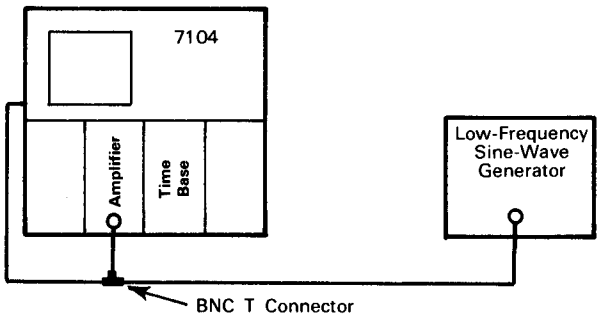
B7. CHECK EXTERNAL Z-AXIS OPERATION

NOTE

If the preceding step was not performed, first refer to the Z-Axis And Display Preliminary Control Settings, then proceed with the following instructions.

B7. SETUP CONDITIONS

7104 Controls:
READOUT INTENSITY ..... OFF
HORIZONTAL MODE ..... A



Test Equipment Controls:
Amplifier Unit
Deflection Factor ..... 0.5 V/div
Time Base
Sweep Rate ..... 20 μs/div
Triggering ..... Auto, AC, Internal

a. Set the A INTENSITY control for a dim display.

b. Connect the output of the low-frequency sine-wave generator to the amplifier unit input (use a bnc T connector at the amplifier input).

c. Set the low-frequency sine-wave generator for a four-division display at 50 kilohertz (one volt above and below ground).

d. Set the A INTENSITY control for a dim display.

e. Connect the signal from the output of the T connector at the amplifier input to the Z-AXIS INPUT connector on the rear panel.

f. **CHECK**—Positive portion of the displayed waveform is blanked out.

C. CALIBRATOR AND OUTPUT SIGNALS

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
4. Time-base unit
8. Precision dc voltmeter (DVM)
10. Time-mark generator
15. Coaxial cable (one 18-inch, two 42-inch required)
17. T connector
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

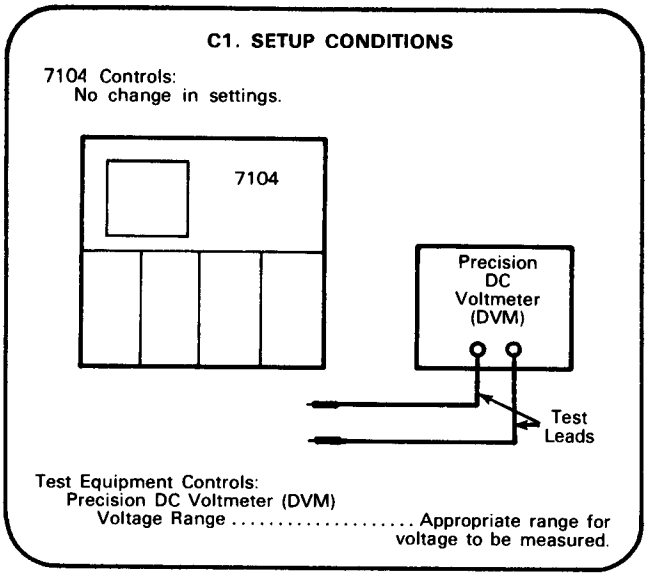
(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the Test Point and Adjustment Locations C foldout page in Section 8, Diagrams and Circuit Board Illustrations.

CALIBRATOR AND OUTPUT SIGNALS PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
VERT TRACE SEPARATION (B) ..... Midrange
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Fully counterclockwise
HORIZONTAL MODE ..... A
B INTENSITY ..... Fully counterclockwise
B TRIGGER SOURCE ..... VERT MODE
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... Midrange
BEAMFINDER ..... Pushbutton out
CALIBRATOR ..... 4 V pushbutton in

C1. CHECK/ADJUST CALIBRATOR OUTPUT VOLTAGE (R385)



a. Set both the 4 V and 0.4 V CALIBRATOR push buttons to the depressed position.

b. Connect the precision dc voltmeter to the CALIBRATOR output connector.

c. **CHECK**—Meter reading for 0.4008 volt within the limits of 0.4004 to 0.4012 volt.

d. **ADJUST**—The 0.4 V ADJ adjustment R385 for a meter reading of exactly 0.4008 volt. (Access to adjustment is through the chassis, inside the vertical compartments, near the front of the instrument and under the VERTICAL MODE switch.)

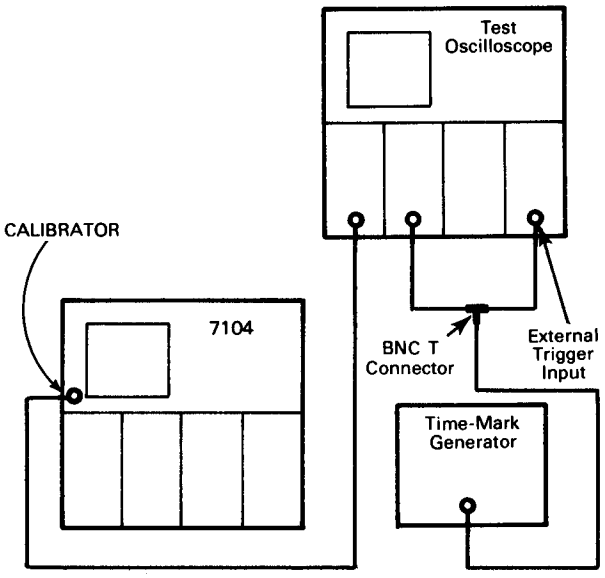
C2. CHECK/ADJUST CALIBRATOR 1 kHz REPETITION RATE (R375)

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

C2. SETUP CONDITIONS

7104 Controls:
CALIBRATOR ..... 4 V pushbutton in



Test Equipment Controls:
Time-Mark Generator ..... 1 ms markers

Test Oscilloscope
Triggering ..... Auto, AC, External
Input Coupling ..... DC
Sweep Rate ..... 1 ms/div
Vertical Mode ..... Add

NOTE

A frequency counter with an accuracy of at least 0.1% may be used to adjust the CALIBRATOR repetition rate.

a. Connect 1-millisecond time-markers to the test oscilloscope external trigger input and to the noninverting vertical channel of the test oscilloscope (use a bnc T connector). Connect the 7104 CALIBRATOR output to the inverting input of the test oscilloscope.

b. Set the test oscilloscope triggering level for a stable time-mark display.

c. Set the test oscilloscope vertical deflection factors to display 2 divisions of CALIBRATOR signal and 1 division of time-marker signal.

d. Set the test oscilloscope sweep rate for 0.2 second/division.

e. **CHECK**—The time required for the 1-millisecond time marks to drift from the positive level of the CALIBRATOR signal to the negative level, and back to the positive level must be more than 0.4 second (2 divisions). This time can be measured directly from the display by observing the number of divisions that the markers move across the display area before it returns to the positive level.

f. **ADJUST**—1 kHz adjustment R375 for minimum drift (access to the adjustment is through the chassis, inside the vertical compartment).

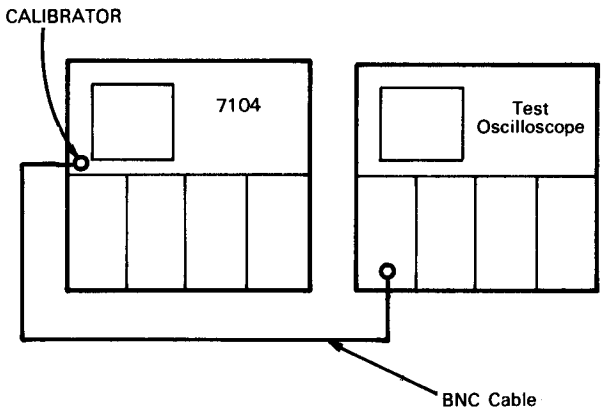
C3. CHECK CALIBRATOR RISE TIME, FALL TIME, AND DUTY CYCLE

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

C3. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Test Oscilloscope
Sweep Rate ..... 0.1 μs/div
Triggering ..... Auto, AC, Internal

a. Connect the CALIBRATOR output to the inverting vertical input of the test oscilloscope.

b. Set the test oscilloscope vertical deflection to display 4 divisions of CALIBRATOR signal.

c. Set the test oscilloscope for a stable display, triggered on the rising portion of the CALIBRATOR signal.

d. **CHECK**—Displayed waveform for not more than 5 divisions horizontally between the 10% to 90% points of the waveform (rise time, 0.5 microsecond or less).

e. Set the test oscilloscope for a stable display triggered on the falling portion of the waveform.

f. **CHECK**—Displayed waveform for not more than 5 divisions between the 90% and 10% points (fall time, 0.5 microsecond or less).

g. Set the test oscilloscope triggering for positive slope and auto mode with ac coupling from the internal source at a sweep rate of 0.1 millisecond/division. Set the triggering controls so that the display starts at the 50% point on the rising edge of the waveform.

h. Set the test oscilloscope sweep magnifier to X10. Then, position the display horizontally so the falling edge of the waveform aligns with the center vertical graticule line.

i. Set the test oscilloscope vertical to invert the display.

NOTE

The display is triggered on the opposite slope, even though the display appears the same.

j. **CHECK**—The 50% point on the falling edge of the waveform now displayed is within 0.2 divisions horizontally of the center line. (Indicates duty cycle of 50% within 0.2%.)

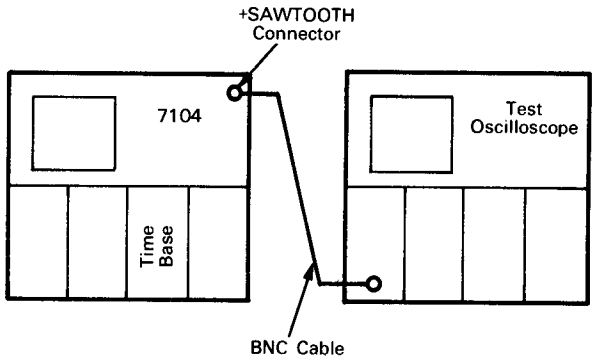
C4. CHECK A AND B SAWTOOTH OUTPUT SIGNALS

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Setting, then proceed with the following instructions.

