INSTRUCTION MANUAL

Serial Number ____________

TYPE 11B1 TIME BASE

Tektronix, Inc.

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070-0424-01

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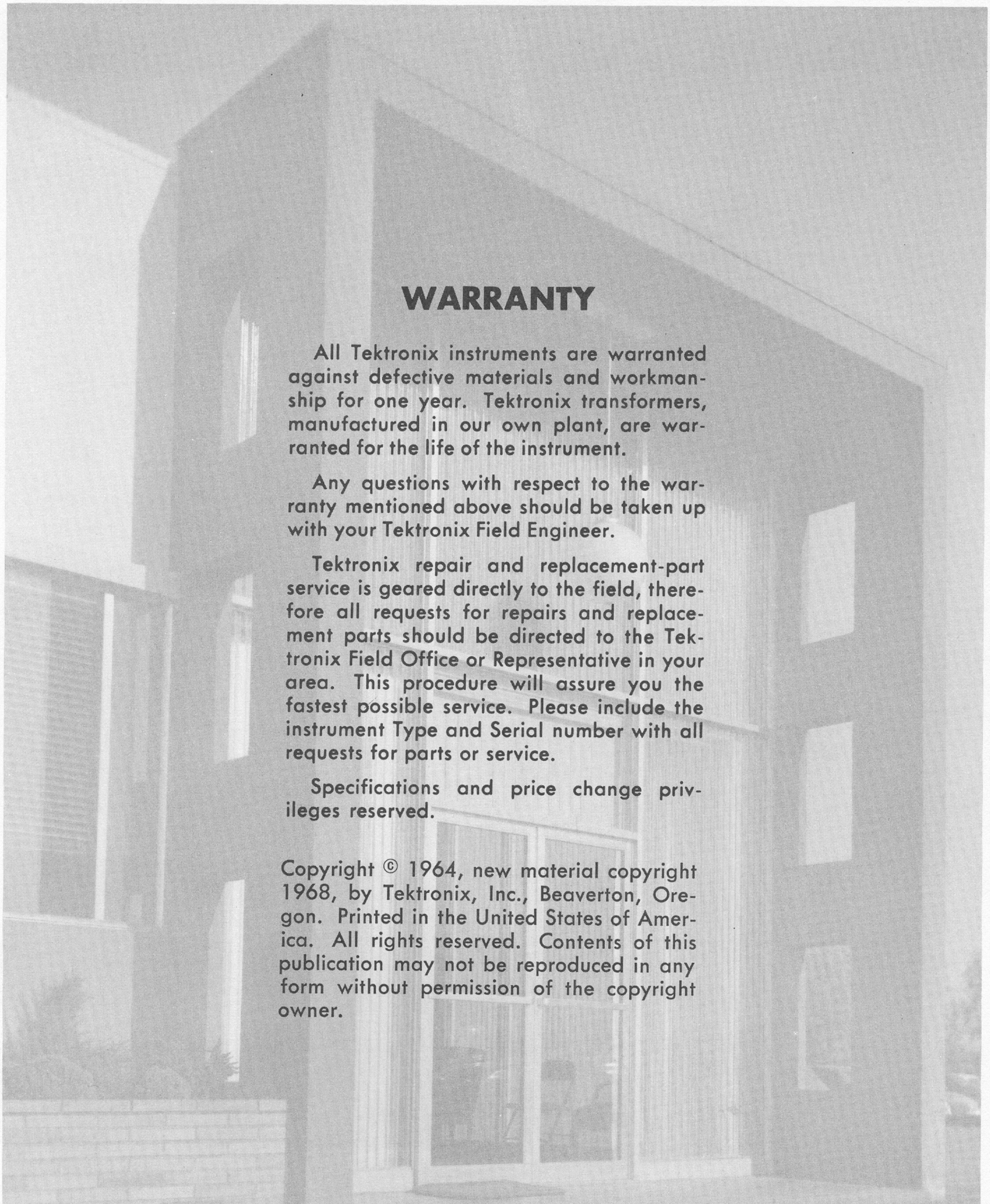


WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

Specifications and price change privileges reserved.

CONTENTS

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

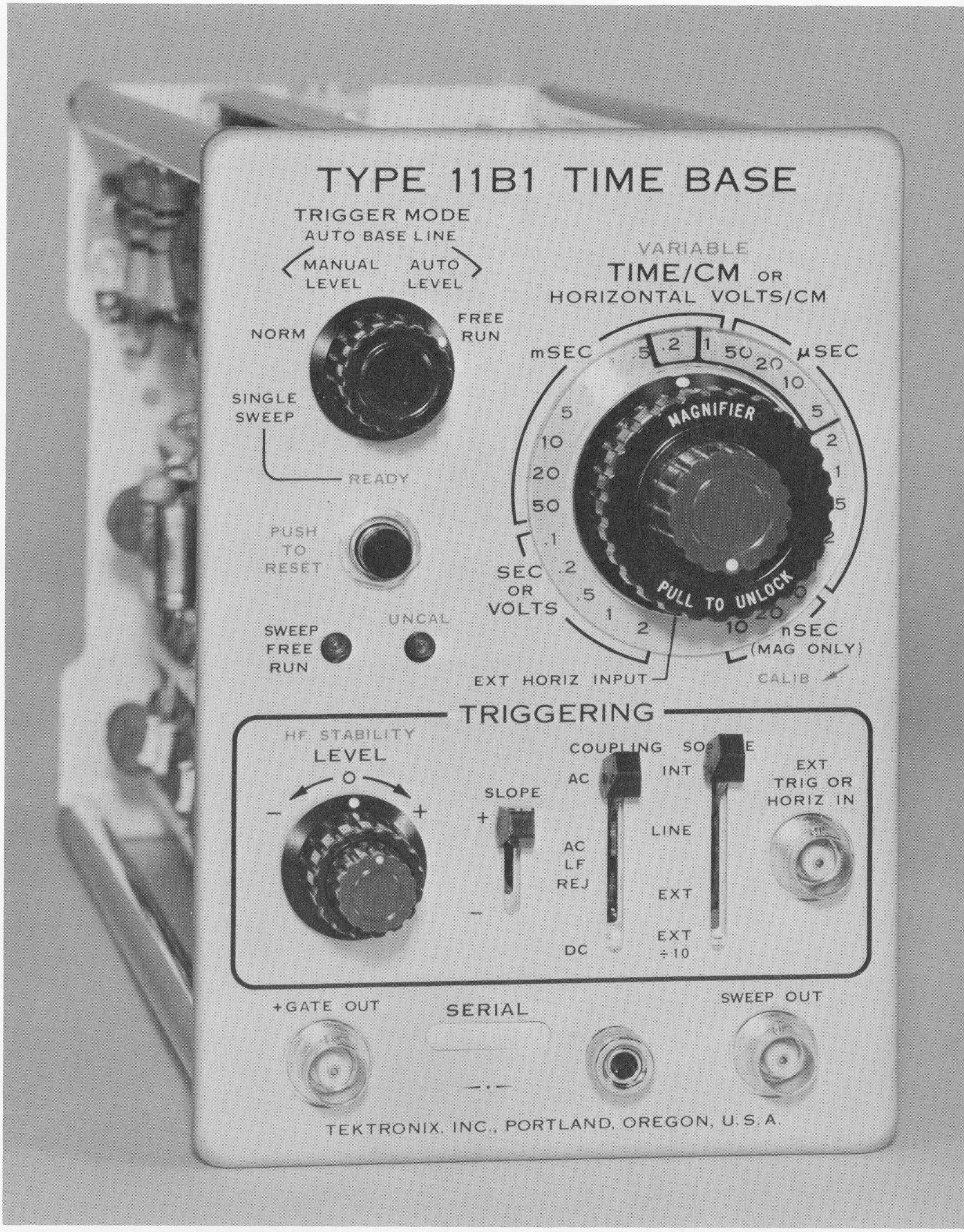


Fig. 1-1. Type 11B1 Time Base Plug-In Unit.

SECTION 1
CHARACTERISTICS

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The Type 11B1 Time Base plug-in unit is part of a wide-band oscilloscope system designed for operation and storage under severe environmental conditions. The Type 11B1 operates in the right-hand compartment of Tektronix 647-series oscilloscopes. The electrical characteristics listed in this section apply only when the Type 11B1 is operated in a calibrated Tektronix 647-series oscilloscope.

Horizontal deflection signals for the oscilloscope system are provided by the Horizontal Preamplifier in the Type 11B1. The TIME/CM OR HORIZONTAL VOLTS/CM switch selects the source of the Horizontal Preamplifier input signals. When the switch is set to the EXT HORIZ INPUT position, the SOURCE switch selects the Horizontal signal from the Vertical plug-in unit, the line, or the HORIZ IN connector on the front panel. In all other positions of the TIME/CM OR HORIZONTAL VOLTS/CM switch, the input to the Horizontal Preamplifier is taken from the Sweep Generator.

The Sweep Generator provides 23 calibrated sweep rates from 2 s/cm to 0.1 μs/cm. A direct-reading magnification feature provides three additional calibrated steps to extend the fastest sweep rate to 10 ns/cm. The magnifier allows each sweep rate to be increased up to 50 times (40 times in 0.2, 2, and 20 steps). A variable control provides continuously variable sweep rates between the calibrated TIME/CM switch settings. A panel lamp indicates when the sweep rates are uncalibrated.

The electrical characteristics which follow are divided into two categories. This instrument will meet the electrical characteristics listed in the Performance Requirement column following complete calibration as given in Section 5. Items listed in the Supplemental Information column are provided for reference use and do not directly reflect the measurement capabilities of this instrument. The performance check procedure given in Section 5 of this manual provides a convenient method of checking the Performance Requirements listed in this section without making internal checks or adjustments. The following characteristics apply over an ambient temperature range of —30°C to +65°C, except as otherwise indicated. Warm-up time for given accuracy is 20 minutes.

ELECTRICAL CHARACTERISTICS

Triggering

Characteristic	Performance Requirement	Supplemental Information
Source	Internal from Vertical plug-in unit. Internal from AC power source of indicator unit. External from signal applied to EXT TRIG IN connector. External from signal applied to EXT TRIG IN connector attenuated 10 times.	
Coupling	AC AC low-frequency reject DC	
Polarity (slope)	Sweep can be triggered from positive-going or negative-going portion of trigger signal.	
Trigger Mode	Free run Auto base line with auto level Auto base line with manual level Normal Single sweep	
Internal Trigger Sensitivity (0°C to +40°C)		
AC	0.2 centimeter of deflection 60 Hz to 20 MHz; increasing to 1 centimeter at 50 MHz (see Fig. 1-2)	Typical lower —3 dB point, 16 Hz
AC LF REJ	0.2 centimeter of deflection 30 kHz to 20 MHz; increasing to 1 centimeter at 50 MHz (see Fig. 1-2)	Typical lower —3 dB point 16 kHz

Characteristic	Performance Requirement		Supplemental Information
DC	0.2 centimeter of deflection DC to 20 MHz; increasing to 1 centimeter at 50 MHz (see Fig. 1-2)		
External Trigger Sensitivity (0°C to +40°C) AC	175 millivolts at 60 Hz 125 millivolts at 50 kHz 250 millivolts at 50 MHz (see Fig. 1-3)		Typical lower —3 dB point, 16 Hz
AC LF REJ	125 millivolts at 50 kHz 250 millivolts at 50 MHz (see Fig. 1-3)		Typical lower —3 dB point 16 kHz
DC	175 millivolts at 60 Hz 125 millivolts at 60 kHz 250 millivolts at 50 MHz (see Fig. 1-3)		
Auto Base line Triggering AUTO LEVEL	Establishes triggering level near waveform average. Offers triggering convenience for waveforms above 20 Hz		Free-running base line is displayed in absence of trigger signal
MANUAL LEVEL	Allows full operator control of triggering level for triggering with small amplitude or low duty cycle signals		
Single Sweep	Permits only one triggered sweep following each reset pulse. Reset pulse can be supplied internally or externally.		External pulse amplitude must be at least +5 volts peak; risetime must be 5 μs or less
LEVEL control Range EXT	At least + and − 5 volts		
EXT ÷ 10	At least + and − 50 volts		
External Trigger Input RC Characteristics EXT			Approximately 1 megohm (except .09 megohm in AC LF REJ) paralleled by 35 picofarads
EXT ÷ 10			Approximately 10 megohms (except 1 megohm in AC LF REJ) paralleled by 6 picofarads
Maximum External Trigger Input Voltage			500 volts combined DC and peak AC
	Sweep Generator		
Sweep Rates	2 second/cm to 0.1 microseconds/cm in 23 calibrated steps. Direct-reading magnifier provides up to ×50 magnification of sweep rates (×40 in 0.2, 2, and 20 positions) and extends maximum sweep rate to 10 nanoseconds		Steps in 1-2-5 sequence Sweep magnified by pulling TIME/CM switch out and rotating clockwise.
Sweep Accuracy	0°C to +40°C	—30°C to +65°C	VARIABLE TIME/CM control set to CALIB
2 s to 0.1 s/cm	Within ±3%	Within +4%, —6%	
50 ms to 0.1 μs/cm	Within ±1.5%	Within ±2.5%	
Additional Magnifier Error 1 ns to 50 ns/cm	Within ±1%	Within ±1.5%	
20 ns and 10 ns/cm	Within ±2%	Within ±2.5%	
Variable Sweep Rate	Uncalibrated sweep rate to 2.5 times, or more, the TIME/CM switch setting		Slowest sweep rate 5 seconds/cm, or slower, in the 2 SEC position
Sweep Length	10.2 to 10.7 centimeters		

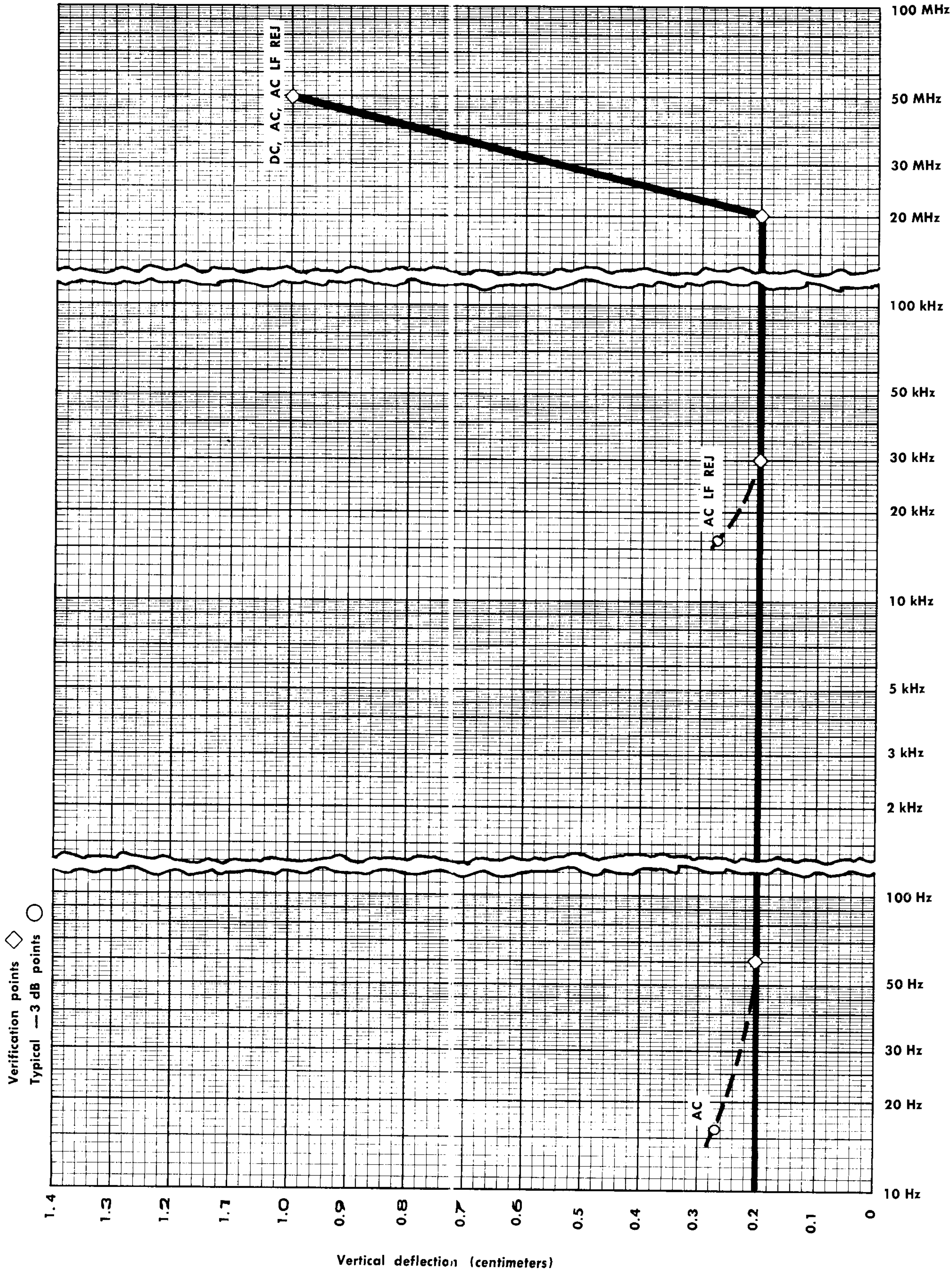


Fig. 1-2. Internal trigger sensitivity characteristic limit curve.

