



**PLEASE CHECK FOR CHANGE INFORMATION
AT THE REAR OF THIS MANUAL.**

**7B15
DELAYING TIME
BASE**

INSTRUCTION MANUAL

**Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077**

070-2318-00
Product Group 42

Serial Number _____

First Printing OCT 1978
Revised APR 1984

Copyright © 1978 Tektronix, Inc. All rights reserved.
Contents of this publication may not be reproduced in any
form without the written permission of Tektronix, Inc.

Products of Tektronix, Inc. and its subsidiaries are covered
by U.S. and foreign patents and/or pending patents.

TEKTRONIX, TEK, SCOPE-MOBILE, and  are
registered trademarks of Tektronix, Inc. TELEQUIPMENT
is a registered trademark of Tektronix U.K. Limited.

Printed in U.S.A. Specification and price change privileges
are reserved.

INSTRUMENT SERIAL NUMBERS

Each instrument has a serial number on a panel insert, tag,
or stamped on the chassis. The first number or letter
designates the country of manufacture. The last five digits
of the serial number are assigned sequentially and are
unique to each instrument. Those manufactured in the
United States have six unique digits. The country of
manufacture is identified as follows:

B000000	Tektronix, Inc., Beaverton, Oregon, USA
100000	Tektronix Guernsey, Ltd., Channel Islands
200000	Tektronix United Kingdom, Ltd., London
300000	Sony/Tektronix, Japan
700000	Tektronix Holland, NV, Heerenveen, The Netherlands

TABLE OF CONTENTS

	PAGE		PAGE
LIST OF ILLUSTRATIONS	iii	SECTION 3 THEORY OF OPERATION	
LIST OF TABLES	iv	BLOCK DIAGRAM DESCRIPTION	3-1
OPERATORS SAFETY INFORMATION	v	TRIGGER GENERATOR	3-1
SERVICE SAFETY INFORMATION	vi	SWEEP GENERATOR	3-1
SECTION 1 GENERAL INFORMATION		PICKOFF COMPARATORS AND	
INTRODUCTION	1-1	DELAY GATE GENERATOR	3-1
OPERATORS MANUAL	1-1	LOGIC	3-1
INSTRUCTION MANUAL	1-1	DIGITAL VOLTMETER	3-1
INSTALLATION	1-1	DETAILED CIRCUIT DESCRIPTION	3-3
INSTRUMENT PACKAGING	1-1	LOGIC FUNDAMENTALS	3-3
SPECIFICATION	1-2	SYMBOLS	3-3
STANDARD ACCESSORIES	1-5	LOGIC POLARITY	3-3
SECTION 2 OPERATING INSTRUCTIONS		INPUT/OUTPUT TABLES	3-3
CONTROLS, CONNECTORS AND INDICATORS	2-1	NON-DIGITAL DEVICES	3-3
OPERATORS CHECKOUT	2-1	FRONT-PANEL WIRING	3-3
SETUP PROCEDURE	2-1	TRIGGER GENERATOR	3-3
SWEEP FUNCTIONS	2-1	EXTERNAL TRIGGER AMPLIFIER	3-3
TRIGGERING FUNCTIONS	2-4	TRIGGER AMPLIFIER AND	
DETAILED OPERATING INFORMATION	2-5	SOURCE SELECTOR	3-7
TRIGGERING MODES	2-5	SLOPE SELECTOR AND	
TRIGGER COUPLING	2-6	TRIGGER GENERATOR	3-7
TRIGGER SOURCE	2-6	GATE GENERATOR	3-7
TRIGGER SLOPE	2-6	LOGIC	3-7
TRIGGER LEVEL	2-8	TRIGGER MODE SWITCHING	3-7
HORIZONTAL SWEEP RATES	2-8	HOLD OFF TIMING	3-8
TIME MEASUREMENTS	2-8	LOCKOUT BUFFER AMPLIFIER	3-9
SWEEP MAGNIFICATION	2-8	HOLD OFF GENERATOR	3-9
VARIABLE HOLD OFF	2-8	DELAY MODE CONTROL	3-9
DELAY-TIME OPERATION	2-8	AUXILIARY Y-AXIS	3-9
Δ TIME OPERATION	2-9	SWEEP GENERATOR	3-10
MAINFRAME OPERATING MODES	2-10	TIMING CURRENT SOURCE	3-10
APPLICATIONS	2-10	RAMP GENERATOR	3-10
DELAYED-SWEEP MEASUREMENTS	2-10	OUTPUT PREAMPLIFIER	3-11
TIME-INTERVAL MEASUREMENTS		AUXILIARY SWEEP PREAMPLIFIER	3-11
(DELAY-TIME MODE)	2-12	SWEEP GATE GENERATOR	3-11
DIFFERENTIAL TIME-INTERVAL		PICKOFF COMPARATORS AND DELAY	
MEASUREMENTS (Δ TIME MODE)	2-12	GATE GENERATOR	3-11
DELAYED-SWEEP MAGNIFICATION	2-14	DELAY PICKOFF COMPARATORS	3-11
TRIGGERED DELAYED-SWEEP		DELAY AND Δ TIME REFERENCE	
MAGNIFICATION	2-16	VOLTAGE SOURCES	3-12
INDEPENDENT TIME-INTERVAL		DELAY GATE GENERATOR	3-12
MEASUREMENTS	2-16	DIGITAL VOLTMETER	3-12
		DELAY COMPARISON VOLTAGE TO	
		RAMP CONVERTER	3-12
		COMPARATOR	3-14
		REFERENCE CURRENT SOURCE	3-14
		REFERENCE CURRENT INVERTER	3-14
		COUNTER AND ENCODER	3-14
		TIME/DIVISION AND READOUT SWITCHING	3-14
		BASIC READOUT SYSTEM	3-14
		TIME/DIVISION READOUT	3-14
		DELAY TIME READOUT	3-15
		Δ SYMBOL ENABLE	3-15
		INTERFACE CONNECTORS AND	
		POWER SUPPLY	3-15

WARNING

THE REMAINING PORTION OF THIS TABLE OF CONTENTS LISTS THE SERVICING INSTRUCTIONS. THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CALLED OUT IN THE OPERATING INSTRUCTIONS UNLESS QUALIFIED TO DO SO.

TABLE OF CONTENTS (CONT.)

	PAGE		PAGE
SECTION 4 MAINTENANCE		COMPONENT REMOVAL AND REPLACEMENT	4-9
PREVENTIVE MAINTENANCE	4-1	CIRCUIT BOARDS	4-9
CLEANING	4-1	SWITCHES	4-10
EXTERIOR	4-1	HYPCON CONNECTORS	4-12
INTERIOR	4-1	INTERCONNECTING PINS	4-13
SWITCH CONTACTS	4-1	FRONT-PANEL LIGHTS	4-16
VISUAL INSPECTION	4-1	ADJUSTMENT AFTER REPAIR	4-16
LUBRICATION	4-1	INSTRUMENT REPACKAGING	4-16
CAM SWITCH LUBRICATION	4-1		
SEMICONDUCTOR CHECKS	4-2	SECTION 5 CALIBRATION	
ADJUSTMENT AFTER REPAIR	4-2	CALIBRATION	5-1
TROUBLESHOOTING	4-3	PRELIMINARY INFORMATION	5-1
TROUBLESHOOTING AIDS	4-3	USING THESE PROCEDURES	5-1
DIAGRAMS	4-3	ADJUSTMENT INTERVAL	5-2
TROUBLESHOOTING CHART	4-3	TEKTRONIX FIELD SERVICE	5-2
VOLTAGES AND WAVEFORMS	4-3	TEST EQUIPMENT REQUIRED	5-6
CIRCUIT-BOARD ILLUSTRATIONS	4-3	SPECIAL FIXTURES	5-6
SWITCH CAM IDENTIFICATION	4-3	TEST EQUIPMENT ALTERNATIVES	5-6
DIODE COLOR CODE	4-3	PART I-PERFORMANCE CHECK	5-8
WIRING COLOR CODE	4-3	PERFORMANCE CHECK PROCEDURE INDEX	5-8
SEMICONDUCTOR BASING	4-3	PERFORMANCE CHECK POWER-UP	
INTER-BOARD PIN CONNECTOR		SEQUENCE	5-8
IDENTIFICATION	4-3	A. TRIGGERING SYSTEM	5-9
MULTI-PIN CONNECTOR IDENTIFICATION	4-3	B. HORIZONTAL SYSTEM	5-14
INTERFACE CONNECTOR PIN LOCATIONS	4-3	PART II-ADJUSTMENT AND PERFORMANCE	
ADJUSTMENT AND PERFORMANCE CHECK	4-3	CHECK	5-23
TROUBLESHOOTING EQUIPMENT	4-5	ADJUSTMENT AND PERFORMANCE	
TROUBLESHOOTING TECHNIQUES	4-6	CHECK INDEX	5-23
1. CHECK CONTROL SETTINGS	4-6	ADJUSTMENT AND PERFORMANCE CHECK	
2. CHECK ASSOCIATED EQUIPMENT	4-6	POWER-UP SEQUENCE	5-23
3. VISUAL CHECK	4-6	A. TRIGGERING SYSTEM	5-24
4. CHECK INSTRUMENT ADJUSTMENT	4-6	B. HORIZONTAL SYSTEM	5-29
5. ISOLATE TROUBLE TO A CIRCUIT	4-6		
6. CHECK VOLTAGES AND WAVEFORMS	4-6	SECTION 6 INSTRUMENT OPTIONS	
7. CHECK INDIVIDUAL COMPONENTS	4-6		
TRANSISTORS	4-7	SECTION 7 REPLACEABLE ELECTRICAL PARTS	
INTEGRATED CIRCUITS	4-7		
DIODES	4-7	SECTION 8 DIAGRAMS AND CIRCUIT BOARD	
RESISTORS	4-7	ILLUSTRATIONS	
INDUCTORS	4-7		
CAPACITORS	4-7	SECTION 9 REPLACEABLE MECHANICAL PARTS	
8. REPAIR AND ADJUSTMENT	4-7		
CORRECTIVE MAINTENANCE	4-8	CHANGE INFORMATION	
OBTAINING REPLACEMENT PARTS	4-8		
SOLDERING TECHNIQUES	4-8		

LIST OF ILLUSTRATIONS

FIGURE NO.	PAGE	FIGURE NO.	PAGE
Frontis- piece	7B15 Features	3-1	Basic block diagram of the 7B15 Delaying Time Base unit.....
1-1	Location of release latch	3-2	Timing diagram for Gate Generator stages Q160, Q164, and Q174
1-2	7B15 dimensional drawing	3-3	Timing diagram for Delay Pickoff Inhibit stage.....
2-1	Front-panel controls, connectors, and indicators	3-4	Digital Voltmeter timing diagram.....
2-2	Effects of LEVEL control and SLOPE switch on crt display	4-1	Lubrication procedure for a typical cam switch
2-3	Area of graticule used for most accurate time measurements	4-2	Semiconductor lead configuration
2-4	Effect of sweep magnifier on crt display.....	4-3	Inter-board multi-pin connector assembly.....
2-5	(A) Delaying-sweep display produced by 7B15 in the A horizontal compartment. (B) Delayed- sweep display produced by companion time-base unit in the B horizontal compartment	4-4	End-lead multi-pin connector assembly.....
2-6	Typical Δ (Differential Time Operation	4-5	Location of pin numbers on Interface connector
2-7	Measuring time intervals from a triggering event (start of sweep) to any point on waveform	4-5	P38 cable dress illustration.....
2-8	Measuring risetime, fall time, period, frequency, or pulse width in the Δ (differential) time mode	4-6	Readout board removal procedure.....
2-9	Magnifying a selected segment of the delaying (A) sweep in the delay-time mode with mainframe alternate or chopped horizontal operation	4-7	Coaxial end-lead connector assembly
2-10	Time-interval measurements in the delay-time and Δ (differential) time mode with mainframe alternate or chopped operation	4-8	Cam switch removal procedure
2-11	Examining an event that occurs within a selected time interval after a known delay time in the delay-time mode	4-9	Removal procedure for typical push- button switch
		4-10	Hypcon connector removal and replacement...
		4-11	Exploded view of circuit-board pin and ferrule
		4-12	Front-panel light socket assembly.....
		4-13	
		8-1	Semiconductor lead configuration.
		8-2	Location of circuit boards in the 7B15.
		8-3	A1-Interface circuit board assembly.
		8-4	A2-Trigger circuit board assembly.
		8-5	A3-Readout circuit board assembly.
		8-6	A4-Digital Voltmeter circuit board assembly.
		8-7	Location of Sweep Timing adjustments.
		8-8	Location of Digital Voltmeter adjustments.
		8-9	Location of Triggering adjustments.

LIST OF TABLES

TABLE NO.		PAGE
1-1	Electrical Characteristics	1-2
1-2	Environmental Characteristics	1-5
1-3	Physical Characteristics	1-5
3-1	Basic Logic Reference	3-4
3-2	Readout Character Selection	3-15
5-1	Performance Check Summary	5-2
5-2	Test Equipment	5-6
5-3	Δ Time Accuracy	5-19
5-4	Sweep Timing	5-21
5-5	Magnified Sweep Timing	5-22
5-6	Δ Time Accuracy	5-37
5-7	Sweep Timing	5-39
5-8	Magnified Sweep Timing	5-40

OPERATORS SAFETY SUMMARY

The following general safety information applies to all operators and service personnel. Specific warnings and cautions will be found throughout the manual where they apply and should be followed in each instance.

WARNING statements identify conditions or practices which could result in personal injury or loss of life.

CAUTION statements identify conditions or practices which could result in damage to the equipment or other property.

WARNING

GROUNDING THE INSTRUMENT

To reduce electrical-shock hazard, the mainframe (oscilloscope) chassis must be properly grounded. Refer to the mainframe manual for grounding information.

DO NOT REMOVE INSTRUMENT COVERS

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.

DO NOT OPERATE IN EXPLOSIVE ATMOSPHERE

To avoid explosion, do not operate this instrument in an explosive atmosphere unless it has been certified for such operation.

CAUTION

PREVENT INSTRUMENT DAMAGE

Plug-in units should not be installed or removed without first turning the instrument power off, to prevent instrument damage.

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary

The following are safety precautions which appear in the servicing information sections of this manual. This Servicing Safety Summary is in addition to the Operators Safety Summary given previously.

WARNING

DO NOT SERVICE ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DISCONNECT INSTRUMENT POWER

To avoid electric-shock disconnect the instrument from the power source before removing protective panels, soldering, or replacing components.

SILICONE GREASE HANDLING

Handle silicone grease with care. Avoid getting the silicone grease in your eyes. Wash hands thoroughly after use.

CAUTION

AVOID EXCESSIVE MOISTURE

Circuit boards and components must be dry before applying power to prevent damage from electrical arcing.

EXERCISE CARE WHEN CHECKING DIODES

When checking diodes, do not use an ohmmeter scale that has a high internal current, since high currents may damage the diodes under test.

EXERCISE CARE WHEN SOLDERING ON MULTI-LAYER BOARDS

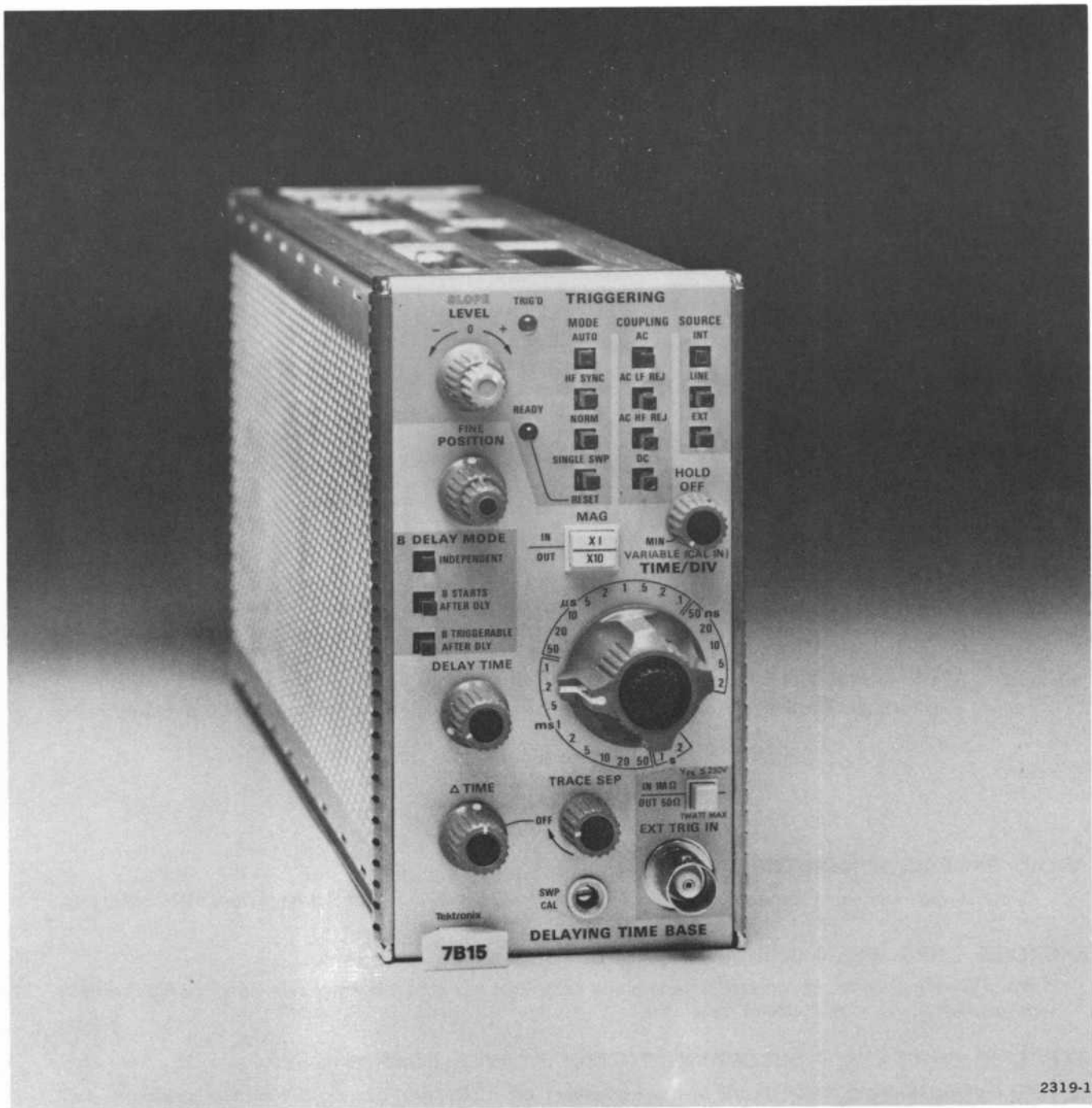
All but the Readout circuit board in the instrument are multi-layer type boards with a conductive path laminated between the top and bottom board layers. All soldering on these boards should be done with extreme care to prevent breaking the connections to this center conductor. Only experienced maintenance personnel should attempt repair of these boards.

USE PROPER CLEANING AGENTS

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Use a non-residue type of cleaner, preferably isopropyl alcohol, totally denatured ethyl alcohol, or Freon TF. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

DO NOT USE PIN SOCKETS FOR CONNECTION POINTS

The spring tension of the pin sockets ensures a good connection between the circuit board and the pin. This spring tension can be destroyed by using the pin sockets as a connecting point for spring-loaded probe tips, alligator clips, etc.



7B15 Features

The 7B15 Delaying Time-Base unit provides calibrated sweep rates from .2 seconds to 2 nanoseconds and triggering to 1 Gigahertz for 7100-, 7700-, 7800-, and 7900-series oscilloscopes. The X10 Magnifier increases each sweep rate by a factor of 10 and a VARIABLE control allows continuously variable sweep rates between calibrated steps. Variable hold off and alpha-numeric readouts are provided. Also, when operating in the AUTO TRIGGERING MODE, a bright baseline trace is displayed in the absence of a trigger signal.

Other features include independent sweep operation of continuously variable sweep delay (DELAY TIME) and differential sweep delay (Δ TIME) with a companion time-base unit. Delay time or differential delay time readout is displayed on the mainframe cathode-ray tube.

GENERAL INFORMATION

INTRODUCTION

OPERATORS MANUAL

The Operators Manual contains information necessary to effectively operate the 7B15 Time Base and is divided into three sections: Section 1 provides a basic description of the 7B15 with instrument specifications and accessories; section 2 contains operating information for the instrument; instrument option information is located in section 3 of the manual.

INSTRUCTION MANUAL

The Instruction Manual provides both operating and servicing information for the 7B15 Time Base. The Instruction Manual is divided into nine sections. Operating information is covered in the first two sections; servicing information for use by qualified service personnel is contained in the remaining seven sections of the manual. Schematic diagrams are located at the rear of the manual and can be unfolded for reference while reading other parts of the manual. The reference designators and symbols used on the schematics are defined on the first page of the Diagrams and Circuit Board Illustrations section. All abbreviations used in this manual, with the exception of the parts lists and schematic diagrams, comply with the American National Institute Y1.1-1972 publication. The parts lists are computer printouts and use computer-supplied abbreviations. Instrument option information is located in section 6 of the Instruction Manual.

INSTALLATION

The time-base unit is designed to operate in the horizontal plug-in compartment of the mainframe. This instrument can also be installed in a vertical plug-in compartment to provide a vertical sweep on the crt. However, when used in this manner, there are no internal triggering or retrace blanking provisions, and the unit may not meet specifications.

To install the unit in a plug-in compartment, align the upper and lower rails of the plug-in with the mainframe tracks and push it in until it fits firmly into the compartment. The front panel of the unit should be flush

with the front panel of the mainframe. Even though the gain of the mainframe is standardized, the sweep calibration of the unit should be checked when installed. The procedure for checking the unit is given under Sweep Functions in the Operators Checkout procedure in section 2.

To remove the unit, pull the release latch (see Fig. 1-1) to disengage the unit from the mainframe, and pull it out of the plug-in compartment.

INSTRUMENT PACKAGING

If this instrument is to be shipped for long distances by commercial means of transportation, it is recommended that it be repackaged in the original manner for maximum protection. The original shipping carton should be saved and used for this purpose. If more information is needed, contact your local Tektronix Field Office or representative.

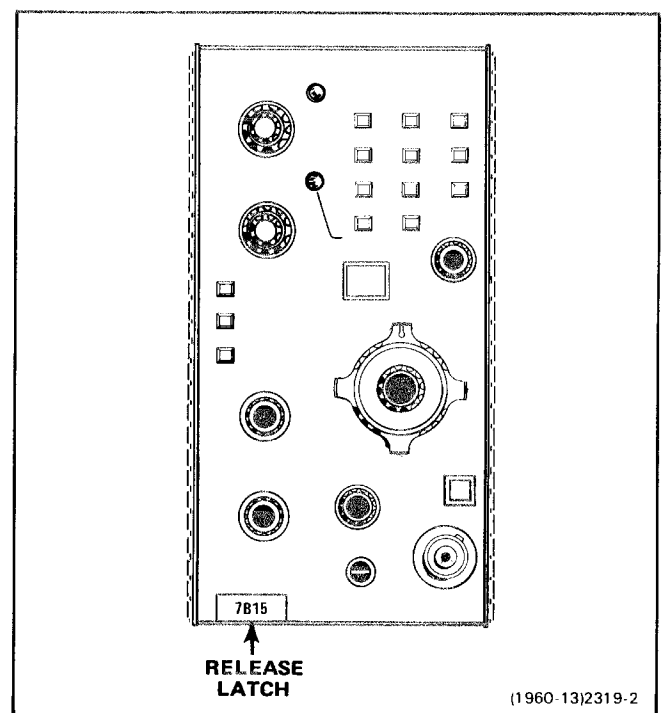


Figure 1-1. Location of release latch.

SPECIFICATION

This instrument will meet the electrical characteristics listed in Table 1-1, following complete adjustment. The following electrical characteristics are valid over the stated environmental range for instruments calibrated at an ambient temperature of +20° to +30° C, and after a twenty-minute warmup unless otherwise noted.

**TABLE 1-1
Electrical Characteristics**

Characteristics	Performance Requirement
-----------------	-------------------------

SWEEP GENERATOR

Sweep Rates		
Calibrated Range	0.2 s/div to 2 ns/div in 25 steps. X10 Magnifier extends fastest calibrated sweep rate to 0.2 ns/div.	
Variable Range	Continuously variable uncalibrated sweep rate to at least 2.5 times the calibrated sweep rate setting.	
Sweep Accuracy ¹ with 7104, 7900 and 7800 Series Mainframes	Measured over center 8 displayed divisions. SWP CAL is adjusted at 1 ms/div within the +20 to +30° C range. (7B15 Delay Mode Switch set to Independent.)	
+15 to +35° C	UNMAG	MAG X10
0.2 s/div to 10 ns/div	2%	3%
5 ns/div and 2 ns/div	3%	4% ²
0 to +50° C	Derate +15 to +35° C accuracy by additional 1%.	
Excluded Portions of Sweep		
7104	None.	
7800, 7900 Series	First 5 ns.	
Sweep Length	At least 10.2 div.	
MAG Registration	0.5 div or less from graticule center when changing from MAG X10 to MAG X1.	
Position Range		
POSITION Controls fully CW	Start of sweep must be to right of graticule center at 1 ms/div.	
POSITION Controls fully CCW	End of sweep must be left of graticule center at 1 ms/div.	

¹Some mainframes limit fastest calibrated sweep rate.

²200 ps/div is measured over any 5 divisions within the center 8 divisions.

TABLE 1-1 (CONT.)
Electrical Characteristics

Characteristics	Performance Requirement
VARIABLE TIME DELAY	
Δ TIME	
Range	0.0 to at least 9.0 times TIME/DIV setting.
Accuracy (20 ms/div to 100 ns/div)	
+15° to +35° C	Within (0.5% of Measurement + 3 digits).
0° to +50° C	Within (0.5% of Measurement + 4 digits).
TRACE SEP Range	Functional only in the Δ TIME Mode when alternating or chopping between timebase units. The second delayed sweep display can be vertically positioned at least 3 divisions below the first delayed sweep display when the mainframe vertical trace separation control is centered.
DELAY TIME	
Range	0.2 or less to at least 9.0 times TIME/DIV setting.
Jitter	
0.2 s/div to 50 μ s/div	(0.02% of TIME/DIV setting) or less
20 μ s/div to 100 ns/div	(0.03% of TIME/DIV setting + 100 ps) or less.
Absolute Delay Accuracy (Start of delayed sweep with respect to start of delaying sweep; 0° to +50° C)	
0.2 s/div to 10 μ s/div	Within (0.5% of Delay + 5% of TIME/DIV setting).
Differential Measurement Accuracy (Measurement is made by subtracting 2 delay time readings; 0.2 s/div to 100 ns/div; 0° to 50° C)	Within (0.5% of Measurement + 4 digits).

TRIGGERING

Trigger Sensitivity for Repetitive Signals	Triggering Frequency Range ³	Minimum Triggering Signal Required	
		Internal	External
Coupling			
AC	30 Hz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV
AC LF REJ ⁴	50 kHz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV
AC HF REJ	30 Hz to 30 kHz	0.5 div	50 mV
DC ⁵	Dc to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV

³The triggering frequency ranges given here are limited to the -3 dB frequency of the oscilloscope vertical system when operating in the Internal mode.

⁴Will not trigger on sine waves at or below 60 Hz when amplitudes are less than 8 divisions Internal or 3 volts External.

⁵The Triggering Frequency Range for DC COUPLING applied to frequencies above 30 Hz when operating in the AUTO TRIGGERING MODE.

**TABLE 1-1 (CONT.)
Electrical Characteristics**

Characteristics	Performance Requirement
Single Sweep	Same as for Repetitive and Pulsed Triggering.
Internal Trigger Jitter	30 ps or less at 1 GHz.
Operating in HF SYNC MODE AC, AC LF REJ, or DC	250 MHz to 1 GHz - 0.3 div Internal 75 mV External
External Trigger Input LEVEL RANGE	At least + and -3.5 V (checked on 1 kHz sine wave).
Maximum Safe Input 1-Megohm Input 50-Ohm Input	250 V (dc plus peak ac). 1 Watt average.
Input R and C 1-Megohm Input 50-Ohm Input	1 MΩ within 5%, 20 pf within 10%. 50 Ω within 2%.
Trigger Holdoff Time Minimum Holdoff Setting ⁶ 0.2 s/div to 50 ms/div 20 ms/div to 2 μs/div 1 μs/div to 2 ns/div	40 ms, or less 2 times TIME/DIV setting, or less 2.0 μs, or less
Maximum Holdoff Setting ⁶ 0.2 s/div to 50 ms/div 20 ms/div to 2 μs/div 1 μs/div to 0.5 μs/div 0.2 μs/div to 2 ns/div	400 ms, or greater 20 times TIME/DIV setting, or greater 20.0 μs, or greater 6.0 μs, or greater

⁶Performance requirement not checked in the manual.

TABLE 1-2
Environmental Characteristics

Refer to the Specification section of the associated mainframe manual.

TABLE 1-3
Physical Characteristics

Net Weight	Approximately 2.6 pounds (1.2 kilogram).
Dimensions	See Figure 1-2, dimensional drawing.

STANDARD ACCESSORIES

- 1 ea. Operators Manual
- 1 ea. Instruction Manual

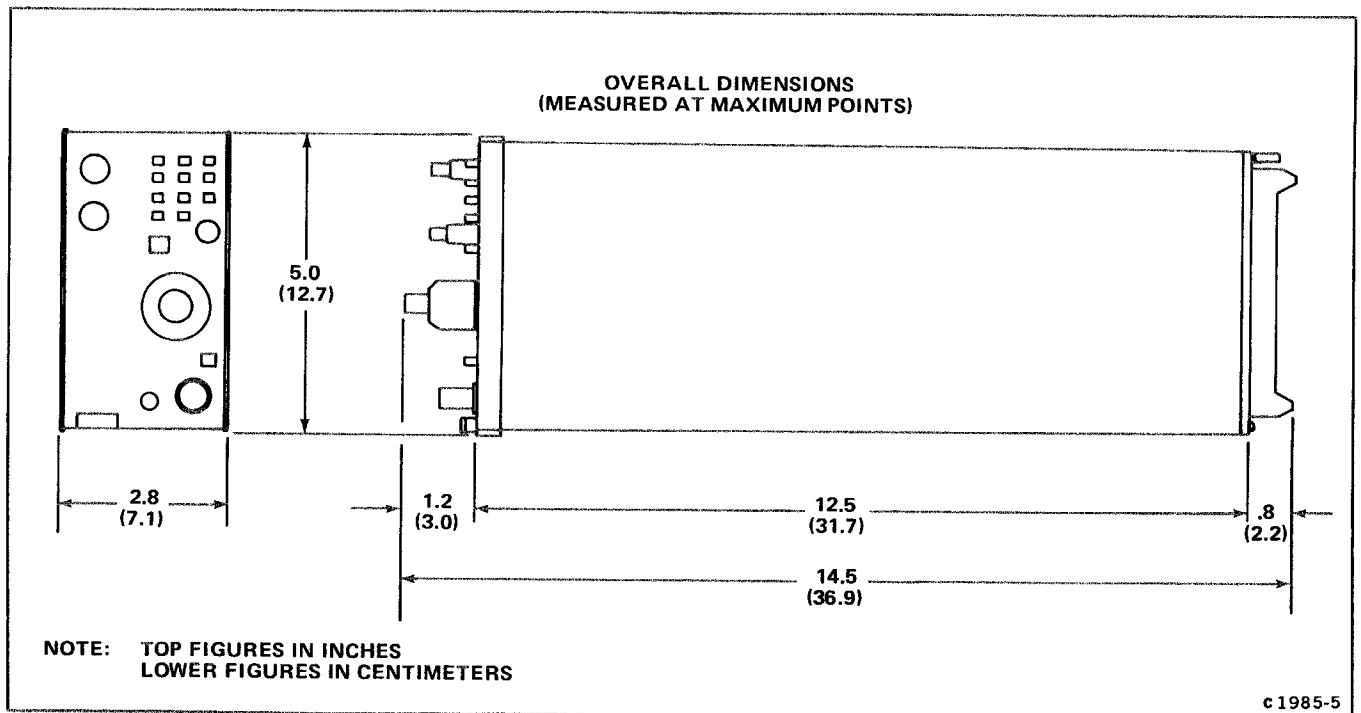


Figure 1-2. 7B15 dimensional drawing.

OPERATING INSTRUCTIONS

The 7B15 Time-Base unit operates with a Tektronix 7100-, 7700-, 7800-, or 7900-series oscilloscope mainframe and a 7A-series amplifier unit to form a complete oscilloscope system. This section describes the operation of the front-panel controls and connectors, provides detailed operating information, an operators checkout procedure, and basic applications for this instrument.

CONTROLS, CONNECTORS, AND INDICATORS

All controls, connectors, and indicators required for the operation of the time-base unit are located on the front panel. Figure 2-1 provides a brief description of all front-panel controls, connectors, and indicators. More detailed information is given in the Detailed Operating Information portion of this section.

OPERATORS CHECKOUT

The following procedures are provided for checking basic instrument functions. Refer to the description of the controls, connectors, and indicators while performing this procedure. If performing the functional check procedure reveals a malfunction or possible maladjustment, first check the operation of the associated plug-in units, then refer to the instruction manual for maintenance and adjustment procedures.

SETUP PROCEDURE

1. Install the 7B15 in the A horizontal compartment of the mainframe.
2. Install an amplifier plug-in unit in a vertical compartment.
3. Set the 7B15 controls as follows:

SLOPE	(+)
MODE	AUTO
COUPLING	AC
SOURCE	INT
B DELAY MODE.....	INDEPENDENT
TRACE SEP	OFF (fully clockwise)
POSITION	Midrange
TIME/DIV	1 ms
VARIABLE (CAL IN).....	Calibrated (Pushed in)
HOLD OFF	MIN (fully counterclockwise)
MAG	X1 (pushed in)
EXT TRIG IN	OUT 50 Ω

4. Turn on the oscilloscope and allow at least 20 minutes warmup.
5. Set the mainframe vertical and horizontal modes to display the plug-in units used and adjust the intensity and focus for a well-defined display. See the oscilloscope mainframe and amplifier unit instruction manuals for detailed operating instructions.

SWEEP FUNCTIONS

Normal Sweep

Perform the following procedure to obtain a normal sweep and to demonstrate the function of the related controls:

1. Perform the preceding Setup Procedure.
2. Connect a 0.4-volt, 1-kilohertz signal from the mainframe calibrator to the amplifier plug-in unit input.
3. Set the amplifier plug-in unit deflection factor for 4 divisions of display.
4. Adjust the LEVEL control for a stable display.
5. Turn the POSITION control and note that the trace moves horizontally.
6. Turn the FINE control and note that the display can be precisely positioned horizontally.
7. Check the display for one complete cycle per division. If necessary, adjust the front-panel SWP CAL screwdriver adjustment for one complete cycle per division over the center 8 graticule divisions. Be sure that the timing of the mainframe calibrator signal is accurate to within 0.25% (+20° to +30° C).
8. Press to release the VARIABLE (CAL IN) control. Turn the VARIABLE (CAL IN) control fully counterclockwise and note that the displayed sweep rate changes to at least the next slower TIME/DIV switch setting (i.e., 2 milliseconds/division). Press the VARIABLE (CAL IN) knob in to the calibrated position.

Magnified Sweep

Perform the following procedure to obtain a X10 magnified display and to demonstrate the function of the related controls:

1. Obtain a one cycle per division display as described in the preceding Normal Sweep procedure.
2. Press to release the MAG button (X10). Note that the unmagnified display within the center division of the graticule is magnified to about 10 divisions.
3. Press the MAG button (X1).

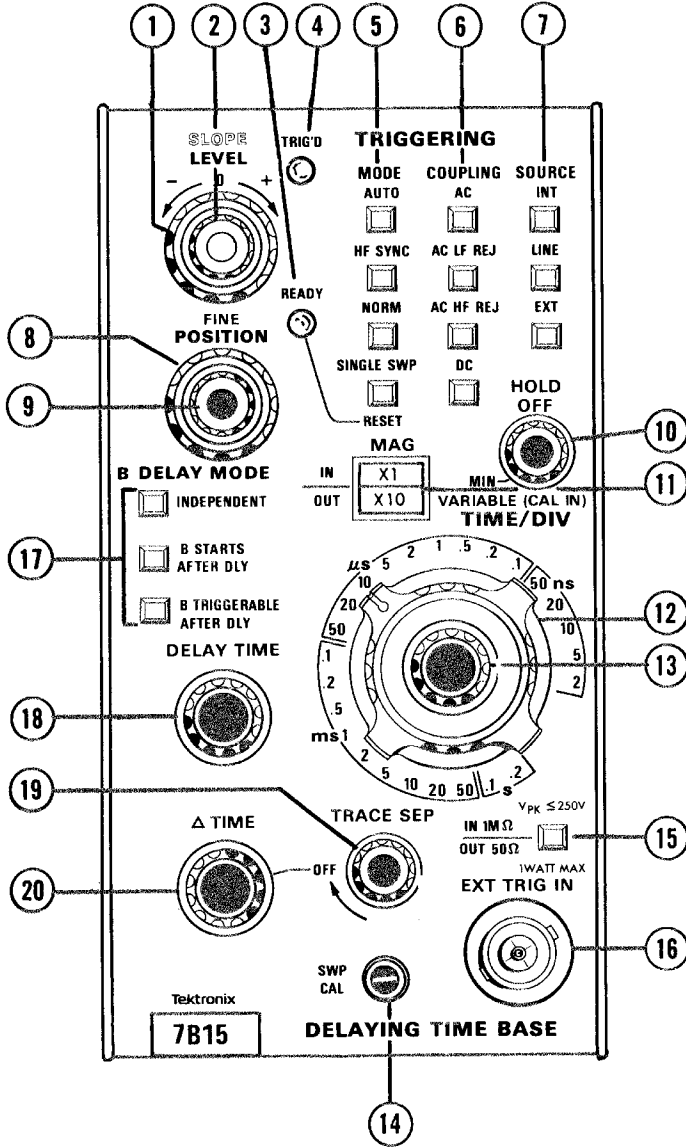


Figure 2-1. Front-panel controls, connectors and indicators.

TRIGGERING

- ① LEVEL Control—Selects a point on the trigger signal where triggering occurs.
- ② SLOPE Switch—Permits sweep to be triggered on negative- or positive-going portions of the trigger signal.
- ③ READY Indicator—Illuminates when sweep circuit is armed (SINGLE SWP MODE).
- ④ TRIG'D Indicator—Illuminates when the display is triggered.
- ⑤ MODE Pushbuttons—Selects the operating mode of the triggering circuits.
- ⑥ COUPLING Pushbuttons—Selects the method of coupling the trigger signal to triggering circuit.
- ⑦ SOURCE Pushbuttons—Selects source of the trigger signal.

SWEEP

- ⑧ POSITION Control—Provides horizontal positioning.
- ⑨ FINE Control—Provides precise horizontal positioning.
- ⑩ HOLD OFF Control—Permits hold off period to be varied to improve triggering stability of repetitive complex waveforms.
- ⑪ MAG Pushbutton—Selects X10 magnified or unmagnified sweep.
- ⑫ TIME/DIV Switch—Selects the sweep rate of the sweep generator.
- ⑬ VARIABLE Control and CAL Switch—Selects calibrated or uncalibrated sweep rates. Uncalibrated sweep rates can be continuously reduced to at least the sweep rate of the next slower position.
- ⑭ SWP CAL Adjustment—Compensates for basic timing changes due to the differences in sensitivity of mainframes in which the 7B15 may be used.

EXTERNAL TRIGGER INPUT

- ⑮ EXT TRIG Button—Selects input impedance.
- ⑯ EXT TRIG IN Connector—Connector (BNC type) provides input for external trigger signals.

SWEEP MODE

- ⑰ B DELAY MODE Pushbuttons—Selects independent or delaying sweep operation. In the B STARTS AFTER DLY and B TRIGGERABLE AFTER DLY delaying sweep modes, the DELAY TIME and Δ TIME functions are activated. There will be a 2 division vertical shift of the trace when switching from INDEPENDENT to B STARTS AFTER DLY.

DELAY TIME

- ⑱ DELAY TIME Control—Provides variable delay time before the start of the delayed sweep produced by companion time-base unit.
- ⑲ TRACE SEP Control and Switch—Enables Δ TIME functions and provides vertical separation of the delayed sweep traces (Δ TIME operation).
- ⑳ Δ TIME Control—Provides differential time measurements between 2 selected intensified zones on the delaying sweep trace. Two delayed sweep traces corresponding to the intensified zones are displayed by the companion time-base unit. Differential time is displayed on the crt readout.

2319-03

Figure 2-1 (Cont.). Front-panel controls, connectors, and indicators.

Delaying And Delayed Sweep

Perform the following procedure to obtain delaying- and delayed-sweep displays and to demonstrate the function of the related controls. To obtain a delayed-sweep display, a companion time-base unit must be installed in the B horizontal compartment of the mainframe.

1. Obtain a display as described in the preceding Normal Sweep procedure.
2. Press the B STARTS AFTER DELAY button.
3. Set the mainframe horizontal mode for chopped operation.
4. Set the companion time-base unit sweep rate for 0.1 millisecond/ division, and triggering for auto mode, ac coupling, internal source, and + slope.
5. Adjust the mainframe B sweep intensity and check for an intensified zone about 1 division wide on the delaying (A) sweep display. Also note that the delayed (B) sweep provides an expanded display of the intensified portion of the delaying (A) sweep.
6. Position the start of the delaying (A) sweep to the left edge of the graticule.
7. Adjust the DELAY TIME control for a crt readout (bottom division of crt graticule) of 5.000 ms. Check that the left edge of the intensified zone is at the graticule center line.
8. Set the 7B15 TIME/DIV switch to .5 ms and the delayed (B) sweep unit sweep rate to 20 microseconds/division.
9. Turn the DELAY TIME control fully counterclockwise to position the intensified zone near the front corner of the first square-wave cycle. Press the B TRIGGERABLE AFTER DLY button and check that the intensified zone moves to the front corner of the next displayed square wave.

Δ (Differential) Time

Perform the following procedure to obtain a Δ (differential) time display and to demonstrate the function of the related controls:

1. Obtain a delaying (A) and delayed (B) sweep display as described in steps 1 through 4 of the preceding Delaying and Delayed Sweep procedure.
2. Turn the TRACE SEP control counterclockwise out of the OFF (detent) position.
3. Set the DELAY TIME and Δ TIME controls to the fully counterclockwise position. Check for two delayed (B) sweeps and note that the crt readout (bottom right of crt) is 0.000 ms.

4. Slowly turn the Δ TIME control clockwise and note that a second intensified zone moves across the delaying (A) sweep display and the crt readout indicates the differential time between the left edge of the stationary intensified zone and the left edge of the second intensified zone. Also note that the lower delayed (B) sweep is an expanded display of the second intensified zone.

TRIGGERING FUNCTIONS

Perform the following procedure to obtain a triggered sweep and to demonstrate the functions of the related controls:

1. Obtain a display as described in the preceding Normal Sweep procedure.
2. Turn the LEVEL control fully counterclockwise to obtain a free-running sweep.
3. Slowly turn the HOLD OFF control clockwise and note that a stable display can be obtained at several positions of the HOLD OFF control. Return the HOLD OFF control to the fully counterclockwise (MIN) position.

NOTE

The HOLD OFF control varies the sweep hold-off time which effectively changes the repetition rate of the horizontal sweep signal. However, its primary function is to obtain a stable display of complex waveforms which are otherwise difficult to trigger.

4. Press the AC, AC HF REJ, and DC COUPLING buttons for both the + and - positions of the SLOPE switch and check for a stable display (LEVEL control may be adjusted, if necessary, to obtain a stable display).
5. Apply the 0.4-volt, 1 kilohertz signal from the mainframe calibrator to the amplifier plug-in unit and to the EXT TRIG IN connector.
6. Press the EXT SOURCE button and set the amplifier plug-in unit deflection factor for a 4-division display.
7. Press the AC, AC HF REJ, and DC COUPLING buttons for both the + and - positions of the SLOPE switch and check for a stable display (LEVEL control may be adjusted, if necessary, for a stable display).
8. Press the AC COUPLING, INT SOURCE, and NORM MODE buttons. Adjust the LEVEL control for a stable display.
9. Press the AUTO MODE button and adjust the LEVEL control for a free-running display.

10. Press the NORM MODE button and check for no display.
11. Adjust the LEVEL control for a stable display and press the SINGLE SWP MODE button.
12. Note that one trace occurs when the SINGLE SWP button is pressed again.
13. Disconnect the mainframe calibrator signal from the amplifier plug-in unit input and press the SINGLE SWP button. Check for no display and note that the READY indicator is lit.
14. Note that one trace occurs and that the READY indicator extinguishes when the mainframe calibrator signal is reconnected to the amplifier plug-in unit input.

DETAILED OPERATING INFORMATION

Triggering Switch Logic

The MODE, COUPLING, and SOURCE push buttons of the TRIGGERING switches are arranged in a sequence which places the most-often used position at the top of each vertical row of push buttons. With this arrangement, a stable display can usually be obtained by pressing the top push buttons: AUTO, AC, INT. When an adequate trigger signal is applied and the LEVEL control is correctly set, the unit is triggered as indicated by the illuminated TRIG'D light. If the TRIG'D light is not on, the LEVEL control is either at a setting outside the range of the trigger signal applied to this unit from the vertical unit; the trigger signal amplitude is inadequate, or its frequency is below the lower frequency limit of the AC COUPLING switch position. If the desired display is not obtained with these buttons pushed in, other selections must be made. Refer to the following discussions or the instruction manuals for the associated oscilloscope mainframe and vertical unit(s) for more information.

TRIGGERING MODES

The MODE push-button switches select the mode in which the sweep is triggered.

Auto

The AUTO MODE provides a triggered display with the correct setting of the LEVEL control whenever an adequate trigger signal is applied (see Trigger Level discussions). The TRIG'D light indicates when the display is triggered.

When the trigger repetition rate is outside the frequency range selected by the COUPLING switch or the trigger signal is inadequate, the sweep free runs at the rate indicated by the TIME/DIV switch (TRIG'D indicator off). An adequate trigger signal ends the free-running condition and a triggered display is presented. The sweep also free runs at the rate indicated by the TIME/DIV switch when the LEVEL control is at a setting outside the

amplitude range of the trigger signal. This type of free-running display is useful when it is desired to measure only the peak-to-peak amplitude of a signal without observing the waveshape (such as bandwidth measurements).

Hf Sync

The HF SYNC mode provides a triggered display with the correct setting of the LEVEL control whenever a high frequency, (100 MHz or higher) low amplitude signal is applied. This mode is most useful when the incoming signal is too small to produce stable triggering in the AUTO or NORMAL modes. The HF SYNC mode increases trigger sensitivity and provides automatic trigger amplifier centering for optimum triggering under these conditions.

Normal

The NORM MODE provides a triggered display with the correct setting of the LEVEL control whenever an adequate trigger signal is applied. The TRIG'D light indicates when the display is triggered.

The normal trigger mode must be used to produce triggered displays with trigger repetition rates below about 30 hertz. When the TRIG'D light is off, no trace is displayed.

Single Sweep

When the signal to be displayed is not repetitive or varies in amplitude, waveshape, or repetition rate, a conventional repetitive type display may produce an unstable presentation. Under these circumstances, a stable display can often be obtained by using the single-sweep feature of this unit. The single-sweep mode is also useful to photograph non-repetitive or unstable displays.

To obtain a single-sweep display of a repetitive signal, first obtain the best possible display in the NORM MODE. Then, without changing the other TRIGGERING controls, press the SINGLE SWP RESET button. A single trace is presented each time this button is pressed. Further sweeps cannot be presented until the SINGLE SWP RESET button is pressed again. If the displayed signal is a complex waveform composed of varying amplitude pulses, successive single-sweep displays may not start at the same point on the waveform. To avoid confusion due to the crt persistence, allow the display to disappear before pressing the SINGLE SWP RESET button again. At fast sweep rates, it may be difficult to view the single-sweep display. The apparent trace intensity can be increased by reducing the ambient light level or by using a viewing hood as recommended in the mainframe instruction manual.

When using the single-sweep mode to photograph waveforms, the graticule may have to be photographed separately in the normal manner to prevent over-exposing the film. Be sure the camera system is well protected against stray light, or operate the system in a

darkened room. For repetitive waveforms, press the SINGLE SWP RESET button only once for each waveform unless the signal is completely symmetrical. Otherwise, multiple waveforms may appear on the film. For random signals, the lens can be left open until the signal triggers the unit. Further information on photographic techniques is given in the appropriate camera instruction manual.

TRIGGER COUPLING

The TRIGGERING COUPLING push buttons select the method in which the trigger signal is connected to the trigger circuits. Each position permits selection or rejection of some frequency components of the signal which triggers the sweep.

Alternating Current

AC COUPLING blocks the dc component of the trigger signal. Signals with low-frequency components below about 30 hertz are attenuated. In general, AC COUPLING can be used for most applications. However, if the signal contains unwanted frequency components or if the sweep is to be triggered at a low repetition rate or dc level, one of the other COUPLING switch positions will provide a better display.

Alternating Current Low Frequency Rejection

AC LF REJ COUPLING rejects dc, and attenuates low-frequency trigger signals below about 50 kilohertz. Therefore, the sweep is triggered only by the higher-frequency components of the trigger signal. This position is particularly useful for providing stable triggering if the trigger signal contains linefrequency components. Also, the AC LF REJ position provides the best alternate-mode vertical displays at fast sweep rates when comparing two or more unrelated signals.

Alternating Current High Frequency Rejection

AC HF REJ COUPLING passes all low-frequency signals between about 30 hertz and 30 kilohertz. Dc is rejected and signals outside the above range are attenuated. When triggering from complex waveforms, this position is useful to provide a stable display of the low-frequency components.

Direct Current

DC COUPLING can be used to provide stable triggering from low-frequency signals which would be attenuated in other COUPLING switch positions. DC COUPLING can be used to trigger the sweep when the trigger signal reaches a dc level set by the LEVEL control. When using internal triggering, the setting of the vertical plug-in unit position control affects the triggering point.

TRIGGER SOURCE

The TRIGGERING SOURCE push buttons select the source of the trigger signal which is connected to the trigger circuits.

Internal

The INT position connects the trigger signal from the vertical plug-in unit. Further selection of the internal trigger signal may be provided by the vertical plug-in unit or by the mainframe; see the instruction manuals for these instruments for more information. For most applications, the internal source can be used. However, some applications require special triggering which cannot be obtained in the INT position. In such cases the LINE or EXT positions of the SOURCE switches must be used.

Line

The LINE position connects a sample of the power-line voltage from the mainframe to the trigger circuit. Line triggering is useful when the input signal is time-related (multiple or submultiple) to the line frequency. It is also useful for providing a stable display of a line-frequency component in a complex waveform.

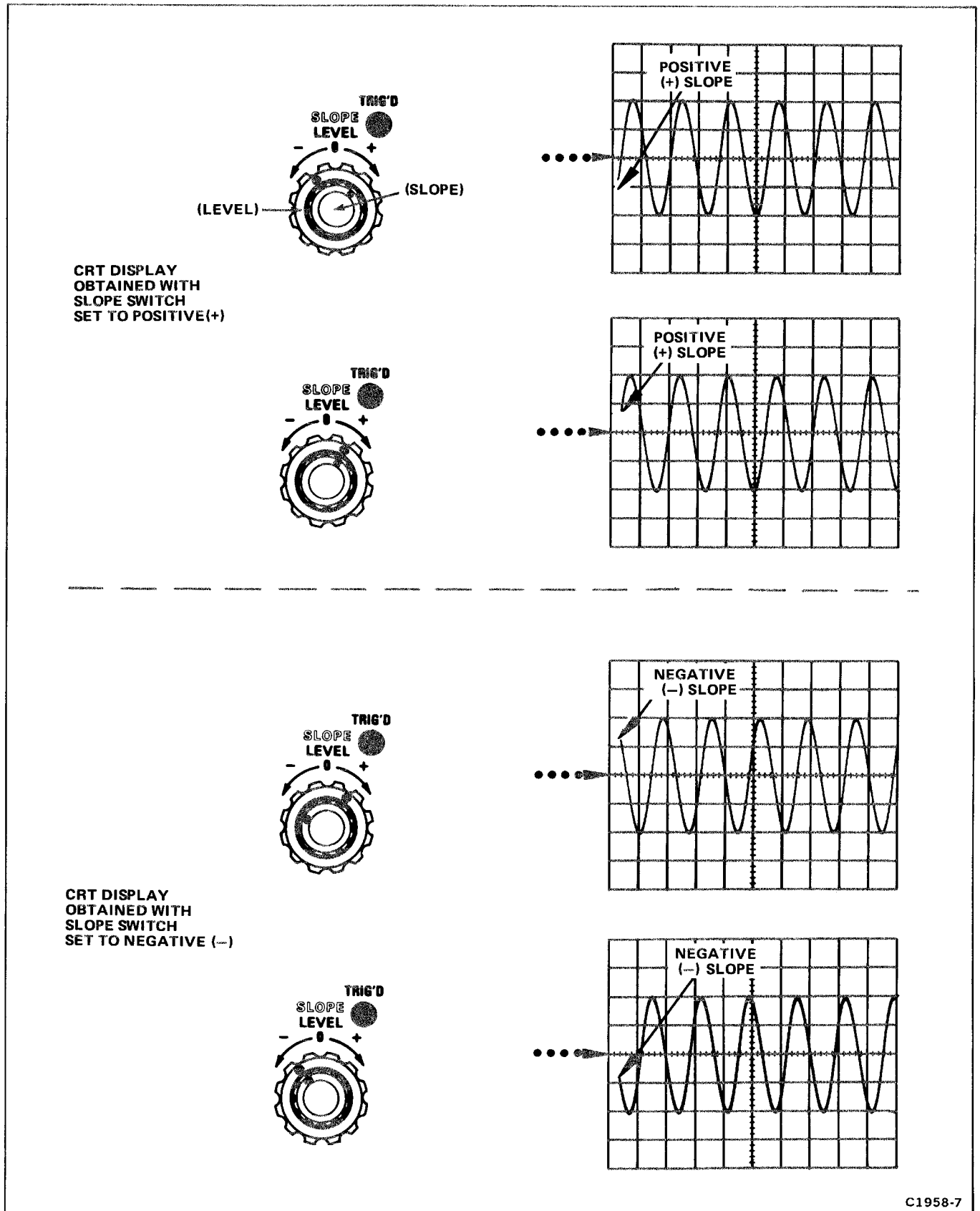
External

The EXT position connects the signal from the EXT TRIG IN connector to the trigger circuit. The external signal must be time-related to the displayed waveform for a stable display. An external trigger signal can be used to provide a triggered display when the internal signal is either too low in amplitude for correct triggering or contains signal components on which triggering is not desired. It is also useful when signal tracing in amplifiers, phase-shift networks, wave-shaping circuits, etc. The signal from a single point in the circuit can be connected to the EXT TRIG IN connector through a probe or cable. The sweep is then triggered by the same signal at all times and allows amplitude, time relationship, or waveshape changes of signals at various points in the circuit to be examined without resetting the TRIGGERING controls.

The IN 1M Ω /OUT 50 Ω push button provides a convenient means of selecting external trigger input impedance. Pushing the button in sets the amplifier input impedance to 1 M Ω and the OUT position provides 50 Ω input impedance.

TRIGGER SLOPE

The TRIGGERING SLOPE switch (concentric with the TRIGGERING LEVEL control) determines whether the trigger circuit responds on the positive- or negative-going portion of the trigger signal. When the SLOPE switch is in the (+) (positive-going) position, the display starts on the positive-going portion of the waveform (see Fig. 2-2). When several cycles of a signal appear in the display, the setting of the SLOPE switch is often unimportant. However, if only a certain portion of a cycle is to be displayed, correct setting of the SLOPE switch is important to provide a display that starts on the desired slope of the input signal.



C1958-7

Figure 2-2. Effects of LEVEL control and SLOPE switch on crt display.

TRIGGER LEVEL

The TRIGGERING LEVEL control determines the voltage level on the trigger signal at which the sweep is triggered. When the LEVEL control is set in the + region, the trigger circuit responds at a more positive point on the trigger signal. When the LEVEL control is set in the - region, the trigger circuit responds at a more negative point on the trigger signal. Figure 2-2 illustrates this effect with different settings of the SLOPE switch.

To set the LEVEL control, first set the TRIGGERING MODE, COUPLING, SOURCE, and slope. Then set the LEVEL control fully counterclockwise and rotate it clockwise until the display starts at the desired point. Less selection of the triggering level is available as the trigger signal frequency exceeds 150 megahertz.

In the HF SYNC mode, the trigger LEVEL control varies the sensitivity of the trigger generator. The LEVEL control is set to provide a stable display.

HORIZONTAL SWEEP RATES

The TIME/DIV switch provides calibrated sweep rates from 0.2 seconds/division to 2 nanoseconds/division in a 1-2-5 sequence. The VARIABLE TIME/DIV control must be in the calibrated position and the MAG switch set to X1 to obtain the sweep rate indicated by the TIME/DIV switch. However, the mainframe crt readout will display the appropriate sweep rate.

The VARIABLE TIME/DIV control includes a two-position switch to determine if the sweep rate is calibrated, or uncalibrated. When the VARIABLE control is pressed in, it is inoperative and the sweep rate is calibrated. When pressed and released outward, the VARIABLE control is activated for uncalibrated sweep rates, to at least the sweep rate of the next slower position.

A calibrated sweep rate can be obtained in any position of the VARIABLE control by pressing the VARIABLE control. This feature is particularly useful when a specific uncalibrated sweep rate has been obtained and it is desired to switch between calibrated and uncalibrated displays.

TIME MEASUREMENT

When making time measurements from the graticule, the area between the second and tenth vertical lines of the graticule provides the most linear time measurements (see Fig. 2-3). Position the start of the timing area to the second vertical line and adjust the TIME/DIV switch so the end of the timing area falls between the second and tenth vertical lines.

SWEEP MAGNIFICATION

The sweep magnifier can be used to expand the display by a factor of 10. The center division of the unmagnified display is the portion visible on the crt in the magnified

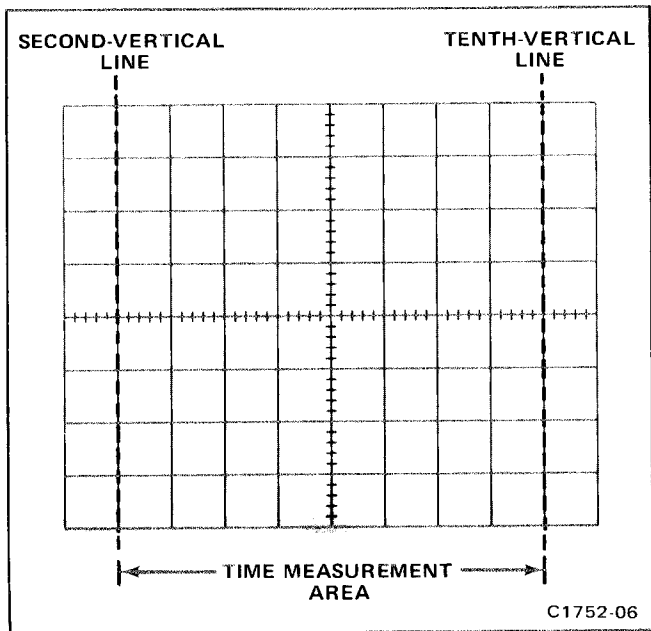


Figure 2-3. Area of graticule used for most accurate time measurements.

form (see Fig. 2-4). The equivalent length of the magnified sweep is more than 100 divisions; any 10-division portion can be viewed by adjusting the POSITION and FINE POSITION controls to bring the desired portion into the viewing area.

When the MAG switch is set to X10 (OUT), the equivalent magnified sweep rate can be determined by dividing the TIME/DIV setting by 10; the equivalent magnified sweep rate is displayed on the crt readout.

VARIABLE HOLD OFF

The HOLD OFF control improves triggering stability on repetitive complex waveforms by effectively changing the repetition rate of the horizontal sweep signal. The HOLD OFF control should normally be set to its minimum setting. When a stable display cannot be obtained with the TRIGGERING LEVEL control, the HOLD OFF control can be varied for an improved display. If a stable display cannot be obtained at any setting of the LEVEL and HOLD OFF controls, check the TRIGGERING COUPLING and SOURCE switch settings.

DELAY-TIME OPERATION

A 7B15 installed in the mainframe A horizontal compartment can delay a companion time-base unit installed in the B horizontal compartment. When operating the 7B15 in a delaying mode (B DELAY MODE switch set to B STARTS AFTER DLY or B TRIGGERABLE AFTER DLY), an intensified zone is provided on the delaying sweep display during the time that the

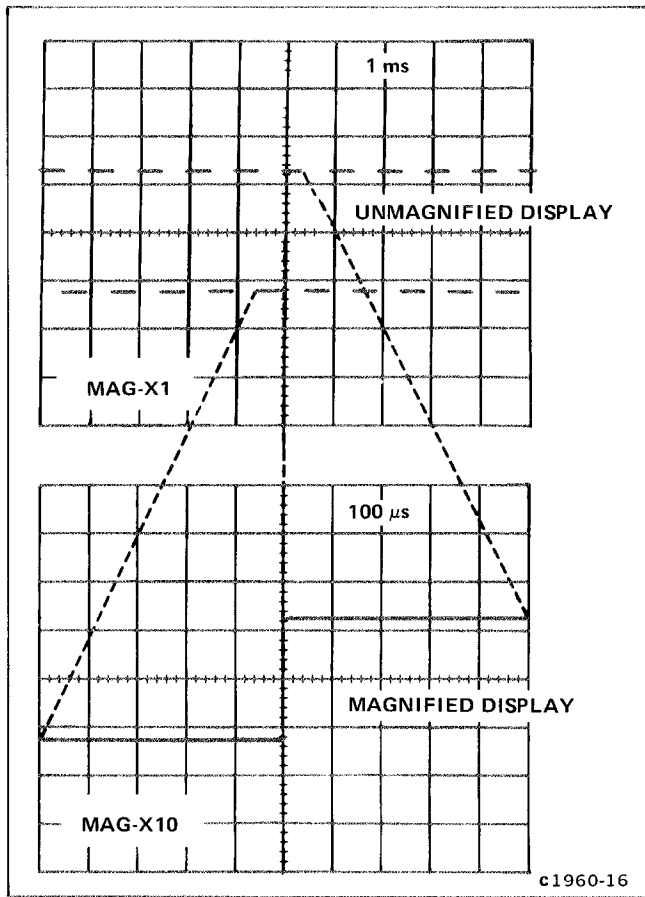


Figure 2-4. Effect of sweep magnifier on crt display.

companion time-base unit runs (see Fig. 2-5). A delayed-sweep trace is provided by the companion time-base unit, corresponding to the intensified zone on the delaying trace, at the sweep rate set by the time/div switch of the companion time-base unit (see Fig. 2-5). The delay time between the triggering event which starts the delaying-sweep trace and the start of the intensified zone (and corresponding delayed sweep), is determined by the 7B15 TIME/DIV switch and DELAY TIME control. The amount of calibrated delay time is displayed on the crt readout.

To view the delaying-sweep trace (intensified display), set the mainframe horizontal mode switch to A; to view the corresponding delayed-sweep trace, set the mainframe horizontal mode switch to B. To view the delaying trace (intensified) and the corresponding delayed-sweep trace on the same display, set the mainframe horizontal mode switch to alternate or chop.

Triggering for the delaying-sweep trace is controlled by the 7B15 TRIGGERING controls. Triggering for the intensified zone on the delaying-sweep trace and the corresponding delayed-sweep trace is controlled by the triggering controls of the companion time-base unit when the 7B15 is in the B TRIGGERABLE AFTER DLY mode.

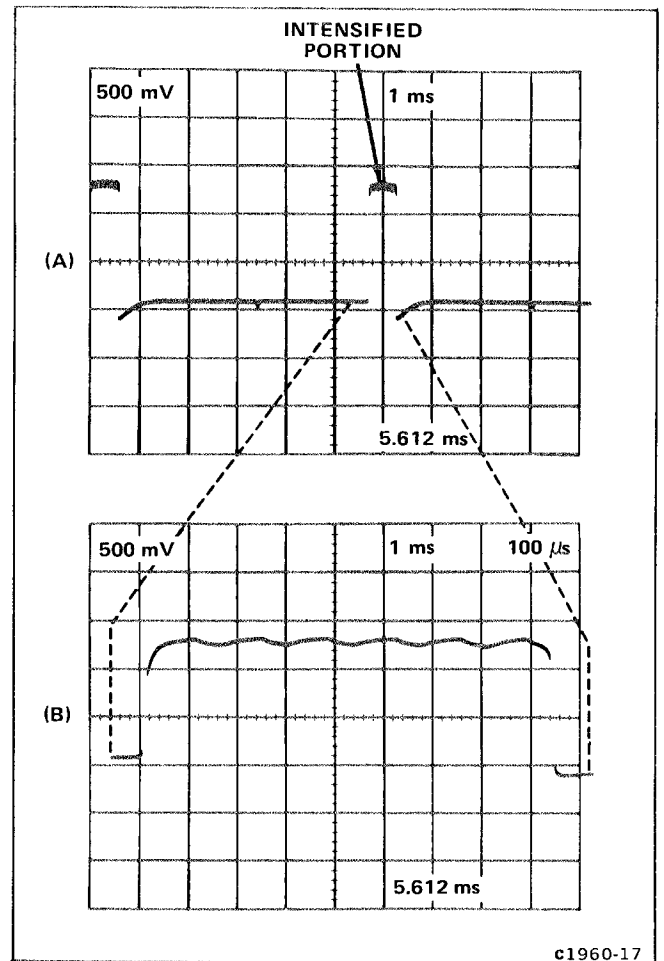


Figure 2-5. (A) Delaying-sweep display produced by 7B15 in the A horizontal compartment. (B) Delayed-sweep display produced by companion time-base unit in the B horizontal compartment.

Delay-time measurements must be made with the B DELAY MODE switch set to B STARTS AFTER DLY. When the B DELAY MODE switch is set to B TRIGGERABLE AFTER DLY, the delayed sweep starts with the first trigger pulse after the delay time shown on the crt readout. Therefore, precision time measurements cannot be made in this mode because the time delay is only partially dependent on the DELAY TIME control. The crt readout displays the greater-than symbol (>) preceding the delay time when operating in the B TRIGGERABLE AFTER DLY mode to indicate that the delay time is uncalibrated. However, the B TRIGGERABLE AFTER DLY mode is useful for triggering on waveforms with excessive jitter.

△ TIME OPERATION

The △ TIME delaying mode provides the best means of making differential time measurements. The 7B15 can delay a companion time-base unit at 2 separate delay times. At the end of the first delay time (determined by the 7B15 DELAY TIME control and TIME/DIV switch) an

intensified zone is provided on the delaying-sweep trace. Further, a separate delayed-sweep trace corresponding to the first intensified zone is provided. At the end of the second delay time (determined by the 7B15 TIME/DIV switch, the DELAY TIME, and Δ TIME controls) a second intensified zone and corresponding second delayed-sweep trace are displayed (see Fig. 2-6). The 7B15 must be installed in the A horizontal compartment. The companion time-base unit must be installed in the B horizontal compartment. The TRACE SEP control must be rotated counterclockwise out of the switch detent position for Δ TIME operation. The sweep rate for the delaying-sweep trace is determined by the 7B15 TIME/DIV switch, and the sweep rate of the intensified zones and corresponding delayed-sweep display is determined by the sweep rate setting of the companion time-base unit.

The differential time between the start of the first intensified zone and the start of the second intensified zone is displayed on the crt readout (see Fig. 2-6). A Δ symbol preceding the delay-time readout indicates a differential measurement. The > (greater than) symbol following the Δ symbol indicates that the TIME/DIV VARIABLE control is activated or that the B DELAY MODE switch is set to B TRIGGERABLE AFTER DLY and therefore the differential time is uncalibrated.

The TRACE SEP control vertically positions the second delayed-sweep trace with respect to the first delayed-sweep trace. Vertical positioning of the delayed-sweep trace is provided by the vertical separation control on the oscilloscope mainframe.

Δ Time Operation In A Dual-Beam Oscilloscope Mainframe

The 7B15 Δ TIME function is compatible with 7000-series dual-beam mainframes and operation is basically the same as given for [delta] Time Operation. The 7B15 must be installed in the A horizontal compartment and the companion time-base unit must be installed in the B horizontal compartment, as with conventional 4 plug-in compartment mainframes. Set the horizontal mode switch so that the 7B15 provides horizontal deflection for one beam and the companion time-base unit provides horizontal deflection for the other beam. Apply the input signal to the desired vertical plug-in unit and select that unit for vertical deflection of both beams.

Operation of the Δ TIME mode in dual-beam mainframes with a dedicated vertical system differs slightly from conventional dual-beam mainframes with vertical-mode switches. The plug-in unit in the left vertical compartment provides vertical deflection of beam 1 and the plug-in unit in the right vertical compartment provides vertical deflection for beam 2. Therefore, the input signal must be applied to the units in both the left and right vertical compartments for Δ TIME operation.

MAINFRAME OPERATING MODES

The 7B15 can also be operated either as an independent time base in any Tektronix 7100-, 7700-, 7800-, or 7900-series mainframes, or as a delayed-sweep unit (B DELAY MODE switch set to INDEPENDENT) in those mainframes that have two horizontal compartments. A companion delaying time-base unit (e.g., another 7B15) is required for delayed-sweep operation. Refer to Applications in this section for additional information.

APPLICATIONS

The 7B15 is designed primarily for use with a companion time-base unit in a readout-equipped mainframe to make delayed-sweep time-interval measurements. The 7B15 can also be used as an independent non-delaying time base. The following procedures provide instructions for making several delayed-sweep time-interval measurements using the delay-time and Δ (differential) time modes. These procedures provide enough detail to enable the operator to adapt them to other related time-interval measurements. Contact your Tektronix Field Office or representative for assistance in making measurements not described in this manual.

DELAYED-SWEEP MEASUREMENTS

Complex signals often consist of a number of individual events of differing amplitudes. Since the trigger circuits are sensitive only to changes in signal amplitude, a stable display can normally be obtained only when the sweep is triggered by the event(s) having the greatest amplitude. However, this may not produce the desired display of a lower amplitude portion which follows the triggering event. The delayed-sweep feature provides a means of delaying the start of the delayed sweep by a selected amount following the event which triggers the sweep generator. Then, the part of the waveform which contains the information of interest can be displayed at the delayed-sweep rate with a higher apparent magnification than is provided by the MAG switch.

The delayed-sweep feature can also be used to provide rapid and accurate time-interval measurements from a triggering event (i.e., the start of the delaying sweep) to a selected point or between two selected points on a displayed waveform. See General Operating Information in this section for a further discussion of delay-time operation.

In the delay-time mode, the delayed (B) sweep runs for a selected interval after the delaying (A) sweep as indicated by an intensified zone superimposed on the delaying (A) sweep trace. The length of the intensified zone indicates the time that the delayed sweep runs and is determined by the delayed (B) sweep plug-in unit sweep rate (TIME/DIV setting). The time from the start of the delaying (A) sweep to the start of the intensified zone (i.e., the start of the delayed sweep) can be read directly on the crt readout.