C4. SETUP CONDITIONS

7104 Controls:
+SAWTOOTH A or B switch ..... A



Test Equipment Controls:
Test Oscilloscope
Sweep Rate ..... 2 ms/div
Vertical Deflection ..... 2 V/div
Vertical Mode ..... Channel 1

Time Base
Sweep Rate ..... 0.1 ms/div
Triggering ..... Auto

a. Connect the +SAWTOOTH output connector to the test oscilloscope channel 1 vertical input (1-megohm input).

b. **CHECK**—That the slope of the test oscilloscope display is 2 volts/division within 10% (10-volt sawtooth for 10 division sweep on 7104 crt screen) and that the sawtooth baseline is within one volt of ground.

c. Move the time-base unit to the B HORIZ compartment.

d. Set the +SAWTOOTH selector switch to the B position.

e. **CHECK**—Test oscilloscope display for 2 volts/division of sweep within 10% (10-volt sawtooth for 10 division sweep on the 7104 crt screen) and that the sawtooth baseline is within one volt of ground.

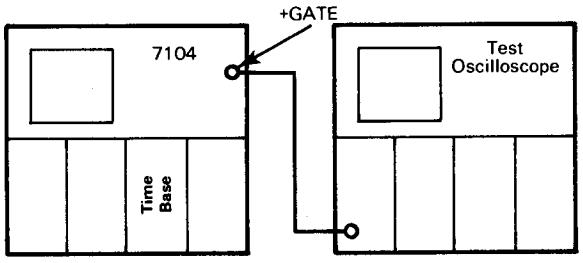
C5. CHECK A AND B GATE OUTPUT SIGNALS

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

C5. SETUP CONDITIONS

7104 Controls:
+GATE A or B Switch ..... A



Test Equipment Controls:
Test Oscilloscope
Vertical Deflection Factor ..... 2 V/div
Sweep Rate ..... 2 ms/div

Time-Base
Mode ..... Delaying
Triggering ..... Auto, AC, Internal
Sweep Rate ..... 0.5 ms/div

a. **CHECK**—Test oscilloscope display for a gate waveform 5 divisions in amplitude, within 10%, and a baseline at zero volts, within one volt.

b. Move the time-base unit to the B HORIZ compartment.

c. Set the +GATE selector switch to the B position.

d. **CHECK**—Test oscilloscope display for a gate waveform 5 divisions in amplitude, within 10%, and a baseiine at zero volts, within one volt.

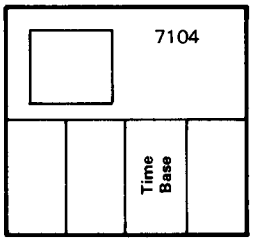
C6. CHECK GRATICULE ILLUMINATION OPERATION

NOTE

If the preceding step was not performed, first refer to the Calibrator And Output Signals Preliminary Control Settings, then proceed with the following instructions.

C6. SETUP CONDITIONS

7104 Controls:
GRAT ILLUM +GATE or EXT switch ..... +GATE
+GATE A or B switch ..... A
HORIZONTAL MODE ..... A



Test Equipment Controls:
Time Base
Sweep Rate ..... 0.2 s
Triggering ..... Auto, AC, Internal

a. **CHECK**—Rotate the GRAT ILLUM control throughout its range and notice that the illumination of the graticule varies.

b. Set the GRAT ILLUM control fully clockwise to the PULSED detent position.

c. Set the A INTENSITY control for a visible display.

d. **CHECK**—Graticule illumination occurs only after the time-base unit has completed a sweep (adjust GRAT ILLUM PRESET, if necessary).

e. Set the GRAT ILLUM +GATE or EXT switch to EXT.

f. **CHECK**—Press the GRAT ILLUM MAN pushbutton and check for one momentary illumination of the graticule.

g. Set the GRAT ILLUM control to midrange (out of the PULSED detent position).

D. TRIGGER SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

1. Test oscilloscope
2 or 3. Amplifier unit
4. Time-base unit (two required)
5. Signal standardizer
6. Plug-In extender (rigid calibration fixture)
15. Coaxial cable (one 18-inch, two 42-inch required)
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

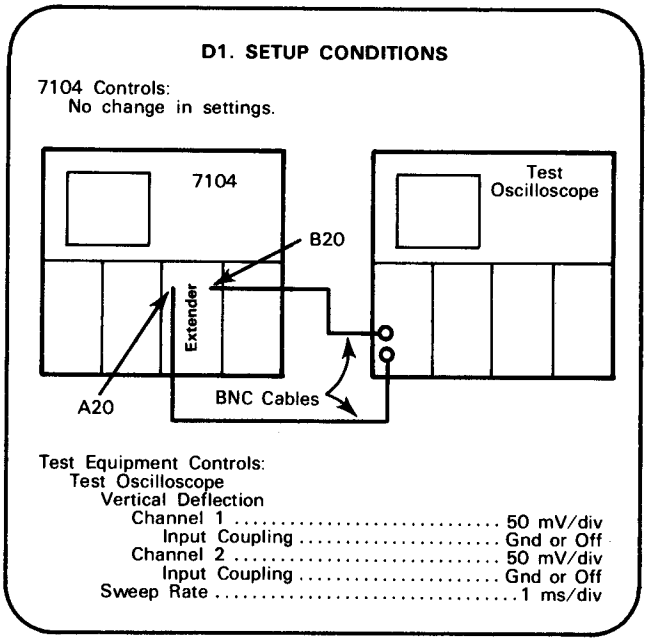
(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the Test Point and Adjustment Locations D foldout page in Section 8, Diagrams and Circuit Board Illustrations.

TRIGGER SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
VERT TRACE SEPARATION (B) ..... Midrange
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Fully counterclockwise
HORIZONTAL MODE ..... A
B INTENSITY ..... Fully counterclockwise
B TRIGGER SOURCE ..... VERT MODE
FOCUS ..... Midrange
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... Midrange
BEAMFINDER ..... Pushbutton out

D1. ADJUST A TRIGGER SELECTOR CENTERING (R255, R270, R274, AND R279)



a. Within the plug-in extender, disconnect the top connector on the left and right sides (labeled A20 and B20). Connect each female connector to one of the test oscilloscope channels with the 42-inch 50-ohm bnc cables and 50-ohm bnc terminations (omit the 50-ohm bnc terminations if the test oscilloscope has a 50-ohm input impedance).

b. Set the test oscilloscope for differential operation between the two channels (added display mode with one channel inverted).

c. Establish a ground reference level for the test oscilloscope by positioning the trace to the center horizontal line of the graticule. Do not change the test oscilloscope position controls after setting this ground reference.

d. Set both channels of the test oscilloscope for dc input coupling.

e. **EXAMINE**—Check the test oscilloscope display a for dc level within 1 division (50 millivolts) of the ground reference level in the LEFT, RIGHT, and ADD positions of the VERTICAL MODE switch.

f. **ADJUST**—The A DC Center adjustment R255 for a dc level within 1 division (50 millivolts) of the ground reference level in the LEFT, RIGHT, and ADD positions of the VERTICAL MODE switch.

g. Install the signal standardizer in the LEFT VERT compartment.

h. Set the VERTICAL MODE switch to LEFT.

i. Set the signal standardizer Test selector switch to Trigger +Step Resp, and the Rep Rate switch to 1 kHz. Use the signal standardizer Position and Amplitude controls to center a 6 division display on the test oscilloscope. Set the test oscilloscope sweep rate to 0.5 millisecond/division.

j. **EXAMINE**—Test oscilloscope display for less than +3% and -3% aberrations.

k. **ADJUST**—The A Thermal adjustment R270 (on the A14 Trigger Selector board) for optimum square wave displayed on the test oscilloscope.

l. Set the signal standardizer Test selector switch to Trigger Gain and the Rep Rate switch to 1 MHz. Use the signal standardizer Position control to move the bright trace display on the test oscilloscope to the center graticule line.

m. **EXAMINE**—Test oscilloscope display for nine traces with six divisions of vertical deflection between the center seven traces, within 0.6 division (300 millivolts, within 20 millivolts).

n. **ADJUST**—The A Gain adjustment R274 for a test oscilloscope display of six divisions of deflection between the center seven traces, within 0.6 division (300 millivolts, within 30 millivolts).

o. Remove the signal standardizer from the LEFT VERT compartment.

p. Set the test oscilloscope to alternate between channel 1 and channel 2. Re-establish a ground reference for both channels of the test oscilloscope. Then set both channels for dc coupling.

q. **EXAMINE**—Check the test oscilloscope display for a dc level within 1 division (50 millivolts) of the established ground reference.

r. **ADJUST**—The A DC Common Mode adjustment R279 for a dc level within 1 division of ground.

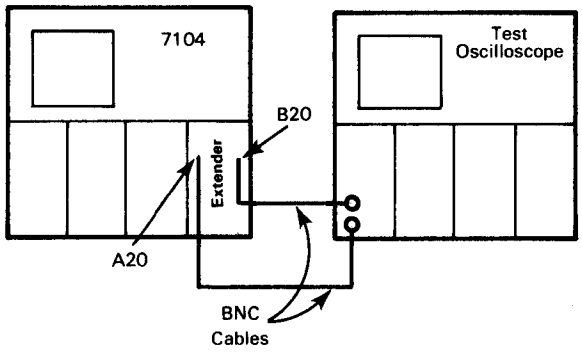
D2. ADJUST B TRIGGER SELECTOR CENTERING AND GAIN (R455, R473, R479)

NOTE

If the preceding step was not performed, first refer to the Trigger System Preliminary Control Settings, then proceed with the following instructions.