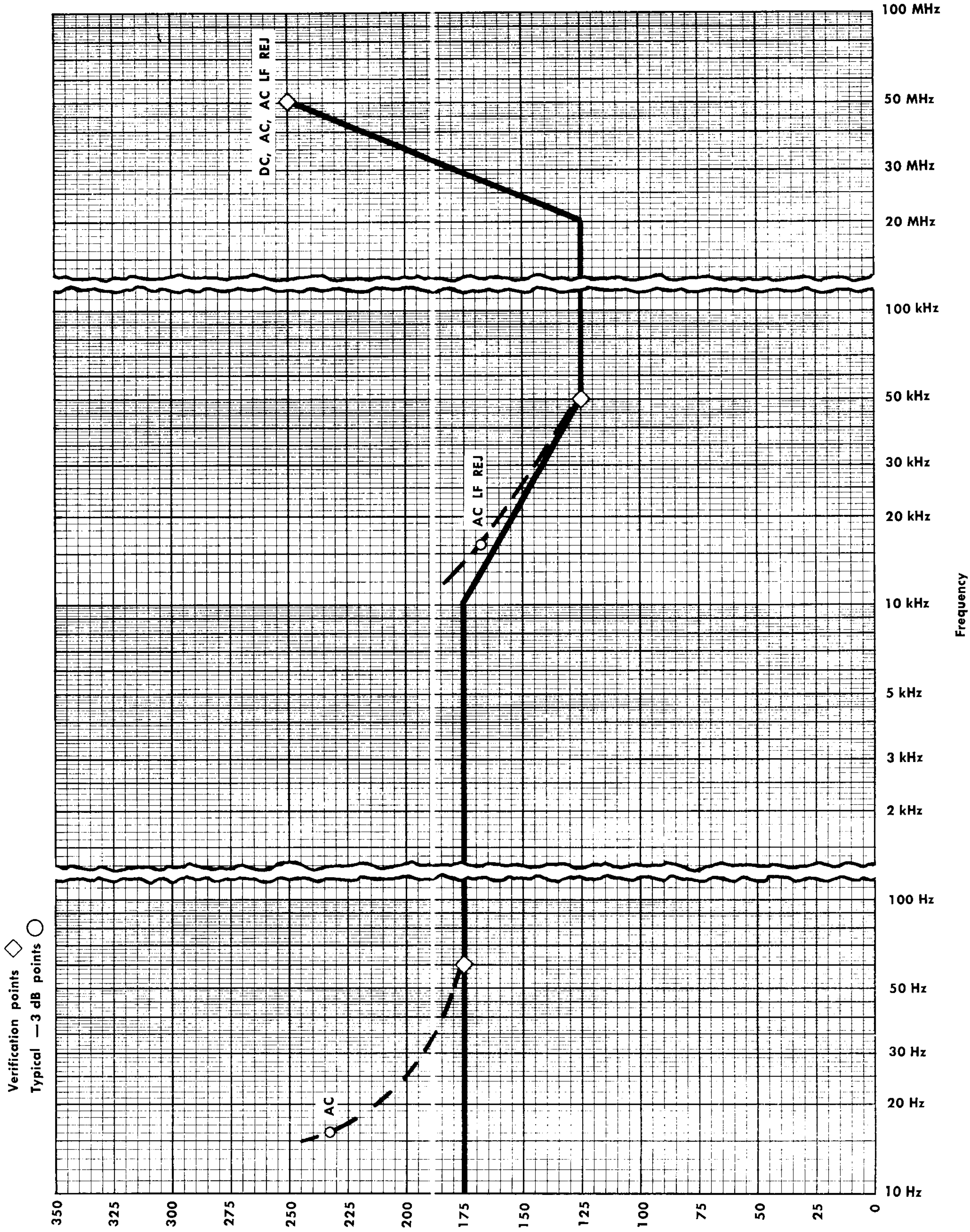


Fig. 1-3. External trigger sensitivity characteristic limit curve.

External Horizontal Input

Characteristic	Performance Requirement	Supplemental Information
Deflection Factor		
EXT	5 volts/cm to 0.1 volt/cm in 6 steps, accurate to within 2%	Signal applied to EXT HORIZ IN connector. Deflection factor set by pulling TIME/CM switch out and rotating clockwise. Variable to 2.5 times.
EXT ÷ 10	50 volts/cm to 1 volt/cm, accurate to within 5%	
Bandwidth (—3 dB points)		
AC	16 Hz to 3 MHz	
AC LF REJ	17 kHz to 3 MHz	
DC	DC to 3 MHz	
Input RC Characteristics		
EXT		Approximately 1 megohm (except .09 megohm in AC LF REJ) paralleled by 35 picofarads
EXT ÷ 10		Approximately 10 megohms (except 1 megohm in AC LF REJ) paralleled by 6 picofarads

Output Signals

Characteristic	Performance Requirement	Supplemental Information
+Gate Output		
Waveshape	Rectangular pulse	
Amplitude	14.5 volts peak, ±10%	
Output Resistance		Approximately 1.6 kilohm
Output Current		Approximately 9 milliamps into zero ohms
Sweep Output		
Waveshape	Sawtooth pulse	
Amplitude	10 volts, peak, ±10%	
Output Resistance		Approximately 750 ohms
Output Current		Approximately 13 milliamps peak into zero ohms

ENVIRONMENTAL CHARACTERISTICS

This instrument will meet the electrical performance requirements given in this section over the following environmental limits. Complete details on environmental test procedures, including failure criteria, etc., can be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

Characteristic	Performance Requirement	Supplemental Information
Temperature		
Operating	—30° C to +65° C	
Non-operating	—55°C to +75°C	
Altitude		
Operating	15,000 feet maximum	Decrease maximum operating temperature by 1°C/1000 feet increase in altitude above 5000 feet
Non-operating	Test limit 50,000 feet	
Humidity		
Non-operating	Five cycles (120 hours) of MIL-STD-202C, Method 106B	Exclude freezing and vibration
Vibration		
Operating and Non-operating	15 minutes vibration along each of the three major axes at a total displacement of .025 inch peak to peak (4 g at 55 c/s) with frequency varied from 10-55-10 c/s in one-minute cycles. Hold at 55 c/s for three minutes on each axis	Installed in indicator ocsilloscope which is secured to vibration platform during test. Total vibration time, about 55 minutes.

Characteristic	Performance Requirement	Supplemental Information
Shock Operating and Non-operating	Two shocks of 20 g, one-half sine, 11 milli-second duration each direction along each major axis	Guillotine-type shocks. Installed in indicator oscilloscope. Total of 12 shocks
Transportation	Meets National Safe Transit type of test when correctly packaged	
Package Vibration	One hour vibration slightly in excess of 1 g	Package should just leave the vibrating surface
Package Drop	30 inch drop on any corner, edge or flat surface	

Standard Accessories

Standard accessories supplied with the Type 11B1 are listed at the rear of the mechanical parts list. For optional accessories available for use with this instrument, see the current Tektonix Inc. catalog.

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

General

The Type 11B1 Time Base plug-in unit operates with the Tektronix 647-series indicator oscilloscope and 10-series vertical plug-in unit to form a complete oscilloscope system. To effectively use the Type 11B1, the operation and capabilities of the instrument should be known. This section describes the operation of the front-panel controls and connectors, gives first-time and general operating information and lists some basic applications for this instrument.

Installation

The Type 11B1 is designed to operate in the horizontal plug-in compartment of Tektronix 647-series oscilloscopes. The Type 11B1 will not operate correctly if installed in the vertical plug-in compartment. To install the Type 11B1 into the plug-in compartment, push it in as far as possible so it is seated against the front panel of the indicator oscilloscope. To remove the plug-in, pull the release bar, grasp the plug-in behind the front panel and pull it partially out of the compartment. Then take hold of the plug-in by the support rods to remove it from the oscilloscope.

The horizontal gain of the indicator oscilloscope is standardized to minimize adjustment when changing from one plug-in to another. To further ensure measurement accuracy, the sweep calibration of the Type 11B1 should be checked when the plug-in is inserted into the indicator oscilloscope.

FRONT-PANEL CONTROLS AND CONNECTORS

All controls and connectors required for the operation of the Type 11B1 are located on the front panel of the unit (see Fig. 2-1). To make full use of the capabilities of this instrument, the operator should be familiar with the function and use of each of these controls and connectors. A brief description of the function or operation of the front-panel controls and connectors follows. More detailed information is given under General Operating Information.

TRIGGER MODE — Determines the manner in which the sweep is initiated.

FREE RUN: Provides recurrent sweep operation at the sweep rate rate selected by the TIME/CM switch. The SWEEP FREE RUN indicator lights in this position.

AUTO BASE LINE—AUTO LEVEL: Automatic sweep. Permits each sweep to be triggered when the trigger signal repetition rate is about 20 Hz or greater. For lower repetition rates or in the absence of a trigger signal the sweeps are recurrent, as in the FREE RUN position, in which condition the SWEEP FREE RUN indicator lights.

AUTO BASE LINE—MANUAL LEVEL: The same as AUTO BASE LINE—AUTO LEVEL except that the trigger LEVEL control must be adjusted so that the sweep triggers at the desired point on the signal.

NORM: Normal method of operation. Each sweep is triggered by the signal from the internal trigger generator.

SINGLE SWEEP: Often used when displays of non-repetitive signals are photographed. After a sweep is displayed, further sweeps are locked out until the sweep is reset. Display is triggered as for NORM operation using the trigger controls.

PUSH TO RESET — When the READY light is on, a display will be presented when a trigger signal is received (SINGLE SWEEP mode). After the sweep is completed the PUSH TO RESET button must be pressed again before another sweep can be displayed.

SLOPE — Selects slope of trigger signal which initiates the sweep.

+: Sweep is triggered from positive-going portion of trigger signal.

—: Sweep is triggered from negative-going portion of trigger signal.

COUPLING — Determines method of coupling trigger signal to trigger circuit.

AC: Rejects DC and attenuates signals below about 30 Hz.

AC LF REJ: Rejects DC and attenuates low frequency AC triggering signals below about 50 kHz.

DC: Accepts AC and DC triggering signals.

SOURCE — Selects the source of the trigger signal.

INT: Internal triggering provided from vertical plug-in unit.

LINE: Sweep triggered at line frequency.

EXT: Sweep triggered from signal applied to the EXT TRIG IN connector.

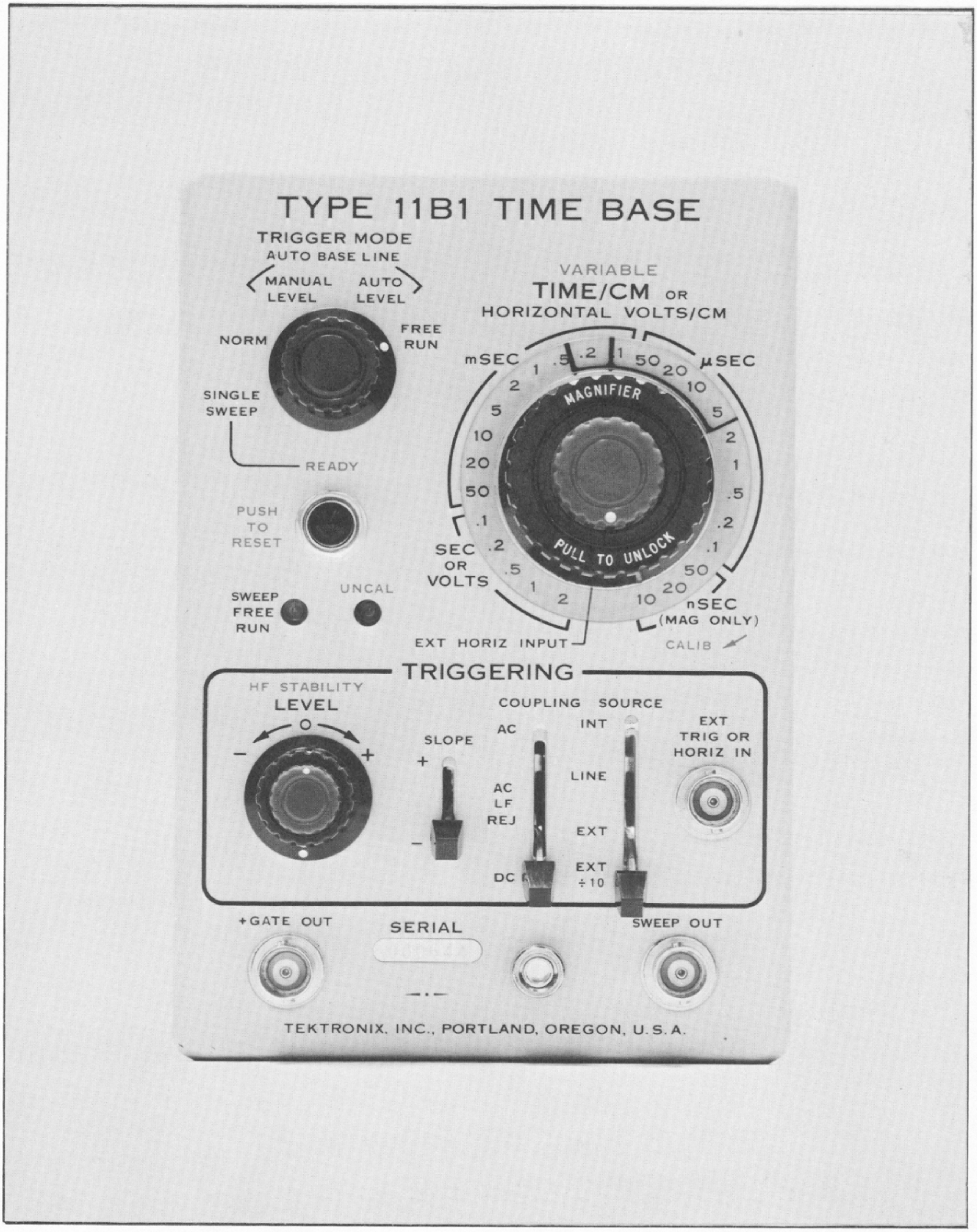


Fig. 2-1. Front-panel controls and connectors of the Type 11B1.

	EXT ÷ 10: External trigger signal applied to EXT TRIG IN connector is attenuated ten times.
LEVEL	Selects amplitude point on trigger signal where sweep is triggered.
HF STABILITY	Decreases display jitter for trigger signals above approximately 5 MHz. Has negligible effect at lower repetition rates.
TIME/CM OR HORIZONTAL VOLTS/CM	Provides 23 calibrated sweep rates (unmagnified). The number opposite the dot on the MAGNIFIER knob skirt always indicates the sweep rate as long as the VARIABLE control is in the CALIB position. The number bracketed by the two black lines on the clear plastic flange is the unmagnified sweep rate. To change the unmagnified sweep rate, the concentric flange and the MAGNIFIER knob must first be interlocked by positioning the dot on the MAGNIFIER knob between the two black lines on the flange. In the EXT HORIZ INPUT position of the TIME/CM OR HORIZONTAL VOLTS/CM switch (flange positioned so that the two black lines bracket the EXT HORIZ INPUT position), horizontal deflection is provided by a signal selected by the SOURCE switch rather than by the time-base generator.
MAGNIFIER	Provides magnification of the horizontal display up to 40× or 50× in five direct-reading steps. (Magnification of the three fastest unmagnified sweep rates is limited to 10 ns/cm.) For example, at 10× magnification, the one-centimeter segment at the center of an unmagnified CRT display is horizontally expanded to full graticule width. Any other one-centimeter segment of the original unmagnified display may then be observed in magnified form by turning the oscilloscope Horizontal POSITION controls. To determine the amount of magnification, divide the number bracketed by the two black lines on the clear plastic flange by the number adjacent to the dot on the MAGNIFIER knob.
VARIABLE	Provides continuously variable uncalibrated sweep rates between 1 and about 2.5 times that indicated by the TIME/CM switch. Whenever the VARIABLE knob is rotated counterclockwise out of the CALIB detent, the UNCAL lamp lights. If the TIME/CM OR HORIZONTAL VOLTS/CM switch is set to EXT HORIZ INPUT, the VARIABLE control increases the horizontal deflection factor by 2.5 times when fully counterclockwise.

FIRST-TIME OPERATION

General

The following steps demonstrate the basic operation of the controls and connectors of the Type 11B1. It is recommended that this procedure by followed completely for familiarization with the instrument. Operation of the indicator oscilloscope and vertical plug-in unit is described in the instruction manuals for these units. The first eight steps of this procedure may be used to check the unit when it is installed in an oscilloscope to ensure accurate measurements.

Setup Information

1. Insert the Type 11B1 into the right plug-in compartment of a 647-series indicator unit.

2. Insert a 10-series vertical unit into the left plug-in compartment.

3. Set the oscilloscope intensity control counterclockwise.

4. Connect the oscilloscope to a power source which meets its voltage and frequency requirements.

5. Turn on the oscilloscope power switch and allow about five minutes warm-up time.

6. Connect the oscilloscope calibrator output to the Channel 1 vertical input with a BNC cable.

7. Set the front-panel controls as follows:

TYPE 11B1

TRIGGER MODE	AUTO LEVEL
LEVEL	Midrange
SLOPE	+
COUPLING	AC
SOURCE	INT
TIME/CM	.5 mSEC
VARIABLE (TIME/CM)	CALIB
MAGNIFIER	.5 mSEC

Vertical Unit (both channels if applicable)

Input Coupling	AC
Volts/cm	5
Variable (Volts/cm)	Cal
Position	Midrange
Invert	Pushed In
Trigger	Norm
Mode	Ch 1

Indicator Oscilloscope

Calibrator	10 volts
Intensity	Adjust for visible display
Focus	Adjust for optimum display
Astigmatism	Adjust for optimum display
Scale Illum	As desired
Position (Horizontal)	Midrange

8. Check the display for five complete cycles. Display of a greater or lesser number of cycles indicates incorrect horizontal timing. Adjustment procedure is given in the Calibration section.

Triggering

9. Set the TRIGGER MODE switch to MANUAL LEVEL. Rotate the LEVEL control throughout its range. The display free runs at the extremes of rotation.

10. Set the TRIGGER MODE switch to NORM. Again rotate the LEVEL control throughout its range. A display is presented only when correctly triggered. Return the TRIGGER MODE switch to MANUAL LEVEL, and set LEVEL control to 0.

11. Set the Slope switch to —; the display starts on the negative half of the square wave. Return the switch to +; the display starts on the positive half of the square wave.

12. Set the COUPLING switch to DC. Turn the vertical position until the display free runs. Return the COUPLING switch to AC; the display is again stable. When the TRIGGER MODE switch is set to MANUAL LEVEL or NORM, and the trigger COUPLING is set to DC, changing the DC level of the input signal affects the triggering point. Return the display to the center of the screen.