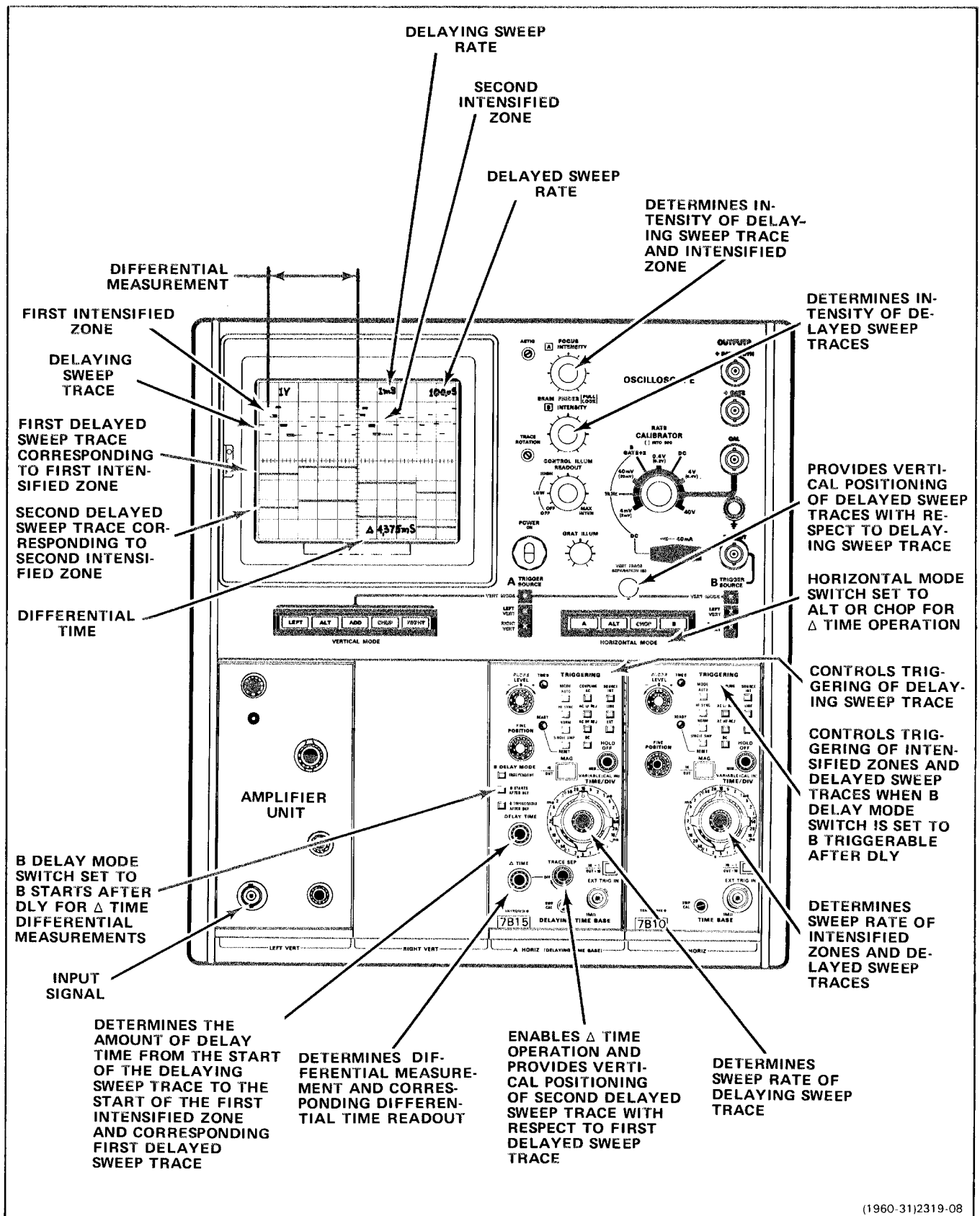


Figure 2-6. Typical Δ (Differential) Time Operation.

(1960-31)2319-08

Operating Instructions—7B15

In the Δ (differential) time mode, the delayed (B) sweep runs for a second selected interval indicated by a second intensified zone superimposed on the delaying (A) sweep trace. The two intensified zones can be positioned with the DELAY TIME and Δ TIME controls. The crt readout then indicates the differential (Δ) time from the start of the first to the start of the second intensified zones.

By selecting the mainframe alternate or chopped horizontal operation, the delaying (A) sweep and either the first delayed (B) sweep interval (delay-time mode) or both delayed (B) sweep intervals (Δ time mode) can be displayed simultaneously. Since the delayed (B) sweep(s) can be displayed at a higher magnification than is available with the MAG switch, more precise selection of time intervals is possible.

The following procedures provide instructions for making several types of time-interval measurements in the delay-time and delta (differential) time modes.

TIME-INTERVAL MEASUREMENTS (DELAY-TIME MODE)

Perform the following procedure to measure the time from a triggering event (start of sweep) to any point on a displayed waveform:

1. Install the 7B15 in the mainframe A horizontal compartment and a companion time-base unit in the B horizontal compartment.

2. Set the 7B15 controls as follows:

B DELAY MODE..... B STARTS AFTER DLY
 (button in)
 MAG..... X1 (button in)
 HOLD OFF..... MIN (fully counterclockwise)
 TRACE SEP..... OFF (fully clockwise)
 VARIABLE TIME/DIV..... CALIBRATED (knob in)

3. Connect the signal to be measured to the vertical plug-in unit input.

4. Set the mainframe for the A horizontal mode to display the 7B15, and the vertical mode to display the vertical plug-in unit.

5. Set the TRIGGERING controls for a stable display (see General Operating Information in this section for selecting proper triggering).

6. Set the vertical deflection factor and 7B15 sweep rate for the desired display. See the example in Figure 2-7.

7. Set the delayed (B) unit sweep rate for about a 0.5 division intensified zone.

8. Rotate the DELAY TIME control to position the leading edge of the intensified zone at the point on the displayed waveform where the desired time interval ends.

9. Read the time interval from the start of the sweep to the leading edge of the intensified zone directly on the crt readout (see Figure 2-7).

DIFFERENTIAL TIME-INTERVAL MEASUREMENTS (DELTA TIME MODE)

Perform the following procedure to measure the time-interval between any two selected points on a waveform. This procedure can be used to measure the rise time, fall time, period, frequency, or pulse width of a displayed waveform.

1. Install the 7B15 in the mainframe A horizontal compartment and a companion time-base unit in the B horizontal compartment.

2. Set the 7B15 controls as follows:

B DELAY MODE..... B STARTS AFTER DLY
 (button in)
 MAG..... X1 (button in)
 HOLD OFF..... MIN (fully counterclockwise)
 TRACE SEP..... OFF (fully clockwise)
 VARIABLE TIME/DIV..... Calibrated (knob in)

3. Connect the signal to be measured to the vertical plug-in unit input.

4. Set the mainframe for the A horizontal mode to display the 7B15 and the vertical mode to display the vertical plug-in unit.

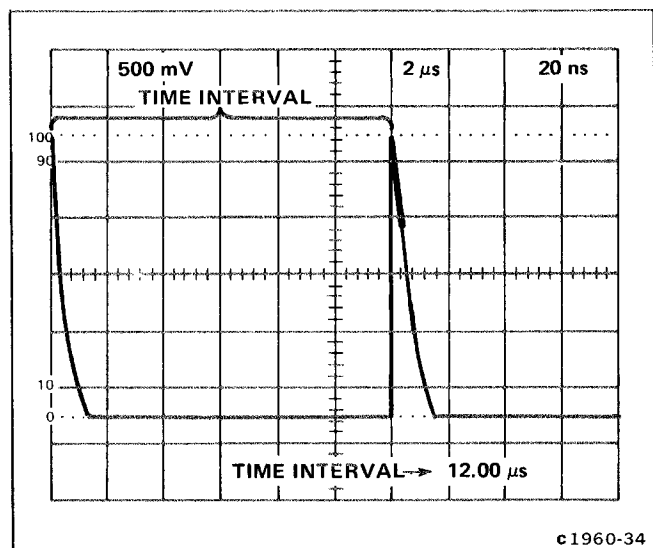


Figure 2-27. Measuring time intervals from a triggering event (start of sweep) to any point on a waveform.

5. Set the TRIGGERING controls for a stable display (see General Operating Information in this section for selection of proper triggering).

6. Set the appropriate triggering, position, deflection-factor, and sweep-rate controls to obtain the desired display. See the examples in Figure 2-8.

7. Adjust the DELAY TIME control to position the leading edge of the first intensified zone to the beginning of the time interval to be measured (see Fig. 2-8, point A).

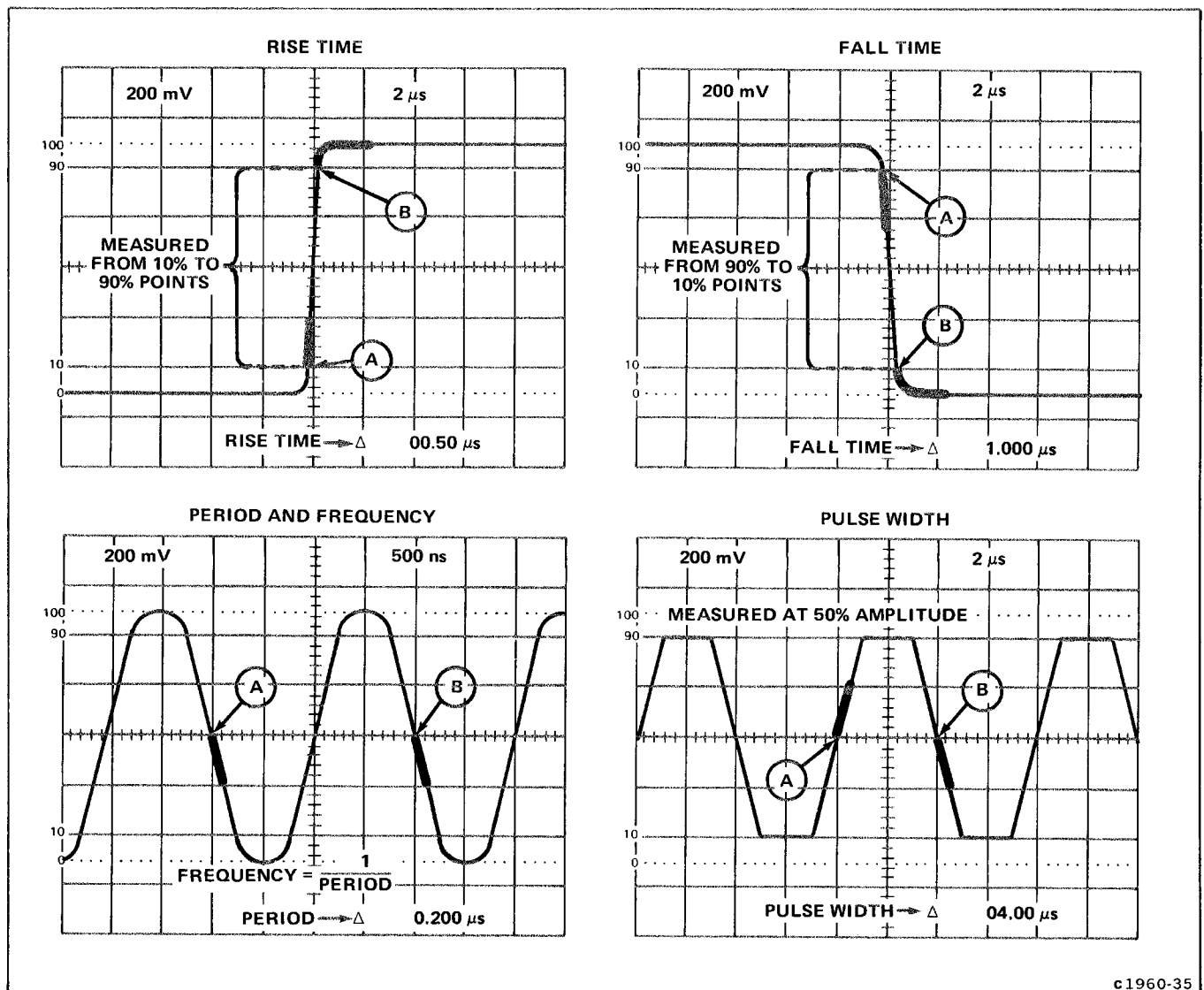
8. Turn the TRACE SEP control counterclockwise just out of the OFF (detent) position to obtain a second intensified zone (delta time mode) on the display.

9. Adjust the Δ TIME control to position the leading edge of the second intensified zone to the end of the time interval to be measured (see Fig. 2-8, point B).

10. Read the time interval between the intensified zones directly from the crt readout.

NOTE

For more accurate time-interval measurements with a dual-trace magnified display, refer to the Delayed-Sweep Magnification procedure.



c1960-35

Figure 2-8. Measuring risetime, fall time, period, frequency, or pulse width in the Δ (differential) time mode.

DELAYED-SWEEP MAGNIFICATION

By selecting the mainframe alternate or chopped horizontal mode, a dual-trace display of both the delaying (A) sweep and the delayed (B) sweep can be obtained. In the delay-time mode (i.e., TRACE SEP control in the OFF position), the delayed (B) sweep appears as a magnified display of the single intensified portion on the delaying (A) sweep trace. In the delta (differential) time mode (i.e., TRACE SEP control rotated counterclockwise out of the OFF position), the delayed (B) sweep appears as a dual magnified display of both intensified portions of the delaying (A) sweep trace. The dual-delayed (B) sweep displays can be superimposed or separated by rotating the TRACE SEP control.

The following procedures use alternate or chopped horizontal (dual-trace) operation to: Magnify a selected segment of the delaying (A) sweep and determine apparent magnification in the delay-time mode, (2) make more accurate time-interval measurements in the delay-time and Δ (differential) time modes, and (3) examine an event that occurs within a selected time interval after a known delay time in the delay-time mode.

1. Install the 7B15 in the mainframe A horizontal compartment and a companion time-base unit in the B horizontal compartment.

2. Set the 7B15 controls as follows:

- B DELAY MODE..... B STARTS AFTER DLY
(button in)
- MAG.....X1 (button in)
- HOLD OFF.....MIN (fully counterclockwise)
- VARIABLE TIME/DIV.....Calibrated (knob in)
- TRACE SEP.....OFF (fully clockwise)

3. Connect the signal to be measured to the vertical unit input.

4. Set the mainframe horizontal mode for alternate or chopped operation (see oscilloscope mainframe instruction manual for discussion of alternate or chopped operation).

5. To magnify a selected segment of the delaying (A) sweep waveform and determine apparent magnification in the delay-time mode:

- a. Perform the procedure in step 1 through 4.
- b. Set the appropriate triggering, position, deflection-factor, and sweep-rate controls for the desired dual-trace display. See the example in Figure 2-9.

NOTE

If there is excessive jitter in the delayed (B) sweep display, refer to the Triggered Delayed Sweep Magnification discussion.

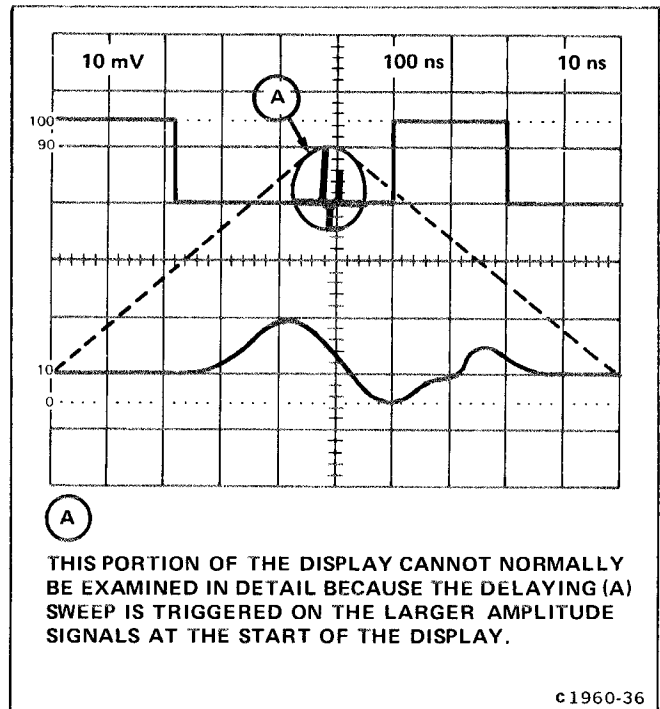


Figure 2-9. Magnifying a selected segment of the delaying (A) sweep in the delay-time mode with mainframe alternate or chopped horizontal operation.

c. Turn the DELAY TIME control to position the intensified zone to the portion of the delaying (A) sweep waveform to be magnified.

d. Set the delayed (B) sweep unit sweep rate to select the desired duration of the magnified display as indicated by the length of the intensified zone.

e. Observe the magnified display on the delayed (B) sweep. See Figure 2-9.

NOTE

For a better look at the delayed (B) sweep waveform, set the mainframe to the B horizontal mode and the amplifier plug-in unit deflection factor to increase the display amplitude. Do not change the 7B15 TIME/DIV setting.

f. Determine apparent magnification by dividing the 7B15 TIME/DIV setting by the delayed (B) sweep unit sweep-rate setting.

Example: The apparent magnification of the delayed (B) sweep shown in Figure 2-9 with a 7B15 TIME/DIV setting of .1 millisecond and a delayed (B) sweep unit sweep-rate setting of 1 microsecond is:

$$\text{Apparent Magnification} = \frac{\text{7B15 TIME/DIV setting}}{\text{(B) Sweep Time/Div setting}}$$

Substituting values:

$$\text{Apparent Magnification} = \frac{1 \times 10^4}{1 \times 10^6} = 100$$

The apparent magnification of the delayed (B) sweep display is 100 times the delaying (A) sweep display.

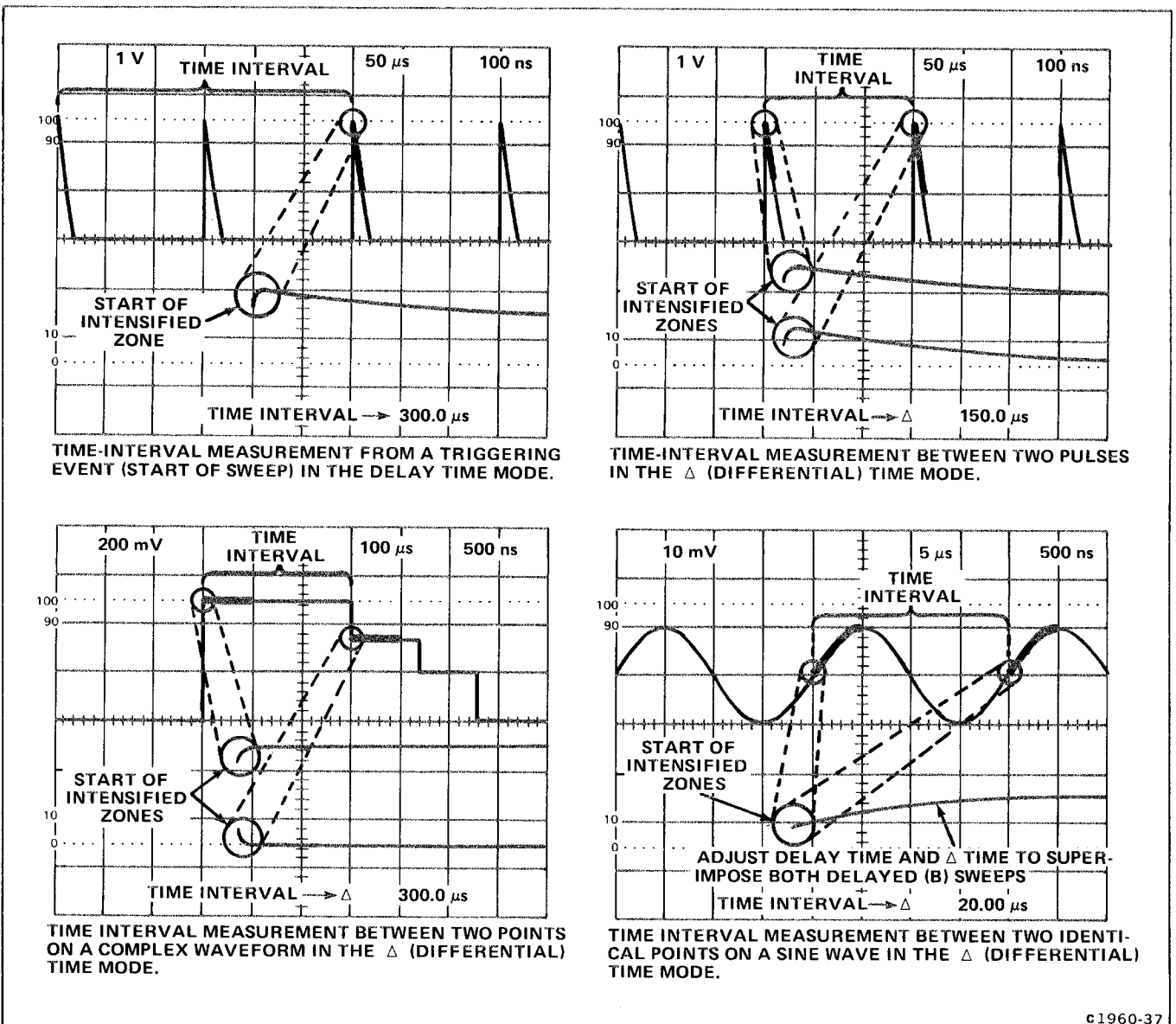
6. To make more accurate time interval measurements in the delay-time or Δ (differential) time mode:

a. Perform the procedures in steps 1 through 4.

NOTE

The remaining steps of this procedure apply for both delay-time and Δ (differential) time measurements. For Δ (differential) time operation, the 7B15 TRACE SEP control must be turned counterclockwise out of the OFF (detent) position. The Δ TIME control then positions the second intensified zone and the DELAY TIME control positions the first intensified zone. Parentheses are used to indicate the instructions that apply only to Δ (differential) time operation.

b. Set the appropriate triggering, position, deflection factor, and sweep-rate controls for the desired dual-trace display. See the examples in Figure 2-10.



c1960-37

Figure 2-10. Time-interval measurements in the delay-time and Δ (differential) time mode with mainframe alternate or chopped operation.

NOTE

If there is excessive jitter in the delayed (B) sweep display, refer to the Triggered Delayed Sweep Magnification discussion.

- c. Turn the DELAY TIME (and delta TIME) control(s) to position the intensified zone(s) for the precise time interval to be measured using the magnified delayed (B) sweep waveform(s). See the examples in Figure 2-10.

NOTE

For a better look at the delayed (B) sweep waveform, set the mainframe to the B horizontal mode and the amplifier-unit deflection-factor to increase the display amplitude. Do not change the 7B15 TIME/DIV setting.

- d. Read the desired time interval directly on the crt readout.

7. To examine an event that occurs within a selected time interval after a known delay time in the delay-time mode:

- a. Perform the procedures in steps 1 through 4.
- b. Set the appropriate triggering, position, deflection-factor, and sweep-rate controls for the desired dual-trace display. See the example in Figure 2-11.

NOTE

If there is excessive jitter in the delayed (B) sweep display, refer to the Triggered Delayed Sweep Magnification discussion.

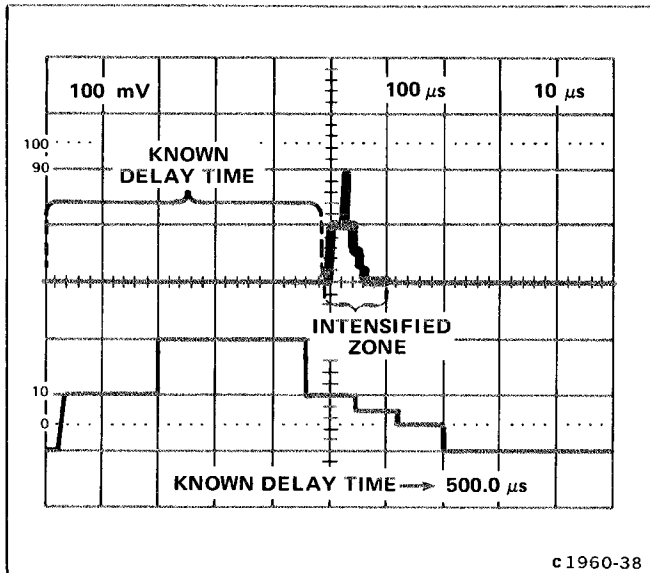


Figure 2-11. Examining an event that occurs within a selected time interval after a known delay time in the delay-time mode.

- c. Adjust the DELAY TIME control for the known delay time as indicated on the crt readout.

- d. Set the delayed (B) sweep rate (i.e., the intensified zone length) for the desired time interval after the delay time selected in part c. Multiply the delayed (B) sweep rate by 10 to determine the actual displayed delayed (B) sweep time interval. See the example in Figure 2-11.

- e. Observe the magnified event to be examined on the delayed (B) sweep.

NOTE

For a better look at the delayed (B) sweep waveform, set the mainframe to the B horizontal mode and the amplifier plug-in unit deflection-factor to increase the display amplitude. Do not change the 7B15 TIME/DIV setting.

TRIGGERED DELAYED-SWEEP MAGNIFICATION

The displayed waveform may have excessive jitter at the faster delayed (B) sweep-rate settings. The B TRIGGERABLE AFTER DLY position (button in) of the B DELAY MODE switch provides a more stable display, since the delayed (B) sweep display is then triggered at the same point each time. The crt readout is uncalibrated in this mode as indicated by the > symbol.

Inability to obtain the intensified zone(s) on the delaying (A) sweep display indicates that the delayed (B) sweep triggering controls are incorrectly set, or that the input signal does not meet triggering requirements. If the condition cannot be corrected with the triggering controls, or by increasing the display amplitude, externally trigger the delayed (B) sweep.

INDEPENDENT TIME-INTERVAL MEASUREMENTS

The 7B15 is designed primarily for use with a companion time-base unit in 7100-, 7700-, 7800-, or 7900-series oscilloscope mainframes with two horizontal compartments and crt readout. However, the 7B15 can also be used as an independent nondelaying time base (e.g., in a compatible mainframe with one horizontal compartment). To operate the 7B15 as an independent time base for time-interval measurements, press the INDEPENDENT button and obtain the desired display as described in step 2 through 6 of the Time-Interval Measurements (Delay-Time Mode) procedure. Measure time intervals by multiplying the horizontal distance, in divisions, between the desired measurement points times the TIME/DIV switch setting.

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.

THEORY OF OPERATION

This section of the manual describes the circuitry in the 7B15 Delaying Time-Base unit. The description begins with a discussion of the instrument, using the block diagram shown in Figure 3-1. The circuit diagrams at the rear of this manual are blocked off according to circuit

function. These circuit block titles serve as indexes to the circuit discussion. Refer to the appropriate diagram along with the Troubleshooting Chart in the Diagrams and Circuit Board Illustrations when reading this discussion.

BLOCK DIAGRAM DESCRIPTION

The following discussion is provided to aid in understanding the overall concept of the 7B15 before the individual circuits are discussed in detail. A basic block diagram is shown in Figure 3-1. The numbered diamond in each block refers to the corresponding circuit diagram at the rear of this manual.

TRIGGER GENERATOR

The Trigger Generator ensures a stable crt display by starting each sweep at the same point on the waveform. Circuitry is included for selection of trigger mode, coupling, and source. The output of the Trigger Generator is a fast-rise gate which enables the Sweep Generator.

SWEEP GENERATOR

The sweep sawtooth signal is initiated when the Trigger Generator output is applied to the Sweep Generator. The rate of change (slope) of the sawtooth signal is determined by the TIME/DIV switch setting. The sawtooth signal provides horizontal deflection for the mainframe (oscilloscope) and is used by the Pickoff Amplifiers and the Delay Gate Generator in the 7B15. The Sweep Generator also generates a Sweep Gate pulse which unblanks the crt in the mainframe.

PICKOFF COMPARATORS AND DELAY GATE GENERATOR

The Pickoff Comparators and Delay Gate Generator circuits produce a delay gate when the sawtooth signal from the sweep generator reaches the level set by the DELAY TIME and Δ TIME controls. The DELAY TIME control determines the pickoff point for the first intensified zone and the Δ TIME control determines the pickoff point for the second intensified zone. The Delay Gate signal enables the companion delayed time-base unit.

LOGIC

The Logic circuit determines the sweep mode (B DELAY MODE) of the 7B15. The 7B15 can operate either independently or delay a companion delayed sweep time-base unit. The Logic circuit also determines the trigger mode and generates control signals for use by the mainframe (e.g., hold off, auxiliary Y-axis, etc.).

DIGITAL VOLTMETER

The Digital Voltmeter circuit converts the selected dc pickoff levels (from the Pickoff Comparators) to a calibrated delay-time readout on the crt. When operating in the DELAY TIME mode, the time before the start of the first intensified zone is displayed on the crt readout; when operating in the Δ TIME mode, the differential time between the start of the first intensified zone and the second intensified zone is displayed.

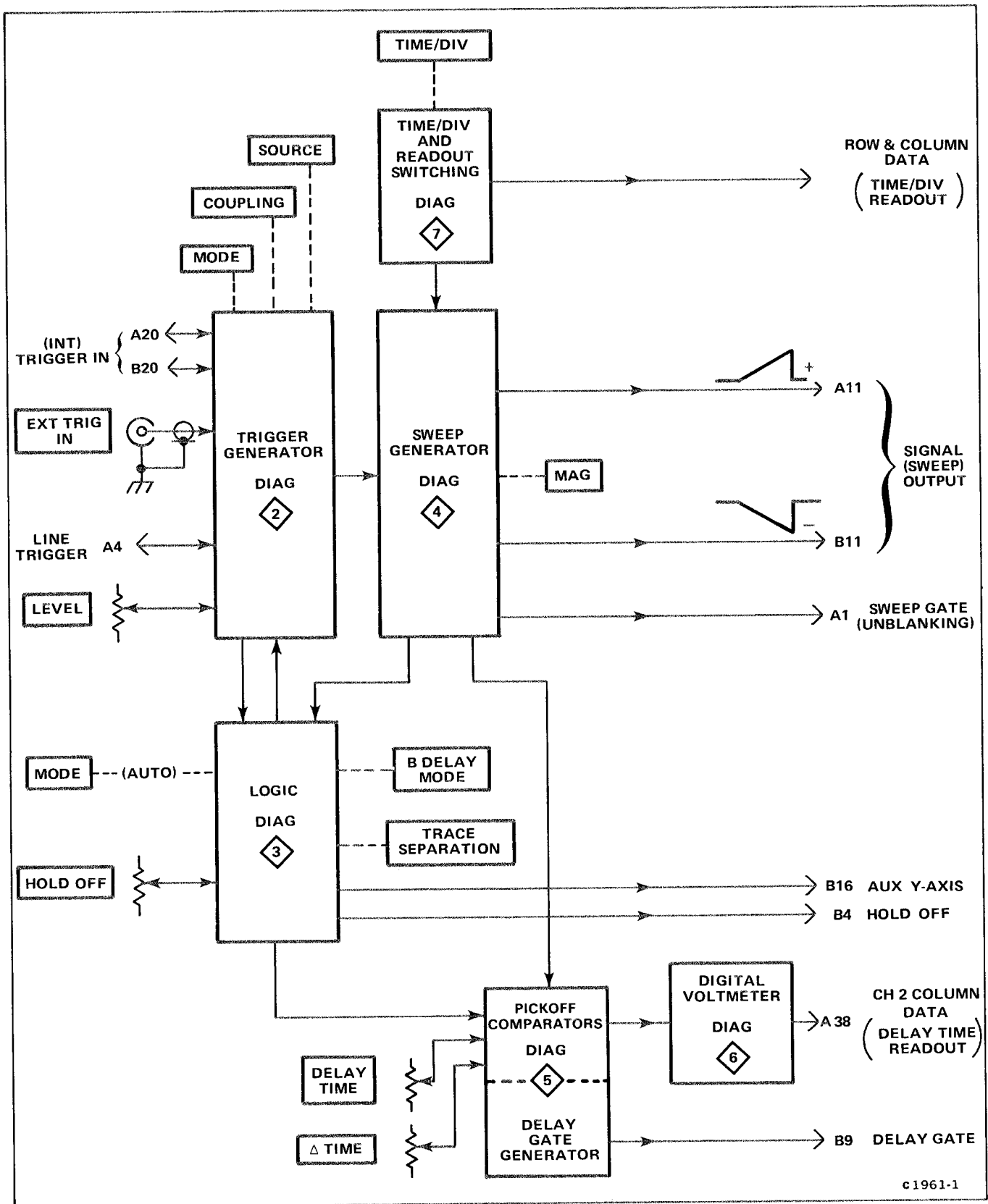


Figure 3-1. Basic block diagram of the 7B15 Delaying Time Base unit.

DETAILED CIRCUIT DESCRIPTION

The operation of circuits unique to this instrument is described in detail in this discussion. Circuits commonly used in the electronics industry are not described in detail.

The following circuit analysis, with supporting illustrations, gives the names of individual stages, and shows how they are connected to form major circuits. These illustrations show the inputs and outputs for each circuit and the relationship of the front-panel controls to the individual stages. The detailed circuit diagrams from which the illustrations are derived are shown in the diagrams foldout section.

LOGIC FUNDAMENTALS

Digital logic techniques are used to perform many functions within this instrument. The function and operation of the logic circuits are described using logic symbology and terminology. This portion of the manual is provided as an aid in the understanding of these symbols and logic concepts, not a comprehensive discussion of the subject.

SYMBOLS

The symbols used to describe digital circuits in this instrument are based on ANSI standard Y32.14-1973. Table 3-1 provides a basic reference for the logic devices used within this instrument. Any deviations from the standard symbology, or devices not defined by the standard, are described in the circuit description for the applicable device.

NOTE

Logic symbols used on the diagrams depict the logic function as used in this instrument, and may differ from the manufacturer's data.

LOGIC POLARITY

All logic functions are described using the positive logic convention. Positive logic is a system of notation where the more positive of two levels (HI) is called the true or 1-state; the more negative level (LO) is called the false or 0-state. The HI-LO method of notation is used in this description. The specific voltages that constitute a HI or LO state may vary between individual devices. Whenever possible, the input and output lines are named to indicate the function performed when at the HI (true) state.

INPUT/OUTPUT TABLES

Input/Output (truth) tables are used to show the input combinations important to a particular function, along with the resultant output conditions. This table may be

given either for an individual device or for a complete logic stage. For examples of input/output tables for individual devices, see Table 3-1.

NON-DIGITAL DEVICES

Not all of the integrated circuits in this instrument are digital logic devices. The function of the nondigital devices is described individually, using operating waveforms or other techniques to illustrate the function.



FRONT-PANEL WIRING

The Front-Panel Wiring diagram shows the interconnections between front-panel functions (controls, connectors, and indicators) and circuit boards within this instrument.



TRIGGER GENERATOR

The Trigger Generator provides a stable display by starting the Sweep Generator (diagram 4) at a selected point on the input waveform. The triggering point can be varied by the LEVEL control and may be on either the positive or negative slope of the waveform. The triggering signal source may be from either the signal being displayed (INT), a signal from an external source (EXT), or a sample of the power-line voltage (LINE).

EXTERNAL TRIGGER AMPLIFIER

The external trigger signal is connected to the Trigger Generator through EXT TRIG IN connector J90. Push-button switch S90 selects either 1 MΩ or 50Ω input impedance. The 0.2 ampere fuse protects the 50 Ω load from signal overload.

Pushing in the EXT push button of SOURCE switch (S50) allows external trigger signals to pass from the External Trigger Amplifier to U124 for amplification. Field-effect transistor Q98 conducts in the DC COUPLING mode only and Q108 is on in all coupling modes except AC LF REJ. Components U110, Q114, and Q118 compose an operational amplifier whose gain is approximately 1/4 determined by feedback resistors R73 and R74. Integrated circuit U110 provides dc stability. Diodes CR74, CR76, and CR77 protect the trigger amplifier from possible overload caused by high amplitude external signals. A portion of the dc leveling voltage from R67 is applied to U110 to provide additional level range in the EXT triggering mode. Pressing the INT button causes Q118 to saturate which interrupts signal flow to U124 and also disables the Ext In amplifier of U124.

TABLE 3-1
Basic Logic Reference

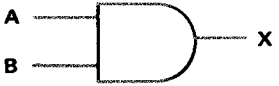




Device	Symbol	Description	Input/Output Table																		
AND gate		A device with two or more inputs and one output. The output of the AND gate is HI if and only if all of the inputs are at the HI state.	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>HI</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	LO	LO	HI	LO	HI	LO	LO	HI	HI	HI
Input		Output																			
A	B	X																			
LO	LO	LO																			
LO	HI	LO																			
HI	LO	LO																			
HI	HI	HI																			
NAND gate		A device with two or more inputs and one output. The output of the NAND gate is LO if and only if all of the inputs are at the HI state.	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>LO</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	HI	LO	HI	HI	HI	LO	HI	HI	HI	LO
Input		Output																			
A	B	X																			
LO	LO	HI																			
LO	HI	HI																			
HI	LO	HI																			
HI	HI	LO																			
OR gate		A device with two or more inputs and one output. The output of the OR gate is HI if one or more of the inputs are at the HI state.	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>HI</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	LO	LO	HI	HI	HI	LO	HI	HI	HI	HI
Input		Output																			
A	B	X																			
LO	LO	LO																			
LO	HI	HI																			
HI	LO	HI																			
HI	HI	HI																			
NOR gate		A device with two or more inputs and one output. The output of the NOR gate is LO if one or more of the inputs are at the HI state.	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>LO</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	HI	LO	HI	LO	HI	LO	LO	HI	HI	LO
Input		Output																			
A	B	X																			
LO	LO	HI																			
LO	HI	LO																			
HI	LO	LO																			
HI	HI	LO																			
Inverter		A device with one input and one output. The output state is always opposite to the input state.	<table border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> </tr> </tbody> </table>	Input	Output	A	X	LO	HI	HI	LO										
Input	Output																				
A	X																				
LO	HI																				
HI	LO																				

TABLE 3-1 (CONT.)

Basic Logic Reference


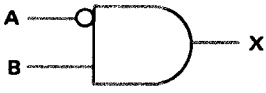
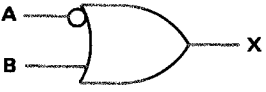
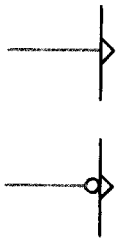
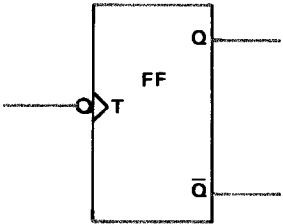
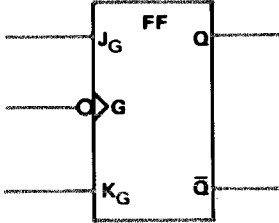
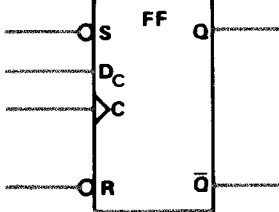
Device	Symbol	Description	Input/Output Table																				
LO-state indicator		<p>A small circle at the input or output of a symbol indicates that the LO state is the significant state. Absence of the circle indicates that the HI state is the significant state. Two examples follow:</p>																					
		<p>AND gate with LO-state indicator at the A input.</p> <p>The output of this gate is HI if and only if the A input is LO and the B input is HI.</p>	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>LO</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	LO	LO	HI	HI	HI	LO	LO	HI	HI	LO		
Input		Output																					
A	B	X																					
LO	LO	LO																					
LO	HI	HI																					
HI	LO	LO																					
HI	HI	LO																					
		<p>OR gate with LO-state indicator at the A input:</p> <p>The output of this gate is HI if either the A input is LO or the B input is HI.</p>	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th>Output</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>HI</td> <td>HI</td> </tr> </tbody> </table>	Input		Output	A	B	X	LO	LO	HI	LO	HI	HI	HI	LO	LO	HI	HI	HI		
Input		Output																					
A	B	X																					
LO	LO	HI																					
LO	HI	HI																					
HI	LO	LO																					
HI	HI	HI																					
Dynamic Indicator		<p>Indicates that this input (usually the trigger input of a flip-flop) responds to the indicated transition of the applied signal.</p>																					
Triggered (toggle) Flip-Flop		<p>A bistable device with one input and two outputs (either or both outputs may be used). When triggered, the outputs change from one stable state to the other stable state with each trigger. The outputs are complementary (i.e., when one output is HI the other is LO). The dynamic indicator on the trigger (T) input may be of either polarity depending on the device.</p>	<table border="1"> <thead> <tr> <th colspan="2">Input</th> <th colspan="2">Output</th> </tr> <tr> <th>Condition before trigger pulse</th> <th>Condition after trigger pulse</th> <th>Q</th> <th>\bar{Q}</th> </tr> </thead> <tbody> <tr> <td>Q</td> <td>\bar{Q}</td> <td>Q</td> <td>\bar{Q}</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>HI</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>LO</td> <td>HI</td> </tr> </tbody> </table>	Input		Output		Condition before trigger pulse	Condition after trigger pulse	Q	\bar{Q}	Q	\bar{Q}	Q	\bar{Q}	LO	HI	HI	LO	HI	LO	LO	HI
Input		Output																					
Condition before trigger pulse	Condition after trigger pulse	Q	\bar{Q}																				
Q	\bar{Q}	Q	\bar{Q}																				
LO	HI	HI	LO																				
HI	LO	LO	HI																				

TABLE 3-1 (CONT.)

Basic Logic Reference

Device	Symbol	Description	Input/Output Table																								
Triggered Set-Clear (J-K) Flip-Flop		A bistable device with three or more inputs and two outputs (either or both outputs may be used). When gated, the outputs change state in response to the states at the inputs prior to the trigger. The outputs are complementary (i.e., when one output is HI the other is LO). The dynamic indicator on the gate (G) input may be of either polarity depending on the device.	<table border="1" data-bbox="1174 405 1438 657"> <thead> <tr> <th colspan="2">Input</th> <th colspan="2">Output</th> </tr> <tr> <th>J</th> <th>K</th> <th>Q</th> <th>\bar{Q}</th> </tr> </thead> <tbody> <tr> <td>LO</td> <td>LO</td> <td colspan="2">No change</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>HI</td> <td>LO</td> <td>HI</td> <td>LO</td> </tr> <tr> <td>HI</td> <td>HI</td> <td colspan="2">Changes state</td> </tr> </tbody> </table> <p data-bbox="1174 688 1417 741">Output conditions shown after gate pulse.</p>	Input		Output		J	K	Q	\bar{Q}	LO	LO	No change		LO	HI	LO	HI	HI	LO	HI	LO	HI	HI	Changes state	
Input		Output																									
J	K	Q	\bar{Q}																								
LO	LO	No change																									
LO	HI	LO	HI																								
HI	LO	HI	LO																								
HI	HI	Changes state																									
D (data) Type Flip-Flop with Direct Inputs (Direct Inputs may be applied to all triggered flip-flops)		A bistable device with two inputs and two outputs (either or both outputs may be used). When clocked, the state of the Q output changes to the state at the data (D) input. The outputs are complementary (e.g., when one output is HI the other is LO). The dynamic indicator on the clock input may be of either polarity, depending upon the device.	<p data-bbox="1174 804 1438 888">Set (S) and reset (R) inputs override data (D) and clock (C) inputs.</p> <table border="1" data-bbox="1174 898 1438 1108"> <thead> <tr> <th colspan="2">Input</th> <th colspan="2">Output</th> </tr> <tr> <th>S</th> <th>R</th> <th>Q</th> <th>\bar{Q}</th> </tr> </thead> <tbody> <tr> <td>HI</td> <td>LO</td> <td>LO</td> <td>HI</td> </tr> <tr> <td>LO</td> <td>LO</td> <td colspan="2">Undefined</td> </tr> <tr> <td>HI</td> <td>HI</td> <td colspan="2">No Effect</td> </tr> <tr> <td>LO</td> <td>HI</td> <td>HI</td> <td>LO</td> </tr> </tbody> </table>	Input		Output		S	R	Q	\bar{Q}	HI	LO	LO	HI	LO	LO	Undefined		HI	HI	No Effect		LO	HI	HI	LO
Input		Output																									
S	R	Q	\bar{Q}																								
HI	LO	LO	HI																								
LO	LO	Undefined																									
HI	HI	No Effect																									
LO	HI	HI	LO																								
		For devices with set (S) or reset (R) inputs, the indicated state at either of these inputs overrides all other inputs to the states shown in the Input/Output Table.	<p data-bbox="1174 1161 1438 1224">Set (S) and Reset (R) inputs both high.</p> <table border="1" data-bbox="1174 1245 1438 1507"> <thead> <tr> <th colspan="2">Input</th> <th colspan="2">Output</th> </tr> <tr> <th>Condition before clock pulse</th> <th>Condition after clock pulse</th> <th>Q</th> <th>\bar{Q}</th> </tr> </thead> <tbody> <tr> <td>D</td> <td>Q</td> <td>Q</td> <td>\bar{Q}</td> </tr> <tr> <td>HI</td> <td></td> <td>HI</td> <td>LO</td> </tr> <tr> <td>LO</td> <td></td> <td>LO</td> <td>HI</td> </tr> </tbody> </table>	Input		Output		Condition before clock pulse	Condition after clock pulse	Q	\bar{Q}	D	Q	Q	\bar{Q}	HI		HI	LO	LO		LO	HI				
Input		Output																									
Condition before clock pulse	Condition after clock pulse	Q	\bar{Q}																								
D	Q	Q	\bar{Q}																								
HI		HI	LO																								
LO		LO	HI																								

When the AC HF REJ button is pressed, 5 Hz to 30 kHz external signals pass from U64A to U64B and then to U124's Level input. Also, U124's Ext In amplifier is disabled and U124's low-frequency amplifier is enabled, allowing only filtered signals from U64B to be amplified.

TRIGGER AMPLIFIER AND SOURCE SELECTOR

The time base trigger source is selected by the SOURCE switch (S50) which enables the appropriate amplifier in U124. A dc voltage from the LEVEL control is applied to pin 8 of U124 to provide internal amplifier voltage offset. The amplifiers' outputs are summed and applied to pins 14 and 16 to drive the following Trigger Generator stage.

The internal trigger signal from the trigger source selector of the mainframe is connected to U12 via interface connector pins A20 and B20. Integrated circuit U12 provides common mode rejection for frequencies up to 100 kHz; T1 provides cmr above 100 kHz. Ac-coupled trigger signals enter U124 at pin 4 and are terminated in 50Ω at pin 3. Integrated circuit U38 provides a path for low-frequency trigger signals which are fed to pin 5 of U64B. These signals then arrive at the level port of U124 (pin 8) where they are summed with the high frequency signals to provide wide-band triggering in the AC and DC COUPLING modes. Pressing the front-panel AC LF REJ push button breaks the low-frequency signal path allowing only high-frequency trigger signals to appear at the output of U124. When the AC HF REJ push button is pressed, the internal signal amplifier is disabled and the low-frequency amplifier is enabled allowing only low-frequency signals to pass.

In the HF SYNC mode, the output of U138A drives the level input of U124. A voltage appears at the output when a voltage difference is detected at the inputs of U138A. Thus, when an unbalanced trigger condition occurs, U138A provides automatic dc leveling of U124 so that U144 will always have a balanced signal input in the HF SYNC mode. Transistor Q142 is turned off in the HF SYNC mode providing a path through CR145 for voltage from the LEVEL control. This enables the LEVEL control to adjust the hysteresis of Trigger Generator U144 to almost zero, allowing very small signals to trigger U144.

SLOPE SELECTOR AND TRIGGER GENERATOR

Integrated circuit U144 converts the differential trigger signal from the Trigger Amplifier and Source Selector block to a differential gate waveform for use by the Gate Generator stage. SLOPE switch S140 is connected to U144-pin 3 to determine whether the display is triggered on the positive-going or negative-going slope. When the SLOPE switch is set to +, a positive-going signal on pin 5 produces a positive-going gate on pin 15 and a negative-going gate on pin 16. When the SLOPE switch is set to -, a negative-going signal on pin 5 produces a positive-going gate on pin 15 and a negative-going gate on pin 16. Trigger Generator sensitivity is controlled by R147.

The delay mode control input at U144-pin 4 provides control when the unit is operating as a delayed sweep unit in the B horizontal compartment of a mainframe with 2 horizontal compartments. When the unit is operating in the independent or triggerable after delay time modes (as determined by the delaying sweep time-base unit in the A horizontal compartment), there is no effect on the Trigger Generator circuits. However, when the unit is operating in the B starts after delay time mode, U144-pin 4 is HI, causing the trigger disable signal at pin 2 to initiate a trigger gate pulse at U144-pins 15 and 16.

GATE GENERATOR

The Gate Generator stage provides an auto enable gate to the Logic circuits (diagram 3), and a sweep start gate and Z-axis gate (unblanking) to the sweep generator circuitry (diagram 4). Refer to Figure 3-2 for a timing diagram of the Gate Generator functions.

When an adequate trigger signal is applied to U144-pins 5 and 8 and when U144 is enabled (pin 2 is LO), a HI level is produced at U144-pin 15 and a LO level is produced at U144-pin 16.

The HI level from U144-pin 15 is coupled through emitter follower Q184 and J200-2 into the Logic circuit (diagram 3) to indicate that a triggering signal has been received. The Logic circuit (diagram 3) sets the auto sense at J200-3 HI, turning off Q160. Simultaneously, the LO level at U144-pin 16 gates comparator Q174-Q164. The collector of Q164 rises HI to provide a sweep start gate at J200-5 and the collector of Q174 falls LO to provide a Z-axis gate (unblanking) at J200-4.

In the absence of a trigger signal at U144-pins 5 and 8, pin 15 is set LO and pin 16 is set HI. The LO level from U144-pin 15 is coupled through J200-2 to the Logic circuit (diagram 3) to indicate the lack of a triggering signal. The Logic circuit provides a LO-level auto sense pulse through J200-3 to the base of Q160. This LO level gates the comparator (Q160 and Q174). The collector of Q160 rises high to provide a sweep start gate and the collector of Q174 falls LO to provide a Z-axis gate (unblanking) at J200-4.



LOGIC

The Logic circuit controls the sweep modes and associated functions to the time-base unit (e.g., sweep display, hold off, auto sweep, single sweep, etc.). The Logic circuit also generates control signals for the mainframe.

TRIGGER MODE SWITCHING

Integrated circuit U220 controls the NORM, AUTO, and SINGLE SWP MODE and also generates control signals used in the 7B15. HF SYNC operation is described in the Trigger Generator circuit description (diagram 2).

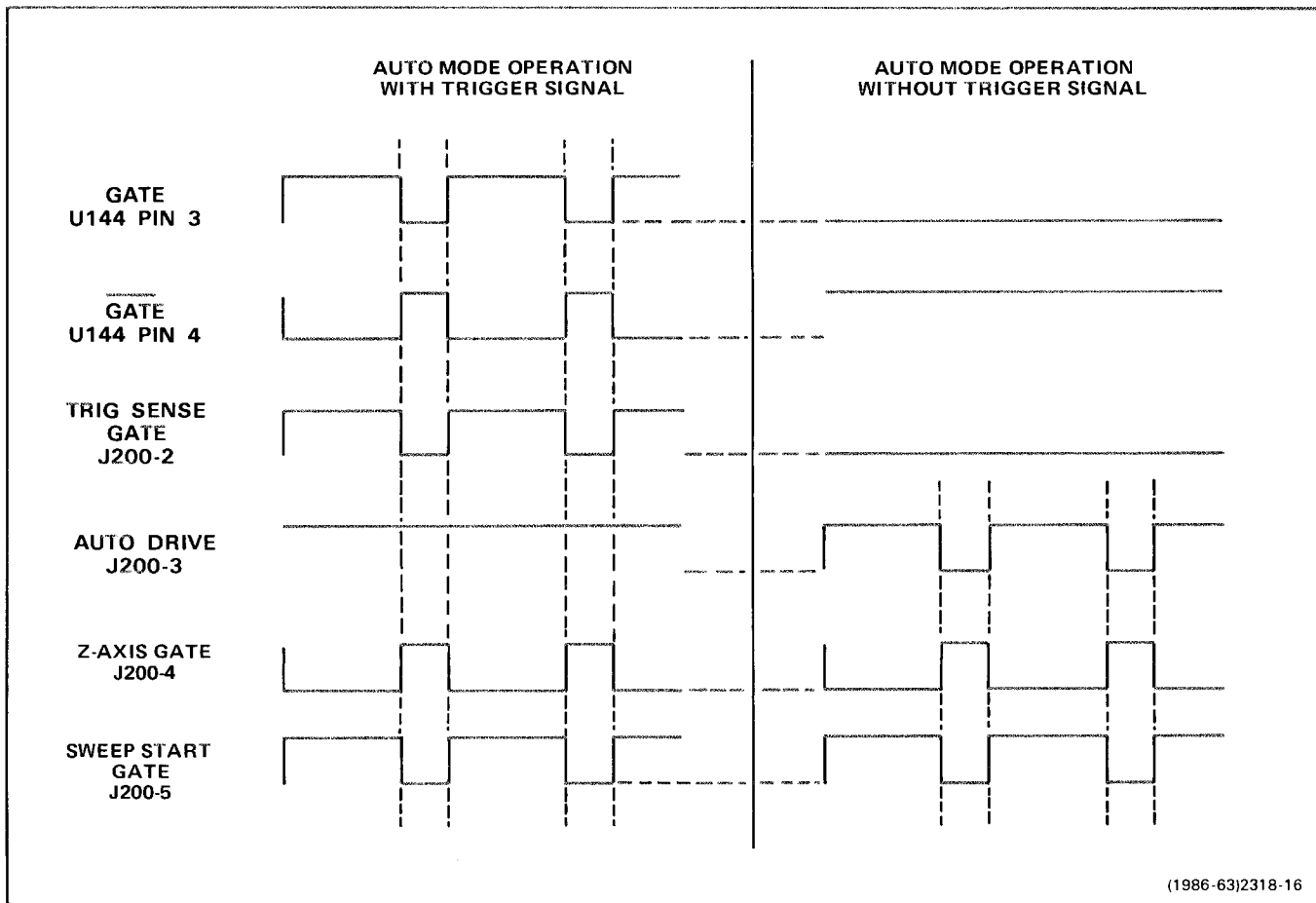


Figure 3-2. Timing diagram for Gate Generator stages Q160, Q164, and Q174.

Normal Mode

The NORM MODE is provided when U220-pin 12 is LO. In the NORM MODE, only the appropriate trigger signal can initiate a sweep gate to the Ramp Generator (diagram 4). Integrated circuit U220 controls sweep lockout and hold off functions.

Auto Mode

An internal control stage (within U220) produces a free-running reference trace (bright base line) in the absence of a trigger signal.

A HI level from MODE switch S230 is inverted by Q230 to set U220-pin 19 LO, which selects AUTO MODE operation. In the presence of a trigger pulse from the Trigger Generator (diagram 2), a HI level at U220-pin 1 discharges an internal control stage which inhibits the auto drive signal from U220-pin 3. In the absence of a trigger pulse, the LO level at U220-pin 1 enables this internal control stage with a time delay generated by R228, C228, and other circuitry internal to U220-pin 2. After the time delay, an auto drive signal is initiated from U220-pin 3 to the Trigger Generator (diagram 2).

Single Sweep Mode

The SINGLE SWP MODE provides display of only one sweep. After one sweep has run, all other sweeps are inhibited until the SINGLE SWP-RESET push button is pressed. The READY light indicates when the sweep is ready to accept a trigger.

After completion of one sweep, the hold off start pulse at U220-pin 16 causes the sweep disable out at pin 17 to rise HI. A HI level at U220-pin 12 initiates single-sweep operation and holds the sweep disable out at U220-pin 17 HI after completion of the sweep. Momentary contact of the RESET push button places a LO at U220-pins 14 and 15, which removes the sweep disable out from pin 17 and allows the Ramp Generator (diagram 4) to accept a trigger. Interface connector B15 provides a remote single-sweep reset input from compatible mainframes.

HOLD OFF TIMING

The hold off stages prevent the Ramp Generator (diagram 4) from being retriggered until the sweep timing capacitors are discharged.

At the end of each sawtooth waveform from the Ramp Generator (diagram 4), a sweep stop comparator pulse (HI) is coupled to U220-pin 16. This pulse enables the hold off timing circuits at U220-pin 8, which sets the sweep disable out at U220-pin 17 HI and the hold off signal at pin 10 LO for the duration of the hold off cycle. Hold off timing (U220-pin 8) is provided by capacitors C211 through C215, and resistors R212 through R214. Transistors Q203 and Q204 prevent the sweep disable out pulse at U220-pin 17 from falling LO until the holdoff timing capacitors have discharged. Transistors Q212 and Q214 and front-panel HOLD OFF control R210 provide variable current to the timing components to change the hold off time period.

LOCKOUT BUFFER AMPLIFIER

A lockout pulse (HI) may be initiated at interface connector pin B8 by mainframe switching functions. A HI level coupled from interface connector B8 through the Lockout Buffer Amplifier (Q201, Q202, and Q206) to the lockout input at U220-pin 18, thereby disabling the sweep. The lockout pulse (HI) is also applied through Q358 (diagram 4) to the hold off start input at U220-pin 16 to enable the hold off cycle.

HOLD OFF GENERATOR

The Hold Off Generator provides an appropriate hold off pulse to the hold off output amplifier (Q272, Q274), depending upon the sweep mode.

In the Δ TIME (delta time) mode, a HI level from Q546 (diagram 5) reverse biases CR248; this sets U250-pins 3 and 10 HI and removes the set input from pin 10. Since the J and K inputs of U250A (pins 2 and 3) are both HI, the outputs at pins 5 and 6 switch with every negative-going hold off pulse. The divide-by-2 output from U250B is coupled to hold off output amplifier Q272 and Q274. A HI level saturates Q272 and blocks the hold off signal from buffer Q262-Q264; a LO level allows the hold off (not bar) signal to pass to the hold off output amplifier. Therefore, a Hold Off output signal is generated on every other hold off (not bar) pulse from U220-pin 10.

When operating in the B DELAY MODE, the LO level from Q546 (diagram 5) forward biases CR248 which switches the set input (pin 10) of U250B LO. As a result, pin 7 switches LO and releases the hold off (not bar) through buffer Q262-Q264 to the Hold Off Output Amplifier. Then, a Hold Off output signal is generated with every hold off (not bar) pulse.

The Hold Off Output Amplifier inverts and amplifies the hold off signal from the Hold Off Generator for use by the mainframe.

Transistor Q272 inverts the hold off signal Q264 to provide a HI level when hold off is present. The inverted signal is coupled through emitter follower Q274 to interface connector B4.

DELAY PICKOFF INHIBIT

The Delay Pickoff Inhibit stage provides an inhibit level to disable the delay pickoff comparator (diagram 4) of the delayed sweep not being displayed (two delayed sweep traces are produced by a delayed companion time base when operating in the Δ TIME mode). When the 7B15 is set to INDEPENDENT, both delay pickoff comparators are inhibited. When the 7B15 is set for DELAY TIME operation (TRACE SEP control set to OFF detent), the second delay pickoff comparator Q512B, Q522B (diagram 5) is inhibited. During Δ TIME operation, the first and second delay pickoff comparators (Q512A, Q522A and Q512B, Q522B diagram 5) are alternately inhibited.

A HI level from the Hold Off Generator turns on Q252 and turns off Q254, which results in a LO level at P33-pin 3 and a HI level at P33-pin 2. A LO level turns off Q252 and turns on Q254 which results in a HI level at P33-pin 3 and a LO level at P33-pin 2. A LO pickoff-inhibit level (P33-pins 2 and 3) disables the appropriate delay time comparator (diagram 5). Refer to the timing diagram in Figure 3-3.

DELAY MODE CONTROL

The Delay Mode Control stage determines whether the delayed companion time-base unit operates in the B STARTS AFTER DLY or B TRIGGERABLE AFTER DLY modes. The delay mode information is coupled from S205 to the delayed companion time-base unit through interface connector B2. In either delay mode, Q282 is turned on to provide a force readout level to the mainframe through interface connector A35. Force readout enables the readout display in the A horizontal compartment of a mainframe with 2 horizontal compartments even though the A horizontal compartment has not been selected for display. This provides delay-time readout in the delaying sweep applications where only the B horizontal unit is displayed.

When Q282 is on, Q288 is turned off to provide a HI level through CR288 to interface connector A37. The HI level disables the channel 1 readout in the A horizontal compartment (top of graticule) when only the B horizontal compartment has been selected for display.

AUXILIARY Y-AXIS GENERATOR

The Auxiliary Y-Axis Generator provides vertical trace separation to the mainframe when operating in the Δ TIME mode (3 trace display). Information from interface connector B7 indicates which trace (delaying or delayed sweep trace) is displayed by the mainframe. Information from U250A-pin 6 of the Hold Off Generator stage indicates which delayed sweep trace is displayed. The Auxiliary Y-Axis Generator processes the sweep mode information and supplies the appropriate positioning current to interface connector B16. Also, auxiliary Y-axis information for dual-beam mainframes is supplied at interface connector B14. This information is supplied by a 2-volt pulse on pin 2 of P38 making cable dress important from this circuitry. See Figure 4-6, in the Maintenance section.

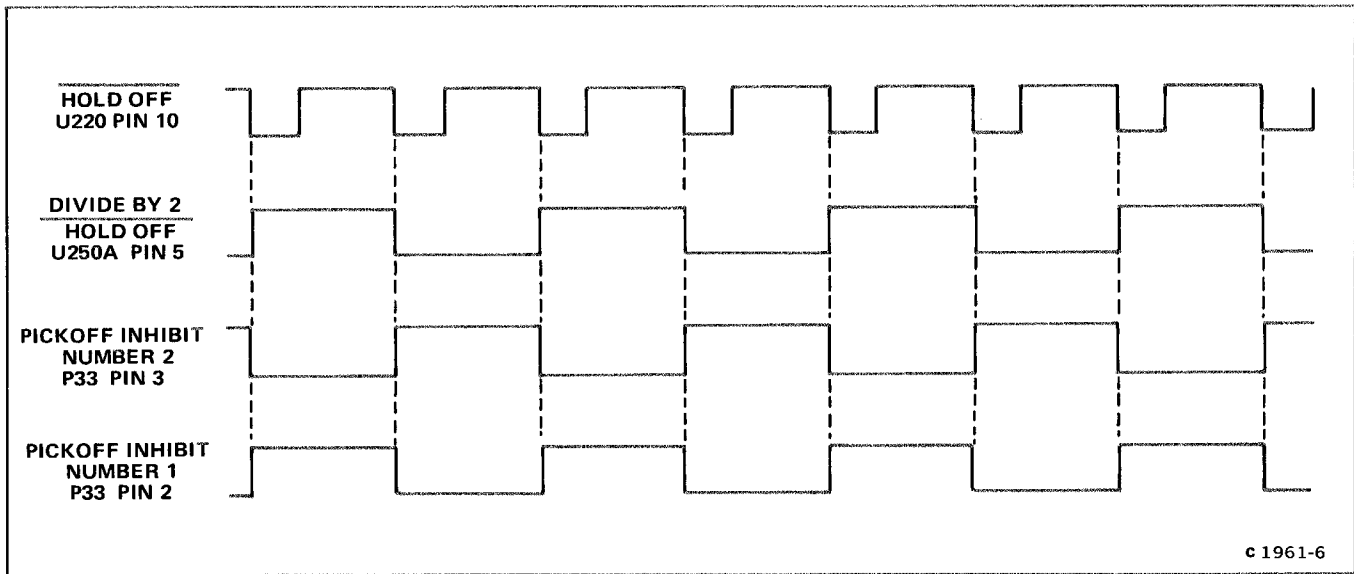


Figure 3-3. Timing diagram for Delay Pickoff Inhibit stage.

During the delaying sweep trace (intensified trace), Q292 turns off, Q294 turns on, and CR293 is reverse biased. As a result, a fixed positioning current is provided to interface connector B16 by R292 and the +15 V supply.

During the delayed sweep traces, Q292 is saturated and Q294 is turned off. Diode CR292 is reverse biased to block positioning current from R292 and the +15 V supply. Therefore, positioning is determined by U250A-pin 6 of the Hold Off Generator stage. The first delayed sweep trace is the reference trace and does not require vertical positioning. Therefore, the HI level from U250A-pin 6 reverse biases CR293 and blocks positioning current. However, during the second delayed sweep trace, the LO level from U250A reverse biases CR295 and opens the variable positioning current path from TRACE SEP control R295, through R294 and CR293 to interface connector B16.



SWEEP GENERATOR

The Sweep Generator produces a linear ramp waveform for the mainframe when gated by the Trigger Generator. The sweep trace is displayed either independently or as the intensified sweep (when used with a companion delayed time-base unit) of an alternate display. The sweep ramp is also used as a time reference for the delay pickoff comparators (diagram 5). A sweep gate (unblanking) is also generated in this circuit block.

The linear sweep ramp waveform is produced by charging a capacitor from a constant current source. The slope of the ramp determines the sweep rate of the displayed trace.

TIMING CURRENT SOURCE

The Timing Current Source stages generate a constant current for the Ramp Generator stages. A reference voltage source is established by the +50 volt supply and R306, R305, R304, and R300 (front-panel SWP CAL adjustment).

The reference voltage is applied to U314. Operational amplifier U314 provides unity voltage gain and low output impedance. The output of U314 is connected through Q322 and Q324 to the timing resistors (R398 through R398). Timing current is the result of the voltage drop across the timing resistors and flows through the collector of Q324 to the Ramp Generator stages.

RAMP GENERATOR

The Ramp Generator stages produce a linear positive-going ramp for the Output Preamplifier and Sweep Gate Generator stages, and for delay pickoff in the Logic circuit (diagram 5).

Upon the arrival of a HI-level sweep start gate at the current switch stage (Q354, Q356), Q354 turns on and Q356 turns off. The source current from Q324 charges the timing capacitors (C364, C365, C366) in a positive ramp. Field effect transistor Q372A, Q372B, and transistor Q376 form a unity-gain ramp voltage follower for the sweep ramp. The output of Q376 is connected to the Output Preamplifier, Auxiliary Sweep Preamplifier, and Sweep Gate Generator.

When the sweep start gate is LO, Q354 turns off and Q356 turns on causing the timing capacitors (C364, C365, and C366) to discharge. The baseline stabilizer stage (Q336, Q342) maintains a constant level from

which the ramp begins. The output of Q376 is compared (by way of Q336A) with the reference level at the base of Q336B. If the output of Q376 is less than the reference, Q342 will charge the timing capacitors through CR345 until the output and reference voltages are equal. If the output of Q376 is greater than the reference, Q342 conducts more and CR345 conducts less causing the timing capacitors to discharge through Q356 and R358. When the output and reference voltages are equal, the current through CR345 and Q354 equal the current through Q356.

OUTPUT PREAMPLIFIER

The Output Preamp stages connect the differential sweep signal to the mainframe and provide an offset voltage for trace positioning. Provisions are made in these stages for sweep magnification, and a negative-going sawtooth signal is supplied to the mainframe for sawtooth output and special plug-in unit functions.

The sweep ramp voltage from Q376 is coupled to the horizontal preamplifier stage at the base of Q454. Transistors Q454 and Q464 form a single-ended to push-pull converter with Q458 and Q468 as current follower stages for the push-pull signal. Transistor Q460 is employed as a nonlinear capacitance to compensate for the nonlinear collector-to-base capacitance of Q458. Output drivers Q476 and Q496 provide final amplification and connect the sweep signal to the mainframe.

The MAG switch, S460, increases the horizontal preamplifier gain ten times by connecting R461 and R460 in parallel with R454 and R464.

In the 2 ns and 5 ns TIME/DIV switch positions field effect transistor Q484 is biased into a low resistance state setting the gain of the output amplifier at two times its normal value.

The position voltage source stage (U386) combines the dc voltages of the FINE and POSITION controls for a position voltage level at the output. This voltage level on the base of Q464 provides a ramp waveform offset voltage to horizontally position the displayed trace.

AUXILIARY SWEEP PREAMPLIFIER

The Auxiliary Sweep Preamp stage provides a negative-going sweep ramp to the mainframe (via interface connector pins-A3 and B3 for sawtooth output and special plug-in unit functions. Transistors Q434 and Q438 form a unity-gain inverting amplifier for the sawtooth signal from the ramp voltage follower stage (Q376). Diode CR434 provides emitter-base compensation.

SWEEP GATE GENERATOR

The Sweep Gate Generator produces an unblanking gate for the Z-axis system of the mainframe. When the sweep is displayed, the crt is unblanked (gate level LO). The sweep is blanked (gate level HI) between sweeps.

The sweep ramp is applied to the sweep stop comparator stage (Q402, Q406, Q410). A comparison voltage is set at the base of Q406. When the ramp voltage exceeds the comparison voltage, Q402 turns off and Q406 couples a HI level through common-base transistor Q410. The output of Q410 is coupled to Q415, Q420, and Q425, and to the Logic circuit (diagram 3) to initiate hold off.

The Z-axis gate from the Trigger Generator circuit (diagram 2) is LO at the start of the sweep. This LO level turns off Q420. The resultant HI-level sweep gate pulse at the collector of Q420 is coupled through emitter follower Q425 to the mainframe for sweep unblanking. At the end of the sweep, the HI level from Q410 turns Q415 off and Q420 on. The resultant LO is coupled through emitter follower Q425 to the mainframe for sweep blanking.



PICKOFF COMPARATORS AND DELAY GATE GENERATOR

The Delay Pickoff Comparators and Delay Gate Generator circuits determine the first and second delay times and generate the delay gate that allows the delayed sweep of the companion time-base unit to run. Calibrated dc voltages are supplied to the Digital Voltmeter circuit (diagram 6) to provide delay time and Δ time crt readout.

DELAY PICKOFF COMPARATORS

Delay Time Comparison

DELAY TIME control R520 determines the delay time before the start of the first delayed sweep trace and the associated intensified zone. The delay-time voltage, selected by R520, is coupled through unity gain buffer amplifier U530B to the delay comparison voltage switch stage (Q592), and to the delay time pickoff comparator (Q512B and Q522B).

When the sweep ramp voltage at the base of Q522B exceeds the delay time voltage at the base of Q512B, the comparator switches (Q522B turns off and Q512B turns on). The resultant LO level at the base of Q562 initiates the delay gate which allows the delayed sweep of the companion time-base unit to run (refer to Delay Gate Generator discussion).

The current source for the delay time pickoff comparator (Q512B and Q522B) is provided by Q518. A LO level from the Logic circuits (diagram 3) at P3-3 turns off Q518 and disables the comparator. The delay time pickoff comparator (Q512B and Q522B) is then inhibited during the time that the second delayed sweep trace (delta TIME mode) is displayed.

△ TIME Comparison

△ TIME control R530 determines the amount of delay time from the start of the first intensified zone and corresponding delayed sweep display, to start the second intensified zone and corresponding delayed sweep display (delta TIME operation only). The △ TIME control also supplies a dc level, which corresponds to the differential time from the start of the first intensified zone to the start of the second intensified zone, through Q592 to the Digital Voltmeter circuit (diagram 6). Refer to the Delay Time and △Time Reference Voltage Sources discussion.

The voltage levels from the DELAY TIME control R520 and △ TIME control R530 are added in the delay summing amplifier U556. The summed voltage levels are coupled to the △ time pickoff comparator stage Q522 to determine the amount of the delay time before the start of the second delayed sweep trace.

When the sweep ramp at the base of Q522A exceeds the △ time voltage at the base of Q512A, the comparator switches (Q522A turns off and Q512A turns on). The collector of Q522A falls LO and initiates the delay gate which allows the second delayed sweep of the companion time-base unit to run (refer to Delay Gate Generator discussion).

The current source for the △ time pickoff comparator (Q512A and Q522A) is provided by Q528. A LO level from the Logic circuits at P3-2 turns off Q528 and disables this comparator. The △ time pickoff comparator (Q512A and Q522A) is inhibited during the time that the first delayed sweep trace is displayed (delta TIME mode).

DELAY AND △ TIME REFERENCE VOLTAGE SOURCES

Bias for delay-time controls R520 and R530 is provided by Q536 and associated circuitry. Base current into Q536, and consequently delay-time bias at the junction of R537 and R533, changes with respect to the front-panel SWP CAL adjustment. The SWP CAL reference voltage is also coupled to the reference current source stage (Digital Voltmeter circuit, diagram 6) in an amount proportional to the change in delay bias and the resultant delay comparison voltage. As a result, a change in SWP CAL adjustment does not affect the delay time readout.

Transistor Q534 senses the output of delay summing amplifier U556 and limits the comparison voltage at Q512A to a level equivalent to approximately 10 divisions of delay time. Transistor Q534 turns on and reduces the △ time voltage output from U530A and thereby limits the second delay pickoff to approximately 10 divisions. The voltage at which Q534 turns on can be varied by Pickoff Bias adjustment R535.

Delay Time or △ Time voltage is coupled through the delay comparison voltage switch to the Digital Voltmeter circuit (diagram 6), where voltage is converted for delay time readout.

When operating in the DELAY TIME mode, S295 couples a HI level to the base of Q546 and to the gate of Q592. Transistor Q546 turns on; the resultant LO at its collector turns off Q582. Field-effect transistor Q592 then turns on and couples the delay time comparison voltage to the Digital Voltmeter circuit (diagram 6).

In the △ TIME operation, S295 is open, and a LO level is coupled to the base of Q546 and to the gate of Q592. Field-effect transistor Q592 and transistor Q546 turn off. The resultant HI at the collector of Q546 turn on Q582 and couples the △ time comparison voltage to the Digital Voltmeter circuit (diagram 6).

DELAY GATE GENERATOR

The Delay Gate Generator produces a square-wave delay gate signal on command of the Delay Pickoff Comparators. The delay gate signal controls the delayed sweep of the delayed companion time-base unit.

At the time of delay pickoff of either the delay time (Q512) or △ time (Q522) pickoff comparator, transistor A turns off and transistor B turns on. The base of emitter follower Q562 then falls LO, as does the input to Schmitt trigger Q564, Q568 (base of Q564). Transistor Q564 turns off and Q568 turns on, and thereby increases the current through R572, Q574, and R574. The collector of Q574 falls and the LO level is coupled through emitter follower Q578 to interface connector B9. The LO level enables the sweep of the delayed companion time-base unit.

Transistor Q572 disables the Delay Gate Generator until the Z-axis circuits are ready for the sweep to run. A HI level at the base of Q572 turns on the transistor and diverts current from Q574, which inhibits the companion time-base unit sweep (delay gate HI).

When B DELAY MODE switch S280 is set to INDEPENDENT, a LO level at the base of Q578 holds the delay gate LO and allows the companion time base to run independently.



DIGITAL VOLTMETER

The Digital Voltmeter circuit converts the Delay Comparison Voltage, determined by the DELAY TIME and Δ TIME front-panel controls, to an accurate time measurement which is displayed on the crt by the mainframe readout system. The schematic for the Digital Voltmeter circuit is given in the diagrams section of this manual.