D2. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Test Oscilloscope
Vertical Deflection
Channel 1 ..... 50 mV/div
Input Coupling ..... Gnd or Off
Channel 2 ..... 50 mV/div
Input Coupling ..... Gnd or Off
Sweep Rate ..... 1 ms/div

a. Set the test oscilloscope for differential operation between the two channels (added display mode with one channel inverted).

b. Establish a ground reference level for the test oscilloscope by positioning the trace to the center horizontal line of the graticule. Do not change the test oscilloscope position controls after setting this ground reference.

c. Within the plug-in extender, disconnect the top connector on the left and right sides (labeled A20 and B20). Connect each female connector to one of the test oscilloscope channels with the 42-inch 50-ohm bnc cables and 50-ohm bnc terminations (omit the 50-ohm bnc terminations if the test oscilloscope has a 50-ohm input impedance).

d. Set both channels of the test oscilloscope for dc input coupling.

e. **EXAMINE**—Test oscilloscope display for a dc level within 1 division (50 millivolts) of the ground reference level in the LEFT, RIGHT, and ADD positions of the 7104 VERTICAL MODE switch.

f. **ADJUST**—B DC Center adjustment R455 for a dc level within 1 division (50 millivolts) of the ground reference level in the LEFT, RIGHT, and ADD positions of the VERTICAL MODE switch.

g. Install the signal standardizer in the LEFT VERT compartment.

h. Set the VERTICAL MODE switch to LEFT.

i. Set the signal standardizer Test selector switch to Trigger Gain and the Rep Rate switch to 1 MHz. Use the signal standardizer Position control to align the bright trace displayed on the test oscilloscope with the center graticule line.

j. **EXAMINE**—Test oscilloscope display for nine traces with six divisions of vertical deflection between the center seven traces, within 0.6 division (300 millivolts, within 30 millivolts).

k. **ADJUST**—B Gain adjustment R474 for a test oscilloscope display of six divisions of deflection between the center seven traces, within 0.6 division.

l. Remove the signal standardizer from the LEFT VERT compartment.

m. Set the test oscilloscope to alternate between channel 1 and channel 2. Re-establish a ground reference for both channels of the test oscilloscope. Then set both channels for dc coupling.

n. **EXAMINE**—Test oscilloscope display for a dc level within 1 division (50 millivolts) of the established ground reference.

o. **ADJUST**—The B DC Common Mode adjustment R479 for a dc level within 1 division of ground.

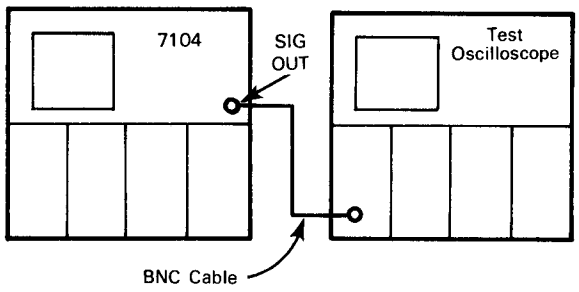
D3. CHECK/ADJUST VERTICAL SIGNAL OUT DC CENTERING (R485, R480, R490)

NOTE

If the preceding step was not performed, first refer to the Trigger System Preliminary Control Settings, then proceed with the following instructions.

D3. SETUP CONDITIONS

7104 Controls:
No change in setting.



Test Equipment Controls:
Test Oscilloscope
Input Coupling ..... Gnd or Off
Vertical Deflection ..... 1 V/div
Vertical Mode ..... Channel 1
Sweep Rate ..... 1 ms/div

a. Establish a ground reference for the test oscilloscope by positioning the trace to the graticule center line. Do not change the test oscilloscope position control after setting this ground reference.

b. Connect the front-panel SIG OUT connector to the vertical input of the test oscilloscope with the 42-inch, 50-ohm bnc cable.

c. Set the test oscilloscope input coupling switch to dc.

d. **EXAMINE**—Test oscilloscope display for a dc level within 1 division of the ground reference established in part a.

e. **ADJUST**—Signal Out DC Center adjustment R485 for a dc level within 1 division of the ground reference level.

f. Install the signal standardizer in the LEFT VERT compartment.

g. Set the Test selector switch to Trigger +Step Resp and the Rep Rate switch to 1 kHz.

h. Rotate the signal standardizer Position and Amplitude controls to display a six division triggered signal on the test oscilloscope.

i. **EXAMINE**—The test oscilloscope square-wave display for optimum flat top within 0.1 division.

j. **ADJUST**—The Signal Out Thermal 1 adjustment R480 to optimize the test oscilloscope square-wave display.

k. Set the signal standardizer Rep Rate switch to 10 kHz.

l. Set the test oscilloscope sweep rate to 0.1 millisecond/division.

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m. **EXAMINE**—The test oscilloscope square-wave display for a flat top within 0.2 division.

n. **ADJUST**—The Signal Out Thermal 2 adjustment R490 to optimize test oscilloscope square-wave display.

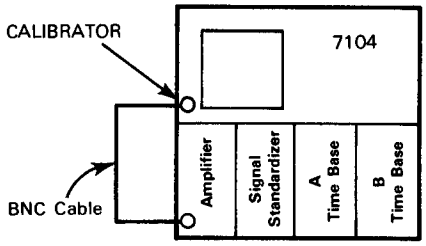
D4. CHECK TRIGGER SELECTOR OPERATION

NOTE

If the preceding step was not performed, first refer to the Trigger System Preliminary Control Settings, then proceed with the following instructions.

D4. SETUP CONDITIONS

7104 Controls:
- VERTICAL MODE ..... LEFT
- HORIZONTAL MODE ..... A
- A TRIGGER SOURCE ..... VERT MODE
- B TRIGGER SOURCE ..... VERT MODE



Test Equipment Controls:

Signal Standardizer
- Test Selector Switch ..... Vert or Horiz +Step Resp
- Rep Rate ..... 10 kHz

A Time Base
- Sweep Rate ..... 0.2 ms/div
- Triggering ..... Auto, AC, Internal
- Magnifier X1
- Mode ..... Independent

B Time Base
- Sweep Rate ..... 0.2 ms/div
- Triggering ..... Auto, AC, Internal
- Magnifier X1
- Mode ..... Independent

a. Connect the CALIBRATOR 4 V output to the amplifier unit (use 18-inch bnc cable). Set the A INTENSITY control for a visible display. Set the amplifier for a 2 division display in the upper half of the graticule area. Use the A time-base unit trigger level to trigger the display.

b. Set the VERTICAL MODE switch to RIGHT.

c. Set the signal standardizer Amplitude and Position controls for a 2 division display in the lower half of the graticule area.

d. Set the VERTICAL MODE switch to ALT.

e. **CHECK**—For 1 kHz and 10 kHz triggered waveforms (adjust the time-base unit trigger level controls as necessary).

f. Set the VERTICAL MODE switch to ADD.

g. **CHECK**—For a triggered waveform.

h. Set the VERTICAL MODE switch to CHOP.

i. **CHECK**—For a stable display of only the 1 kHz waveform.

j. Set the A TRIGGER SOURCE switch to LEFT VERT.

k. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 1 kHz waveform.

l. Set the A TRIGGER SOURCE switch to RIGHT VERT.

m. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 10 kHz waveform.

n. Set the VERTICAL MODE switch to ALT, the HORIZONTAL MODE switch to B, and the B INTENSITY control for a visible display.

o. **CHECK**—For a 1 kHz and 10 kHz triggered waveforms.

p. Set the VERTICAL MODE switch to ADD.

q. **CHECK**—For a stable display.

r. Set the VERTICAL MODE switch to CHOP.

s. **CHECK**—Crt display for a stable display of only the 1 kHz waveform.

t. Set the B TRIGGER SOURCE switch to LEFT VERT.

u. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 1 kHz waveform.

v. Set the B TRIGGER SOURCE switch to RIGHT VERT.

w. **CHECK**—Sequentially select all positions of the VERTICAL MODE switch and check for a stable display of only the 10 kHz waveform.

x. Set the VERTICAL MODE switch to ALT, the HORIZONTAL MODE switch to ALT, and the A and B TRIGGER SOURCE switches to VERT MODE.

y. **CHECK**—Vary the time-base units Trigger Level controls; the B HORIZ time-base unit should be triggered on the 1 kHz waveform and the A HORIZ time-base unit should be triggered on the 10 kHz waveform.

E. HORIZONTAL SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit (two required, one with variable delay)
4. Time-base unit
5. Signal standardizer
8. Precision dc voltmeter (DVM)
10. Time-mark generator
11. Low-frequency sine-wave generator
15. Coaxial cable (one 18-inch, two 42-inch required)
17. T connector
19. Low-capacitance screwdriver
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the Test Point and Adjustment Locations E foldout page in Section 8, Diagrams and Circuit Board Illustrations.

HORIZONTAL SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
VERT TRACE SEPARATION (B) ..... Midrange
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Fully counterclockwise
HORIZONTAL MODE ..... A
B INTENSITY ..... Fully counterclockwise
B TRIGGER SOURCE ..... VERT MODE
FOCUS ..... Midrange
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... As desired
BEAMFINDER ..... Pushbutton out
X-Y Z-Axis Selector ..... X-Y DC-Controlled Z-Axis (see note below)

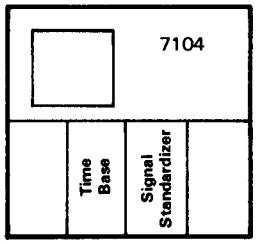
NOTE

The X-Y Z-Axis Selector is an internal switch, located on the Logic board (A13). Refer to Figure 8-29, Test Point and Adjustment Locations E, in section 8 of this manual. When the X-Y Z-Axis Selector is set to the X-Y DC Controlled Z-Axis position, control of the Z-Axis drive signal to the crt is determined by the horizontal plug-in unit selected by the HORIZONTAL MODE switch. When the X-Y Z-Axis Selector is set to the X-Y Time-Base Controlled Z-Axis position (In) and an amplifier unit is installed in one of the horizontal copartments, control of the Z-Axis drive signal to the crt is determined by a time-base unit installed in the other horizontal compartment. Return the X-Y Z-Axis Selector to the X-Y Time-Base Controlled Z-Axis position (In) after performing all or part of the E. Horizontal System procedure.