13. Connect the Calibrator signal to the vertical input connector and to the EXT TRIG IN connector. Set the SOURCE switch to EXT. Operation of the LEVEL, SLOPE and COUPLING controls for external triggering is the same as described in steps 9 through 12.

14. Set the SOURCE switch to EXT ÷ 10. Operation is the same as for EXT. Note that the LEVEL control has less range in this position, indicating trigger signal attenuation. Return the SOURCE switch to INT.

Sweep Variable and Magnifier

15. Set the TIME/CM switch to .1 mSEC to display one cycle of the calibrator signal in ten centimeters. Rotate the VARIABLE control counterclockwise out of the CALIB position. Note that the UNCAL light comes on when the VARIABLE control is in use. In the fully counterclockwise position, the sweep rate is slowed to about 2.5 times the indicated setting, displaying 2.5 cycles of the calibrator waveform on the CRT. Return the VARIABLE control to the CALIB position.

16. Set the TIME/CM switch to .5 mSEC. Pull the MAGNIFIER knob out and rotate clockwise. Note that the sweep is magnified to the sweep rate indicated by the MAGNIFIER knob. Five magnified positions are available for this sweep rate. Return the MAGNIFIER knob to the .5 mSEC position.

Single Sweep

17. Set the TRIGGER MODE switch to SINGLE SWEEP. Remove the Calibrator signal from the vertical input connector. Press the RESET button; the READY light should come on and remain on. Re-apply the signal to the vertical input connector; a single trace should be presented and the READY light should go out. Set the TRIGGER MODE switch to AUTO LEVEL.

External Horizontal

18. With the 10-volt calibrator signal connected to the vertical input connector and to the EXT TRIG OR HORIZ IN connector, rotate the TIME/CM OR HORIZONTAL VOLTS/CM switch counterclockwise to the EXT HORIZ INPUT position. Set the SOURCE switch to EXT.

19. Increase the intensity control setting slightly until two dots are displayed diagonally on the CRT. The horizontal deflection factor, in this unmagnified position, is 5 volts/cm. Therefore, the two dots, representing the two levels of the calibrator square wave, should be 2 centimeters (10 volts) apart both vertically and horizontally.

20. To change the external horizontal deflection factor, pull the MAGNIFIER knob out and rotate to one of the five clockwise positions.

21. The VARIABLE control can be used to increase the horizontal deflection factor to approximately 2.5 times the switch setting, or a maximum of about 12.5 volts per centimeter when fully counterclockwise.

22. The EXT ÷ 10 position of the SOURCE switch provides calibrated deflection factors of 1, 2, 5, 10, 20 and 50 volts per centimeter. The VARIABLE control increases the maximum deflection factor to about 125 volts per centimeter. Refer to the Characteristics section for maximum external horizontal input voltage.

This completes the basic operating procedure for the Type 11B1. Instrument operations not explained here, or operations which need further explanation are discussed under General Operating Information.

CONTROL SETUP CHART

Figure 2-2 shows the front panel of the Type 11B1. This chart can be reproduced and used as a test-setup for special measurements, applications or procedures; or it may be used as a training aid for familiarization with this instrument.

GENERAL OPERATING INSTRUCTIONS

Trigger Mode

FREE RUN. Free-running operation produces continuously repetitive sweeps even in the absence of a triggering signal. These sweeps provide a reference trace, as do the AUTO BASE LINE positions.

AUTO BASE LINE. These positions are frequently used for ease of operation and because of the reference trace produced in the absence of a triggering signal. In either the MANUAL LEVEL or AUTO LEVEL positions, the time base free runs when a trigger signal is not applied or when the repetition rate is too low. When a triggering signal is received, the free running condition is interrupted, but this first event in the signal does not trigger the sweep. If the first event is followed by a second event within about 80 milliseconds (trigger signal repetitive), a triggered sweep is initiated. If not, the free running condition resumes, as indicated by the SWEEP FREE RUN light. Signal frequencies below about 20 hertz cannot produce a triggered sweep in the AUTO BASE LINE modes. For such signals, the NORM mode of operation must be used.

With the SOURCE switch set to INT and the TRIGGER MODE switch set to AUTO LEVEL, the sweep will trigger on signals that produce about one centimeter or more of vertical

TYPE 11B1 TEST SET-UP CHART

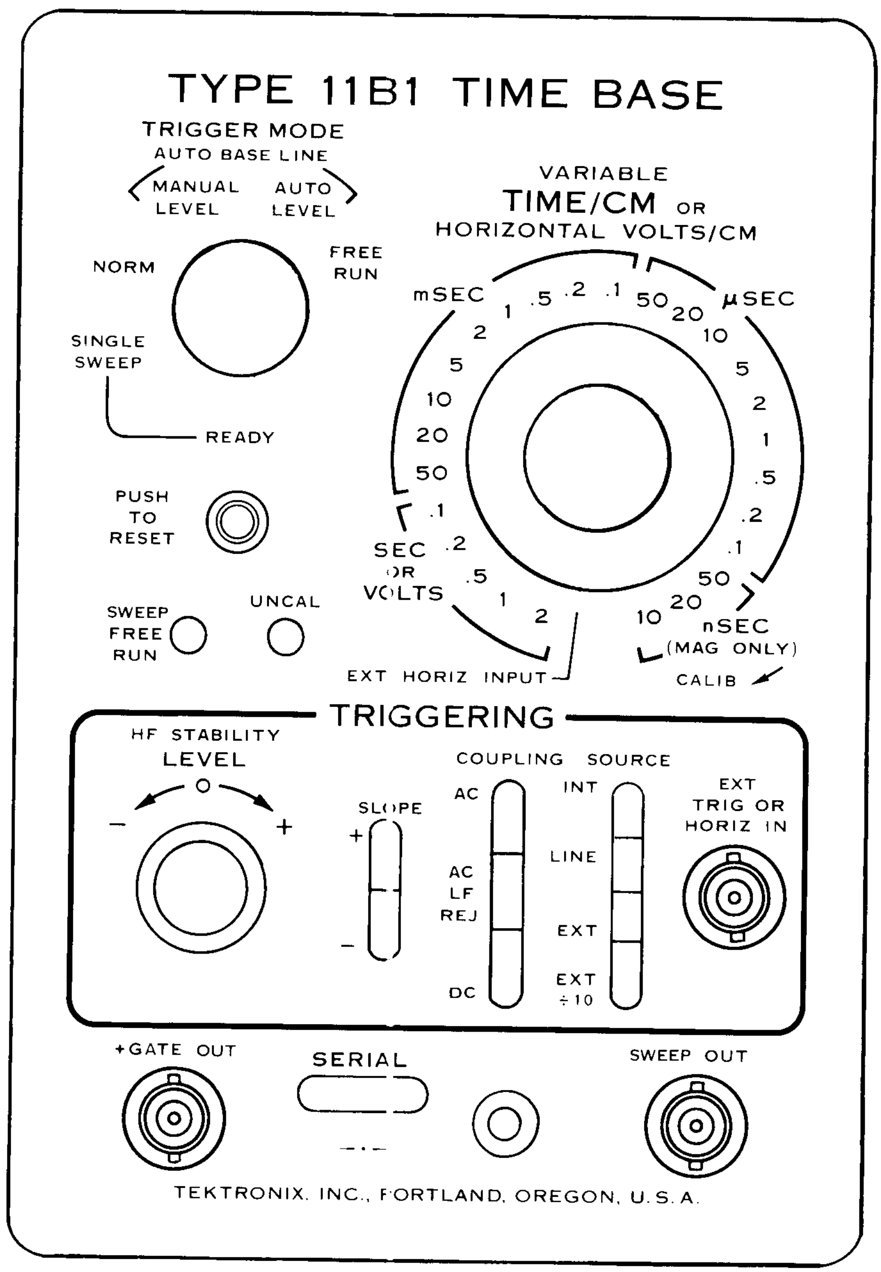


Fig. 2-2. Type 11B1 test set-up chart.

deflection. Little or no resetting of the trigger controls is required when operating in this mode. However, the instrument will not trigger on low duty-cycle, negative-going waveforms in the AUTO LEVEL mode.

When operating in the MANUAL LEVEL mode, it is necessary to adjust the LEVEL control to provide a triggered sweep. The sweep can be triggered with signals that produce less vertical deflection than is required when operating in the AUTO LEVEL mode.

NORM. In the NORM or normal mode, the time base is inoperative in the absence of a triggering signal. Each sweep must be initiated by the trigger signal.

SINGLE SWEEP. Single sweep is often used when photographing non-repetitive waveforms and in other applications where the vertical input signal continually varies in amplitude, shape, or time interval. A continuous display of such signals would appear as a mixture of many different waveforms and would yield little or no useful information. The Type 11B1 permits a single sweep to be presented with the elimination of all subsequent sweeps. The information in the one sweep is thus clearly recorded without the confusion resulting from multiple non-repetitive traces.

When the TRIGGER MODE switch is set to SINGLE SWEEP, the time base becomes inoperative and all trigger signals are locked out. The time base can be reset to receive a trigger signal by pressing the RESET button or by applying a fast-rise positive-going pulse about five volts in amplitude to pin F of J101 on the rear panel of the oscilloscope (pin C is ground). If there is sufficient delay before triggering occurs, the READY lamp will light to show that the time base is ready to be triggered. When an adequate trigger signal is applied, the sweep is triggered. After one sweep is completed, the time base again becomes inoperative and the READY lamp extinguishes.

Trigger Source

INT. For most applications, the sweep can be triggered internally. In the INT position of the SOURCE switch, the trigger signal is obtained from the vertical plug-in unit.

LINE. The LINE position connects a sample of the power-line frequency to the Trigger Generator. Line triggering is useful when the input signal is time-related to the line frequency. It is also useful for providing a stable display of a line-frequency component in a complex waveform.

EXT. An external signal connected to the EXT TRIG IN connector can be used to trigger the sweep in the EXT position of the SOURCE switch. The external signal must be time-related to the displayed signal for a stable display. An external trigger signal can be used to provide a triggered display when the internal signal is too low in amplitude for correct triggering, or contains signal components on which it is not desired to trigger. 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 signal 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 trigger controls.

EXT ÷ 10. Operation in the EXT ÷ 10 position is the same as described for EXT except that the external triggering signal is attenuated ten times. Attenuation of high-amplitude external trigger signals is desirable to broaden the range of the LEVEL control.

Trigger Coupling

AC. The AC position blocks the DC component of the trigger signal. Signals with low frequency components below about 60 hertz are attenuated. In general, AC coupling can be used for most applications. However, if the trigger signal contains unwanted frequency components, or if the sweep is to be triggered at a low repetition rate or a DC level, the remaining positions will provide a better display.

The triggering point in the AC position depends on the average voltage level of the trigger signal. If the trigger signals occur in a random fashion, the average voltage level will vary, causing the triggering point to vary also. This shift of the triggering point may be enough to make it impossible to maintain a stable display. In such cases, use DC coupling.

AC LF REJ. In the AC LF REJ position, DC is rejected and signals below about 50 kilohertz are attenuated. Therefore, the sweep is triggered only by the higher-frequency components of the signal. This position is particularly useful for providing stable triggering if the trigger signal contains line-frequency components. Also, for alternate mode operation of a multi-trace unit, the AC LF REJ position provides the best display at fast sweep rates when comparing two unrelated signals.

DC. DC coupling can be used to provide stable triggering with low-frequency signals which would be attenuated in the AC position, or with low-repetition rate signals. The LEVEL control can be adjusted to provide triggering at the desired DC level on the waveform. When using internal triggering, the settings of the vertical unit position controls affect the DC triggering level.

Trigger Slope

The trigger SLOPE switch determines whether the trigger circuit responds to the positive-going or negative-going portion of the trigger signal. When the SLOPE switch is in the + (positive-going) position, the display starts with the positive-going portion of the waveform; in the — (negative-going) position, the display starts with the negative-going portion of the waveform (see Fig. 2-3). When several cycles of a signal appear in a 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 which starts on the desired slope of the input signal.

Trigger Level

When the TRIGGER MODE switch is set to MANUAL LEVEL, NORM, or SINGLE Sweep, the LEVEL control determines the voltage on the triggering waveform at which the sweep is triggered. When the LEVEL control is in the + region, the trigger circuit responds at a positive point on the trigger signal. When the LEVEL control is set in the

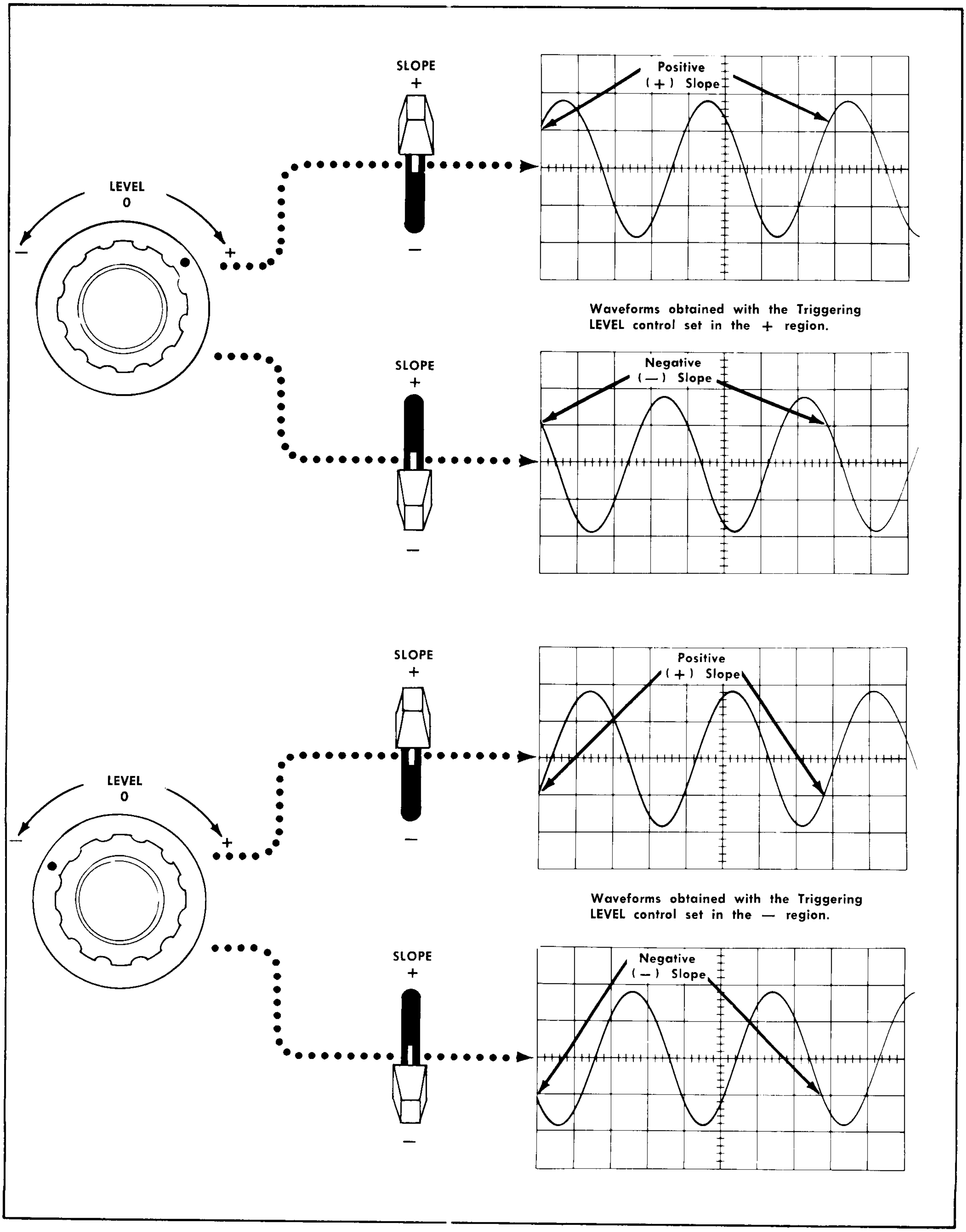


Fig. 2-3. Effects of trigger LEVEL control and SLOPE switch on displayed waveform.

— region, the trigger circuit responds at a negative point on the trigger signal. Figure 2-3 illustrates this effect with different settings of the SLOPE switch.

To set the LEVEL control, first select the trigger SOURCE, COUPLING and SLOPE. Then set the LEVEL control fully counterclockwise and rotate clockwise until the display starts at the desired point.

High-Frequency Stability

The HF STABILITY control is used only when the triggering signal repetition rate is greater than about 20 megahertz, and then only if the triggered sweep tends to jitter horizontally. In such cases, the control is set for minimum jitter. At lower repetition rates, the setting of the HF STABILITY control has no effect.

Horizontal Sweep Rate

The Time Base has 23 calibrated sweep rates ranging from 2 SEC/CM to .1 μSEC/CM (unmagnified). The number opposite the dot on the MAGNIFIER knob (see Fig. 2-4) indicates the sweep rate as long as the VARIABLE control is in the CALIB position. The VARIABLE control permits the sweep rate to be varied continuously between the calibrated steps. All sweep rates obtained with the VARIABLE control in any but the fully clockwise position are uncalibrated. The UNCAL indicator lights when the VARIABLE control is in use.

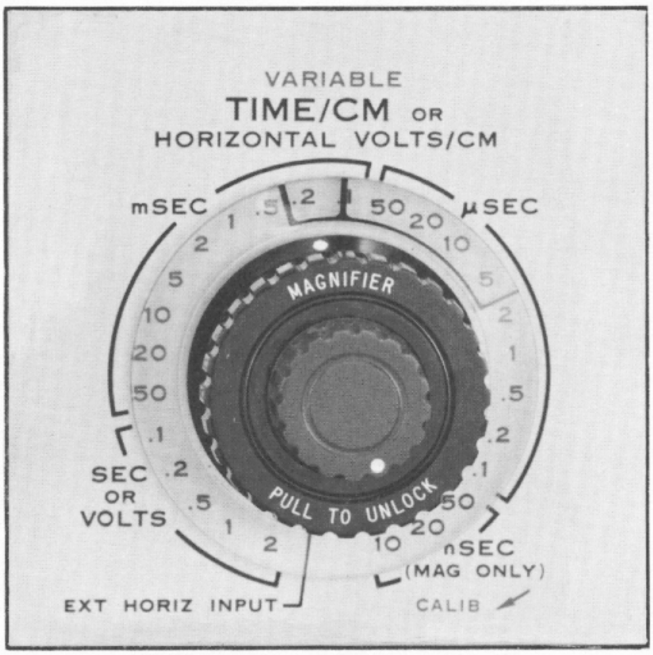


Fig. 2-4. TIME/CM or HORIZONTAL VOLTS/CM switch.