DELAY COMPARISON VOLTAGE TO RAMP CONVERTER

The Delay Comparison Voltage to Ramp Converter stage develops a positive- and negative-going ramp (see Fig. 3-4, pin 6 of the U626 waveform). Integrated circuit U626 is connected as a Miller integrator. The current that flows

through R621 and R622 (delay comparison current, determined by the DELAY TIME and Δ TIME front-panel controls) causes the voltage at pin 6 of U626 to go negative. The rate at which this can occur is limited by the charging of C627. The result is a negative-going ramp with a slope proportional to the delay comparison voltage. Consequently, the more positive the delay comparison voltage, the more negative the ramp will run.

After a period of time (determined by U686) diode CR632 turns on and adds reference current to the delay comparison current. This reference current polarity is opposite to the delay comparison current and is always at least 10 times greater. Therefore, the output of U626 becomes a positive-going ramp. When the positive-going ramp reaches about 7 volts, the Comparator stage switches and the Ramp control turns off CR632. The output of U626 becomes a negative-going ramp, completing the cycle.

The DVM Zero adjustment R625 provides a dc offset current to set the quiescent operating level of the Delay Comparison Voltage to Ramp Converter. DVM Gain adjustment R620 allows for calibration of the delay comparison current.

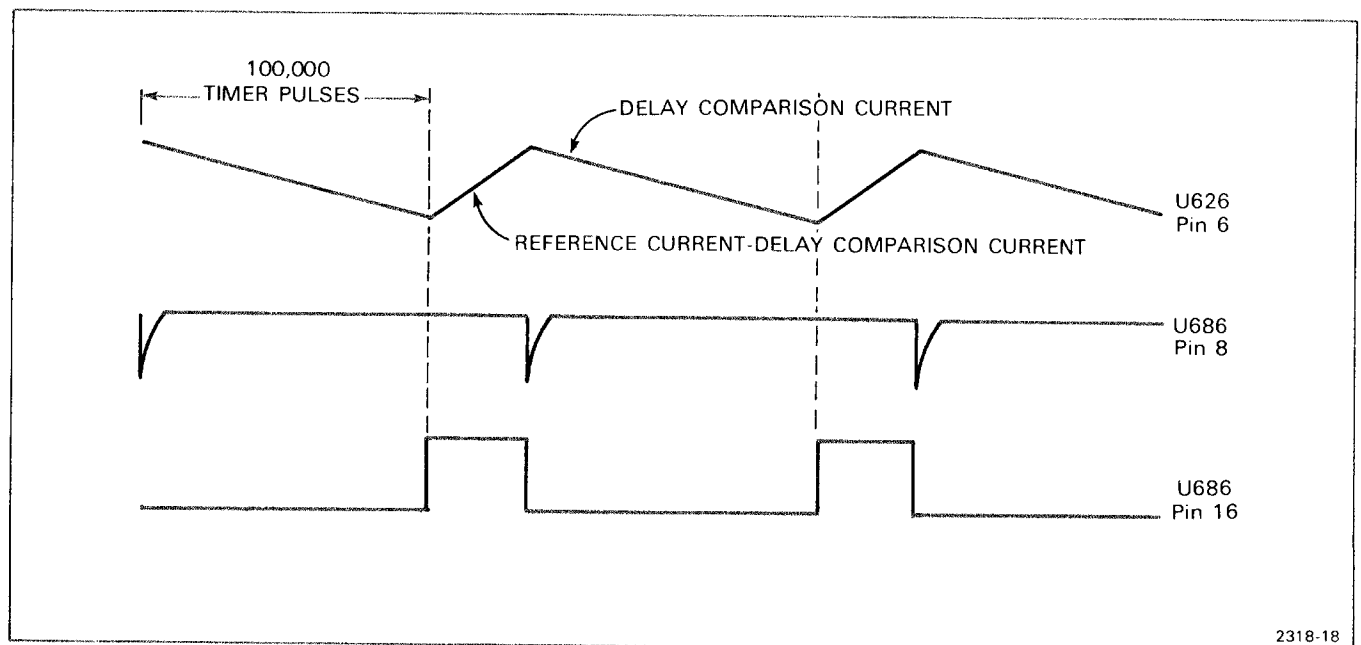


Figure 3-4. Digital Voltmeter timing diagram.

COMPARATOR

The Comparator circuitry drives the comparator input of U686. When the output of U626 rises to about 7 volts, CR643 becomes forward biased which turns on Q644. Components U662B and D and R654 provide rapid latchup of the positive-going signal from Q644. Integrated circuit U662C inverts this signal which causes pin 8 of U686 to go low. A low is then generated at pin 16; the ramp control output of U686. This ramp control signal is used for reference current switching.

REFERENCE CURRENT SOURCE

The Reference Current Source determines the amount of current to be used for comparison with the delay comparison current. The front-panel SWP CAL control determines the absolute value of reference current. The swp cal reference input, on pin 1 of J100, changes the reference current value to compensate for different front-panel SWP CAL settings.

REFERENCE CURRENT INVERTER

The Reference Current Inverter acts as a current "mirror" to produce an equivalent current in opposite polarity. Thus, current flowing through R631 is reversed in direction as it flows through R632. Reversing current flow direction allows U626 to sum the reference current with the delay comparison current.

Reference current switching is controlled by the ramp control output of U686. A high on pin 16 of U686 causes a low at U654's output which reverse biases CR634. This forward biases CR632 allowing reference current to flow into the summing node at pin 2 of U626. A low at pin 16 of U686 causes CR634 to forward bias turning off CR632 which routes the reference current away from the summing node at U626.

COUNTER AND ENCODER

The Counter and Encoder integrated circuit consists basically of a 4-decade counter with multiplexer and associated circuitry.

An integration cycle of 100,000 counts (see Fig. 3-4) begins with the ramp control (pin 16) going high and the start of a short internal delay. During the delay, the counters are cleared and set to their initial state. After the delay, the counters are enabled and count until a transition occurs on the comparison input (pin 8) signaling that the counters contain the desired digital output which is a direct function of the unknown input current. At this point clock pulses to the counters are disabled, the ramp control is set low, and the contents of the counter are latched. The counter then resumes operation.

Each decade counter counts synchronously with data read out by sequentially strobing the four column-select lines, pins 3, 4, 5, and 6. The output appears at pin 18 as a current which varies from 0 ma to 1 ma in 100 μ a steps.

Integrated circuit U686 uses S800 cam switch control voltages at pins 10 and 11 for accurate 1, 2, and 5 sweep speed scaling. The presence of voltages at pins 10 and/or 11 allows the IC to determine if it should be dividing by 2 or 5. An absence of voltage at both pins is interpreted as divide by one.



TIME/DIVISION AND READOUT SWITCHING

The readout switching circuits provide sweep rate and delay time information to the mainframe readout system. Readout circuitry is shown on the Time/Division and Readout Switching diagram (7) at the rear of this manual.

BASIC READOUT SYSTEM

The readout system in 7000-series mainframes provides alpha-numeric display of information encoded by the plug-in units. This display is presented on the crt, and is written by the crt beam on a time-shared basis with the analog waveform display.

The readout system produces a pulse train consisting of ten negative-going pulses called time-slots. Each pulse represents a possible character in a readout word, and is assigned a time-slot number corresponding to its position in the word. Each time-slot pulse is directed to one of ten output lines, labeled TS1 through TS10 (time slots one through ten), which are connected to the vertical and horizontal plug-in compartments. Two output lines, row and column, are connected from each channel (two channels per plug-in compartment) back to the readout system.

Data is encoded on these output lines either by connecting resistors between them and the time-slot input lines or by generating equivalent currents. The resultant output is a sequence of analog current levels on the row and column output lines. The row and column current levels are decoded by the readout system to address a character matrix during each time slot, thus selecting a character to be displayed or a special instruction to be followed.

TIME/DIVISION READOUT

Time/Division readout is displayed on channel 1 (top of the graticule) corresponding to the plug-in compartment in which the time-base unit is installed. The sweep rate is selected by TIME/DIV switch S800, which also selects the resistors that determine the various readout characters shown in Table 3-2.

DELAY TIME READOUT

Both delay-time readout (delay time before the start of the first intensified zone) and Δ time readout (differential delay time between the start of the first intensified zone and the start of the second intensified zone) are displayed on channel 2 (bottom of the graticule) corresponding to the plug-in compartment in which the 7B85 is operating. Delay time is selected by DELAY TIME control R520 and differential delay time is selected by Δ TIME control R530 as explained in the Pickoff Comparators and Delay Gate Generator description (diagram 5).

The resistors that control the various delay time readout functions are shown in the channel 2 portions of Table 3-2. Numerical scaling for delay time readout (0, 1, 2, 3, etc.) is explained in the Digital Voltmeter Description (diagram 6). Origin of the Δ readout symbol is explained in the Logic discussion (diagram 3).

Δ SYMBOL ENABLE

The Δ symbol enable stage senses Δ TIME operation and sets the readout row and column output current necessary to enable the Δ symbol.

During DELAY TIME operation, the HI level from S295 (diagram 5) turns Q548 on; its emitter rises and reverse biases CR543. Column current is thus blocked from interface connector A38, thereby disabling the Δ symbol.

During Δ TIME operation, S295 is open and the LO level through R547 holds Q548 off. A -15 volt pulse, during time-slot 2, at interface connector A33 provides approximately 0.9 ma column current through R543 and approximately 0.1 ma row current through R542. This enables the Δ symbol via interface connectors A38 and B38. At time slots other than time-slot 2, the -15 volt pulse is not present at interface connector A33.



INTERFACE CONNECTORS AND POWER SUPPLY

The Interface Connectors provide interconnection for control signals and power supply voltages between the mainframe and the time-base unit.

The Power Supply derives supply voltages from the mainframe supplies for power requirements unique to this instrument. Additional voltage regulation is also provided. TABLE 3-2 Readout Character Selection

TABLE 3-2

Readout Character Selection

Characters	Time-Slot	Description	Encoded by	
			Channel 1	Channel 2
Decimal	TS-1	Determines decimal magnitude (number of zeroes displayed or prefix change information).	R751, U752 R756	R753, R754 R755, R757
Uncalibrated TS-3 (>)	TS-3	Indicates calibrated or uncalibrated sweep rates and delay times.	R761, R764	S205 R762, R763
1, 2, 5	TS-4	Scaling (TIME/DIV).	R771, R772 R773	
0 through 9	TS-4, TS-5, TS-6, TS-7	Scaling (Delay Time).		U686
m, u, n, p	TS-8	Defines the prefix which modifies the units of measurement.	R781, R782 R783, R784	R785, R786 R787
s(seconds)	TS-9	Defines the unit of measurement.	R793, R794	R791, R792
Δ	TS-2	Indicates differential delay-time measurement.		R542, R543

MAINTENANCE

This section of the manual contains information for performing preventive maintenance, troubleshooting, and corrective maintenance for this instrument.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, lubrication, etc. Preventive maintenance performed on a regular basis may prevent instrument breakdown and will improve the reliability of the instrument. The severity of the environment to which this instrument is subjected determines the frequency of maintenance. A convenient time to perform preventive maintenance is preceding adjustment of the instrument.

CLEANING

This instrument should be cleaned as often as operating conditions require. Accumulation of dirt on components acts as an insulating blanket and prevents efficient heat dissipation which can cause overheating and component breakdown.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Use a non-residue type of cleaner, preferably isopropyl alcohol, totally denatured ethyl alcohol, Freon TF. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

EXTERIOR

Loose dust accumulated on the front panel can be removed with a soft cloth or small brush. Dirt that remains can be removed with a soft cloth dampened with a mild detergent and water solution. Abrasive cleaners should not be used.

WARNING

To avoid electric shock, disconnect the instrument from the power source before removing protective panels.

INTERIOR

Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-pressure air. Remove any dirt which remains with a soft brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces.

SWITCH CONTACTS

Switch contacts and pads are designed to operate dry for the life of the switch. However, as the switches are not sealed, dust attracted to the contact area may cause switch contacts to become electrically noisy. Cleaning may be accomplished by flushing the contact area with isopropyl alcohol or kelite (1 part kelite to 20 parts water). Do not use chemical cleaning agents that leave a film or that might damage plastic parts. Do not use cotton swabs or similar applicators to apply cleaning agents, as they tend to snag and leave strands of cotton on switch contacts. Should it become necessary to remove a switch for replacement or cleaning, refer to Component Removal and Replacement in this section.

VISUAL INSPECTION

This instrument should be inspected occasionally for such defects as broken connections, improperly seated semiconductors, damaged circuit boards, and heat-damaged parts.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, it is important that the cause of overheating be corrected to prevent recurrence of the damage.

LUBRICATION

Generally, there are no components in this instrument that require a regular lubrication program during the life of the instrument.

CAM SWITCH LUBRICATION

In most cases, factory lubrication should be adequate for the life of the instrument. However, if the switch has been disassembled for replacement of switch sub-parts, a lubrication kit containing the necessary lubricating materials and instruction is available through any

Tektronix Field Office. Order Tektronix Part 003-0342-02. General Electric Versilube™ silicone grease should be applied sparingly so that the lubricant does not get on the contacts. Refer to Figure 4-1 for lubrication instructions.

SEMICONDUCTOR CHECKS

Periodic checks of the semiconductors in this instrument are not recommended. The best check of semiconductor performance is actual operation in the instrument. More details on checking semiconductor operation are given under Troubleshooting.

ADJUSTMENT AFTER REPAIR

After any electrical component has been replaced, the adjustment of that particular circuit should be checked, as well as the adjustment of other closely related circuits. The Performance Check procedure in this manual provides a quick and convenient means of checking instrument operation. In some cases, minor troubles may be revealed or corrected by adjustment.

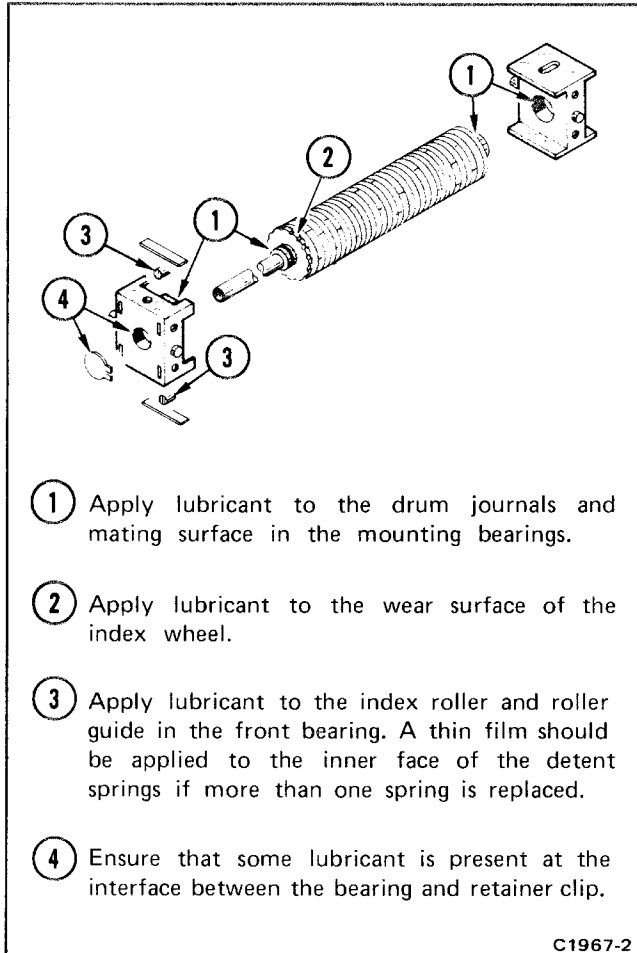


Figure 4-1. Lubrication procedure for a typical cam switch.

TROUBLESHOOTING

The following information is provided to help troubleshoot this instrument. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is very helpful in locating troubles, particularly where integrated circuits are used.

TROUBLESHOOTING AIDS

DIAGRAMS

Circuit diagrams are shown on foldout pages in section 8. The component number and electrical value of each component in this instrument is shown on the diagrams. Components that are mounted on circuit boards are outlined on the diagrams with a heavy black line.

TROUBLESHOOTING CHART

The Troubleshooting Chart in Section 8 is useful for locating a fault in the absence or presence of specific symptoms. Refer to the chart, circuit description, and circuit diagrams when troubleshooting the instrument.

VOLTAGES AND WAVEFORMS

Typical operating voltages and waveforms are shown next to the diagram where they were measured. Each waveform is numbered to locate on the diagram the point where the waveform was taken. Voltages and waveform conditions given on the diagram page list the test equipment used and the front-panel control status necessary to obtain the given waveform.

CIRCUIT-BOARD ILLUSTRATIONS

Circuit-board illustrations are shown on the foldout page preceding the associated diagram. Each board-mounted electrical component is identified by its circuit number, as are interconnecting wires and connectors.

Figure 8-2, in the front of the diagrams section, shows the location and assembly number of each circuit board in this instrument.

SWITCH CAM IDENTIFICATION

Switch cam numbers shown on diagrams indicate the position of each cam in the complete switch assembly. The switch cams are numbered from front to rear.

DIODE COLOR CODE

The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes, or a dot. The cathode and anode ends of metal-encased diodes are identified by the diode symbol marked on the case. For most silicon or germanium diodes with a series of stripes, the color code identifies the four significant digits of the JEDEC or vendor number using the resistor color-code system (e.g., a diode color-coded yellow-brown-green-red indicates a 1N-4152 diode).

WIRING COLOR CODE

Insulated wire and cable used in this instrument is color-coded to facilitate circuit tracing.

SEMICONDUCTOR BASING

Figure 4-2 illustrates the basing configurations for all semi-conductors used in this instrument. Some plastic-case transistors have lead configurations that do not agree with those shown here. If a replacement transistor is made by a different manufacturer than the original, check the manufacturer's basing diagram. All transistor sockets in this instrument are wired for the standard basing used for metal-case transistors.

INTER-BOARD PIN CONNECTOR IDENTIFICATION

The inter-board pin connector sockets are installed on circuit boards, in groups of 5 sockets (as in Fig. 4-3). Socket number 1 is indexed on the circuit board with either a triangular mark or the number 1. Each group of sockets is identified by its J (jack) number etched on the circuit board. The J numbers correspond with the J (jack) and P (plug) circuit numbers on the schematic diagrams.

MULTI-PIN CONNECTOR IDENTIFICATION

Multi-pin connectors mate with groups of pins soldered to circuit boards. Pin number 1 is indexed with a triangular mark on the circuit board and molded on the holder of the multi-pin connector, as shown in Figure 4-4. Each group of pins is identified by its corresponding J number etched on the circuit board. J numbers on the circuit boards correspond with J and P component numbers on the schematic diagrams.

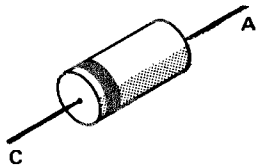
INTERFACE CONNECTOR PIN LOCATIONS

The Interface circuit board couples the plug-in unit to the associated mainframe (oscilloscope). Figure 4-5 identifies the pins on the interface connector as shown on Interface Connectors and Power Supply (diagram 8) in the Diagrams section.

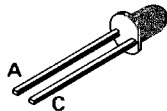
ADJUSTMENT AND PERFORMANCE CHECK

The Adjustment and Performance Check procedure in section 5 of this manual provides a quick and convenient means of checking instrument operation. In some cases, minor troubles may be revealed or corrected by adjustment.

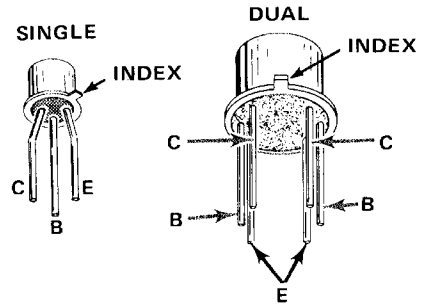
NOTE
LEAD CONFIGURATIONS AND CASE STYLES ARE TYPICAL, BUT MAY VARY DUE TO VENDOR CHANGES OR INSTRUMENT MODIFICATIONS.



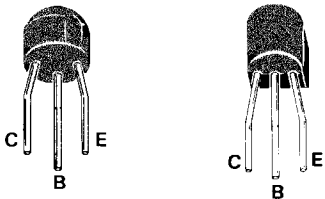
SIGNAL DIODE



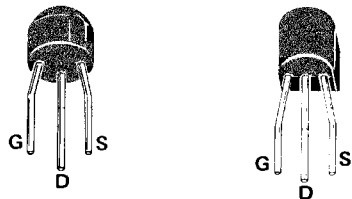
LIGHT EMITTING DIODE (L.E.D.)



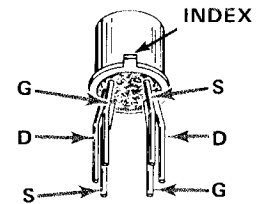
METAL CASE TRANSISTORS



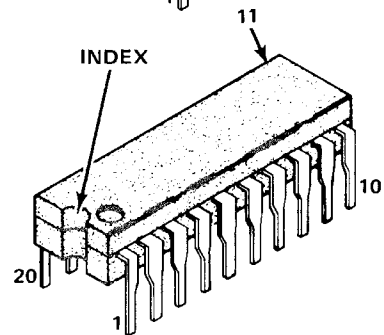
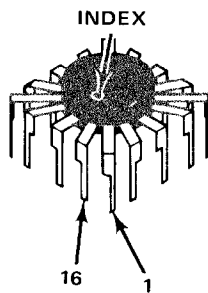
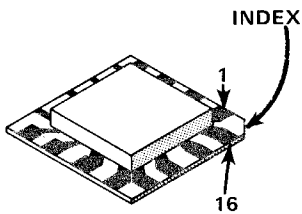
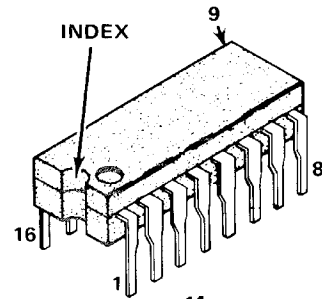
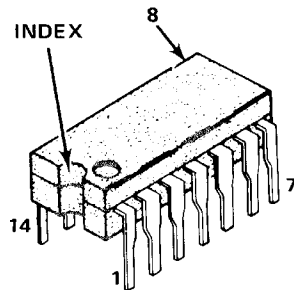
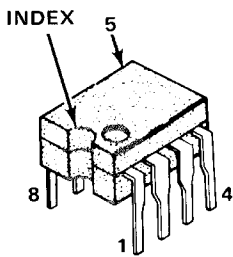
PLASTIC CASE TRANSISTORS



PLASTIC CASE FETS



DUAL METAL CASE FET



INTEGRATED CIRCUITS

(1986-66)2318-20A

Figure 4-2. Semiconductor lead configuration.

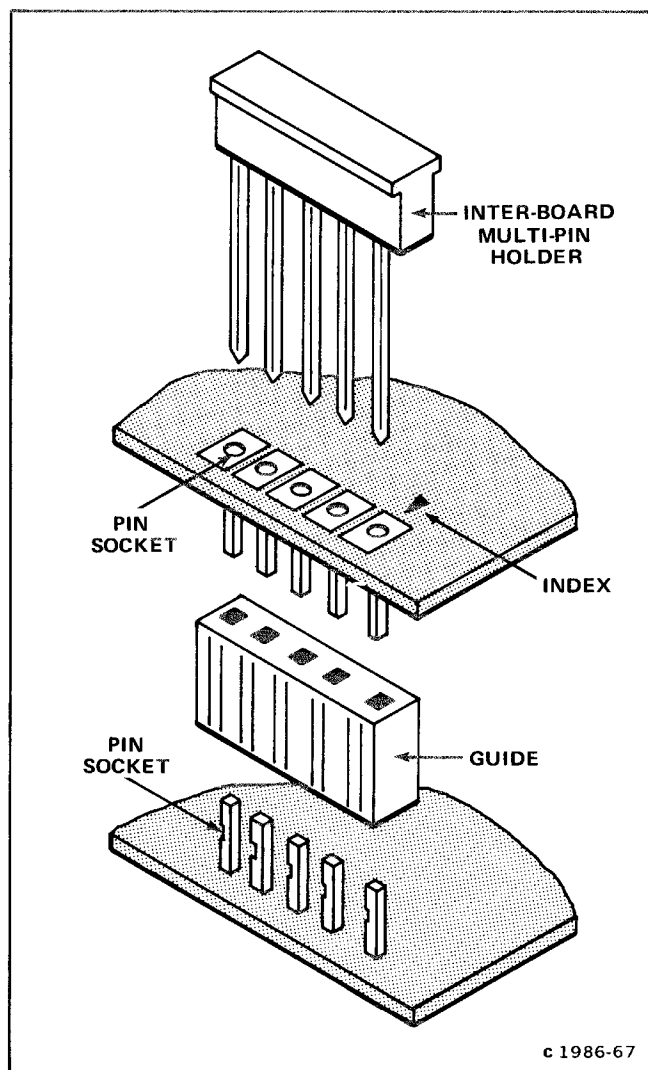


Figure 4-3. Inter-board multi-pin connector assembly.

TROUBLESHOOTING EQUIPMENT

The following equipment, in addition to that listed in the Calibration section, is useful for troubleshooting.

Transistor Tester

Description: Dynamic-type tester.

Purpose: Test semiconductors.

Recommended Tektronix types: 576 Curve Tracer, 577/177 Curve Tracer system, 7CT1N Curve Tracer unit and a 7000-series oscilloscope system, or a 5CT1N Curve Tracer unit and a 5000-series oscilloscope.

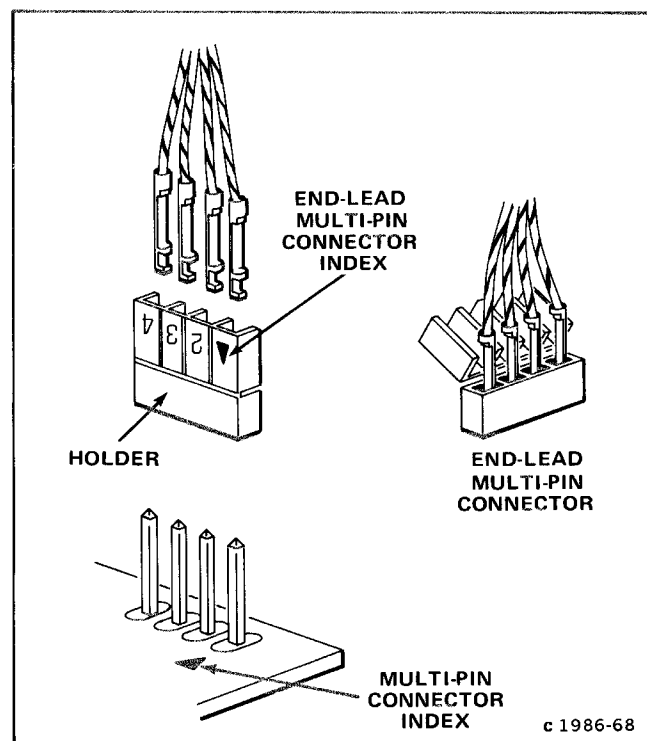


Figure 4-4. End-lead multi-pin connector assembly.

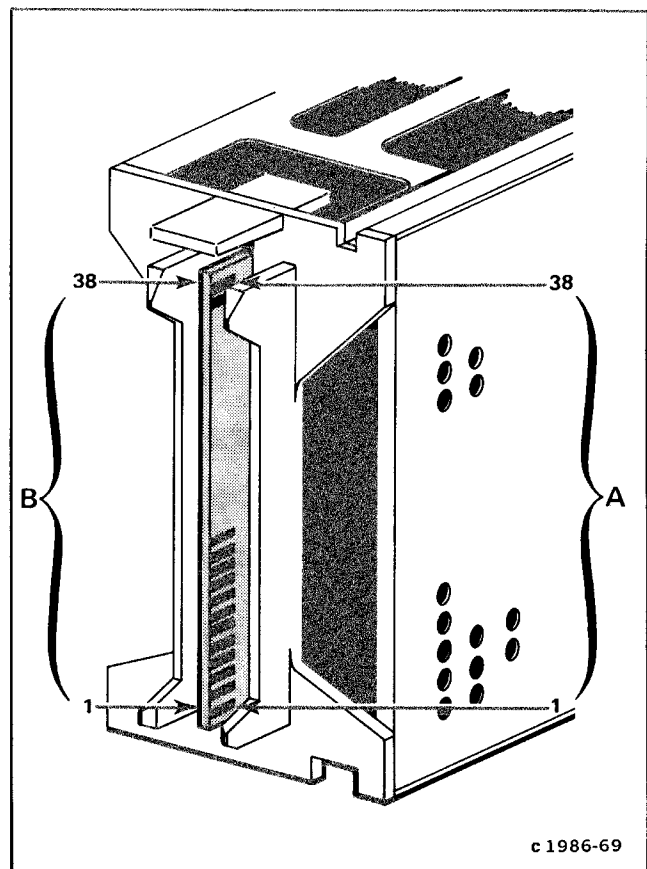


Figure 4-5. Location of pin numbers on Interface connector.

Multimeter

Description: Voltmeter, 10 megohm input impedance and a range from 0 to at least 50 volts dc; accuracy, within 0.1%. Ohmmeter, 0 to 20 megohms. Test probes should be insulated to prevent accidental shorting.

Purpose: Check voltage and resistance.

Test Oscilloscope

Description: Frequency response, dc to 100 megahertz minimum; deflection factor, 5 millivolts to 5 volts/division. A 10X, 10 megohm voltage probe should be used to reduce circuit loading.

Purpose: Check operating waveforms.

TROUBLESHOOTING TECHNIQUES

The following troubleshooting procedure is arranged to check the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks ensure proper connection, operation, and adjustment. If the trouble is not located by these checks, the remaining steps aid in locating the defective component. When the defective component is located, it should be replaced using the replacement procedure provided in Corrective Maintenance.

1. CHECK CONTROL SETTINGS

Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see Operating Instructions, section 2.

2. CHECK ASSOCIATED EQUIPMENT

Before troubleshooting, check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source. If the trouble persists, the time-base unit is probably at fault.

3. VISUAL CHECK

Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visible indications such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

4. CHECK INSTRUMENT ADJUSTMENT

Check the adjustment of this instrument, or the affected circuit if the trouble appears in one circuit. The apparent trouble may be the result of misadjustment. Complete adjustment instructions are provided in the Adjustment and Performance Check, section 5.

5. ISOLATE TROUBLE TO A CIRCUIT

To isolate trouble to a circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. When trouble symptoms appear in more than one circuit, check the affected circuits by taking voltage and waveform readings. Incorrect operation of all circuits often indicates trouble in the power supply. Check first for correct voltages of the individual supplies. However, a defective component elsewhere in the instrument can appear as a power-supply trouble and may also affect the operation of other circuits.

The Troubleshooting Chart in Section 8, Diagrams and Circuit Board Illustrations, serves as a guide for locating a defective circuit. Start at the top of the chart and perform the checks given on the left side of the page until a step is found that does not produce the indicated results. Further checks, or the circuit in which the trouble is probably located, are listed to the right of the step. The shaded blocks on the Troubleshooting Chart indicate circuit(s) that may cause instrument malfunction. The circuit(s) listed in shaded blocks are discussed in detail in the Theory of Operation section of this manual. This chart does not include checks for all possible defects; use steps 6 and 7 in such cases. After the defective circuit has been located, proceed with steps 6 and 7 to locate the defective component(s).

6. CHECK VOLTAGES AND WAVEFORMS

Often the defective component can be located by checking for the correct voltages and waveforms in the circuit. Refer to the diagrams section at the rear of the manual for typical voltages and waveforms.

NOTE

Voltages and waveforms on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the voltage and waveforms page adjacent to each schematic diagram. Note the recommended test equipment, front-panel control settings, voltage and waveform conditions, and test equipment cable connection instructions.

7. CHECK INDIVIDUAL COMPONENTS

The following procedures describe methods for checking individual components. Two-lead components that are soldered in place are best checked by first disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

WARNING

To avoid electric shock, always disconnect the instrument from the power source before replacing components.

TRANSISTORS

The best check of transistor operation is actual performance under operating conditions. A transistor can be most effectively checked by substituting a new component or one that has been checked previously. However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester. Static-type testers are not recommended, since they do not check operation under simulated operating conditions.

INTEGRATED CIRCUITS

IC's can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of circuit operation is desirable when troubleshooting circuits using IC's. Use care when checking voltages and waveforms around the IC's so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the inline IC's is with an IC test clip. This device also serves as an extraction tool. The lead configuration for the semiconductors used in this instrument are shown on a pullout page in the front of the diagrams section.

CAUTION

When checking diodes, do not use an ohmmeter scale that has a high internal current, since high currents may damage the diodes under test.

DIODES

A diode can be checked for an open or shorted condition by measuring the resistance between terminals with an ohmmeter scale having a low internal source current, such as the R X 1K scale. The resistance should be very high in one direction and very low when the meter leads are reversed.

The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes, or a dot. The cathode and anode ends of metal-encased diodes are identified by the diode symbol marked on the case. For most silicon or germanium diodes with a series of stripes, the color code identifies the four significant digits of the JEDEC or vendor number using the resistor color-code system (e.g., a diode color-coded yellow-brown-green-red indicates a 1N-4152 diode).

RESISTORS

Check resistors with an ohmmeter. See the Replaceable Electrical Parts list for the tolerance of the resistors used in this instrument. Resistors normally do not need to be replaced unless the measured value varies widely from that specified.

INDUCTORS

Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit. Partial shorting often reduces high-frequency response.

CAPACITORS

A leaky or shorted capacitor can usually be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking that the capacitor does not pass ac signals.

8. REPAIR AND ADJUSTMENT

If any defective parts are located, follow the replacement procedures in Corrective Maintenance. Be sure to check the performance of any circuit that has been repaired or had any electrical components replaced.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in this instrument are given here.

OBTAINING REPLACEMENT PARTS

All electrical and mechanical part replacements can be obtained through your Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts check the parts list for value, tolerance, rating, and description.

NOTE

When selecting replacement parts, remember that the physical size and shape of a component may affect the performance of the instrument, particularly at high frequencies. All parts should be direct replacements unless a different component will not adversely affect instrument performance. Some parts are manufactured or selected by Tektronix, Inc. to satisfy particular requirements, or are manufactured to specifications for Tektronix, Inc. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. To determine the manufacturer of parts, refer to parts list, Cross Index Mfr. Code Number to Manufacturer.

When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type.
2. Instrument number.
3. A description of the part (if electrical, include circuit number).
4. Tektronix part number.

SOLDERING TECHNIQUES

WARNING

To avoid electrical shock, disconnect the instrument from the power source before soldering.

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques, which apply to maintenance of any precision electronic equipment, should be used when working on this instrument. Use only 60/40 rosin-core, electronic-grade solder. The choice of soldering iron is determined by the repair to be made. When soldering on circuit boards, use a 15- to 40-watt pencil-type soldering iron with a 1/8-inch wide, wedge-shaped tip. Keep the tip properly tinned for best heat transfer to the solder point. A higher wattage soldering iron may separate the wiring from the base material. Avoid excessive heat; apply only enough heat to remove the component or to make a good solder joint. Also, apply only enough solder to make a firm solder joint; do not apply too much solder.

CAUTION

All circuit boards, except the readout circuit board, in this instrument are multilayer type boards with a conductive path(s) laminated between the top and bottom board layers. All soldering on these boards should be done with extreme care to prevent breaking the connections to the center conductor(s); only experienced maintenance personnel should attempt repair of these boards.

For metal terminals (e.g., switch terminals, potentiometers, etc.) a higher wattage-rating soldering iron may be required. Match the soldering iron to the work being done. For example, if the component is connected to the chassis or other large heat-radiating surface, it will require a 75-watt or larger soldering iron.

The following techniques should be used to replace a component on a circuit board:

1. Grip the component lead with long-nose pliers. Touch the soldering iron to the lead at the solder connection. Do not lay the iron directly on the board, as it may damage the board.
2. When the solder begins to melt, gently pull the lead out. If unable to pull out the lead without using force, try removing the other end of the component as it may be more easily removed.

NOTE

Some component leads are difficult to remove due to a bend placed on each lead during the manufacturing process. The bent leads hold components in place during a process that solders many components at one time.

If a component lead is extremely difficult to remove, it may be helpful to straighten the leads on the back side of the board with a small screwdriver or pliers while heating the soldered connection.

Use only enough heat to remove the component lead without removing the solder from the board. If it is desired to remove solder from a circuit-board hole for easier installation of a new component, a solder-removing wick or solder extractor should be used.

3. Bend the leads of the new component to fit the holes in the board. If the component is replaced while the board is mounted in the instrument, cut the leads so they will just protrude through the board. Insert the leads into the holes so the component is firmly seated against the board (or as positioned originally). If it does not seat properly, heat the solder and gently press the component into place.

4. Touch the iron to the connection and apply a small amount of solder to make a firm solder-joint. To protect heat-sensitive components, hold the lead between the component body and the solder joint with a pair of long-nose pliers or other heat sink.

5. Clip any excess lead protruding through the board (if not clipped in step 3).

6. Clean the area around the solder connection with a flux-removing solvent. Be careful not to remove information printed on the board.

COMPONENT REMOVAL AND REPLACEMENT

WARNING

To avoid electrical shock, disconnect the instrument from the power source before replacing components.

The exploded-view drawing associated with the Replaceable Mechanical Parts list may be helpful in the removal or disassembly of individual components or subassemblies. Component location and circuit board locations are shown in the Diagrams section.

CIRCUIT BOARDS

If a circuit board is damaged beyond repair, replace the entire board assembly. Part numbers for completely wired boards are given in the Replaceable Electrical Parts list.

A4-Digital Voltmeter Circuit Board

To remove the circuit board:

1. Remove 2 inter-board multi-pin connectors (see Fig. 4-3 for identification).
2. Note color of other multi-pin connectors and J numbers to which each is attached (see Fig. 4-4 for identification).
3. Disconnect all cables that terminate on Digital Voltmeter board.
4. Remove 3 securing screws from circuit board.
5. Lift rear of circuit board away from frame and slide toward rear until board clears the B DELAY MODE switch.

To replace the circuit board, reverse the order of removal. Be sure to dress the cable from P38 behind the mounting posts as shown in Figure 4-6 to prevent signal coupling to the circuit board.

A3. Readout Circuit Board

To remove circuit board, follow procedure given in Figure 4-7.

A2-Trigger Circuit Board

To remove circuit board:

1. Remove 3 inter-board multi-pin connectors (see Fig. 4-3 for identification).
2. Remove 2 screws from circuit board.
3. Lift rear of circuit board away from frame and slide board to the rear until push-button switches are clear of front panel.
4. Note wire color on single-conductor shielded cables (see Fig. 4-8 for identification) and connector to which each is attached.
5. Disconnect cables from back of circuit board.

To replace circuit board, reverse order of removal.

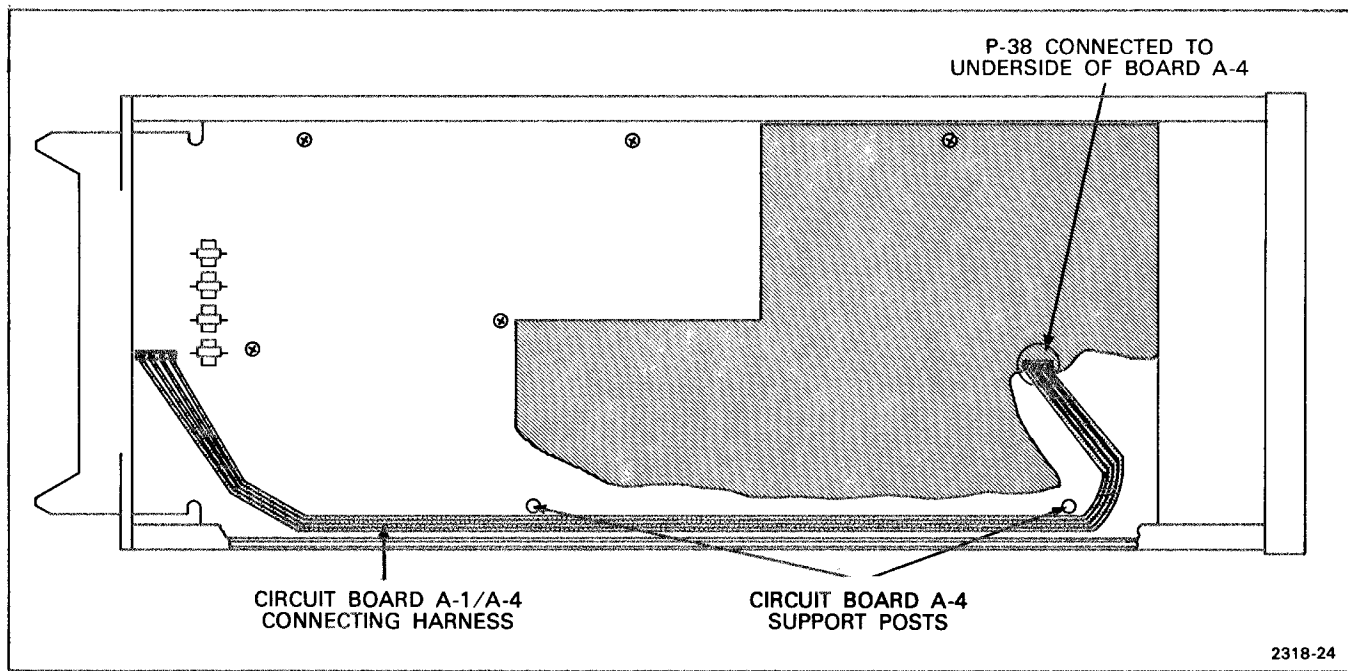


Figure 4-6. P38 cable dress illustration.

A1-Interface Circuit Board

To remove circuit board:

1. Remove Trigger and Digital Voltmeter circuit boards using procedures given previously.
2. Set TIME/DIV knob to 2 ms position and VARIABLE TIME/DIV knob to expose the set screw.
3. With hex-key wrench, loosen set screws in both knobs. Remove knobs from shafts.
4. Note color of multi-pin connectors (see Fig. 4-4 for identification) and P numbers to which each connect. Disconnect all multi-pin connectors from board.
5. Remove 4 screws that secure gray plastic rear panel to instrument frame.
6. Remove 6 screws that secure perimeter of board to instrument frame.
7. Remove Interface circuit board through rear of instrument.

To install the Interface circuit board:

1. Guide TIME/DIV switch shaft through hole in front-panel.

2. Install 6 screws that secure perimeter of board to instrument frame.
3. Install gray plastic rear panel with 4 securing screws.
4. Replace TIME/DIV knob on shaft. Align knob index with 2 ms position; then, tighten 2 set screws on knob.
5. Replace VARIABLE knob and tighten set screw.
6. Replace all cables as noted during removal procedure.
7. Replace Trigger and Digital Voltmeter circuit boards.

SWITCHES

Two types of switches are used in this instrument. Contact alignment and spacing are critical to the operation of the push-button and cam switches. Therefore, defective switches should either be replaced as a unit or repaired only by personnel experienced with these types of switches. Your local Tektronix Field Office or representative can provide additional repair information. The following special maintenance information is provided for switch replacement.

Cam Switches

Cam switches consist of a rotating cam that mates with contacts on the adjacent circuit board. These contacts are

activated by lobes on the cam as the switch is rotated. A cam switch can be disassembled for inspection, cleaning, repair, or replacement; however, it is recommended that the switch be removed and replaced as a unit. Refer to Figure 4-9 for special instructions on cam switch removal.

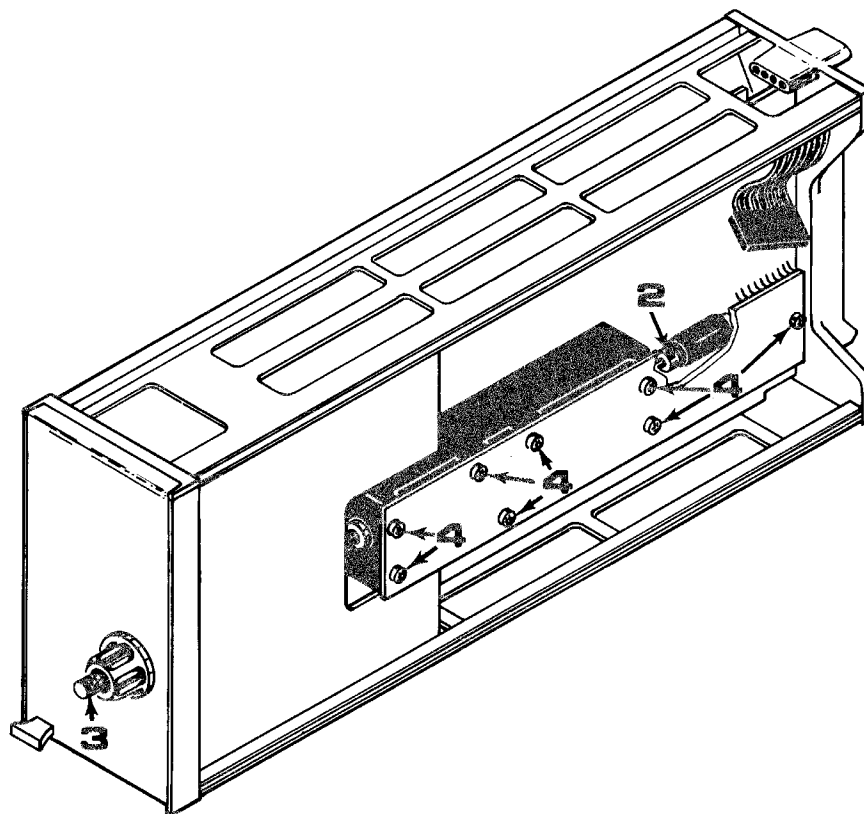
CAUTION

Cam switch repair should be undertaken only by experienced maintenance personnel. Switch alignment and contact spacing must

be carefully maintained for proper operation. A cam switch repair kit is available (Tektronix part 040-0541-00) which contains special alignment tools for use in repairing or replacing the switch contacts. For information or assistance on maintenance of cam switches, contact your local Tektronix Field Office or representative.

Push-Button Switches

Removal and replacement instructions for push-button switches are shown in Figure 4-10.



REMOVE READOUT BOARD AS FOLLOWS:

1. Note index of multi-pin connector attached to board and disconnect cable.
2. Loosen set screw on variable switch assembly.
3. Remove VARIABLE (CAL IN) TIME/DIV knob and attached shaft out the front of the instrument.
4. Remove the 8 securing screws from board.
5. Lift board away from cam switch assembly.

TO REPLACE READOUT BOARD, REVERSE THE ORDER OF REMOVAL.

c 1986-70

Figure 4-7. Readout board removal procedure.

WARNING

Handle silicone grease with care. Avoid getting silicone grease in eyes. Wash hands thoroughly after use.

Replacement devices should be of the original type or a direct replacement. Figure 4-2 shows the lead configurations of the semiconductor devices used in this instrument. Some plastic-case transistors have lead configurations that do not agree with those shown here. When replacing, check the manufacturer's basing diagram for correct basing. All transistor sockets in this instrument are wired for the standard basing used for metal-case transistors. Semiconductors that have heat radiators use silicone grease to increase heat transfer. Replace the silicone grease when replacing these semiconductors. See HYPCON CONNECTORS for hybrid integrated circuit replacement instructions.

An extraction tool should be used to remove the inline integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. Order Tektronix part 003-0619-00. If an extraction tool is not available when removing one of these integrated circuits, pull slowly and evenly on both ends of the device. Try to avoid having one end of the integrated circuit disengage from the socket before the other, as the pins may be damaged.

HYPCON CONNECTORS

The Hypcon connector is a precision-made connector designed to provide low loss electrical and thermally efficient connection between the printed circuit board and hybrid integrated circuit. An exploded view of the Hypcon connector is shown in Figure 4-11. Care must be taken when replacing the hybrid IC's not to touch the elastomer gold-plated contacts with the fingers or to use a cleaner which will degrade the conductivity of the contacts. The Hypcon connector and hybrid IC should be removed if it becomes necessary to use a cleaning solvent near the connector when replacing adjacent (within 1/2") circuit board components. **IMPORTANT:** Remove all traces of solder flux or foreign material contamination from the circuit board contact area before replacing the connector. Contamination usually takes place during the soldering and cleaning processes. Even when the soldering is done carefully, flux, oil, or other contaminants can be carried into these devices during the cleaning operation. When the solvent evaporates, non-conductive contaminants may remain on or near the contact interfaces.

The cleaning process, either hand cleaning with a solvent or machine cleaning in an automatic detergent wash, is not recommended with boards fitted for Hypcon connectors.

If a component adjacent to a Hypcon connector must be replaced, the following steps are recommended:

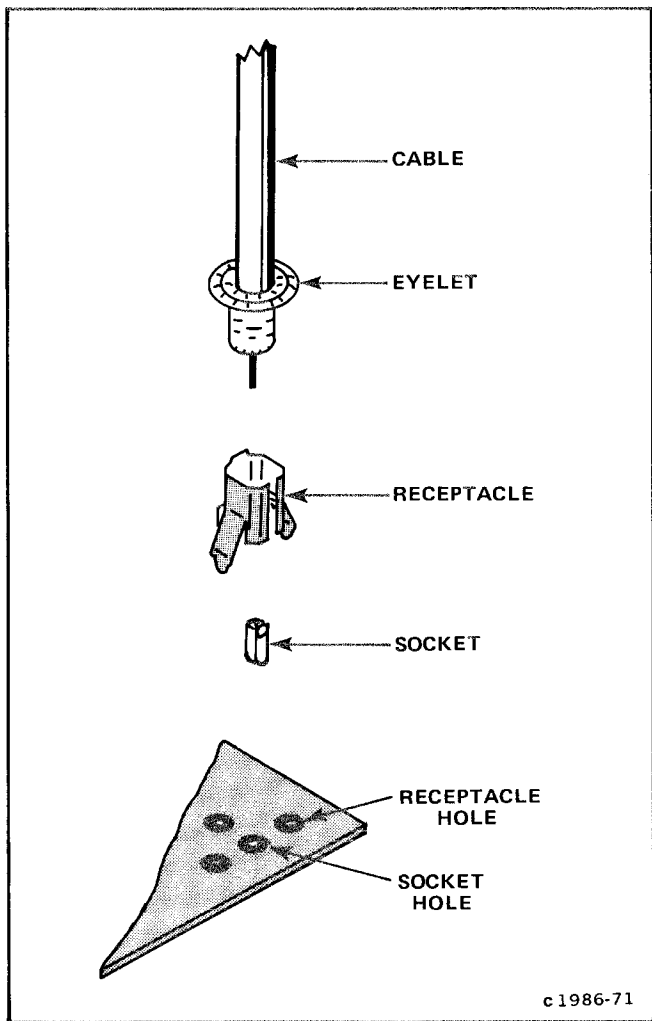


Figure 4-8. Coaxial end-lead connector assembly.

SEMICONDUCTORS

WARNING

To avoid electric shock, disconnect the instrument from the power source before replacing components.

Semiconductors should not be replaced unless actually defective. If semiconductors are removed during routine maintenance, return them to their original sockets. Unnecessary replacement of semiconductors may affect the adjustment of this instrument. When semiconductors are replaced, check the operation of that part of the instrument which may be affected.

1. Remove the hybrid IC and Hypcon connector (see Disassembly and Removal instructions) before any soldering or cleaning and store in a dirt-free covered container. When several hybrids and Hypcon connectors are to be removed, keep parts together and replace as sets; do not interchange parts.

2. Hand soldering:

- a. Use small diameter solder (0.030"-0.040").
- b. Use low wattage soldering irons (15 to 40 watts).
- c. Use care with flux amount and placement.

3. Remove solder flux and contact contamination with isopropyl alcohol.

4. Flush the hybrid and Hypcon connector mounting area with isopropyl alcohol. Do not scrub with a cotton-tipped applicator, as cotton fibers will adhere to edges and surfaces of contact areas and cause open or intermittent connections. If the etched circuit board surfaces require more cleaning, scrub with a pink pearl rubber eraser and blow or vacuum clean while dusting surface with a small soft clean brush.

5. If the hybrid IC and elastomer contact holder are contaminated, clean the contact holder and hybrid by brushing or spraying with alcohol and oven dry at 100° C. Do not scrub with a cotton-tipped applicator or similar device. If the contact holder is excessively contaminated, replace it with a new one.

Two inch-pounds of torque should be applied to the mounting screws to secure the Hypcon to the circuit board.

Exercise care when mounting the frame-elastomer connector holder-hybrid IC assembly to the circuit board to prevent misalignment between the connector and board. Grasp the assembly at the hybrid with tweezers to facilitate correct alignment of the plastic frame projections with the circuit board.

CAUTION

Because of the close tolerances involved, special care must be taken to assure correct index alignment of each Hypcon part during reassembly. Failure to do so can result in damage to the parts when they are joined together. See Figure 4-11 for index locations.

If your instrument contains both the flush and stepped type of Hypcon connectors be careful not to mix the elastomer contact holders during reassembly. The flush Hypcon connectors have green elastomer contact holders and the plastic frame is marked "FLUSH." The stepped Hypcons have neutral-colored elastomer contact holders

with a light ridge or step on the contact surface; the large frames are marked "STEPPED." The registration pins on the stepped plastic frame are slightly longer than those on the flush frame. The elastomer contact holder in the small stepped connectors is indexed differently than the large connectors. Look for a small gold arrow in one corner of the holder instead of a flat corner. Match this corner arrow with the pointed corner of the plastic frame. Give close attention to this indexing, as it is easy to insert the elastomer contact holder incorrectly.

Differences also exist between the large flush and large stepped Hypcon circuit board receptacles. Figure 4-11 shows the cross-sectional differences which must be observed when working with an instrument that contains both types of Hypcon connectors.

CAUTION

Damage to the elastomer contact holder can result if the connectors are not mated properly with the board receptacles.

When replacing the flush-type hybrid, insert the hybrid in the board opening and then position the Hypcon connector in the board registration holes for perfect alignment. With the large and small-size stepped connectors, assemble the connector and hybrid before installing on the circuit board. Use tweezers to hold the assembly by the hybrid "hat" and guide the frame registration pins into the circuit board openings. Avoid touching the hybrid and elastomer contact holder with your fingers; finger oils can degrade conductivity.

A procedure for removal and replacement is included in Figure 4-11.

Beginning and ending hybrid substrate contact numbers are printed on the substrate at the index corner. See Figure 4-2, Semiconductor lead configurations.

INTERCONNECTING PINS

Three methods of interconnection are used to connect the circuit boards with other boards and components. When the interconnection is made with a coaxial cable, a special end-lead connector plugs into a socket on the board (Fig. 4-8). When the interconnection is made with a wire lead, an end-lead connector is used which mates with the interconnecting pin soldered into the board (Fig. 4-4). When the interconnection is made between adjacent boards, an inter-board multi-pin connector is used (Fig. 4-3). The following information provides the removal and replacement procedure for the various types of interconnection methods.

Coaxial End-Lead Connectors

Replacement of the coaxial-type end-lead connectors requires special tools and techniques; only experienced maintenance personnel should attempt to remove and replace these connectors. It is recommended that the

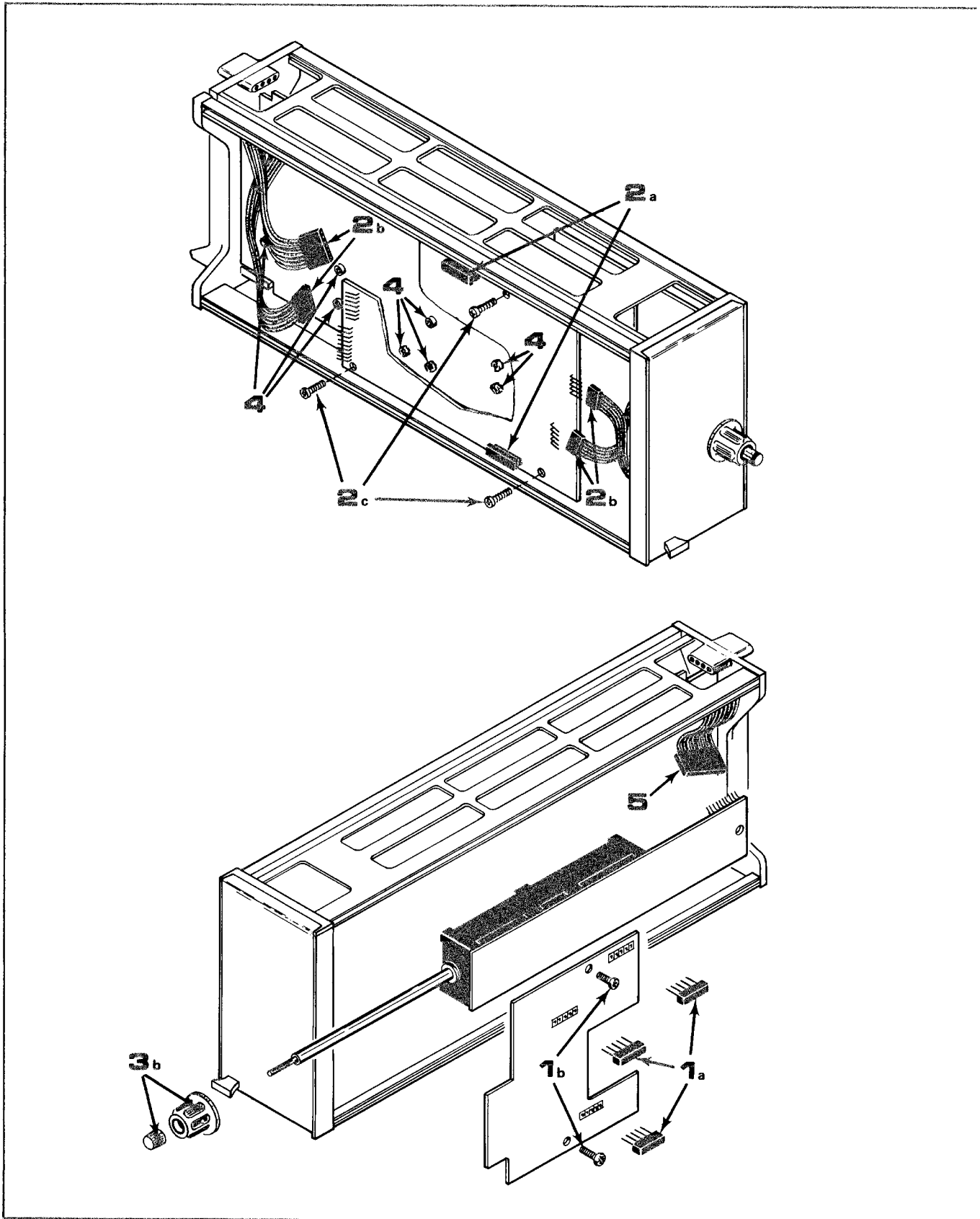


Figure 4-9. Cam switch removal procedure.

REMOVE CAM-TYPE SWITCH ASSEMBLY AS FOLLOWS:

1. Remove Trigger circuit board as follows:
 - a. Remove the 3 inter-board multi-pin connectors.
 - b. Remove 2 screws from circuit board.
 - c. Lift rear of board away from frame and slide toward rear of instrument.
 - d. Note wire color of single-conductor shielded cables and connector to which each attach. Then, disconnect cables.

2. Remove Digital Voltmeter circuit board as follows:
 - a. Remove the 2 inter-board multi-pin connectors.
 - b. Note color of multi-pin connectors and J numbers to which each attach. Then, disconnect 4 multi-pin connectors.
 - c. Remove the 3 securing screws from circuit board.
 - d. Lift rear of board and slide toward rear of instrument until board clears the B DELAY MODE switch.

3. Remove the TIME/DIV and VARIABLE (CAL IN) knobs as follows:
 - a. Set the TIME/DIV switch to the 2 ms position and the VARIABLE (CAL IN) knob out to expose set screw.
 - b. With a hex key wrench loosen the set screws in both knobs. Remove knobs from shaft.

4. Remove 8 screws securing cam-type switch to the Interface circuit board.

5. Disconnect multi-pin connector from Readout circuit board.

To replace the cam-type switch, reverse the order of removal.

c 1961-20

Figure 4-9 (Cont.). Cam switch removal procedure.

cable be replaced as a unit. For cable part numbers see the Replaceable Mechanical Parts list. An alternative solution is to refer the replacement of the defective connector to your local Tektronix Field Office or representative.

End-Lead Connectors

The pin connectors used to connect the wires to the interconnecting pins are clamped to the ends of the associated leads. To remove and replace damaged end-lead pin connectors, remove the old pin connector from the end of the lead and clamp the replacement connector to the lead.

Some of the pin connectors are grouped and mounted together in a plastic holder; the overall result is that these connectors are removed and installed as a multi-pin connector (see Fig. 4-4). To provide correct orientation of this multi-pin connector when it is replaced, an arrow is marked on the circuit board and a matching arrow is molded into the plastic holder of the multi-pin connector. Be sure these arrows are aligned as the multi-pin connector is replaced. If the individual end-lead pin connectors are removed from the plastic holder, note the color of the individual wires for replacement.

Inter-Board Multi-Pin Connector

The inter-board multi-pin connector pin-holder is not repairable and should be replaced as a unit (see Fig. 4-3). Refer to the Replaceable Mechanical Parts list for part number. Inter-board multi-pin connector pin-sockets are soldered to circuit boards (see Fig. 4-3). To replace a socket, first remove the guide. Then, remove the old socket using soldering techniques previously described. Solder the new socket in place, making sure it will align properly with the inter-board connector pins.

Circuit-Board Pins



All circuit boards in this instrument, except the Readout circuit board, are multilayer type boards with a conductive path(s) laminated between the top and bottom board layers. All soldering on these boards should be done with extreme care to prevent breaking the connection to the center conductor(s); only experienced maintenance personnel should attempt repair on these boards.

A circuit board pin replacement kit including the necessary tools, instructions, and replacement pins is available from Tektronix, Inc. Order Tektronix part 040-0542-01. Replacement of circuit-board pins on multilayer boards is not recommended; refer such repairs to your local Tektronix Field office or representative.

To replace a damaged pin which is mounted on a single-layer circuit board, first disconnect any pin connectors. Then (using Soldering Techniques given earlier in this section), unsolder the damaged pin and pull it from the board with a pair of pliers, leaving the ferrule (see Fig. 4-12) in the hole, if possible. If the ferrule remains in the circuit board, remove the spare ferrule from the replacement pin and press the new pin into the hole in the circuit board. If the ferrule is removed with the damaged pin, clean out the hole, using a solder-removing wick and a scribe. Then, press the replacement pin with attached spare ferrule into the hole. Position the replacement pin in the same manner as the damaged pin. Solder the pin to the circuit board on each side of the board. If the old pin was bent at an angle to mate with a connector, carefully bend the new pin to the same angle. Replace the pin connector.

FRONT-PANEL LIGHTS

This instrument uses LED's (light-emitting diodes) and incandescent lamps for front-panel lights.

LED's are used to illuminate the TRIG'D and SINGLE SWP READY lights. To replace LED's, remove the cap from the sleeve as in Figure 4-13. Note lead wire color coding and LED lead configuration. Unsolder wire leads and remove LED from the cap. Solder the replacement LED and lead wires to the socket cap as noted previously. Install the cap in the sleeve.

Incandescent lamps are used to illuminate the transparent push-button switches. To replace incandescent lamps unsolder the lead wires from the rear of the cap (see Fig. 4-13), pull the cap and bulb out of the sleeve. Solder the replacement lamp and lead wires to the cap. Install the assembly in the sub-panel sleeve.

ADJUSTMENT AFTER REPAIR

After any electrical component has been replaced, the adjustment of that particular circuit should be checked, as well as other closely related circuits. See section 5 for a complete adjustment procedure.

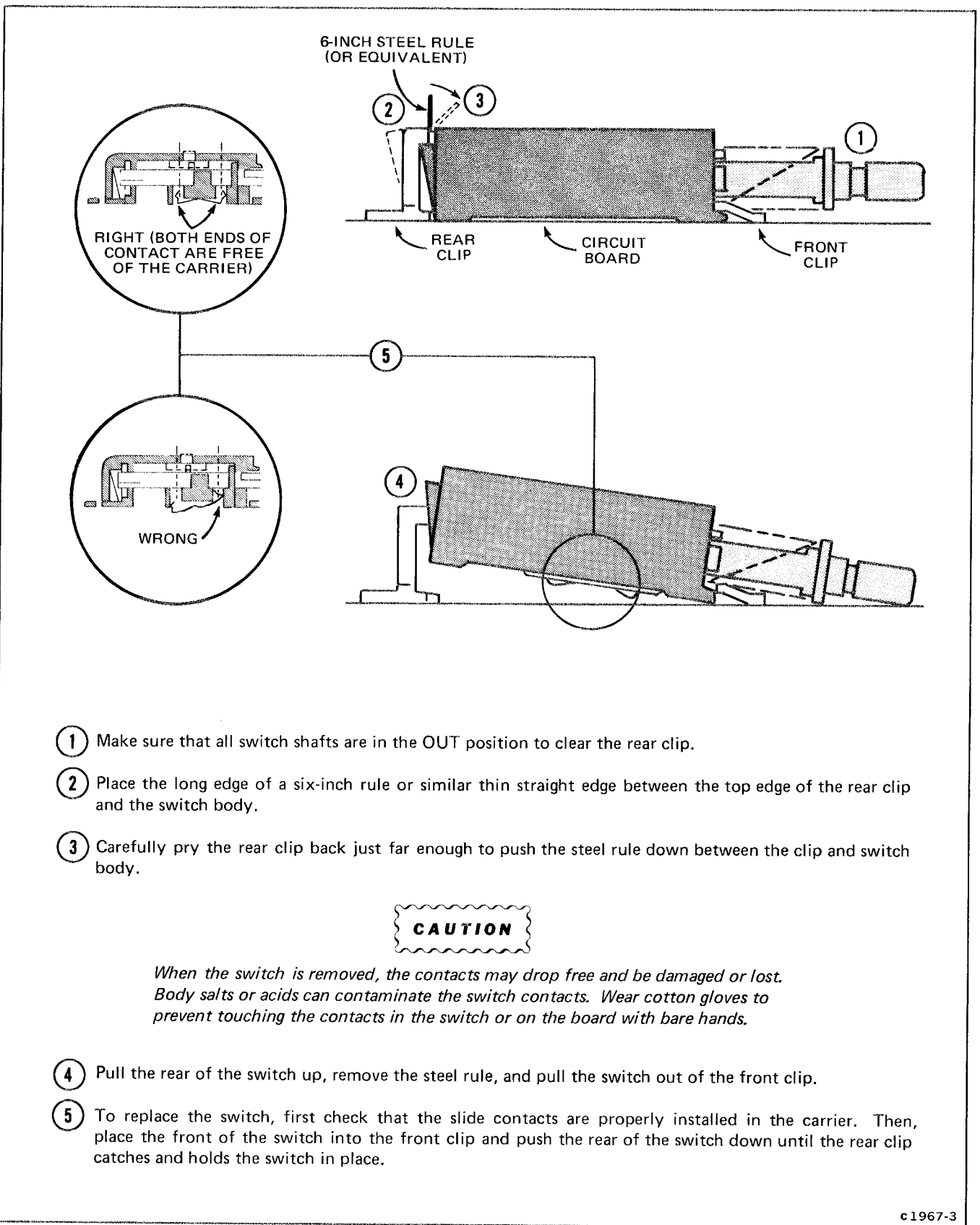
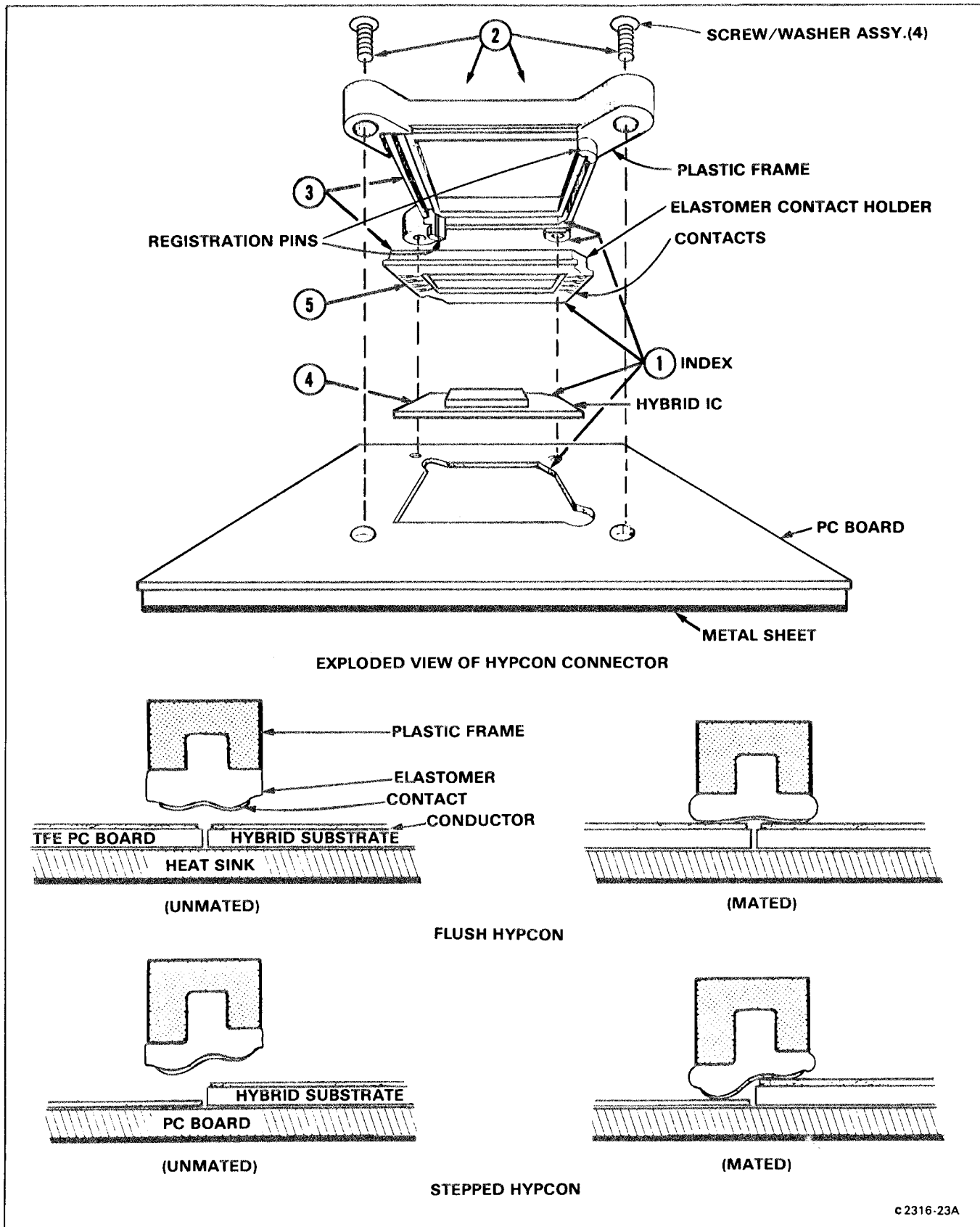


Figure 4-10. Removal procedure for typical push-button switch.



c 2316-23A

Figure 4-11. Hypcon connector removal and replacement.

DISASSEMBLY AND REMOVAL

- ① Note index on circuit board (arrow) and Hypcon plastic frame (pointed mounting ear).
- ② Unscrew and remove the 4 screw/washer assemblies.
- ③ Lift Hypcon connector from board.
- ④ Note index location of hybrid and remove from board with tweezers.
- ⑤ Note index location of elastomer contact holder and remove by grasping a corner of the contact holder with tweezers and lifting up. Do not touch the gold-plated contacts with your fingers.

REASSEMBLY AND REPLACEMENT

Grasp corner of elastomer contact holder with tweezers and place in plastic frame slot being careful to match the flat contact holder with the flat frame corner. Place a clean plastic envelope over finger and press with finger to seat contact holder into the frame. The contact holder must be evenly seated on all four sides.

Flush Hypcon: Match hybrid flat corner with board receptacle flat corner and place hybrid in receptacle. Match pointed mounting ear of Hypcon connector with flat corner of receptacle and guide registration pins into the board holes.

Stepped Hypcon: Using tweezers, match the hybrid corner index with the elastomer contact holder index and insert between the registration pins. Turn the assembly over, grasp the hybrid "hat" with the tweezers, and guide the registration pins into the board holes. Match the plastic frame pointed mounting ear with the circuit board arrow.

Insert mounting hardware and apply 2 inch-pounds of torque to secure the connector assembly.

c 2316-23B

Figure 4-11 (Cont.). Hypcon connector removal and replacement.