E1. CHECK/ADJUST HORIZONTAL AMPLIFIER GAIN (R1030, R995, R965, R1062)

E1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Signal Standardizer
Test Selector Switch .....Vert or Horiz Com Mode
Rep Rate.....1 MHz

Time Base
Sweep Rate.....1 ms/div
Triggering.....Auto, AC, Internal

a. Set the A INTENSITY control for a visible trace.

b. Move jumper P1062 to short together the two pins nearer to the outside of the 7104.

NOTE

Test Point and Adjustment Locations E (Section 8, Diagrams and Circuit Board Illustrations) illustrates the correct position of P1062 located by dotted lines.

c. **EXAMINE**—The vertical trace should be within 0.5 division of the center vertical graticule line.

d. **ADJUST**—The Ctr adjustment R1030 (on the A19 Horizontal Amplifier board) to align the displayed trace with the center vertical graticule line.

e. Return jumper P1062 to the storage pins.

f. **EXAMINE**—The vertical trace should be within 0.5 division of the center graticule line.

g. **ADJUST**—A Ctr adjustment R995 to align the trace with the center graticule line.

h. Move the signal standardizer to the B HORIZ compartment.

i. Set the HORIZONTAL MODE switch to B.

j. Set the B INTENSITY control for a visible trace.

k. **EXAMINE**—The trace should be within 0.5 division of the center graticule line.

l. **ADJUST**—B Ctr adjustment R965 to align the trace with the center graticule line.

m. Set the signal standardizer Test selector switch to Vert or Horiz Gain and the Rep Rate switch to 1 MHz. Align the bright vertical trace with the center vertical graticule line using the signal standardizer Position control.

n. **CHECK**—For 8 divisions of deflection between the center nine traces within 0.08 division. Note the exact error for comparison in part t.

o. **ADJUST**—The LF Gain adjustment R1062 for exactly 8 divisions of deflection between the center nine traces measured at the second and tenth graticule lines.

p. **INTERACTION**—If R1062 was adjusted in part o, step E2 will have to be performed.

q. **CHECK**—That the other vertical traces align with their respective graticule lines within 0.05 division. (The LF Gain adjustment R1062 should be set for optimum for valid check.)

r. Move the signal standardizer to the A HORIZ compartment.

s. Set the HORIZONTAL MODE switch to A.

t. **CHECK**—For 8 divisions of deflection between the center nine traces within 0.08 division of the error noted in part n. And, that the other vertical traces align with their respective graticule lines within 0.05 divisions. (Specified at the center graticule line.)

u. **ADJUST**—If necessary, compromise the setting of R1062 for optimum gain for both A and B HORIZ compartments. If readjustment is necessary, recheck parts a through o.

v. **INTERACTION**—If R1062 was adjusted in step E1, step E2 will have to be performed.

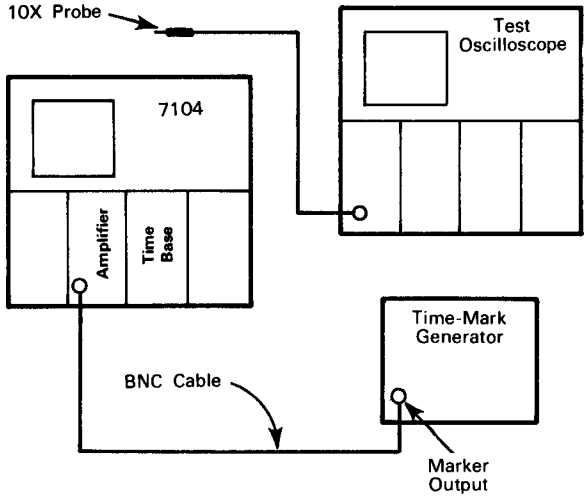
E2. CHECK/ADJUST HIGH-FREQUENCY TIMING (R1005, R1062, R975, R945, R958, R955, R952, R950, R988, R985, R982, R980, R1082, R1073, C1036, C1040, C1060, R1099)

NOTE

If the preceding step was not performed, first refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

E2. SETUP CONDITIONS

7104 Controls:
No change in setting



Test Equipment Controls:

Test Oscilloscope
- Vertical Deflection ..... 0.5 V/div
- Sweep Rate ..... 5 μs/div
- Input Coupling ..... DC
- Triggering ..... Auto, AC, Internal

Time Base
- Sweep Rate ..... 1 ms/div
- Triggering ..... Auto, AC, Internal
- Mode ..... Independent

Amplifier
- Deflection Factor ..... 0.5 V/div
- Input Coupling ..... DC

Time-Mark Generator ..... 1 ms markers

a. Connect 1-millisecond markers from the time-mark generator to the amplifier unit input and adjust the amplifier unit deflection factor for about 2 divisions of display. Set the A INTENSITY control for a visible display, if necessary.

b. Set the time-base unit triggering controls for a stable display.

c. Position the first marker to the extreme left line on the graticule.

d. Set the time-base unit sweep calibration control for 1 marker at each major graticule division between the second and tenth graticule lines (center 8 divisions).

e. **CHECK**—Refer to the time-base unit instruction manual for performance check or calibration procedures for checking high-frequency timing and linearity. If the given limits are met, omit the remainder of this step.

NOTE

If the instrument under test contains Option 2, disconnect P984 while performing the remainder of this step.

f. Remove the amplifier and time-base units from the 7104.

g. Install a time-base unit in the RIGHT VERT compartment and a signal standardizer in the A HORIZ compartment.

h. Set the signal standardizer Test selector switch to Vert or Horiz +Step and the Rep Rate to 1 MHz.

i. Set the time-base unit Time/Div switch to 1 millisecond/division, the magnifier to X1, and the triggering for auto mode with ac coupling from the external source.

j. Set the signal standardizer Amplitude and Position controls for a 10 division display centered on the crt.

k. Connect a 10X probe from the test oscilloscope to the horizontal crt Termination R1099 and the probe ground lead to the 7104 chassis.

NOTE

Figure 8-29, Test Point and Adjustment Locations E, in Section 8 (Diagrams and Circuit Board Illustrations) shows correct placement of the 10X probe.

l. Set the test oscilloscope variable gain control for 2 divisions of displayed waveform and set the position control so the bottom of the displayed waveform is aligned with the center graticule line on the test oscilloscope crt.

m. Rotate the signal standardizer Position control counterclockwise to align the right side of the 7104 displayed waveform with the first graticule line on the left side of the crt.

n. **ADJUST**—Clamp adjustment R1005 so that the bottom of the displayed test oscilloscope waveform aligns with the first graticule line below the center graticule line on the test oscilloscope crt.

o. Disconnect the 10X probe.

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p. Preset LF Gain adjustment R1062, A LF ADJ adjustment R975, and B LF ADJ adjustment R945 to mechanical midrange. Preset Comp #1, 2, 3, 4, 5, 6, 7 and 8 (adjustments R958, R955, R952, R950, R988, R985, R982, and R980 respectively) fully clockwise.

q. Set the time-base unit Time/Div switch to 0.2 millisecond/division, the magnifier to X10 and the triggering to +Slope, Auto, ac coupling and external.

r. Connect a bnc cable from the signal standardizer Pre Trigger Out connector to the time-base unit External Trigger In connector.

s. Set the signal standardizer Position and Amplitude controls for an 8 division display at a Rep Rate of 10 kHz. (Align the waveform on the second and tenth graticule lines.)

t. Set the time-base unit Time/Div switch to 0.5 microsecond/division and the signal standardizer Rep Rate to 1 MHz.

u. **ADJUST**—HF Gain adjustment R1082 so that the displayed pulse is 8 divisions wide at a point 10 nanoseconds from the leading edge.

v. **ADJUST**—SP Damp adjustment R1073 and Delay adjustment C1036 to optimize step response.

w. Set the time-base unit Time/Div switch to 20 nanoseconds/division.

x. Use the time-base unit Position and Trigger Level controls to align the leading edge of the pulse near the second graticule line from the bottom of the crt.

y. **ADJUST**—Comp #9 and #10 adjustments C1040 and C1060 to optimize the first 2 nanoseconds of the front corner on the displayed pulse.

z. **ADJUST**—HF Gain adjustment R1082 to align the area of the pulse 3 nanoseconds from the front corner with the retrace.

aa. **ADJUST**—Termination adjustment R1099 to align the area of the pulse 8 nanoseconds from the front corner of the pulse with the retrace.

bb. **INTERACTION**—Adjustments in parts y and z interact. Repeat as necessary.

cc. Set the time-base unit Time/Div switch to 0.5 microsecond/division and the triggering to negative slope. Use the time-base unit Position control to align the front corner of the pulse with the second graticule line from the bottom of the crt.

dd. **ADJUST**—SP Damp adjustment R1073, and Delay adjustment C1036 to optimize the the front corner of the displayed pulse.

ee. Set the time-base unit Time/Div switch to 2 microseconds/division.

ff. Set the signal standardizer Position nd Amplitude controls so the displayed pulse is exactly 8 divisions in amplitude (align the waveform on the second and tenth graticule lines; use the center horizontal graticule line to set 8 divisions), measured 200 nanoseconds from the front-corner of the pulse (front corner of pulse is right side of displayed waveform lower corner).

NOTE

Care should be taken not to change the signal standardizer Amplitude control throughout the remaining parts of this step.

gg. Set the time-base unit Time/Div switch to 2 milliseconds/division, the magnifier to X1, and the signal standardizer Rep Rate to 100 Hz.