The sweep rates from 2 SEC to .5 μSEC can be magnified up to forty or fifty times in five steps. Four steps of magnification are available in the .2 μSEC position and three in the .1 μSEC position to a maximum sweep rate of 10 nSEC/CM. The amount of magnification is the ratio between the indicated magnified sweep rate (number opposite the dot on the MAGNIFIER knob) and the unmagnified sweep rate (number bracketed by the two black lines on the clear plastic flange). Since the magnified sweep rate is always read directly, it is seldom necessary to determine the actual magnifying factor used. To magnify the sweep, pull the MAGNIFIER knob out and rotate it clockwise up to five positions to the desired sweep rate indicated by the number opposite the dot on the MAGNIFIER knob.

When making time measurements from the graticule, the area between the second and tenth graticule lines provide the most linear display. Set the TIME/CM switch so that the timing area falls between the second and tenth graticule lines as illustrated in Figure 2-5. When measuring displays of less time duration than eight centimeters, position the display near the center of the CRT.

External Horizontal

In the EXT HORIZ INPUT position of the TIME/CM OR HORIZONTAL VOLTS/CM switch, external horizontal deflection signal can be applied to the horizontal amplifier through the EXT HORIZ IN connector. With the SOURCE switch set to EXT, six calibrated external horizontal deflection factors are available from 5 volts to 0.1 volt/centimeter.

To set the TIME/CM switch to the EXT HORIZ INPUT position, rotate the dual control fully counterclockwise. In this position, the external horizontal deflection factor is 5 volts/centimeter (50 volts/centimeter with SOURCE switch set to EXT ÷ 10). The deflection factor may now be changed by pulling the MAGNIFIER knob out and turning it clockwise to the desired volts/centimeter position. The VARIABLE control provides uncalibrated deflection factors up to about 2.5 times the HORIZONTAL VOLTS/CM switch setting. Uncalibrated deflection factors are indicated when the UNCAL lamp is on.

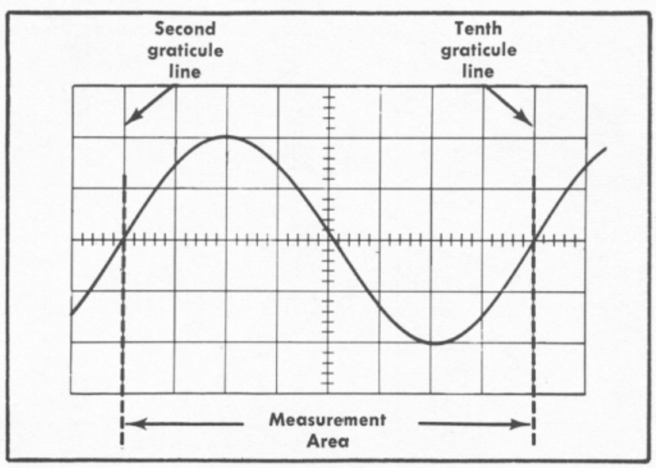


Fig. 2-5. Measuring the time duration of a waveform.

Sweep Generator Output Signals

+ GATE OUT. The + GATE OUT connector provides a rectangular output pulse which is coincident with the sweep produced by the sweep generator. This rectangular pulse is about +14 volts in amplitude into a high-impedance load.

SWEEP OUT. The SWEEP OUT connector provides a sample of the sawtooth sweep signal from the sweep generator. Amplitude of the sweep output signal is about +10 volts into a high-impedance load.

BASIC APPLICATIONS

General

The following information describes the procedure and technique for making basic measurements with a Type 11B1 Time Base Unit and associated vertical unit and indicator oscilloscope. These applications are not described in detail since each application must be adapted to the requirements of the individual measurements. Familiarity with the Type 11B1 and associated instruments will permit these basic applications to be applied to a variety of uses.

Time-Duration Measurements

To measure time between two points on a waveform, use the following procedure:

1. Connect the signal to the input connector of the vertical unit.

2. Set the vertical unit volts/centimeter switch to display about four centimeters of the waveform.

3. Set the trigger controls to obtain a stable display.

4. Set the TIME/CM switch to the fastest sweep rate that displays eight centimeters or less between the time measurement points (see Fig. 2-5). See the topic entitled "Selecting Sweep Rate" in this section concerning nonlinearity of the first and last centimeter of the display.

5. Adjust the vertical unit position control to move the points between which the time measurement is made to the center horizontal line.

6. Adjust the horizontal position control to center the time measurement area on the center horizontal graticule line.

7. Measure the horizontal distance between the time measurement points. Be sure the VARIABLE control is set to CALIB.

8. Multiply the distance measured in step 7 by the setting of the TIME/CM switch. If sweep magnification is used, multiply by the setting of the MAGNIFIER knob.

Example. Assume that the distance between the time measurement points is eight centimeters (see Fig. 2-5) and the TIME/CM switch is set to 5 μSEC. Using the formula:

$$\text{Time Duration} = \begin{matrix}\text{horizontal}\\ \text{distance in}\\ \text{centimeters}\end{matrix} \times \begin{matrix}\text{TIME/CM}\\ \text{MAGNIFIER}\\ \text{setting}\end{matrix}$$

Substituting the given values:

$$\text{Time Duration} = 8 \times 5\,\mu\text{sec} = 40\,\mu\text{sec}$$

Determining Frequency

The time measurement technique can also be used to determine the frequency of a signal. The frequency of a recurrent signal is the reciprocal of the time duration (period) of one cycle.

Use the following procedure:

1. Measure the time duration of one complete cycle of the waveform as described in the previous application.

2. The frequency of a signal is the reciprocal of the time duration of one cycle.

Example. The frequency of the signal shown in Figure 2-5 which has a time duration of 40 microseconds is:

$$\text{Frequency} = \frac{1}{\text{time duration}} = \frac{1}{40\,\mu\text{s}} = 25\text{ kHz}$$

Risetime Measurements

Risetime measurements employ basically the same techniques as time-duration measurements. The main difference is the area in which the measurement is made. The following procedure gives the basic method of measuring risetime between the 10% and 90% points of the waveform. Falltime can be measured in the same manner on the trailing edge of the waveform.

1. Connect the signal to the input connector of the vertical unit.

2. Set the vertical unit volts/centimeter switch and the variable control to produce a display five centimeters in amplitude.

3. Center the display about the center horizontal line. With five centimeters of vertical deflection, the 10% and 90% points on the waveform are two centimeters below and two centimeters above the center horizontal line (see Fig. 2-6).

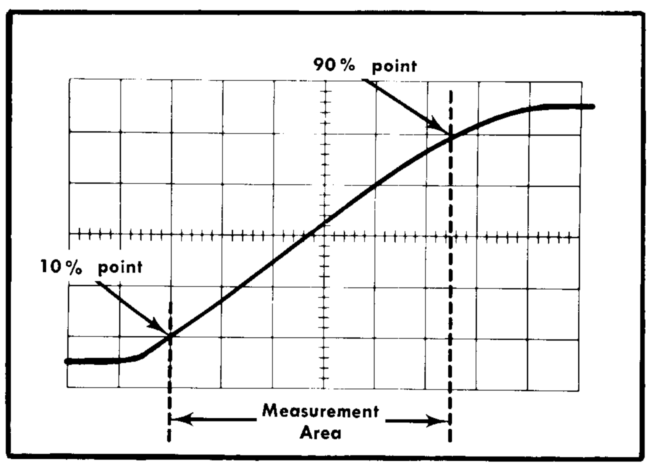


Fig. 2-6. Measuring the risetime of a waveform.

4. Set the TIME/CM switch to the fastest sweep rate that displays less than eigth centimeters horizontally between the 10% and 90% points on the waveform. Be sure that the VARIABLE control is set to CALIB.

5. Adjust the horizontal position control to center the measurement area on the CRT with the 10% point intersecting a vertical graticule line as in Fig. 2-6.

6. Measure the horizontal distance between the 10% and 90% points.

7. Multiply the distance measured in step 6 by the setting of the TIME/CM switch. If sweep magnification is used, multiply by the setting of the MAGNIFIER knob.

Example. Assume that the horizontal distance between the 10% and 90% points is 5.5 centimeters (see Fig. 2-6) and the MAGNIFIER switch is set to 10 nSEC. Using the formula:

Risetime (Time Duration)	=	horizontal distance (centimeters)	X	TIME/CM MAGNIFIER settings

Substituting the values:

Risetime = 5.5 X 10 sec = 55 nsec

Trigger Generator

Ordinarily, the signal to be displayed also provides the trigger signal for the oscilloscope. In some instances, it may be desirable to reverse this situation and have the oscilloscope trigger the signal source. This can be done by connecting the + GATE OUT signal to the input of the signal source. Set the TRIGGER MODE switch to FREE RUN and adjust the TIME/CM switch for the desired display. Since the signal source is triggered by a signal that has a fixed time relationship to the sweep, the output of the signal source can be displayed on the CRT as though the Type 11B1 were triggered in the normal manner.

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section contains the theory of operation of the various circuits in the Type 11B1. The discussions are supported by block diagrams inserted in the text and by the schematics in Section 8. The relationship of the circuits in each block to those in other portions of the system is discussed in the description of that block.

The block diagram in Fig. 3-1 shows the basic elements of the Type 11B1. The input signal is selected from three sources: internal from the plug-in vertical amplifier unit through the internal (INT) trigger preamplifier; a low-voltage winding on the oscilloscope transformer (LINE); or from external sources (EXT TRIG OR HORIZ IN). The selected input signal is applied to the input cathode follower in the Trigger Generator circuit.

The output of the cathode follower is applied either to the Trigger Generator or directly to the Horizonal Preamplifier, depending upon the setting of the TIME/CM OR HORIZONTAL VOLTS/CM switch. The switching arrangement permits using any of the three inputs to provide horizontal deflection, or the input signal can be used to trigger the Sweep Generator which in turn provides an accurate time base for the horizontal sweep.

The input to the Horizontal Preamplifier is selected from the Sweep Generator or from the cathode follower in the Trigger Generator. The Horizontal Preamplifier splits the selected signal into a push-pull signal and applies it to the Horizontal Amplifier in the oscilloscope. The Horizontal Preamplifier aslo receives positioning voltages from the horizontal Position control on the oscilloscope and applies a corresponding offset voltage to the push-pull output signal.

Internal Trigger Preamplifier

The internal Trigger Preamplifier (see schematic) consists of a push-pull driven, single-ended output, emitter coupled amplifier driving a complementary emitter follower. The samples of the vertical deflection signal from the vertical amplifier plug-in units are applied in push-pull to the bases of transistors Q4 and Q14. If, for example, the signal increases the Q4 current, it decreases the current through Q14. Due to the common-emitter coupling, a current increase through Q4 compounds the current reduction in Q14. INT TRIG DC LEVEL R1 is adjusted during calibration so the "no signal" DC voltage delivered to the SOURCE switch is zero volts when the trace is vertically positioned near the center of the graticule.

The amplifier triggering signal from the paraphase amplifier is applied to the base of Q23, and in slightly attenuated form, to the base of Q33. The combined function of Q23 and Q33 is that of an emitter follower, but this special configuration overcomes a common limitation of conventional emitter followers by providing equally fast response for both positive- and negative-going portions of a signal. The output signal is applied to the SOURCE switch.

The SOURCE switch selects the triggering signal either from the Internal Trigger Preamplifier, the line, or from the EXT TRIG OR HORIZ IN connector. High-amplitude signals from the EXT TRIG OR HORIZ IN connector can be attenuated by setting the SOURCE switch to EXT ÷ 10. In the EXT ÷ 10 position, the externally applied signal is applied to a 10 × attenuator consisting of R28, R32, and R33. From the SOURCE switch, the selected signal is applied to the COUPLING switch.

In the AC position of the COUPLING switch, C30A, R32 and R33 provide a coupling time constant such that DC and very low-frequency AC signals are rejected. In the AC LF REJ position, the coupling time constant is decreased so that the AC rejection includes somewhat higher frequencies. This rejection is primarily intended to prevent triggering on the DC-level switching information encountered in alternate-trace operation of vertical plug-in units. The signal from the COUPLING switch is applied through a choice of coupling devices to the grid of cathode follower V43. Reed switch SW31 is included in the circuit to short out C31 if the TRIGGER MODE switch is left in AUTO BASE LINE—AUTO LEVEL when the TIME/CM OR HORIZONTAL VOLTS/CM switches are positioned for external horizontal deflection. SW35 and SW36 are included to switch in a voltage divider when switching the TIME/CM OR HORIZONTAL VOLTS/CM to the EXT HORIZ INPUT position.

Trigger Generator

For best triggering stability, the time-base generator requires trigger pulses that are representative of the triggering-signal frequency, but with greater wave-shape consistency than the signals generally encountered. The Trigger Generator converts the triggering signal into a pulse having a consitently fast risetime while retaining the characteristic repetition frequency of the triggering signal. The converted pulse is then used to trigger the time-base sweep. The block diagram in Fig. 3-2 shows the basic elements of the Trigger Generator.

The signal from the COUPLING switch and the coupling components is applied to the grid of cathode follower V43. D38 and D39 protect V43 from triggering signals of excessive amplitude. (V43 serves as an isolation stage when external horizontal deflection signals are used.)

The triggering signal from the cathode follower is applied to D43 and D46. D43, D46, R44, R45, R47, R48 and R49 operate in conjunction with the TIME/CM OR HORIZONTAL VOLTS/CM switch to route the signal to Q54 in the Trigger

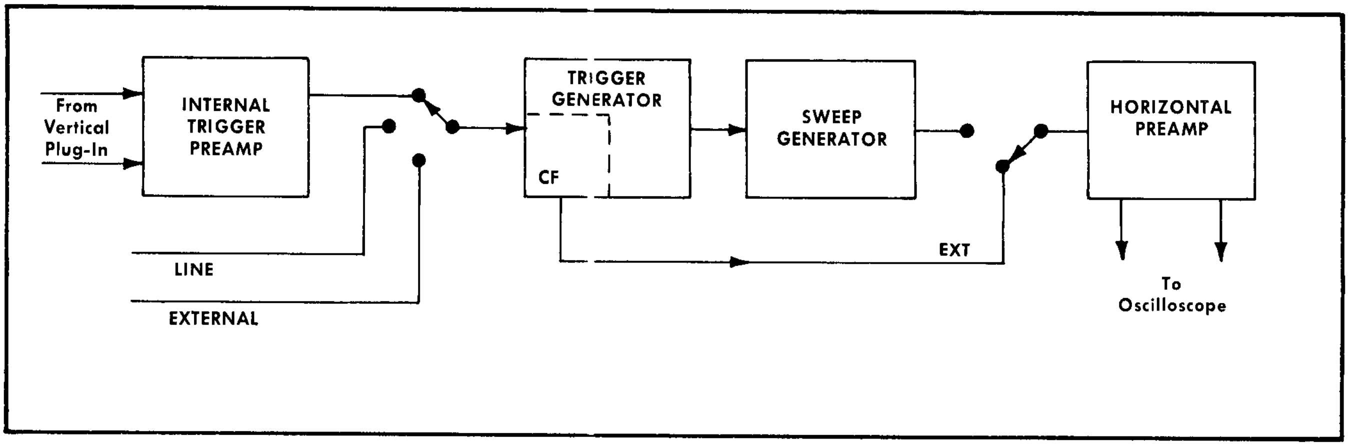


Fig. 3-1. Type 11B1 simplified block diagram.

Generator or to Q303 in the Horizontal Preamplifier, depending upon the setting of the switch. When the switch is in the TIME/CM positions, the current flow through R43, D43, R44 and R49 (in conjuncion with the —15 volts on R48) reverse biases D46 and prevents any signal from passing through D45 and D47. If the switch is in the EXT HORIZ INPUT position, the current flow through R43, D46, D47, R47, and R49 reverse biases D43 and prevents the signal from reaching the base of Q54.

Assuming that the TIME/CM OR HORIZONTAL VOLTS/CM switch is in the TIME/CM positions, the signal from V43 is applied via D43 to the base of Q54. Q54 and Q64 form a very sensitive current switch. If the instantaneous triggering signal voltage at the base of Q54 is more positive than the voltage established at the base of Q64 by the triggering LEVEL control and Q73, Q54 conducts. Unless the base voltages are very nearly equal, the two transistors cannot conduct at the same time due to the common-emitter coupling. Hence, as the positive-going portion of the triggering signal drives the base of Q54 from negative to positive (with respect to the base of Q64) the current through R54 switches from Q64 to Q54.