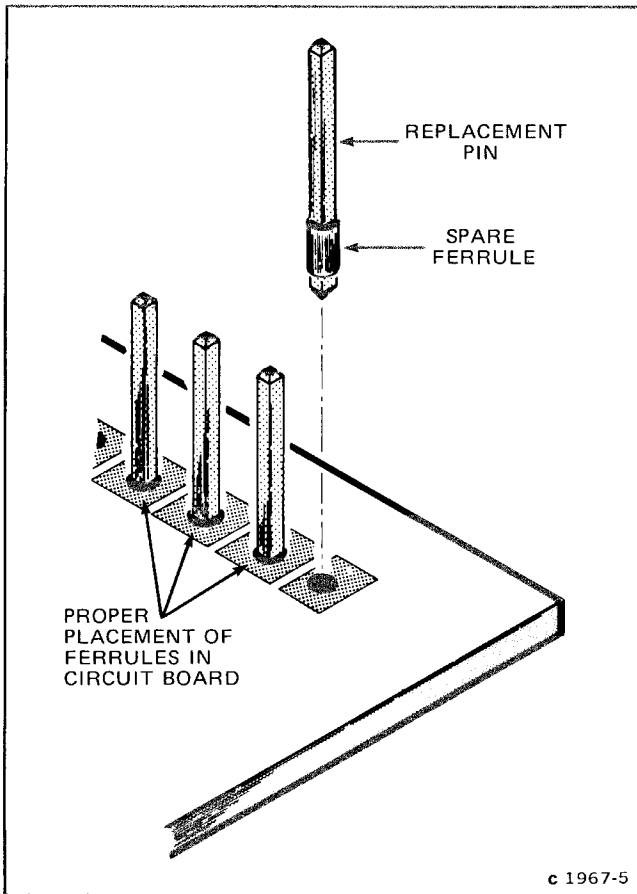


Figure 4-12. Exploded view of circuit-board pin and ferrule.

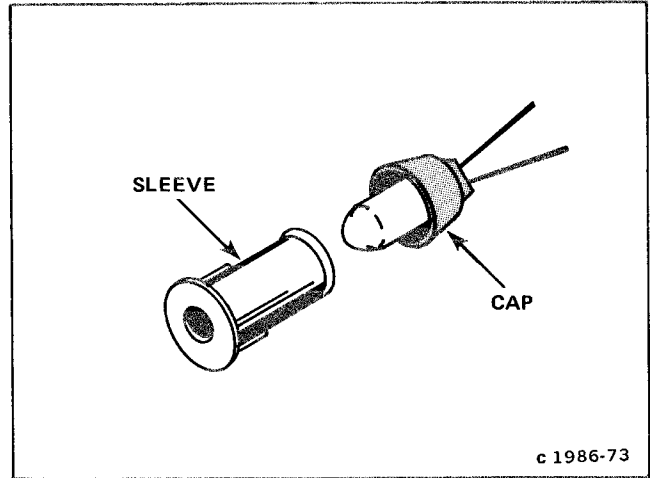


Figure 4-13. Front-panel light socket assembly.

REPACKAGING FOR SHIPMENT

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing: owner (with address) and the name of an individual at your firm that can be contacted. Include complete instrument serial number and a description of the service required.

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

Surround the instrument with polyethylene sheeting to protect the finish of the instrument. Obtain a carton of corrugated cardboard of the correct carton strength and having inside dimensions of no less than six inches more than the instrument dimensions. Cushion the instrument by tightly packing three inches of dunnage or urethane foam between carton and instrument, on all sides. Seal carton with shipping tape or industrial stapler.

The carton test strength for your instrument is 200 pounds.

CALIBRATION

This section provides information necessary to: (1) Verify that this instrument meets the electrical specifications in Section 1, General Information, (2) verify that all controls function properly, and (3) perform all internal adjustments. The Part I-Performance Check procedure checks the electrical specifications listed in section 1 without making any internal adjustments. The Part II-Adjustment and Performance Check procedure provides a complete sequential check of instrument performance concurrent with a complete sequential adjustment of internal controls. A separate Operators Checkout Procedure, in the Installation section of this manual, can be used to check only the functions of the front-panel controls and connectors.

PRELIMINARY INFORMATION

USING THESE PROCEDURES

Both the Part I-Performance Check and Part II-Adjustment and Performance Check are divided into functional block subsections (e.g., A. Triggering System and B. Horizontal System). The order in which the subsections and steps (A1, A2, B1, B2, etc.) appear in each procedure is the recommended sequence for accomplishing a performance check or calibration of the instrument. Subsections within either procedure can be performed independently, as can each step within any subsection. Refer to Partial Procedures for specific instructions on performing either a partial Performance Check or a partial Adjustment and Performance Check.

All functional block subsections begin with a list of required test equipment, followed by instructions for Before You Begin and the list of Preliminary Control Settings for that subsection (e.g., TRIGGERING SYSTEM Preliminary Control Settings, etc.). Each step contains separate Setup Conditions which, if applicable, include the instrument control settings, an illustrated test setup, and test equipment control settings. The instrument and test equipment control settings listed in the Setup Conditions for each step may include additional settings, changes from the previous step, or changes to the Preliminary Control Settings making it possible to perform partial procedures. The illustrated test setup in the Setup Conditions shows all test equipment needed to perform the entire step, as well as the setup necessary to begin the step instructions.

Partial Procedures

Part I-Performance Check. To perform a partial Performance Check procedure, first determine which electrical specifications are to be checked. Table 5-1, Performance Check Summary, lists the applicable electrical specifications from Section 1, General Information, and provides references to the step(s) in which the performance requirements are checked. The Performance Check Index, at the start of Part I Performance Check, provides a convenient means for locating the desired subsections and steps. For example: if the external trigger amplifier had been repaired and a performance check was considered necessary, use the Performance Check Summary table to locate the

specifications affected by the repair, and the step title of Part I-Performance Check in which those performance requirements are checked. Then use the Performance Check Index to locate the TRIGGER SYSTEM subsection and the step and page number of the applicable step(s).

Any step of a subsection can be performed separately by following the instructions given below.

1. Locate the desired subsection and applicable steps (e.g., B1, B2, B4, etc.) with the Performance Check Summary table and the Performance Check Index.
2. Perform the Performance Check Power Up Sequence at the start of Part I-Performance Check, and the instructions under Before You Begin and Preliminary Control Settings at the beginning of the subsection.
3. Perform the Setup Conditions instructions for the desired step. Disregard any control settings which are the same as those under Preliminary Control Settings.
4. Proceed with the lettered instructions (e.g., a, b, c, etc.).

NOTE

If the steps performed are consecutive, it is not necessary to repeat the Preliminary Control Settings after the first step. However, when a step is skipped, the Preliminary Control Settings must be performed again.

Part II-Adjustment and Performance Check. Although each step in the Part II-Adjustment and Performance Check procedure can be performed independently, we recommend that the entire subsection be performed if any adjustments are made. Table 5-1, Performance Check Summary, lists the electrical specifications from Section 1, General Information, and provides references to the step(s) in which the performance requirements are checked and appropriate adjustments are made. The Adjustment and Performance Check Index, at the start of Part II provides a convenient means for locating the desired subsections and steps. For

Calibration—7B15

example: If the A1 Interface board had been replaced, use the Performance check and Calibration Summary table to locate the specifications affected by the repair, and the step title(s) of Part II-Adjustment and Performance Check in which those performance requirements are checked and adjusted. Then use the Adjustment and Performance Check Index to locate the HORIZONTAL SYSTEM subsection and the step and page number of the appropriate step(s).

A heading system is used to readily identify the steps (A1, A2, B1, B2, etc.) that contain performance check and/or adjustment instructions. For example, if CHECK appears in the title of a step, a performance requirement listed in the Specifications is checked. If ADJUST appears as 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 one or more performance requirement checks and adjustments.

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

1. **CHECK**—indicates that the instruction accomplishes a performance requirement check.

2. **EXAMINE**—usually precedes an ADJUST instruction and describes how to determine whether the adjustment is necessary.

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

ADJUSTMENT INTERVAL

To maintain instrument accuracy, check the performance of the time base every 1000 hours of operation, or every 6 months if used infrequently. Before complete adjustment, thoroughly clean and inspect this instrument as outlined in Section 4, Maintenance.

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.

**TABLE 5-1
Performance Check Summary**

Characteristic	Performance Requirement	Performance Check Step	Adjustment and Performance Step	
HORIZONTAL SYSTEM				
Sweep Rates				
Calibrated Range	0.2 s/div to 2 ns/div in 25 steps. X10 Magnifier extends fastest calibrated sweep rate to 0.2 ns/div.	B11. Check Sweep Timing. B12. Check Magnified Sweep Timing.	B5 Adjust Sweep Timing (C361, R305, R310, R480) B18. Check Magnified Sweep Timing	
Variable Range	Continuously variable uncalibrated sweep rate to at least 2.5 times the calibrated sweep rate setting.	B4. Check Variable Time/Division and Variable Hold Off.	B4. Check Variable Time/Division and Variable Hold Off.	
Sweep Accuracy ¹ with 7104, 7900 and 7800 Series Mainframes	Measured over center 8 displayed divisions. SWP CAL is adjusted at 1 ms/div within the +20° to +30° C range. (7B15 DELAY MODE Switch set to INDEPENDENT.)			
+15° to +35° C	UNMAG	B11. Check Sweep Timing. B12. Check Magnified Sweep Timing.	B5. Adjust Sweep Timing (C361, R305, R310, R480) B18. Check Magnified Sweep Timing.	
0.2 s/div to 10 ns/div	2%			MAG X10
5 ns/div and 2 ns/div	3%			3%
			4% ²	
0° to +50° C	Derate +15° to +35° C accuracy by additional 1%.	Customer verification normally not required.		
Sweep Length	At least 10.2 div.	B2. Check Sweep Length and Positioning Range.	B2. Check Sweep Length and Positioning Range.	

¹Some mainframes limit fastest calibrated sweep rate.

²200 ps/div is measured over any 5 divisions within the center 8 divisions.

**TABLE 5-1 (CONT.)
Performance Check Summary**

Characteristic	Performance Requirement	Performance Check Step	Adjustment and Performance Step
MAG Registration	0.5 div or less from graticule center when changing from MAG X10 to MAG X1.	B3. Check Magnifier Gain and Registration.	B3. Check/Adjust Magnifier Gain and Registration (R460, R470)
Position Range POSITION Controls fully CW	Start of sweep must be to right of graticule center at 1 ms/div.	B2. Check Sweep Length and Positioning Range.	B2. Check Sweep Length and Positioning Range.
POSITION Controls fully CCW	End of sweep must be left of graticule center at 1 ms/div.		
Δ TIME Range	0.0 to at least 9.0 times TIME/DIV setting.	B6. Check Delay Time, Δ Time, and Trace Separation Ranges.	B10. Adjust Delay Start and Pickoff Bias (R335, R535).
Accuracy (20 ms/div to 100 ns/div) +15° to +35° C	Within (0.5% of Measurement + 3 digits).	B7. Check Δ Time Accuracy.	B7. Check Δ Time Accuracy. B8. Check Δ Time Linearity. B9. Check Delay Time Accuracy (Start of Delayed Sweep Display with Respect to Delaying Sweep Display). B12. Check Magnified Sweep Timing.
0° to +50° C	Within (0.5% of Measurement + 4 digits).	Customer verification normally not required.	
DELAY TIME Range	0.2 or less to at least 9.0 times TIME/DIV setting.	B6. Check Delay Time, Δ Time, and Trace Separation Ranges.	B10. Adjust Delay Start and Pickoff Bias (R335, R535).
Jitter 0.2 s/div to 50 μ s/div 20 μ s/div to 100 ns/div	(0.02% of TIME/DIV setting) or less. (0.03% of TIME/DIV setting + 100 ps) or less.	B10. Check Delay Time Jitter.	B16. Check Delay Time Jitter.

**TABLE 5-1 (CONT.)
Performance Check Summary**

Characteristic	Performance Requirement	Performance Check Step	Adjustment and Performance Step
Differential Measurement Accuracy (Measurement is made by subtracting 2 delay time readings; 0.2 s/div to 100 ns/div; 0° to 50° C)	Within (0.5% of Measurement + 4 digits).	Customer verification normally not required. Satisfactory operation is substantiated by other tests in the procedures.	
Absolute Delay Accuracy (Start of delayed sweep with respect to start of delaying sweep; 0° to +50° C) 0.2 s/div to 10 μs/div	Within (0.5% of Delay + 5% of TIME/DIV setting).	B9. Check Delay Time Accuracy (Start of Delayed Sweep Display with respect to Delaying Sweep Display).	B10. Adjust Delay Start and Pickoff Bias (R335, R535).
Trigger Holdoff	Variable Holdoff is stable at least three times throughout HOLD OFF control range.	B4. Check Variable Time/Division and Variable Hold Off.	B4. Check Variable Time/Division and Variable Hold Off.

TRIGGERING SYSTEM

Trigger Sensitivity for Repetitive Signals	Triggering Frequency Range ³	Minimum Triggering Signal Required		A4. Check External Triggering Sensitivity. A5. Check Internal Triggering Sensitivity.	A2. Adjust External Trigger Compensation (C117). A3. Adjust Sensitivity (R147).
		Internal	External		
Coupling					
AC	30 Hz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV		
AC LF REJ ⁴	50 kHz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV		
AC HF REJ	30 Hz to 30 kHz	0.5 div	50 mV		
DC ⁵	Dc to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV		
Single Sweep	Same as for Repetitive and Pulsed Triggering.		Customer verification normally not required. Satisfactory operation is substantiated by tests in the procedures.		
Internal Trigger Jitter	30 ps or less at 1 GHz.		A6. Check Internal Trigger Jitter.	A8. Check Internal Trigger Jitter.	

³The triggering frequency ranges given here are limited to the -3 dB frequency of the oscilloscope vertical system when operating in the Internal mode.

⁴Will not trigger on sine waves at or below 60 Hz when amplitudes are less than 8 divisions Internal or 3 volts External.

⁵The Triggering Frequency Range for DC COUPLING applies to frequencies above 30 Hz when operating in the AUTO TRIGGERING MODE.

TABLE 5-1 (CONT.)
Performance Check Summary

Characteristic	Performance Requirement	Performance Check Step	Adjustment and Performance Step
Operating in HF SYNC MODE AC, AC LF REJ, or DC	250 MHz to 1 GHz - 0.3 div Internal 75 mV External	A5. Check Internal Triggering Sensitivity. A4. Check External Triggering Sensitivity.	A3. Adjust Sensitivity (R147). A2. Adjust External Trigger Compensation (C117).
External Trigger Input LEVEL Range	At least + and -3.5 V (checked with 1 kHz sine wave).	A3. Check External Level Range.	A5. Check External Level Range.
Maximum Safe Input 1-Megohm Input 50-Ohm Input	250 V (dc plus peak ac). 1 Watt average.	Specification applicable under fault conditions; therefore this is not a procedural check.	
Input R and C 1-Megohm Input 50-Ohm Input	1 MΩ within 5%, 20 pf within 10%. 50 Ω within 2%.	Customer verification normally not required. Input resistance and capacitance can be determined with appropriate testing bridge if necessary. A1. Check External Trigger Input Resistance.	A1. Check External Trigger Input Resistance.
Trigger Holdoff Time Minimum Holdoff Setting 0.2 s/div to 50 ms/div 20 ms/div to 2 μs/div 1 μs/div to 2 ns/div Maximum Holdoff Setting 0.2 s/div to 50 ms/div 20 ms/div to 2 μs/div 1 μs/div to 0.5 μs/div 0.2 μs/div to 2 ns/div	40 ms. 2 times TIME/DIV setting. 2.0 μs. 400 ms. 20 times TIME/DIV setting. 20.0 μs. 6.0 μs.	Customer verification normally not required. Satisfactory operation is substantiated by other tests in the procedures.	

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 5-2 is required for a complete Performance Check and Calibration of this instrument. The specifications for test equipment, given in Table 5-2, 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.

If only a Performance Check is to be performed, not all of the listed test equipment is required. Footnote 1 denotes equipment used only for performance checks. Items used only for calibration are indicated by footnote 2. The remaining items of equipment are common to both procedures.

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 instrument. However, complete checking or calibration 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 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 5-2 is not available, first check the 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 check or adjustment that is of little or no importance for your measurement requirements, the item and corresponding step(s) can be deleted.

TABLE 5-2
Test Equipment

Description	Minimum Specifications	Purpose	Examples of Applicable Test Equipment
1. Oscilloscope Mainframe	Tektronix 7000-series. Bandwidth, 1 GHz with 2 horizontal plug-in compartments.	Provides a display for unit under test.	a. TEKTRONIX 7104 Oscilloscope.
2. High-Frequency Amplifier Plug-in Unit	Tektronix 7A-series Bandwidth, 1 GHz; deflection factor, 10 mV to 0.5 V.	Provides vertical input to oscilloscope mainframe.	a. TEKTRONIX 7A29 Amplifier plug-in unit.
3. High Impedance Amplifier Plug-in Unit.	Tektronix 7A-series. Bandwidth, 80 MHz; deflection factor, 5 mV to 10 V/div. Input Impedance, 1 MΩ.	Provides high impedance vertical input to oscilloscope mainframe.	a. TEKTRONIX 7A15A Amplifier Plug-in Unit.
4. High-Frequency Sine-Wave Generator ¹	Frequency, 250 MHz to 1 GHz; output amplitude, variable from 50 mV to 0.5 V into 50Ω.	High-frequency triggering checks.	a. TEKTRONIX SG 504 Leveled Sine Wave Generator with power module. b. Wavetek 2001 Sweep/Signal Generator.
5. Time-Mark Generator	Marker outputs, 1 ns to 5 ns; accuracy, within 0.1%.	Sweep timing checks and adjustments.	a. TEKTRONIX TG 501 Time-Mark Generator with power module.
6. Low-Frequency Function Generator	Frequency, 5 Hz to 500 kHz; output amplitude, variable from 50 mV to 3 V into 50 Ω.	Low-frequency triggering checks and adjustments.	a. TEKTRONIX FG 503 Function Generator with power module. b. General Radio 1310-B Oscillator.

¹Used for performance check only; NOT used for adjustment.

**TABLE 5-2 (CONT.)
Test Equipment**

Description	Minimum Specifications	Purpose	Examples of Applicable Test Equipment
7. Digital Ohmmeter (with test leads) ¹	Range, 200 Ω , accuracy, 0.5% of reading, ± 1 count.	Input resistance check.	a. TEKTRONIX DM 502 Digital Multi-meter with power module.
8. Time-Base Unit	Tektronix 7B-series delayed sweep unit.	Companion delayed sweep unit for delay time checks and adjustments.	a. TEKTRONIX 7B10 Time-Base unit. b. TEKTRONIX 7B15 Time-Base unit.
9. Rigid Plug-in Extender ²	Tektronix 7000-series extender.	Provides access to internal adjustments and test points.	a. Tektronix 067-0589-00 Calibration Fixture.
10. Coaxial Cables (2 required)	Impedance, 50 Ω ; type, RG 58/U; length, 42 and 18 inches; connectors, BNC.	Provides signal interconnections.	a. Tektronix Part 012 0057-01, 012-0076-00.
11. T Connector ¹	Connectors, BNC.	External triggering checks.	a. Tektronix Part 103-0030-00.
12. 10X Attenuator ¹	Dc resistance, 50 Ω , ± 1 Ω ; connectors, BNC.	Trigger checks and adjustments.	a. Tektronix Part 011-0059-02.
13. Screwdriver ²	3-inch shaft, 3/32-inch bit.	Adjustments.	a. Xcelite R3323.
14. 10X Probe ²	Attenuation, 10X; for use with 1 M Ω inputs.	External trigger compensation adjustment.	a. Tektronix Part 010-6105-03.
15. Low-capacitance screwdriver ²	2-inch shaft, 3/32-inch bit.	Used for adjusting variable capacitor.	a. Tektronix Part 003-0675-00.

¹Used for performance check only; NOT used for adjustment.

²Used for adjustment only; NOT used for performance check.

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 the Operators Manual for familiarization with the instrument and also to verify that all controls and connectors function properly. See Preliminary Information, at the beginning of this section, for information on performing a partial Performance Check procedure.

PERFORMANCE CHECK PROCEDURE INDEX

PERFORMANCE CHECK POWER-UP SEQUENCE

	PAGE
A. TRIGGERING SYSTEM	
1. Check External Trigger Input Resistance	5-9
2. Check Triggering Modes	5-9
3. Check External Level Range	5-10
4. Check External Triggering Sensitivity	5-11
5. Check Internal Triggering Sensitivity	5-11
6. Check Internal Trigger Jitter	5-12
7. Check Line Triggering	5-13
B. HORIZONTAL SYSTEM	
1. Set Basic Sweep Calibration.....	5-14
2. Check Sweep Length and Positioning Range	5-15
3. Check Magnifier Gain and Registration	5-15
4. Check Variable Time/Division and Variable Hold Off	5-15
5. Check Delay Modes	5-16
6. Check Delay Time, Δ Time, and Trace Separation Ranges	5-17
7. Check Δ Time Accuracy	5-17
8. Check Δ Time Linearity	5-18
9. Check Delay Time Accuracy (Start of Delayed Sweep Display with Respect to Delaying Sweep Display)	5-18
10. Check Delay Time Jitter.....	5-19
11. Check Sweep Timing.....	5-20
12. Check Magnified Sweep Timing	5-21

NOTE

The performance of this instrument can be checked at any ambient temperature within the 0°C to +50°C range unless stated otherwise. Adjustment at 20°C to 30°C ambient is required to maintain stated accuracy.

1. Install a high frequency amplifier plug-in unit in the left vertical compartment of the oscilloscope mainframe.
2. Install the 7B15 in the A horizontal compartment of the oscilloscope mainframe.
3. Set the mainframe vertical mode switch to display the left vertical unit and the horizontal mode switch to display the A horizontal unit. Set the mainframe intensity controls fully counterclockwise and set the trigger source switches to vertical mode.
4. Turn on the mainframe and allow at least 20 minutes warmup before beginning the procedure.

A. TRIGGERING SYSTEM

Equipment Required: (Numbers correspond to test equipment listed in Table 5-2)

- | | |
|--|---------------------------------|
| 1. Oscilloscope mainframe | 10. Coaxial cables (2 required) |
| 2. High-frequency amplifier plug-in unit | 11. T connector |
| 4. High-frequency sine-wave generator | 12. 10X attenuator |
| 6. Low-frequency function generator | |
| 7. Digital ohmmeter | |

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 the manual for any modifications which may affect this procedure.
- (3) See **TEST POINT AND ADJUSTMENT LOCATIONS** foldout page in Section 8, Diagrams and Circuit Board Illustrations.

TRIGGERING SYSTEM PRELIMINARY CONTROL SETTINGS:

7B15 Time Base

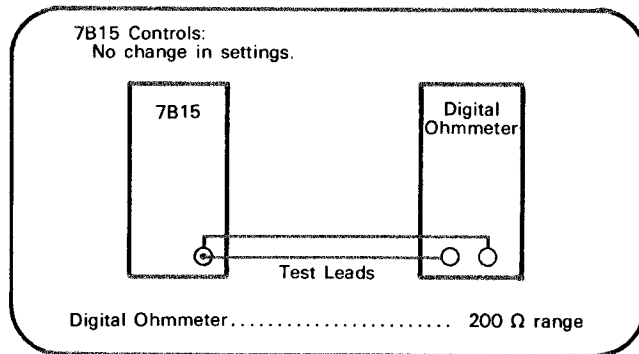
TRIGGERING AUTO, AC, EXT, OUT 50 Ω
 LEVEL Midrange
 TIME/DIV 10 μs
 VARIABLE CAL IN
 MAG X1
 B DELAY MODE INDEPENDENT
 TRACE SEP OFF
 DELAY TIME Fully counterclockwise
 Δ TIME Fully clockwise
 POSITION Midrange
 HOLD OFF MIN

Oscilloscope Mainframe

Vertical (plug-in) Midrange
 Intensity Visible display
 Focus Well defined display

A1. CHECK EXTERNAL TRIGGER INPUT RESISTANCE

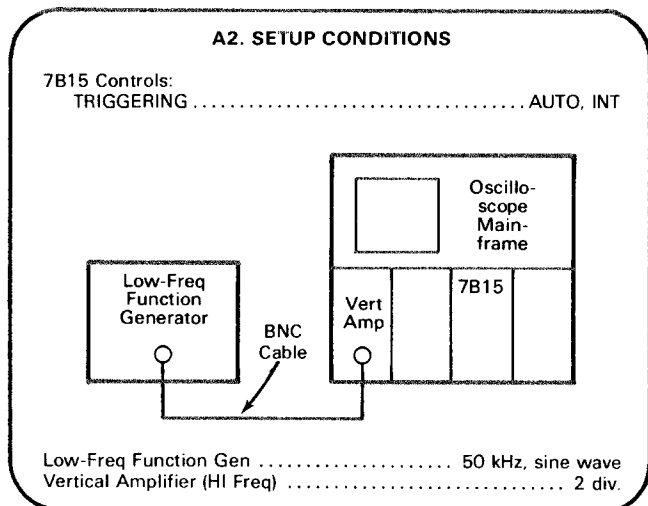
SETUP CONDITIONS



- a. **CHECK**—That the input resistance is 50Ω within 2% (1Ω).

A2. CHECK TRIGGERING MODES

SETUP CONDITIONS



**Calibration Part I--7B15
Performance Check**

NOTE

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

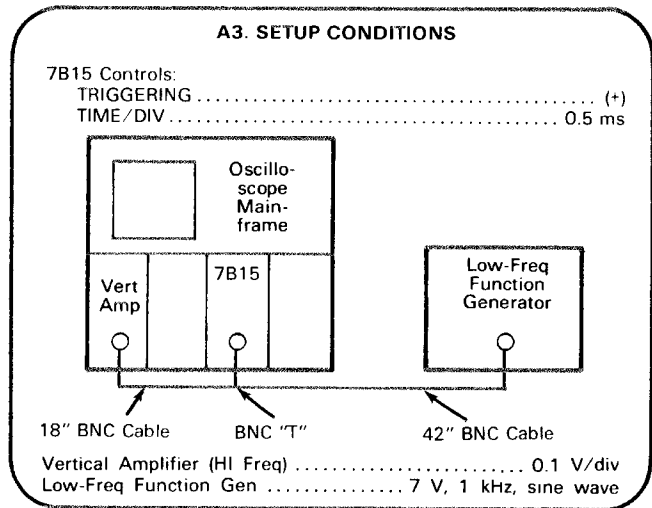
- a. Set the TRIGGERING LEVEL control for a stable display (TRIG'D light on).
- b. **CHECK**—For a free-running display with the TRIG'D light off when the TRIGGERING LEVEL control is set fully clockwise and fully counterclockwise.
- c. Set the TRIGGERING MODE to NORM.
- d. Set the TRIGGERING LEVEL control for a stable display (TRIG'D light on).
- e. **CHECK**—For no display (TRIG'D light off) when the TRIGGERING LEVEL control is set fully clockwise and fully counterclockwise.
- f. Set the TRIGGERING LEVEL control for a stable display (TRIG'D light on).
- g. Set the TRIGGERING MODE to SINGLE SWP and the SOURCE to EXT.
- h. **CHECK**—Press the SINGLE SWP RESET push button and check that the READY light is on.
- i. **CHECK**—For one sweep and that the READY light is out after completion of that sweep when the INT SOURCE push button is pressed (oscilloscope intensity may need to be increased to view the single-sweep display).
- j. Remove the low-frequency function generator cable from the vertical amplifier plug-in unit and connect the high-frequency sine-wave generator to the amplifier input with a 10X attenuator.
- k. Set the time base TRIGGERING MODE to HF SYNC and the TIME/DIV to 2 ns.
- l. Set the high-frequency sine-wave generator and amplifier plug-in unit deflection factor for approximately a 1-division display of 250 MHz signal.
- m. **CHECK**—For a stable display (TRIG'D light on) at all positions of the TRIGGERING LEVEL control.
- n. Set the TRIGGERING MODE to AUTO and the SOURCE to EXT.

A3. CHECK EXTERNAL LEVEL RANGE

SETUP CONDITIONS

NOTE

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



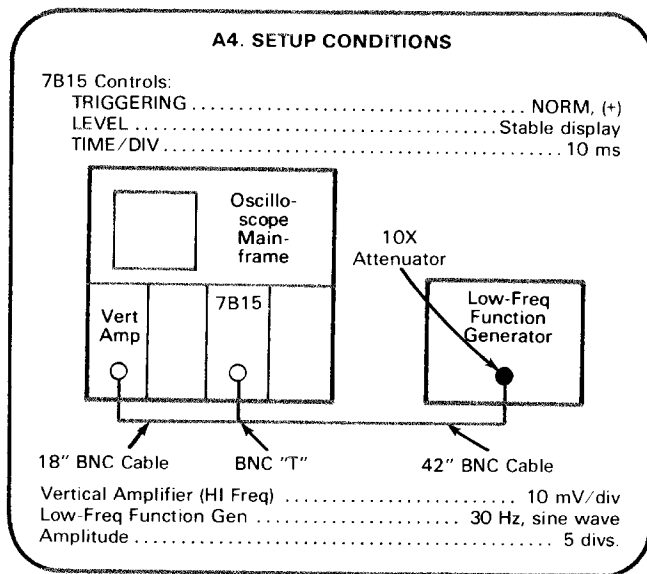
- a. **CHECK**—That all levels of the positive slope may be selected for the sweep starting point as the TRIGGERING LEVEL control is rotated throughout its range (indicates an external level range of at least plus and minus 1.5 volts). Check that the display is not triggered at either end of the LEVEL control rotation.
- b. **CHECK**—Change the TRIGGERING SLOPE to (-) and repeat part a for the negative slope of the waveform.

A4. CHECK EXTERNAL TRIGGERING SENSITIVITY

SETUP CONDITIONS

NOTE

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



a. **CHECK**—Set the TRIGGERING MODE to AUTO and check for a stable display (TRIG'D light on) with the COUPLING push button set to:

1. AC
2. AC HF REJ
3. DC

(Set TRIGGERING LEVEL control as necessary.)

b. **CHECK**—Change the TRIGGERING SLOPE to (-) and repeat part a.

c. Disconnect the low-frequency function generator from the 10X attenuator and connect the high-frequency sine-wave generator to the 10X attenuator.

d. Set the SLOPE to (+) and the TIME/DIV switch to 2 ns.

e. Set the high-frequency signal generator for a 5-division display (50 millivolts) at 250 megahertz.

f. **CHECK**—For a stable display (TRIG'D light on) with the COUPLING switch set to:

1. AC
2. AC LF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

g. **CHECK**—Set the SLOPE switch to (-) and repeat part f.

h. Set the amplifier plug-in unit deflection factor to 50 millivolts/ division and set the high frequency sine-wave generator for a 3-division display (150 millivolts) at 1 GHz.

i. **CHECK**—For a stable display (TRIG'D light on) with the COUPLING switch set to:

1. AC
2. AC LF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary)

j. **CHECK**—Set the SLOPE switch to (+) and repeat part i.

k. Set the TRIGGERING MODE switch to HF SYNC.

l. Set the amplifier plug-in unit deflection factor to 10 millivolts/division and set the high frequency sine-wave generator for a 7.5 division display (75 millivolts) at 1 GHz.

m. **CHECK**—For a stable display (TRIG'D light on) with the COUPLING switch set to:

1. AC
2. AC LF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

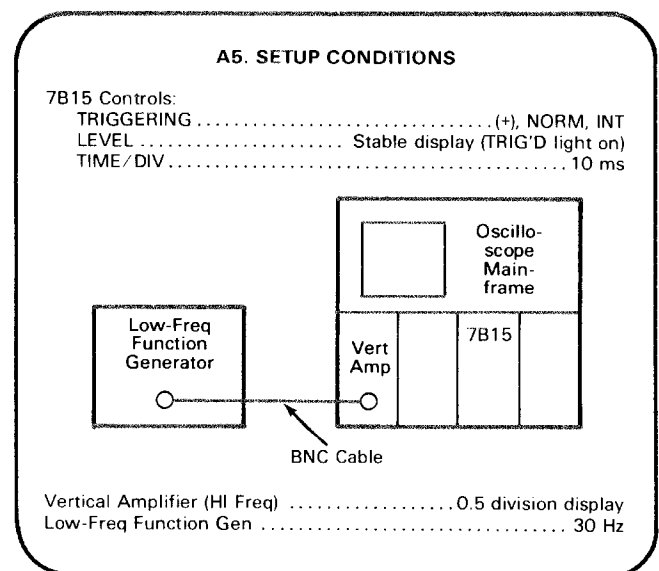
n. **CHECK**—Set the SLOPE switch to (-) and repeat part m.

A5. CHECK INTERNAL TRIGGERING SENSITIVITY

SETUP CONDITIONS

NOTE

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



**Calibration Part I—7B15
Performance Check**

a. **CHECK**—Set the TRIGGERING MODE to AUTO and check for a stable display (TRIG'D light on) with the COUPLING switch set to:

1. AC
2. AC HF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

b. Change the TRIGGERING SLOPE to (-) and repeat part a.

c. Disconnect the low-frequency function generator and connect the high-frequency sine-wave generator to the amplifier plug-in unit input.

d. Set the SLOPE to (+) and the TIME/DIV switch to 2 ns.

e. Set the high-frequency sine-wave generator and the amplifier plug-in unit deflection factor for a 0.5-division display at 250 megahertz. (Use 10X attenuator.)

f. **CHECK**—For a stable display (TRIG'D light on) with the COUPLING switch set to:

1. AC
2. AC LF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

g. **CHECK**—Set the TRIGGERING SLOPE to (-) and repeat part f.

h. Set the high-frequency sine-wave generator and the amplifier plug-in unit deflection factor for a 1.5 division display at 1 GHz.

i. **CHECK**—For a stable display (TRIG'D light on) with the COUPLING switch set to:

1. AC
2. AC LF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

j. **CHECK**—Set the TRIGGERING SLOPE to (+) and repeat part i.

k. Set the TRIGGERING MODE switch to HF SYNC and the high-frequency sine-wave generator and amplifier plug-in unit deflection factor for a 0.3-division display at 1 GHz.

l. **CHECK**—For a stable display (TRIG'D light on) with the COUPLING switch set to:

1. AC
2. DC LF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

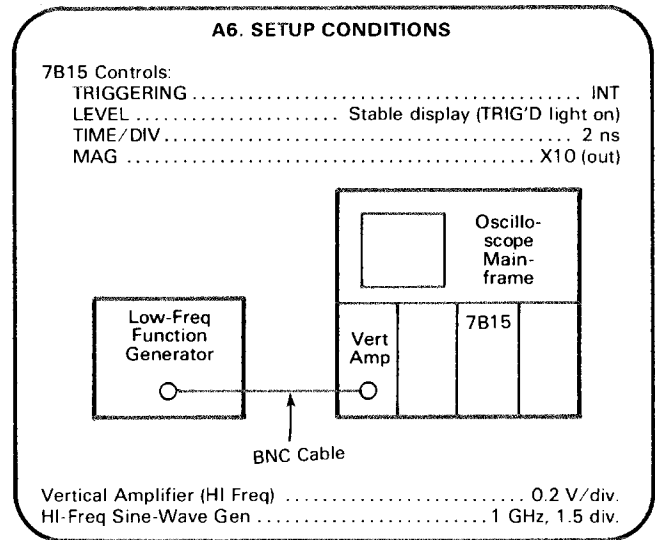
m. **CHECK**—Set the SLOPE to (-) and repeat part l.

A6. CHECK INTERNAL TRIGGER JITTER

SETUP CONDITIONS

NOTE

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



a. **CHECK**—For a stable display with no more than 0.15 division (30 picosecond) of jitter.

A7. CHECK LINE TRIGGERING

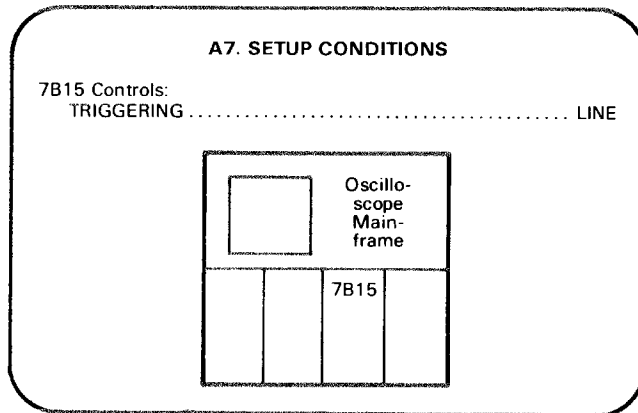
SETUP CONDITIONS

NOTE

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

a. **CHECK**—Set the TRIGGERING LEVEL to approximately midrange and check that the TRIG'D light is on.

b. **CHECK**—That the display is not triggered (TRIG'D light off) at either end of the TRIGGERING LEVEL control rotation.



B. HORIZONTAL SYSTEM

Equipment Required: (Numbers correspond to test equipment listed in Table 5-2)	
1. Oscilloscope mainframe	10. Coaxial cable (1 required)
2. High-frequency amplifier plug-in unit	13. Screwdriver
5. Time-mark generator	
8. Time-base unit	

BEFORE YOU BEGIN:

- (1) Perform the Performance Check Power-Up Sequence. (Not necessary if continuing Performance Check.)
- (2) Refer to Section 6, Instrument Options and the Change Information at the rear of the manual for any modifications which may affect this procedure.
- (3) See **TEST POINT AND ADJUSTMENT LOCATIONS** foldout pages in Section 8, Diagrams and Circuit Board Illustrations.

HORIZONTAL SYSTEM PRELIMINARY CONTROL SETTINGS:

7B15 Time Base

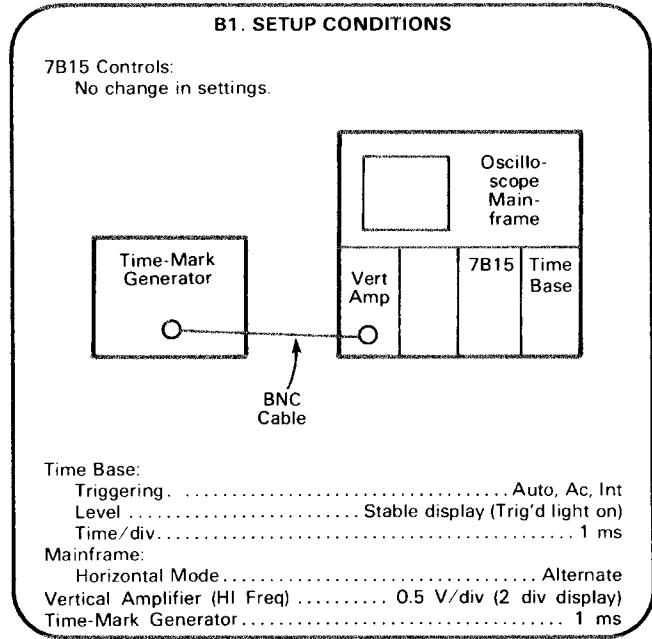
TRIGGERING AUTO, AC, INT
 LEVEL Midrange
 TIME/DIV 1 ms
 VARIABLE CAL IN
 MAG X1
 B DELAY MODE INDEPENDENT
 TRACE SEP OFF
 DELAY TIME Fully counterclockwise
 Δ TIME Fully clockwise
 POSITION Midrange
 HOLD OFF MIN

Oscilloscope Mainframe

Vertical (plug-in) Midrange
 Intensity Visible display
 Focus Well defined display

B1. SET BASIC SWEEP CALIBRATION

SETUP CONDITIONS



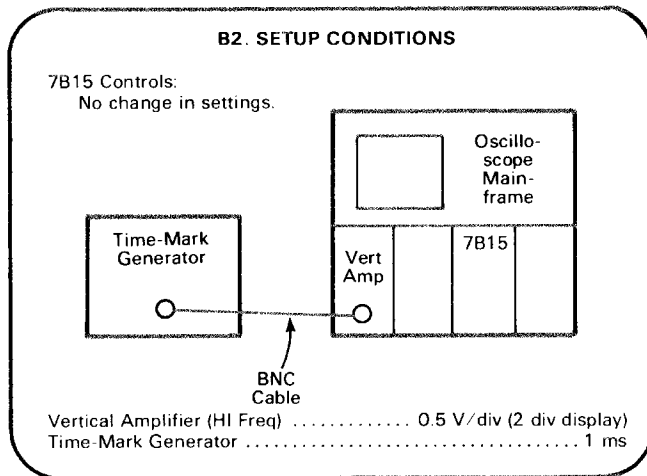
- a. Center the 7B15 trace in the upper half of the graticule and the companion unit trace in the lower half.
- b. **EXAMINE**—For exactly 1 marker/division (upper trace) over center 8 divisions (position as necessary).
- c. **ADJUST**—The 7B15 front-panel SWP CAL adjustment for exactly 1 marker/division (upper trace) over the center 8 divisions (position as necessary).
- d. **EXAMINE**—For exactly 1 marker/division (lower trace) over center 8 divisions (position as necessary).
- e. **ADJUST**—Front-panel SWP CAL adjustment on the companion time base unit for exactly 1 marker/division (lower trace) over the center 8 divisions (position as necessary).
- f. Set mainframe horizontal mode to A.

B2. CHECK SWEEP LENGTH AND POSITIONING RANGE

SETUP CONDITIONS

NOTE

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



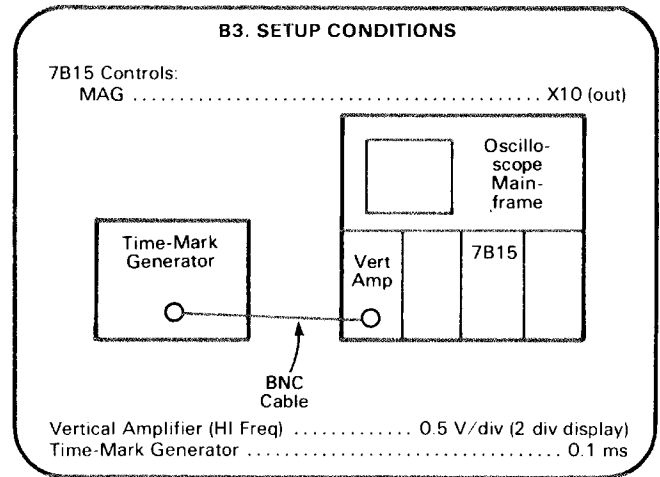
- a. Horizontally position the display to place the second time marker to the first graticule line.
- b. **CHECK**—That the end of the sweep extends to at least 9.2 graticule divisions (indicates sweep length of at least 10.2 divisions).
- c. Set the POSITION and FINE controls fully clockwise.
- d. **CHECK**—The start of the sweep must be to the right of graticule center.
- e. Set the POSITION and FINE controls fully counterclockwise.
- f. **CHECK**—The end of the sweep must be to the left of graticule center.

B3. CHECK MAGNIFIER GAIN AND REGISTRATION

SETUP CONDITIONS

NOTE

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



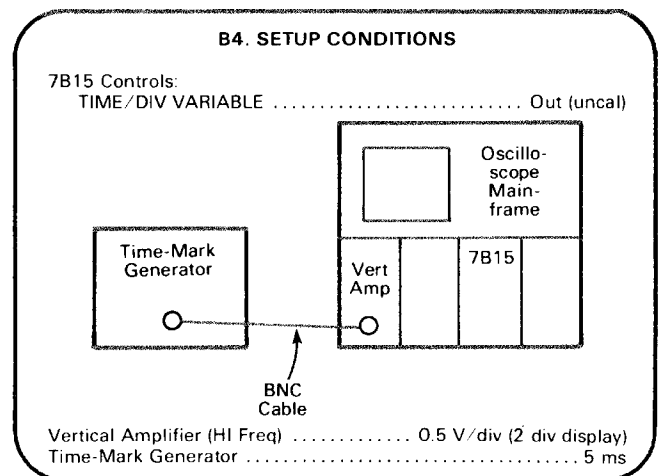
- a. **CHECK**—For 1 marker/division over the center 8 divisions of the display (position as necessary).
- b. Set the time-mark generator for 5-millisecond markers. Align the center time marker with graticule center.
- c. **CHECK**—Set the MAG switch to X1 and check that the center time marker is at graticule center within 0.5 division.

B4. CHECK VARIABLE TIME/DIVISION AND VARIABLE HOLD OFF

SETUP CONDITIONS

NOTE

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



**Calibration Part I—7B15
Performance Check**

- a. Set the VARIABLE control fully clockwise and note 3 time markers in 10 graticule divisions.
- b. **CHECK**—Set the VARIABLE control fully counterclockwise and check for 2 divisions or less between 5-millisecond markers.
- c. Press the VARIABLE control for calibrated sweep rates.
- d. Set the TRIGGERING LEVEL control for a free-running display (TRIG'D light off).
- e. Set the HOLD OFF control fully counterclockwise.
- f. **CHECK**—Rotate the HOLD OFF control slowly clockwise throughout its range and check that the display (3 time markers in 10 divisions) will nearly stabilize at least 3 times throughout the range of the HOLD OFF control (disregard any slow drift).
- g. Set the HOLD OFF control counterclockwise to MIN and set the TRIGGERING LEVEL control for a stable display.

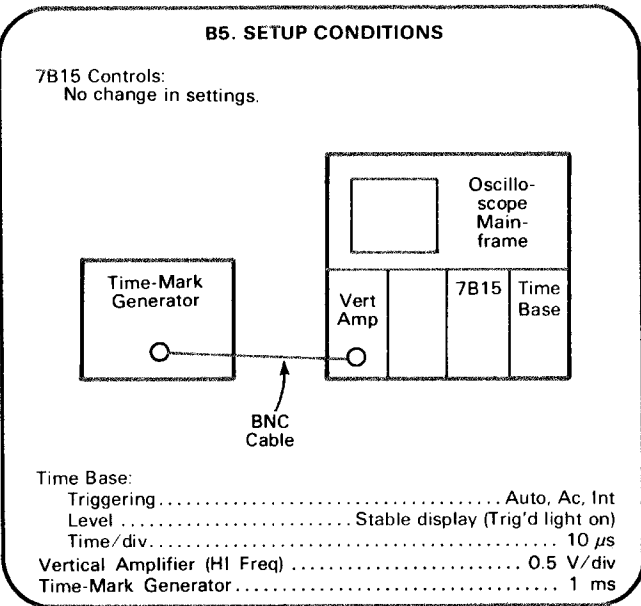
- a. **CHECK**—Rotate the DELAY TIME control and note that it has no effect on the independent sweep display.
- b. **CHECK**—Rotate the TRACE SEP control counterclockwise out of switch detent to enable the Δ TIME mode. Rotate the Δ TIME control and check for no effect on the independent sweep display.
- c. Rotate the TRACE SEP control into the switch detent to disable the Δ TIME operation. Set the B DELAY MODE switch to B STARTS AFTER DLY.
- d. Set the mainframe horizontal mode to alternate.
- e. Set the mainframe intensity control for optimum brightness of the intensified- and delayed-sweep traces. Center the delaying-sweep trace in the upper half of the graticule and the delayed-sweep trace in the lower half of the graticule.
- f. **CHECK**—Rotate the DELAY TIME control throughout its range and note that the delay before the start of the intensified zone is continuously variable.
- g. Set the B DELAY MODE switch to B TRIGGERABLE AFTER DLY.
- h. **CHECK**—Rotate the DELAY TIME control throughout its range and note that the intensified zone jumps from time marker to time marker. This indicates that the intensified zone does not start at the completion of delay time, but waits for the next trigger pulse.
- i. **CHECK**—That the greater-than symbol (>) precedes the delay-time readout indicating that the delay-time readout is uncalibrated.

B5. CHECK DELAY MODES

SETUP CONDITIONS

NOTE

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



NOTE

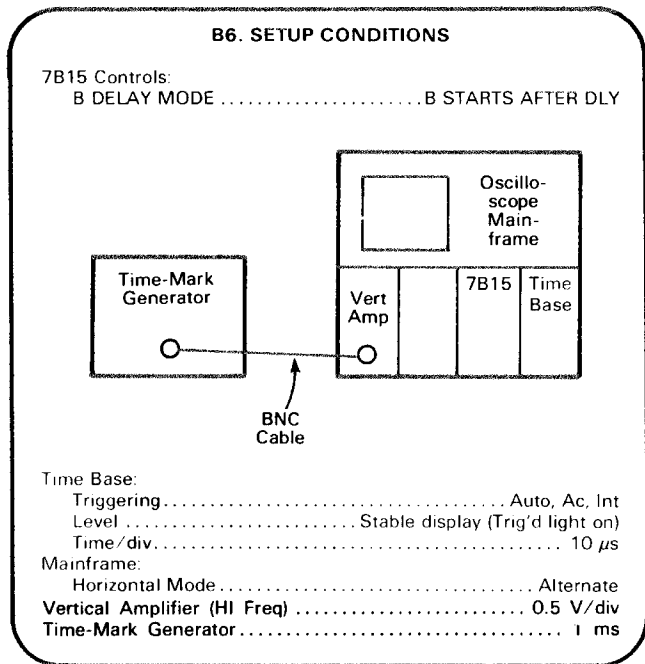
The 7B15 may be operated as a delayed-sweep unit (B horizontal compartment) with a companion delaying sweep unit (A horizontal compartment). To check 7B15 delayed-sweep operation, install the 7B15 in the B horizontal compartment and a companion delaying sweep unit into the A horizontal compartment. Set the 7B15 B DELAY MODE to INDEPENDENT and the TIME/DIV switch to 0.1 ms. Set the delaying-sweep unit for a 1-millisecond time markers to the amplifier plug-in unit input. Check delayed-sweep operation as outlined step B5 parts d through i.

B6. CHECK DELAY TIME, Δ TIME, AND TRACE SEPARATION RANGES

SETUP CONDITIONS

NOTE

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



a. **CHECK**—Set the DELAY TIME control fully clockwise and check for a delay-time readout of 9.000 ms or greater.

b. **CHECK**—Set the DELAY TIME control fully counterclockwise and check for a delay-time readout of 0.200 ms or less.

c. Set the TRACE SEP control counterclockwise, out of the switch detent, to enable Δ TIME operation.

d. **CHECK**—That the Δ symbol appears in the delay-time readout.

e. **CHECK**—Set the Δ TIME control fully clockwise and check for a Δ time reading of 9.000 ms or greater.

f. **CHECK**—Set the Δ TIME control fully counterclockwise and check for a Δ time readout of 0.000 ms to 0.001 ms. Check that the Δ symbol precedes the readout display.

g. Set the TRACE SEP control fully clockwise. Set the mainframe vertical trace separation control to midrange. Position the delayed-sweep trace, with the amplifier plug-in unit position control, to the center graticule line.

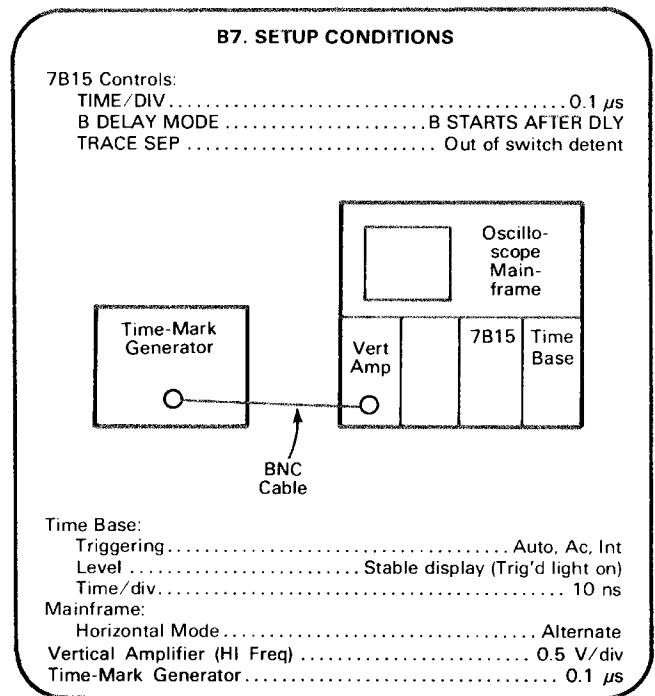
h. **CHECK**—Set the TRACE SEP control fully counterclockwise and check that the second delayed-sweep trace is at least 3 divisions below graticule center.

B7. CHECK Δ TIME ACCURACY

SETUP CONDITIONS

NOTE

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



a. Set the TRACE SEP control to position the second delayed-sweep trace approximately 0.2 divisions below the first delayed-sweep trace.

b. Position the display for 1 marker/division over the center 8 divisions of intensified display.

c. Set the DELAY TIME control to start the first intensified zone on the time marker which is nearest the second graticule line. Set the Δ TIME control to start the second intensified zone on the time marker which is nearest the tenth graticule line.

**Calibration Part I—7B15
Performance Check**

d. Further adjust the Δ TIME control to horizontally align the time markers of the first and second delayed-sweep traces.

e. **CHECK**—For a Δ time readout between 795.7 ns and 804.3 ns.

NOTE

The limits in part e and Table 5-3 are derived from the Performance Requirement in the Specification section.

EXAMPLE: The Performance Requirement for Δ TIME accuracy at 0.1 μ s/DIV is:

Within (0.5% measurement + 3 digits.)

For an 8 division measurement (800 ns), the accuracy is:

$$\pm (0.5\% \text{ of } 800 \text{ ns} + 0.3 \text{ ns}) = \pm (4.0 \text{ ns} + 0.3 \text{ ns}) = \pm 4.3 \text{ ns}$$

Therefore, the specified limits for a measurement interval of 800 ns are:

$$800 \text{ ns} \pm 4.3 \text{ ns} = 795.7 \text{ ns to } 804.3 \text{ ns}$$

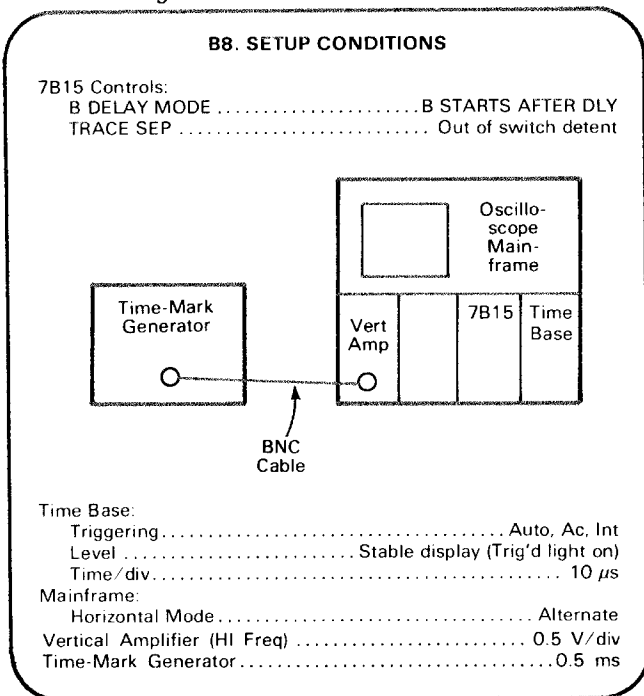
f. **CHECK**—Follow the procedure outlined in parts c through e and check for Δ TIME accuracy as given in Table 5-3.

B8. CHECK Δ TIME LINEARITY

SETUP CONDITIONS

NOTE

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



a. Position the delaying- and delayed-sweep traces horizontally to start on the first graticule line.

b. Set the DELAY TIME control to place the first intensified zone on the time marker which is between the first and second graticule lines (second time marker).

c. Set the Δ TIME control to place the second intensified zone to the time marker which is 0.5 division from the first intensified time marker (third time marker).

d. Set the Δ TIME control to precisely align the delayed-sweep traces.

e. **CHECK**— Δ time readout for 0.496 ms to 0.504 ms.

f. Set the DELAY TIME control to position the first intensified zone to the next 0.5-ms time marker (third time marker). Then, rotate the Δ TIME control to precisely align the delayed-sweep traces.

g. **CHECK**— Δ time readout for 0.496 ms to 0.504 ms.

h. Set the DELAY TIME control to position the first intensified zone to the next 0.5-ms time marker (fourth time marker). Then, rotate the Δ TIME control to precisely align the delayed sweep traces.

i. **CHECK**— Δ time readout for 0.496 ms to 0.504 ms.

j. **CHECK**—Use the procedure outlined in parts f through i and check Δ TIME linearity at each 0.5-division point until the first intensified zone is beyond the tenth graticule line.

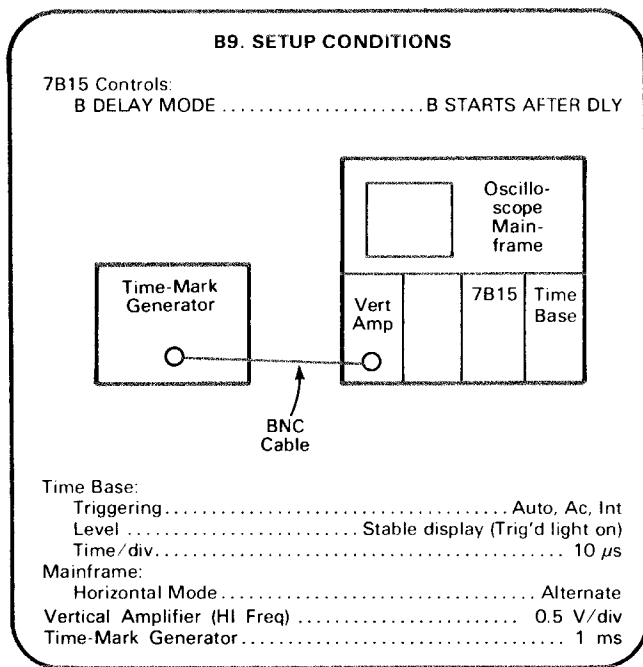
k. Turn TRACE SEP control to OFF.

B9. CHECK DELAY TIME ACCURACY (START OF DELAYED SWEEP DISPLAY WITH RESPECT TO DELAYING SWEEP DISPLAY)

SETUP CONDITIONS

NOTE

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



- a. Set the time-mark generator for 1-millisecond markers.
- b. Position the delaying- and delayed-sweep traces to start on the first graticule line.
- c. Set the DELAY TIME control to place the intensified zone on the second time marker.
- d. Set the DELAY TIME control to precisely position the leading edge of the delayed-time marker to the first graticule line.
- e. **CHECK**—Delay-time readout for 0.945 ms to 1.055 ms.
- f. Set the DELAY TIME control to place the intensified zone on the sixth time marker.
- g. Set the DELAY TIME control to precisely position the leading edge of the delayed time marker to the first graticule line.
- h. **CHECK**—Delay-time readout for 4.925 ms to 5.075 ms.
- i. Set the DELAY TIME control to place the intensified zone on the tenth time marker.

j. Set the DELAY TIME control to precisely position the leading edge of the delayed-time marker to the first graticule line.

k. **CHECK**—Delay time readout for 8.905 ms to 9.095 ms.

TABLE 5-3
 Δ Time Accuracy

7B15 TIME/DIV	Companion Time Base Sweep Rate	Time Markers	Δ Time Readout Range
.1 μ s	10 ns	.1 μ s	795.7 ns to 804.3 ns
.2 μ s	20 ns	.2 μ s	1.589 μ s to 1.611 μ s
.5 μ s	50 ns	.5 μ s	3.977 μ s to 4.023 μ s
1 μ s	.1 μ s	1 μ s	7.957 μ s to 8.043 μ s
2 μ s	.2 μ s	2 μ s	15.89 μ s to 16.11 μ s
5 μ s	.5 μ s	5 μ s	39.77 μ s to 40.23 μ s
10 μ s	1 μ s	10 μ s	79.57 μ s to 80.42 μ s
20 μ s	2 μ s	20 μ s	158.9 μ s to 161.1 μ s
50 μ s	5 μ s	50 μ s	397.7 μ s to 402.3 μ s
.1 ms	10 μ s	.1 ms	795.7 μ s to 804.3 μ s
.2 ms	20 μ s	.2 ms	1.589 ms to 1.611 ms
.5 ms	50 μ s	.5 ms	3.977 ms to 4.023 ms
1 ms	.1 ms	1 ms	7.957 ms to 8.043 ms
2 ms	.2 ms	2 ms	15.89 ms to 16.11 ms
5 ms	.5 ms	5 ms	39.77 ms to 40.23 ms
10 ms	1 ms	10 ms	79.57 ms to 80.43 ms
20 ms	2 ms	20 ms	158.9 ms to 161.1 ms

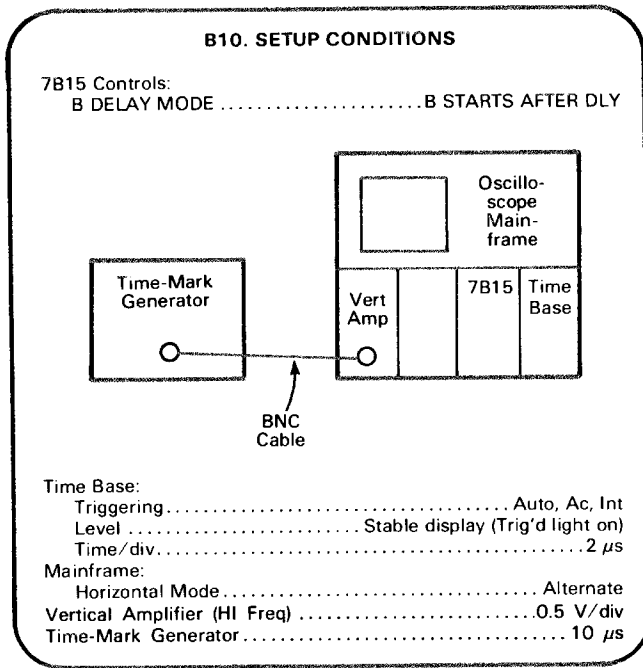
B10. CHECK DELAY TIME JITTER

SETUP CONDITIONS

NOTE

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

**Calibration Part I—7B15
Performance Check**



- a. Set the DELAY TIME control for a delay-time readout of approximately 1.000 ms.
- b. Set the DELAY TIME control further to position a delayed-sweep time marker near the display center.
- c. Magnify the companion time-base unit sweep rate to 200 nanoseconds/ division (MAG X10) and position the delayed-sweep time marker near the graticule center.
- d. **CHECK**—For 1 division or less jitter. (Jitter specification is 0.02% of 1 ms delaying sweep setting or 200 ns.)
- e. Set the companion time-base unit for X1 sweep magnification microseconds/division). Set the DELAY TIME control for a delay-time readout of approximately 9.000 ms.
- f. **CHECK**—Repeat parts b through d.
- g. Set the companion time-base unit sweep rate to 20 nanoseconds/ division and magnification to X1. Set the time-mark generator for 0.1-microsecond markers.
- h. Set the 7B15 TIME/DIV switch to 10 μ sec.
- i. Set the DELAY TIME control for a delay-time readout of approximately 10.00 μ s.
- j. Set the DELAY TIME control further to position a delayed-sweep time marker near the display center.

k. Magnify the companion time-base unit sweep rate to 2 nanoseconds/division (MAG X10) and position the delayed-sweep time marker near the graticule center.

l. **CHECK**—For 1.5 divisions or less jitter. (Jitter specification is 0.03 % of 10 μ s delaying sweep setting or 3 ns.

m. Set the companion time-base unit sweep magnification to X1 (20 nanoseconds/division). Set the DELAY TIME control for a delay-time readout of approximately 90.00 μ s.

n. **CHECK**—Repeat parts j through l.

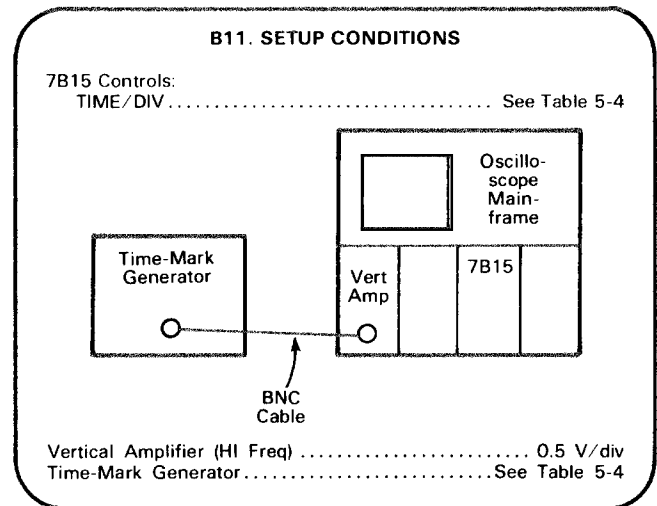
o. Set mainframe horizontal mode to A and the 7B15 time base B DELAY MODE to INDEPENDENT.

B11. CHECK SWEEP TIMING

SETUP CONDITIONS

NOTE

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



NOTE

The tolerances given in Table 5-4 are for an ambient temperature range of +15°C to +35°C. If outside this range, see the Specification section for applicable tolerances.

a. Set the POSITION controls to midrange and the TRIGGERING MODE to NORM.

b. **CHECK**—Using the TIME/DIV setting and time-mark generator settings from Table 5-4, check sweep accuracy for 1 time mark/ division over the center 8 divisions within the tolerance given in Table 5-4. Set the POSITION controls and TRIGGERING LEVEL control as necessary for a stable display aligned with the vertical graticule lines.

NOTE

If the time-mark generator used does not have 1-2-5 sequence markers, apply 1 unit markers in place of 2 unit markers and check for 2 markers/division, over the center eight divisions of display, to the tolerances given in Table 5-4 and 5-5.

TABLE 5-4
Sweep Timing

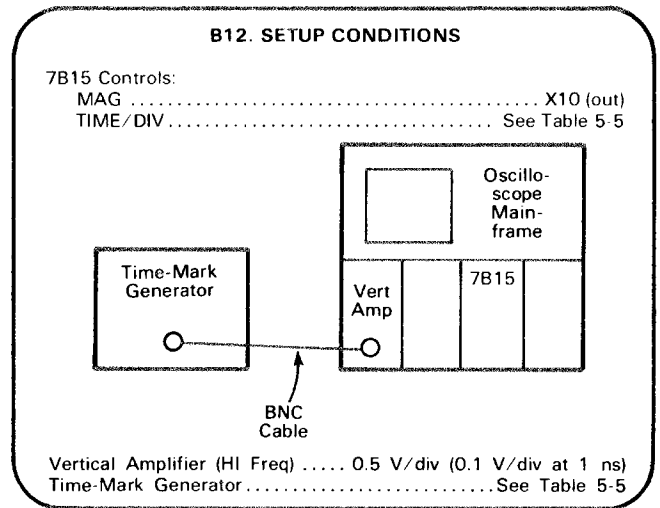
Time/Div	Time Markers	Tolerance (+15° to +35° C)
2 ns	2 ns	Within 0.24 div
5 ns	5 ns	Within 0.24 div
10 ns	10 ns	Within 0.16 div
20 ns	20 ns	Within 0.16 div
50 ns	50 ns	Within 0.16 div
.1 μs	.1 μs	Within 0.16 div
.2 μs	.2 μs	Within 0.16 div
.5 μs	.5 μs	Within 0.16 div
1 μs	1 μs	Within 0.16 div
2 μs	2 μs	Within 0.16 div
5 μs	5 μs	Within 0.16 div
10 μs	10 μs	Within 0.16 div
20 μs	20 μs	Within 0.16 div
50 μs	50 μs	Within 0.16 div
.1 ms	.1 ms	Within 0.16 div
.2 ms	.2 ms	Within 0.16 div
.5 ms	.5 ms	Within 0.16 div
1 ms	1 ms	Within 0.16 div
2 ms	2 ms	Within 0.16 div
5 ms	5 ms	Within 0.16 div
10 ms	10 ms	Within 0.16 div
20 ms	20 ms	Within 0.16 div
50 ms	50 ms	Within 0.16 div
.1 s	.1 s	Within 0.16 div
.1 s	.1 s	Within 0.16 div
.2 s	.2 s	Within 0.16 div

B12. CHECK MAGNIFIED SWEEP TIMING

SETUP CONDITIONS

NOTE

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



NOTE

The tolerances in Table 5-5 are for an ambient temperature range of +15°C to +35°C. If outside this range, see the Specification section for applicable tolerances.

a. **CHECK**—Using the TIME/DIV settings and time-mark generator settings in Table 5-5, check magnified sweep accuracy for 1 time/mark division, over the center 8 divisions, within the tolerance given in Table 5-5. Set the POSITION controls and TRIGGERING LEVEL control as necessary for a stable display aligned with the vertical graticule line.

NOTE

The 7B15 may be operated as a delayed sweep unit (B horizontal compartment) with a companion delaying sweep unit (A horizontal compartment). To check 7B15 delayed sweep operation, refer to a delaying sweep checkout procedure in the Operating Instructions or calibration sections of the instruction manual for the delaying sweep unit.

Calibration Part I—7B15
Performance Check

TABLE 5-5
Magnified Sweep Timing

Time/Div	Time Markers	Tolerance (+15° to +35° C)
2 ns	1 ns ¹	Within 0.2 div
5 ns	1 ns	Within 0.32 div
10 ns	1 ns	Within 0.24 div
20 ns	2 ns	Within 0.24 div
50 ns	5 ns	Within 0.24 div
.1 μs	10 ns	Within 0.24 div
.2 μs	20 ns	Within 0.24 div
.5 μs	50 ns	Within 0.24 div
1 μs	.1 μs	Within 0.24 div
2 μs	.2 μs	Within 0.24 div
5 μs	.5 μs	Within 0.24 div
10 μs	1 μs	Within 0.24 div
20 μs	2 μs	Within 0.24 div
50 μs	5 μs	Within 0.24 div
.1 ms	10 μs	Within 0.24 div
.2 ms	20 μs	Within 0.24 div
.5 ms	50 μs	Within 0.24 div
1 ms	.1 ms	Within 0.24 div
2 ms	.2 ms	Within 0.24 div
5 ms	.5 ms	Within 0.24 div
10 ms	1 ms	Within 0.24 div
20 ms	2 ms	Within 0.24 div
50 ms	5 ms	Within 0.24 div
.1 s	10 ms	Within 0.24 div
.2 s	20 ms	Within 0.24 div

¹Check for 1 cycle in 5 divisions at 200 ps/div over center 8 divisions.

This completes the Performance Check procedure.

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 and connectors function properly.

ADJUSTMENT AND PERFORMANCE CHECK INDEX

	PAGE
A. TRIGGERING SYSTEM	
1. Check External Trigger Input Resistance ...	5-24
2. Adjust External Trigger Compensation (C117)	5-24
3. Adjust Trigger Sensitivity (R147)	5-25
4. Check Triggering Modes	5-25
5. Check External Level Range	5-26
6. Check External Triggering Sensitivity	5-26
7. Check Internal Triggering Sensitivity	5-27
8. Check Internal Trigger Jitter	5-28
9. Check Line Triggering	5-28
B. HORIZONTAL SYSTEM	
1. Set Basic Sweep Calibration	5-29
2. Check Sweep Length and Positioning Range	5-30
3. Check/Adjust Magnifier Gain and Registration (R460, R470)	5-30
4. Check Variable Time/Division and Variable Hold Off	5-31
5. Adjust Sweep Timing (C361, R305 R310, R480)	5-31
6. Check Delay Modes	5-32
7. Adjust Delay Offset and Delay Gain (R555, R510)	5-32
8. Adjust DVM Zero (R625)	5-33
9. Adjust DVM Gain (R620)	5-34
10. Adjust Delay Start and Pickoff Bias (R335, R535)	5-34
11. Check Delay Time, Δ Time, and Trace Separation Ranges	5-35
12. Adjust 10 μ s and 10 ms Delay Timing (R305, R310)	5-35
13. Check Δ Time Accuracy	5-36
14. Check Δ Time Linearity	5-37
15. Check Delay Time Accuracy (Start of Delayed Sweep Display with Respect to Delaying Sweep Display)	5-38
16. Check Delay Time Jitter	5-38
17. Check Sweep Timing	5-39
18. Check Magnified Sweep Timing	5-40

ADJUSTMENT AND PERFORMANCE CHECK POWER-UP SEQUENCE

NOTE

The performance of this instrument can be checked at any ambient temperature within the 0°C to +50°C range unless stated otherwise. Adjustment between 20° and 30° C ambient is required to maintain stated accuracy.

1. Install a high impedance amplifier plug-in unit in the left vertical compartment of the oscilloscope mainframe.
2. Install the 7B15 in the A horizontal compartment of the oscilloscope mainframe.
3. Set the mainframe vertical mode switch to display the left vertical unit and the horizontal mode switch to display the A horizontal unit. Set the mainframe intensity controls fully counterclockwise and set the trigger source switches to vertical mode.
4. Turn on the mainframe and allow at least 20 minutes warmup before beginning the procedure.

A. TRIGGERING SYSTEM

Equipment Required: (Numbers correspond to test equipment listed in Table 5-2)

- | | |
|--|---------------------------------|
| 1. Oscilloscope mainframe | 9. Rigid Plug-in extender |
| 2. High-frequency amplifier plug-in unit | 10. Coaxial cables (2 required) |
| 3. High Impedance amplifier plug-in unit | 11. T connector |
| 4. High-frequency sine-wave generator | 13. Screwdriver |
| 6. Low-frequency function generator | 14. 10X probe |
| 7. Digital ohmmeter | 15. Low-capacitance screwdriver |

BEFORE YOU BEGIN:

- Perform the Adjustment and Performance Check Power-Up Sequence.
- Refer to Section 6, Instrument Options and the Change Information at the rear of the manual for any modifications which may affect this procedure.

(3) See **TEST POINT AND ADJUSTMENT LOCATIONS** foldout page in Section 8, Diagrams and Circuit Board Illustrations.