NOTE

Adjustments in the remainder of this step are measured and adjusted at the graticule's vertical center by vertically positioning the trace using the time-base unit Position control as needed.

hh. **ADJUST**—A LF ADJ adjustment R975 for exactly 8 divisions at the trailing edges of the displayed pulse (trailing edge of pulse is upper portion of pulse on left and right sides of waveform).

ii. Set the time-base unit Time/Div switch to 1 millisecond/division.

jj. **ADJUST**—Comp #5 adjustment, R988 for 8 divisions of pulse amplitude 0.2 millisecond from the front corner of the pulse.

kk. Set the time-base unit Time/Div switch to 0.1 millisecond/division. Set the signal standardizer Rep Rate to 1 KHz.

ll. **ADJUST**—Comp #6 adjustment R985 for 8 divisions of pulse amplitude 20 microseconds from the front corner of the pulse.

mm. Set the time-base unit Time/Div switch to 10 microseconds/division, and the signal standardizer Rep Rate to 10 KHz.

nn. **ADJUST**—Comp #7 adjustment R982 for 8 divisions of pulse amplitude 2 microseconds from the front corner of the pulse.

oo. Set the time-base unit Time/Div switch to 1 microsecond/division, and the signal standardizer Rep rate to 100 kHz.

pp. **ADJUST**—Comp #8 adjustment R980 for 8 divisions of pulse amplitude 0.2 microsecond from the front corner of the pulse.

qq. Set the time-base unit to internal triggering and the signal standardizer Test selector switch to Vert or Horiz Gain.

rr. **ADJUST**—Align the bright center trace with the center graticule line and set LF Gain adjustment R1062 for 8 divisions of deflection between the center nine traces.

ss. Set the time-base unit magnifier to X10 and the triggering to External. Set the signal standardizer Test selector switch to Vert or Horiz +Step and the Rep Rate to 1 MHz.

tt. **ADJUST**—HF Gain R1082 for a flat top.

uu. Move the signal standardizer to the B HORIZ compartment.

vv. Set the HORIZONTAL MODE switch to B.

NOTE

If the instrument under calibration contains Option 2, disconnect P984 while performing the remainder of this step.

ww. Set the signal standardizer Position and Amplitude controls so the pulse is exactly 8 divisions in amplitude measured 200 nanoseconds from the front corner (align the waveform on the second and tenth graticule lines).

NOTE

Care should be taken not to change the signal standardizer amplitude control throughout the remaining parts of this step.

xx. Set the time-base unit Time/Div switch to 2 milliseconds/division, the magnifier to X1 and the signal standardizer Rep Rate to 100 Hz.

yy. **ADJUST**—B LF ADJ adjustment R945 for exactly 8 divisions of displayed pulse at the trailing edges.

zz. Set the time-base unit sweep rate to 1 millisecond/division.

aaa. **ADJUST**—Comp #1 adjustment R958 for exactly 8 divisions of pulse amplitude 0.2 millisecond from the front corner.

bbb. Set the time-base unit Time/Div to 0.1 milliseconds/division and the signal standardizer Rep Rate to 1 kHz.

ccc. **ADJUST**—Comp #2 adjustment R955 for 8 divisions of amplitude 20 microseconds from the front corner.

ddd. Set the time-base unit sweep rate to 10 microseconds/division and the signal standardizer Rep Rate to 10 kHz.

eee. **ADJUST**—Comp #3 adjustment R952 for 8 divisions of pulse amplitude 2 microseconds from the front corner.

fff. Set the time-base unit Time/Div switch to 1 microsecond/division and the signal standardizer Rep Rate to 100 kHz.

ggg. **ADJUST**—Comp #4 adjustment R950 for 8 divisions of pulse amplitude 0.2 microsecond from the front corner.

hhh. **INTERACTION**—The adjustments in this step interact; repeat part e of this step.

NOTE

If the instrument under calibration contains Option 2 reconnect P984.

E3. CHECK/ADJUST X-Y COMPENSATION (OPTION 2 ONLY) (R1105, R1120, R1110, R1113, R1112, C1114, R1114, R1156)

NOTE

If the instrument under test does not contain Option 2, omit this step.

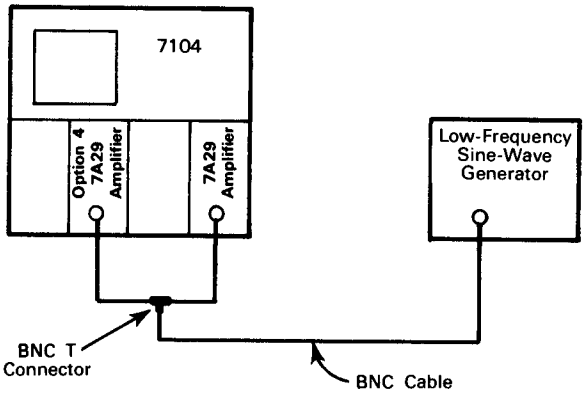
@

NOTE

If the preceding step was not performed, refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

E3. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE ..... B



Test Equipment Controls:
7A29 Amplifier Option 4
Deflection Factor ..... 0.1 V/div
Input Coupling ..... DC
Polarity ..... + UP

7A29 Amplifier
Deflection Factor ..... 0.1 V/div
Input Coupling ..... DC
Polarity ..... + UP

a. Set the low-frequency sine-wave generator for eight divisions of vertical and horizontal deflection at 25 megahertz.

b. Set the variable delay control on the 7A29 Option 4 Amplifier unit to minimize the separation on the Lissajous display.

c. Set the low-frequency sine-wave generator to 50 megahertz.

d. **CHECK**—Crt Lissajous display for a separation of 0.28 division or less (indicates 2 degrees or less phase shift).

NOTE

If the specification in part d is met, omit the remainder of this step.

e. Remove the cables and the 7A29 Amplifier units from the RIGHT VERT and B HORIZ compartments.

f. Install a signal standardizer in the B HORIZ compartment.

g. Set the signal standardizer Test selector switch to Vert or Horiz Com Mode.

h. Install a time-base unit in the RIGHT VERT compartment.

i. Set the time-base unit Time/Div switch to 1 millisecond/division, the magnifier to X1, and the triggering to auto with ac coupling from the internal source.

j. **ADJUST**—Ctr adjustment R1105 (on the A28 X-Y Delay Compensation board) so that disconnecting and reconnecting P984 produces no trace shift.

k. Set the signal standardizer Test selector switch to Vert or Horiz Gain and use the Position control to align the bright center trace with the center graticule line.

l. **EXAMINE**—The second and tenth vertical traces should align with the second and tenth graticule lines within 0.08 division.

m. **ADJUST**—Gain adjustment R1120 so that the second and tenth vertical traces align with the second and tenth graticule lines.

n. Set the signal standardizer Test selector switch to Vert or Horiz +Step.

o. Set the signal standardizer Amplitude and Position controls for an 8 division display centered on the crt at a Rep Rate of 10 kHz.

p. Connect the signal standardizer Pretrigger Out connector to the time-base unit External Trigger In connector.

q. Set the time-base unit Time/Div switch to 20 microseconds/division and the triggering to +Slope, Auto, AC and External.

r. **ADJUST**—Comp #1 adjustment R1110 to optimize the front corner of the displayed pulse.

s. Set the time-base unit sweep rate to 2 microsecond/division.

t. Set the signal standardizer Rep Rate to 100 kHz.

u. **ADJUST**—Comp #2 adjustment R1113 to optimize the front corner of the displayed pulse.

v. Set the time-base unit magnifier to X10, and the signal standardizer Rep Rate to 1 MHz.

w. **ADJUST**—Comp #3 adjustment R1112 to optimize the front corner of the displayed pulse.

x. Set the time-base unit sweep rate to 0.1 microsecond/division.

y. **ADJUST**—Comp #4 adjustment C1114, and Comp #5 adjustment R1114 to optimize the front corner of the displayed pulse.

z. Set the time-base unit Time/Div switch to 20 nanoseconds/division.

aa. **ADJUST**—Comp #6 adjustment R1156 to optimize the displayed pulse.

bb. **INTERACTION**—Adjustments in parts q through aa interact; repeat as necessary.

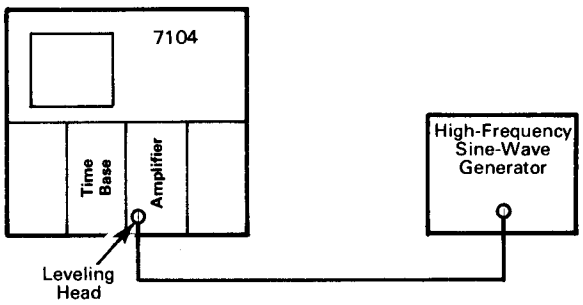
E4. CHECK HORIZONTAL BANDWIDTH

NOTE

If the preceding step was not performed, refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

E4. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE ..... A



Test Equipment Controls:
Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, External

Amplifier
Deflection Factor ..... 0.5 mV
Input Coupling ..... DC

a. Set the high-frequency sine-wave generator for 8 divisions of displayed signal on the 7104 crt at the generator's reference frequency (6 MHz).

b. Set the high-frequency sine-wave generator output frequency to 350 megahertz.

c. **CHECK**—Displayed 350 MHz amplitude is at least 5.7 divisions.

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F. VERTICAL SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit
4. Time-base unit (two required)
5. Signal standardizer
11. Low-frequency sine-wave generator
12. High-frequency sine-wave generator
16. 2X attenuator
19. Low-capacitance screwdriver
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the **Test Point and Adjustment Locations F** foldout page in Section 8, Diagrams and Circuit Board Illustrations.

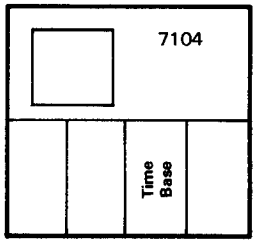
VERTICAL SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
VERT TRACE SEPARATION (B) ..... Midrange
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Midrange
HORIZONTAL MODE ..... A
B INTENSITY ..... Midrange
B TRIGGER SOURCE ..... VERT MODE
FOCUS ..... Midrange
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... As desired
BEAMFINDER ..... Pushbutton out

F1. ADJUST VERTICAL AMPLIFIER CENTERING (R740, R535)

F1. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE ..... ALT



Test Equipment Controls:
Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal

a. Set the A INTENSITY control as desired.

b. **EXAMINE**—The vertical position of the alternating traces (might appear as a single trace). They should be within 0.5 division of the graticule center line.

c. Set the VERTICAL MODE switch to LEFT.

d. **ADJUST**—MVA Center adjustment R740 (on the A17 Vertical Amplifier board) to align the trace with the center graticule line.

e. Set the VERTICAL MODE switch to RIGHT.

f. **ADJUST**—Right Ctr adjustment R535 (on the A16 Vertical Channel Switch board) to align the trace with the center graticule line.

f. **CHECK**—For one trace per graticule division within 0.06 division of the error noted in part b, over the center 6 graticule divisions.

g. **ADJUST**—If necessary, compromise the setting of Vert Gain adjustment R830 for optimum gain for both LEFT and RIGHT compartments.