With the TRIGGER MODE switch set to AUTO BASE LINE-AUTO LEVEL, the voltages on the bases of Q54 and Q64

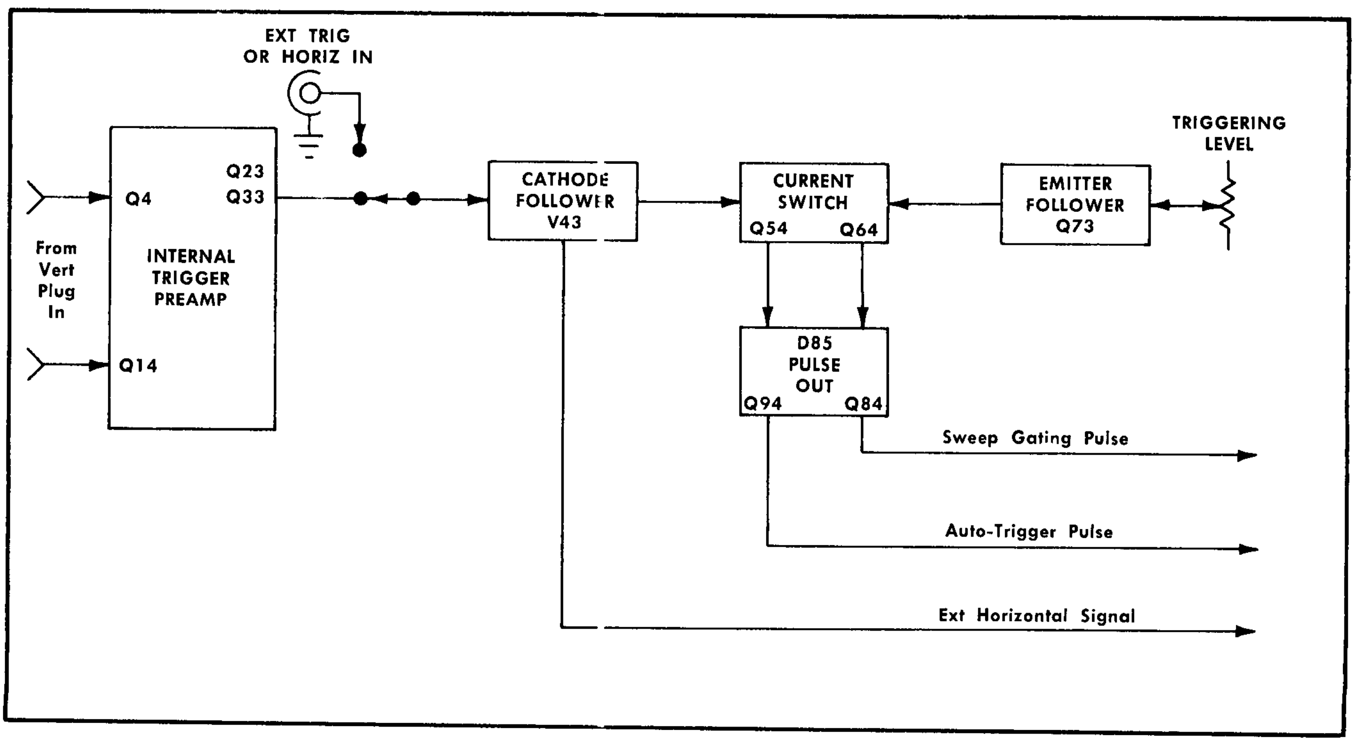


Fig. 3-2. Trigger Generator simplified block diagram.

are close to being equal due to the base of Q73 being connected to the base of Q54 through D52 and R51. This eliminates the need for setting the triggering LEVEL control when making measurements in which the voltage level of the trigger point is not important.

When the SLOPE switch is set to +, D66 shunts R66 and raises the collector voltage of Q64 to the point where very little current can flow through D65. Current flow through R81 divides; part going through R80 and part through L85 and D85. The current flow through L85 and D85 is sufficient only to bias D85 to its low-voltage state (see Fig. 3-3). With the arrival of a positive trigger, Q54 is biased into conduction, cutting off Q64 and forward biasing D55. The current flow through D55 flows through R80, increasing the voltage drop across R80. The resulting decrease in current flow through D80 makes more current available for D85, and D85 switches to its high-voltage state. The switching of D85 causes a sudden increase in the conduction of Q84. The increase in current through Q84 sends a trigger pulse to sweep-gating tunnel diode D135, and in addition, biases Q94 into heavier conduction, which sends a trigger pulse to the automatic trigger circuit.

If the SLOPE switch is set to —, D56 shunts R56. Q64 is kept cut off by the conduction of Q54. The arrival of a negative-going signal cuts off Q54 and permits Q64 to conduct. The conduction of Q64 through D65 and R80 reduces the current flow through D80. The decreased current flow through D80 makes more of the current flow through R81 available to tunnel diode D85, and D85 switches to its high-voltage state as previously explained.

As is characteristic of a tunnel diode, the transition from the low-voltage state to the high-voltage state occurs very rapidly, no matter how slowly the current increases (see Fig. 3-3). Therefore, this switching action of the tunnel diode provides the base of Q84 with a fast-rise negative-going pulse.

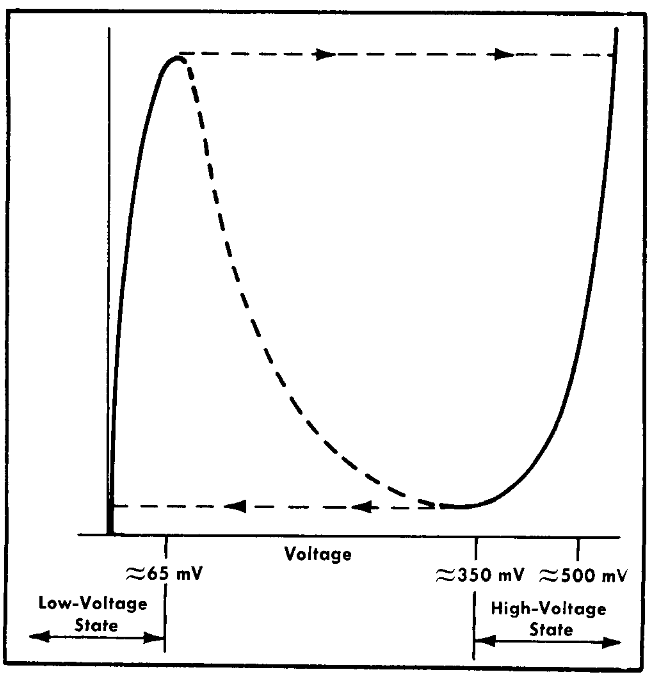


Fig. 3-3. Tunnel diode characteristics.

The steady-state current of Q84 passes through the high resistance of R84. When the tunnel diode suddenly drives the base of Q84 negative, the very fast rise of the pulse forces Q84 to draw upon the charge of C83 to supply the sudden current demand. Since the time constant of C83 and its charge path are very short, the change in the charge on C83 is accomplished very quickly, and the current through Q84 decays very rapidly to a steady state value, even though the tunnel diode may remain in its high-voltage state.

When the triggering signal resets the tunnel diode to its low-voltage state, Q84 turns off, but rapidly recovers to its steady-state conduction level. The output pulses produced at reset are insignificant and have no effect on the Sweep Generator.

Sweep Generator

The Sweep Generator (see Fig. 3-4) produces four simultaneous output signals:

1. A positive-going sawtooth that is applied to the Horizontal Preamplifier by setting the TIME/CM OR HORIZONTAL VOLTS/CM switch to any of the TIME/CM positions. The positive-going sawtooth is also available for external use at the SWEEP OUT front-panel connector.
2. A negative-going CRT unblanking pulse with the same duration as the sweep sawtooth rise. This pulse is coupled to the oscilloscope CRT when the TIME/CM or HORIZONTAL VOLTS/CM switch is set to any of the TIME/CM positions.
3. A positive-going pulse with the same duration as the sawtooth rise. This pulse is coupled to the front-panel + GATE OUT connector for external use.
4. A negative-going multi-trace sync pulse occurring at the end of the sweep-sawtooth rise. This pulse is coupled to the vertical plug-in unit interconnecting socket. The pulse is used to switch channels in a multi-trace plug-in unit when operating in the alternate mode.

In most applications, each cycle of events is started by a trigger pulse from the Trigger Generator. However, it is also possible to free run the Sweep Generator; that is, the end of one cycle causes the next cycle to begin. The desired operation is selected by the TRIGGER MODE switch. The five operating modes provided by the TRIGGER MODE switch are described in Section 2 of this manual.

The Sweep Gating Multi (see Fig. 3-4) is an electronic switch that drives the Gate Amplifier to turn the Disconnect Diode on and off. When the Disconnect Diode is switched off, the Miller Runup Integrator begins to produce a sawtooth signal. A sample of the sawtooth is fed back to the Gate Enable Multi to reset the Sweep Gating Multi when the sawtooth reaches a certain amplitude. As the Sweep Gating Multi resets, the Disconnect Diode is switched on, and the Miller Runup resets to form the retrace or falling portion of the sawtooth. Following a short stabilization period, the Sweep Generator is ready to repeat the sequence.

The TRIGGER MODE switch provides five ways to switch the Sweep Gating Multi so that the sweep begins:

1. In NORM, the multi is switched by a pulse from the Trigger Generator.

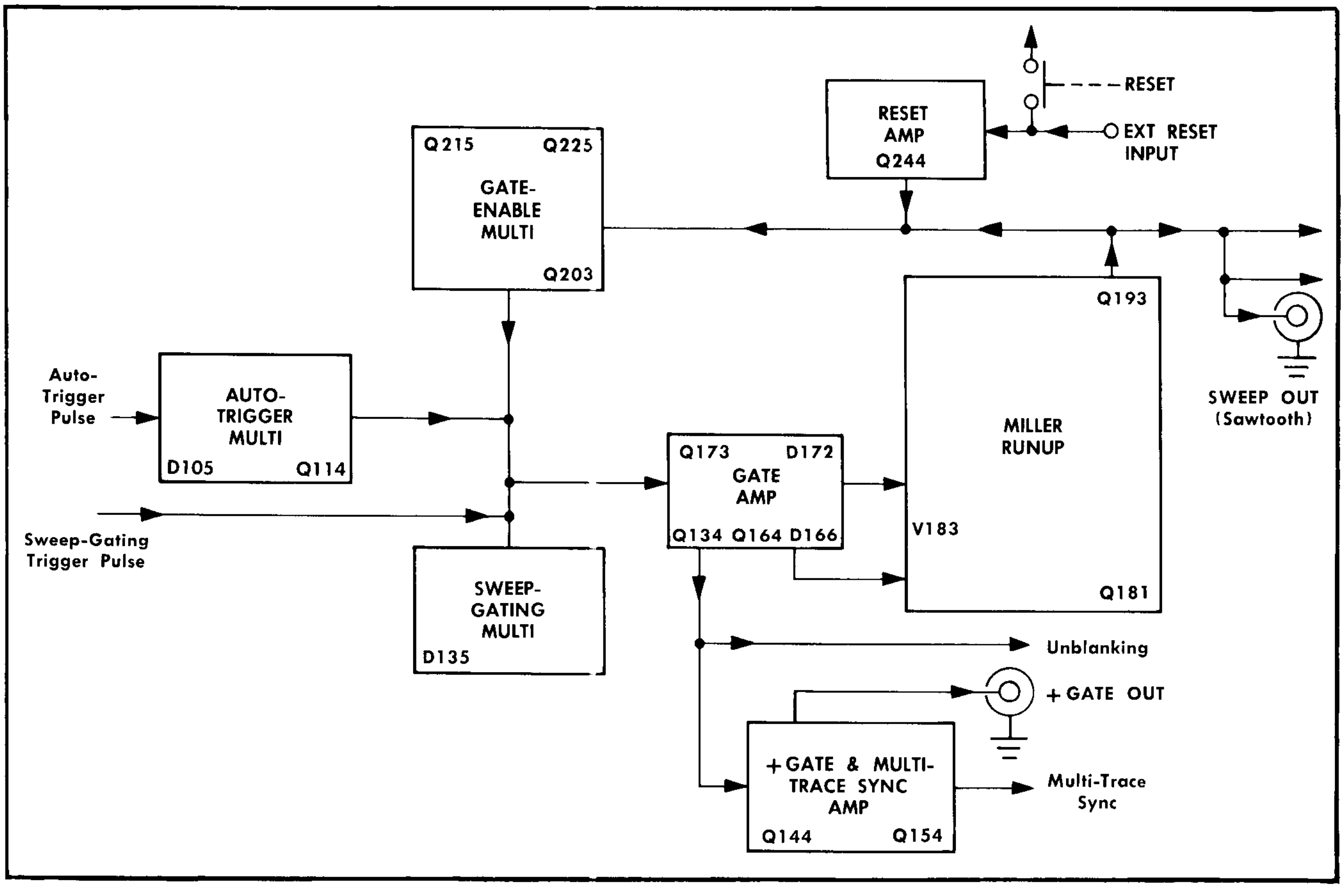


Fig. 3-4. Sweep Generator block diagram.

2. In SINGLE SWEEP, two pulses are required to start each sweep. First, a pulse from the Reset Amplifier (originating at the RESET pushbutton or from an external device through pin F of J101 on the rear panel of the oscilloscope) resets the Gate Enable Multi. Then, after reset, the Sweep Gating Multi can be switched by a pulse from the Trigger Generator.

3. FREE RUN results in recurrent sweeps that are independent of any triggering signal. The retrace portion of one sawtooth switches the multi to begin the next sawtooth.

4. The AUTO BASE LINE-MANUAL LEVEL position is a combination of NORM and FREE RUN. If there are no trigger pulses coming from the Trigger Generator, the Auto Trigger Multi permits the sweep gating circuit to "free run". When a pulse comes from the Trigger Generator, the Auto-Trigger Multi switches the sweep gating circuit to the "normal" condition, but this first trigger pulse does not start a sweep. If the first trigger pulse is followed by a second within about 80 ms, the sweep gating circuit switches and a sweep begins. If trigger pulses continue to arrive every 80 ms or less, the Auto Trigger Multi remains in the "normal" condition and each sweep is triggered sweep. Whenever the period between trigger pulses exceeds 80 ms, the Auto Trigger Multi reverts to the free-run condition until the next trigger pulse arrives.

5. Operation in the AUTO BASE LINE-AUTO LEVEL position is the same as the operation in the AUTO BASE LINE-MANUAL LEVEL position, except that it is unnecessary to adjust the LEVEL control to trigger the time base with the triggering signal if the triggering signal is a low duty-cycle, negative-going pulse of about one centimeter or more in amplitude.

The following discussion is based on the Sweep Generator schematic in Section 6. The first part of the discussion pertains to operation with the TRIGGER MODE switch set to NORM.

Quiescent Conditions. In the quiescent state; that is, when the sweep generator is triggerable but no sweep is being generated, the circuit conditions are as follows:

Q225 is conducting and Q215 is cut off. Q225 establishes current through the parallel arrangement of D135, D131, and D122. Tunnel diode D135 is in the low-voltage state (see Fig. 3-3) so that Q134 is cut off. With Q134 cut off, its collector voltage goes positive and forward biases Q164 and Q173. The conduction of Q164 forward biases Disconnect Diode D166.

The conduction of Q164 through R134, R136, R173, R171, and R164 produces about +6.5 volts at the collector of Q134. This voltage is divided to about zero volts by R401 and R403 in the unblanking circuit (see Interconnecting Plug schematic). Q144 is conducting heavily, but its collector and the + GATE OUT output connector are clamped at about −0.6 volt by D144. Q154 is cut off and the voltage on the multi-trace sync-pulse bus is about +5 volts.

With Disconnect Diode D166 conducting, the grid of V183 is clamped at about zero volts. D172 and Q173 form a servo loop with the Miller Integrator circuit which clamps the sawtooth output bus at about +2.4 volts to provide a stable, repeatable sawtooth starting volage.

V183, Q181, and Q193 form a Miller Runup Integrator. The tube and transistors are clamped at moderate conduction levels by D166, D172, Q173, and Q164. The Q193 emitter voltage is about +1.8 volts, forward biasing D200 and D201. Q203 conducts heavily and reverse biases D203. Q225 is held on by the divider consisting of R232, R231, R229, R215 and R216.

NORM Mode Operating Cycle. With the TRIGGER MODE switch set to NORM, Q114 has no collector supply and the Auto Trigger Multi is disabled. A sweep gating trigger pulse turns on D130 and turns off D131. The current through Q225 does not decrease when D131 cuts off, but is transferred instead to tunnel diode D135, rapidly switching it to its high-voltage state.

When the tunnel diode switches, Q134 turns on. The negative voltage step at the collector of Q134 provides the oscilloscope CRT unblanking pulse. Q144 is cut off by the negative step, forming the rise of the + GATE OUT signal. Q154 remains cut off.

The negative-going voltage step at the collector of Q134 is applied to the emitter of Q164, turning the transistor off. Thus, Disconnect Diode D166 is rapidly switched off.

When the Disconnect Diode (D166) turns off, the current through timing resistor R_t does not cease, but instead begins to charge timing capacitor C_t. As the timing capacitor charges, the grid of V183 goes negative. The inverted and greatly amplified change at the collector of Q181 is fed back to the timing capacitor and opposes the grid voltage change. (The positive-going change also turns off D172). This action persists throughout the sawtooth period and limits the total grid voltage change to less than 0.1 volt. Since the voltage drop across the timing resistor is held nearly constant, the current through the resistor is essentially a fixed value. This fixed current flows into the timing capacitor, producing a linearly increasing voltage (sawtooth) across the capacitor. D166 is a special diode that exhibits very low leakage under reverse-bias conditions. This characteristic prevents the diode from effectively altering the timing resistance value.

The rate of the sawtooth rise is a function of the RC time constant of the timing resistor and capacitor, and of the voltage magnitude at the negative end of the timing resistor. Increasing the voltage across the timing resistor increases the current into the timing capacitor and therefore increases the sawtooth rate of rise. The voltage across the timing resistor can be varied over about a 9-volt range by adjusting Swp Cal R180W shown on the Timing Switch schematic. R180W is adjusted during calibration to establish the correct absolute rate of sawtooth rise and effects all sweep rates equally.

The VARIABLE front-panel control operates in much the same manner as the Swp Cal control, but permits the operator to obtain uncalibrated sweep rates as must as two and one-half times slower than the calibrated rates obtained with the control set fully clockwise.

The sawooth signal at the collector of Q181 is available to the Horizontal Preamplifier through the TIME/CM OR HORIZONTAL VOLTS/CM switch and is applied also to the base of Q193. The rising voltage at the emitter of Q193 supplies the front-panel SWEEP OUT connector output signal and charges holdoff capacitor C_{ho} through D200 and D201. As the holdoff capacitor charges, the base and emitter of Q203 go more positive. D203 becomes forward biased and the positive-going change at the emitter of Q203 drives the base of Q225 more positive. As the positive-going base voltage of Q225 equals and then surpasses the base voltage of Q215, the current through R225 switches regeneratively from Q225 to Q215.