TRIGGERING SYSTEM PRELIMINARY CONTROL SETTINGS:

7B15 Time Base

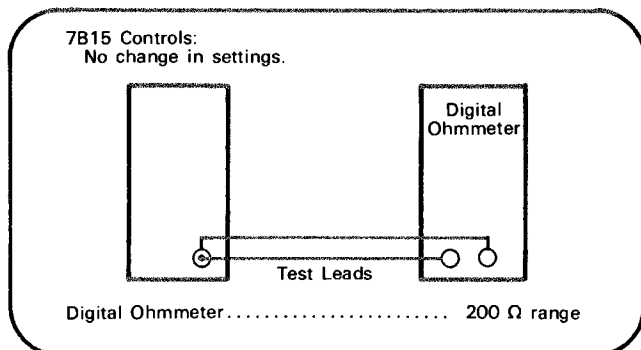
TRIGGERING AUTO, AC, EXT, OUT 50 Ω
LEVEL Midrange
TIME/DIV5 ms
POSITION Midrange
HOLD OFF MIN
B DELAY MODE INDEPENDENT
MAG CAL IN
VARIABLE CAL IN

Oscilloscope Mainframe

Intensity Visible display
Focus Well defined display

A1. CHECK EXTERNAL TRIGGER INPUT RESISTANCE

SETUP CONDITIONS



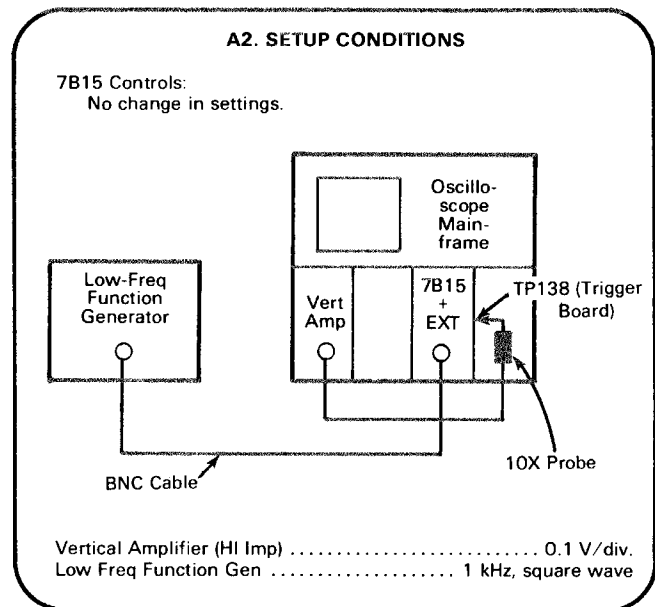
a. **CHECK**—That the input resistance is 50Ω within 2% (1Ω).

A2. ADJUST EXTERNAL TRIGGER COMPENSATION (C117)

SETUP CONDITIONS

NOTE

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



a. Set the low-frequency function generator and the amplifier plug-in unit for a 4 to 6 division display at 1 kHz (position as necessary).

b. **EXAMINE**—Display pulse for minimum spike and optimum flat top.

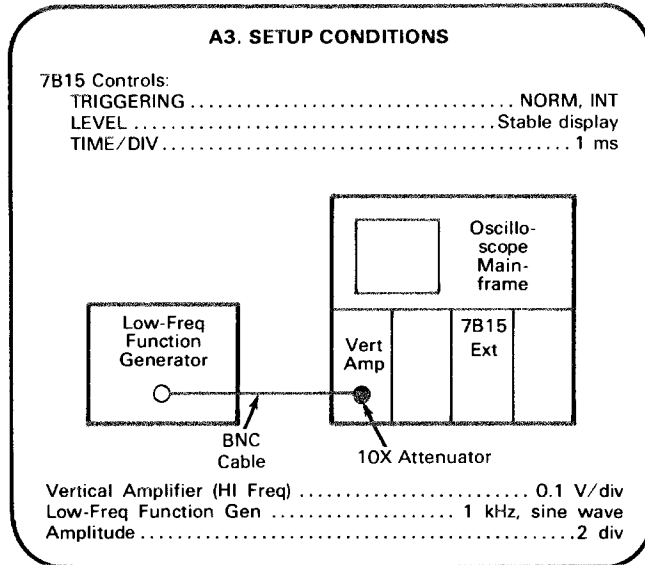
c. **ADJUST**—C117 (External Trigger Comp) on the Trigger circuit board for minimum spike and optimum flat top on the displayed pulse.

A3. ADJUST TRIGGER SENSITIVITY (R147)

SETUP CONDITIONS

NOTE

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



a. Set the amplifier plug-in unit deflection factor for 1V (0.2 division).

b. **EXAMINE**—For a stable 0.2 division display (set TRIGGERING LEVEL control as necessary).

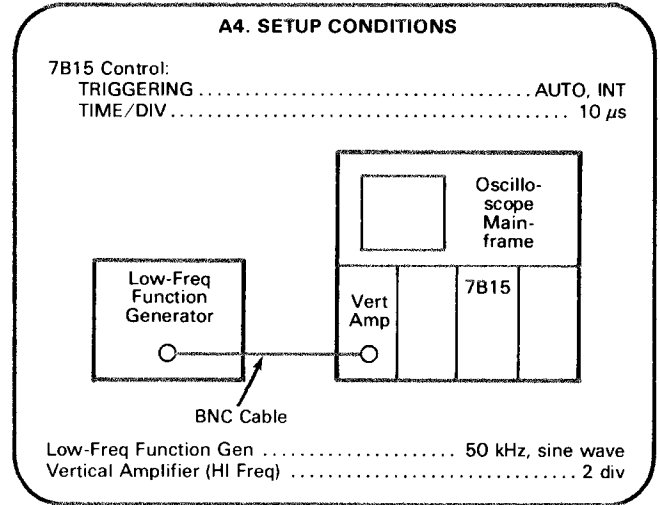
c. **ADJUST**—R147 (Sensitivity) on the Trigger circuit board for a stable 0.2 display.

A4. CHECK TRIGGERING MODES

SETUP CONDITIONS

NOTE

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



a. Set the TRIGGERING LEVEL control for a stable display (TRIG'D light on).

b. **CHECK**—For a free-running display with TRIG'D light off when the TRIGGERING LEVEL control is set fully clockwise and fully counterclockwise.

c. Set the TRIGGERING MODE to NORM.

d. Set the TRIGGERING LEVEL control for a stable display (TRIG'D light on).

e. **CHECK**—For no display (TRIG'D light off) when the TRIGGERING LEVEL control is set fully clockwise and fully counterclockwise.

f. Set the TRIGGERING LEVEL control for a stable display (TRIG'D light on).

g. Set the TRIGGERING MODE to SINGLE SWP and the SOURCE to EXT.

h. **CHECK**—Press the SINGLE SWP RESET push button and check that the READY light is on.

**Calibration Part II--7B15
Adjustment and Performance Check**

i. **CHECK**—For one sweep and that the READY light is out after completion of that sweep when the INT SOURCE push button is pressed (oscilloscope intensity may need to be increased to view the single-sweep display).

j. Remove the low-frequency function generator cable from the amplifier plug-in unit and connect the high-frequency sine-wave generator to the amplifier plug-in unit input with a 10X attenuator.

k. Set the TRIGGERING MODE to HF SYNC and the TIME/DIV to 2 ns.

l. Set the high-frequency sine-wave generator and amplifier unit deflection factor for approximately a 1-division display of 250 MHz signal.

m. **CHECK**—for a stable display (TRIG'D light on) at all positions of the TRIGGERING LEVEL control.

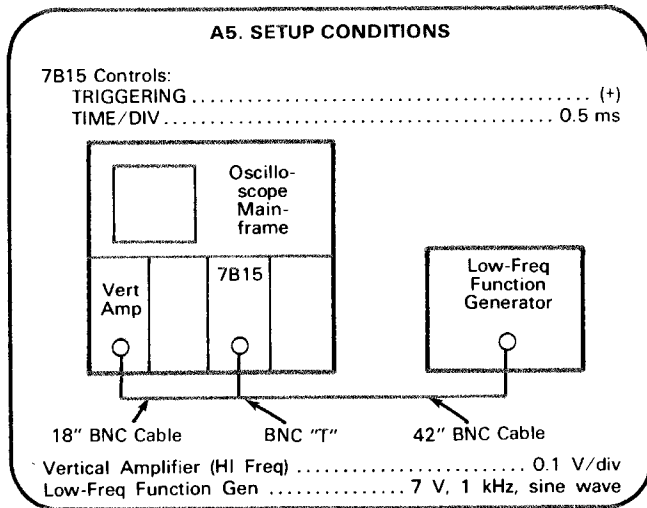
n. Set the TRIGGERING MODE to NORM and source to EXT.

A5. CHECK EXTERNAL LEVEL RANGE

SETUP CONDITIONS

NOTE

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



a. **CHECK**—That all levels of the positive slope may be selected for the sweep starting point as the TRIGGERING LEVEL control is rotated throughout its range (indicates an external level range of at least plus and minus 3.5 volts). Check that the display is not triggered at either end of the TRIGGERING LEVEL control rotation.

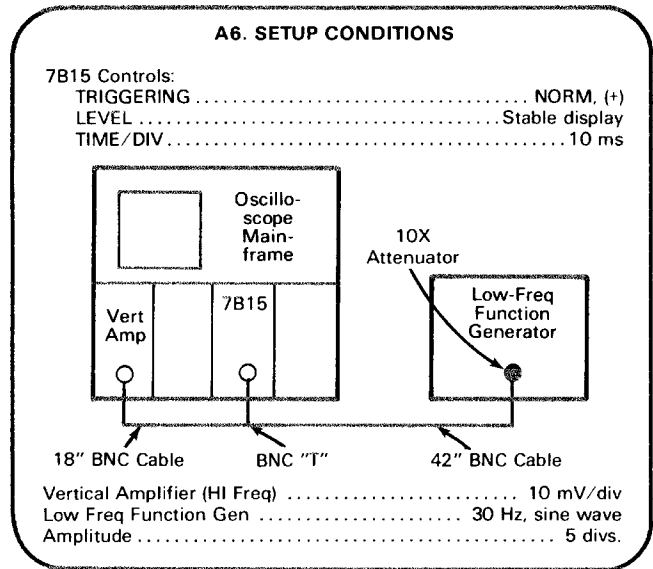
b. **CHECK**—Change the TRIGGERING SLOPE to (-) and repeat part a for the negative slope of the waveform.

A6. CHECK EXTERNAL TRIGGERING SENSITIVITY

SETUP CONDITIONS

NOTE

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



a. **CHECK**—Set the TRIGGERING MODE to AUTO and check for a stable display (TRIG'D light on) with the COUPLING push button set to:

1. AC
2. AC HF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

b. **CHECK**—Change the TRIGGERING SLOPE to (-) and repeat part a.

c. Disconnect the low-frequency function generator from the 10X attenuator and connect the high-frequency sine-wave generator to the 10X attenuator.

d. Set the SLOPE to (+) and the TIME/DIV switch to 2 ns.

e. Set the high-frequency sine-wave generator for a 5-division display (50 millivolts) at 250 megahertz.

f. **CHECK**—For a stable display (TRIG'D light on) with the COUPLING switch set to:

1. AC
2. AC LF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

g. **CHECK**—Set the SLOPE switch to (-) and repeat part f.

h. Set the amplifier plug-in unit deflection factor to 50 millivolts/ division and set the high-frequency sine-wave generator for a 3-division display (150 millivolts) at 1 GHz.

i. **CHECK**—For a stable display (TRIG'D light on) with the COUPLING switch set to:

1. AC
2. AC LF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

j. **CHECK**—Set the SLOPE switch to (+) and repeat part i.

k. Set the TRIGGERING MODE to HF SYNC and the amplifier plug-in unit deflection factor to 10 millivolts/division.

l. Set the high-frequency sine-wave generator for a 7.5-division display (75 millivolts) at 1 GHz.

m. **CHECK**—For a stable display (TRIG'D light on) with the COUPLING switch set to:

1. AC
2. AC LF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

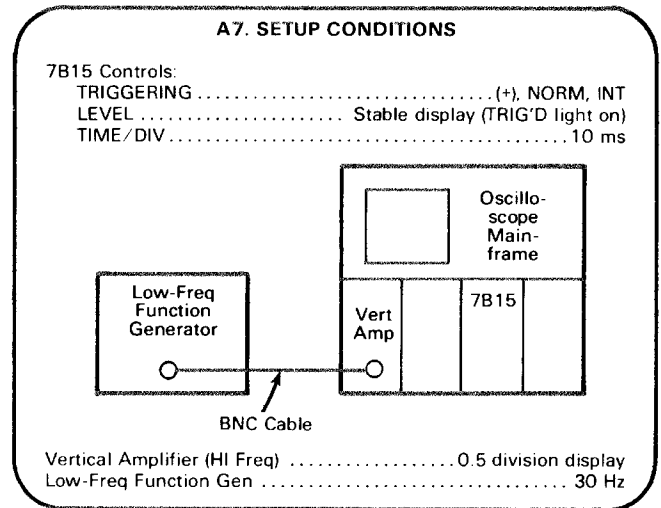
n. **CHECK**—Set the SLOPE switch to (-) and repeat part m.

A7. CHECK INTERNAL TRIGGERING SENSITIVITY

SETUP CONDITIONS

NOTE

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



a. **CHECK**—Set the TRIGGERING MODE to AUTO and check for a stable display (TRIG'D light on) with COUPLING set to:

1. AC
2. AC HF REJ
3. DC

(Set the TRIGGERING LEVEL control as necessary.)

b. Change the TRIGGERING SLOPE to (-) and repeat part a.

c. Disconnect the low-frequency function generator and connect the high-frequency sine-wave generator to the amplifier plug-in unit input.

d. Set the SLOPE to (+) and the TIME/DIV switch to 2 ns.

e. Set the high-frequency sine-wave generator and the amplifier plug-in unit deflection factor for a 0.5-division display at 250 megahertz (use 10X attenuator).

f. **CHECK**—For a stable display (TRIG'D light on) with COUPLING set to:

1. AC
2. AC LF REJ
3. DC

**Calibration Part II—7B15
Adjustment and Performance Check**

(Set the TRIGGERING LEVEL control as necessary.)

- g. **CHECK**—Set the SLOPE to (-) and repeat part f.
- h. Set the high-frequency sine-wave generator and the amplifier plug-in unit deflection factor for a 1.5 division display at 1 GHz.
- i. **CHECK**—For a stable display (TRIG'D light on) with the COUPLING switch set to:
 - 1. AC
 - 2. AC LF REJ
 - 3. DC

(Set the TRIGGERING LEVEL control as necessary.)

- j. **CHECK**—Set the SLOPE to (+) and repeat part i.
- k. Set the TRIGGERING MODE switch to HF SYNC and the high-frequency sine-wave generator and amplifier plug-in unit deflection factor for a 0.3-division display at 1 GHz.
- l. **CHECK**—For a stable display (TRIG'D light on) with the COUPLING switch set to:
 - 1. AC
 - 2. AC LF REJ
 - 3. DC

(Set the TRIGGERING LEVEL control as necessary.)

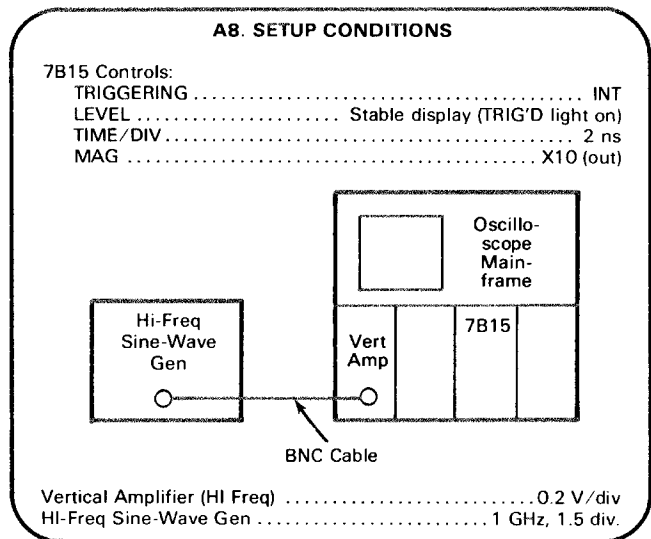
- m. **CHECK**—Set the SLOPE to (-) and repeat part l.

A8. CHECK INTERNAL TRIGGER JITTER

SETUP CONDITIONS

NOTE

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



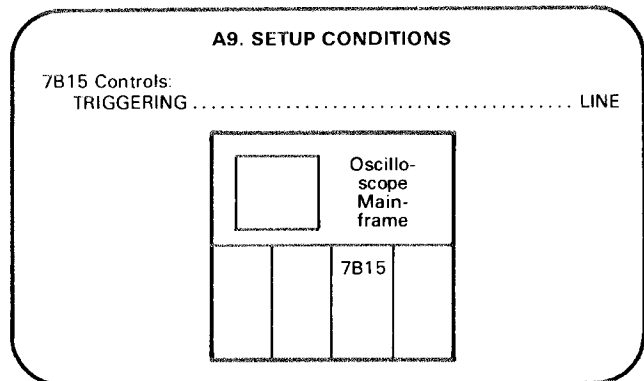
- a. **CHECK**—For a stable display with no more than 0.15 division (30 picosecond) of jitter.

A9. CHECK LINE TRIGGERING

SETUP CONDITIONS

NOTE

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



- a. **CHECK**—Set the TRIGGERING LEVEL to approximately midrange and check that the TRIG'D light is on.
- b. **CHECK**—That the display is not triggered (TRIG'D light off) at either end of the TRIGGERING LEVEL control rotation.

B. HORIZONTAL SYSTEM

Equipment Required: (Numbers correspond to test equipment listed in Table 5-2)

- | | |
|--|--------------------------------|
| 1. Oscilloscope mainframe | 9. Rigid plug-in extender |
| 2. High-Frequency amplifier plug-in unit | 10. Coaxial cable (1 required) |
| 5. Time-mark generator | 13. Screwdriver |
| 8. Time-base unit | |

BEFORE YOU BEGIN:

(1) Perform the Adjustment and Performance Check Power-up Sequence. (Not necessary if continuing Adjustment and Performance Check.)

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

(3) See **TEST POINT AND ADJUSTMENT LOCATIONS** foldout pages in Section 8, Diagrams and Circuit Board Illustrations.

HORIZONTAL SYSTEM PRELIMINARY CONTROL SETTINGS:

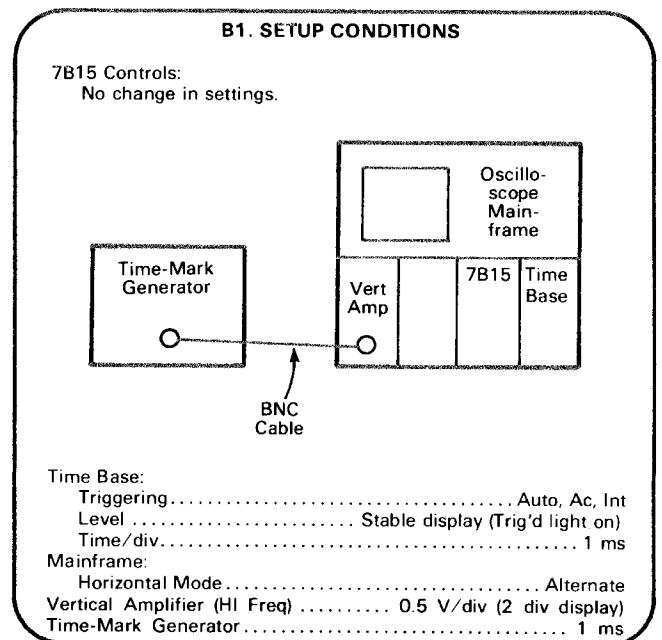
7B15 Time Base

TRIGGERING AUTO, AC, INT
LEVEL Midrange
TIME/DIV 1 ms
B DELAY MODE INDEPENDENT
TRACE SEP OFF
DELAY TIME Fully counterclockwise
 Δ TIME Fully clockwise
VARIABLE CAL IN
MAG X1
POSITION Midrange
HOLD OFF MIN

Oscilloscope Mainframe

Vertical position plug-in Midrange
Intensity Visible display
Focus Well defined display

B1. SET BASIC SWEEP CALIBRATION SETUP CONDITIONS



a. Center the 7B15 trace in the upper half of the graticule and the companion unit trace in the lower half.

b. **EXAMINE**—For exactly 1 marker/division (upper trace) over center 8 divisions (position as necessary).

c. **ADJUST**—The 7B15 front-panel SWP CAL adjustment for exactly 1 marker/division (upper trace) over the center 8 divisions (position as necessary).

d. **EXAMINE**—For exactly 1 marker/division (lower trace) over center 8 divisions (position as necessary).

**Calibration Part II—7B15
Adjustment and Performance Check**

e. **ADJUST**—Front-panel SWP CAL adjustment on the companion time base unit for exactly 1 marker/division (lower trace) over the center 8 division (position as necessary).

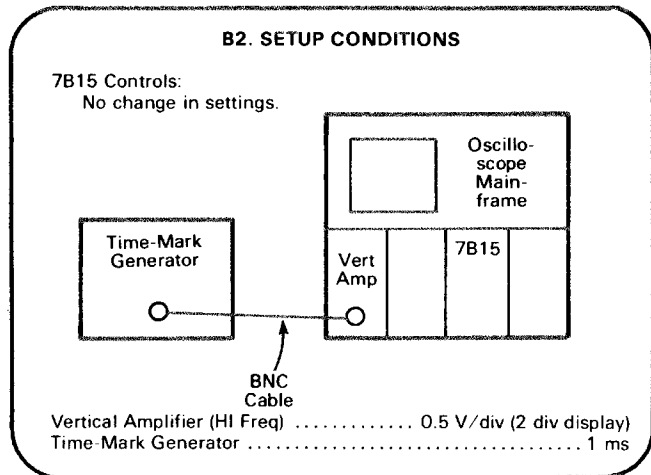
f. Set mainframe horizontal mode to A.

B2. CHECK SWEEP LENGTH AND POSITIONING RANGE

SETUP CONDITIONS

NOTE

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



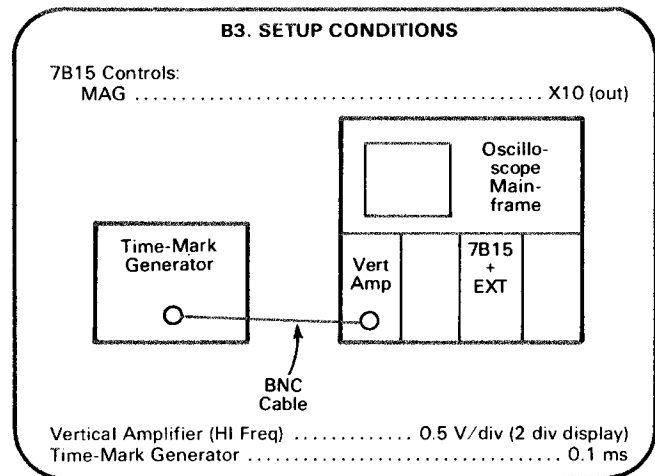
- a. Horizontally position the display to place the second time marker to the first graticule line.
- b. **CHECK**—That the end of the sweep extends to at least 9.2 graticule divisions (indicates sweep length of at least 10.2 divisions).
- c. Set the POSITION and FINE controls fully clockwise.
- d. **CHECK**—The start of the sweep must be to the right of graticule center.
- e. Set the POSITION and FINE controls fully counterclockwise.
- f. **CHECK**—The end of the sweep must be to the left of graticule center.

B3. CHECK/ADJUST MAGNIFIER GAIN AND REGISTRATION (R460, R470)

SETUP CONDITIONS

NOTE

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



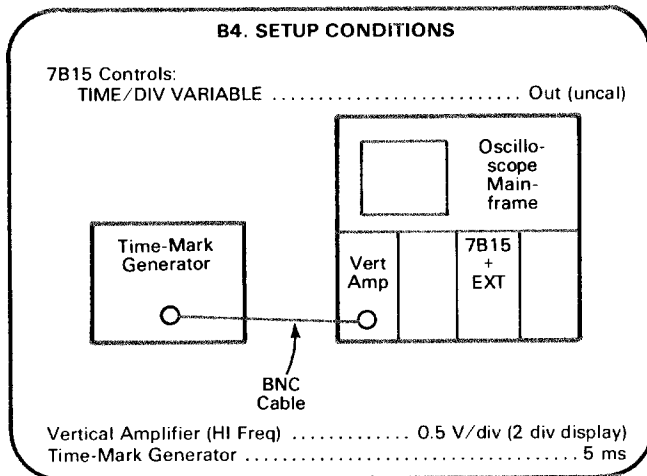
- a. **CHECK**—for 1 marker/division over the center 8 divisions of the display (position as necessary).
- b. **ADJUST**—R460 (Mag Gain) for 1 marker/division over the center 8 divisions of the display.
- c. Set the time-mark generator for 5-millisecond markers. Align the center time marker with graticule center.
- d. **CHECK**—Set the MAG switch to X1 and check that the center time marker is at graticule center within 0.5 division.
- e. **ADJUST**—R470 (Mag Reg) to align the center time marker with graticule center.
- f. Repeat parts c through e until the center time marker is at graticule center within 0.5 division.

B4. CHECK VARIABLE TIME/DIVISION AND VARIABLE HOLD OFF

SETUP CONDITIONS

NOTE

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



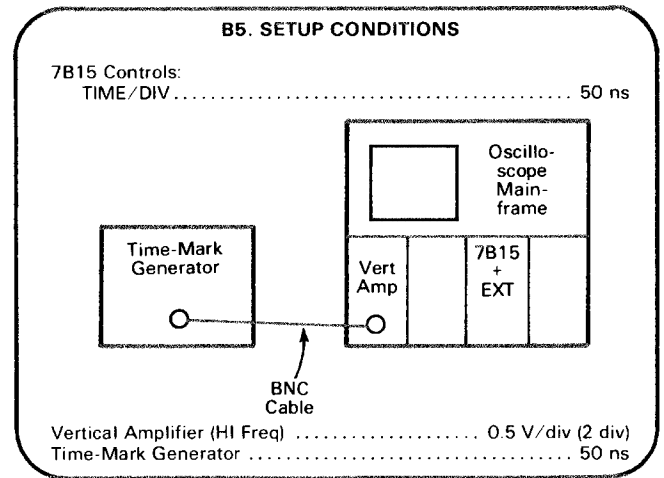
- Set the VARIABLE control fully clockwise and note 3 time markers in 10 graticule divisions.
- CHECK**—Set the VARIABLE control fully counterclockwise and check for 2 divisions or less between 5-millisecond markers.
- Press in the VARIABLE control for calibrated sweep rates.
- Set the TRIGGERING LEVEL control for a free-running display (TRIG'D light off).
- Set the HOLD OFF control fully counterclockwise.
- CHECK**—Rotate the HOLD OFF control slowly clockwise throughout its range and check that the display (3 time markers in 10 divisions) will nearly stabilize at least 3 times throughout the range of the HOLD OFF control (disregard any slow drift).
- Set the HOLD OFF control counterclockwise to MIN and set the TRIGGERING LEVEL control for a stable display.

B5. ADJUST SWEEP TIMING (C361, R305, R310, R480)

SETUP CONDITIONS

NOTE

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



- EXAMINE**—For 1 marker/division over the center 8 divisions of the display (position as necessary).
- ADJUST**—C361 (50 ns Timing) for 1 marker/division over the center 8 divisions of the display (position as necessary).
- Set the TIME/DIV switch to 5 nanoseconds and set the time mark generator for 5 nanosecond markers.
- EXAMINE**—For 1 marker/division over the center 8 divisions of display (position as necessary).
- ADJUST**—R480 (5 ns Timing) for 1 marker/division over the center 8 divisions of display (position as necessary).
- Set the TIME/DIV switch to 10 μ s and set the time-mark generator for 10-microsecond markers.
- EXAMINE**—For 1 marker/division over the center 8 divisions of the display (position as necessary).
- ADJUST**—R310 (10 μ s Timing) for 1 marker/division over the center 8 divisions of the display (position as necessary).

**Calibration Part II—7B15
Adjustment and Performance Check**

- i. Set the TIME/DIV switch to 10 ms and set the time-mark generator for 10 millisecond markers.
- j. Check for 1 marker/division over the center 8 divisions of the display (position as necessary).
- k. **ADJUST**—R305 (10 ms Timing) for 1 marker/division over the center 8 divisions of the display (position as necessary).
- l. Set 7B15 TIME/DIV to 1 ms.

NOTE

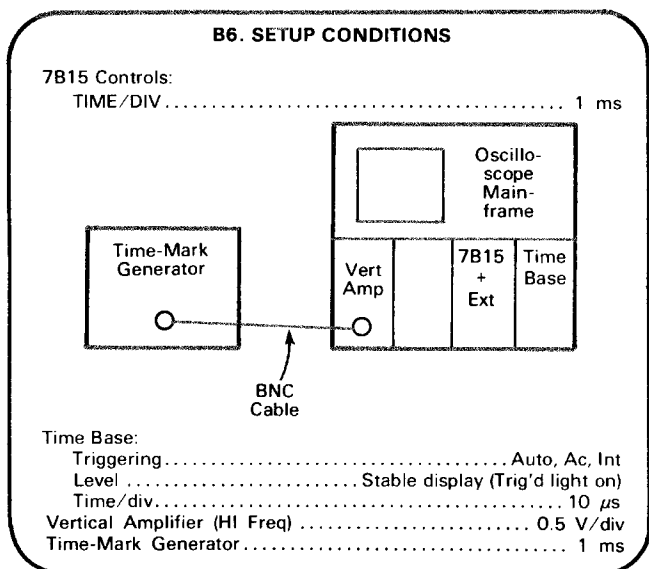
Final adjustment of R305 and R310 is made in step B12.

B6. CHECK DELAY MODES

SETUP CONDITIONS

NOTE

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



- a. **CHECK**—Rotate the DELAY TIME control and note that it has no effect on the independent sweep display.
- b. **CHECK**—Rotate the TRACE SEP control counterclockwise out of switch detent to enable the Δ TIME mode. Rotate the Δ TIME control and check for no effect on the independent sweep display.
- c. Rotate the TRACE SEP control into the switch detent to disable the Δ TIME operation. Set the B DELAY MODE switch to B STARTS AFTER DLY.
- d. Set the mainframe horizontal mode to alternate.

e. Set the mainframe intensity control for optimum brightness of the intensified- and delayed-sweep traces. Center the delaying-sweep trace in the upper half of the graticule and the delayed-sweep trace in the lower half of the graticule.

f. **CHECK**—Rotate the DELAY TIME control throughout its range and note that the delay before the start of the intensified zone is continuously variable.

g. Set the B DELAY MODE switch to B TRIGGERABLE AFTER DLY.

h. **CHECK**—Rotate the DELAY TIME control throughout its range and note that the intensified zone jumps from time marker to time marker. This indicates that the intensified zone does not start at the completion of delay time, but waits for the next trigger pulse.

i. **CHECK**—that the greater-than symbol (>) precedes the delay-time readout indicating that the delay-time readout is uncalibrated.

NOTE

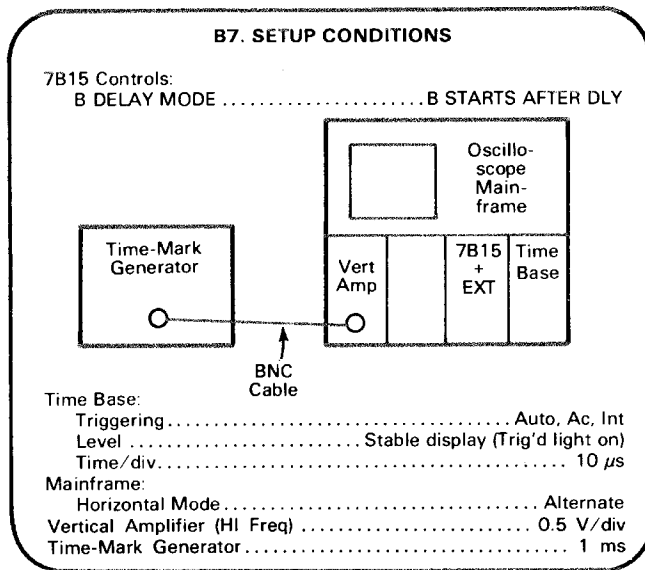
The 7B15 may be operated as a delayed-sweep unit (B horizontal compartment) with a companion delaying-sweep unit (A horizontal compartment). To check 7B15 delayed-sweep operation, install the 7B15 in the B horizontal compartment and a companion delaying-sweep unit into the A horizontal compartment. Set the 7B15 B DELAY MODE to INDEPENDENT and the TIME/DIV switch to 0.1 ms. Set the delaying-sweep unit for a 1-millisecond/division sweep rate and apply 1-millisecond time markers to the amplifier plug-in unit input. Check delayed-sweep operation as outlined in step B6, parts c through h.

B7. ADJUST DELAY OFFSET AND DELAY GAIN (R555, R510)

SETUP CONDITIONS

NOTE

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



a. Rotate the Δ TIME control fully counterclockwise and rotate the TRACE SEP control counterclockwise out of the switch detent. Rotate the DELAY TIME control to start the intensified zone approximately 1 division from the start of the delaying-sweep trace (upper trace). Rotate the DELAY TIME control to further position the time markers on the delaying-sweep traces to graticule center.

NOTE

Do not disturb the setting of the Δ TIME control (fully counterclockwise) during the remainder of step B7.

b. **EXAMINE**—The time markers of both the first and second delayed-sweep traces are horizontally aligned within 0.1 division. It may be necessary to rotate the TRACE SEP control to distinguish the two delayed-sweep traces.

c. **ADJUST**—R555 (Delay Offset) to horizontally align the time markers of the first and second delayed-sweep traces.

d. Rotate the DELAY TIME control to start the intensified zone approximately 8 divisions from the start of the trace. Further rotate the DELAY TIME control to position the time markers of the delayed-sweep traces near graticule center.

e. **EXAMINE**—The time-markers of both delayed-sweep traces are horizontally aligned within 0.1 division.

f. **ADJUST**—R510 (Delay Gain) to horizontally align the time markers of the delayed-sweep traces.

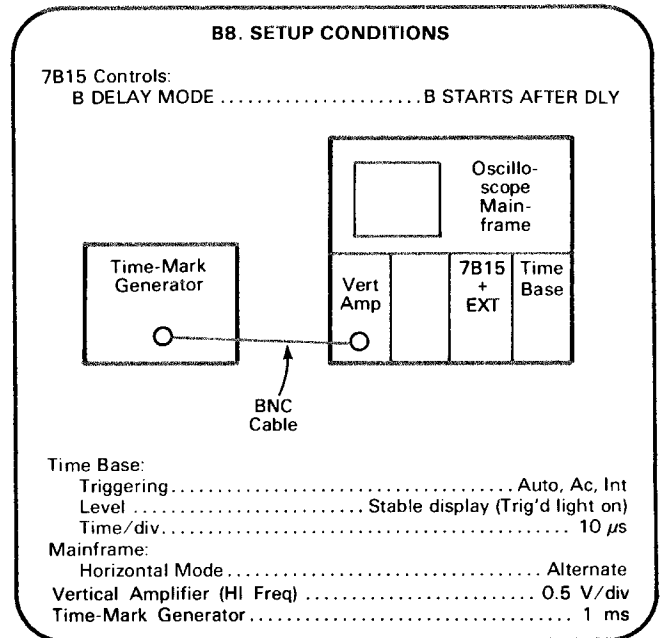
g. **INTERACTION**—Repeat step B7 until there is no change in the adjustment.

B8. ADJUST DVM ZERO (R625)

SETUP CONDITIONS

NOTE

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



a. Rotate the Δ TIME control fully counterclockwise and the TRACE SEP counterclockwise out of the switch detent.

b. Set the DELAY TIME control to position the intensified zones near the second graticule line so that the time markers in the delayed-sweep display are on the center graticule line.

c. Advance the Δ TIME control until the first and second delayed time markers are 2.0 divisions (20 microseconds) apart (1 horizontal division equals 10 microseconds of delayed sweep).

NOTE

If it is difficult to set the Δ TIME control for exactly 2 divisions (20 microseconds) between delayed-sweep time markers, note the actual time separation displayed. Then, follow the procedure outlined in part d and adjust R625 so that the Δ time readout corresponds to the actual time separation displayed between the delayed-sweep time markers.

**Calibration Part II—7B15
Adjustment and Performance Check**

EXAMPLE: A 2.2-division time delay corresponds to a 0.022 ms Δ time readout. Adjust R625 for a Δ time readout of 0.021 ms. Then, adjust R625 until the Δ time readout just changes to 0.022 ms.

d. **ADJUST**—R625 (DVM Zero) for a Δ time readout of 0.019 ms. Then, adjust R625 until the Δ time readout just changes to 0.020 ms.

e. Rotate the Δ TIME control fully counterclockwise.

f. Check for a Δ time readout of 0.000 ms to 0.001 ms and for horizontal alignment of the delayed sweep time markers within 0.1 division.

NOTE

If the Δ TIME control cannot be set to at least obtain 8 divisions between intensified zones, preset R535 (Pickoff Bias) fully clockwise. Final adjustment of R535 is made in step B10.

b. Check for a Δ time readout of exactly 8.000 ms.

c. **ADJUST**—R620 (DVM Gain) for a Δ time readout of exactly 8.000 ms. Disregard an occasional Δ time readout of ± 1 digit.

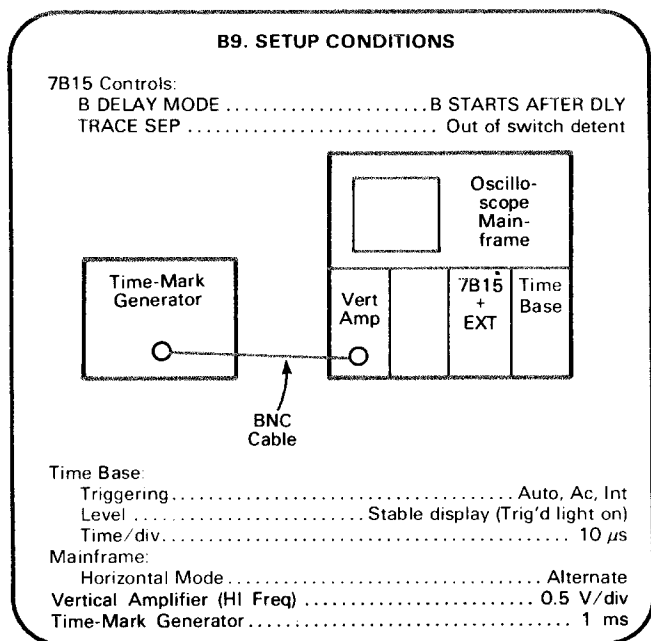
d. Set the TRACE SEP fully clockwise to the OFF position.

B9. ADJUST DVM GAIN (R620)

SETUP CONDITIONS

NOTE

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



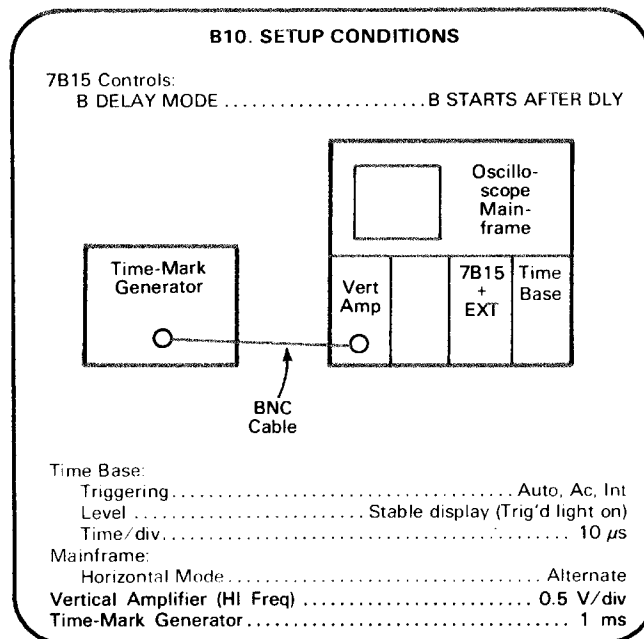
a. Set the DELAY TIME control to start the first intensified zone on the second time marker and set the Δ TIME control to start the second intensified zone on the tenth time marker. Further rotate the Δ TIME control to horizontally align the delayed-sweep traces (it may be necessary to rotate the TRACE SEP control to view the 2 delayed-sweep traces).

B10. ADJUST DELAY START AND PICKOFF BIAS (R335, R535)

SETUP CONDITIONS

NOTE

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



a. Position both traces horizontally (7B15 trace and companion time-based trace) to start on the first graticule line.

b. Set the DELAY TIME control for 0.950 ms of delay-time readout.

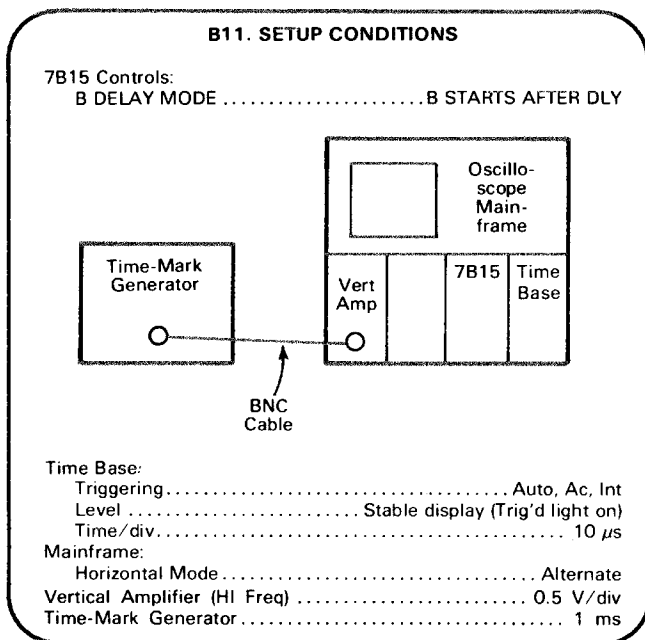
- c. Check for a delayed-sweep time marker (lower trace) at graticule center, within 1.0 division.
- d. **ADJUST**—R335 until the leading edge of the time mark is on the center graticule line.
- e. Rotate the TRACE SEP control counterclockwise, just out of the switch detent, to enable the Δ TIME mode. Set the DELAY TIME control fully counterclockwise and the Δ TIME control fully clockwise.
- f. Check for a time readout of 9.200 ms, within 0.100 ms.
- g. **ADJUST**—R535 (Pickoff Bias) for a Δ time readout of 9.200 ms.
- h. Set the TRACE SEP control fully clockwise to the OFF position.

B11. CHECK DELAY TIME, Δ TIME, AND TRACE SEPARATION RANGES

SETUP CONDITIONS

NOTE

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



- a. **CHECK**—Set the DELAY TIME control fully clockwise and check for a delay-time readout of 9.000 ms or greater.
- b. **CHECK**—Set the DELAY TIME control fully counterclockwise and check for a delay-time readout of 0.200 ms or less.
- c. Set the TRACE SEP control counterclockwise, out of the switch detent, to enable Δ TIME operation.

- d. **CHECK**—That the Δ symbol appears in the delay-time readout.
- e. **CHECK**—Set the Δ TIME control fully clockwise and check for a Δ time reading of 9.000 ms or greater.
- f. **CHECK**—Set the Δ TIME control fully counterclockwise and check for a Δ time readout of 0.000 ms. Check that the Δ symbol precedes the readout display. Disregard an occasional Δ time readout of 0.001 ms.
- g. Set the TRACE SEP control fully clockwise. Set the mainframe vertical trace separation control to midrange. Position the delayed-sweep trace, with the amplifier plug-in unit position control, to the center graticule line.
- h. **CHECK**—Set the TRACE SEP control fully counterclockwise and check that the second delayed-sweep trace is at least 3 divisions below graticule center.

B12. ADJUST 10 μ s AND 10 ms DELAY TIMING (R305, R310)

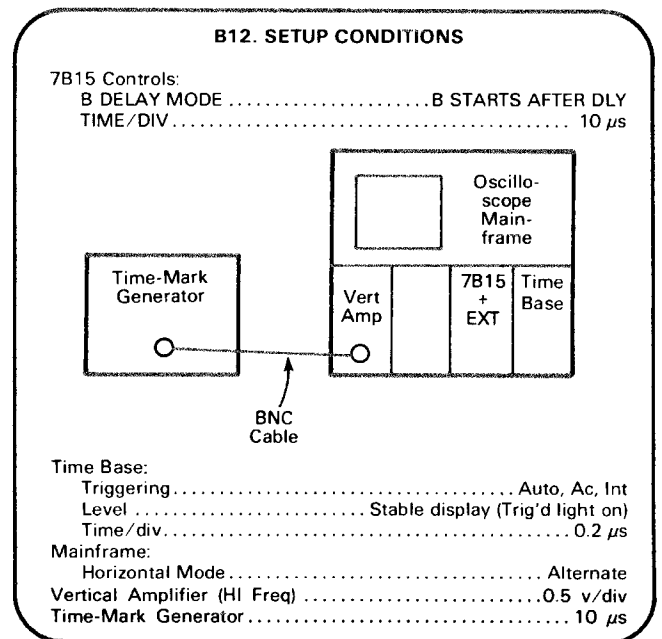
NOTE

Step B5 must have been performed before proceeding with this step if servicing and/or adjustment has occurred prior to this step.

SETUP CONDITIONS

NOTE

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



- a. **CHECK**—Set the DELAY TIME control fully clockwise and check for a delay-time readout of 9.000 ms or greater.
- b. **CHECK**—Set the DELAY TIME control fully counterclockwise and check for a delay-time readout of 0.200 ms or less.
- c. Set the TRACE SEP control counterclockwise, out of the switch detent, to enable Δ TIME operation.

**Calibration Part II—7B15
Adjustment and Performance Check**

a. Set the amplifier plug-in unit position control to center the intensified trace in the upper half of the graticule. Set the TRACE SEP control out of detent to enable Δ TIME operation and position the delayed-sweep traces together.

b. Set the DELAY TIME control to start the first intensified zone on the second time marker and set the Δ TIME control to start the second intensified zone on the tenth time marker. Rotate the Δ TIME control for a Δ time readout of exactly 80.00 μ s.

c. **EXAMINE**—The time markers of both the first and second delayed-sweep traces are horizontally aligned within 1.0 division.

d. **ADJUST**—R310 (10 μ s Timing) to horizontally align the delayed-sweep time markers.

e. Set the 7B15 TIME/DIV switch to 10 ms and set the companion time-base unit for a 0.2-millisecond/ division sweep rate.

f. Set the time-mark generator for 10-millisecond markers.

g. Set the DELAY TIME control to start the first intensified zone on the second time marker and set the Δ TIME control to start the second intensified zone on the tenth marker. Rotate the Δ TIME control for a Δ time readout of exactly 80.00 ms.

h. **EXAMINE**—The time markers of both the first and second delayed-sweep traces are horizontally aligned within 1.0 division.

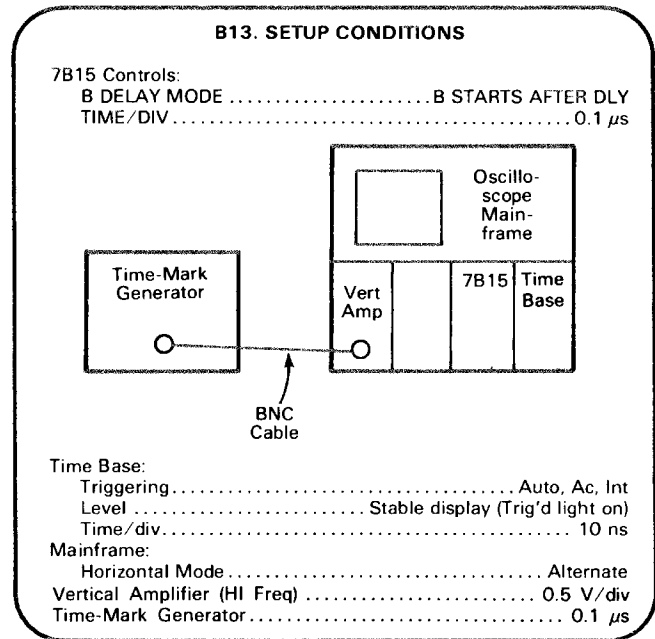
i. **ADJUST**—R305 (10 ms Timing) to horizontally align the delayed-sweep time markers.

B13. CHECK Δ TIME ACCURACY

SETUP CONDITIONS

NOTE

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



a. Set the TRACE SEP control to position the second delayed-sweep trace approximately 0.2 division below the first delayed-sweep trace.

b. Position the display for 1 marker/division over the center 8 divisions of intensified display.

c. Set the DELAY TIME control to start the first intensified zone on the time marker which is nearest the second graticule line. Set the Δ TIME control to start the second intensified zone on the time marker which is nearest the tenth graticule line.

d. Further adjust the Δ TIME control to horizontally align the time markers of the first and second delayed-sweep traces.

e. **CHECK**—For a Δ time readout between 795.7 ns and 804.3 ns.

NOTE

The limits in part e and Table 5-6 are derived from the Performance Requirement in the Specification section.

EXAMPLE: The Performance Requirement for Δ TIME accuracy at 0.1 μ s/DIV is:

Within (0.5% measurement +3 digits).

For an 8 division measurement (800 ns), the accuracy is:

$$\pm (0.5\% \text{ of } 800 \text{ ns} + 0.3 \text{ ns}) = \pm (4.0 \text{ ns} + 0.3 \text{ ns}) = \pm 4.3 \text{ ns}$$

Therefore, the specified limits for a measurement interval of 800 ns are:

$$800 \text{ ns} \pm 4.3 \text{ ns} = 795.7 \text{ ns to } 804.3 \text{ ns}$$

f. **CHECK**—Follow the procedure outlined in parts c through e and check for Δ TIME accuracy as given in Table 5-6.

TABLE 5-6
 Δ Time Accuracy

7B15 TIME/DIV	Companion Time Base Sweep Rate	Time Markers	Δ Time Readout Range
.1 μ s	10 ns	.1 μ s	795.7 ns to 804.3 ns
.2 μ s	20 ns	.2 μ s	1.589 μ s to 1.611 μ s
.5 μ s	50 ns	.5 μ s	3.977 μ s to 4.023 μ s
1 μ s	.1 μ s	1 μ s	7.957 μ s to 8.043 μ s
2 μ s	.2 μ s	2 μ s	15.89 μ s to 16.11 μ s
5 μ s	.5 μ s	5 μ s	39.77 μ s to 40.23 μ s
10 μ s	1 μ s	10 μ s	79.57 μ s to 80.42 μ s
20 μ s	2 μ s	20 μ s	158.9 μ s to 161.1 μ s
50 μ s	5 μ s	50 μ s	397.7 μ s to 402.3 μ s
.1 ms	10 μ s	.1 ms	795.7 μ s to 804.3 μ s
.2 ms	20 μ s	.2 ms	1.589 ms to 1.611 ms
.5 ms	50 μ s	.5 ms	3.977 ms to 4.023 ms
1 ms	.1 ms	1 ms	7.957 ms to 8.043 ms
2 ms	.2 ms	2 ms	15.89 ms to 16.11 ms
5 ms	.5 ms	5 ms	39.77 ms to 40.23 ms
10 ms	1 ms	10 ms	79.57 ms to 80.43 ms
20 ms	2 ms	20 ms	158.9 ms to 161.1 ms

g. Set the 7B15 TIME/DIV to 1 ms.

B14. CHECK Δ TIME LINEARITY

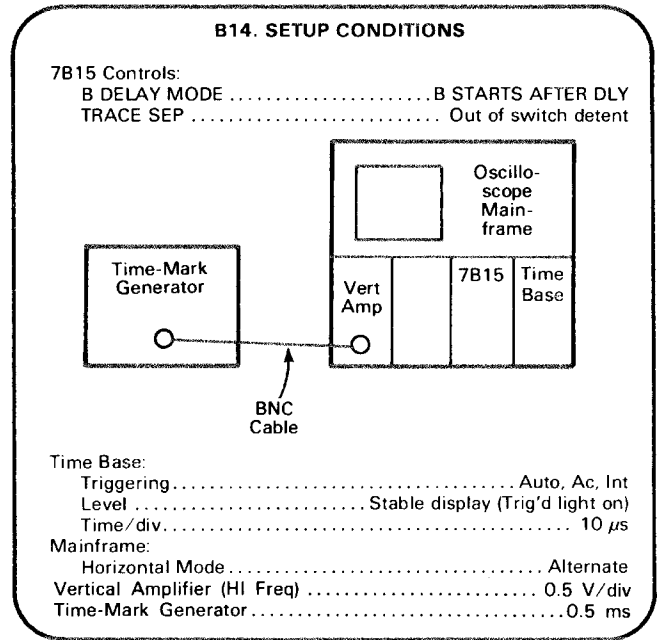
NOTE

Steps B5, B7, B8, B9, and B10 must have been performed before proceeding with this step.

SETUP CONDITIONS

NOTE

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



a. Position the delaying- and delayed-sweep traces horizontally to start on the first graticule line.

b. Set the DELAY TIME control to place the first intensified zone on the time marker that is between the first and second graticule lines (second time marker).

c. Set the Δ TIME control to place the second intensified zone to the time marker that is 0.5 division from the first intensified time marker (third time marker).

d. Set the Δ TIME control to precisely align the delayed-sweep traces.

e. **CHECK**— Δ time readout for 0.497 ms to 0.503 ms.

f. Set the DELAY TIME control to position the first intensified zone to the next 0.5 ms time marker (third time marker). Then, rotate the Δ TIME control to precisely align the delayed sweep traces.

g. **CHECK**— Δ time readout for 0.497 ms to 0.503 ms.

h. Set the DELAY TIME control to position the first intensified zone to the next 0.5 ms time marker (fourth time marker). Then, rotate the Δ TIME control to precisely align the delayed sweep traces.

i. **CHECK**— Δ time readout for 0.497 ms to 0.503 ms.

j. **CHECK**—Use the procedure outlined in parts f through i and check Δ TIME linearity at each 0.5 division point until the first intensified zone is beyond the tenth graticule line.

k. Set the TRACE SEP control to OFF.

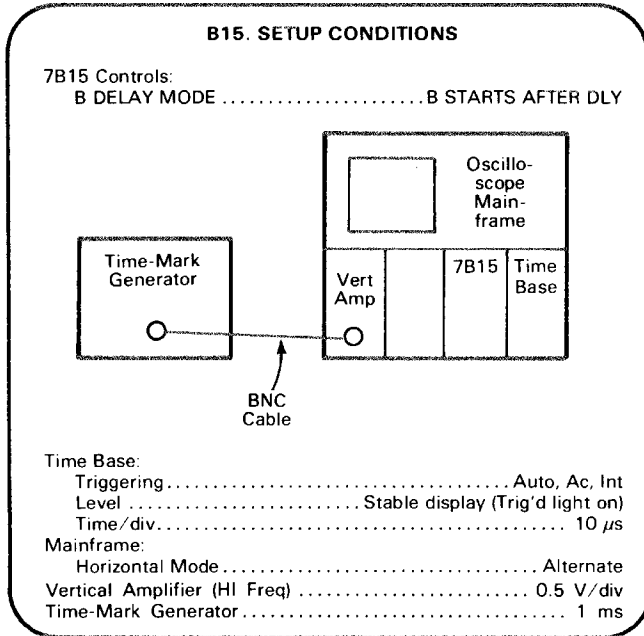
Calibration Part II—7B15
Adjustment and Performance Check

**B15. CHECK DELAY TIME ACCURACY
(START OF DELAYED SWEEP DISPLAY
WITH RESPECT TO DELAYING SWEEP
DISPLAY)**

SETUP CONDITIONS

NOTE

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



- a. Position the delaying- and delayed-sweep traces to start on the first graticule line.
- b. Set the DELAY TIME control to place the intensified zone on the second time marker.
- c. Set the DELAY TIME control to precisely position the leading edge of the delayed-time marker to the first graticule line.
- d. **CHECK**—Delay-time readout for 0.945 ms to 1.055 ms.

NOTE

These limits are derived from the Delay Time accuracy Performance Requirement (0.5% of Delay + 5% Time/Div setting) in the Specification section. Therefore, the specified limits for a measurement interval of 1 ms using a 1 ms/div sweep setting are: $\pm(0.5\% \text{ of } 1 \text{ ms} + 5\% \text{ of } 1 \text{ ms}) = \pm(0.005 \text{ ms} + 0.050 \text{ ms}) = \pm 0.055 \text{ ms}$ or 9.945 ms to 1.055 ms.

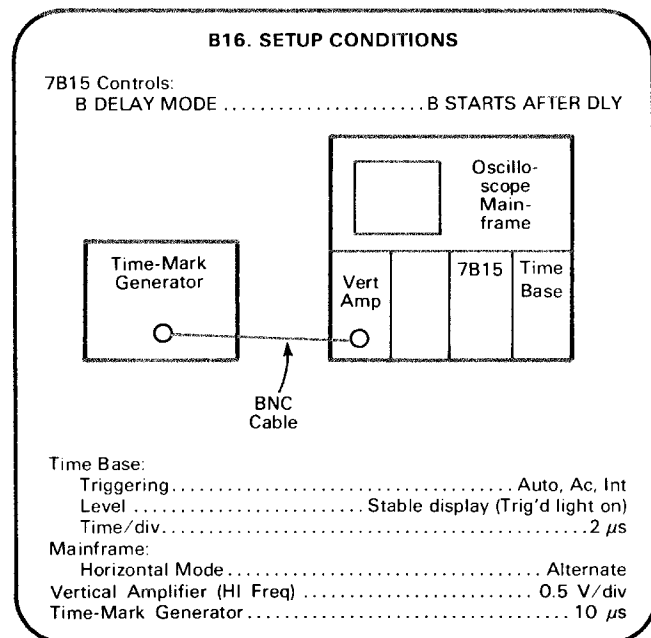
- e. Set the DELAY TIME control to place the intensified zone on the sixth time marker.
- f. Set the DELAY TIME control to precisely position the leading edge of the delayed time marker to the first graticule line.
- g. **CHECK**—Delay-time readout for 4.925 ms to 5.075 ms.
- h. Set the DELAY TIME control to place the intensified zone on the tenth time marker.
- i. Set the DELAY TIME control to precisely position the leading edge of the delayed time marker to the first graticule line.
- j. **CHECK**—Delay time readout for 8.905 ms to 9.095 ms.

B16. CHECK DELAY TIME JITTER

SETUP CONDITIONS

NOTE

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



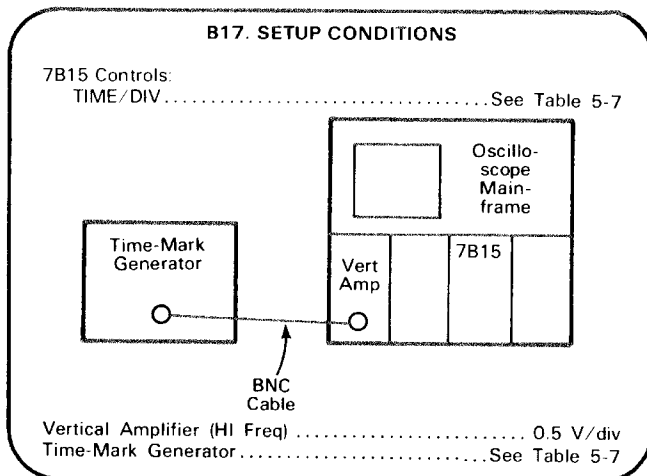
- a. Set the DELAY TIME control for a delay-time readout of approximately 1.000 ms.
- b. Set the DELAY TIME control further to position a delayed-sweep time marker near the display center.

- c. Magnify the companion time-base unit sweep rate to 200 nanoseconds/division (MAG X10) and position the delayed-sweep time marker near the graticule center.
- d. **CHECK**—For 1 division or less jitter. (Jitter specification is 0.02% of 1 ms delaying sweep setting or 200 ns.)
- e. Set the companion time-base unit for X1 sweep magnification (2 microseconds/division). Set the DELAY TIME control for a delay-time readout of approximately 9.000 ms.
- f. **CHECK**—Repeat parts b through d.
- g. Set the companion time-base unit sweep rate to 20 nanoseconds/ division and magnification to X1. Set the time-mark generator for 0.1 microsecond markers.
- h. Set the 7B15 TIME/DIV switch to 10 μ s.
- i. Set the DELAY TIME control for a delay-time readout of approximately 10.00 μ s.
- j. Set the DELAY TIME control further to position a delayed-sweep time marker near the display center.
- k. Magnify the companion time-base unit sweep rate to 2 nanoseconds/division (MAG X10) and position the delayed-sweep time marker near the graticule center.
- l. **CHECK**—For 1.5 division or less jitter. (Jitter specification is 0.03% of 10 μ s delaying sweep settings or 3 ns.)
- m. Set the companion time-base unit sweep magnification to X1 (20 nanoseconds/division). Set the DELAY TIME control for a delay-time readout of approximately 90.00 μ s.
- n. **CHECK**—Repeat parts j through l.
- o. Set mainframe horizontal mode to A and the 7B15 time base B DELAY MODE to INDEPENDENT.

B17. CHECK SWEEP TIMING
SETUP CONDITIONS

NOTE

Partial procedure: first perform the Horizontal System Preliminary Control Settings, then proceed with the following instructions.



NOTE

The tolerances given in Table 5-7 are for an ambient temperature range of +15°C to +35°C. If outside this range, see the Specification section for applicable tolerances.

- a. Set the POSITION controls to midrange and TRIGGERING MODE to NORM.
- b. **CHECK**—Using the TIME/DIV setting and time-mark generator settings from Table 5-7, check sweep accuracy for 1 time mark/division over the center 8 divisions within the tolerance given in Table 5-7. Set the POSITION controls and TRIGGERING LEVEL controls as necessary for a stable display aligned with the vertical graticule lines.

NOTE

If the time-mark generator used does not have 1-2-5 sequence markers, apply 1 unit markers in place of 2 unit markers and check for 2 markers/division, over the center eight divisions of display, to the tolerances given in Tables 5-7 and 5-8.

**TABLE 5-7
Sweep Timing**

Time/Div	Time Markers	Tolerance (+15° to +35° C)
2 ns	2 ns	Within 0.24 div
5 ns	5 ns	Within 0.24 div
10 ns	10 ns	Within 0.16 div
20 ns	20 ns	Within 0.16 div
50 ns	50 ns	Within 0.16 div
.1 μ s	.1 μ s	Within 0.16 div
.2 μ s	.2 μ s	Within 0.16 div
.5 μ s	.5 μ s	Within 0.16 div
1 μ s	1 μ s	Within 0.16 div
2 μ s	2 μ s	Within 0.16 div
5 μ s	5 μ s	Within 0.16 div
10 μ s	10 μ s	Within 0.16 div
20 μ s	20 μ s	Within 0.16 div
50 μ s	50 μ s	Within 0.16 div
.1 ms	.1 ms	Within 0.16 div
.2 ms	.2 ms	Within 0.16 div
.5 ms	.5 ms	Within 0.16 div
1 ms	1 ms	Within 0.16 div
2 ms	2 ms	Within 0.16 div
5 ms	5 ms	Within 0.16 div
10 ms	10 ms	Within 0.16 div
20 ms	20 ms	Within 0.16 div
50 ms	50 ms	Within 0.16 div
.1 s	.1 s	Within 0.16 div
.1 s	.1 s	Within 0.16 div
.2 s	.2 s	Within 0.16 div

B18. CHECK MAGNIFIED SWEEP TIMING

SETUP CONDITIONS

NOTE

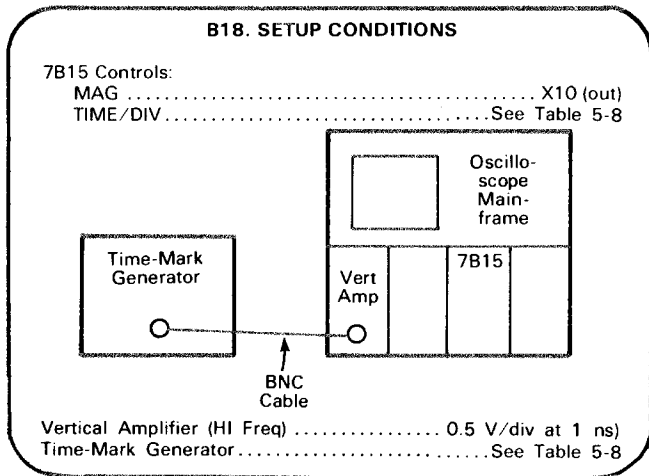
If the preceding step was not performed, first refer to the Horizontal System Preliminary Control Settings, then proceed with the following instructions.

NOTE

The 7B15 may be operated as a delayed sweep unit (B horizontal compartment) with a companion delaying sweep unit (A horizontal compartment). To check 7B15 delayed sweep operation, refer to a delaying sweep checkout procedure in the operating instructions or calibration sections of the instruction manual for the delaying sweep unit.

TABLE 5-8
Magnified Sweep Timing

Time/Div	Time Markers	Tolerance (+15° to +35° C)
2 ns	1 ns ¹	Within 0.2 div
5 ns	1 ns	Within 0.32 div
10 ns	1 ns	Within 0.24 div
20 ns	2 ns	Within 0.24 div
50 ns	5 ns	Within 0.24 div
.1 μs	10 ns	Within 0.24 div
.2 μs	20 ns	Within 0.24 div
.5 μs	50 ns	Within 0.24 div
1 μs	.1 μs	Within 0.24 div
2 μs	.2 μs	Within 0.24 div
5 μs	.5 μs	Within 0.24 div
10 μs	1 μs	Within 0.24 div
20 μs	2 μs	Within 0.24 div
50 μs	5 μs	Within 0.24 div
.1 ms	10 μs	Within 0.24 div
.2 ms	20 μs	Within 0.24 div
.5 ms	50 μs	Within 0.24 div
1 ms	.1 ms	Within 0.24 div
2 ms	.2 ms	Within 0.24 div
5 ms	.5 ms	Within 0.24 div
10 ms	1 ms	Within 0.24 div
20 ms	2 ms	Within 0.24 div
50 ms	5 ms	Within 0.24 div
.1 s	10 ms	Within 0.24 div
.2 s	20 ms	Within 0.24 div



NOTE

The tolerances in Table 5-8 are for an ambient temperature range of +15°C to +35°C. If outside this range, see the Specification section for applicable tolerances.

a. **CHECK**—Using the TIME/DIV settings and time-mark generator settings in Table 5-8, check magnified sweep accuracy for 1 time mark/division, over the center 8 divisions, within the tolerance given in Table 5-8. Set the POSITION controls, TRIGGERING LEVEL and vertical volts/division control as necessary for a stable display aligned with the vertical graticule lines.

¹ Check for 1 cycle in 5 divisions at 200 ps/div over center 8 divisions.

This completes the Adjustment and Performance Check procedure.

INSTRUMENT OPTIONS

No options were available for this instrument at the time of this printing.