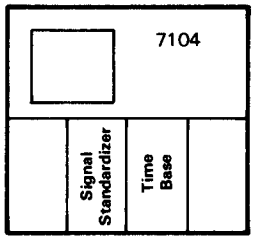
F2. CHECK/ADJUST VERTICAL AMPLIFIER GAIN (R830)

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F2. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, External

Signal Standardizer
Test Selector Switch ..... Vert or Horiz Gain
Rep Rate ..... 100 kHz

a. Position the signal standardizer display to align the bright center trace with the graticule center line.

b. **CHECK**—For one trace per graticule division within 0.06 division over the center 6 graticule divisions. Note the exact error for comparison in part f.

c. **ADJUST**—Vert Gain adjustment R830 for one division between each of the center 7 displayed traces, within 0.01 division.

d. Remove the signal standardizer from the RIGHT VERT compartment and install it in the LEFT VERT compartment.

e. Set the VERTICAL MODE switch to LEFT.

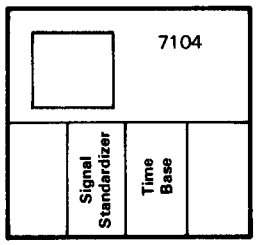
F3. CHECK VERTICAL LOW-FREQUENCY LINEARITY

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F3. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE ..... RIGHT



Test Equipment Controls:
Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal

Signal Standardizer
Test Selector Switch ..... Vert or Horiz +Step Resp
Rep Rate ..... 1 kHz

a. Set the signal standardizer Amplitude and Position controls so the display is exactly two divisions in amplitude in the center of the graticule area.

b. **CHECK**—Position the two-division display vertically and check for not more than 0.1 division of compression or expansion anywhere within the graticule area.

c. **ADJUST**—If the specification of part b was not met, perform steps F1, F2, F4, and F5.

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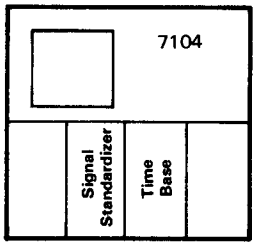
F4. ADJUST THERMAL COMPENSATIONS (C808, R785, R801, R795, R806, R791, R787)

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F4. SETUP CONDITIONS

7104 Controls:
A TRIGGER SOURCE.....RIGHT VERT



Test Equipment Controls:
Time Base
Sweep Rate.....10 μs/div
Triggering.....Auto, AC, Internal

Signal Standardizer
Test Selector Switch .....Vert or Horiz +Step Resp
Rep Rate.....100 kHz

a. Set the signal standardizer Position and Amplitude controls for an 8 division display centered on the crt.

b. Set the VERTICAL MODE switch to CHOP.

c. Set the READOUT INTENSITY control for a visible readout display.

d. **EXAMINE**—Readout display for less than 0.05 divisions of jitter and 0.05 divisions of deviation in the center displayed trace using the time-base sweep rates and signal standardizer rep rates given in Table 5-5.

e. **ADJUST**—Thermal Compensation adjustments as given in Table 5-5 for minimum Readout display jitter and minimum deviation of the displayed center trace.

f. **INTERACTION**—The adjustment listed in Table 5-5 may interact with step F2, F3, F4, and F5; repeat as necessary.

TABLE 5-5
Vertical Compensation Adjustments
(Signal Rep Rate vs. Sweep Rate)

Adjustment	Signal Standardizer Rep Rate	Sweep Rate
Comp #1 (R785), Comp #7 (C808)	1 MHz	1 μs
Comp #5 (R801)	100 kHz	10 μs
Comp #4 (R795)	10 kHz	0.1 ms
Comp #3 (R791)	1 kHz	1 ms
Comp #6 (R806)	100 Hz	10 ms
Comp #2 (R787)	10 Hz	50 ms

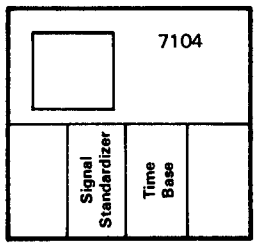
F5. ADJUST VERTICAL LOW-FREQUENCY COMPENSATION (C538, R530, R525, R520, R515, R512, C638, R630, R625, R620, R615, R612, C705)

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F5. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE.....RIGHT VERT
A TRIGGER SOURCE.....VERT MODE



Test Equipment Controls:
Time Base
Sweep Rate.....2 μs/div
Triggering.....Auto, AC, Internal

Signal Standardizer
Test Selector Switch .....Vert or Horiz +Step Resp
Rep Rate.....100 kHz

a. Set the signal standardizer Amplitude control for a 6-division display.

b. Set the time-base unit triggering and position controls for a stable display.

c. **EXAMINE**—Displayed pulse for optimum flat top within 0.06 division with the signal standardizer Rep Rate and time-base unit sweep rates given in Table 5-6A.

TABLE 5-6A
Low-Frequency Compensation
(Signal Rep Rate vs. Sweep Rate)

Adjustment	Signal Standardizer Rep Rate	Sweep Rate
Comp #14 (C538), Comp #13 (R530)	100 kHz	2.0 μs
Comp #12 (R525)	10 kHz	20.0 μs
Comp #11 (R520)	1 kHz	0.2 ms
Comp #10 (R515)	100 Hz	2.0 ms
Comp #9 (R512)	10 Hz	20.0 ms

TABLE 5-6B
Low-Frequency Compensation
(Signal Rep Rate vs. Sweep Rate)

Adjustment	Signal Standardizer Rep Rate	Sweep Rate
Comp #20 (C638), Comp #19 (R630)	100 kHz	2.0 μs
Comp #18 (R625)	10 kHz	20 μs
Comp #17 (R620)	1 kHz	0.2 ms
Comp #16 (R615)	100 Hz	2.0 ms
Comp #15 (R612)	10 Hz	20.0 ms

d. **ADJUST**—Compensation adjustments #14, #13, #12, #11, #10 and #9 (on the A16 Vertical Channel Switch board) as given in Table 5-6A for optimum flat top on the displayed waveform.

e. Move the signal standardizer to the LEFT VERT compartment.

f. Set the VERTICAL MODE switch to LEFT VERT.

g. Set the signal standardizer Rep Rate switch to 100 kHz. Set the Amplitude and Position controls for a six-division display, centered on the graticule area.

h. **EXAMINE**—Displayed pulse for optimum flat top within 0.06 division with the signal standardizer Rep Rate and the time-base unit sweep rates given in Table 5-6B.

i. **ADJUST**—Compensation adjustments #20, #19, #18, #17, #16, and #15 as given in Table 5-6B for optimum flat top on the displayed waveform.

j. Set the signal standardizer Test selector switch to Vert or Horiz +Step Resp and the Rep Rate to 1 MHz.

k. Set the time-base unit for a sweep rate of 2.0 nanoseconds/division. Set the triggering controls for a stable display triggered on the rising portion of the pulse.

l. **EXAMINE**—For optimum square corner and flat top on the displayed pulse within the following limits: Aberrations in the first 5 nanoseconds after the 50% point of the step should not exceed 0.3 division peak-to-peak. Aberrations from 5 to 10 nanoseconds after the 50% point of the step should not exceed 0.18 division peak-to-peak. Aberrations after 10 nanoseconds of the 50% point of the step should not exceed 0.06 divisions peak-to-peak except to allow 0.12 division of aberrations for delay-line termination at about 105 nanoseconds from the step. Rise time of the pulse should be 350 picoseconds between the 10% and 90% points.

m. **ADJUST**—High-frequency Comp #21 adjustment C705 for optimum rise time (less than 350 picoseconds) and flat top with minimum aberrations within the limits given in part l. Use the low-capacitance screwdriver to adjust the variable capacitors. Repeat the complete adjustment procedure as necessary to obtain optimum step response.

n. **INTERACTION**—Adjustments in step F5 interact with steps F2, F3, and F4; repeat as necessary.

o. Move the signal standardizer to the RIGHT VERT compartment and set the VERTICAL MODE switch to RIGHT.

p. **ADJUST**—If necessary, compromise the high-frequency Comp #21 adjustment C705 for optimum pulse response for both vertical compartments.

q. **EXAMINE**—For optimum square corner and flat top on the displayed pulse with aberrations within the limits given in part l.

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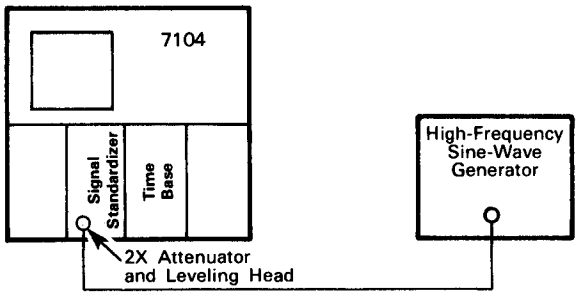
F6. CHECK VERTICAL AMPLIFIER 1 GHz GAIN

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F6. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE.....RIGHT



Test Equipment Controls:
Time Base
Sweep Rate.....0.1 ms/div
Triggering.....Auto, AC, External

Signal Standardizer
Test Selector Switch.....Vert or Horiz Freq Resp

High-Frequency Sine-Wave Generator
Reference Frequency.....6 MHz

a. Set the signal standardizer Amplitude control fully clockwise.

b. Connect the high-frequency sine-wave generator to the signal standardizer Aux In-Cw In (Freq Resp) input with a 2X attenuator.

c. Set the high-frequency sine-wave generator for a 10-division display at the reference frequency (between 6 and 50 megahertz) centered on the graticule. (To obtain a 10-division display first set for 8 divisions, then vertically position the display 1 division down and set the sine-wave generator to return the top of the display to the top of the graticule.)

d. Set the signal standardizer Amplitude control for a 6-division display, centered on the graticule. (The CW Leveled indicator should be lit.)

e. Without changing the output amplitude, increase the generator frequency until the displayed amplitude is reduced to 5 divisions. If the CW Leveled indicator extinguishes, increase the amplitude of the sine-wave generator signal until the light just turns on.