When Q225 turns off, tunnel diode D135 reverts to its low-voltage state. The time duration of the sweep-gating trigger pulse, which started the cycle of operation is always considerably less than the time duration of the sweep. However, once the sweep-gating pulse switches the tunnel diode to its high-voltage state, additional trigger pulses can have no further affect on the operation (see Fig. 3-3). The tunnel diode reverts to its low-voltage state only when Q225 turns off.

As the tunnel diode reverts to its low-voltage state, Q134 turns off. The collector voltage of Q134 rises, blanking the oscilloscope CRT. Q144 turns on, forming the falling portion of the + GATE OUT connector output signal and driving Q154 into conduction. C149 quickly discharges and Q154 again turns off. Thus, the multi-trace sync pulse is negative-going and has a very short duration.

The positive-going step at the collector of Q134 turns on Q164, forward biasing Disconnect Diode D166. Since the timing capacitor still holds the charge developed during the sweep, D172 remains back biased. The timing capacitor begins to discharge through D166, Q164, and the series-parallel combination of R134, R136, R161, and R173. D172 does not conduct until the charge is nearly depleted.

The removal of the timing capacitor charge forms the retrace of falling portion of the output sawtooth. As the emitter voltage of Q193 falls, D200 becomes back biased. During the sawtooth rise, hold-off capacitor C_{ho} charges through D200 and D201, but now must discharge through the high resistance of R200 and R201. Thus, timing capacitor C_t will have discharged, restoring the Miller Runup circuit to its quiescent condition before the base voltage of Q203 reaches its quiescent level. This time lag can be varied slightly by adjusting the front-panel HF STABILITY control. The need for this variable time lag is discussed in a later paragraph.

As the hold-off capacitor discharges, the emitter voltage of Q203 falls. However, this falling voltage does not immediately cause the current through R225 to switch to Q225. The voltage drop across R215 and Q216, produced by the conduction of Q215, is divided by R232, R231, and R229 and keeps Q225 cut off. When the emitter voltage of Q203 becomes low enough to forward bias D213, the added current through R232, R231, R229 and R215 pulls down the base voltage of Q225 and switches the current through R225 and Q225. The entire sweep generator is then restored to the quiescent condition previously described.

HF STABILITY R201 permits the operator to vary slightly the time between the completion of a sweep and the instant when the sweep generator again becomes triggerable. As

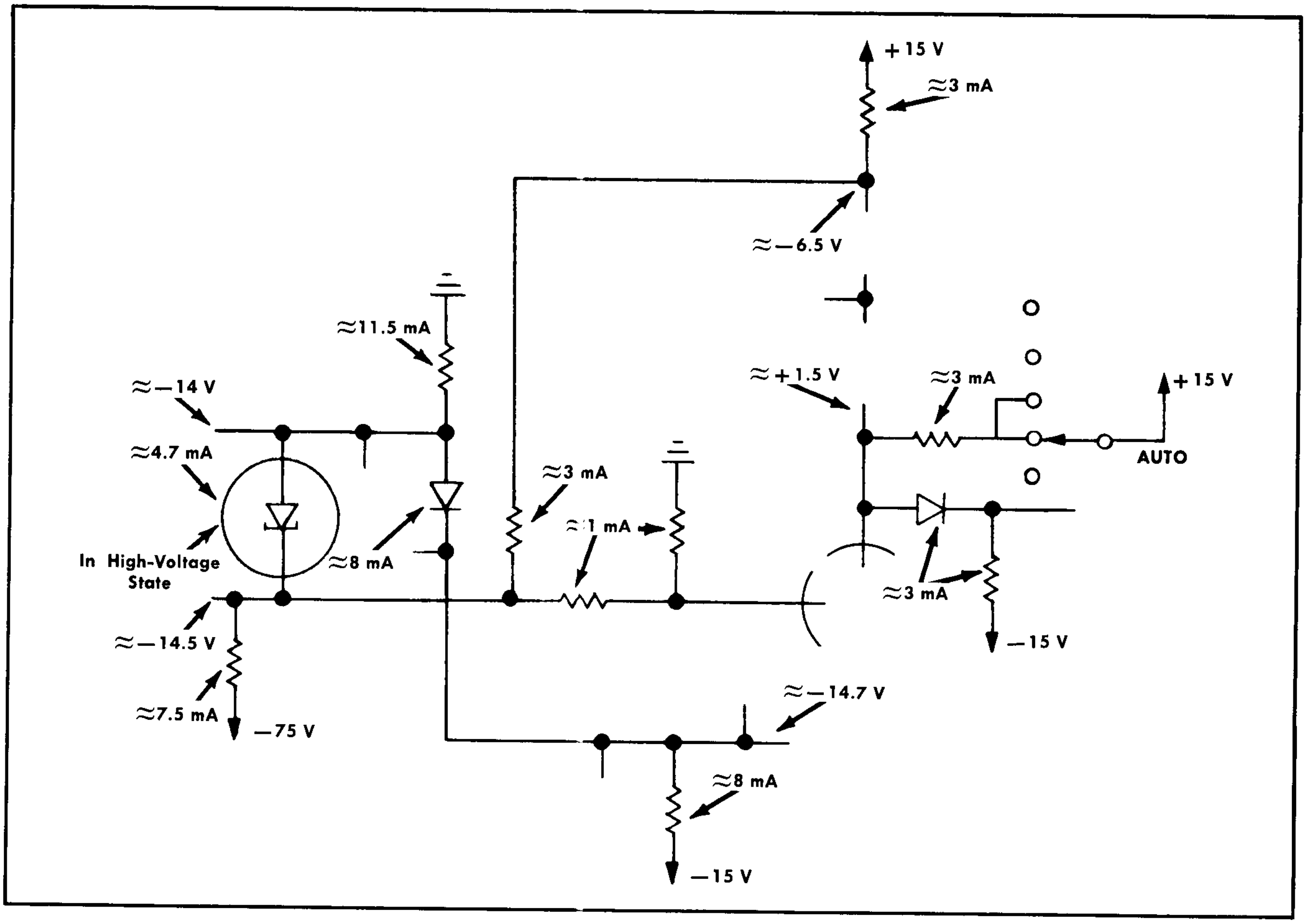


Fig. 3-5. Auto Trigger Multi static conditions.

Q225 turns on after sawtooth retrace, a very short but sometimes significant amount of time is required for the current through tunnel diode D135 to reach the quiescent level. This recovery time is significant only under the following conditions:

1. When the sweep rate is faster than about 0.2 μs/cm (unmagnified).

2. When the triggering frequency is above approximately 5 MHz.

3. When the relationship between the sweep rate and triggering frequency is such that the sweep-gating trigger pulse tends to trigger each new sweep while the tunnel diode current is approaching the quiescent level.

A display obtained under these conditions may jitter horizontally. The operator can minimize and often eliminate the jitter by resetting the HF STABILITY control. This either advances or delays the turn-on time of Q225 so that D135 can stabilize at the quiescent level in the interval between sweep-going trigger pulses.

FREE RUN Mode. The FREE RUN mode of operation differs from the NORM mode as follows:

When the TRIGGER MODE switch is set to FREE RUN, R122 is connected to + 15 volts and D122 is reverse biased. The current through Q225, carried by D122 in NORM operation, is now carried by tunnel diode D135. As Q225 turns on following a sawtooth retrace, D135 switches to its high-voltage state without waiting for a sweep-gating trigger pulse (moreover, at low sweep speeds the trigger pulses have no effects on the overall operation). Thus, the completion of one sweep causes the next to begin.

AUTO mode. The basic operation of the Auto Trigger Multi was described previously in the Sweep Generator block diagram discussion. The conduction state of the Auto Trigger Multi determines whether D122 is forward biased or reverse biased. When forward biased, the Sweep Generator operates exactly as described for the NORM mode. When D122 is reverse biased, the Sweep Generator operates as described for the FREE RUN mode.

When C102 has received no trigger pulse for more than 80 ms, tunnel diode D105 goes to its high-voltage state (see Fig. 3-3) and Q114 is turned off. D114 conducts through R116, reverse biasing D122, and the Sweep Generator free runs. The current paths, static current magnitude, and voltages with the circuit in this condition are shown in Fig. 3-5.

The first portion of the following discussion describes the sequence of events caused by a single auto-trigger pulse. The only effect of such a pulse would be an interruption of the free-running sweeps. The latter portion of the discussion describes how triggered sweeps are produced by triggering signals occurring more often than every 80 ms.

When a current pulse is applied to C102, D102 conducts by diverting current from tunnel diode D105. The tunnel diode rapidly switches to its low-voltage state, driving Q114 into saturation. The collector of Q114 drops to about —14 volts, reverse biasing D114, and D122 turns on. (D122 may turn on while a "free-run initiated" sweep is in progress. If this occurs, the Sweep Generator will complete the sweep and become triggerable at the end of the usual sweep hold-off period.)

As Q114 goes into saturation, the greater portion of its collector current passes through R114 and begins to discharge C114. The voltage across C114 decreases and D113 begins to conduct, decreasing the current through R112. The current through R105, no longer carried by R112, is diverted to tunnel diode D105, switching it to its high-voltage state. (By this time, the auto-trigger pulse current through D102 has subsided.) Q114 turns off, but C114 must recharge before the collector voltage of Q113 can rise. Hence, D114 remains off and D122 remains on.

As Q114 turns off, C114 begins to charge through R114 and R116 in parallel with R113. When the voltage at the junction of C114 and R114 reaches about —7 volts, D113 turns off and C114 continues to charge through R114 and R116. D114 becomes forward biased when the collector of Q114 reaches about zero volts. D122 then cuts off and the Sweep Generator returns to its free-running condition.

As previously stated, the Auto Trigger Multi probably will turn on D122 while a free-run initiated sweep is in progress. If this happens, the sweep generator cannot become triggerable until the end of the hold-off period for this sweep, but from then on, every sweep is a triggered sweep if the repetition rate of the auto-trigger and sweep-gating trigger pulse is greater than about 20 pulses/second.

If an auto-trigger pulse arrives at C102 after tunnel diode D105 has reset to its high state, but before C114 has completely recharged, D105 again switches to its low state. Q114 turns on and discharges the partially recharged C114 as discussed previously. Additional auto-trigger pulses that arrive while the tunnel diode is in its low state have no significant effect on the circuit. Pulses that arrive while the tunnel diode is in its high state switch the diode back to its low state if the current through D113 has decreased sufficiently. Thus auto-trigger pulses with a repetition rate greater than about 20 pulses/second will repeatedly switch the multi, preventing C114 from charging enough to turn on D114. With D114 turned off continously, the Sweep Generator operates exactly as it does in the NORM mode.

SINGLE SWEEP Mode. As described previously in the NORM mode discussion, the retrace portion of a sawtooth normally allows discharging hold-off capacitor C_{ho} to pull down the base voltage of Q203 to near zero volts. D213 then conducts and turns on Q225. However, in the SINGLE SWEEP mode, R202 is connected to +15 volts, forming a divider with R200 and R201. This divider stops the hold-off capacitor discharge at about +4.5 volts. Under these conditions, the emitter of Q203 does not drop far enough to cause D213 to conduct, and Q22 cannot turn on. D200 is reverse biased and D201, in series with the divider, remains on.

Since Q225 does not turn on following a sweep, the Sweep Generator is locked in an inoperative state. With Q215 on, Q234 is held cut off and READY lamp B234 remains unlit, indicating the inoperative state of the Sweep Generator. The Sweep Generator can be reset to the operative state either by pressing the RESET button or by applying a positive-going pulse to pin F of J101 on the rear panel of the oscilloscope. Externally applied pulses must have a reasonably fast rise for adequate energy to pass through C270.

In SINGLE SWEEP mode, Q244 is normally off. The RESET button is connected to a divider consisting of R238 and R239. When the RESET button is pressed, neon lamp B241 fires, supplying a fast-rise turn-on pulse to Q244. The negative-going pulse at the collector of Q244 is applied to the base of Q203. (At this time, D201 serves its only purpose: it is reverse biased by the pulse so that the hold-off capacitor will not pass the pulse to ground.) The pulse pulls down the emitter of Q203 and turns on D213. Q225 and Q234 turn on and Ready lamp B234 lights to indicate that the Sweep Generator is ready to be triggered. At the end of one conventionally triggered sweep, the generator again becomes inoperative.

Horizontal Preamplifier

The block diagram in Fig. 3-6 shows the basic subcircuits of the Horizontal Preamplifier. The input signal is selected from the Sweep Generator or from an external source, depending on the setting of the TIME/CM HORIZONTAL VOLTS/CM switch. The push-pull output of the preamplifier connects to the input of the oscilloscope horizontal amplifier through pins 8 and 9 of the interconnecting plug. Gain of the preamplifier may be increased up to 50 times by setting the MAGNIFIER switch as described in Section 2.

Emitter follower Q303 provides a high-impedance load for cathode follower V43 in the trigger generator whenever the TIME/CM OR HORIZONTAL VOLTS/CM switch is placed in the EXT HORIZ INPUT position. The output of Q303 is applied to the TIME/CM OR HORIZONTAL VOLTS/CM switch. The input of Q313 is the external deflection signal from Q303 or the sawtooth from the Sweep Generator, depending on the setting of the TIME/CM OR HORIZONTAL VOLTS/CM switch. Q333 couples the horizontal positioning voltage to Q344 and provides a low source impedance.

Refer to the Horizontal Preamplifier schematic in Section 6. The following explanation of circuit operation assumes that the Horizontal Preamplifier input signal is the sawtooth from the Sweep Generator.

The sawtooth applied to Q313 swings symmetrically around approximately +8 volts, rising from about +3 to +13 volts. The oscilloscope horizontal Position controls provide a means of varying the base voltage of emitter follower Q333 from about zero volts to about +15 volts. The output of Q333 is applied to the base of Q344, providing a range of adjustment that exceeds peak voltages of the sawtooth at the base of Q324.

Transistors Q324, Q353, Q344 and Q363 form a paraphase amplifier with degenerative emitter coupling through R_{mag}. The two transistors in each side of the paraphase are compound connected to achieve the high effective gain needed to make the stage gain dependent only upon the coupling resistor (R340). Feedforward resistors R355 and R365 feed

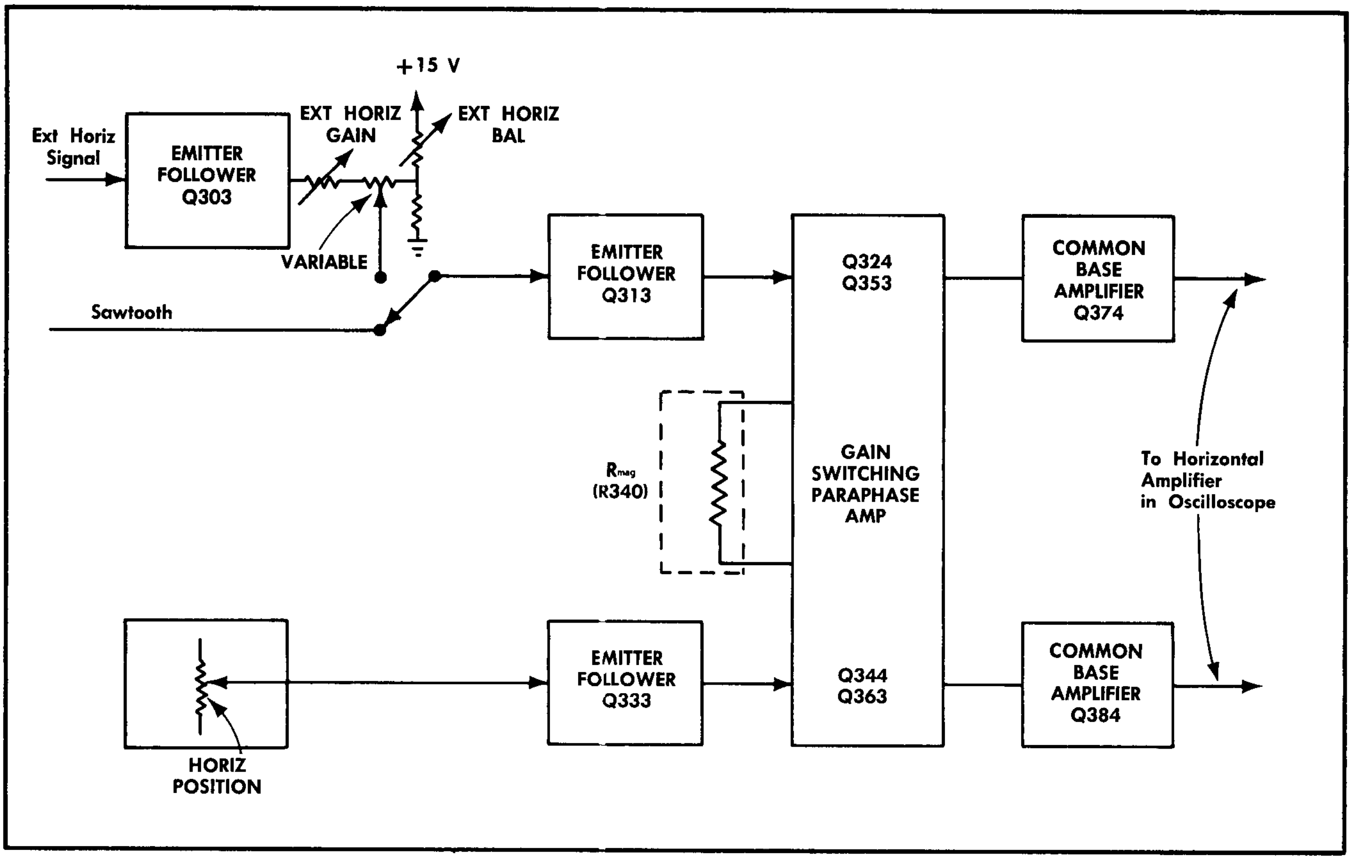


Fig. 3-6. Horizontal Preamp simplified block diagram.

signals around each half of the paraphase amplifier stage to cancel the signal current generated in the stage due to the supply-return resistors R321 and R341. This cancellation has two beneficial effects: (1) it eliminates any common-mode current at the stage output even though the stage is driven single-ended, and (2) it makes the gain of the stage exactly proportional to the conductance of R_{mag}. R_{mag} is about 2.5 k when no magnification is used (×1) and is decreased to about 50 Ω for 50× magnification.