Information on any subsequent options may be found in the CHANGE INFORMATION section in the back of this manual.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number

00X Part removed after this serial number

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

Replaceable Electrical Parts—7B15

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00213	NYTRONICS, COMPONENTS GROUP, INC., SUBSIDIARY OF NYTRONICS, INC.	ORANGE STREET	DARLINGTON, SC 29532
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P.O. BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC. SEMICONDUCTOR GROUP	P.O. BOX 5012	DALLAS, TX 75222
02111	SPECTROL ELECTRONICS CORPORATION	17070 EAST GALE AVENUE	CITY OF INDUSTRY, CA 91745
03888	KDI PYROFILM CORPORATION	60 S JEFFERSON ROAD	WHIPPANY, NJ 07981
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD, PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
09023	CORNELL-DUBILIER ELECTRONIC DIVISION FEDERAL PACIFIC ELECTRIC CO.	2652 DALRYMPLE ST.	SANFORD, NC 27330
11237	CTS KEENE, INC.	3230 RIVERSIDE AVE.	PASO ROBLES, CA 93446
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON STREET	DOVER, NH 03820
12969	UNITRODE CORPORATION	580 PLEASANT STREET	WATERTOWN, MA 02172
14552	MICRO SEMICONDUCTOR CORP.	2830 E FAIRVIEW ST.	SANTA ANA, CA 92704
14752	ELECTRO CUBE INC.	1710 S. DEL MAR AVE.	SAN GABRIEL, CA 91776
15801	FENWAL ELECTRONICS, DIV. OF KIDDE WALTER AND CO., INC.	63 FOUNTAIN ST.	FRAMINGHAM, MA 01701
17856	SILICONIX, INC.	2201 LAURELWOOD DRIVE	SANTA CLARA, CA 95054
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32293	INTERSIL, INC.	10900 N. TANTAU AVE.	CUPERTINO, CA 95014
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
50434	HEWLETT-PACKARD COMPANY	640 PAGE MILL ROAD	PALO ALTO, CA 94304
51642	CENTRE ENGINEERING INC.	2820 E COLLEGE AVENUE	STATE COLLEGE, PA 16801
51984	NEC AMERICA INC. RADIO AND TRANSMISSION DIV.	2990 TELESTAR CT. SUITE 212	FALLS CHURCH, VA 22042
53184	XCITON CORPORATION	5 HEMLOCK STREET	LATHAM, NY 12110
54473	MATSUSHITA ELECTRIC, CORP. OF AMERICA	1 PANASONIC WAY	SECAUCUS, NJ 07094
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
59660	TUSONIX INC.	2155 N FORBES BLVD	TUCSON, AZ 85705
59821	CENTRALAB INC SUB NORTH AMERICAN PHILIPS CORP	7158 MERCHANT AVE	EL PASO, TX 79915
63743	WARD LEONARD ELECTRIC CO., INC.	31 SOUTH ST.	MOUNT VERNON, NY 10550
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
76493	BELL INDUSTRIES, INC., MILLER, J. W., DIV.	19070 REYES AVE., P O BOX 5825	COMPTON, CA 90224
78488	STACKPOLE CARBON CO.		ST. MARYS, PA 15857
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E. WASHINGTON STREET P. O. BOX 372	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601
96733	SAN FERNANDO ELECTRIC MFG CO	1501 FIRST ST	SAN FERNANDO, CA 91341
S3774	OSHINO ELECTRIC LAMP WORKS LTD	5 2 MINAMI SHINAGAWA 2 CHORE SHINAGAWA KU	TOKYO, JAPAN
T0900	UNITED CHEMI-CON	9801 W. HIGGINS ROAD	ROSEMONT, IL 60018

Replaceable Electrical Parts---7B15

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	672-0650-00			CKT BOARD ASSY:TIME/CM	80009	672-0650-00
A2	670-5108-00			CKT BOARD ASSY:TRIGGER	80009	670-5108-00
A3	670-4183-00			CKT BOARD ASSY:READOUT	80009	670-4183-00
A4	670-4184-01			CKT BOARD ASSY:DVM	80009	670-4184-01
C3	290-0748-00			CAP.,FXD,ELCLTL:10UF,+50-10%,25V	T0900	SL25T10(T)TP
C5	290-0748-00			CAP.,FXD,ELCLTL:10UF,+50-10%,25V	T0900	SL25T10(T)TP
C7	290-0748-00			CAP.,FXD,ELCLTL:10UF,+50-10%,25V	T0900	SL25T10(T)TP
C10	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	51642	G1710100NP0151K
C12	281-0599-00			CAP.,FXD,CER DI:1PF,+/-0.25PF,500V	59660	374-018-C0K0109C
C37	283-0249-00			CAP.,FXD,CER DI:0.068UF,10%,50V	72982	8131N075 C 683K
C41	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	56289	1C10Z5U223M050B
C42	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	56289	1C10Z5U223M050B
C43	281-0572-00			CAP.,FXD,CER DI:6.8PF,+/-0.5PF,500V	59660	301-000C0H0689D
C61	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C63	281-0815-00			CAP.,FXD,CER DI:0.027UF,20%,50V	72982	8005D9AABW5R273M
C64	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	51642	G1710100NP0151K
C65	281-0791-00			CAP.,FXD,CER DI:270PF,10%,100V	04222	GC101C271K
C90	281-0611-00			CAP.,FXD,CER DI:2.7PF,+/-0.25PF,200V	59660	374-018C0J0279C
C95	281-0534-00			CAP.,FXD,CER DI:3.3PF,+/-0.25PF,500V	04222	7001-COJ-3R3C
C98	281-0617-00			CAP.,FXD,CER DI:15PF,10%,200V	59660	374-018-C0G0150K
C108	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C113	283-0066-00			CAP.,FXD,CER DI:2.5PF,20%,200V	72982	8101-047C0J259D
C114	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C117	281-0219-00			CAP.,VAR,CER DI:5-35PF,+2-2.5%,100V	59660	0513-501 A 5.035
C118	283-0066-00			CAP.,FXD,CER DI:2.5PF,20%,200V	72982	8101-047C0J259D
C133	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	96733	R3015
C144	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C183	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C184	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	51642	G1710100NP0151K
C204	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C211	283-0641-00	B010100	B031579	CAP.,FXD,MICA D:180PF,1%,100V	00853	DD155F181F0
C211	283-0640-00	B031580		CAP.,FXD,MICA D:160PF,1%,100V	00853	D155F161F0
C212	283-0555-00			CAP.,FXD,MICA D:2000PF,1%,500V	09023	CD19FD202F03
C213	285-0683-00			CAP.,FXD,PLSTC:0.022UF,5%,100V	56289	192P22352
C214	290-0269-00			CAP.,FXD,ELCLTL:0.22UF,5%,35V	56289	162D224X5035BC2
C215	290-0523-00			CAP.,FXD,ELCLTL:2.2UF,20%,20V	56289	196D225X0020HA1
C221	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C222	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	59660	855-547-E-502Z
C225	290-0536-00			CAP.,FXD,ELCLTL:10UF,20%,25V	90201	TDC106M025FL
C228	290-0534-00			CAP.,FXD,ELCLTL:1UF,20%,35V	56289	196D105X0035HA1
C230	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	51642	G1710100NP0151K
C255	283-0028-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	59660	0805585Y5SO222M
C263	281-0629-00			CAP.,FXD,CER DI:33PF,5%,600V	04222	7027-C0G-330J
C302	290-0420-00			CAP.,FXD,ELCLTL:0.68UF,20%,75V	56289	150D684X0075A2
C315	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	59660	855-547-E-502Z
C322	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	96733	R2676
C323	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C324	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	59660	855-547-E-502Z
C338	283-0691-00			CAP.,FXD,MICA D:650PF,1%,300V	00853	D153F651F0
C352	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C361	281-0166-00			CAP.,VAR,AIR DI:1.9-15.7PF,250V	74970	187-0109-055
C362	283-0633-00			CAP.,FXD,MICA D:77PF,1%,100V	00853	D155E770F0
C364	295-0172-00			CAP SET,MATCHED:0.1UF,10UF,905PF,0.75%	80009	295-0172-00
C365	-----			(PART OF C364)		
C366	-----			(PART OF C364)		

Replaceable Electrical Parts—7B15

Ckt No.	Tektronix Part No.	Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont			
C371	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C376	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C386	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C388	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C405	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	04222	GA101A470KAA
C409	283-0616-00			CAP.,FXD,MICA D:75PF,5%,500V	00853	D155E750J0
C457	281-0658-00			CAP.,FXD,CER DI:6.2PF,+/-0.25PF,500V	59660	301-000C0H0629C
C461	281-0618-00			CAP.,FXD,CER DI:4.7PF,+/-0.5PF,200V	59660	374-018C0H0-479D
C483	281-0811-00	B020800		CAP.,FXD,CER DI:10PF,10%,100V	96733	R2911
C520	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C522	283-0119-00			CAP.,FXD,CER DI:2200PF,5%,200V	59660	855-536Y5E0222J
C523	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C526	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C530	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C532	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C556	281-0826-00	B031770		CAP.,FXD,CER DI:2200PF,5%,100V	12969	CGB222KEX
C573	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C574	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C576	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C626	281-0762-00			CAP.,FXD,CER DI:27PF,20%,100V	04222	GC101A270M
C627	285-0809-00	B010100	B031815	CAP.,FXD,PLSTC:1UF,10%,50V	56289	LP66A1A105K
C627	285-1056-00	B031816		CAP.,FXD,PLSTC:1UF,2%,50V	14752	650B1A105G
C686	283-0691-00			CAP.,FXD,MICA D:650PF,1%,300V	00853	D153F651F0
C687	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C691	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
C692	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
C693	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C694	290-0748-00			CAP.,FXD,ELCTLT:10UF,+50-10%,25V	T0900	SL25T10(T)TP
C795	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	59660	855-547-E-502Z
C810	283-0178-00			CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131N145651 104Z
C820	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C821	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C830	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C831	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C840	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C844	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
CR74	152-0321-00			SEMICONV DEVICE:SILICON,30V,0.1A	07263	FSA1480
CR76	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR77	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR145	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR202	152-0153-00			SEMICONV DEVICE:SILICON,15V,50MA	07263	FD7003
CR206	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR208	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR224	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR225	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR226	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR248	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR250	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR252	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR254	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR255	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR256	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
CR264	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R

Ckt No.	Tektronix	Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
	Part No.	Eff	Dscont			
CR286	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR288	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR291	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR292	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR293	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR294	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR295	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR296	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR303	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR304	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR336	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR337	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR345	152-0322-00			SEMICON D DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
CR375	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR406	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR415	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR420	152-0322-00			SEMICON D DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
CR434	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR452	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR455	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR465	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR526	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR543	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR548	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR567	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR574	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR632	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR634	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR635	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR643	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR725	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR751	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR752	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR753	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR754	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR763	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR772	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR773	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR782	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR783	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR785	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
CR786	152-0141-02			SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
DS227	150-1029-00			LT EMITTING DIO:GREEN,565NM,35MA	53184	XC209G
DS232	150-1033-00			LT EMITTING DIO:YELLOW,585NM,40MA MAX	50434	HLMP 1401
DS810	150-0048-01			LAMP,INCAND:5V,0.06A,SEL	S3774	OL683AS15 TPL
DS820	150-0048-01			LAMP,INCAND:5V,0.06A,SEL	S3774	OL683AS15 TPL
E274	276-0507-00	B031890		SHIELDING BEAD,;FERRITE	78488	57-3443
E425	276-0507-00	B031890		SHIELDING BEAD,;FERRITE	78488	57-3443
F90	159-0120-00			FUSE,CARTRIDGE:0.2A,125V,0.08 SEC AXIAL	75915	279.200
L3	108-0537-00			COIL,RF:200UH	80009	108-0537-00

Replaceable Electrical Parts—7B15

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
L5	108-0537-00		COIL,RF:200UH	80009	108-0537-00
L7	108-0537-00		COIL,RF:200UH	80009	108-0537-00
L324	276-0543-00		SHLD BEAD,ELEK:FERRITE	80009	276-0543-00
L462	108-0240-00		COIL,RF:FIXED,820UH	76493	B5147
L485	108-0509-00		COIL,RF:2.45UH	80009	108-0509-00
L577	108-0509-00		COIL,RF:2.45UH	80009	108-0509-00
L691	108-0543-00		COIL,RF:FIXED,1.1UH	80009	108-0543-00
L694	108-0543-00		COIL,RF:FIXED,1.1UH	80009	108-0543-00
LR68	108-0325-00		COIL,RF:0.5UH	80009	108-0325-00
LR88	108-0325-00		COIL,RF:0.5UH	80009	108-0325-00
LR810	108-0537-00		COIL,RF:200UH	80009	108-0537-00
LR820	108-0537-00		COIL,RF:200UH	80009	108-0537-00
LR830	108-0537-00		COIL,RF:200UH	80009	108-0537-00
LR840	108-0537-00		COIL,RF:200UH	80009	108-0537-00
Q98	151-1005-00		TRANSISTOR:SILICON,JFE,N-CHANNEL	27014	F55037
Q108	151-1005-00		TRANSISTOR:SILICON,JFE,N-CHANNEL	27014	F55037
Q114	151-1025-00		TRANSISTOR:SILICON,JFE,N-CHANNEL	01295	SFB8129
Q118	151-0441-00		TRANSISTOR:SILICON,NPN	04713	SRF501
Q142	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
Q160	151-0453-00		TRANSISTOR:SILICON,PNP	80009	151-0453-00
Q164	151-0221-00		TRANSISTOR:SILICON,PNP	04713	SPS246
Q174	151-0221-00		TRANSISTOR:SILICON,PNP	04713	SPS246
Q184	151-0427-00		TRANSISTOR:SILICON,NPN	80009	151-0427-00
Q201	151-0221-00		TRANSISTOR:SILICON,PNP	04713	SPS246
Q202	151-0325-00		TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q203	151-0435-00		TRANSISTOR:SILICON,PNP	04713	SPS8335
Q204	151-0223-00		TRANSISTOR:SILICON,NPN	04713	SPS8026
Q206	151-0223-00		TRANSISTOR:SILICON,NPN	04713	SPS8026
Q210	151-0273-00		TRANSISTOR:SILICON,NPN	80009	151-0273-00
Q214	151-0220-00		TRANSISTOR:SILICON,PNP	07263	S036228
Q230	151-0302-00		TRANSISTOR:SILICON,NPN	07263	S038487
Q234	151-0301-00		TRANSISTOR:SILICON,PNP	27014	2N2907A
Q242	151-0223-00		TRANSISTOR:SILICON,NPN	04713	SPS8026
Q252	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
Q254	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
Q262	151-0223-00		TRANSISTOR:SILICON,NPN	04713	SPS8026
Q264	151-0223-00		TRANSISTOR:SILICON,NPN	04713	SPS8026
Q272	151-0223-00		TRANSISTOR:SILICON,NPN	04713	SPS8026
Q274	151-0223-00		TRANSISTOR:SILICON,NPN	04713	SPS8026
Q282	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
Q284	151-0223-00		TRANSISTOR:SILICON,NPN	04713	SPS8026
Q288	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
Q292	151-0192-00		TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q294	151-0220-00		TRANSISTOR:SILICON,PNP	07263	S036228
Q322	151-0220-00		TRANSISTOR:SILICON,PNP	07263	S036228
Q324	151-0220-00		TRANSISTOR:SILICON,PNP	07263	S036228
Q328	151-0273-00		TRANSISTOR:SILICON,NPN	80009	151-0273-00
Q336	151-0354-00		TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q342	151-0220-00		TRANSISTOR:SILICON,PNP	07263	S036228
Q354	151-0367-00		TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	04713	EP7426
Q356	151-0367-00		TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	04713	EP7426
Q372	151-1036-00		TRANSISTOR:SILICON,JFE,N-CHANNEL,DUAL	17856	DN1663

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q376	151-0127-00			TRANSISTOR:SILICON,NPN	07263	S006075
Q402	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
Q406	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
Q410	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q415	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
Q420	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q425	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q434	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q438	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q454	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q458	151-0325-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q460	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q464	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q468	151-0325-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q476	151-0472-00	B010100	B020204	TRANSISTOR:SILICON,NPN	51984	NE41632B
Q476	151-0212-00	B020205		TRANSISTOR:SILICON,NPN	04713	SRF 518
Q484	151-1113-00			TRANSISTOR:FE,N CHANNEL,SILICON	80009	151-1113-00
Q496	151-0472-00	B010100	B020204	TRANSISTOR:SILICON,NPN	51984	NE41632B
Q496	151-0212-00	B020205		TRANSISTOR:SILICON,NPN	04713	SRF 518
Q512	151-0354-00			TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q518	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q522	151-0354-00			TRANSISTOR:SILICON,PNP,DUAL	32293	ITS1200A
Q528	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q534	151-0216-00			TRANSISTOR:SILICON,PNP	04713	SPS8803
Q536	151-0216-00			TRANSISTOR:SILICON,PNP	04713	SPS8803
Q546	151-0432-00			TRANSISTOR:SILICON,NPN	27014	T07391E2
Q548	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q562	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q564	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q568	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q572	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q574	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q576	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q578	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q582	151-1059-00			TRANSISTOR:SILICON,FE,N-CHANNEL	80009	151-1059-00
Q592	151-1059-00			TRANSISTOR:SILICON,FE,N-CHANNEL	80009	151-1059-00
Q618	151-0216-00			TRANSISTOR:SILICON,PNP	04713	SPS8803
Q642	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
Q844	151-0301-00			TRANSISTOR:SILICON,PNP	27014	2N2907A
R2	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R10	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	91637	MFF1816G60400F
R12	321-0201-00			RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
R20	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	91637	MFF1816G60400F
R22	321-0201-00			RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
R23	321-0099-00			RES.,FXD,FILM:105 OHM,1%,0.125W	91637	MFF1816G105R0F
R24	321-0099-00			RES.,FXD,FILM:105 OHM,1%,0.125W	91637	MFF1816G105R0F
R34	321-0074-00			RES.,FXD,FILM:57.6 OHM,1%,0.125W	91637	MFF1816G57R60F
R35	315-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.25W	01121	CB1635
R36	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R37	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R38	321-0332-00			RES.,FXD,FILM:28K OHM,1%,0.125W	91637	MFF1816G28001F
R39	321-0184-00			RES.,FXD,FILM:806 OHM,1%,0.125W	91637	MFF1816G806R0F
R42	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025

Replaceable Electrical Parts—7B15

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R43	321-0349-00			RES.,FXD,FILM:42.2K OHM,1%,0.125W	91637	MFF1816G42201F
R63	321-0270-00			RES.,FXD,FILM:6.34K OHM,1%,0.125W	91637	MFF1816G63400F
R64	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R65	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R66	321-0248-00			RES.,FXD,FILM:3.74K OHM,1%,0.125W	91637	MFF1816G37400F
R67	315-0335-00			RES.,FXD,CMPSN:3.3M OHM,5%,0.25W	01121	CB3355
R68	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R69	301-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.50W	01121	EB3015
R71	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R72	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R74	321-0423-00			RES.,FXD,FILM:249K OHM,1%,0.125W	91637	MFF1816G24902F
R76	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R77	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R79	301-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.50W	01121	EB3015
R84	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R85	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R86	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R90	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R91	323-0095-00			RES.,FXD,FILM:95.3 OHM,1%,0.50W	75042	CECT0-95R30F
R92	323-0095-00			RES.,FXD,FILM:95.3 OHM,1%,0.50W	75042	CECT0-95R30F
R93	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R94	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R95	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R96	315-0335-00			RES.,FXD,CMPSN:3.3M OHM,5%,0.25W	01121	CB3355
R97	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R106	315-0335-00			RES.,FXD,CMPSN:3.3M OHM,5%,0.25W	01121	CB3355
R107	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R110	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R114	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R117	317-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.125W	01121	BB1015
R118	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R131	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R132	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R133	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R134	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R135	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R138	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R139	325-0053-00			RES.,FXD,FILM:50 OHM,1%,0.05W	03888	PME50C50R00F
R140	311-1192-00			RES.,VAR, NONWIR:10K OHM,20%,1W,W/SW	71590	BA-232-001
R141	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R142	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R143	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R144	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R146	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R147	311-1234-00			RES.,VAR, NONWIR:50K OHM,20%,0.50W	32997	3386F-T06-503
R148	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R154	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R155	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R158	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R159	325-0053-00			RES.,FXD,FILM:50 OHM,1%,0.05W	03888	PME50C50R00F
R161	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R162	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R164	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R168	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025

Replaceable Electrical Parts—7B15

Ckt No.	Tektronix	Serial/Model No.		Name & Description	Mfr	Mfr Part Number
	Part No.	Eff	Dscont		Code	
R173	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R174	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R182	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
R183	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R184	321-0202-00			RES.,FXD,FILM:1.24K OHM,1%,0.125W	91637	MFF1816G12400F
R185	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R201	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R202	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R203	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R204	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R205	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R206	321-0219-00			RES.,FXD,FILM:1.87K OHM,1%,0.125W	91637	MFF1816G18700F
R207	321-0173-00			RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G61900F
R208	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R209	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F
R210	311-0467-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	11237	300SF-41334
R211	301-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.50W	01121	EB4325
R212	321-0373-00			RES.,FXD,FILM:75K OHM,1%,0.125W	91637	MFF1816G75001F
R213	321-0373-00			RES.,FXD,FILM:75K OHM,1%,0.125W	91637	MFF1816G75001F
R214	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
R215	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R216	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
R217	321-0292-00			RES.,FXD,FILM:10.7K OHM,1%,0.125W	91637	MFF1816G10701F
R218	321-0267-00			RES.,FXD,FILM:5.9K OHM,1%,0.125W	91637	MFF1816G59000F
R219	321-0293-00			RES.,FXD,FILM:11K OHM,1%,0.125W	91637	MFF1816G11001F
R222	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R224	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R225	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R226	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R227	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R228	315-0184-00			RES.,FXD,CMPSN:180K OHM,5%,0.25W	01121	CB1845
R230	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R231	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R232	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R233	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R234	315-0430-00			RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
R240	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R241	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R242	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R243	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R244	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R248	315-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.25W	01121	CB1635
R249	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R250	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R251	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R253	315-0113-00			RES.,FXD,CMPSN:11K OHM,5%,0.25W	01121	CB1135
R254	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R255	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R261	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R263	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R264	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R271	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R272	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R273	321-0243-00			RES.,FXD,FILM:3.32K OHM,1%,0.125W	91637	MFF1816G33200F

Replaceable Electrical Parts—7B15

Ckt No.	Tektronix		Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
	Part No.	Eff	Dscont				
R274	315-0472-00				RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R275	315-0101-00				RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R280	315-0820-00				RES.,FXD,CMPSN:82 OHM,5%,0.25W	01121	CB8205
R281	315-0203-00				RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R282	315-0624-00				RES.,FXD,CMPSN:620K OHM,5%,0.25W	01121	CB6245
R283	315-0512-00				RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R284	315-0471-00				RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R285	315-0201-00				RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R286	315-0563-00				RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R287	315-0242-00				RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R288	315-0182-00				RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R291	315-0202-00				RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R292	315-0752-00				RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R293	315-0303-00				RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R294	315-0432-00				RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R295	311-1322-00				RES.,VAR,NONWIR:5K OHM,10%,1W	12697	381-CM39701
R296	315-0432-00				RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R297	315-0152-00				RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R300	311-0467-00				RES.,VAR,NONWIR:100K OHM,20%,0.50W	11237	300SF-41334
R301	321-0438-00				RES.,FXD,FILM:357K OHM,1%,0.125W	91637	MFF1816G35702F
R302	315-0121-00				RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R303	321-0363-00				RES.,FXD,FILM:59K OHM,1%,0.125W	91637	MFF1816G59001F
R304	321-0360-00				RES.,FXD,FILM:54.9K OHM,1%,0.125W	91637	MFF1816G54901F
R305	311-1232-00				RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T04-503
R306	321-0458-00				RES.,FXD,FILM:576K OHM,1%,0.125W	91637	MFF1816G57602F
R310	311-1232-00				RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T04-503
R312	315-0273-00				RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R313	315-0273-00				RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R315	315-0562-00				RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R316	301-0432-00				RES.,FXD,CMPSN:4.3K OHM,5%,0.50W	01121	EB4325
R317	315-0101-00				RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R321	315-0104-00				RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R322	315-0221-00				RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R323	315-0103-00				RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R328	321-0133-00				RES.,FXD,FILM:237 OHM,1%,0.125W	91637	MFF1816G237R0F
R332	315-0103-00				RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R333	315-0221-00				RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R334	315-0470-00				RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R335	311-1228-00				RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R336	321-0275-00				RES.,FXD,FILM:7.15K OHM,1%,0.125W	91637	MFF1816G71500F
R337	321-0301-00				RES.,FXD,FILM:13.3K OHM,1%,0.125W	91637	MFF1816G13301F
R338	315-0201-00				RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R341	315-0301-00				RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R342	315-0392-00				RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R343	315-0101-00				RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R344	315-0101-00				RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R345	315-0112-00				RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R352	315-0100-00				RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R353	315-0222-00				RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R354	315-0101-00				RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R356	315-0101-00				RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R357	315-0221-00				RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R358	323-0175-00				RES.,FXD,FILM:649 OHM,1%,0.50W	75042	CECT0-6490F
R359	315-0122-00				RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225

Replaceable Electrical Parts—7B15

Ckt No.	Tektronix		Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
	Part No.	Eff	Dscont				
R361	315-0330-00				RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
R362	315-0330-00				RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
R363	315-0560-00				RES.,FXD,CMPSN:56 OHM,5%,0.25W	01121	CB5605
R364	315-0100-00				RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R371	315-0470-00				RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R373	315-0101-00				RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R375	315-0101-00				RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R376	315-0470-00				RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R377	315-0272-00				RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R380	311-1781-00				RES.,VAR,NONWIR:10K OHM,10%,0.50W	12697	388CM40913
R383	315-0513-00				RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R384	315-0105-00				RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R385	321-0362-00				RES.,FXD,FILM:57.6K OHM,1%,0.125W	91637	MFF1816G57601F
R386	321-0289-03				RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R388	315-0180-00				RES.,FXD,CMPSN:18 OHM,5%,0.25W	01121	CB1805
R391	323-1500-07				RES.,FXD,FILM:1.6M OHM,0.1%,0.50W	91637	HFF129C16003B
R392	323-1500-07				RES.,FXD,FILM:1.6M OHM,0.1%,0.50W	91637	HFF129C16003B
R393	323-0620-07				RES.,FXD,FILM:800K OHM,0.1%,0.50W	91637	MFF1226C80002B
R394	323-0806-07				RES.,FXD,FILM:266.7K OHM,0.1%,0.50W	91637	MFF1226C26672B
R395	323-1404-07				RES.,FXD,FILM:160K OHM,0.1%,0.50W	91637	MFF1226C16002B
R396	323-0805-07				RES.,FXD,FILM:80.0K OHM,0.1%,0.50W	91637	MFF1226C80001B
R397	323-0802-07				RES.,FXD,FILM:26.67K OHM,0.1%,0.50W	91637	MFF1226C26671B
R398	323-1308-07				RES.,FXD,FILM:16.0K OHM,0.1%,0.50W	91637	MFF1226C16001B
R399	308-0586-00				RES.,FXD,WW:5K OHM,0.25%,3W	00213	1240S-5 K 0.25%
R401	315-0751-00				RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R402	315-0222-00				RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R403	315-0101-00	B010100	B031434		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R403	315-0161-00	B031435			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
R404	321-0222-07				RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R405	321-0196-00				RES.,FXD,FILM:1.07K OHM,1%,0.125W	91637	MFF1816G10700F
R406	315-0162-00				RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R409	321-0229-00				RES.,FXD,FILM:2.37K OHM,1%,0.125W	91637	MFF1816G23700F
R410	321-0185-00				RES.,FXD,FILM:825 OHM,1%,0.125W	91637	MFF1816G825R0F
R415	315-0122-00				RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R419	315-0121-00				RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R421	315-0102-00				RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R422	321-0173-00				RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G619R0F
R425	315-0272-00				RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R426	315-0510-00				RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R431	321-0260-00				RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R432	315-0474-00				RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R433	321-0263-00	B010100	B032219		RES.,FXD,FILM:5.36K OHM,1%,0.125W	91637	MFF1816G53600F
R433	321-0265-00	B032220			RES.,FXD,FILM:5.62K OHM,1%,0.125W	91637	MFF1816G56200F
R434	315-0431-00				RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R435	315-0242-00				RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R438	315-0472-00				RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R439	315-0510-00				RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R451	321-0400-00				RES.,FXD,FILM:143K OHM,1%,0.125W	91637	MFF1816G14302F
R452	315-0151-00				RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R454	321-0190-00				RES.,FXD,FILM:931 OHM,1%,0.125W	91637	MFF1816G931R0F
R455	315-0330-00				RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
R456	315-0103-00				RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R457	315-0111-00				RES.,FXD,CMPSN:110 OHM,5%,0.25W	01121	CB1115
R458	321-0928-07				RES.,FXD,FILM:250 OHM,0.1%,0.125W	91637	MFF1816C250R0B

Replaceable Electrical Parts—7B15

Ckt No.	Tektronix	Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
	Part No.	Eff	Dscont			
R459	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R460	311-1423-00			RES.,VAR,NONWIR:20 OHM,20%,0.50W	73138	72-1-0
R461	321-0122-00			RES.,FXD,FILM:182 OHM,1%,0.125W	91637	MFF1816G182R0F
R462	308-0366-00			RES.,FXD,WW:3.4K OHM,1%,3W	63743	29338
R464	321-0190-00			RES.,FXD,FILM:931 OHM,1%,0.125W	91637	MFF1816G931R0F
R465	315-0820-00			RES.,FXD,CMPSN:82 OHM,5%,0.25W	01121	CB8205
R466	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R468	321-0928-07			RES.,FXD,FILM:250 OHM,0.1%,0.125W	91637	MFF1816C250R0B
R469	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R470	311-1226-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	32997	3386F-T04-252
R471	322-0200-00			RES.,FXD,FILM:1.18K OHM,1%,0.25W	91637	MFF1421G11800F
R472	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R474	321-0071-00			RES.,FXD,FILM:53.6 OHM,1%,0.125W	91637	MFF1816G53R60F
R475	321-0055-00			RES.,FXD,FILM:36.5 OHM,1%,0.125W	91637	MFF1816G36R50F
R476	322-0224-00			RES.,FXD,FILM:2.15K OHM,1%,0.25W	75042	CEBT0-2101F
R480	311-1232-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T04-503
R481	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R482	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R483	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R484	307-0472-00			RES.,THERMAL:100K OHM,5% DISC	15801	JP51J5
R485	323-0186-00			RES.,FXD,FILM:845 OHM,1%,0.50W	75042	CECT0-8450F
R491	322-0200-00			RES.,FXD,FILM:1.18K OHM,1%,0.25W	91637	MFF1421G11800F
R492	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R494	321-0071-00			RES.,FXD,FILM:53.6 OHM,1%,0.125W	91637	MFF1816G53R60F
R495	321-0055-00			RES.,FXD,FILM:36.5 OHM,1%,0.125W	91637	MFF1816G36R50F
R496	322-0224-00			RES.,FXD,FILM:2.15K OHM,1%,0.25W	75042	CEBT0-2101F
R509	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R510	311-1594-00			RES.,VAR,NONWIR:10 OHM,20%,0.50W	73138	91-93-0
R513	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R514	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R515	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R518	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R520	311-1889-00			RES.,VAR,WW:PNL,50K OHM,2W	32997	3541S-458-503
R521	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R522	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R523	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R524	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R526	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R527	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R528	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R530	311-1889-00			RES.,VAR,WW:PNL,50K OHM,2W	32997	3541S-458-503
R531	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R532	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R533	321-0161-00			RES.,FXD,FILM:464 OHM,1%,0.125W	91637	MFF1816G464R0F
R534	321-0257-00			RES.,FXD,FILM:4.64K OHM,1%,0.125W	91637	MFF1816G46400F
R535	311-1560-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	73138	91-82-0
R536	321-0340-00			RES.,FXD,FILM:34K OHM,1%,0.125W	91637	MFF1816G34001F
R537	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R541	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R542	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R543	321-0308-00			RES.,FXD,FILM:15.8K OHM,1%,0.125W	91637	MFF1816G15801F
R544	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R546	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R547	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R548	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R552	321-0222-07			RES.,FXD,FILM:2K OHM,0.1%,0.125W	91637	MFF1816C20000B
R554	315-0205-00			RES.,FXD,CMPSN:2M OHM,5%,0.25W	01121	CB2055
R555	311-1230-00			RES.,VAR,NONWIR:20K OHM,20%,0.50W	32997	3386F-T04-203
R560	321-0196-00			RES.,FXD,FILM:1.07K OHM,1%,0.125W	91637	MFF1816G10700F
R561	321-0302-00			RES.,FXD,FILM:13.7K OHM,1%,0.125W	91637	MFF1816G13701F
R562	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R563	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R564	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R567	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R570	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R571	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R572	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
R573	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R574	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R575	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R576	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R577	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R578	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R579	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R582	315-0275-00			RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
R592	315-0275-00			RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
R616	321-0820-06			RES.,FXD,FILM:42K OHM,0.25%,0.125W	91637	MFF1816C42001C
R617	321-0259-00			RES.,FXD,FILM:4.87K OHM,1%,0.125W	91637	MFF1816G48700F
R620	311-1336-00			RES.,VAR,NONWIR:100K OHM,0.50W	02111	43P104T672
R621	321-0967-03			RES.,FXD,FILM:55K OHM,0.25%,0.125W	91637	MFF1816D55001C
R622	321-0995-00			RES.,FXD,FILM:549K OHM,1%,0.125W	24546	NA55D5493F
R623	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R624	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R625	311-1230-00			RES.,VAR,NONWIR:20K OHM,20%,0.50W	32997	3386F-T04-203
R626	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R631	321-0289-06			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816C10001C
R632	321-0289-06			RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816C10001C
R636	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R637	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R644	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R653	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R654	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R655	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R672	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R674	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R676	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R678	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R681	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R682	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R683	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R687	321-1651-04			RES.,FXD,FILM:37.5K OHM,0.1%,0.125W	91637	MFF1816D37501B
R725	311-1590-00			RES.,VAR,NONWIR:10K OHM,10%,1W	12697	CM40256
R725	-----			(FURNISHED AS A UNIT WITH S725)		
R751	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R752	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R753	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R754	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R755	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	91637	MFF1816G37401F

Replaceable Electrical Parts—7B15

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R756	315-0753-00		RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R757	321-0327-00		RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
R761	315-0154-00		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R762	315-0154-00		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R763	315-0133-00		RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R764	315-0133-00		RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R771	315-0753-00		RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R772	321-0356-00		RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R773	315-0154-00		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R779	315-0151-00		RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R781	315-0154-00		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R782	315-0753-00		RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R783	315-0154-00		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R784	321-0356-00		RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R785	315-0154-00		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R786	315-0753-00		RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R787	321-0356-00		RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R791	321-0344-00		RES.,FXD,FILM:37.4K OHM,1%,0.125W	91637	MFF1816G37401F
R792	315-0154-00		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R793	321-0344-00		RES.,FXD,FILM:37.4K OHM,1%,0.125W	91637	MFF1816G37401F
R794	315-0154-00		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R821	315-0510-00		RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R832	315-0150-00		RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R841	321-0260-00		RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R842	321-0289-03		RES.,FXD,FILM:10K OHM,0.25%,0.125W	91637	MFF1816D10001C
R844	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
S20	263-0016-03		SWITCH,PB ASSY:4 CATCH,7.5MM,6 CONTACTS	80009	263-0016-03
S50	263-0015-00		SWITCH PB ASSY:3 LATCHING,7.5 MM	80009	263-0015-00
S90	263-0010-02		SWITCH PB ASSY:1 PUSH,7.5MM,1 CONTACT	80009	263-0010-02
S140	311-1192-00		RES.,VAR,NONWIR:10K OHM,20%,1W,W/SW	71590	BA-232-001
S205	263-0015-01		SWITCH PB ASSY:3 LATCHING,7.5 MM,5 CONTACT	80009	263-0015-01
S230	263-0016-02		SWITCH,PB ASSY:3 LCH & 1 CANC,7.5MM,5 CONT	80009	263-0016-02
S295	311-1322-00		RES.,VAR,NONWIR:5K OHM,10%,1W	12697	381-CM39701
S460	260-1771-00		SWITCH,PUSH:DPDT,1 BUTTON,2 POLE	80009	260-1771-00
S725	311-1590-00		RES.,VAR,NONWIR:10K OHM,10%,1W	12697	CM40256
S725	-----		(FURNISHED AS A UNIT WITH R725)		
S800	263-1166-00		SW,CAM,ACTR AS:TIME/CM	80009	263-1166-00
T1	120-0444-00		XFMR,TOROID:5 TURNS,BIFILAR	80009	120-0444-00
U12	156-0105-00		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	27014	LM301AN
U38	156-1149-00		MICROCIRCUIT,LI:OPERATIONAL AMP,JFET INPUT	27014	GLEA134
U64	156-0158-00		MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U110	156-1149-00		MICROCIRCUIT,LI:OPERATIONAL AMP,JFET INPUT	27014	GLEA134
U124	155-0160-00		MICROCIRCUIT,LI:TRIGGER AMPL/CHANNEL SW	80009	155-0160-00
U138	156-0158-00		MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
U144	155-0150-00		MICROCIRCUIT,DI:TRIGGER	80009	155-0150-00
U220	155-0049-02		MICROCIRCUIT,DI:SWEEP CONTROL,W/LOCKOUT	80009	155-0049-02
U250	156-0118-03		MICROCIRCUIT,DI:1 DUAL J-K FF,BURN-IN	01295	SN74S112JP3
U314	156-1149-00		MICROCIRCUIT,LI:OPERATIONAL AMP,JFET INPUT	27014	GLEA134
U386	156-0067-02		MICROCIRCUIT,LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-02
U530	156-0158-07		MICROCIRCUIT,LI:DUAL OPNL AMPL,SCREENED	01295	MC1458JG4
U556	156-0158-07		MICROCIRCUIT,LI:DUAL OPNL AMPL,SCREENED	01295	MC1458JG4
U608	156-1149-01		MICROCIRCUIT,LI:OPER AMPL,JFET,BURN-IN	27014	GLEA134/A+

Replaceable Electrical Parts---7B15

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U626	156-0105-02			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER,SEL	01295	LM301AJG4
U662	156-0030-03			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE,SCRN	01295	SN7400(NP3 OR JP
U686	155-0185-00			MICROCIRCUIT,LI:ML 4 DECADE DGTL VOLTMETER	80009	155-0185-00
U842	156-0067-02			MICROCIRCUIT,LI:OPNL AMPLIFIER,SELECTED	80009	156-0067-02
VR118	152-0226-00			SEMICONV DEVICE:ZENER,0.4W,5.1V,5%	14552	TD3810980
VR124	152-0278-00			SEMICONV DEVICE:ZENER,0.4W,3V,5%	04713	SZG35009K20
VR134	152-0395-00			SEMICONV DEVICE:ZENER,0.4W,4.3V,5%	14552	TD332317
VR154	152-0395-00			SEMICONV DEVICE:ZENER,0.4W,4.3V,5%	14552	TD332317
VR317	152-0226-00			SEMICONV DEVICE:ZENER,0.4W,5.1V,5%	14552	TD3810980
VR644	152-0280-00			SEMICONV DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

- Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μ F).
- Resistors = Ohms (Ω).

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it goes to the low state.

Abbreviations are based on ANSI Y1.1-1972.

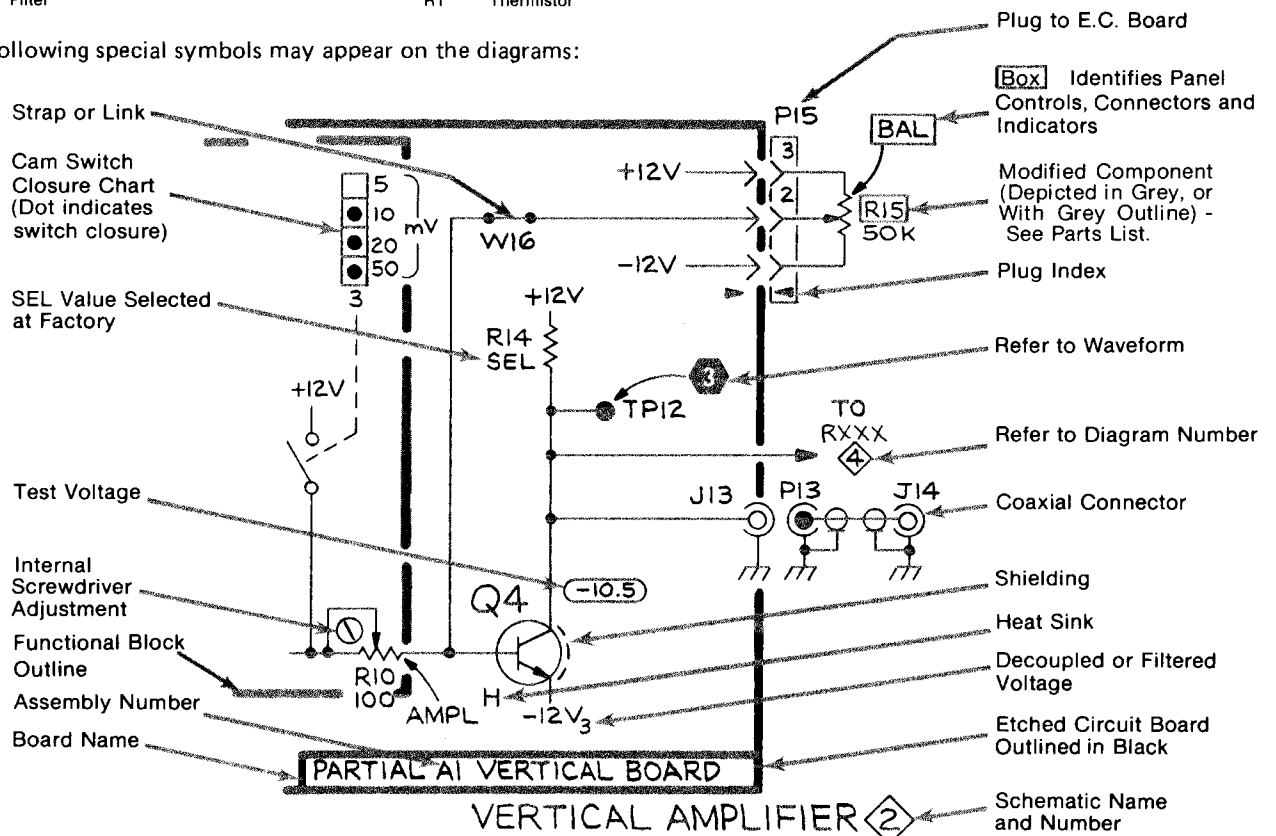
Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

- Y14.15, 1966 Drafting Practices.
- Y14.2, 1973 Line Conventions and Lettering.
- Y10.5, 1968 Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

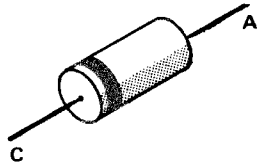
The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc)	H	Heat dissipating device (heat sink, heat radiator, etc)	S	Switch or contactor
AT	Attenuator, fixed or variable	HR	Heater	T	Transformer
B	Motor	HY	Hybrid circuit	TC	Thermocouple
BT	Battery	J	Connector, stationary portion	TP	Test point
C	Capacitor, fixed or variable	K	Relay	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CB	Circuit breaker	L	Inductor, fixed or variable	V	Electron tube
CR	Diode; signal or rectifier	M	Meter	VR	Voltage regulator (zener diode, etc.)
DL	Delay line	P	Connector, movable portion	W	Wirestrap or cable
DS	Indicating device (lamp)	Q	Transistor or silicon-controlled rectifier	Y	Crystal
E	Spark Gap, Ferrite bead	R	Resistor, fixed or variable	Z	Phase shifter
F	Fuse	RT	Thermistor		
FL	Filter				

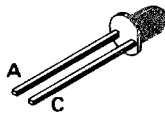
The following special symbols may appear on the diagrams:



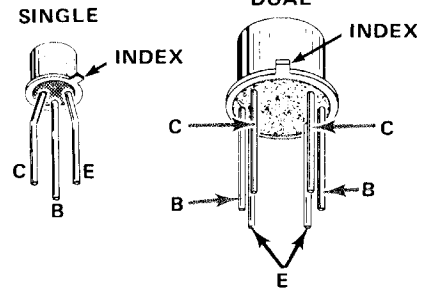
NOTE
LEAD CONFIGURATIONS AND CASE STYLES ARE TYPICAL, BUT MAY VARY DUE TO VENDOR CHANGES OR INSTRUMENT MODIFICATIONS.



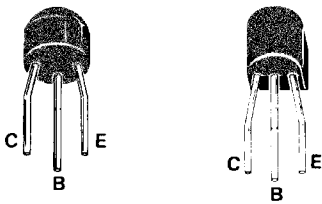
SIGNAL DIODE



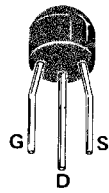
LIGHT EMITTING DIODE (L.E.D.)



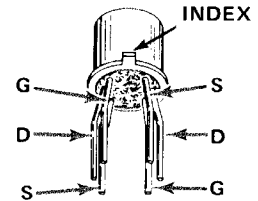
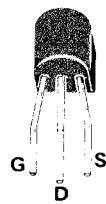
METAL CASE TRANSISTORS



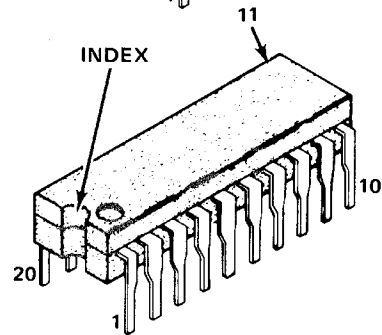
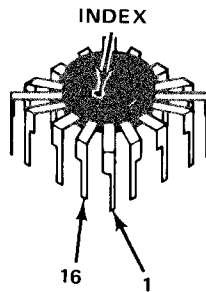
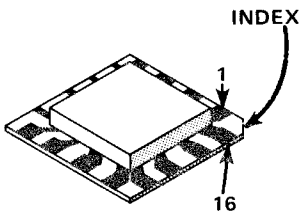
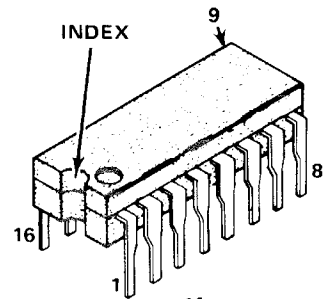
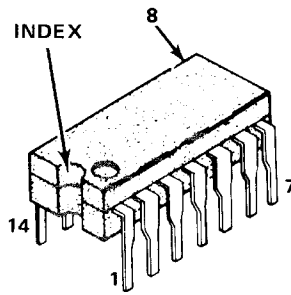
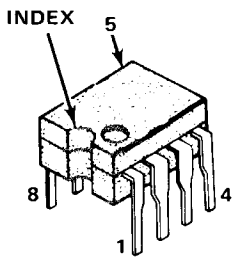
PLASTIC CASE TRANSISTORS



PLASTIC CASE FETS



DUAL METAL CASE FET



INTEGRATED CIRCUITS

(1986-66)2318-20A

Figure 4-2. Semiconductor lead configuration.

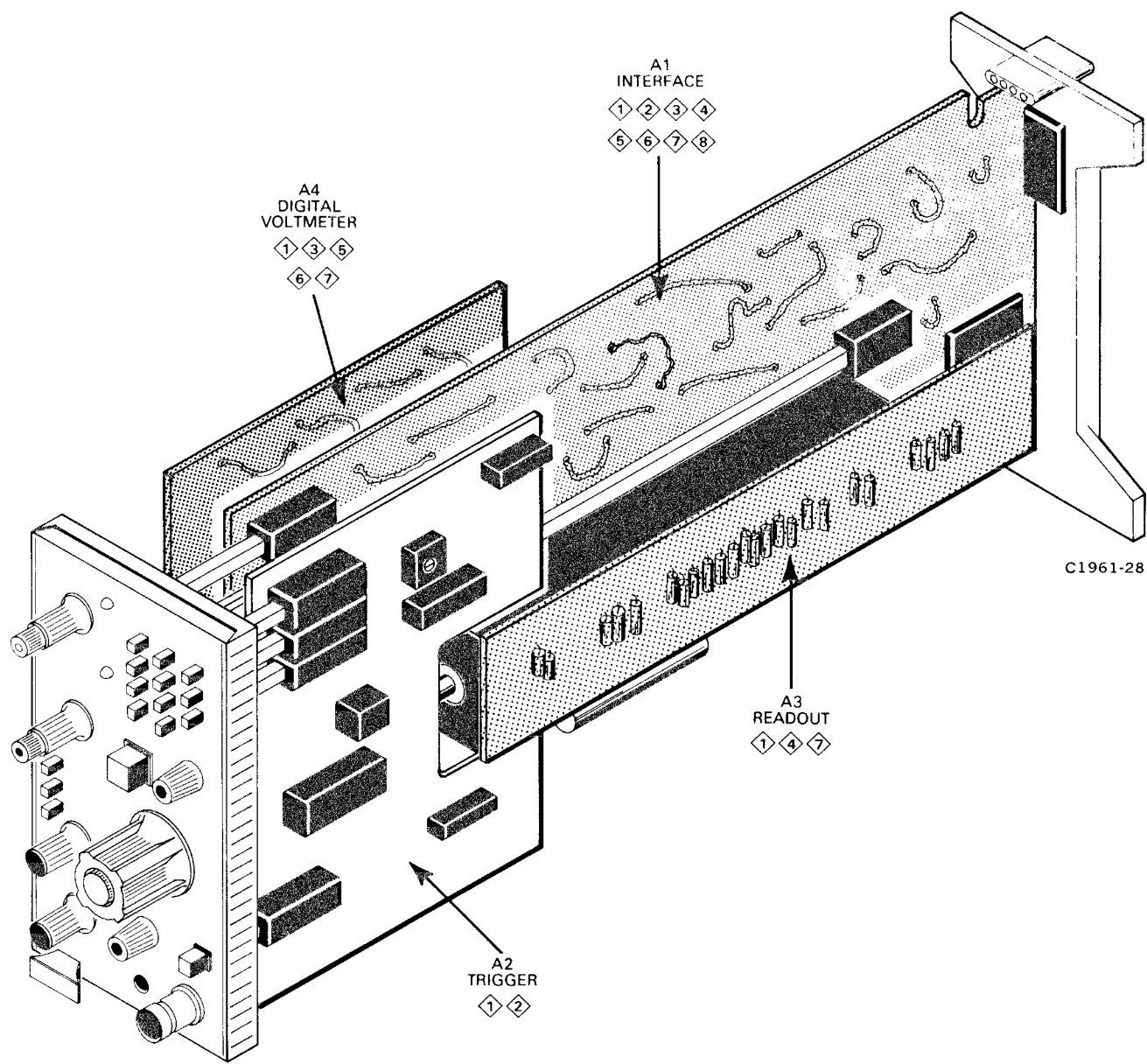
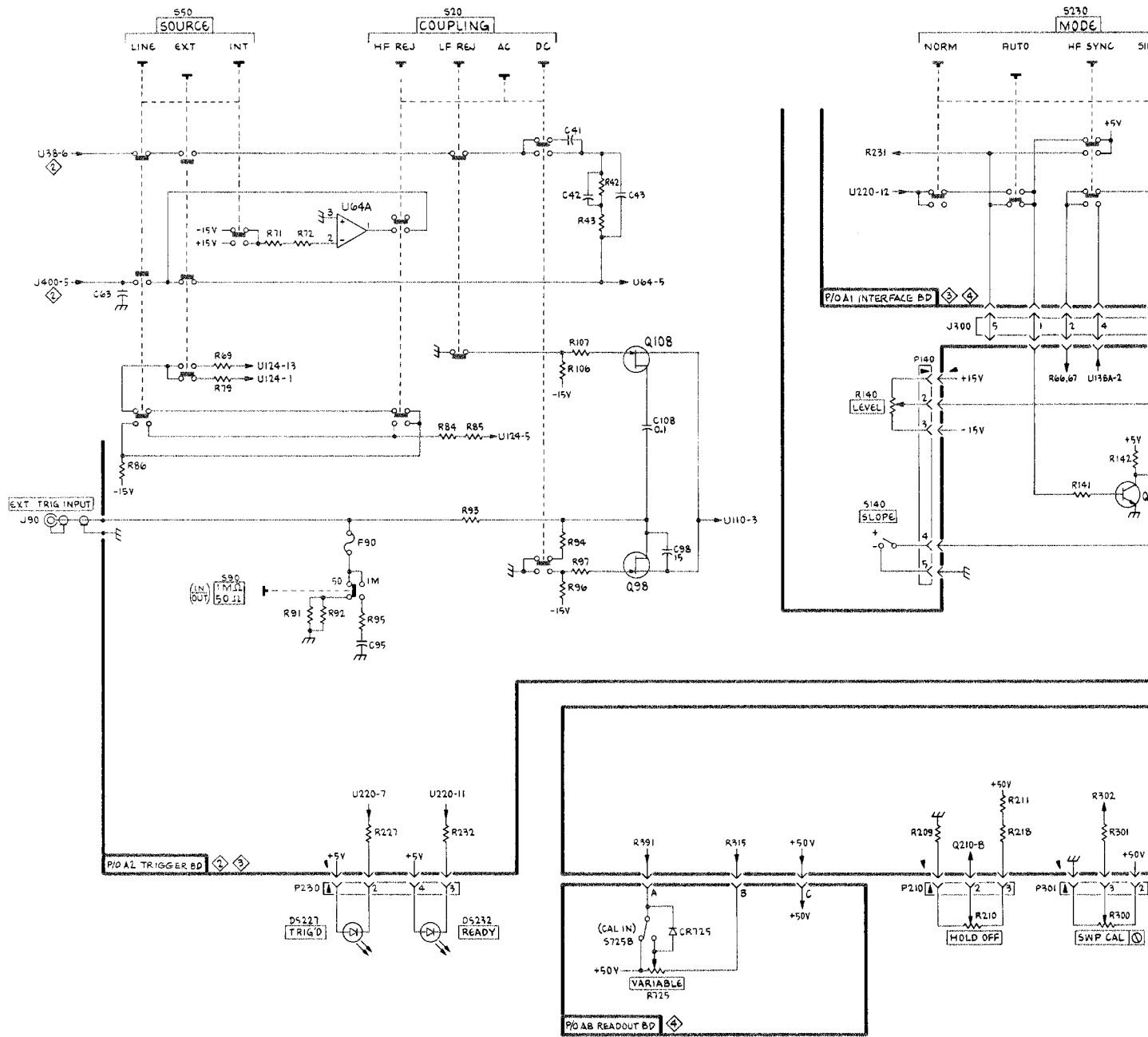
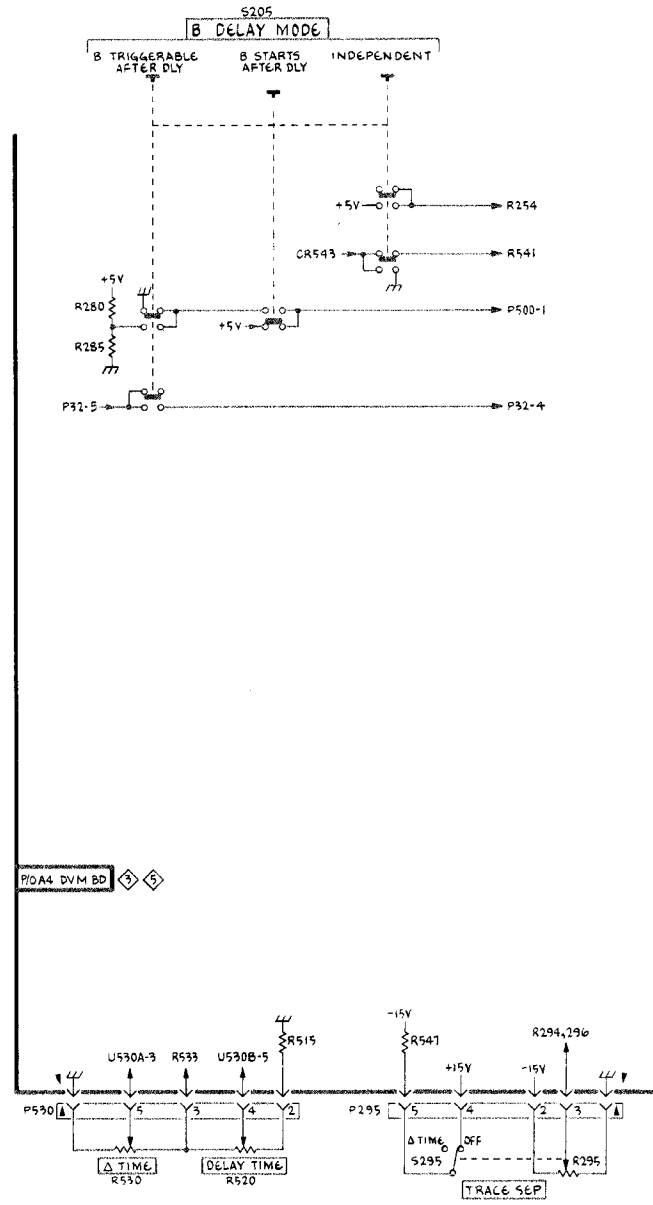
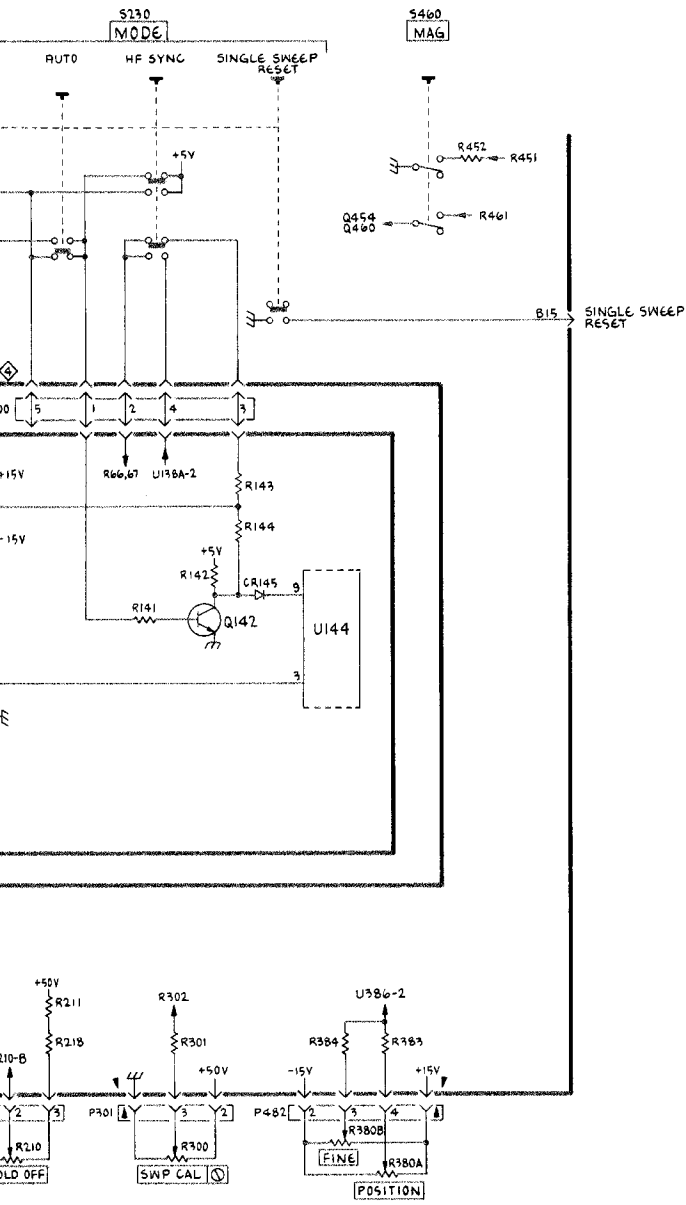


Figure 8-2. Location of circuit boards in the 7B15.



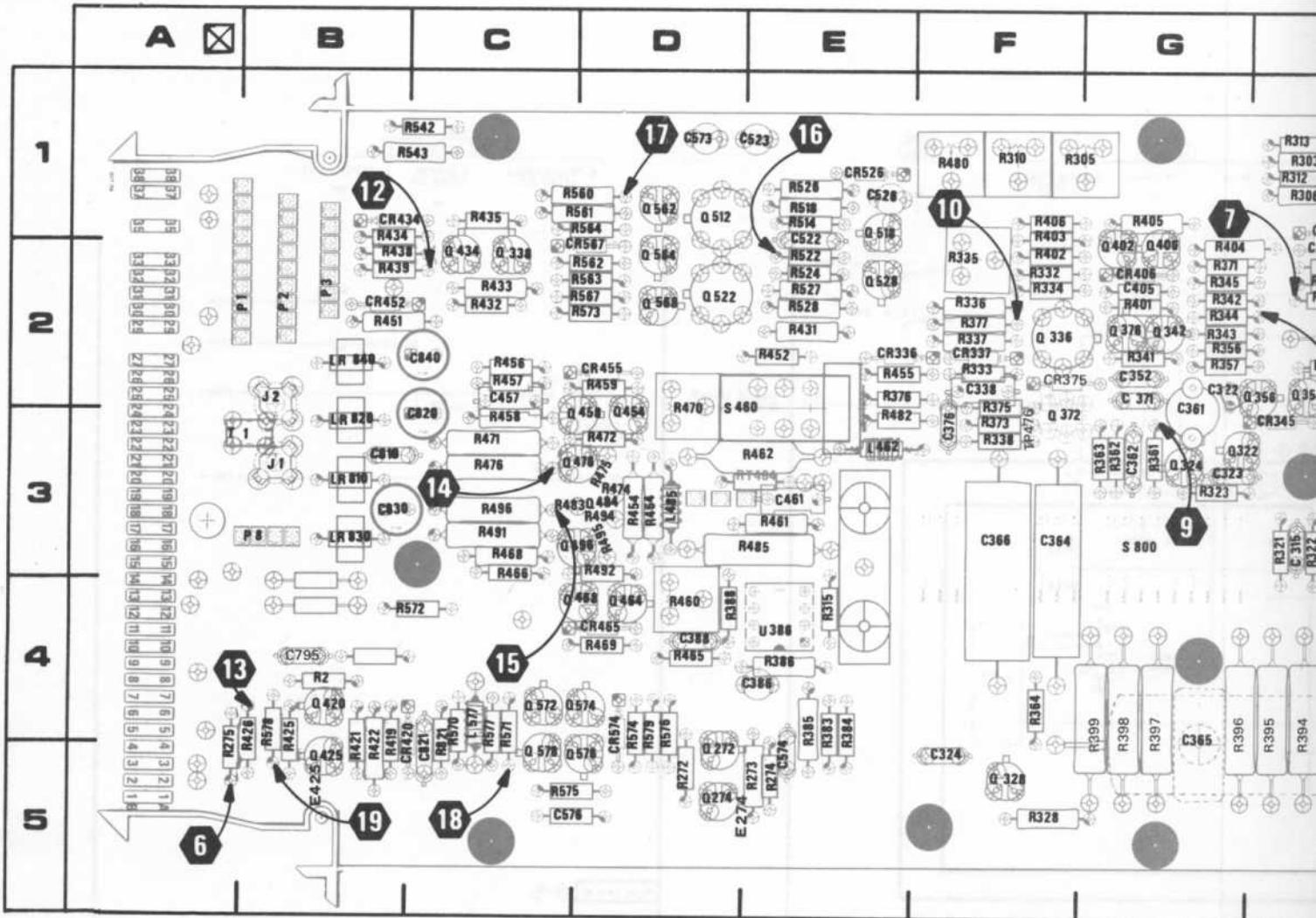


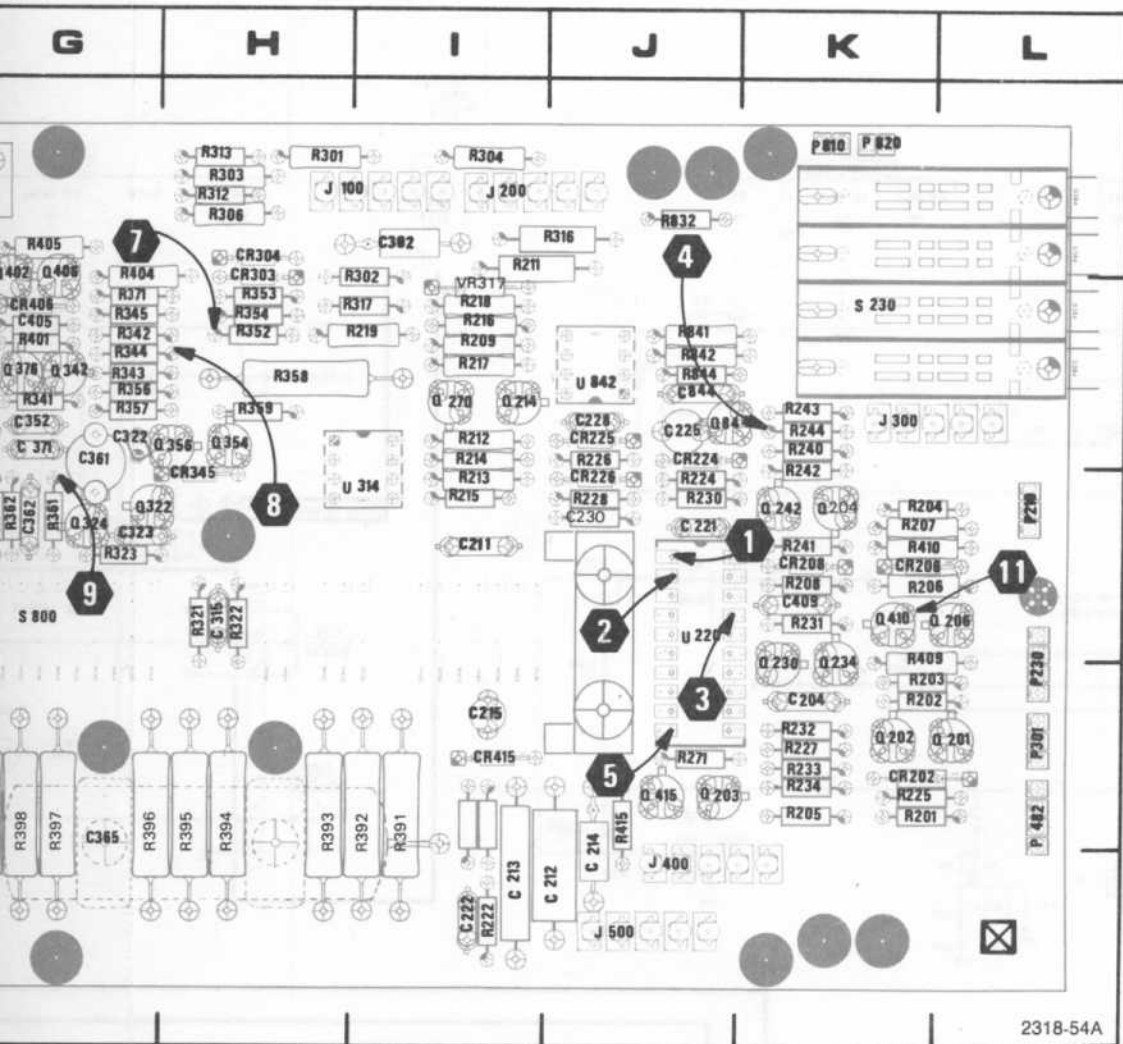
FRONT PANEL WIRING



FRONT PANEL WIRING



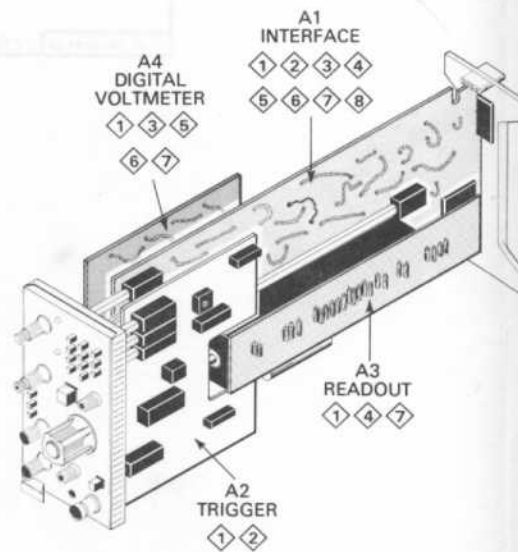




ard assembly.

GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
K	R334	2F	R394	4G	R459	2D	R561	1D
J	R335	2F	R395	4H	R460	4D	R562	2D
J	R336	2F	R396	4G	R461	3E	R563	2D
K	R337	2F	R397	4G	R462	3E	R564	1D
K	R338	3F	R398	4G	R464	3D	R567	2D
K	R341	2G	R399	4I	R465	4D	R570	4C
K	R342	2G	R401	2G	R466	3C	R571	4C
K	R343	2G	R402	2F	R468	3C	R572	4C
K	R344	2G	R403	1F	R469	4D	R573	2D
K	R345	2G	R404	2G	R470	2D	R574	4D
K	R352	2H	R405	1G	R471	3C	R575	5C
K	R353	2H	R406	1F	R472	3D	R576	4D
J	R354	2H	R409	3K	R474	3D	R577	4C
J	R356	2G	R410	3K	R475	3D	R578	4B
J	R357	2G	R415	4J	R476	3C	R579	4D
J	R358	2H	R419	4B	R480	1F	R821	4C
J	R359	2H	R421	4B	R482	2E	R832	1J
J	R361	3G	R422	4B	R483	3D	R841	2J
J	R362	3G	R425	4B	R485	3E	R842	2J
J	R363	3G	R426	4B	R491	3C	R844	2J
J	R364	4F	R431	2E	R492	3D		
J	R371	2G	R432	2C	R494	3D	S230	2K
J	R373	3F	R433	2C	R495	3D	S460	2D
J	R375	2F	R434	1B	R496	3C	S800	3G
J	R376	2E	R435	1C	R514	1E		
J	R377	2F	R438	2B	R518	1E	T1	3B
J	R383	4E	R439	2B	R522	2E	TP476	3F
J	R384	4E	R451	2B	R524	2E	U220	2J
J	R385	4E	R452	2E	R526	1E	U314	3I
J	R386	4E	R454	3D	R527	2E	U388	4E
J	R388	4D	R455	2E	R528	2E	U842	2J
J	R391	4I	R456	2C	R542	1C		
J	R392	4H	R457	2C	R543	1C		
J	R393	4H	R458	3C	R560	1D		

*See Parts List for serial number ranges.



REV JUN 1983

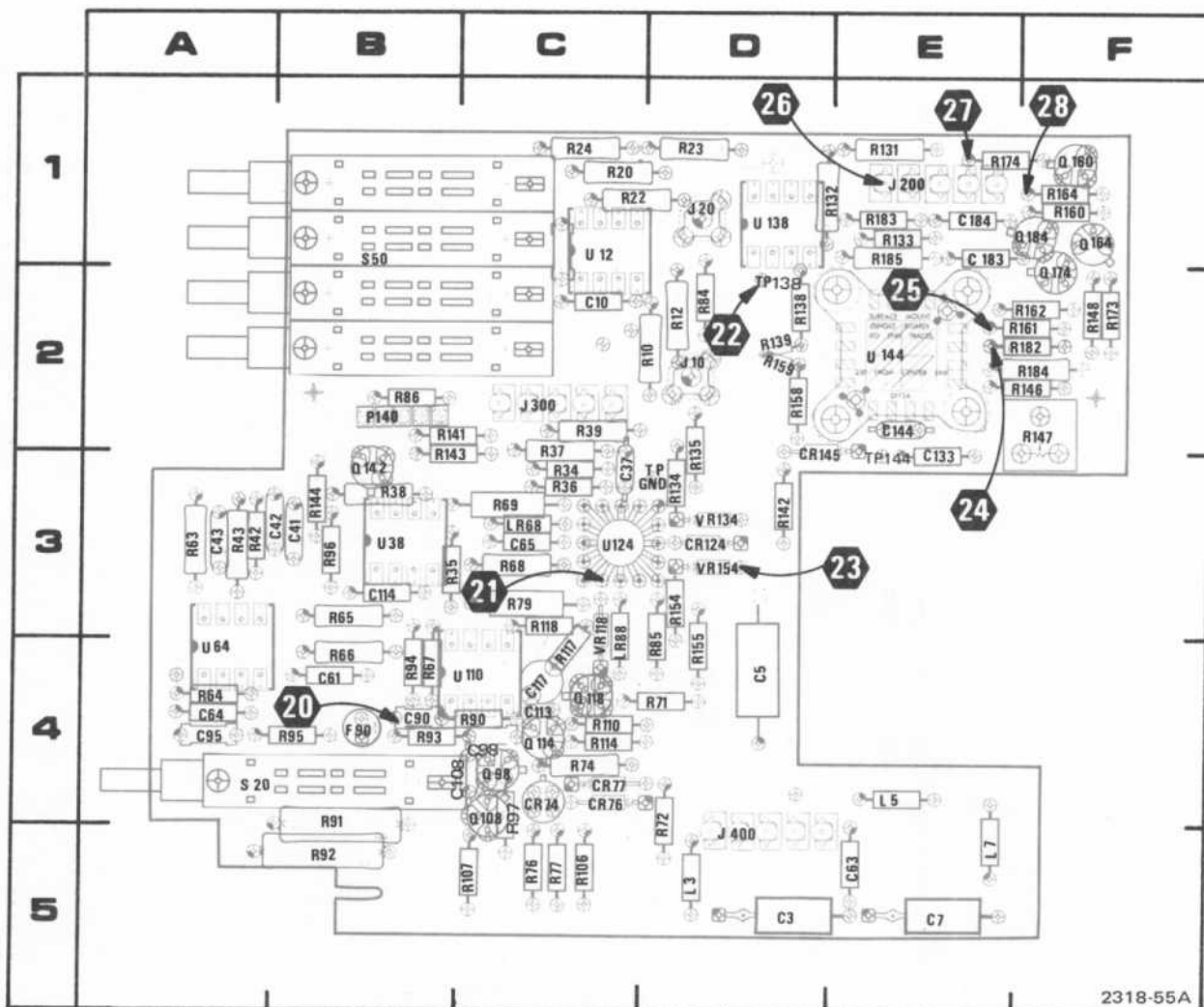


Figure 8-4. A2-Trigger circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C3	5D	GND	3D	R22	1C	R93	4B	R162	2F
C5	4D			R23	1D	R94	4B	R164	1F
C7	5E	J10	2D	R24	1C	R95	4B	R173	2F
C10	2C	J20	1D	R34	3C	R96	3B	R174	1E
C37	3C	J200	1E	R35	3B	R106	5C	R182	2F
C41	3B	J300	2C	R36	3C	R107	5C	R183	1E
C42	3B	J400	5D	R37	3C	R110	4C	R184	2F
C43	3A			R38	3B	R114	4C	R185	1E
C61	4B	L3	5D	R39	2C	R117	4C		
C63	5E	L5	4E	R42	3A	R118	3C	S20	4A
C64	4A	L7	5E	R43	3A	R131	1E	S50	1B
C65	3C			R63	3A	R132	1D		
C90	4B	LR68	3C	R64	4A	R133	1E	TP138	2D
C95	4A	LR88	4C	R65	3B	R134	3D	TP144	3E
C98	4C			R66	4B	R135	3D	TPGND	3D
C108	4C	P140	2B	R67	4B	R138	2D		
C113	4C			R68	3C	R139	2D	U12	1C
C114	3B	Q98	4C	R69	3C	R141	2B	U38	3B
C117	4C	Q108	4C	R71	4D	R142	3D	U64	4A
C133	3E	Q114	4C	R72	5D	R143	3B	U110	4C
C144	2E	Q118	4C	R74	4C	R144	3B	U124	3C
C183	1E	Q142	3B	R76	5C	R146	2F	U138	1D
C184	1E	Q160	1F	R77	5C	R147	2F	U144	2E
CR74	4C	Q164	1F	R79	3C	R148	2F		
CR76	4C	Q174	2F	R84	2D	R154	3D	VR118	4C
CR77	4C	Q184	1F	R85	4D	R155	4D	VR134	3D
CR124	3D			R86	2B	R158	2D	VR154	3D
CR145	3D	R10	2D	R90	4C	R159	2D		
F90	4B	R12	2D	R91	4B	R160	1F		
		R20	1C	R92	5B	R161	2F		

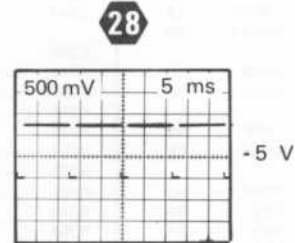
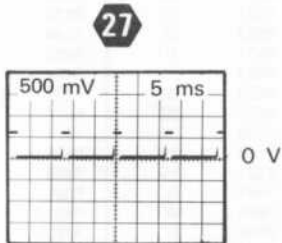
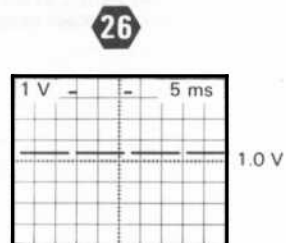
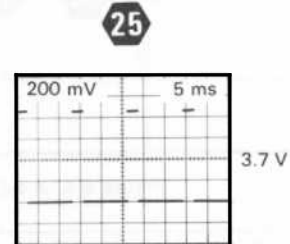
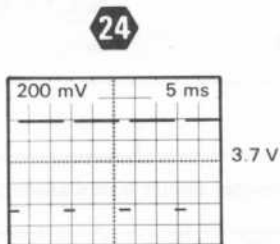
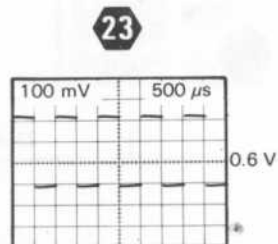
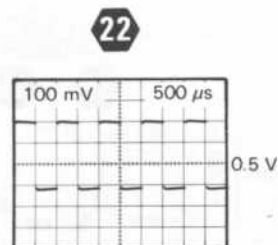
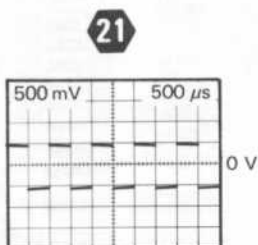
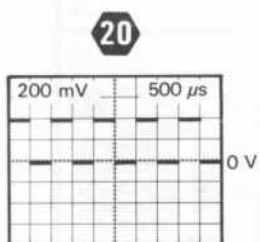
VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the controls set as follows:

TIME/DIV, 1 ms; VARIABLE (CAL IN), knob in; MAG X1 (button in); HOLD OFF, fully counterclockwise; SWP CAL, midranged; POSITION, midranged; TRIGGERING: LEVEL, midranged; MODE, AUTO; COUPLING, AC; SOURCE, EXT; SLOPE, +; EXT TRIG IN, IN (1 M Ω); B DELAY MODE, B STARTS AFTER DLY; DELAY TIME, fully counterclockwise; TIME, fully clockwise; TRACE SEP, fully counterclockwise.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 1 M Ω input impedance (Tektronix DM 501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with readout equipped, 7000-series oscilloscope).