NOTE

The signal standardizer CW Leveled light must be on and the sine-wave generator must be properly connected for a valid check. Refer to the signal standardizer and high-frequency sine-wave generator manuals.

f. **CHECK**—Sine-wave generator frequency is 1 gigahertz or higher (verifies 1 gigahertz gain).

g. Move the signal standardizer to the LEFT VERT compartment (leave signal connected) and set the VERTICAL MODE switch to LEFT.

h. **CHECK**—Repeat parts d through f for the LEFT VERT compartment.

i. **ADJUST**—If the specifications of steps f or h were not met, perform steps F1, F2, F3, F4, and F5.

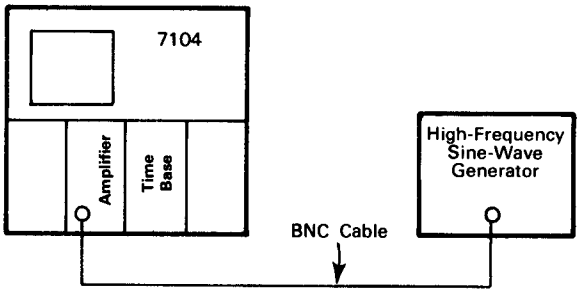
F7. CHECK VERTICAL CHANNEL ISOLATION

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F7. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE.....RIGHT



Test Equipment Controls:
Time Base
Sweep Rate.....1 ms/div
Triggering.....Auto, AC, Internal

Amplifier
Input Coupling.....DC

High-Frequency Sine-Wave Generator.....1 GHz

a. Connect the output of the high-frequency sine-wave generator to the Amplifier unit input.

b. Set the output of the high-frequency sine-wave generator and the amplifier unit deflection factor for 8 divisions of deflection at 1 gigahertz.

c. Set the VERTICAL MODE switch to LEFT.

d. **CHECK**—Crt display amplitude for 0.1 division or less of the 1 gigahertz signal (verifies isolation at least 80:1 at 1 gigahertz).

e. Move the amplifier unit to the LEFT VERT compartment without disturbing the set-up.

f. Set the VERTICAL MODE switch to RIGHT.

g. **CHECK**—Crt display amplitude for 0.1 division or less of the 1 gigahertz signal (verifies isolation at least 80:1 at 1 gigahertz).

h. Set the VERTICAL MODE switch to LEFT.

i. Connect the low-frequency sine-wave generator to the amplifier unit input.

j. Set the low-frequency sine-wave generator for 8 divisions of deflection at 100 megahertz.

k. Set the VERTICAL MODE switch to RIGHT.

l. **CHECK**—Crt display amplitude for 0.05 division or less of 100 megahertz signal (verifies 100 megahertz isolation of at least 160:1).

m. Move the amplifier unit to the RIGHT VERT compartment without disturbing the set-up.

n. Set the VERTICAL MODE switch to LEFT.

o. **CHECK**—Crt display amplitude for 0.05 division or less of 100 megahertz signal (verifies isolation of at least 160:1 from dc to 100 megahertz).

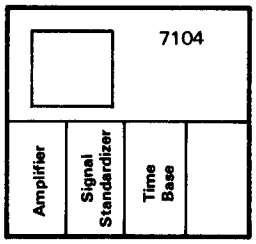
F8. CHECK VERTICAL DISPLAY MODES

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F8. SETUP CONDITIONS

7104 Controls:
VERTICAL MODE.....RIGHT



Test Equipment Controls:
Time Base
Sweep Rate.....1 ms/div
Triggering.....Auto, AC, Internal

Amplifier
Deflection Factor.....0.1 V/div
Input Coupling.....DC

Signal Standardizer
Test Selector Switch.....Vert or Horiz Aux In

a. Position the trace to the upper half of the graticule area with the right-vertical unit position control.

b. Set the VERTICAL MODE switch to LEFT and position the trace to the lower half of the graticule area with the left-vertical unit position control.

c. **CHECK**—Crt display for two traces in the ALT and CHOP positions of the VERTICAL MODE switch.

d. Set the VERTICAL MODE switch to ADD.

e. **CHECK**—Crt display for a single trace that can be positioned vertically with either left or right vertical-unit position controls.

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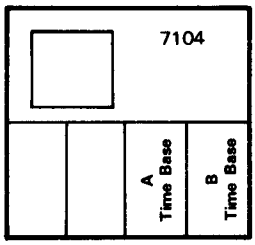
F9. CHECK VERTICAL TRACE SEPARATION OPERATION

NOTE

If the preceding step was not performed, first refer to the Vertical System Preliminary Control Settings, then proceed with the following instructions.

F9. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE ..... CHOP
VERTICAL MODE ..... ADD



Test Equipment Controls:
A Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal

B Time Base
Sweep Rate ..... 1 ms/div
Triggering ..... Auto, AC, Internal

a. **CHECK**—Rotate the VERT TRACE SEPARATION (B) control throughout its range and check that the trace produced by the B time-base unit can be positioned above and below the trace produced by the A time-base unit by at least 3.5 divisions. Repeat with the HORIZONTAL MODE switch set to ALT.

G. READOUT SYSTEM

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

3. Amplifier unit (dual trace)
4. Time-base unit
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the **Test Point and Adjustment Locations G** foldout page in Section 8, Diagrams and Circuit Board Illustrations.

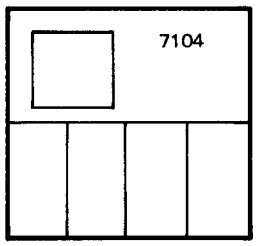
READOUT SYSTEM PRELIMINARY CONTROL SETTINGS:

POWER switch	On
VERTICAL MODE	RIGHT
VERT TRACE SEPARATION (B)	Midrange
A TRIGGER SOURCE	VERT MODE
A INTENSITY	Midrange
HORIZONTAL MODE	A
B TRIGGER SOURCE	VERT MODE
B INTENSITY	Midrange
READOUT INTENSITY	OFF (in detent)
GRAT ILLUM	Midrange
BEAMFINDER	Pushbutton out
Readout Selector Switch	Free Run (see Test Point and Adjustment Locations G.)

G1. ADJUST READOUT VERTICAL SEPARATION, CENTERING AND CHARACTER HEIGHT (R2291, R701, R2273, R1025, R1035)

G1. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
No equipment necessary.

a. Set the POWER switch to OFF.

b. Remove Q2225 from its socket on the Readout System board A15.

c. Set the POWER switch to on.

d. Set the READOUT INTENSITY control for visible characters (all zeros).

NOTE

The following tolerances are provided as guides to correct instrument operation and are not instrument specifications.

e. **EXAMINE**—The crt display for two rows of zeros, 40 zeros to a row with no character overlap. The two rows of zeros should be located vertically in the middle of the top and bottom divisions of the graticule (see Fig. 5-2).

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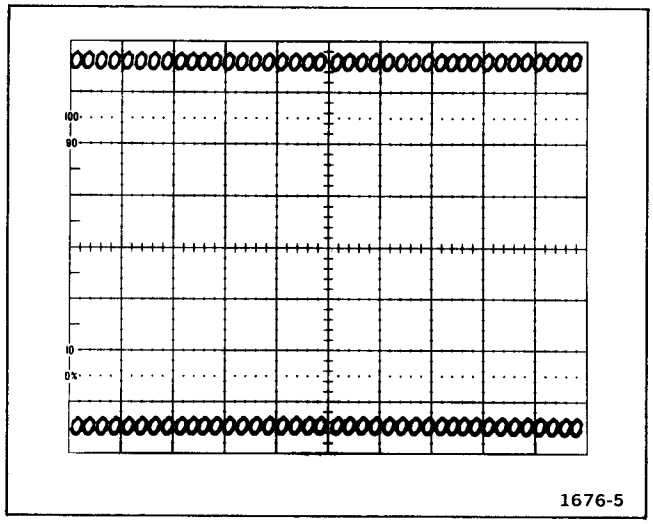


Figure 5-2. Readout display with Q2225 removed.

NOTE

The MVA (Main Vertical Amplifier) Center Adjustment R740 must be correct before making the next adjustment. Refer to F. Vertical System procedure.

f. **ADJUST**—Vertical Separation adjustment R2291, and R/O Center adjustment R701 to position the two rows of readout characters to the middle of the top and bottom divisions of the graticule. Set Character Height adjustment R2273 as desired.

g. **EXAMINE**—Display for two rows of zeros, 40 zeros to each row with no character overlap. Total length of each row of characters is between 9.5 and 10 divisions.

h. **ADJUST**—RO Ctr adjustment R1025 and RO Gain R1035 to horizontally center the zeros display and so that the length of each row of characters is between 9.5 divisions and 10 divisions.

i. Set the POWER switch to OFF and replace Q2225 in its socket.

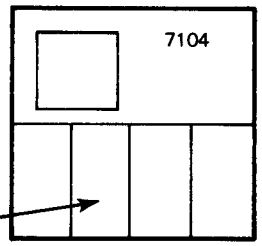
G2. ADJUST FULL CHARACTER SCAN (R2128)

NOTE

If the preceding step was not performed, first refer to the Readout System Preliminary Control Settings, then proceed with the following instructions.

G2. SETUP CONDITIONS

7104 Controls:
POWER.....On
VERTICAL MODE.....RIGHT



Test Equipment Controls:
Amplifier Unit
Deflection Factors.....50 mV/div
Display Mode.....Dual trace

a. **EXAMINE**—The displayed characters for completeness without overscanning; overscanning causes a bright dot where traces overlap.

b. **ADJUST**—Scan adjustment R2128 for fully scanned characters without overscanning. The m and the 5 will show the most change.