Diodes D324 and D349 and resistor R343 provide the amplifier with a self-limiting feature which prevents transistors Q363 and Q384 from becoming cut off when sweep voltages reach left-of-screen values. When the paraphase amplifier is overdriven in the left-of-screen direction by a signal equivalent to about 10 centimeters left of center, diode D349 begins to conduct, cutting off transistor Q344. The remainder of the amplifier now remains in a static condition, but with the capability of achieving a fast recovery and generating screen at the fastest sweep rates.

The output signals from the paraphase amplifier are applied to common-base stage Q374 and Q384. The collectors of Q374 and Q384 are near ground potential and connect to the low-impedance input of the oscilloscope horizontal amplifier. Because of this low input impedance, the Type 11B1 Horizontal Preamplifier provides a current output at essentially a fixed voltage.

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance and troubleshooting of the Type 11B1.

PREVENTIVE MAINTENANCE

General

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 this instrument. The severity of the environment to which the Type 11B1 is subjected determines the frequency of maintenance. A convenient time to perform preventime maintenance is preceding recalibration of the instrument.

Cleaning

The Type 11B1 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical conduction path.

The covers of the indicator oscilloscope minimize the amount of dust which reaches the interior of the Type 11B1. Operation of the system without the indicator oscilloscope covers in place necessitates more frequent cleaning. When the Type 11B1 is not in use, it should be stored in a protected location such as a dust-tight cabinet.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents.

Exterior. Loose dust accumulated on the outside of the Type 11B1 can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

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-velocity air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning ceramic terminal strips.

Lubrication

General. The reliability of potentiometers, rotary switches and other moving parts can be maintained if they are kept properly lubricated. Use a cleaning-type lubricant (e.g., Tektronix Part No. 006-0218-00) on switch contacts and the interconnecting plug. Lubricate switch detents with a heavier grease (e.g., Tektronix Part No. 006-0219-00). Potentiometers which are not permanently sealed should be lubricated with a lubricant which does not affect electrical characteristics (e.g., Tektronix Part No. 006-0220-00). The potentiometer lubricant can also be used on shaft bushings. Do not over lubricate. A lubrication kit containing the necessary lubricants and instructions is available from Tektronix, Inc. Order Tektronix Part No. 003-0342-01.

Visual Inspection

The Type 11B1 should be inspected occasionally for such defects as broken connections, broken or damaged ceramic strips, improperly seated transistors or nuvistors, 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 a recurrence of the damage.

Transistor and Nuvistor Checks

Periodic checks of the transistors and nuvistors in the Type 11B1 are not recommended. The best check of transistor or nuvistor performance is its actual operation in the instrument. More details on checking transistor and nuvistor operation is given under Troubleshooting.

Recalibration

To ensure accurate measurements, check the calibration of this instrument after each 1000 hours of operation or every six months if used infrequently. In addition, replacement of components may necessitate recalibration of the affected circuits. Complete calibration instructions are given in Section 5.

The Performance Check/Calibration Procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed and/or corrected by recalibration.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting of the Type 11B1, if trouble develops. 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. See the Circuit Description section for complete information.

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in Section 8. The component number and electrical value of each component in this instrument are shown on the diagrams. Important voltages and waveforms are also shown on the diagrams.

Switch Wafer Identification. Switch wafer shown on the diagrams are coded to indicate the position of the wafer in the complete switch assembly. The numbered portion of the code refers to the wafer number counting from the front, or mounting end of the switch, toward the rear. The letters F and R indicate whether the front or rear of the wafer performs the particular switching function. For example, a wafer designated 2R indicates that the rear of the second wafer is used for this particular switching function.

Wiring Color-Code. All insulated wire and cable used in the Type 11B1 is color-coded to facilitate circuit tracing. Signal carrying leads are identified with one or two colored stripes. Voltage supply leads are identified with three stripes to indicate the approximate voltage using the EIA resistor color code. A white background indicates a positive voltage and a tan background indicates a negative voltage. The widest stripe identifies the first color of the code. Table 4-1 gives the wiring color-code for the power-supply voltages used in the Type 11B1.

TABLE 4-1

Power Supply Wiring Color Code

Supply	Background Color	First Stripe	Second Stripe	Third Stripe
−75 volt	Tan	Violet	Green	Black
−15 volt	Tan	Brown	Green	Black
+15 volt	White	Brown	Green	Black
+100 volt	White	Brown	Black	Brown
+300 volt	White	Orange	Black	Brown

Resistor Color-Code. In addition to the brown composition resistors, some metal-film resistors and some wire-wound resistors are used in the Type 11B1. The resistance values of wire-wound resistors are printed on the body of the component. The resistance values of composition resistors and metal-film resistors are color-coded on the components (some metal-film resistors may have the value printed on the body) with EIA color-code. The color is read starting with the stripe nearest the end of the resistor. Composition resistors have four stripes which consist of two significant figures, a multiplier and a tolerance value (see Fig. 4-1). Metal-film resistors have five stripes consisting of three significant figures, a multiplier and a tolerance value.

Capacitor Marking. The capacitance values of common disc capacitors and small electrolytics are marked in microfarads on the side of the component body. The white ceramic capacitors used in the Type 11B1 are color-coded in picofarads using a modified EIA code (see Fig. 4-1).

Diode Color-Code. The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes or a dot. For most silicon or germanium diodes with a series of stripes, the color-code aslo indicates the type of diode or identifies the Tektronix Part Number using the resistor color-code system (e.g., and diode color-code blue- or pink-brown-gray-green indicates Tektronix Part Number 152-0185-00). The cathode and anode end of metal-encased diodes can be identified by the diode symbol marked on the body.

Troubleshooting Equipment

The following equipment is useful for troubleshooting the Type 11B1.

1. Transistor Tester

Description: Tektronix Type 575 Transistor-Curve Tracer or equivalent.

Purpose: To test the semiconductors used in this instrument.

2. Volt-ohmmeter

Description: 20,000 ohms/volt. 0-500 volts DC.

Accurate within 3%.

Test probes must be well insulated.

Purpose: To check voltage and for general troubleshooting in this instrument.

3. Test Oscilloscope

Description: DC to 50 MHz frequency response, 50 millivolts to 50 volts/division deflection factor. Use a 10× probe.

Purpose: To check waveforms in the instrument.

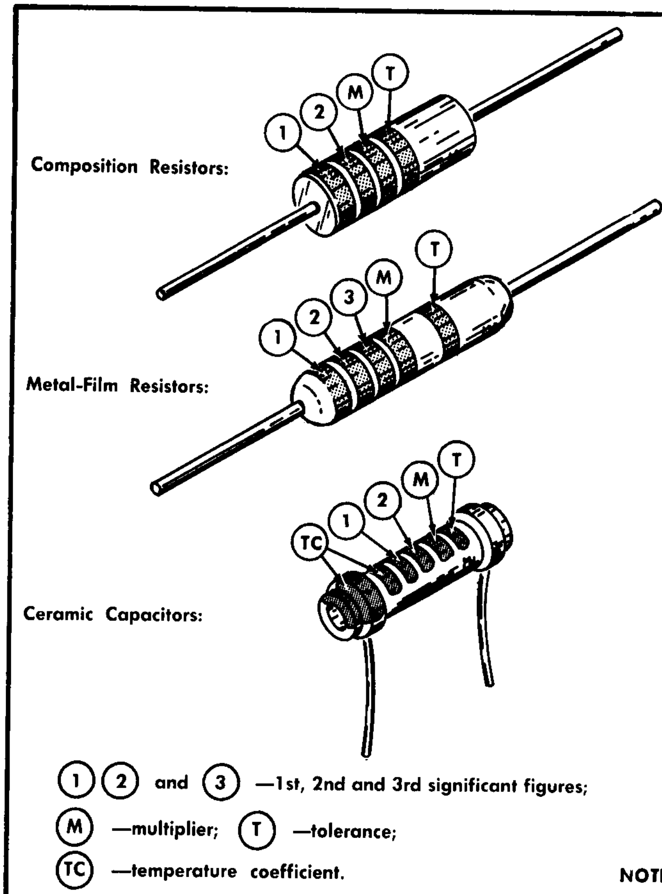
4. Plug-In Extension.

Description: 32-pin rigid extender. Tektronix Part No. 013-0077-00.

Purpose: Permits operation of the unit outside the plug-in compartment for better accessibility during troubleshooting.

Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks ensure proper connection, operation and calibration. If the trouble is not located by these checks, the remaining steps



Resistor and Capacitor Color Code

Color	Significant Figures	Multiplier		Tolerance	
		Resistors	Capacitors	Resistors	Capacitors
Silver	---	10^{-2}	---	±10%	---
Gold	---	10^{-1}	---	±5%	---
Black	0	1	1	---	±20% or 2 pF*
Brown	1	10	10	±1%	±1% or 0.1 pF*
Red	2	10^2	10^2	±2%	±2%
Orange	3	10^3	10^3	±3%	±3%
Yellow	4	10^4	10^4	±4%	+100% −0%
Green	5	10^5	10^5	±0.5%	±5% or 0.5 pF*
Blue	6	10^6	10^6	---	---
Violet	7	---	---	---	---
Gray	8	---	10^{-2}	---	+80% −20% or 0.25 pF*
White	9	---	10^{-1}	---	±10% or 1 pF*
(none)	---	---	---	±20%	±10% or 1 pF*

*For capacitance of 10 pF or less.

NOTE: (T) and/or (TC) color code for capacitors depends upon manufacturer and capacitor type. May not be present in some cases.

Fig. 4-1. Color-code for resistors and ceramic capacitors.

aid in locating the defective component. When the defective component is located, it should be replaced following the replacement procedures given under Corrective Maintenance.

1. Check Control Setting. 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 the Operating Instructions section of this manual.

2. Check Associated Equipment. Before proceeding with troubleshooting of the Type 11B1, 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. The indicator oscilloscope and vertical plug-in unit can be checked for proper operation by substituting another time-base unit which is known to be operating properly (preferably another Type 11B1 or similar unit). If the trouble persists after substitution, the indicator oscilloscope and/or vertical plug-in unit is defective.

3. Check Instrument Calibration. Check the calibration of this instrument, or the affected circuit if the trouble exists in one circuit. The apparent trouble may only be a result of misadjustment or may be corrected by calibration. Complete calibration instructions are given in the Calibration Section of this manual.

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

5. Isolate Trouble to a Circuit. To isolate a trouble to a circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. For example, sweep will not run in any setting of TRIGGER MODE switch indicates that the sweep generator circuit is probably at fault. When trouble symptoms appear in more than one circcuit, check all affected circuits by taking voltage and waveform readings. Also check for the correct output signals at the front-panel output connectors with a test oscilloscope. If the signal is correct, the circuit is working correctly up to that point. For example, correct sawtooth output indicates that the Sweep Trigger and Sweep Genera-or circuits are operating correctly.

Fig. 4-2 provides a guide to aid in locating a defective circuit. This chart may not include checks for all possible defects; use steps 6 and 7 in such cases. Start from the top of the chart and perform the given checks on the left side of the page until a step is found which is not correct. Further checks and/or the circuit in which the trouble is probably located are listed to the right of this step.

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 volt-

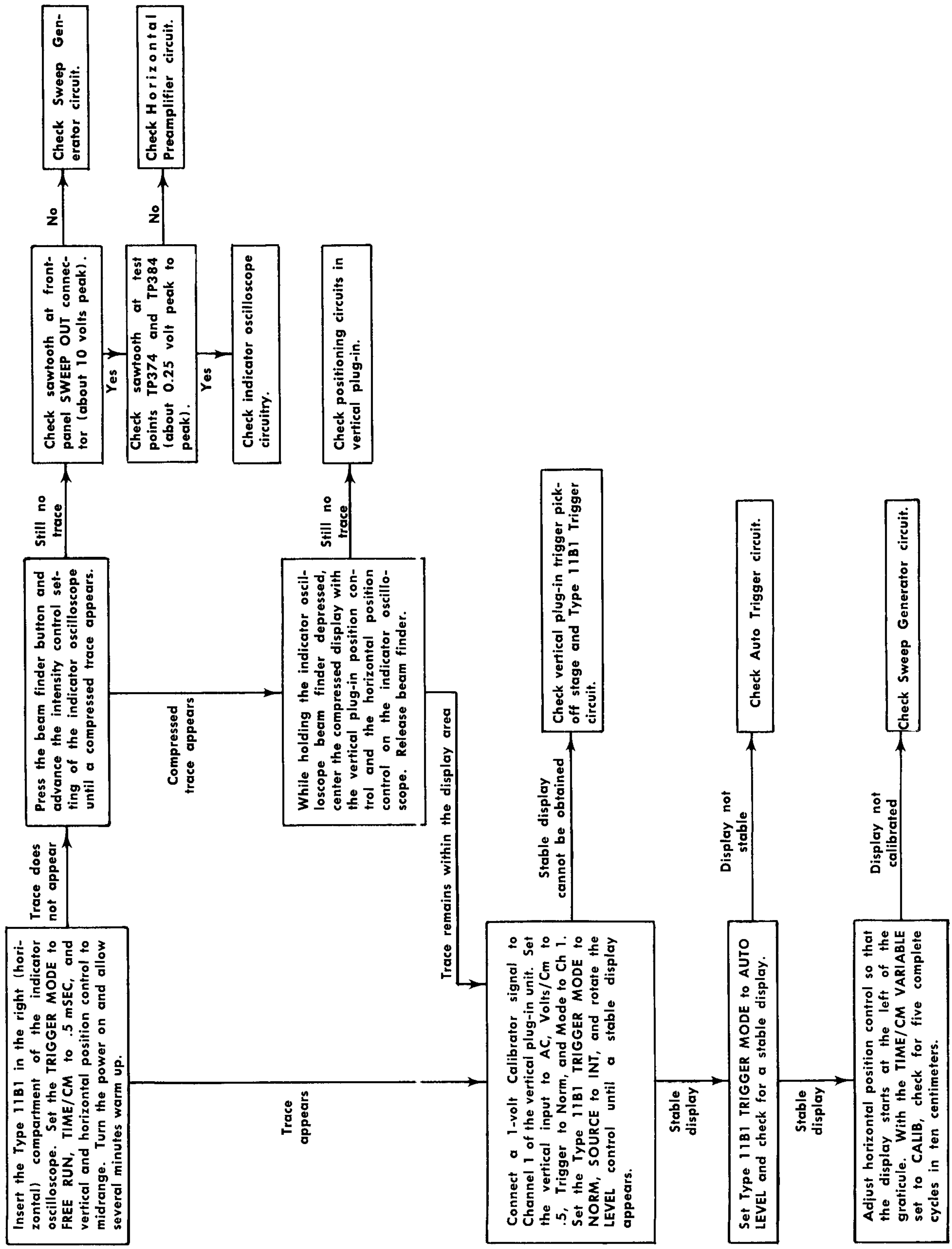


Fig. 4-2. Troubleshooting chart.

age or waveform in the circuit. Typical voltages and waveforms are given on the diagrams.

NOTE

Voltages and waveforms given 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 first diagram page.

7. Check Individual Components. The following procedures describe methods of checking individual components in the Type 11B1. Components which are soldered in place are best checked by disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

A. TRANSISTORS AND NUVISTORS. The best check of transistor or nuvistor operation is actual performance under operating conditions. If a transistor or nuvistor is suspected of being defective, it can best be checked by substituting a new component or one which has been checked previously. However, be sure that circuit conditions are not such that a replacement transistor or nuvistor might also be damaged. If substitute transistors or nuvistors are not available, use a dynamic tester (such as Tektronix Type 570 or 575).

B. DIODES. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 millivolts and 3 volts, the resistance should be very high in one direction and very low when the leads are reversed.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High currents may damage the diode. Do not measure tunnel diodes with an ohmmeter; use a dynamic tester (such as a Tektronix Type 575 Transistor-Curve Tracer).

C. RESISTORS. Resistors can be checked with an ohmmeter. Check the 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 differs widely from the specified value.

D. 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 (roll-off).

E. CAPACITORS. A leaky or shorted capacitor can best 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 whether the capacitor passes AC signals.

F. REED-DRIVE COIL. The reed-drive coil can be checked for correct operation as follows (the coil has four mounting leads for rigidity; make measurements between the two leads on either end of the coil): 1) Check the DC resistance of the coil with an ohmmeter; typical resistance values are given in the electrical parts list. 2) Check the DC voltage drop across the coil when the actuating level is applied. 3) If both the resistance and voltage are correct, the coil can be assumed to be correct; check the reed relay position and continuity. 4) If the resistance is incorrect (take into account surrounding circuitry), disconnect the coil and check the resistance again. 5) If the voltage across the coil is incorrect but the coil resistance is correct, check the circuit originating the actuating level.

8. Repair and Readjust the Circuit. If any defective parts are located, follow the replacement procedures given in this section. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced.

CORRECTIVE MAINTENANCE

General

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

Obtaining Replacement Parts

Standard Parts. All electrical and mechanical part replacements for the Type 11B1 can be obtained through your local 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 lists for value, tolerance, rating and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance in the instrument, particularly at high frequencies. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Special Parts. In addition to the standard electronic components, some special parts are used in the Type 11B1. These parts are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. These special parts are indicated in the parts list by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

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

1. Instrument Type.

2. Instrument Serial Number.

3. A description of the part (if electrical, include circuit number).

4. Tektronix Part Number.

Soldering Techniques

WARNING

Disconnect the instrument from the power source before soldering.

Ceramic Terminal Strips. Solder used on the ceramic terminal strips should contain about 3% silver. Use a 40-to 75-watt soldering iron with a 1/8 inch wide wedge-shaped tip. Ordinary solder can be used occasionally without damage to the ceramic terminal strips. However, if ordinary solder is used repeatedly or if excessive heat is applied, the solder-to-ceramic bond may be broken.

Solder containing 3% silver should be available locally, or it can be purchased from Tektronix, Inc. in one pound rolls; order by Tektronix Part No. 251-0514-00.

Observe the following precautions when soldering to ceramic terminal strips.