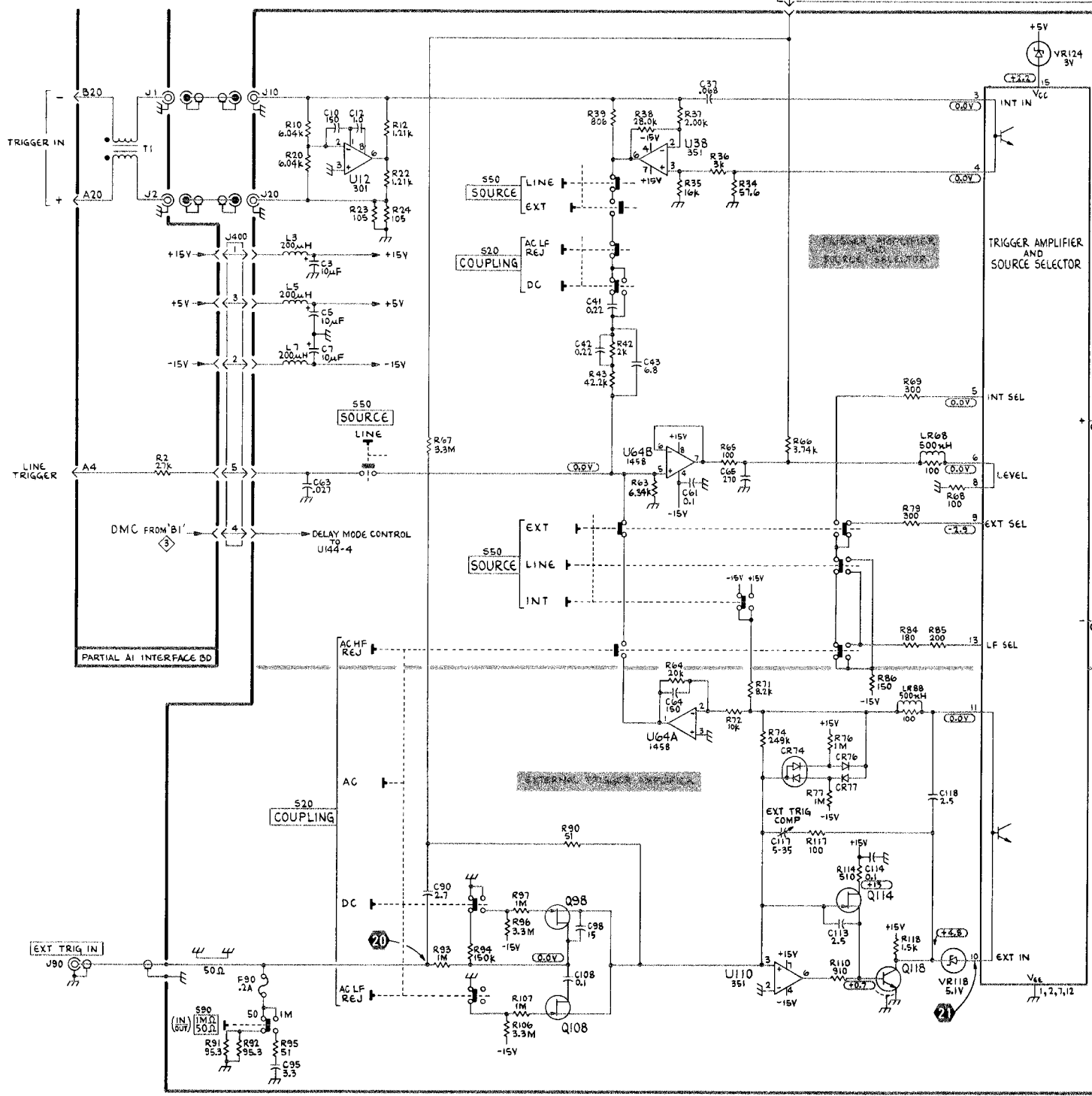
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 M Ω input impedance and at least 15 MHz bandwidth (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with 10X probe). A 4 volt, 1 kHz square wave signal was fed to the EXT TRIG IN connector.



VOLTAGE & WAVEFORM CONDITIONS

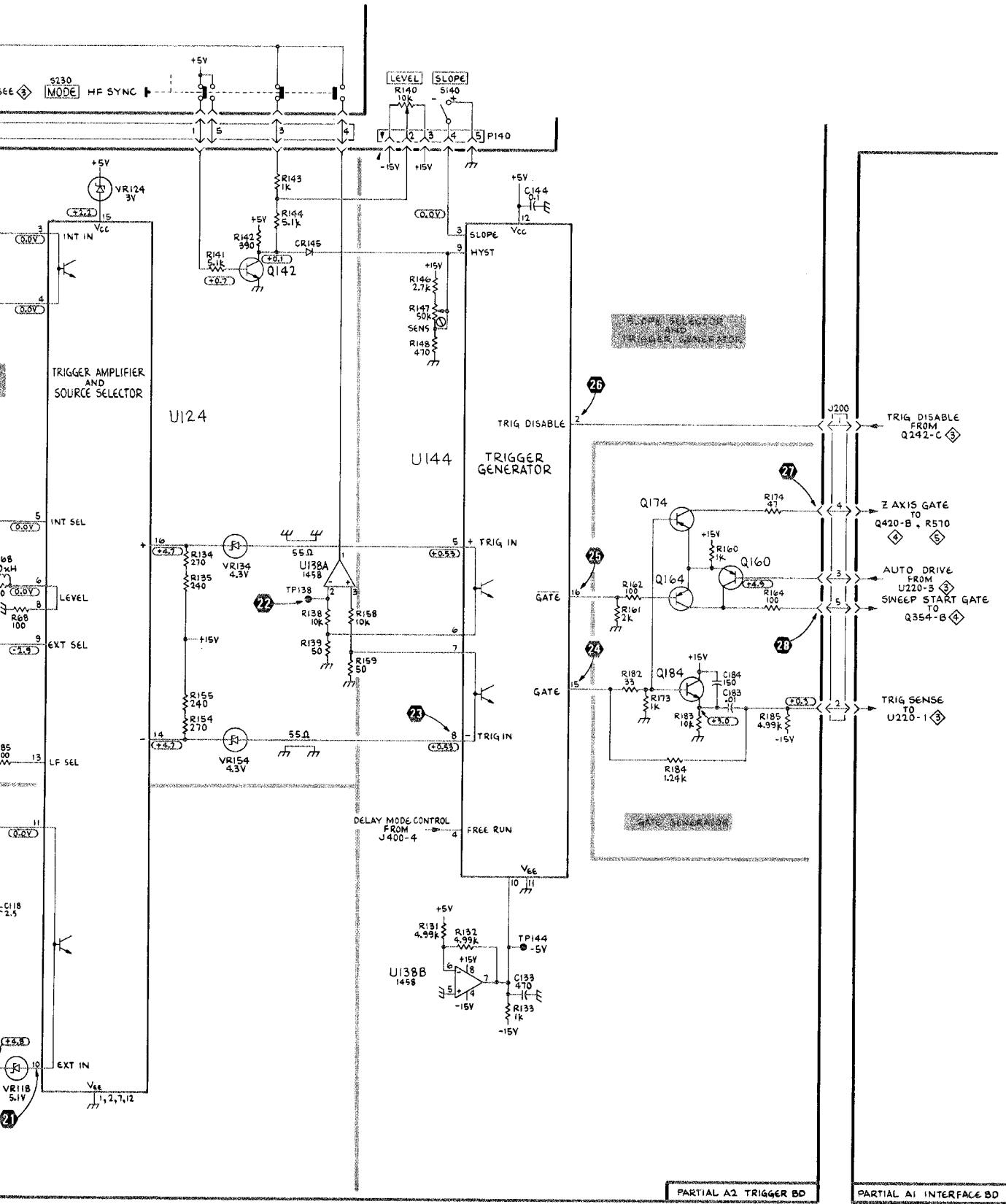
PARTIAL A1 INTERFACE BD

5230 MODE HF SYNC



7B15

2318-65
REV NOV 1982



2318-65
REV NOV 1982

TRIGGER GENERATOR

TRIGGER GENERATOR

2

2

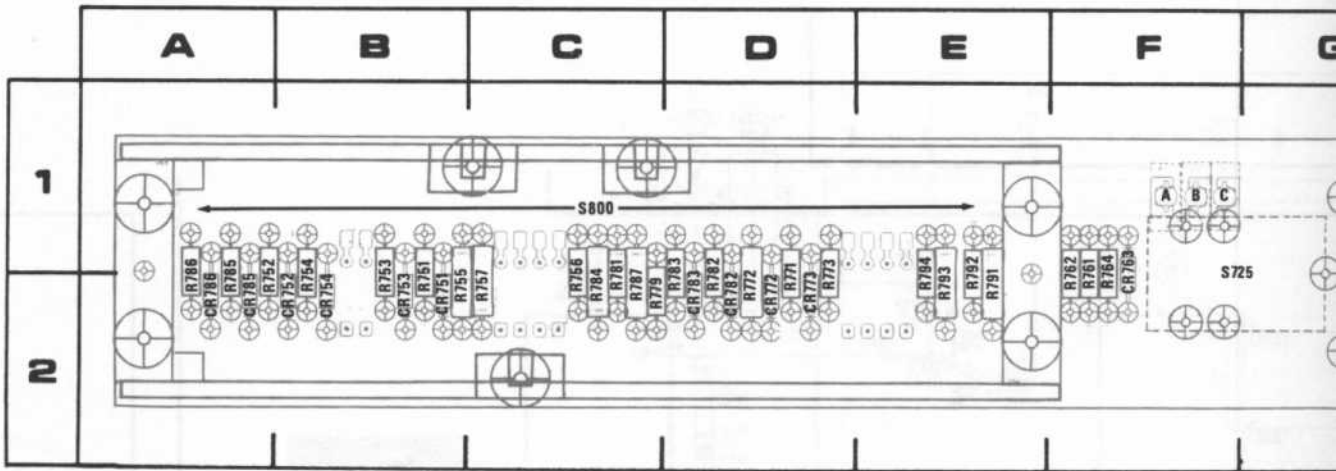
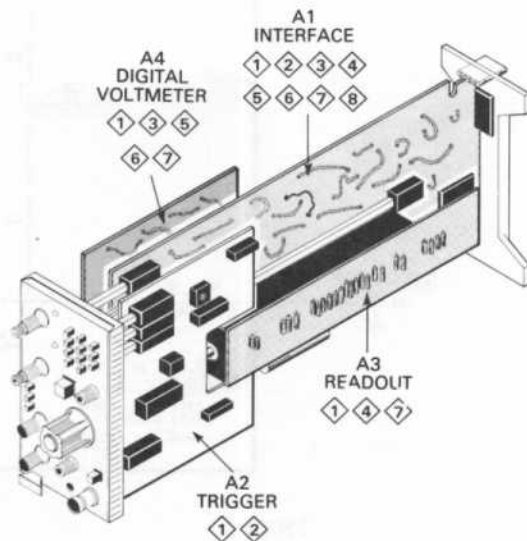
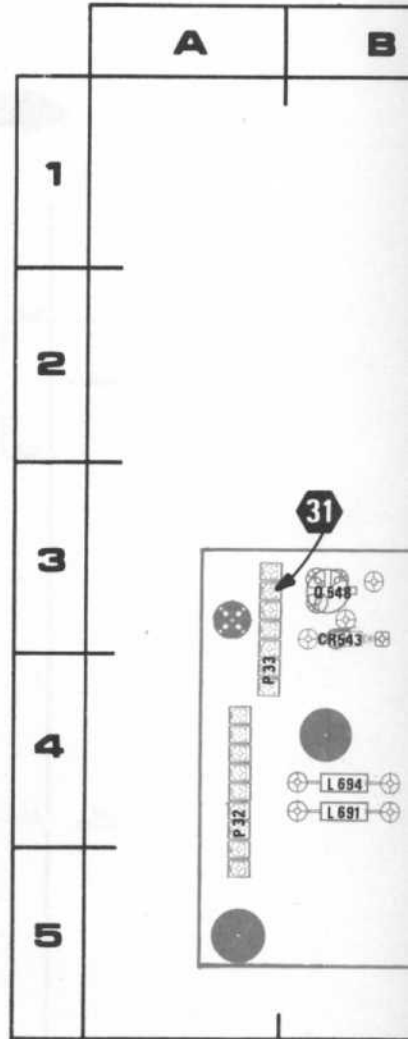
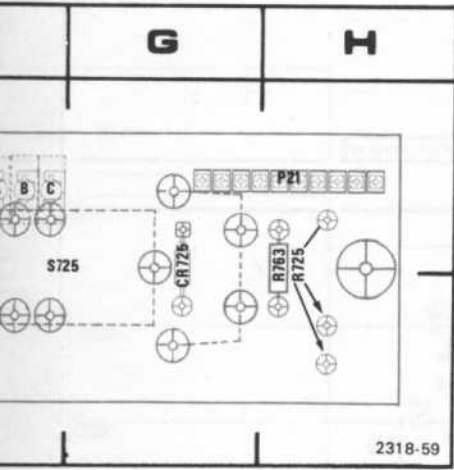


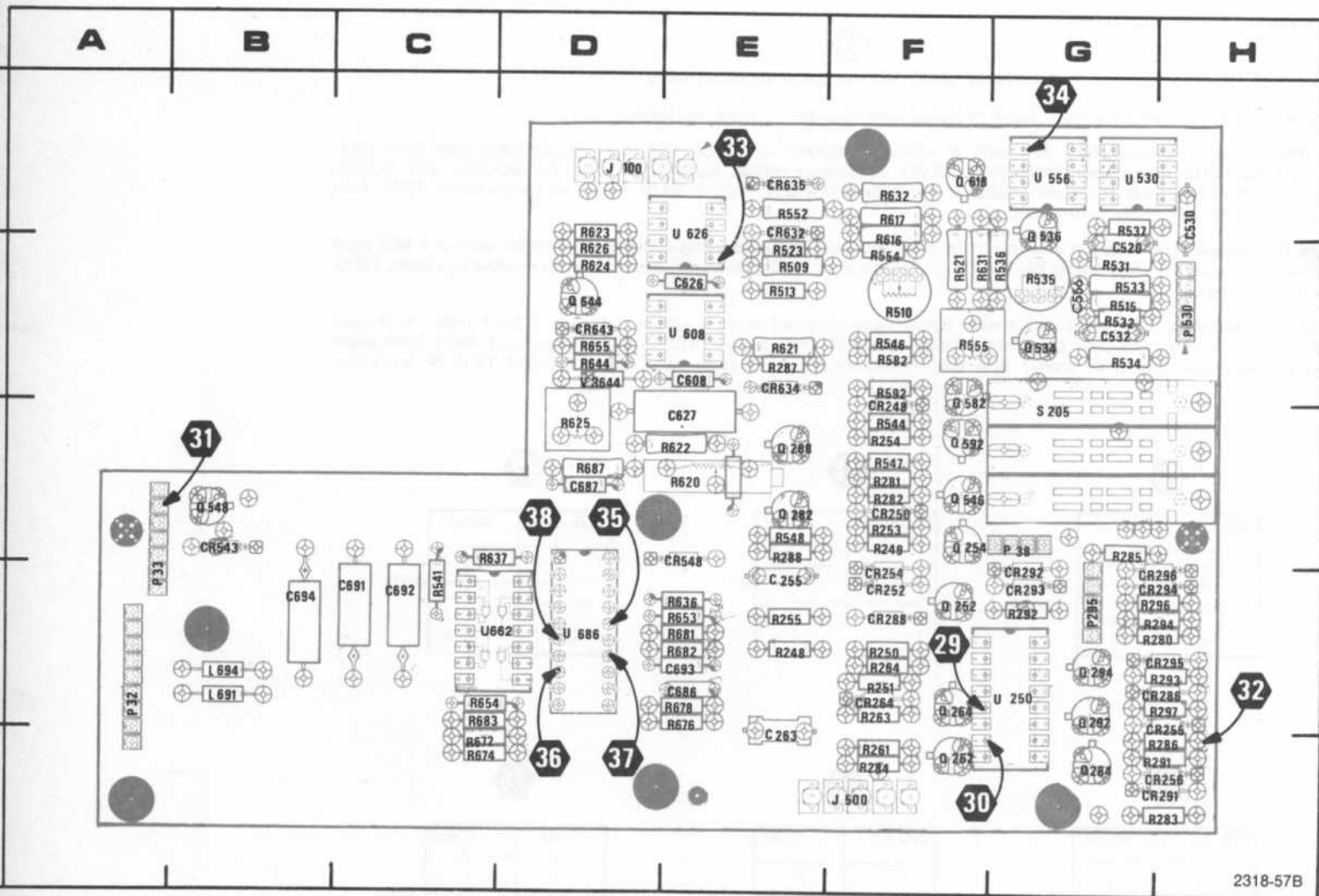
Figure 8-5. A 3-Readout circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD
CR725	2G	R761	2F
CR751	2B	R762	2F
CR752	2B	R763	2H
CR753	2B	R764	2F
CR754	2B	R771	2D
CR763	2F	R772	2D
CR772	2D	R773	2D
CR773	2D	R779	2C
CR782	2D	R781	2C
CR783	2D	R782	2D
CR785	2A	R783	2D
CR786	2A	R784	2C
		R785	2A
P21	1H	R786	2A
		R787	2C
R725	2H	R791	2E
R751	2B	R792	2E
R752	2A	R793	2E
R753	2B	R794	2E
R754	2B		
R755	2B	S725	1F
R756	2C	S800	1C
R757	2C		



CKT NO
C255
C263
C520
C532
C556 *
C608
C626
C627 *
C630
C686
C687
C691
C692
C693
C694
CR248
CR250
CR252
CR254
CR255
CR256
CR264
CR286
CR288
CR291
CR292
CR293
CR294
CR295
CR296
CR543

REV JUN 1983



2318-57B

Figure 8-6. A 4-Digital Voltmeter circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
C255	4E	CR548	3E	Q582	2F	R510	2F	R631	2F
C263	5E	CR632	1E	Q592	3F	R513	2E	R632	1F
C520	2G	CR634	2E	Q618	1F	R515	2G	R636	4E
C532	2G	CR635	1E	Q644	2D	R521	2F	R637	3C
C556	2G	CR643	2D			R523	2E	R644	2D
C608	2E			R248	4E	R531	2G	R653	4E
C626	2E	J100	1D	R249	3F	R532	2G	R654	4C
C627	3E	J500	5F	R250	4F	R533	2G	R655	2D
C630	1H			R251	4F	R534	2G	R672	5C
C686	4E	L691	4B	R253	3F	R535	2G	R674	5C
C687	3D	L694	4B	R254	3F	R536	2G	R676	4E
C691	4C			R255	4E	R537	1G	R678	4E
C692	4C	P295	4G	R261	5F	R541	4C	R681	4E
C693	4E	P32	4A	R263	4F	R544	3F	R682	4E
C694	4B	P33	4A	R264	4F	R546	2F	R683	4C
CR248	2F	P38	3G	R280	4H	R547	3F	R687	3D
CR250	3F	P530	2H	R281	3F	R548	3E		
CR252	4F			R282	3F	R552	1E	S205	3G
CR254	4F	Q252	4F	R283	5H	R554	2F		
CR255	4H	Q254	3F	R284	5F	R555	2F	U250	4G
CR256	5H	Q262	5F	R285	3G	R582	2F	U530	1G
CR264	4F	Q264	4F	R286	5H	R592	2F	U556	1G
CR286	4H	Q282	3E	R287	2E	R616	1F	U608	2E
CR288	4F	Q284	5G	R288	3E	R617	1F	U626	1E
CR291	5H	Q288	3E	R291	5H	R620	3E	U662	4C
CR292	4G	Q292	4G	R292	4G	R621	2E	U686	4D
CR293	4G	Q294	4G	R293	4H	R622	3E		
CR294	4H	Q534	2G	R294	4H	R623	1D	VR644	2D
CR295	4H	Q536	1G	R296	4H	R624	2D		
CR296	4H	Q546	3F	R297	4H	R625	3D		
CR543	3B	Q548	3B	R509	2E	R626	2D		

*See Parts List for serial number ranges.

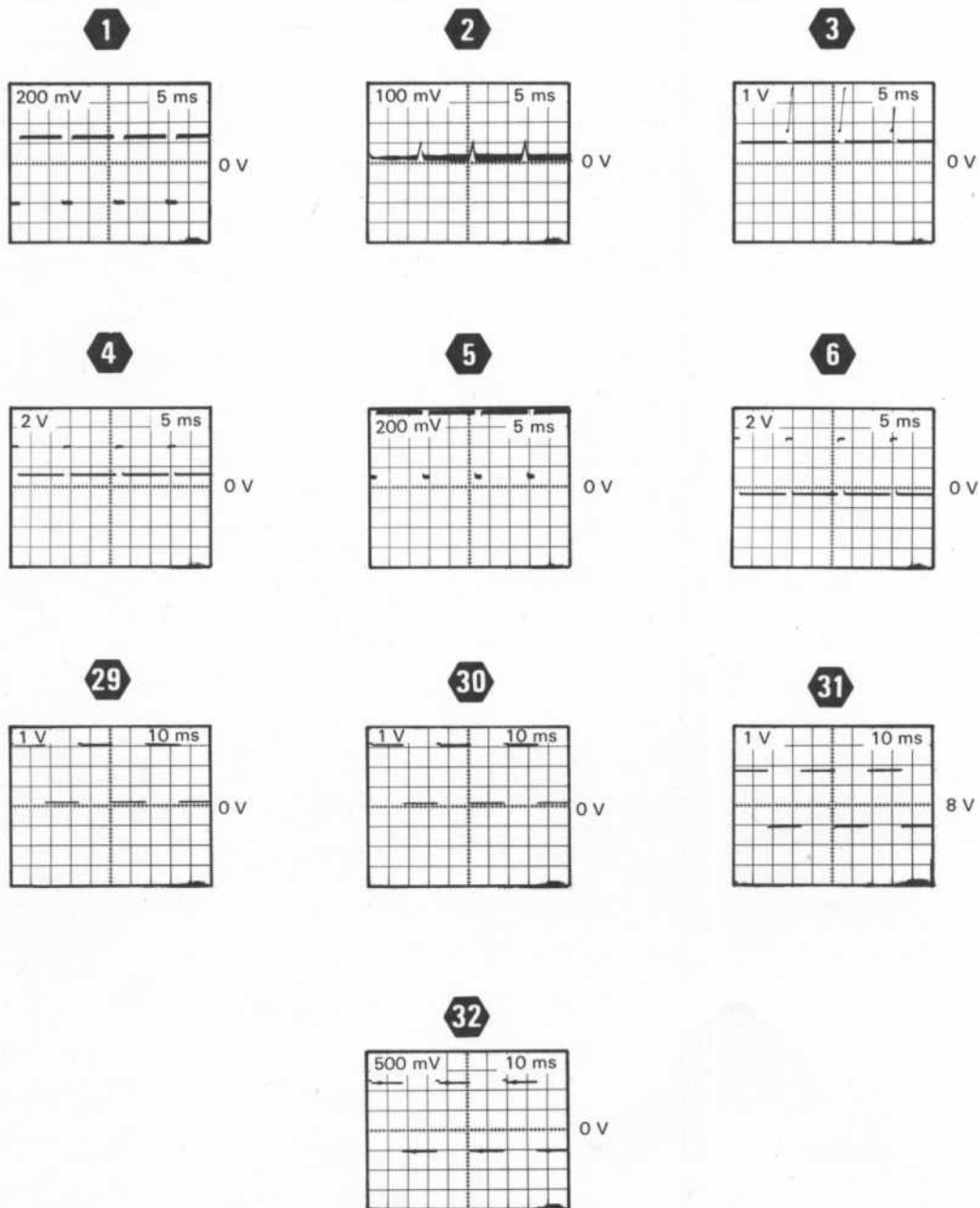
VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the controls set as follows:

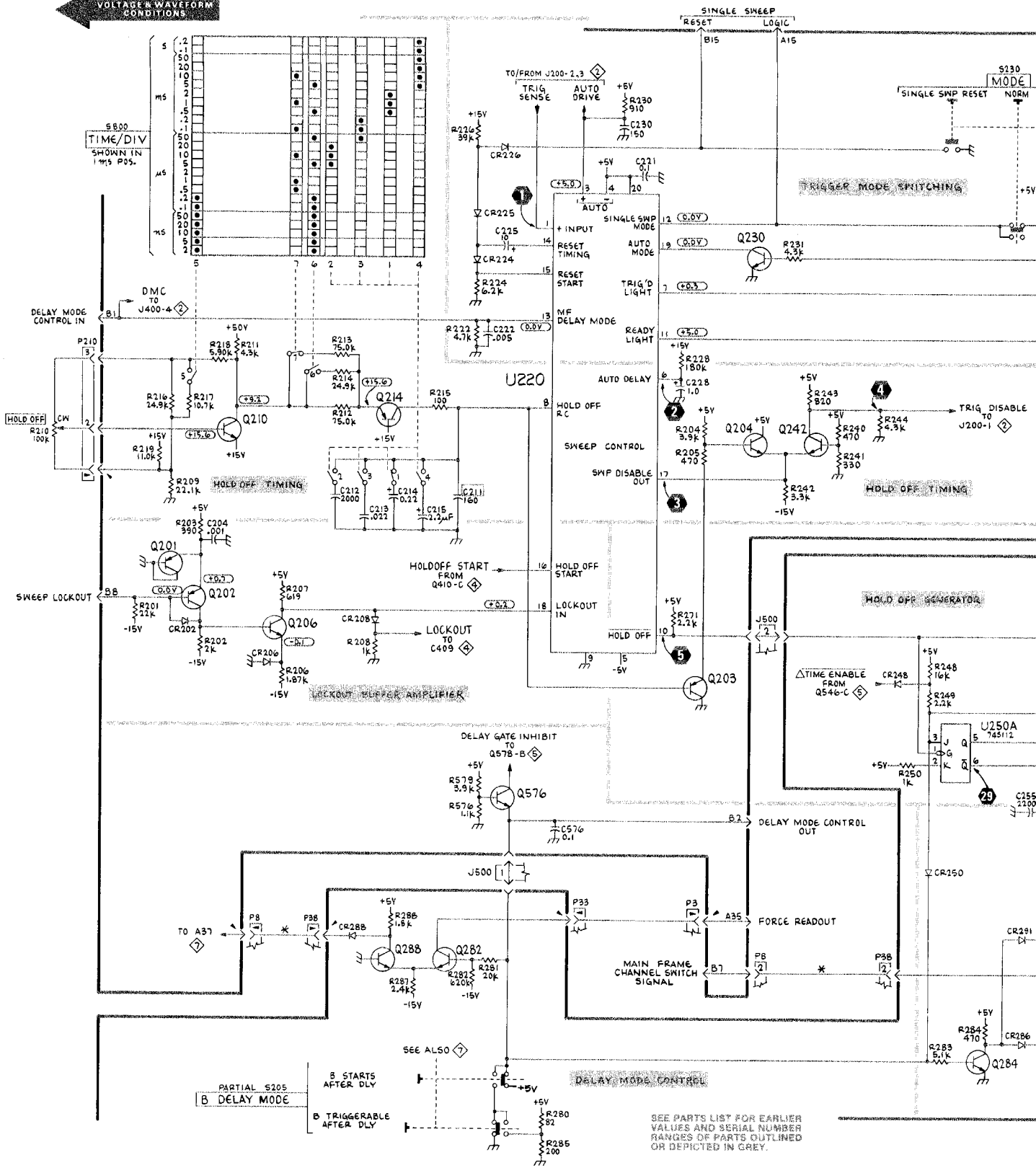
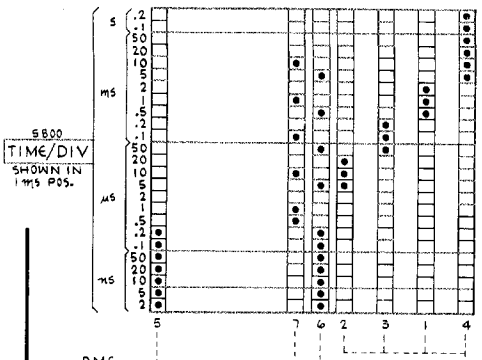
TIME/DIV, 1 ms; VARIABLE (CAL IN), knob in; MAG X1 (button in); HOLD OFF, fully counterclockwise; SWP CAL, midranged; POSITION, midranged; TRIGGERING: LEVEL, midranged; MODE, AUTO; COUPLING, AC; SOURCE, EXT; SLOPE, +; EXT TRIG IN, IN (1 M Ω); B DELAY MODE, B STARTS AFTER DLY; DELAY TIME, fully counterclockwise; TIME, fully clockwise; TRACE SEP, fully counterclockwise.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 1 M Ω input impedance (Tektronix DM 501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with readout equipped, 7000-series oscilloscope).

Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 M Ω input impedance and at least 15 MHz bandwidth (Tektronix Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with 10X probe). A 4 volt, 1 kHz square wave signal was fed to the EXT TRIG IN connector.



VOLTAGE & WAVEFORM CONDITIONS

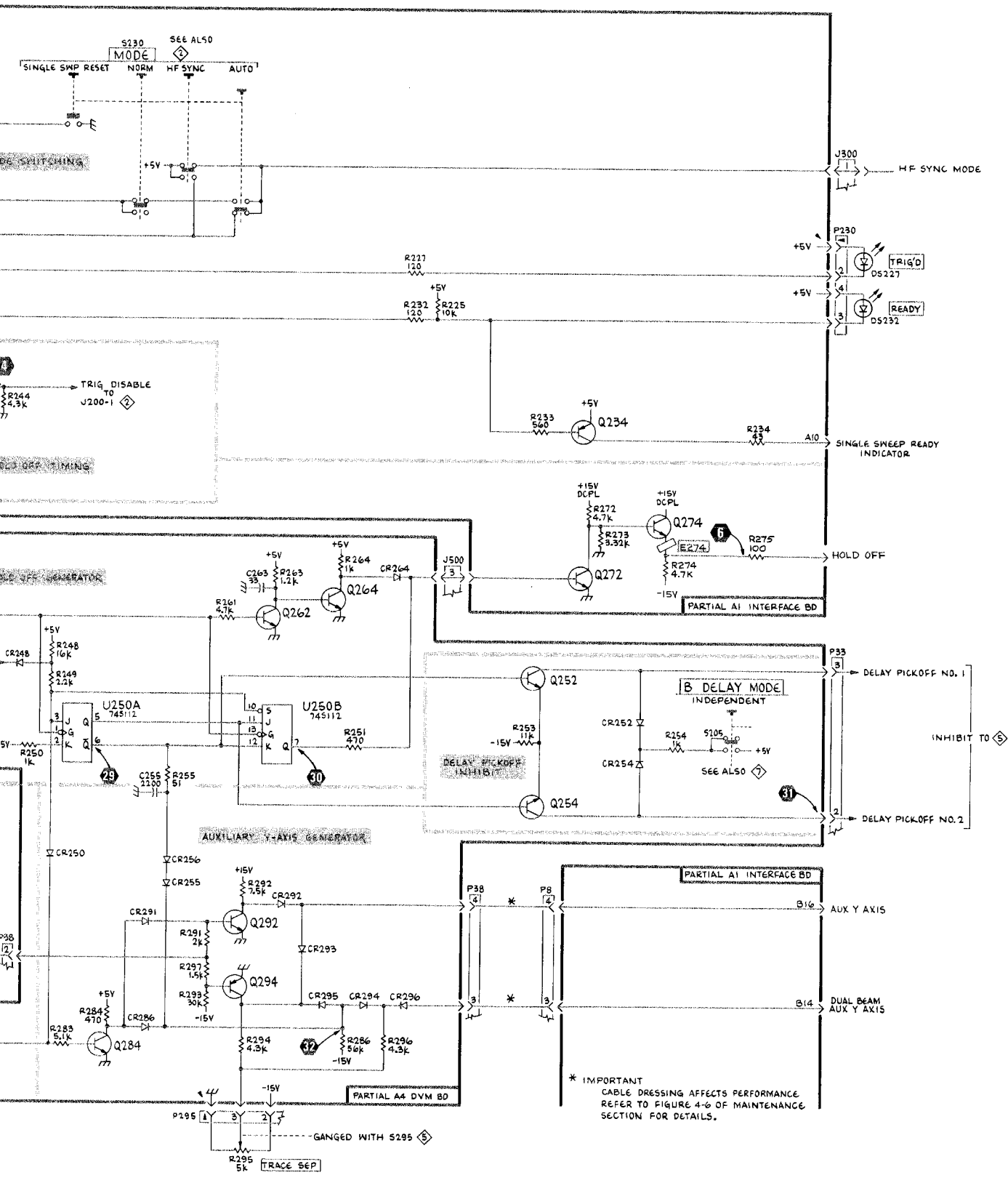


PARTIAL S205
B DELAY MODE

B STARTS AFTER DLY

B TRIGGERABLE AFTER DLY

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.



* IMPORTANT
CABLE DRESSING AFFECTS PERFORMANCE
REFER TO FIGURE 4-6 OF MAINTENANCE
SECTION FOR DETAILS.

LOGIC

3

LOGIC

3

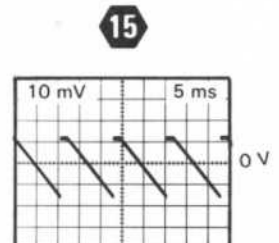
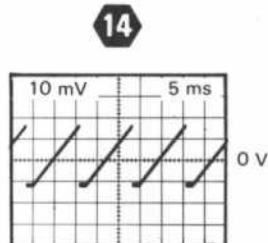
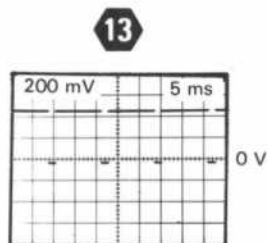
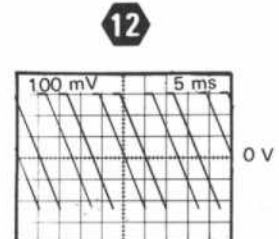
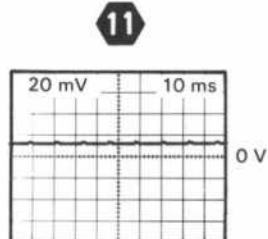
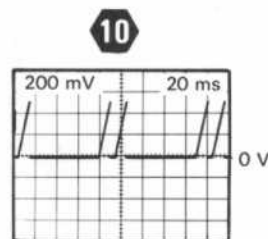
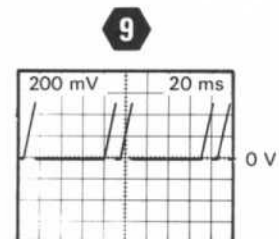
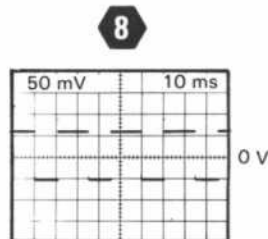
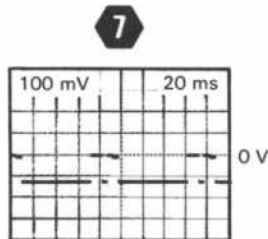
VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the controls set as follows:

TIME/DIV, 1 ms; VARIABLE (CAL IN), knob in; MAG X1 (button in); HOLD OFF, fully counterclockwise; SWP CAL, midranged; POSITION, midranged; TRIGGERING: LEVEL, midranged; MODE, AUTO; COUPLING, AC; SOURCE, EXT; SLOPE, +; EXT TRIG IN, IN (1 M Ω); B DELAY MODE, B STARTS AFTER DLY; DELAY TIME, fully counterclockwise; TIME, fully clockwise; TRACE SEP, fully counterclockwise.

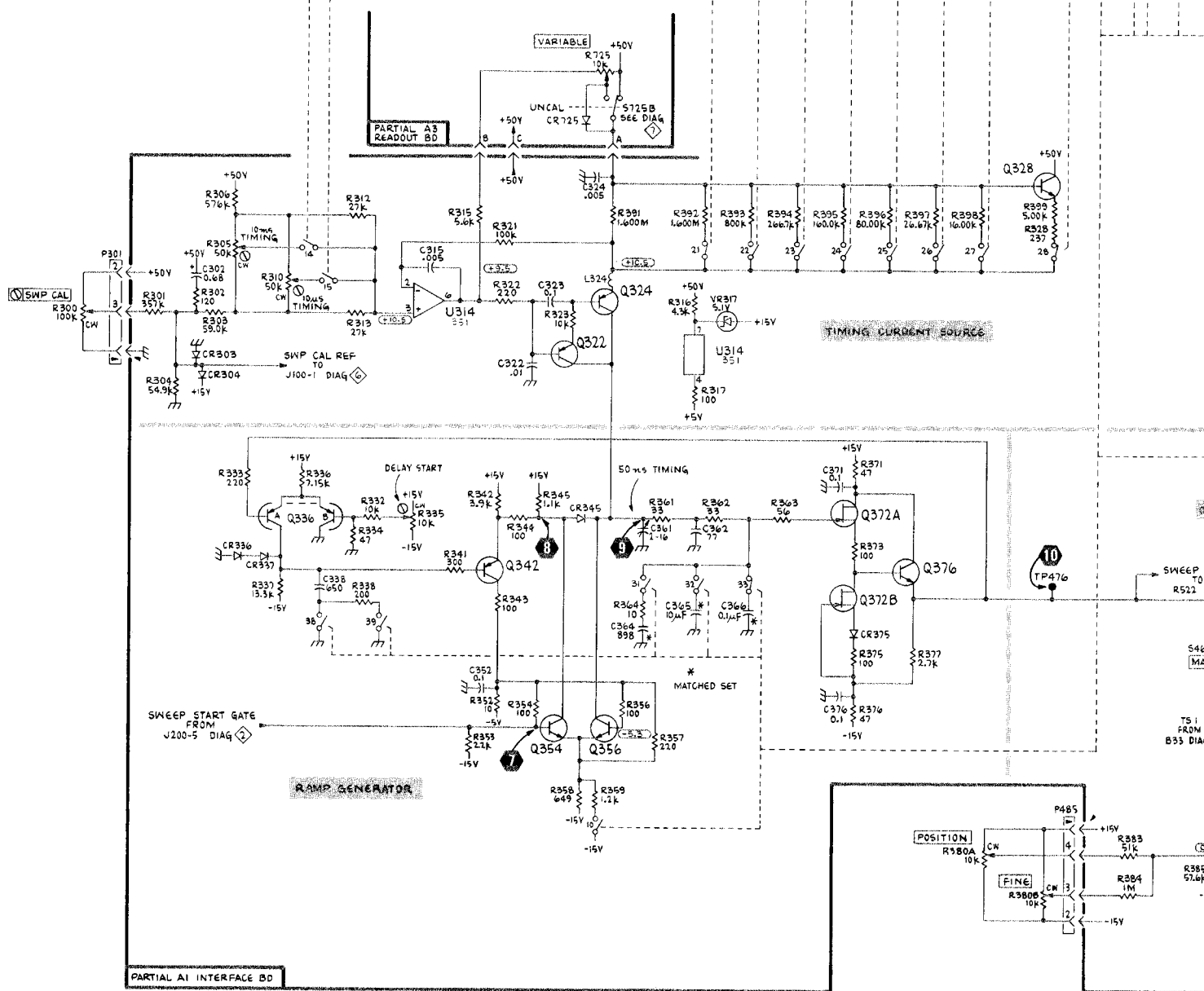
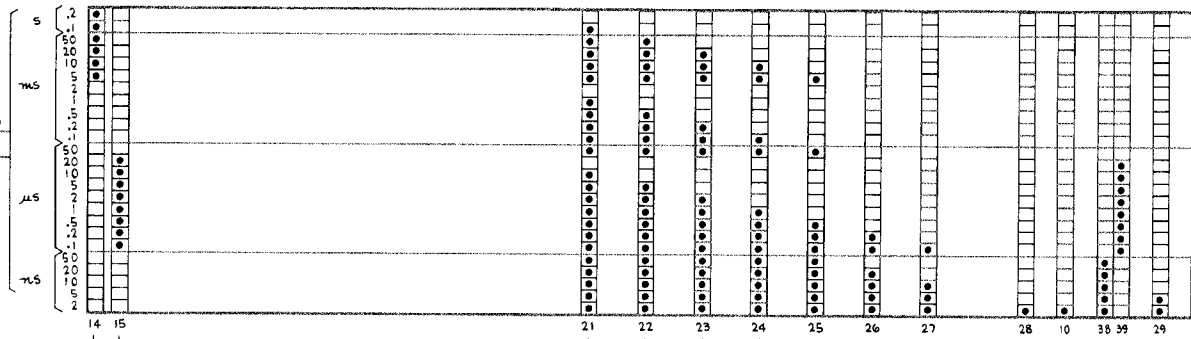
Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 1 M Ω input impedance (Tektronix DM 501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with readout equipped, 7000-series oscilloscope).

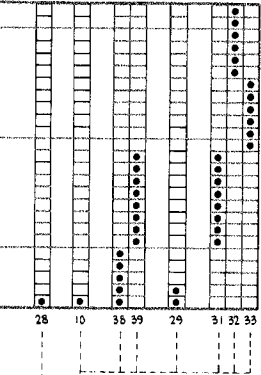
Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 M Ω input impedance and at least 15 MHz bandwidth (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with 10X probe).



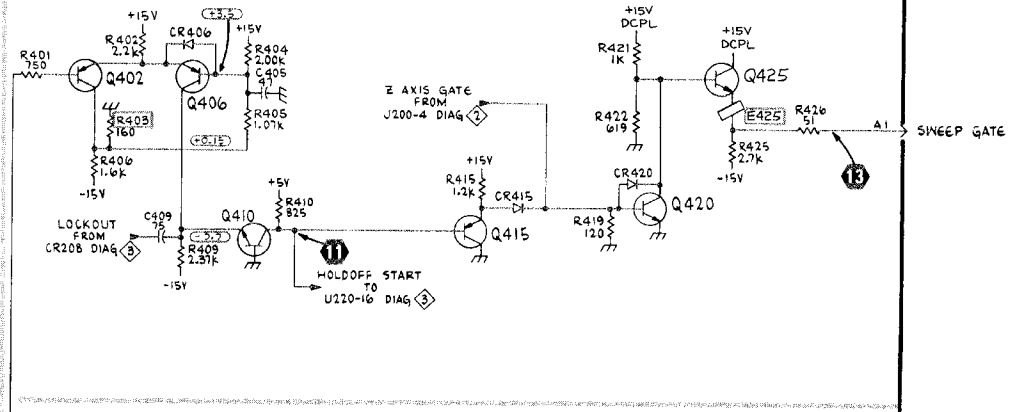
VOLTAGE & WAVEFORM CONDITIONS

PARTIAL S800
TIME/DIV
SHOWN IN
1-MS POS.

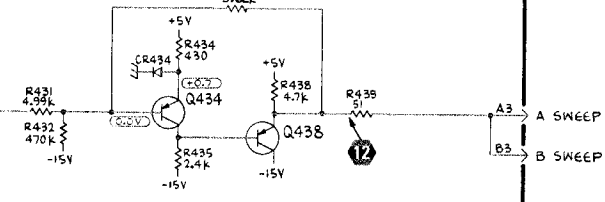




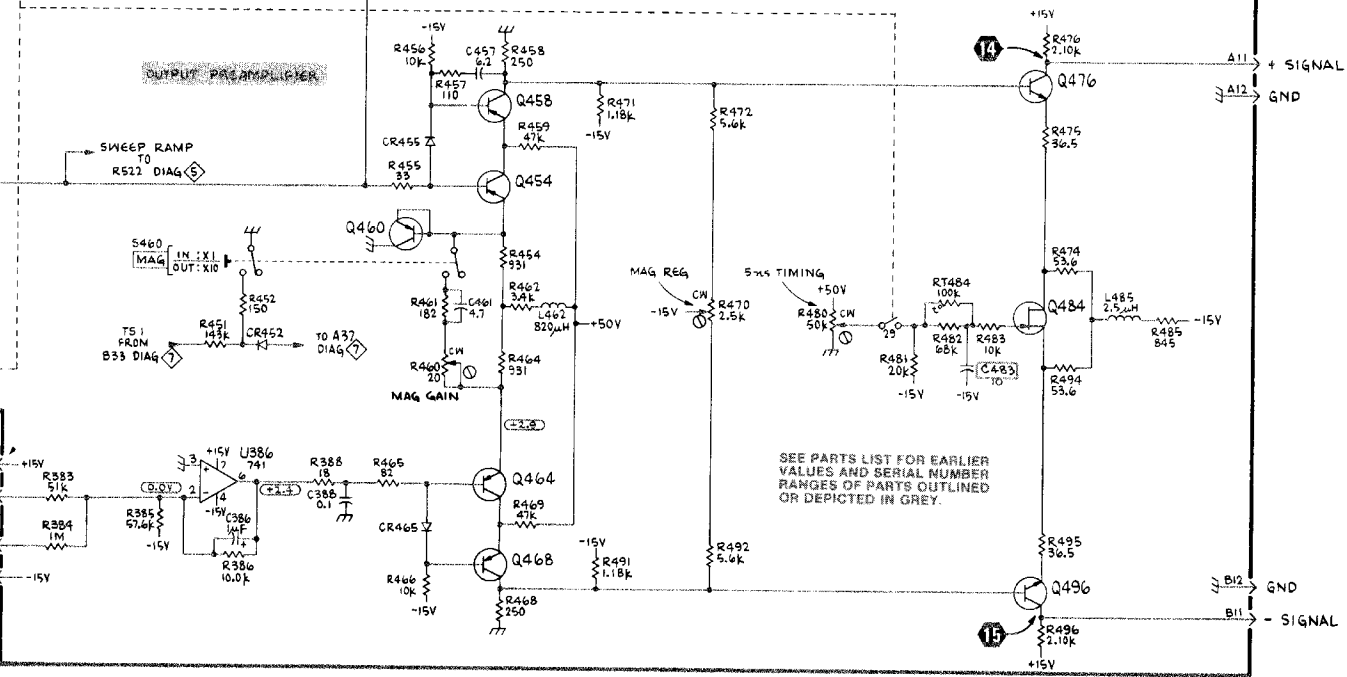
SWEEP GATE GENERATOR



AUXILIARY SWEEP PREAMPLIFIER



OUTPUT PREAMPLIFIER



VOLTAGE AND WAVEFORM CONDITIONS

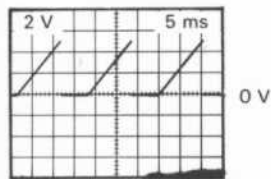
The voltages and waveforms shown were obtained with the controls set as follows:

TIME/DIV, 1 ms; VARIABLE (CAL IN), knob in; MAG X1 (button in); HOLD OFF, fully counterclockwise; SWP CAL, midranged; POSITION, midranged; TRIGGERING: LEVEL, midranged; MODE, AUTO; COUPLING, AC; SOURCE, EXT; SLOPE, +; EXT TRIG IN, IN (1 M Ω); B DELAY MODE, B STARTS AFTER DLY; DELAY TIME, fully counterclockwise; TIME, fully clockwise; TRACE SEP, fully counterclockwise.

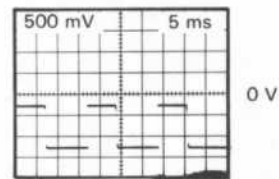
Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 1 M Ω input impedance (Tektronix DM 501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with readout equipped, 7000-series Oscilloscope).

Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 M Ω input impedance and at least 15 MHz bandwidth (Tektronix Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with 10X probe). A 4 volt, 1 kHz square wave signal was fed to the EXT TRIG IN connector.

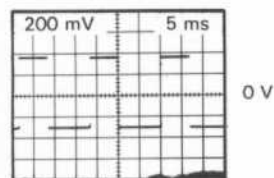
16



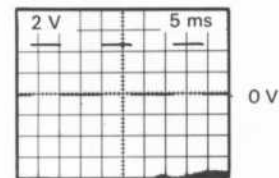
17



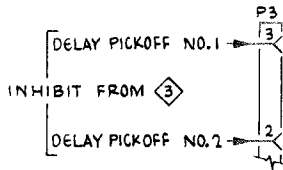
18



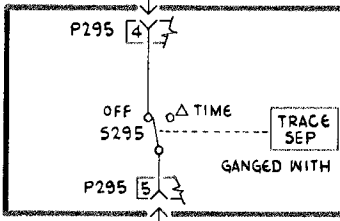
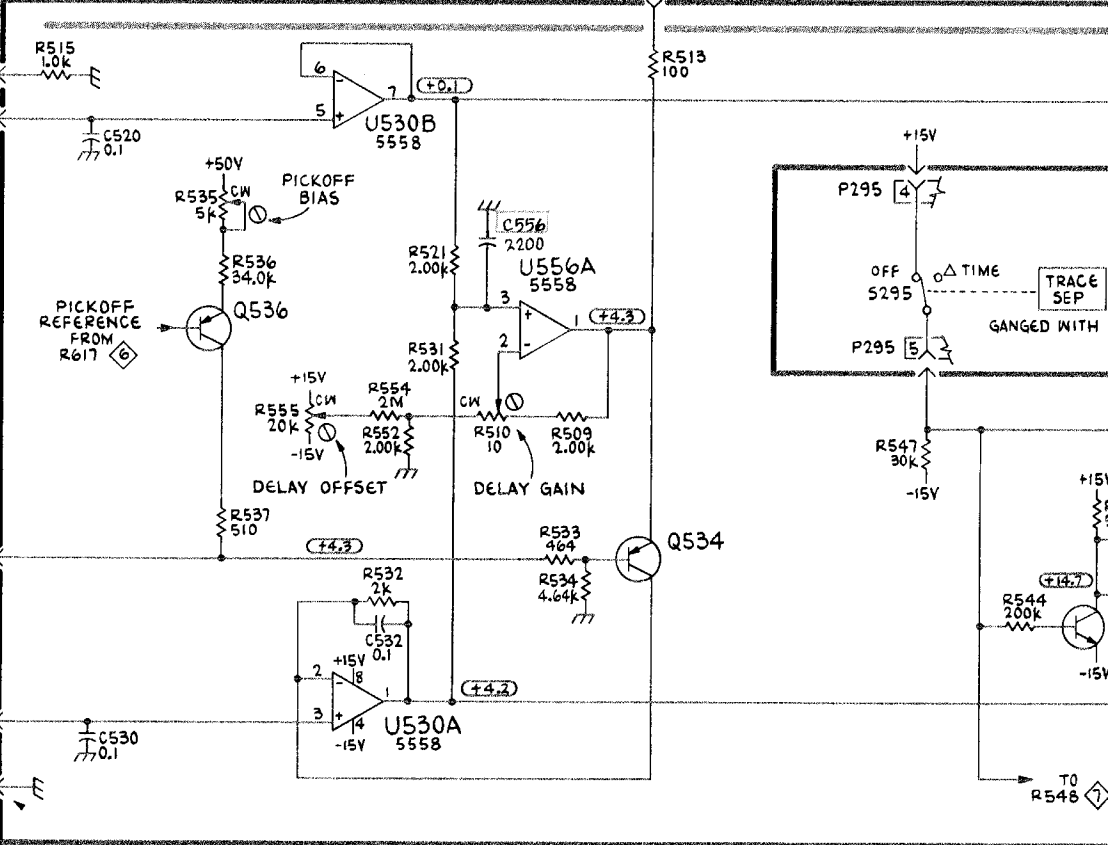
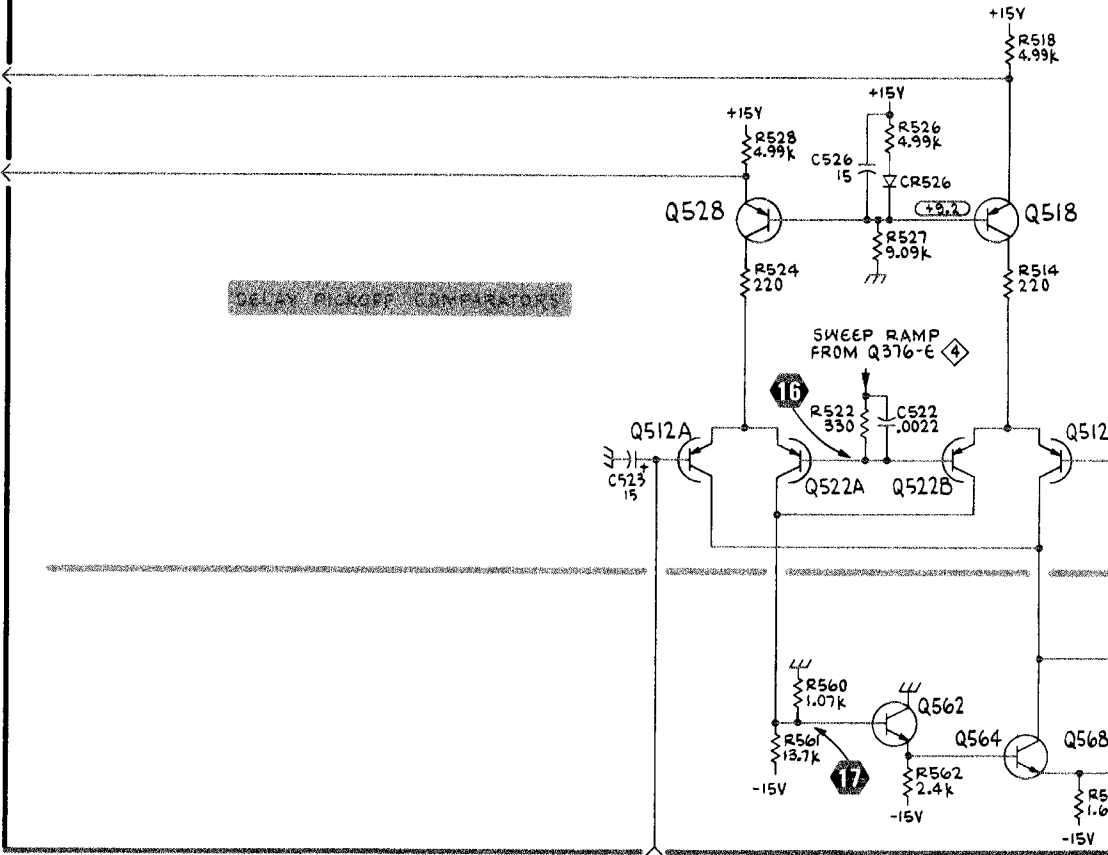
19

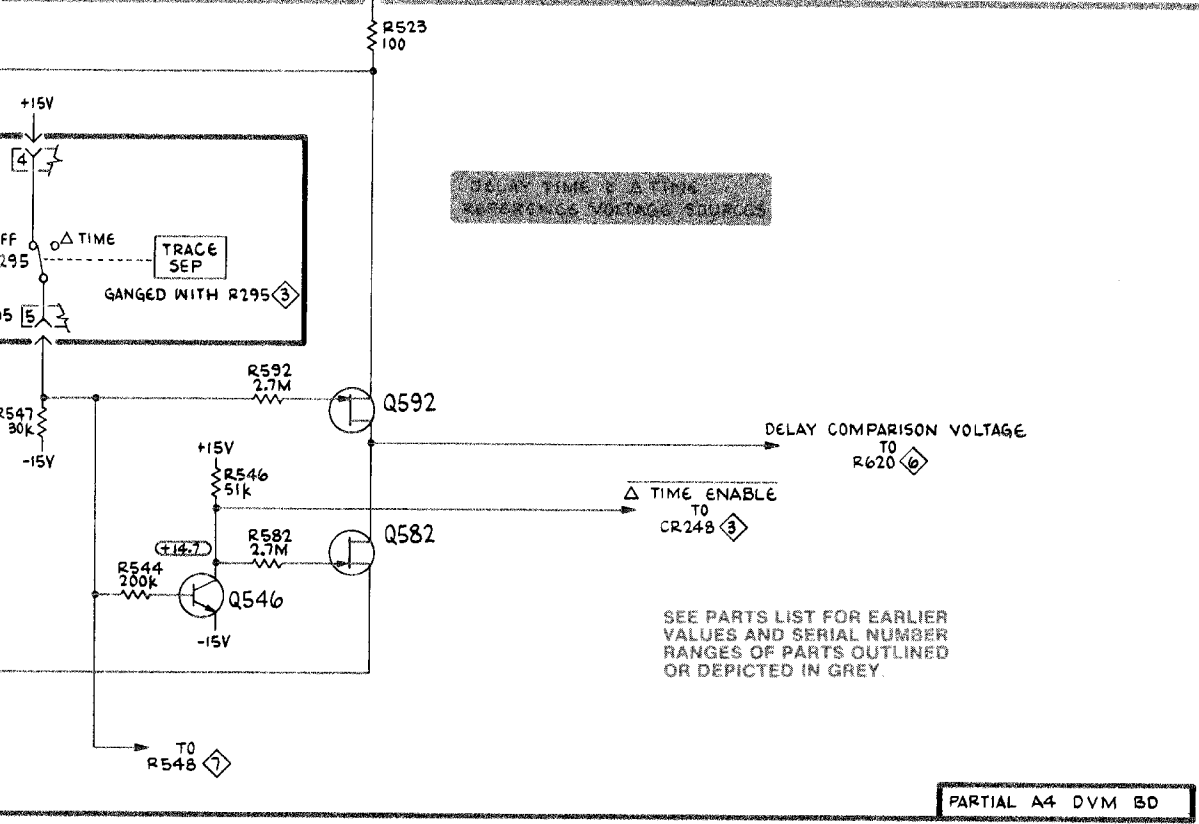
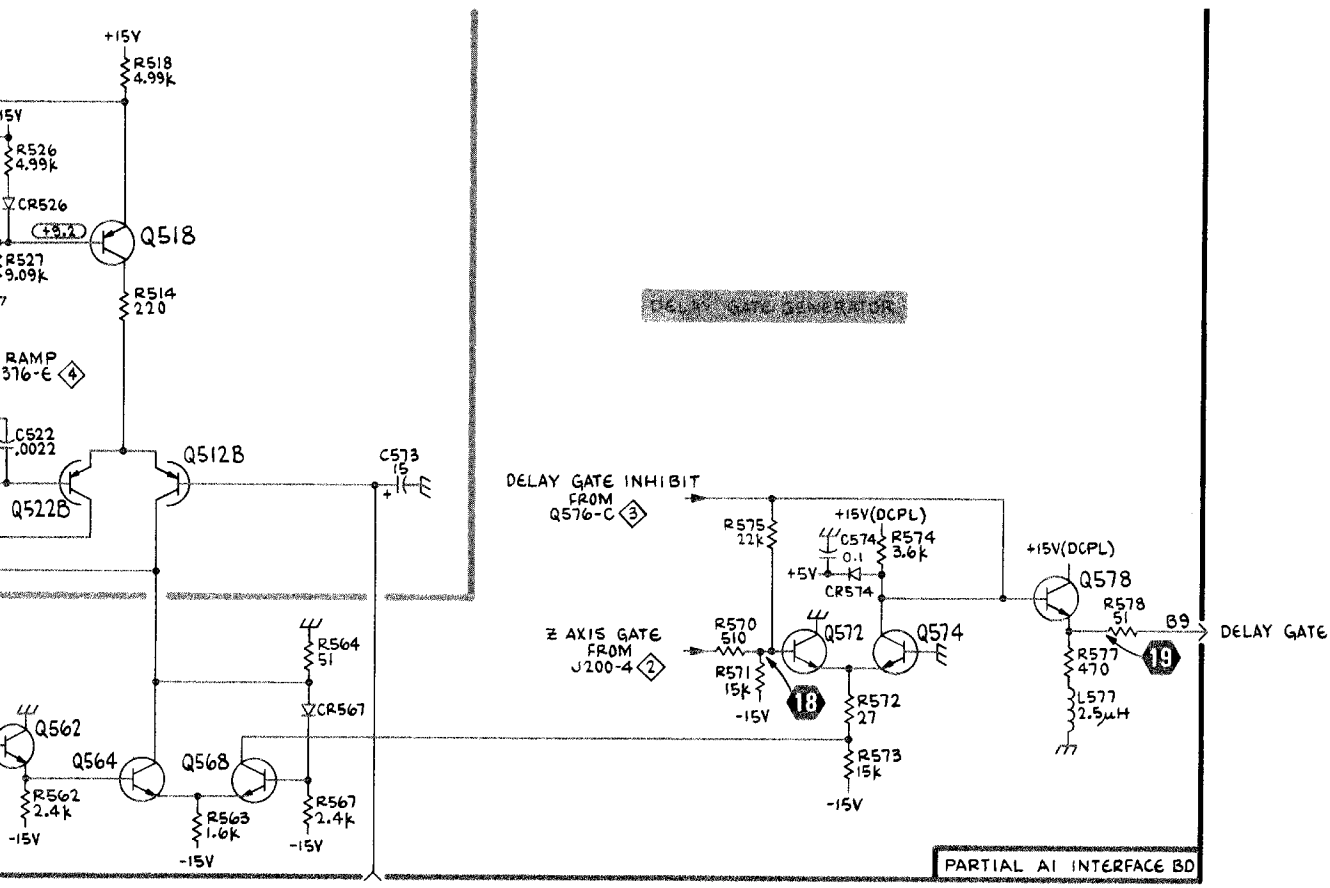


VOLTAGE & WAVEFORM CONDITIONS



DELAY PICKOFF COMPARE





REPLACE WITH THIS VERSION

REPLACE WITH THIS VERSION

SEE PARTS LIST FOR EARLIER
VALUES AND SERIAL NUMBER
RANGES OF PARTS OUTLINED
OR DEPICTED IN GREY.

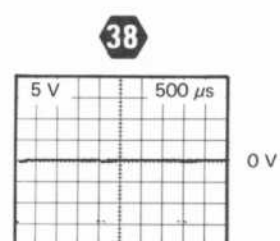
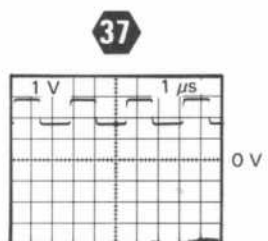
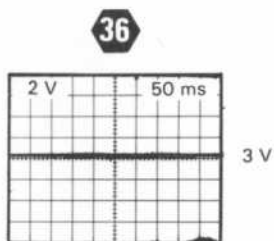
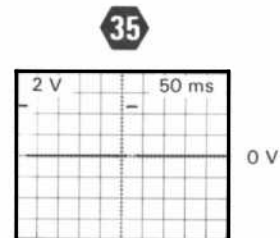
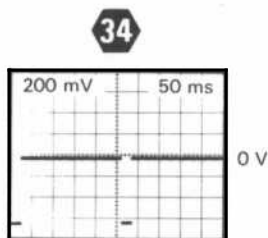
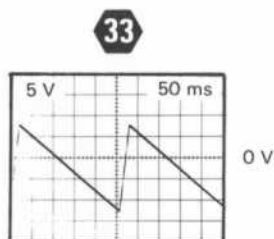
VOLTAGE AND WAVEFORM CONDITIONS

The voltages and waveforms shown were obtained with the controls set as follows:

TIME/DIV, 1 ms; VARIABLE (CAL IN), knob in; MAG X1 (button in); HOLD OFF, fully counterclockwise; SWP CAL, midranged; POSITION, midranged; TRIGGERING: LEVEL, midranged; MODE, AUTO; COUPLING, AC; SOURCE, EXT; SLOPE, +; EXT TRIG IN, IN (1 M Ω); B DELAY MODE, B STARTS AFTER DLY; DELAY TIME, fully counterclockwise; TIME, fully clockwise; TRACE SEP, fully counterclockwise.

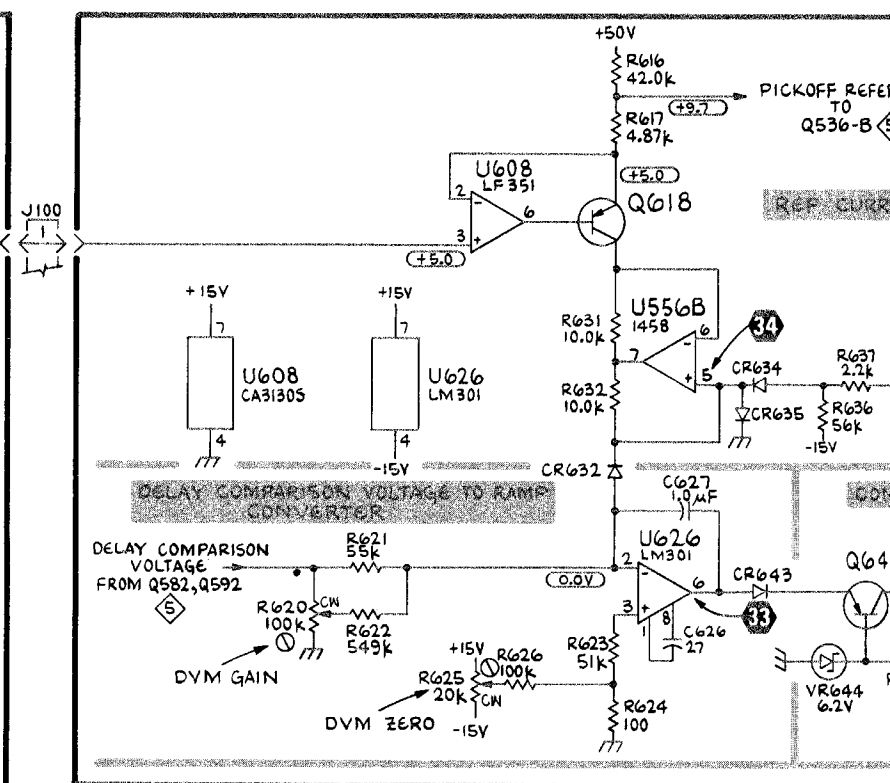
Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 1 M Ω input impedance (Tektronix DM 501 Digital Multimeter or Tektronix 7D13 Digital Multimeter used with readout equipped, series oscilloscope).

Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 1 M Ω input impedance and at least 15 MHz bandwidth (Tektronix 7603 Oscilloscope, 7B53A Time Base, and 7A13 Differential Comparator equipped with 10X probe). A 4 volt, 1 kHz square wave signal was fed to the EXT TRIG IN connector.