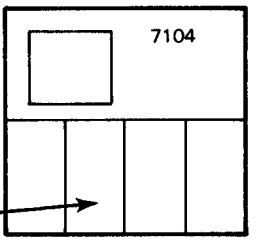
G3. ADJUST COLUMN AND ROW MATCH (R2214, R2183)

NOTE

If the preceding step was not performed, first refer to the Readout System Preliminary Control Settings, then proceed with the following instructions.

G3. SETUP CONDITIONS

7104 Controls:
No change in settings.



Test Equipment Controls:
Amplifier
Display Mode.....Dual trace

a. Press and hold one of the amplifier unit trace-identify buttons.

b. **EXAMINE**—The readout display for correct indication of "IDENTIFY." If the readout display is incorrect, adjustment is required.

c. **ADJUST**—Column Match adjustment R2214, and Row Match adjustment R2183, for correct readout of "IDENTIFY." Set these adjustments to the center of the adjustment range which provides correct readout indication. Release the amplifier unit trace-identify button.

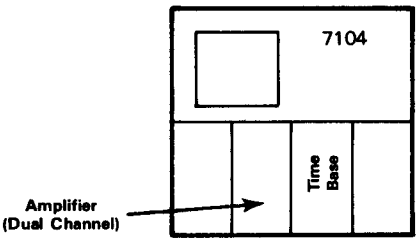
G4. CHECK READOUT MODES

NOTE

If the preceding step was not performed, first refer to the Readout System Preliminary Control Settings, then proceed with the following instructions.

G4. SETUP CONDITIONS

7104 Controls:
HORIZONTAL MODE.....A



Test Equipment Controls:
Time Base
Sweep Rate.....1 ms/div
Triggering.....Auto, AC, Internal

a. Set the READOUT INTENSITY control for a visible display.

b. **CHECK**—Set the time-base unit to several sweep rates throughout the time/division switch range and check that the readout characters are displayed independently of the sweep.

c. Set the READOUT +GATE or EXT switch to +GATE and the READOUT INTENSITY control to PULSED.

d. Set the +GATE mode switch to A.

e. Set the READOUT PRESET control for a visible readout display.

f. Set the time-base unit for a free-running (not triggered) sweep at a rate of 0.2 second/division.

g. **CHECK**—The readout characters are blanked out while the sweep is running, and are displayed immediately after the end of the sweep; each character encoded by the plug-in units is displayed only once for each sweep.

h. Set the READOUT +GATE or EXT switch to EXT.

i. **CHECK**—Press the READOUT MAN pushbutton and notice that one frame of readout is displayed.

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H. PHOTOGRAPHIC WRITING RATE

Equipment Required: (Numbers correspond to those listed in Table 5-3, Test Equipment.)

2. Amplifier unit
4. Time-base unit
7. Camera
12. High-frequency sine-wave generator
20. Screwdriver

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-Up Sequence.

(2) Refer to Section 6, Instrument Options, and the Change Information at the rear of this manual for any modifications which may affect this procedure.

(3) See the Test Point and Adjustment Locations H foldout page in Section 8, Diagrams and Circuit Board Illustrations.

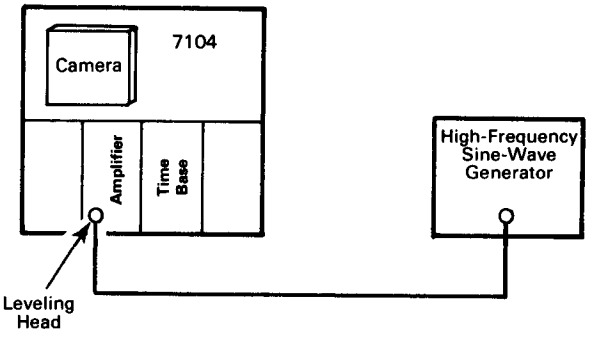
PHOTOGRAPHIC WRITING RATE PRELIMINARY CONTROL SETTINGS:

POWER switch ..... On
VERTICAL MODE ..... RIGHT
VERT TRACE SEPARATION (B) ..... Midrange
A TRIGGER SOURCE ..... VERT MODE
A INTENSITY ..... Midrange
HORIZONTAL MODE ..... A
B TRIGGER SOURCE ..... VERT MODE
B INTENSITY ..... Midrange
READOUT INTENSITY ..... OFF (in detent)
GRAT ILLUM ..... PULSED
BEAMFINDER ..... Pushbutton out

H1. CHECK/ADJUST PHOTOGRAPHIC WRITING RATE

H1. SETUP CONDITIONS

7104 Controls:
GRAT ILLUM +GATE or EXT ..... +GATE
+GATE A or B ..... A



Test Equipment Controls:
Amplifier
Deflection Factor ..... 0.5 V/div
Input Coupling ..... DC

Time Base
Sweep Rate ..... 5 ns
Magnifier X10
Triggering ..... Auto, AC, Internal

High-Frequency Sine-Wave Generator
Frequency ..... 1 GHz

Camera
Mode ..... Time
Aperture f/1 9

a. Set the A INTENSITY control for a visible display.

b. Set the time-base unit sweep magnifier to X10.

c. Set the high-frequency sine-wave generator output amplitude to display 7.5 divisions on the 7104 crt.

d. Set the FOCUS and ASTIG controls for a well-defined display.

e. Set the time base unit to single-sweep mode.

f. Repeatedly press the time-base unit single-sweep reset control and set the GRAT ILLUM PRESET control to illuminate the graticule.

g. Focus the camera.

h. Install 3000 ASA film in camera and close the camera viewing port.

i. Rotate the A INTENSITY control fully clockwise.

j. Press the camera shutter button.

k. Press the time base single-sweep reset button.

l. Press the camera shutter button.

m. Develop film.

n. **CHECK**—Photograph should show the 1 gigahertz sine-wave clearly (See Fig. 5-3 for typical photograph).

o. **ADJUST**—Rotate the MCP Output adjustment R1720 clockwise to increase the photographic writing rate. Note that background scintillation can be reduced by rotating R1720 counterclockwise at the expense of the photographic writing rate.

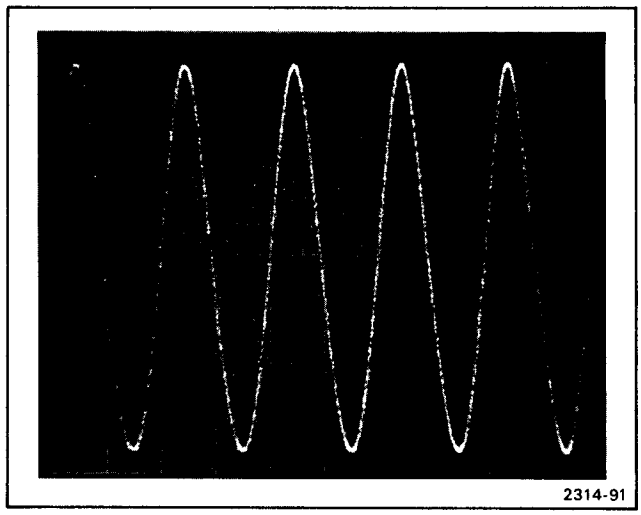


Figure 5-3. Typical 7104 Photographic Writing Rate.

This concludes the Adjustment and Performance Check of the 7104.

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INSTRUMENT OPTIONS

Your instrument may be equipped with one or more instrument options. A brief description of each available option is given in the following discussion. Option information is incorporated into the appropriate sections of the manual. Refer to Table 6-1 and the Table of Contents for location of option information. For further information on instrument options, see your Tektronix Products catalog or contact your Tektronix Field Office.

WARNING

To avoid electric shock hazard, operating personnel must not remove the protective instrument covers. Component replacement and internal adjustments must be made by qualified service personnel only.

OPTION 2

Option 2 provides X-Y Mode Phase Correction. A horizontal delay line and compensation network equalizes the signal delay between either vertical compartment and the B HORIZ compartment. When this network is installed and activated, the phase shift between the vertical and B horizontal channels is adjustable to less than 2° from dc to 50 megahertz (phase balance can be obtained at any frequency up to 250 MHz). This option is factory installed.

OPTION 3

With Option 3 installed, the instrument will meet EMC (electromagnetic compatibility) specifications given in section 1. This option can be added at any time. Refer to the Tektronix Products catalog for part number.

TABLE 6-1
Option Information Locator

Instrument Options	Manual Section	Location of Information
Option 2 (Provides X-Y Delay Compensation)	1 General Information	Specification Table 1-4 contains the electrical characteristics for Option 2.
	2 Operating Instructions	Applications Provides discussion on X-Y Operation.
	3 Theory of Operation	Delay Comp (Option 2) 16 Provides discussion of circuitry.
	5 Calibration	Horizontal System E3. Check/Adjust Option 2 X-Y compensation.
	6 Instrument Options	Introductory page Includes a brief description of Option 2.
	7 Replaceable Electrical Parts	Replaceable Electrical Parts Replaceable parts unique to Option 2 are footnoted "Option 2 only".

TABLE 6-1 (CONT.)
Option Information Locator

Instrument Option	Manual Section	Location of Information
Option 2 (cont.)	8 Diagrams and Circuit Board Illustrations	Delay Comp (Option 2) 16 Diagram 16, shows circuitry unique to Option 2.
	9 Replaceable Mechanical Parts	Instrument Options (pull-out page) Provides a mechanical parts list and an exploded-view drawing unique to Option 2.
Option 3 (Provides EMC)	1 General Information	Specification Table 1-5 contains the electrical characteristics for Option 3.
	2 Operating Instructions	Detailed Operating Information Light Filter; includes basic description. Installation of Plug-In Units Refers to EMC shielded blank plug-in panel.
	6 Instrument Options	Introductory page Includes a brief description of Option 3.
	7 Replaceable Electrical Parts	Replaceable Electrical Parts Replaceable parts unique to Option 3 contain the footnote "Option 3 only".
	9 Replaceable Mechanical Parts	Instrument Options (pull-out page) Provides a mechanical parts list and an exploded-view drawing unique to Option 3.

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