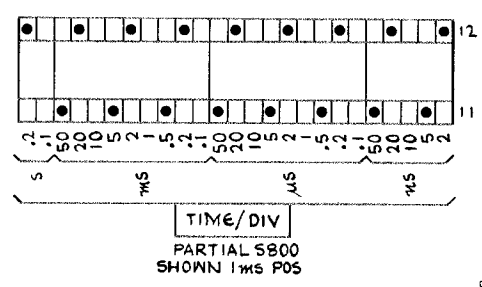
VOLTAGE & WAVEFORM CONDITIONS

SWP CAL REFERENCE FROM CR717, CR718



DELAY COMPARISON VOLTAGE FROM Q582, Q592

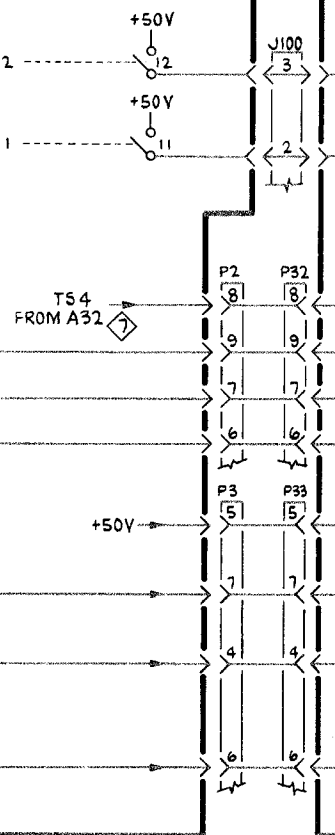
DVM GAIN
DVM ZERO

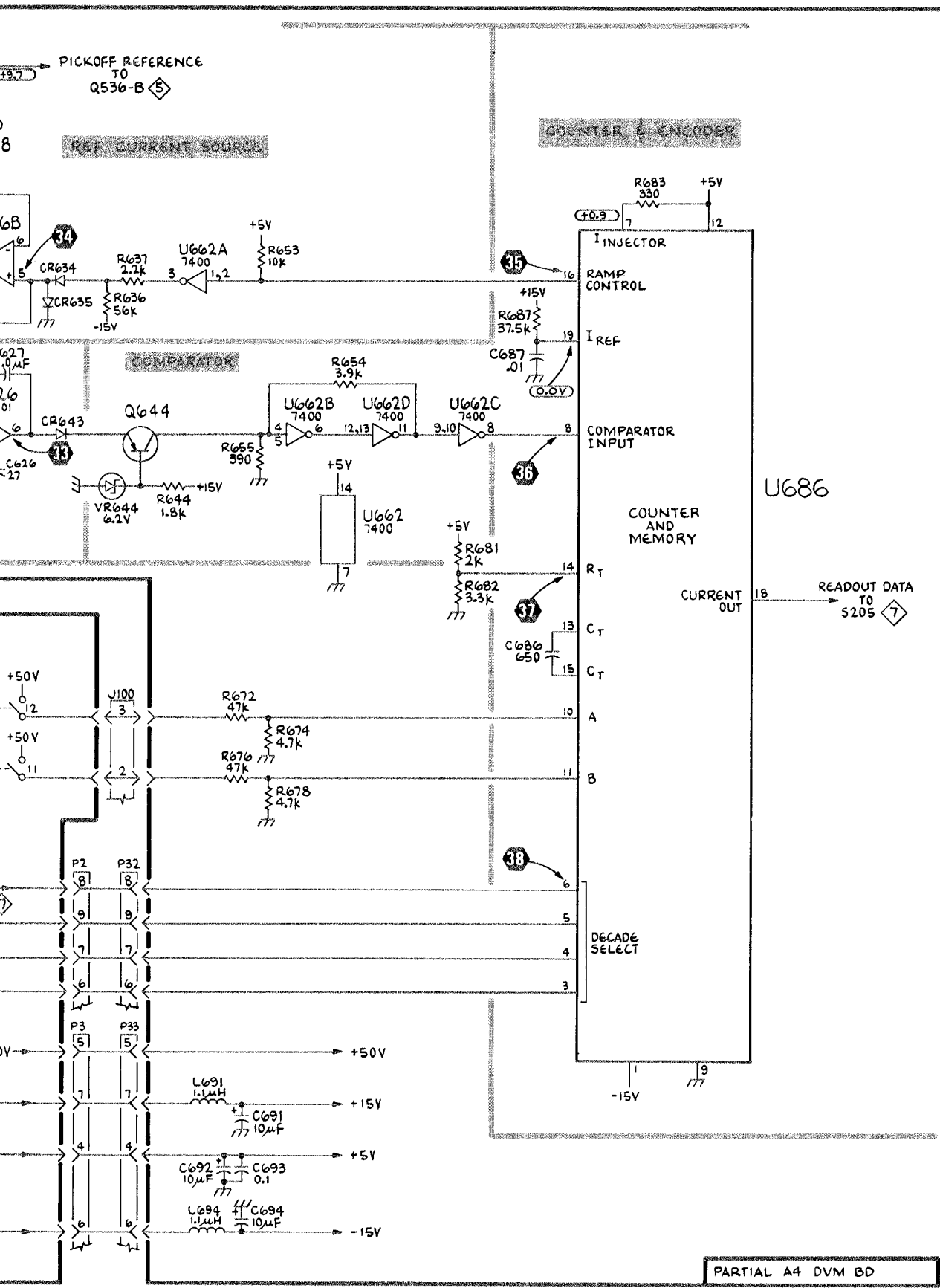


TIMESLOT PULSE LINES
TS 5
TS 6
TS 7

POWER
+15V
+5V
-15V

PARTIAL AI INTERFACE BD

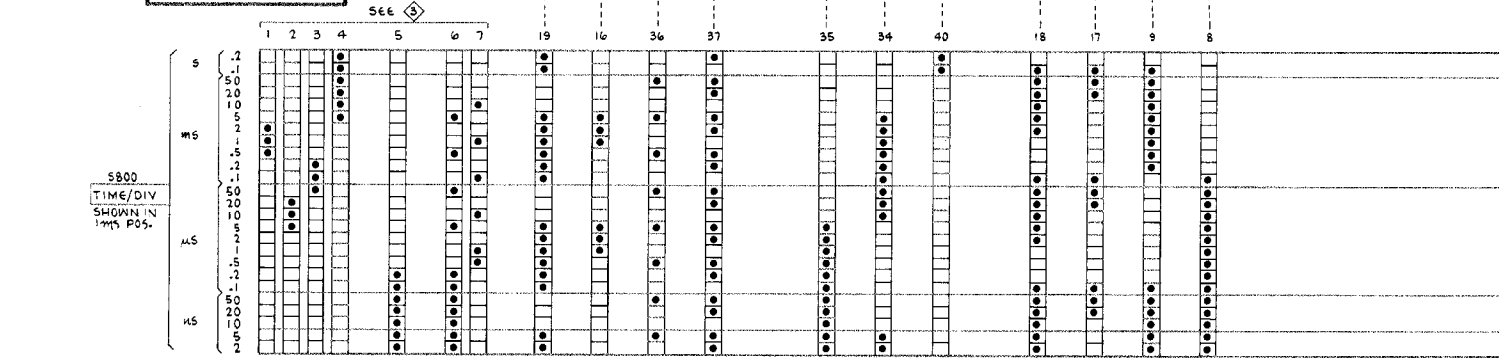
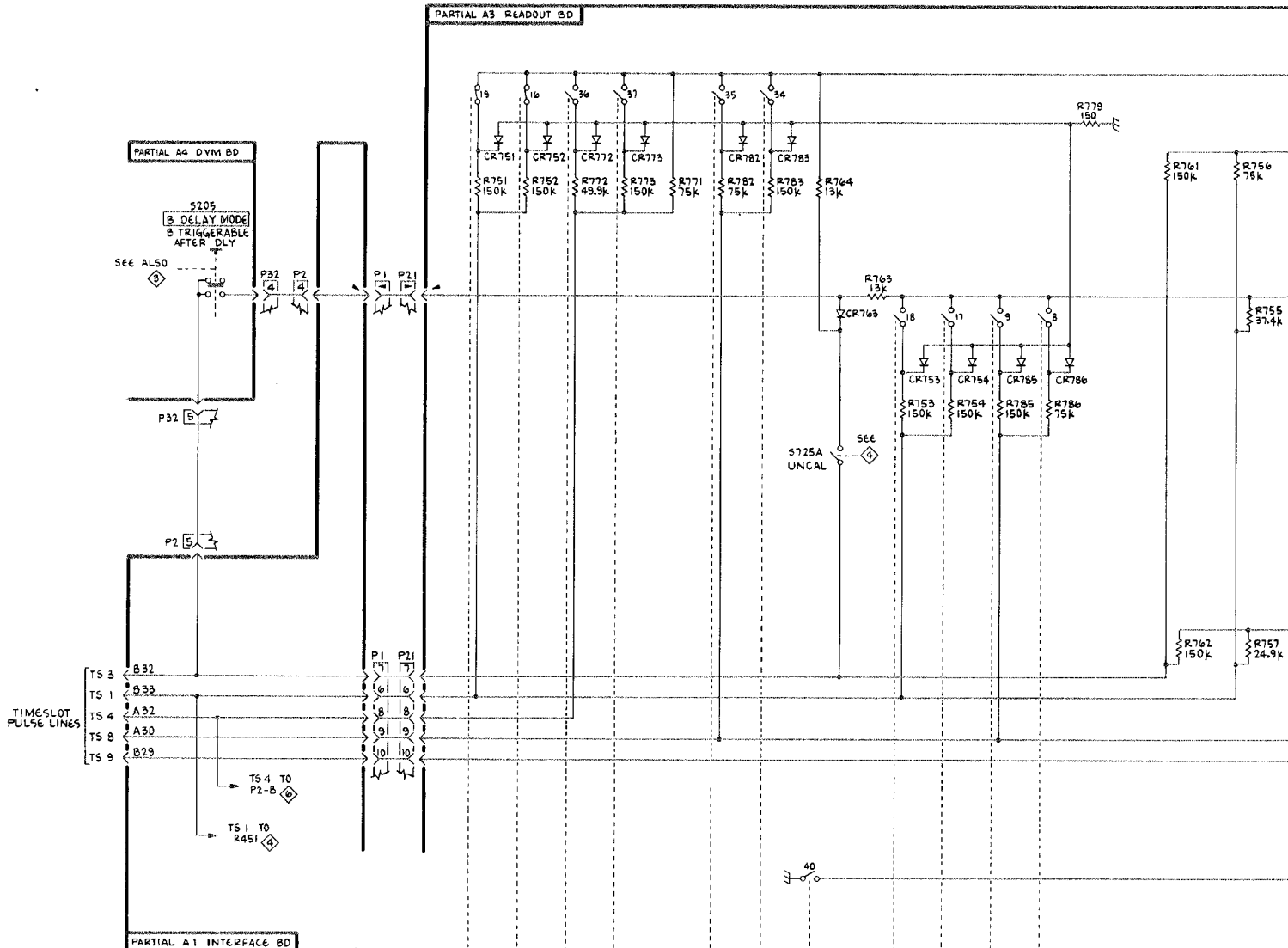


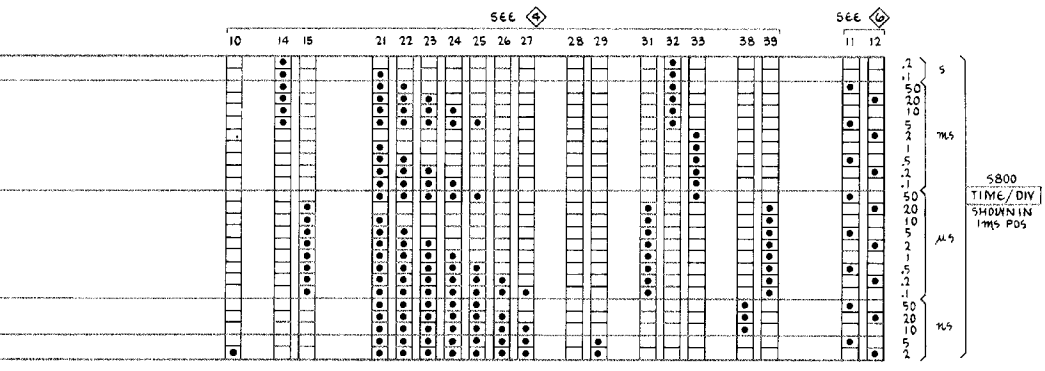
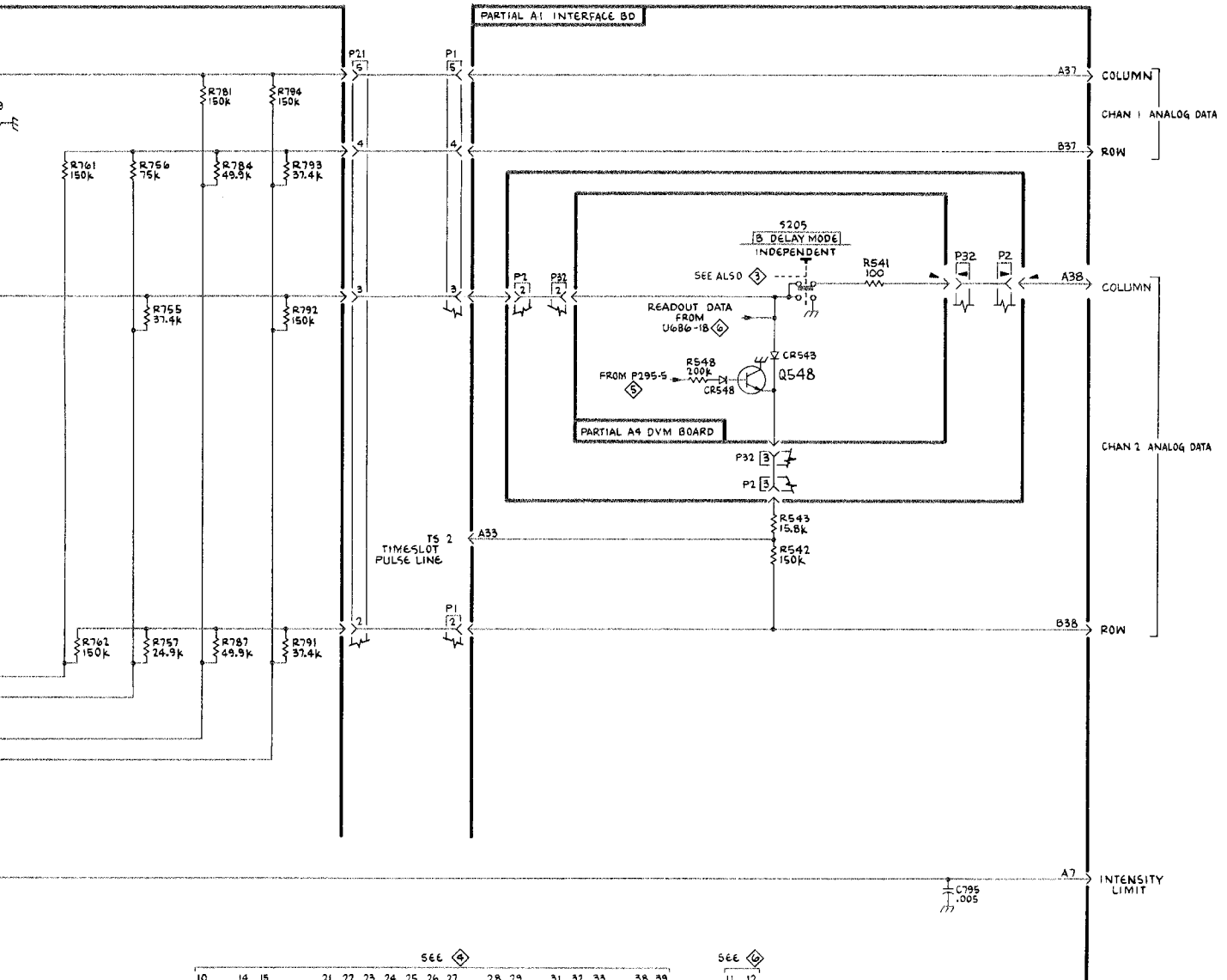


DIGITAL VOLTMETER (DVM)

6

PARTIAL A4 DVM BD

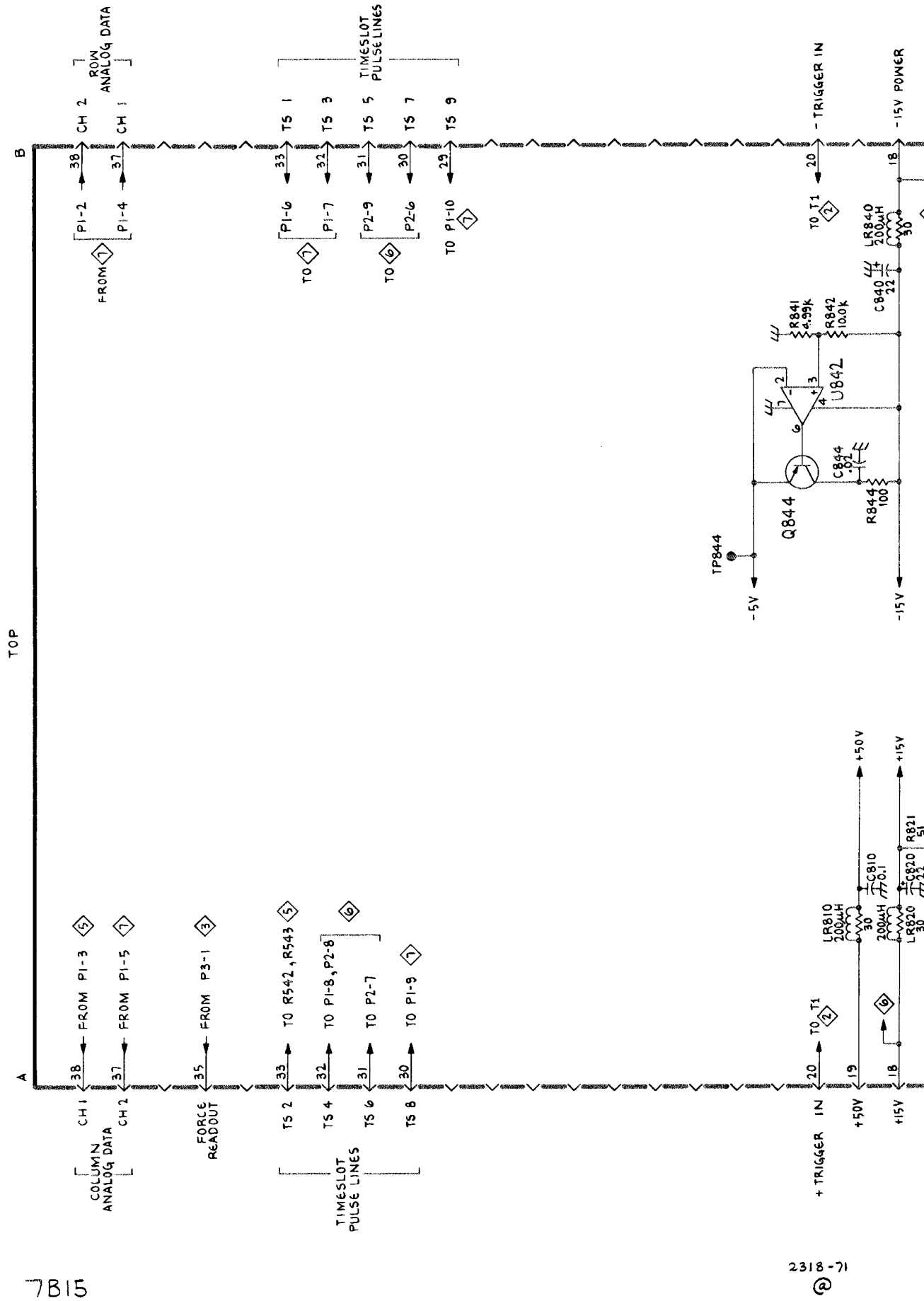




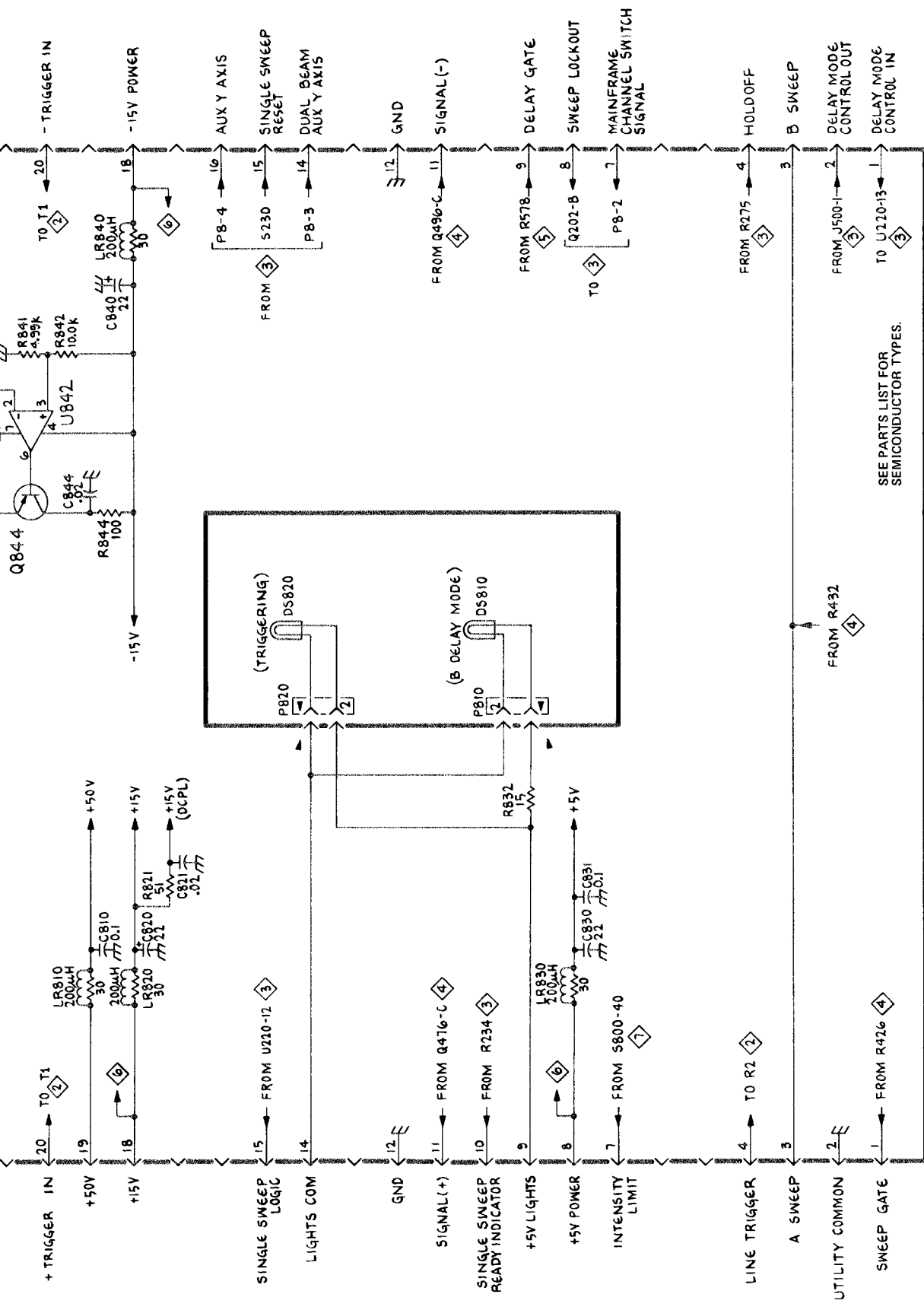
18-70
V JUN 1983

TIME/DIVISION AND READOUT SWITCHING

TIME/DIVISION AND
READOUT SWITCHING



7B15



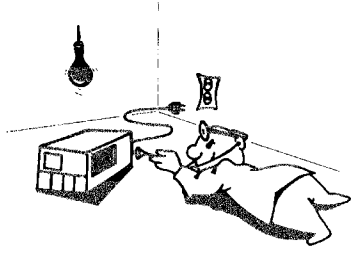
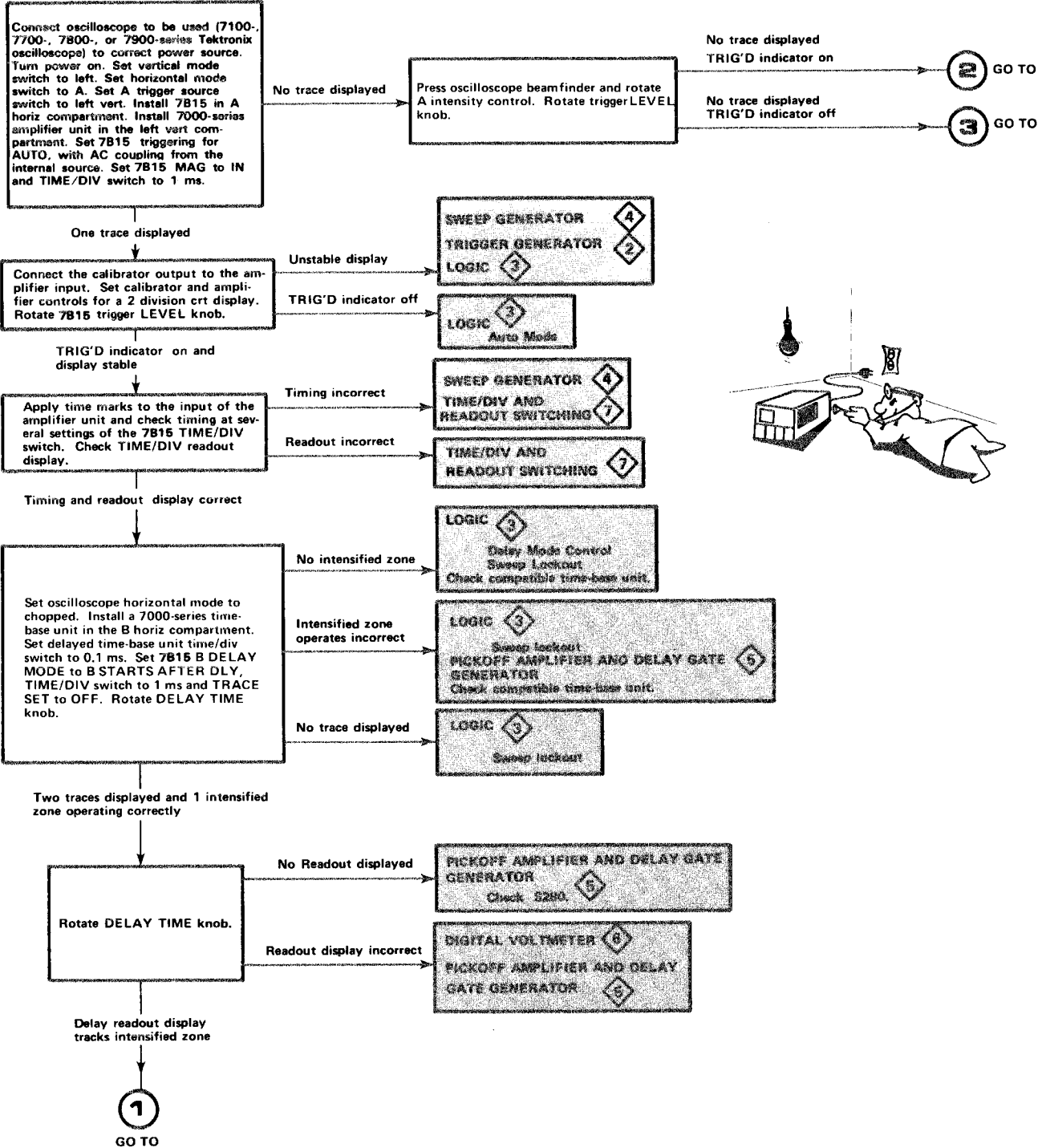
SEE PARTS LIST FOR SEMICONDUCTOR TYPES.

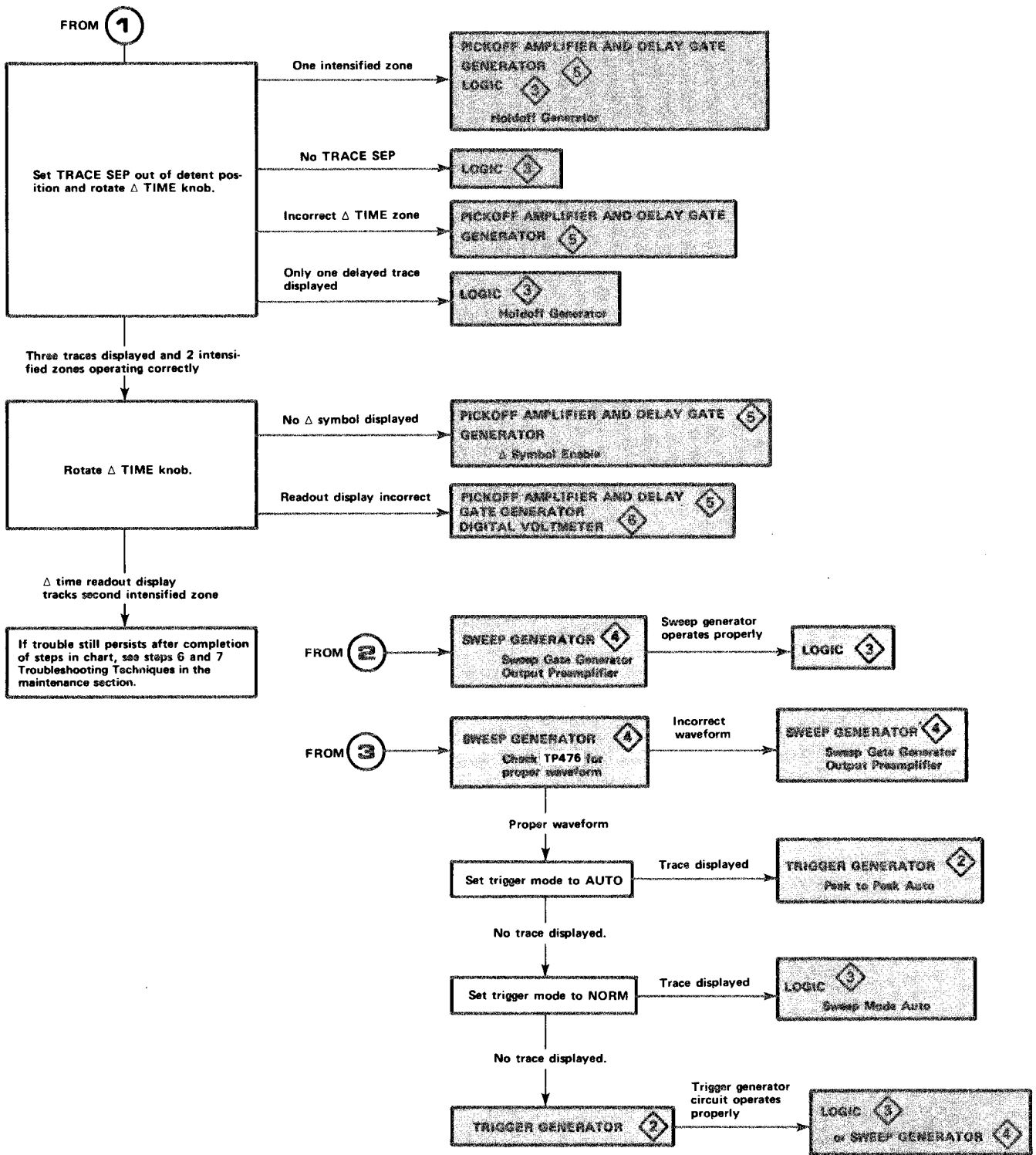
TROUBLESHOOTING CHART INSTRUCTIONS:

1. Proceed down the left side of chart until the instrument does not perform as indicated. Then proceed to the right as the symptom(s) indicates.
2. Follow the path(s) of symptoms until a shaded block is reached. The shaded block indicates the circuit(s) that may cause instrument malfunction. Refer to the Theory of Operation section for a detailed discussion of the circuit(s).

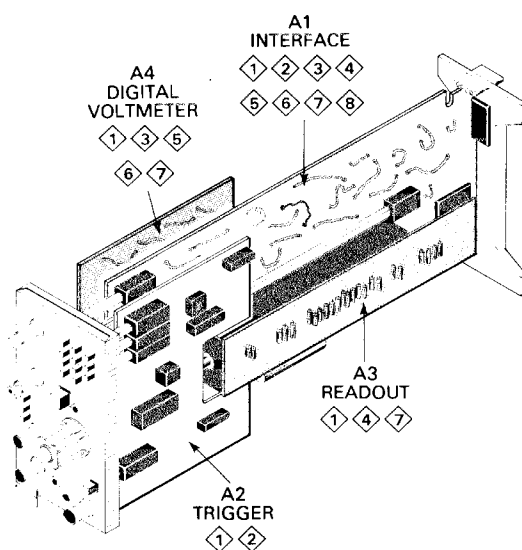
NOTE

The upper case titles in shaded blocks are the same titles as used in the Theory of Operation section and on tabs in the diagrams section.





C1961-2



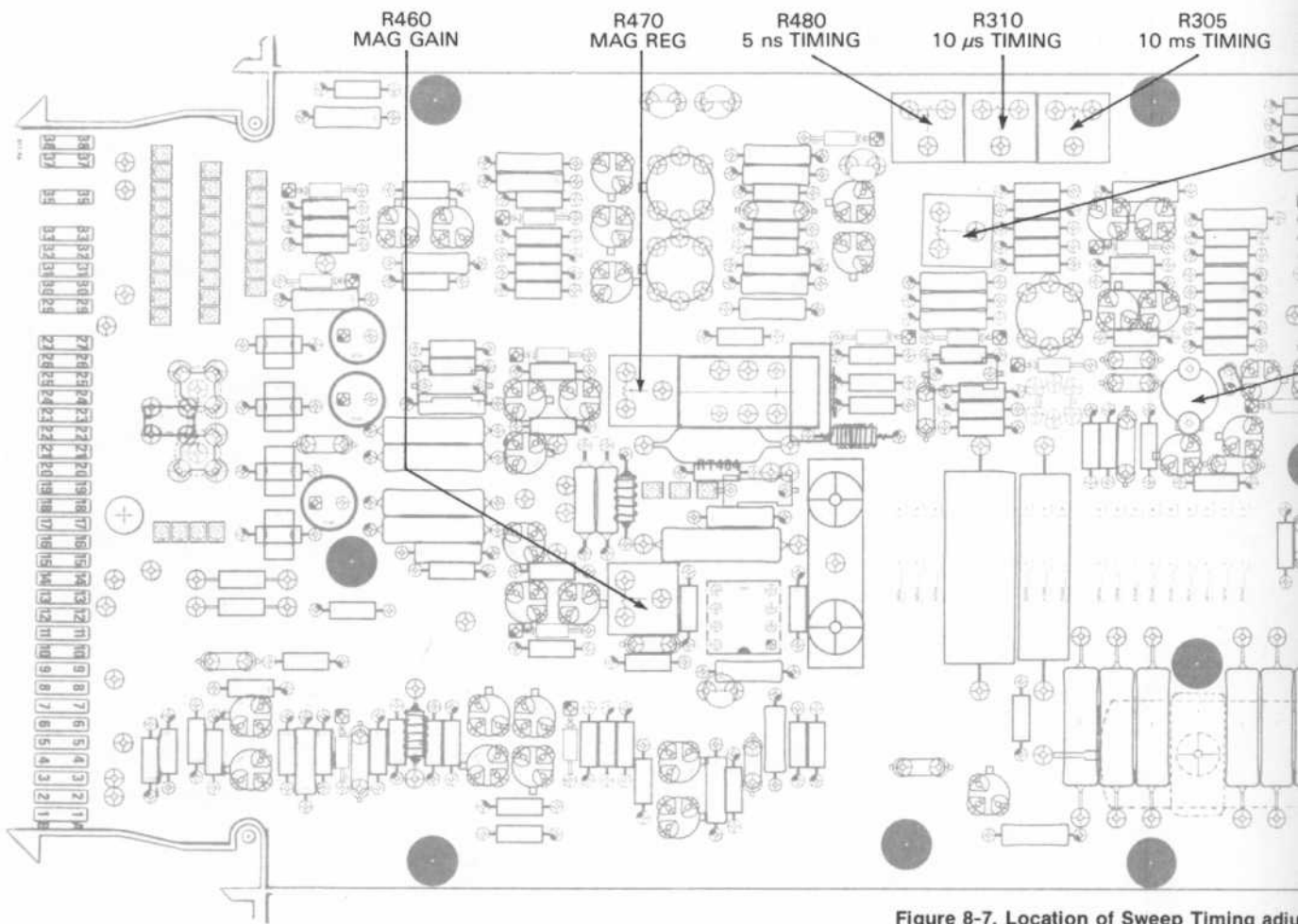


Figure 8-7. Location of Sweep Timing adjustments.

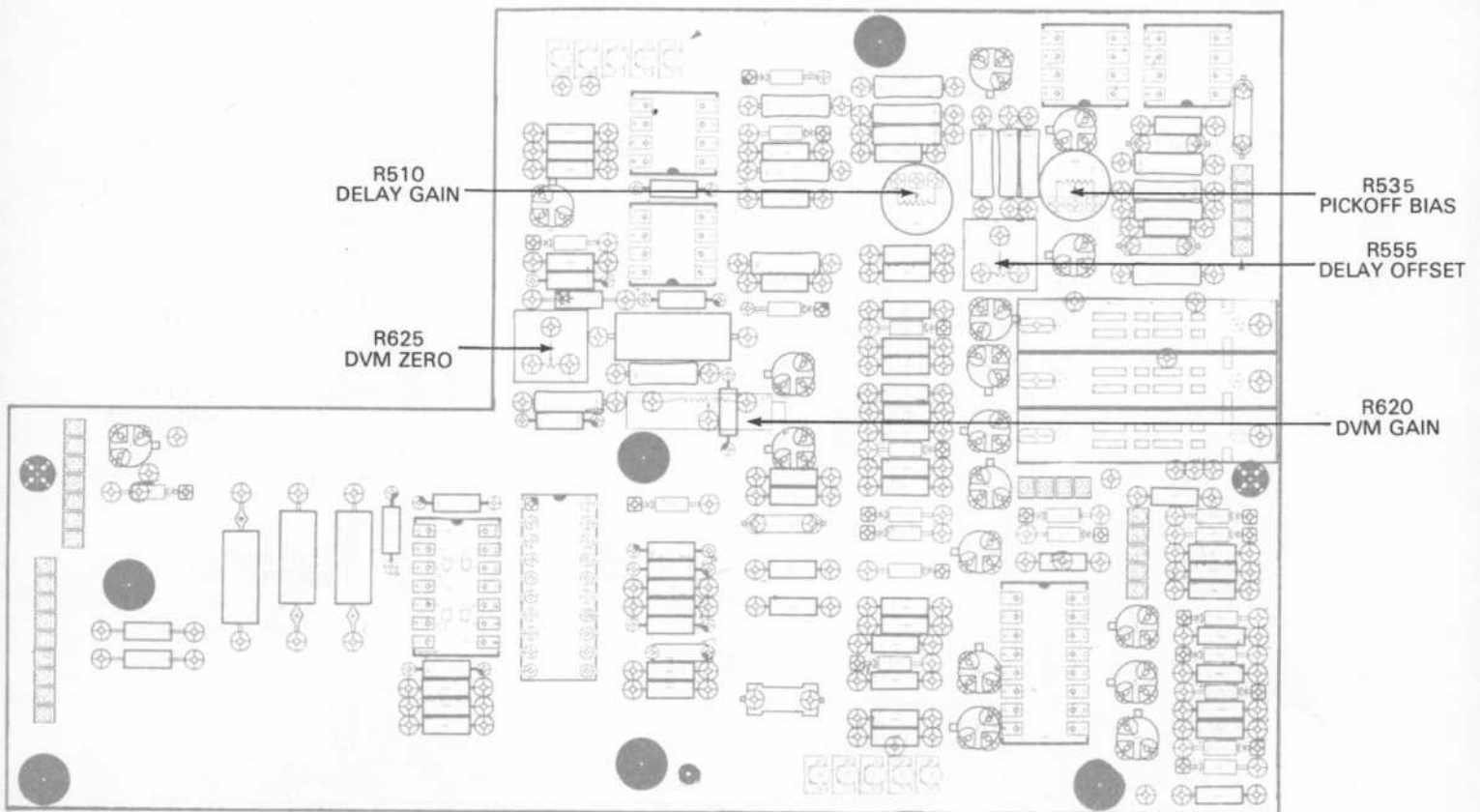
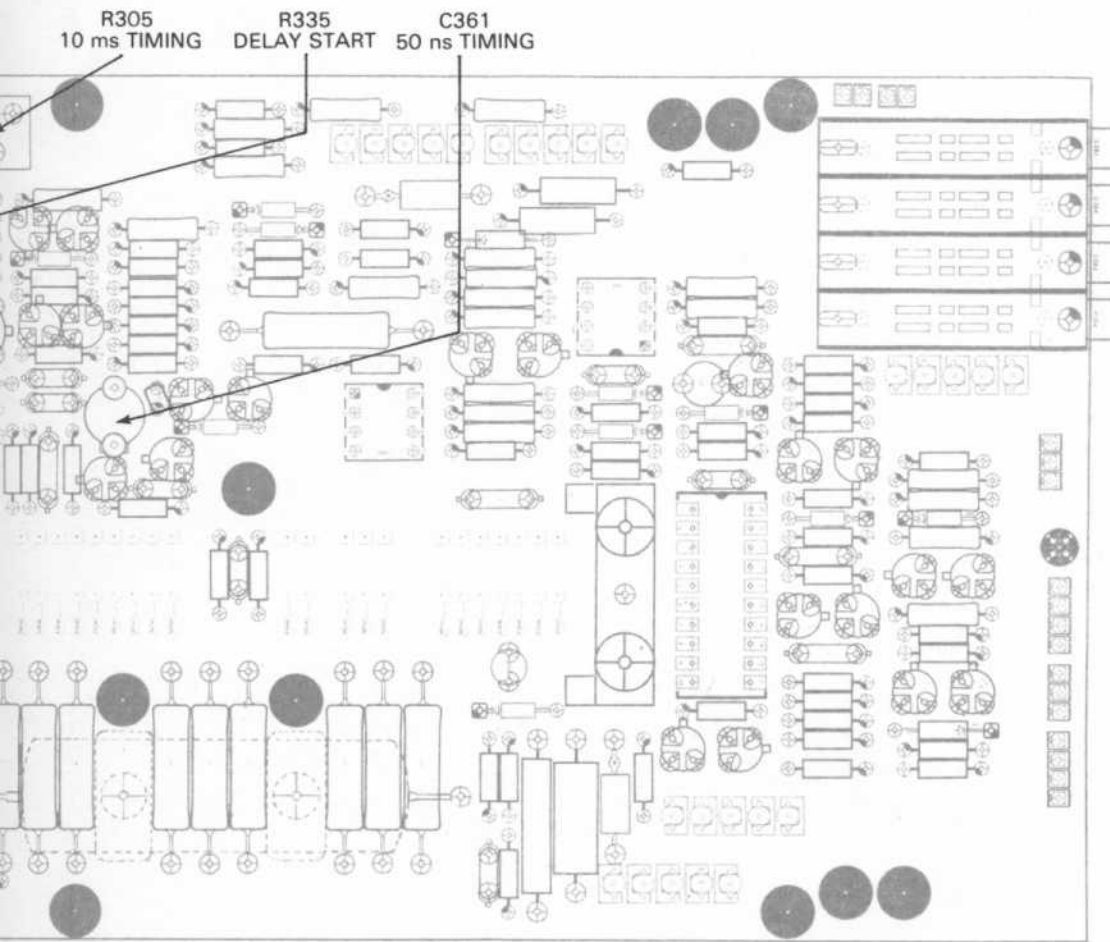


Figure 8-8. Location of Digital Voltmeter adjustments.

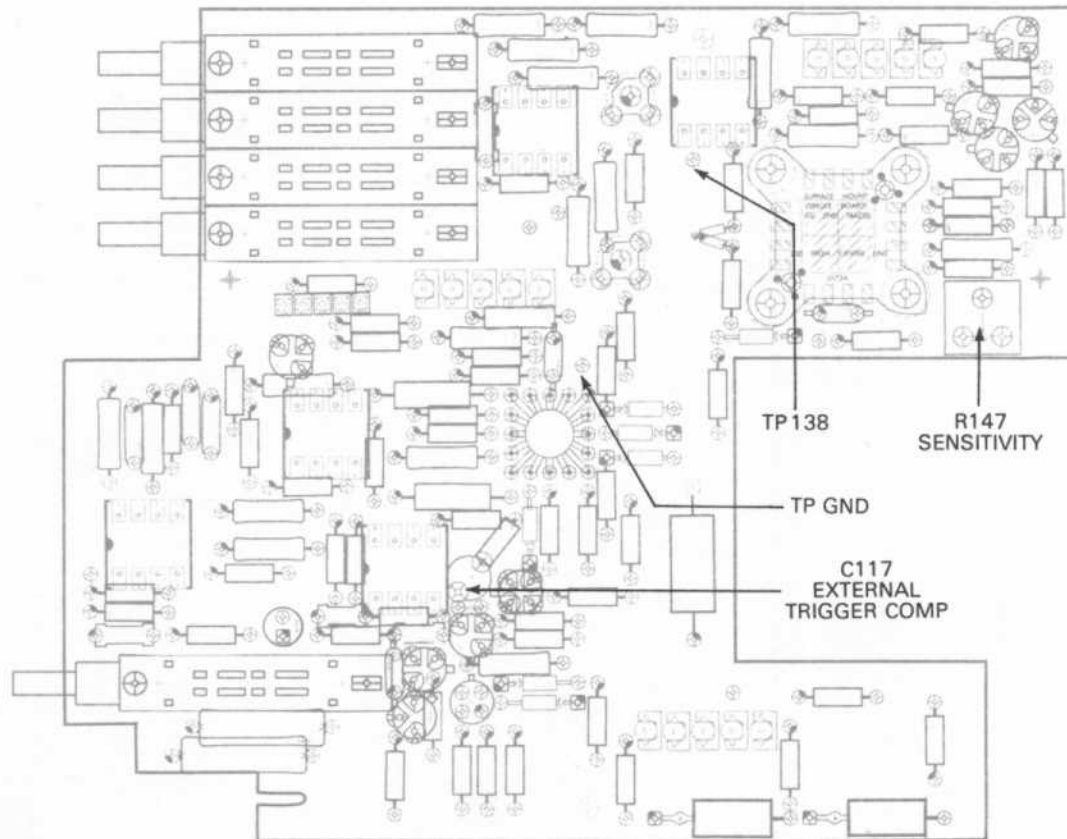
2318-62



Location of Sweep Timing adjustments.

2318-61

- R535
PICKOFF BIAS
- R555
DELAY OFFSET
- R620
DVM GAIN



TEST POINT AND
ADJUSTMENT LOCATIONS

Figure 8-9. Location of Triggering adjustments.

2318-63

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

- X000 Part first added at this serial number
- 00X Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```

1 2 3 4 5
Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
    --- * ---
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
    --- * ---
Parts of Detail Part
Attaching parts for Parts of Detail Part
    --- * ---
    
```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol --- * --- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

"	INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
#	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ACTUATOR	ELECTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	SEMICONDUCTOR
ADPTR	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGN	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVEING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLCP	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDNT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

Replaceable Mechanical Parts—7B15

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000CY	NORTHWEST FASTENER SALES, INC.	7923 SW CIRRUS DRIVE	BEAVERTON, OR 97005
000EX	O'HARA METAL PRODUCT COMPANY	542 BRANNAN STREET	SAN FRANCISCO, CA 94107
01536	CAMCAR DIV OF TEXTRON INC. SEMS PRODUCTS UNIT	1818 CHRISTINA ST.	ROCKFORD, IL 61108
07707	USM CORP., USM FASTENER DIV.	510 RIVER RD.	SHELTON, CT 06484
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
09922	BURNDY CORPORATION	RICHARDS AVENUE	NORWALK, CT 06852
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
22599	ESNA, DIV. OF AMERACE CORPORATION	16150 STAGG STREET	VAN NUYS, CA 91409
24931	SPECIALITY CONNECTOR CO., INC.	2620 ENDRESS PLACE	GREENWOOD, IN 46142
46384	PENN ENGINEERING AND MFG. CORP.	P O BOX 311	DOYLESTOWN, PA 18901
57668	R-OHM CORP.	16931 MILLIKEN AVE.	IRVINE, CA 92713
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
79136	WALDES, KOHINOOR, INC.	47-16 AUSTEL PLACE	LONG ISLAND CITY, NY 11101
79807	WROUGHT WASHER MFG. CO.	2100 S. O BAY ST.	MILWAUKEE, WI 53207
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
87308	N. L. INDUSTRIES, INC., SOUTHERN SCREW DIV.	P. O. BOX 1360	STATESVILLE, NC 28677
92101	SCHULZE MFG, 50 INGOLD RD BURLINGAME, CA 94010		
93907	TEXTRON INC. CAMCAR DIV	600 18TH AVE	ROCKFORD, IL 61101

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont					
1-1	337-1064-04	B010100	B032490	2		SHIELD,ELEC:SIDE PLUG-IN UNITS	80009	337-1064-00
	337-1064-12	B032491		2		SHIELD,ELEC:SIDE FOR PLUG-IN UNIT	80009	337-1064-12
-2	366-1391-02			1		KNOB:GY,0.081 ID,0.28 OD,0.32 L	80009	366-1391-02
	213-0725-00			1		.SETSCREW:3-48 X 0.095 INCH,HEX SOC S	74445	OBD
-3	366-1319-02			1		KNOB:GY,0.79 ID,0.28 OD,0.32 H	80009	366-1319-02
	213-0725-00			1		.SETSCREW:3-48 X 0.095 INCH,HEX SOC S	74445	OBD
-4	366-1077-00			2		KNOB:GRAY	80009	366-1077-00
	213-0153-00			2		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-5	366-1189-00			2		KNOB:GRAY	80009	366-1189-00
	213-0153-00			2		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-6	366-1058-75			1		KNOB:LATCH,MARKED 7B15 ***** (ATTACHING PARTS) *****	80009	366-1058-75
-7	214-1095-00			1		PIN,SPG,SPLIT:0.094 OD X 0.187 INCH LONG ***** (END ATTACHING PARTS) *****	22599	52-022-094-0187
-8	366-1023-01			1		KNOB:GY,0.127 ID X 0.392 OD X 0.	80009	366-1023-01
	213-0153-00			1		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-9	366-1166-00			1		KNOB:RED,0.127 ID X 0.392 OD	80009	366-1166-00
	213-0153-00			1		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-10	366-1103-00			1		KNOB:GRAY	80009	366-1103-00
	213-0153-00			2		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-11	366-1023-01			1		KNOB:GY,0.127 ID X 0.392 OD X 0.	80009	366-1023-01
	213-0153-00			1		.SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-12	366-1257-93			1		PUSH BUTTON: + 10 MAG	80009	366-1257-93
-13	366-1559-00			1		PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-14	426-0681-00			1		FR,PUSH BUTTON:GRAY PLASTIC	80009	426-0681-00
-15	426-1072-00			1		FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
-16	131-1315-01			1		CONN,RCPT,ELEC:BNC,FEMALE	24931	OBD
-17	210-0012-00			1		WASHER,LOCK:INTL,0.384 ID,INTL,0.022 TH	78189	1220-02-00-0541C
-18	105-0076-02	B010100	B031839	1		REL BAR,LATCH:PLUG-IN UNIT	80009	105-0076-02
	105-0076-04	B031840		1		RELEASE BAR,LCH:PLUG-IN UNIT	80009	105-0076-04
-19	214-1280-00			1		SPRING,HLCPS:0.14 OD X 1.126"L,0.16"DIA	80009	214-1280-00
-20	333-1213-12			1		PANEL,FRONT:	80009	333-1213-12
-21	378-0074-00			7		REFLECTOR,LIGHT:PUSH BUTTON	80009	378-0074-00
-22	366-1650-00			7		PUSH BUTTON:CLEAR,0.184 X 0.214 X 8.0 L	80009	360-1650-00
-23	351-0469-00			2		GUIDE,SWITCH:4 BUTTON	80009	351-0469-00
-24	351-0469-01			2		GUIDE,SWITCH:3 BUTTON	80009	351-0469-01
-25	200-0935-00			4		BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-26	352-0157-00			2		LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-27	-----			1		RESISTOR,VAR:(SEE R140 AND S140 REPL) ***** (ATTACHING PARTS) *****		
-28	210-0583-00			1		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
	210-0940-00	B032436		2		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL ***** (END ATTACHING PARTS) *****	79807	OBD
-29	-----			1		RESISTOR,VAR:(SEE R380A AND B REPL) ***** (ATTACHING PARTS) *****		
-30	210-0583-00			2		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-31	210-0046-00			1		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS ***** (END ATTACHING PARTS) *****	78189	1214-05-00-0541C
-32	-----			2		RESISTOR,VAR:(SEE R520 AND R530 REPL) ***** (ATTACHING PARTS) *****		
-33	210-0583-00	B010100	B032435	4		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
	210-0583-00	B032436		2		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-34	210-0046-00	B010100	B032435	2		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
	210-0076-00	B032436		2		WASHER,LOCK:0.255 ID SPLIT,0.065 THK,ST ***** (END ATTACHING PARTS) *****	80009	210-0076-00
-35	-----			1		RESISTOR,VAR:(SEE R210 REPL) ***** (ATTACHING PARTS) *****		
-36	210-0583-00			2		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-38	210-0046-00			3		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS ***** (END ATTACHING PARTS) *****	78189	1214-05-00-0541C
	-----			1		RESISTOR,VAR:(SEE R295 REPL) ***** (ATTACHING PARTS) *****		
-39	210-0583-00			1		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-40	210-0046-00	B010100	B032435	1		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
	210-0076-00	B032436		1		WASHER,LOCK:0.255 ID SPLIT,0.065 THK,ST ***** (END ATTACHING PARTS) *****	80009	210-0076-00
-41	-----			1		RESISTOR,VAR:(SEE R300 REPL)		
-42	210-0046-00			1		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C

Replaceable Mechanical Parts—7B15

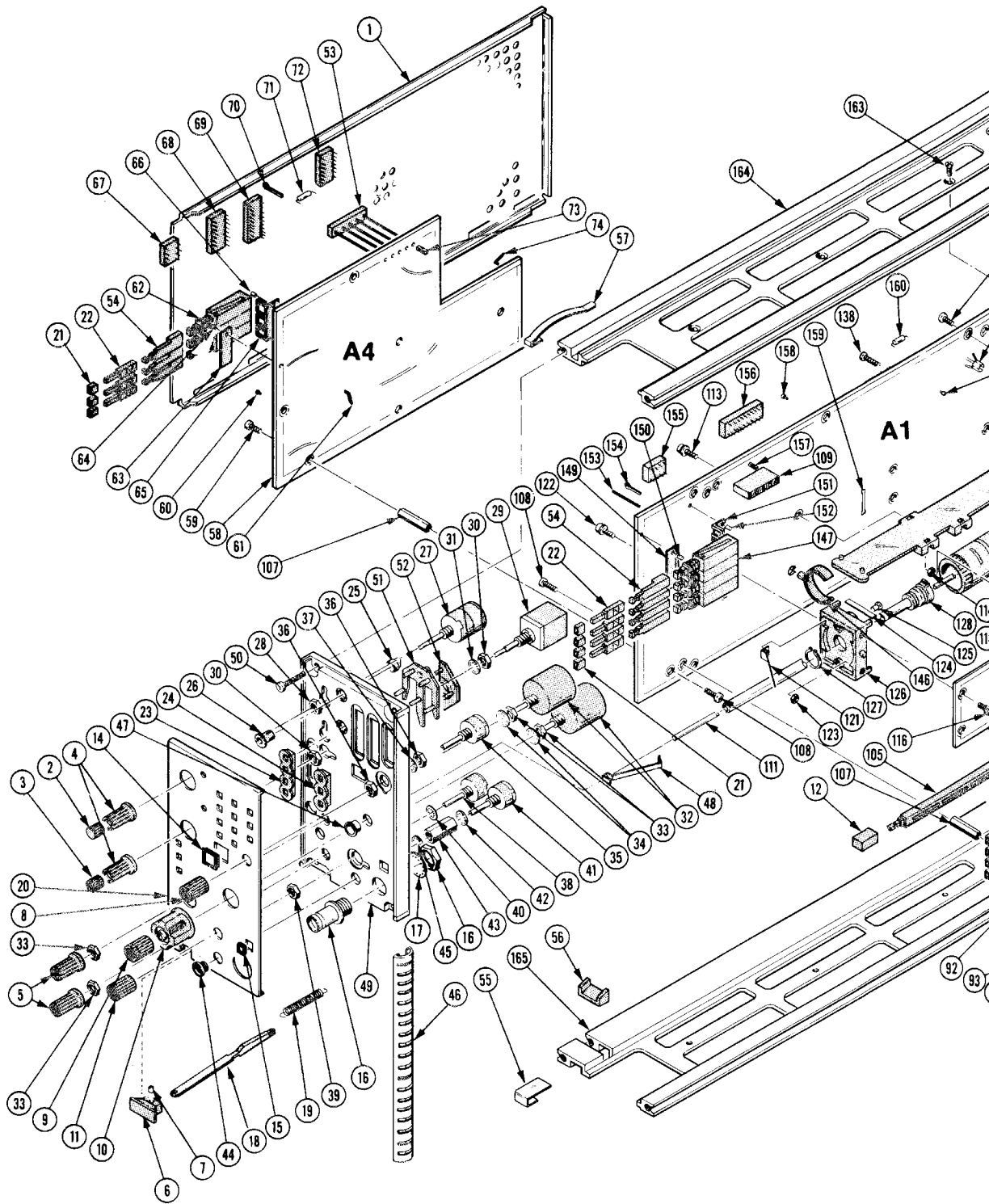
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-43	129-0290-00			1		POST,ELEC-MECH:0.635 INCH LONG,HEX ***** (ATTACHING PARTS) *****	80009	129-0290-00
-44	358-0342-00			1		BSHG,MACH,THD:0.25 X 32 X 0.352 INCH LONG	80009	358-0342-00
-45	210-0046-00			1		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS ***** (END ATTACHING PARTS) *****	78189	1214-05-00-0541C
-46	348-0235-00			2		SHLD GSKT,ELEC:4.734 INCH LONG	92101	OBD
-47	348-0067-00			1		GROMMET,PLASTIC:0.312 INCH DIA	80009	348-0067-00
-48	131-1266-00			1		CONTACT,ELEC:GROUND SPRING	80009	131-1266-00
-49	386-3256-00			1		SUBPANEL,FRONT: ***** (ATTACHING PARTS) *****	80009	386-3256-00
-50	213-0192-00	B010100	B021149	4		SCR,TPG,THD FOR:6-32 X 0.50 INCH,PNH STL	87308	OBD
	213-0793-00	B021150		4		SCREW,TPG,TF:6-32 X 0.4375,TAPTITE,FIL ***** (END ATTACHING PARTS) *****	93907	OBD
-51	386-3440-00			1		LT CNDCT,PB ILL:3 BUTTON,7.5 MM SPACING	80009	386-3440-00
-52	386-3439-00			1		LT CNDCT,PB ILL:10 BUTTON,7.5MM SPACING	80009	386-3439-00
-53	131-1820-00			5		CONNECTOR,PLUG,:CKT CD,5 MALE	22526	65306-002
-54	384-1382-00			7		EXTENSION SHAFT:1.09 INCH LONG	80009	384-1382-00
-55	214-1054-00			1		SPRING,FLAT:0.825 X 0.322,SST	80009	214-1054-00
-56	105-0075-00			1		BOLT,LATCH:7A & 7B SER PL-IN	80009	105-0075-00
-57	214-1061-00			1		SPRING,GROUND:FLAT	80009	214-1061-00
-58	-----			1		CKT BOARD ASSY:DVM(SEE A4 REPL) ***** (ATTACHING PARTS) *****		
-59	211-0008-00			3		SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ ***** (END ATTACHING PARTS) *****	83385	OBD
	-----			-		CKT BOARD ASSY INCLUDES:		
-60	136-0252-07			105		.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-61	131-0608-00			10		.TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-62	263-0015-01			1		.SWITCH PB ASSY:3 LATCHING,7.5 MM,5 CONTACT	80009	263-0015-01
-63	343-0495-03			5		.CLIP,SWITCH:FRONT,7.5 MM,3 UNIT ***** (ATTACHING PARTS) *****	80009	343-0495-03
-64	210-3033-00			3		.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG ***** (END ATTACHING PARTS) *****	07707	SE-25
-65	343-0499-03	B010100	B021609	1		.CLIP,SWITCH:7.5 MM,4 UNIT	80009	343-0499-03
	343-0499-12	B021610		1		.CLIP,SWITCH:REAR,7.5MM X 3 UNIT ***** (ATTACHING PARTS) *****	80009	343-0499-12
-66	210-3033-00			3		.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG ***** (END ATTACHING PARTS) *****	07707	SE-25
-67	136-0514-00			3		.SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
-68	136-0260-02			1		.SKT,PL-IN ELEC:MICROCIRCUIT,16 DIP,LOW CL	71785	133-51-92-008
-69	136-0634-00	B010100	B031889	1		.SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
	136-0752-00	B031890		1		.SKT,PL-IN ELEC:MICROCIRCUIT,20 DIP	09922	DILB20P-108
-70	214-0579-00			1		.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-71	131-0566-00			1		.BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200EO
-72	136-0269-02			3		.SKT,PL-IN ELEC:MICROCIRCUIT,14 DIP,LOW CL	73803	CS9002-14
-73	136-0263-04			10		.SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
-74	131-0589-00			22		.TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-75	-----			1		CKT BOARD ASSY:TRIGGER(SEE A2 REPL) ***** (ATTACHING PARTS) *****		
-76	211-0008-00			2		SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ ***** (END ATTACHING PARTS) *****	83385	OBD
	-----			-		CKT BOARD ASSY INCLUDES:		
-77	378-0074-00			7		.REFLECTOR,LIGHT:PUSH BUTTON	80009	378-0074-00
-78	366-1650-00			7		.PUSH BUTTON:CLEAR,0.184 X 0.214 X 8.0 L	80009	360-1650-00
-79	263-0016-03			1		.SWITCH,PB ASSY:4 CATCH,7.5MM,6 CONTACTS	80009	263-0016-03
-80	263-0015-00			2		.SWITCH PB ASSY:3 LATCHING,7.5 MM	80009	263-0015-00
-81	343-0495-04			1		.CLIP,SWITCH:FRONT,7.5 MM,4 UNIT ***** (ATTACHING PARTS) *****	80009	343-0495-04
-82	210-3050-00			3		.EYELET,METALLIC:0.218 L X 0.059 OD,BRS	07707	SE-27
	210-3033-00			1		.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG ***** (END ATTACHING PARTS) *****	07707	SE-25
-83	343-0499-04	B010100	B021609	1		.CLIP,SWITCH:REAR,7.5MM X 4 UNIT	80009	343-0499-04
	343-0499-13	B021610		1		.CLIP,SWITCH:7.5MM X 4 UNIT ***** (ATTACHING PARTS) *****	80009	343-0499-13
-84	210-3050-00			3		.EYELET,METALLIC:0.218 L X 0.059 OD,BRS	07707	SE-27
	210-3033-00			1		.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG ***** (END ATTACHING PARTS) *****	07707	SE-25

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
1-85	343-0495-03			1						.CLIP,SWITCH:FRONT,7.5 MM,3 UNIT	80009	343-0495-03
-86	343-0499-03	B010100	B021609	1						.CLIP,SWITCH:7.5 MM,4 UNIT	80009	343-0499-03
	343-0499-12	B021610		1						.CLIP,SWITCH:REAR,7.5MM X 3 UNIT	80009	343-0499-12
-87	263-0010-02			1						.SWITCH PB ASSY:1 PUSH,7.5MM,1 CONTACT	80009	263-0010-02
-88	343-0495-01			1						.CLIP,SWITCH:FRONT,7.5 MM,1 UNIT *****ATTACHING PARTS*****	80009	343-0495-01
-89	210-3033-00			1						.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG *****END ATTACHING PARTS*****	07707	SE-25
-90	343-0499-01			1						.CLIP,SWITCH:REAR,7.5 MM,1 UNIT *****ATTACHING PARTS*****	80009	343-0499-01
-91	210-3033-00			1						.EYELET,METALLIC:0.59 OD X 0.156 INCH LONG *****END ATTACHING PARTS*****	07707	SE-25
-92	131-0589-00			5						.TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-93	131-1003-00			2						.CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-94	136-0252-07			50						.SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-95	426-1337-00			1						.FRAME,MICROCKT:1.22 CM *****ATTACHING PARTS*****	80009	426-1337-00
-96	211-0259-00			4						.SCR,ASSEM WSHR:2-56 X 0.437,PNH,STL CD PL	78189	OBD
-97	220-0797-00			4						.NUT,CAPTIVE:2-56 X 0.218 DIA,STL CD PL *****END ATTACHING PARTS*****	46384	KF2-256
-98	131-1923-00			1						.CONTACT,ELEC:MICROCIRCUIT	80009	131-1923-00
-99	214-0579-00			3						.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-100	136-0514-00	B010100	B031799	4						.SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
-101	136-0263-04			14						.SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
-102	386-1402-00			1						PANEL,REAR: *****ATTACHING PARTS*****	80009	386-1402-00
-103	213-0192-00	B010100	B021149	4						SCR,TPG,THD FOR:6-32 X 0.50 INCH,PNH STL	87308	OBD
	213-0793-00	B021150		4						SCREW,TPG,TF:6-32 X 0.4375,TAPTITE,FIL	93907	OBD
-104	361-0326-00			1						SPACER,SLEEVE:0.18 ID X 0.25 OD X 0.10"L *****END ATTACHING PARTS*****	80009	361-0326-00
-105	384-1100-00			1						EXTENSION SHAFT:0.13 SQ X 6.215" LONG,PLST	80009	384-1100-00
-106	384-1292-00			1						EXTENSION SHAFT:2.417 INCH LONG,PLASTIC	80009	384-1292-00
-107	129-0198-00			5						POST,ELEC-MECH:0.188 HEX X 0.74 INCH L,BRS *****ATTACHING PARTS*****	80009	129-0198-00
-108	211-0008-00			5						SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ *****END ATTACHING PARTS*****	83385	OBD
-109	204-0683-00			5						BODY,CONN,RCPT:5 FEMALE POSN CONTACT	22526	65058-061
	672-0650-00			1						CKT BOARD ASSY:TIME/CM *****ATTACHING PARTS*****	80009	672-0650-00
-110	211-0008-00			6						SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ *****END ATTACHING PARTS*****	83385	OBD
	-----			-						CKT BOARD ASSY INCLUDES:		
-111	384-1417-00			1						.EXTENSION SHAFT:10.275 INCH LONG,PLASTIC	80009	384-1417-00
-112	200-1362-00			2						.COVER,CAM SW:BLACK PLASTIC *****ATTACHING PARTS*****	80009	200-1362-00
-113	211-0244-00	B010100	B021199	3						.SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	OBD
	211-0292-00	B021200		3						.SCR,ASSEM WSHR:4-40 X 0.29,BRS NI PL	78189	OBD
-114	210-0406-00			3						.NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS *****END ATTACHING PARTS*****	73743	12161-50
-115	-----			1						.CKT BOARD ASSY:READOUT(SEE A3 REPL) *****ATTACHING PARTS*****		
-116	211-0678-00			4						.SCR,ASSEM WSHR:4-40 X 0.281 L,PNH STEEL	01536	OBD
-117	211-0008-00			1						.SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ *****END ATTACHING PARTS*****	83385	OBD
	-----			-						CKT BOARD ASSY INCLUDES:		
-118	131-0604-00			13						..CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-119	136-0263-04			3						..SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PI	22526	75377-001
-120	131-0589-00			10						..TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-121	131-0963-00			2						.CONTACT,ELEC:GROUNDING	000EX	OBD
	263-1166-00			1						..SW,CAM,ACTR AS:TIME/CM *****ATTACHING PARTS*****	80009	263-1166-00
-122	211-0207-00			4						.SCR,ASSEM WSHR:4-40 X 0.312 DOUBLE SEMS *****END ATTACHING PARTS*****	83385	OBD
-123	210-0406-00			2						..NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-124	214-1139-00			2						..SPRING,FLAT:0.885 X 0.156 CU BE GLD CLR	80009	214-1139-00

Replaceable Mechanical Parts---7B15

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont									
1-125	214-1752-00			2						..ROLLER,DETENT:	80009	214-1752-00
-126	401-0180-00			1						..BEARING,CAM SW:FRONT & REAR ..***** (ATTACHING PARTS)*****	80009	401-0180-00
-127	354-0390-00			2						..RING,RETAINING:0.338 ID X 0.025" THK,STL ..***** (END ATTACHING PARTS)*****	79136	5100-37MD
-128	384-0878-00			1						..SHAFT,CAM SW:W/DRIVER	80009	384-0878-00
-129	105-0755-00			1						..ACTUATOR,CAM SW:TIME/CM,DRUM TYPE	80009	105-0755-00
-130	210-0406-00			2						..NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	12161-50
-131	401-0178-01			1						..BEARING,CAM SW:CENTER/REAR	80009	401-0178-01
-132	-----			1						..SWITCH,PUSH:(SEE S460 REPL)		
-133	361-0411-00			2						..SPACER,PUSH SW:0.13 W X 0.375 INCH L,PLST	71590	J64285-00
-134	352-0274-00			1						..HOLDER,TERMINAL:FOR 8 SQUARE PINS	80009	352-0274-00
-135	131-0593-00			3						..CONTACT,ELEC:1.15 INCH LONG	22526	47354
-136	351-0180-00			1						..SLIDE,GUIDE:SWITCH ACTUATOR	80009	351-0180-00
-137	129-0570-00			1						..POST,ELEC-MECH:0.188 HEX X 0.976" LONG,BRS ..***** (ATTACHING PARTS)*****	80009	129-0570-00
-138	211-0008-00			1						..SCREW,MACHINE:4-40 X 0.250,PNH,STL,POZ ..***** (END ATTACHING PARTS)*****	83385	OBD
-139	214-1136-00			1						..ACTUATOR,SL SW:DUAL DPST	80009	214-1136-00
-140	214-1190-00			1						..CPLG,SHAFT,RGD:0.125 OD TO 0.125 OD,AL	80009	214-1190-00
-141	-----			1						..RESISTOR,VAR:(SEE R725 AND S725 REPL)		
-142	210-0583-00			1						..NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-143	210-0046-00			1						..WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
-144	407-0803-00			1						..BRACKET,ELEC SW:BRASS	80009	407-0803-00
-145	136-0252-04			2						..SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-146	352-0196-00			2						..HLDR,ELEK CMPNT:PNL MT 0.531 ID MOLD PLST	80009	352-0196-00
-147	263-0016-01			1						..SWITCH PB ASSY:3 LCH & 1 CANC,7.5MM,5 CON	80009	263-0016-01
-148	-----			1						..CKT BOARD ASSY:INTERFACE(SEE A1 REPL)		
-149	343-0495-04			1						..CLIP,SWITCH:FRONT,7.5 MM,4 UNIT ..***** (ATTACHING PARTS)*****	80009	343-0495-04
-150	210-3033-00			4						..EYELET,METALLIC:0.59 OD X 0.156 INCH LON ..***** (END ATTACHING PARTS)*****	07707	SE-25
-151	343-0499-04	B010100	B021609	1						..CLIP,SWITCH:REAR,7.5MM X 4 UNIT	80009	343-0499-04
	343-0499-13	B021610		1						..CLIP,SWITCH:7.5MM X 4 UNIT ..***** (ATTACHING PARTS)*****	80009	343-0499-13
-152	210-3033-00			4						..EYELET,METALLIC:0.59 OD X 0.156 INCH LON ..***** (END ATTACHING PARTS)*****	07707	SE-25
-153	131-0608-00			48						..TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-154	214-0579-00			6						..TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-155	136-0514-00	B010100	B031829	3						..SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
	136-0752-00	B031830		1						..SKT,PL-IN ELEC:MICROCIRCUIT,20 DIP	09922	DILB20P-108
-156	136-0634-00			1						..SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
-157	136-0263-04			25						..SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PI	22526	75377-001
-158	136-0252-07			150						..SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-159	131-0604-00			27						..CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-160	131-0566-00			5						..BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
-161	131-1003-00			2						..CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-162	220-0547-00			6						NUT,BLOCK:0.38 X 0.25 X 0.282 INCH OA ..***** (ATTACHING PARTS)*****	80009	220-0547-00
-163	211-0105-00			6						SCREW,MACHINE:4-40 X 0.188,100 DEG,FLH ST ..***** (END ATTACHING PARTS)*****	83385	OBD
-164	426-0505-11			1						FR SECT,PLUG-IN:TOP	80009	426-0505-11
-165	426-0499-11			1						FR SECT,PLUG-IN:BOTTOM	80009	426-0499-11
	198-3826-00			1						WIRE SET,ELEC:	80009	198-3826-00
-166	131-0707-00			63						..CONNECTOR,TERM:22-26 AWG,BRS & CU BE GOLD	22526	47439
-167	352-0161-05			1						..CONN BODY,PL,EL:3 WIRE GREEN	80009	352-0161-05
-168	352-0162-05			2						..CONN BODY,PL,EL:4 WIRE GREEN	80009	352-0162-05
-169	352-0165-06			2						..CONN BODY,PL,EL:7 WIRE BLUE	80009	352-0165-06
-170	352-0167-07			2						..CONN BODY,PL,EL:9 WIRE VIOLET	80009	352-0167-07
-171	352-0168-00			2						..CONN BODY,PL,EL:10 WIRE BLACK	80009	352-0168-00
-172	175-0826-00			FT						..WIRE,ELECTRICAL:3 WIRE RIBBON	80009	175-0826-00
-173	175-0827-00			FT						..CABLE,SP,ELEC:4,26 AWG,STRD.PVC JKT,RBN	08261	SS04267(1061)0C
-174	175-0830-00			FT						..WIRE,ELECTRICAL:7 WIRE RIBBON	08261	SS-0726-710610C
-175	175-0832-00			FT						..WIRE,ELECTRICAL:9 WIRE RIBBON	08261	SS-0926(1061)0C
-176	175-0833-00			FT						..WIRE,ELECTRICAL:10 WIRE RIBBON	08261	SS-1026-7

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty	1 2 3 4 5	Name & Description	Mfr	
		Eff	Dscont				Code	Mfr Part Number
1-177	210-0774-00			6		.EYELET,METALLIC:0.152 OD X 0.245 INCH L,B	80009	210-0774-00
-178	210-0775-00			6		.EYELET,METALLIC:0.126 OD X 0.23 INCH L,BR	80009	210-0775-00
	198-2479-00			1		WIRE SET ELEC:	80009	198-2479-00
	131-0707-00			30		.CONNECTOR,TERM:22-26 AWG,BRS & CU BE GOLD	22526	47439
-179	352-0169-00			1		.HLDR,TERM CONN:2 WIRE BLACK	80009	352-0169-00
	352-0161-07			1		.CONN BODY,PL,EL:3 WIRE VIOLET	80009	352-0161-07
	352-0162-00			1		.HLDR,TERM CONN:4 WIRE BLACK	80009	352-0162-00
	352-0162-04			1		.CONN BODY,PL,EL:4 WIRE YELLOW	80009	352-0162-04
-180	352-0163-04			1		.CONN BODY,PL,EL:5 WIRE YELLOW	80009	352-0163-04
	352-0163-05			1		.CONN BODY,PL,EL:5 WIRE GREEN	80009	352-0163-05
	352-0163-06			1		.CONN BODY,PL,EL:5 WIRE BLUE	80009	352-0163-06
-181	175-0825-00			FT		.WIRE,ELECTRICAL:2 WIRE RIBBON	80009	175-0825-00
	175-0826-00			FT		.WIRE,ELECTRICAL:3 WIRE RIBBON	80009	175-0826-00
	175-0827-00			FT		.CABLE,SP,ELEC:4,26 AWG,STRD,PVC JKT,RBN	08261	SS04267(1061)0C
-182	175-0828-00			FT		.WIRE,ELECTRICAL:5 WIRE RIBBON	08261	SS-0526-710610C
-183	198-4156-00			1		WIRE SET,ELEC:	80009	198-4156-00



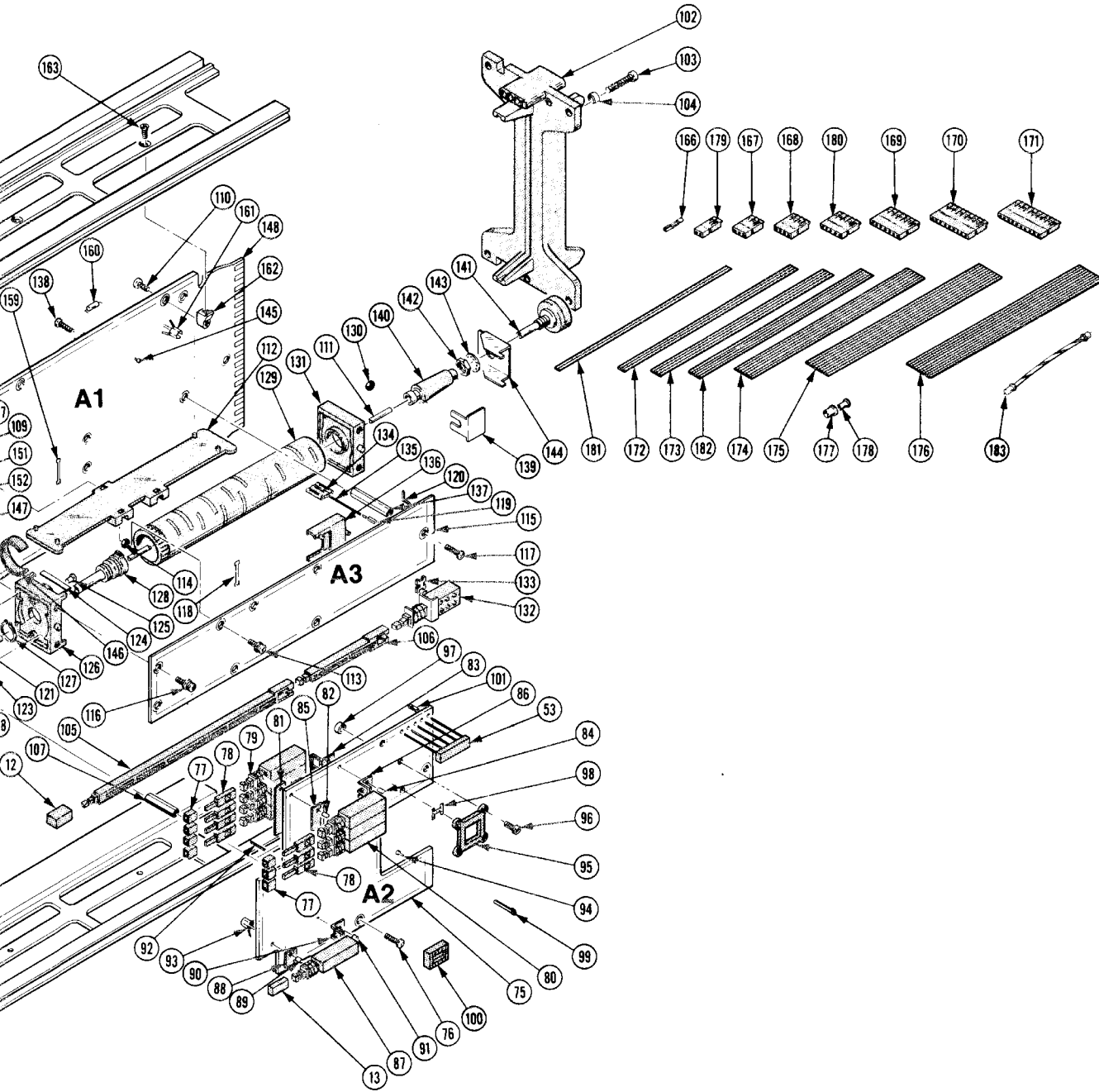


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
STANDARD ACCESSORIES												
	070-2318-00			1						MANUAL, TECH:INSTRUCTION	80009	070-2318-00
	070-2319-00			1						MANUAL, TECH:OPERATORS	80009	070-2319-00

ACCESSORIES