1. Use a hot iron for a short time. Apply only enough heat to make the solder flow freely.

2. Maintain a clean, properly tinned tip.

3. Avoid putting pressure on the ceramic terminal strip.

4. Do not attempt to fill the terminal-strip notch with solder; use only enough solder to cover the wires adequately.

5. Clean the flux from the terminal strip with a flux-remover solvent.

Metal Terminals. When soldering metal terminals (e.g., switch terminals, potentiometers, etc.), ordinary 60/40 solder can be used. Use a soldering iron with a 40- to 75-watt rating and a 1/8-inch wide wedge-shaped tip.

Observe the following precautions when soldering metal terminals:

1. Apply only enough heat to make the solder flow freely.

2. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.

3. If a wire extends beyond the solder joint, clip off the excess.

4. Clean the flux from the solder joint with a flux-remover solvent.

Component Replacement

WARNING

Disconnect the instrument from the power source before replacing components.

Ceramic Terminal Strip Replacement. A complete ceramic terminal strip assembly is shown in Fig. 4-3. Replacement strips (including studs) and spacers are supplied under separate part numbers. However, the old spacers may be re-used if they are not damaged. The applicable Tektronix Part numbers for the ceramic strips and spacers used in this instrument are given in the Mechanical Parts List.

To replace a ceramic terminal strip, use the following procedure:

REMOVAL:

1. Unsolder all components and connections on the strip. To aid in replacing the strip, it may be advisable to mark each lead or draw a sketch to show location of the components and connections.

2. Pry or pull the damaged strip from the chassis. Be careful not to damage the chassis.

3. If the spacers come out with the strip, remove them from the stud pins for use on the new strip (spacers should be replaced if they are damaged).

REPLACEMENT:

1. Place the spacers in the chassis holes.

2. Carefully press the studs of the strip into the spacers until they are completely seated. If necessary, use a soft mallet and tap lightly, directly over the stud, to seat the strip completely.

3. If the studs extend through the spacers, cut off the excess.

4. Replace all components and connections. Observe the soldering precautions given under Soldering Techniques in this section.

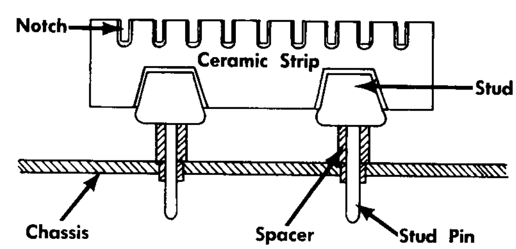
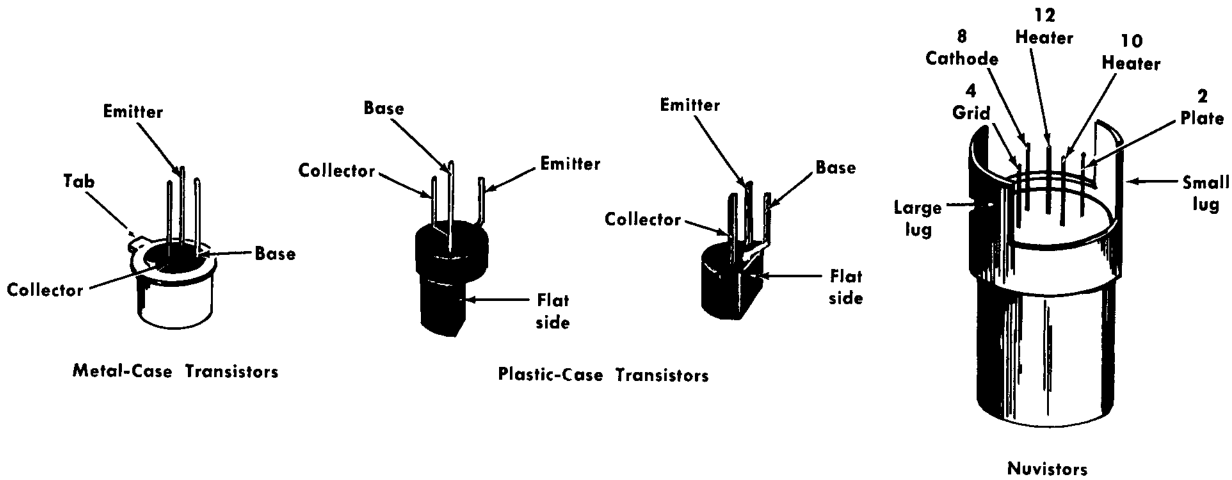


Fig. 4-3. Ceramic terminal strip assembly.

Transistor and Nuvistor Replacement. Transistors and nuvistors should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of transistors or nuvistors may affect the calibration of this instrument. When transistors or nuvistors are replaced, check the operation of that part of the instrument which may be affected.

Replacement transistors or nuvistors should be of the original type or a direct replacement. Remount the transistors in the same manner as the original.

Fig. 4-4 shows the lead configurations of the transistors and nuvistors used in this instrument. This view is as seen from the bottom of the transistor or nuvistor. Notice that there are two different lead configurations for plastic-case transistors. When replacing these transistors, check the manufacturer's basing diagram for correct basing. All



Note: All sockets in this instrument are wired for metal-case transistors.

Fig. 4-4 Electrode configuration for transistors and nuvistors in this instrument (as viewed from bottom).

transistor sockets in this instrument are wired for the basing used for metal-case transistors.

Rotary Switch Replacement. Individual wafers or mechanical parts of rotary switches are normally not replaceable. If a switch is defective, replace the entire assembly. Replacement switches can be ordered either wired or unwired; refer to the Parts List for the applicable part numbers.

When replacing a switch, mark the leads and switch terminals with corresponding identification tags as the leads are disconnected. Then, use the old switch as a guide for installing the new one. An alternative method is to draw a sketch of the switch layout and record the wire color at each terminal. When soldering to the new switch, be careful that the solder does not flow beyond the rivets on the switch terminals. Spring tension of the switch contact can be destroyed by excessive solder.

Glass Reed-Relay Replacement. The glass reed-relay used in this instrument is pressurized. Therefore, safety glasses should be worn to protect the eyes when replacing this relay. To avoid damage to the reed-relay, do not apply stress to the metal-glass bond. When it is necessary to bend a lead, use two pairs of long-nose pliers. Before replacing a reed-relay, be sure the actuating circuitry is not at fault. See the Troubleshooting procedure for methods of checking the circuit. It is important that the replacement reed-relay be correctly positioned within the drive-coil assembly with the same lead length as the original to provide similar magnetic characteristics.

REMOVAL:

1. Observe the physical position of the leads and glass bulb of the old reed-relay.

2. Unsolder the leads of the old reed-relay from the solder posts.

3. Pull the old reed-relay out of the drive-coil.

REPLACEMENT:

1. Slip the new reed-relay into the drive-coil.

2. Position the new reed-relay in exactly the same physical position as the old one.

3. Position the leads correctly and solder the new reed-relay to the solder posts. Avoid excessive heat on the reed-relay; use heat sink on the leads if soldering close to the glass body.

4. Clip off the excess lead length beyond the solder posts. Do not clip the lead closer than 1/4 inch from the glass body.

Recalibration After Repair

After any electrical component has been replaced, the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuits. The Performance Check procedure in Section 5 provides a quick and convenient means of checking instrument operation.

NOTES

SECTION 5
PERFORMANCE CHECK/ CALIBRATION PROCEDURE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section provides procedures to be used in checking the performance or in calibrating the Type 11B1. Limits, tolerances, and waveforms in this section are given as calibration guides and are not necessarily instrument specifications.

To ensure measurement accuracy, check the calibration of the Type 11B1 every 1000 hours of operation, or every six months if used infrequently. Before calibration, thoroughly clean and inspect the instrument as outlined in the Maintenance section.

The features provided by this section are:

Index. The Short-Form Procedure lists the step numbers and titles of the complete Performance Check/Calibration Procedure and gives the page on which each step begins. Therefore, the Short-Form Procedure can be used as an index to the steps in the complete procedure.

Calibration Record. The Short-Form Procedure can be reproduced and used as a permanent record of instrument calibration. Spaces are provided to record performance data for this instrument or to check off steps as they are completed.

Abridged Calibration Procedure. The Short-Form Procedure lists the adjustments necessary for each step and/ or the applicable tolerance for correct calibration. The experienced calibrator who is familiar with the calibration of this instrument can use this procedure to facilitate checking or calibrating this instrument.

Performance Check. The Calibration Procedure can be used as a performance checkout procedure by completing all portions except the ADJUST— part of a step. This checks the Type 11B1 to the original performance standards without removing the instrument covers or making internal adjustments. Steps which are not applicable to the performance checkout procedure have a note titled PERFORMANCE CHECK NOTE which gives the next applicable step and any changes in control settings or equipment setup necessary for the next check.

Complete Calibration. Completion of each step in the Calibration Procedure checks this instrument to the original performance standards and gives the procedure to set each adjustment to its optimum setting. Where possible, instrument performance is checked before an adjustment is made. For best overall instrument performance make each adjustment to the exact setting even if the CHECK— is within the allowable tolerance.

Partial Calibration. To check or adjust only part of the instrument circuitry, start with the nearest equipment required picture preceding the desired portion. To prevent recalibration of other parts of the instrument when performing a partial calibration readjust only if the tolerance given in the CHECK- part of the step is not met.

EQUIPMENT REQUIREMENT

General

The following items are required for complete calibration of the Type 11B1. Specifications given are the minimum necessary for accurate calibration. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

For the quickest and most accurate calibration, special Tektronix calibration fixtures are used where necessary. These special calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Test Equipment

1. Indicator oscilloscope. Tektronix Type 647-series required.

2. Amplifier plug-in. Tektronix calibrated 10-series amplifier plug-in recommended. The associated amplifier unit must have a bandwidth of at least DC to 50 MHz for the Type 11B1 internal triggering to accurately checked.

3. Constant amplitude sine wave generator. Frequency, 350 kHz to 50 MHz; reference frequency, 50 kHz; output amplitude, variable from less than 100 mV to above 4 volts; amplitude regulation accuracy, constant within 3% of reference at 50 kHz as output frequency changes. Tektronix Type 191 Constant Amplitude Signal Generator recommended.

4. Low frequency sine wave generator. Frequency, 60 Hz to 30 kHz; output amplitude, variable from less than 100 mV to above 500 mV; amplitude regulation accuracy constant within 3% of reference at 1 kHz as output frequency changes. For example, General Radio 1310-A Oscillator.

5. Time mark generator. Marker outputs 0.1 μs to 1 s; sinewave outputs 10 ns, 20 ns, and 50 ns; accuracy .001%. Tektronix Type 184 Time-Mark Generator recommended.

6. Standard amplitude calibrator. Amplitude accuracy, within 0.25%; signal amplitude 0.5 mV to 10 V; output signal, 1 kHz square wave. Tektronix calibration fixture 067-0502-00 recommended.

7. Test oscilloscope. Bandwidth DC to 10 MHz; deflection factor, 10 mV/div; sweep output of approximately 15 volts. Tektronix Type 454 and P6047 Probe recommended.

Accessories

8. Cable. Impedance, 50 ohm; length, 5 ns; connectors, GR. Tektronix Part No. 017-0502-00.

9. Cable. Impedance, 50 ohm; length 18-inches, connectors, BNC. Tektronix Part No. 012-0076-00

10. Cable (two). Impedance, 50 ohm; length, 42-inches, connectors, BNC. Tektronix Part No. 012-0057-01.

11. Adapter. Connectors, BNC male to GR. Tektronix Part No. 017-0064-00.

12. Adapter. Connectors, probe tip to BNC male. Tektronix Part No. 013-0084-00.

13. Adapter (BNC T). Connectors, female BNC two ends, male BNC third end. Tektronix Part No. 103-0030-00.

14. Termination. Impedance, 50 ohm; accuracy within ±3%; connectors BNC. Tektronix Part No. 011-0049-00.

15. Capacitor. Description, 47 pf, 10%. Tektronix Part No. 281-0519-00.

16. Adjustment tool, non-conducting. Tektronix Part Nos. 003-0307-00 (handle), and 003-0334-00 (insert).

SHORT-FORM PROCEDURE

Type 11B1, Serial No. ____________________

Calibration date ____________________

Calibrated by ____________________

☐ 1. Check/Adjust Internal Trigger DC Level (R1) (Page 5-4)

REQUIREMENT: No spot movement as COUPLING is switched between AC LF REJ and DC.

PERFORMANCE: Correct ______; not correct ______

☐ 2. Check Free-Run Operation (Page 5-5)

REQUIREMENT: Free-running trace; SWEEP RUN indicator lights.

PERFORMANCE: Correct ______; not correct ______

☐ 3. Check Internal Triggering Operation (Page 5-5)

REQUIREMENT: Stable display in AC, AC LF REJ and with 0.2-centimeter deflection at 50 kilohertz and one-centimeter deflection at 50 megahertz

PERFORMANCE: Correct ______; not correct ______

☐ 4. Check External Triggering Operation (Page 5-6)

REQUIREMENT: Stable display in AC, AC LF REJ and DC with 125 millivolt triggering signal at 50 kilohertz and 250 millivolt triggering signal at 50 megahertz.

PERFORMANCE: Correct ______; not correct ______

☐ 5. Check Low-Frequency Triggering Operation (Page 5-6)

REQUIREMENT: Internal, stable display in AC and DC with 0.2-centimeter deflection at 60 hertz; external, stable display in AC and DC with 175 millivolt triggering signal at 60 hertz.

PERFORMANCE: Correct ______; not correct ______

☐ 6. Check AC low-frequency Reject Operation (Page 5-7)

REQUIREMENT: Stable display in AC LF REJ with 0.2-centimeter deflection (internally triggered) at 30 kilohertz; stable display cannot be obtained at 60 hertz.

PERFORMANCE: Correct ______; not correct ______

☐ 7. Check Trigger Slope Operation (Page 5-7)

REQUIREMENT: Display starts on correct slope of input signal.

PERFORMANCE: Correct ______; not correct ______

☐ 8. Check Single Sweep Operation (Page 5-8)

REQUIREMENT: One sweep occurs each time the RESET button is pressed.

PERFORMANCE: Correct ______; not correct ______

☐ 9. Check Auto Base Line - Manual Level Operation (Page 5-8)

REQUIREMENT: Stable display obtained with LEVEL control; SWEEP FREE RUN indicator lights when not triggered.

PERFORMANCE: Correct ______; not correct ______

☐ 10. Check Auto Base Line - Auto Level Operation (Page 5-8)

REQUIREMENT: Stable display independent of LEVEL control; SWEEP FREE RUN indicator lights when not triggered.

PERFORMANCE: Correct ______; not correct ______

☐ 11. Check Auto Base Line Recovery Time (Page 5-9)

REQUIREMENT: Stable display can be obtained with 50-millisecond markers but not with 0.1-second markers. If 0.1-second is triggered, must not be at start of sweep.

PERFORMANCE: Correct ______; not correct ______

☐ 12. Check/Adjust Normal Sweep Timing (R180W) (Page 5-10)

REQUIREMENT: Correct timing within 0.12 centimeter (±1.5%), between second and tenth graticule line (TIME/CM set to 1 mSEC).

PERFORMANCE Within ______ centimeters

☐ 13. Check Sweep Length (Page 5-10)

REQUIREMENT: Sweep length is 10.5 to 11 centimeters.

PERFORMANCE Within ______ centimeters

☐ 14. Check Variable Control Range (Page 5-10)

REQUIREMENT: At least 2.5; 1 reduction in sweep rate.

PERFORMANCE: Correct ______; not correct ______

☐ 15. Check/Adjust Magnified Registration (R322) (Page 5-10)

REQUIREMENT: No trace shift as MAGNIFIER is switched from 20 μSEC to 1 mSEC (TIME/CM set to 1 mSEC).

PERFORMANCE: Correct _____; not correct _____

☐ 16. Adjust High-Speed Timing (C180C, C180A) (Page 5-10)

REQUIREMENT: Correct timing at 1 μSEC (C180C) and .1 μSEC range (C180A) within ±0.12 centimeter.

PERFORMANCE: Correct _____; not correct _____

☐ 17. Check Normal Sweep Timing (Page 5-11)

REQUIREMENT: .1 μSEC to 50 mSEC range within 0.12 centimeter; .1 SEC to 2 SEC range 0.24 centimeter.

PERFORMANCE: Correct _____; not correct (list exceptions) _____

☐ 18. Check Magnified Sweep Timing (Page 5-12)

REQUIREMENT. Within Normal Sweep Timing tolerance (step 17) plus 0.16 centimeter 10 nSEC and 20 nSEC ranges, .08 centimeter 50 nSEC to 1 SEC range.

PERFORMANCE: Correct _____; not correct (list exceptions) _____

☐ 19. Check Alternate Trace Sync Pulse (Page 5-13)

REQUIREMENT: Approximately 350 millivolts peak to peak at pin 17 of vertical plug-in unit (47-picofarad capacitive load).

PERFORMANCE: _____ millivolts

☐ 20. Check Sweep Output (Page 5-14)

REQUIREMENT: Positive-going ramp waveform, 10 volts peak (±1 volt).

PERFORMANCE: Correct _____; not correct _____

☐ 21. Check +Gate Output (Page 5-14)

REQUIREMENT: Positive-going rectangular waveform, 14.5 volts peak (±1.5 volts).

PERFORMANCE: Correct _____; not correct _____

☐ 22. Check/Adjust External Horizontal Variable Balance (R307) (Page 5-15)

REQUIREMENT: Spot is positioned at same point at both extremes of VARIABLE control (EXT HORIZ INPUT).

PERFORMANCE: Correct _____; not correct _____

☐ 23. Check/Adjust External Horizontal Compensation (C32, C28) (Page 5-15)

REQUIREMENT: C32 adjusted for square corner on displayed square wave with MAGNIFIER set to 1 VOLT; display shifts from center to left half of CRT when COUPLING is switched from DC to AC; C28 adjusted for square corner on displayed square wave with MAGNIFIER set to .1 VOLT.

PERFORMANCE: Correct _____; not correct (list exceptions) _____

☐ 24. Check/Adjust External Horizontal Gain (R304) (Page 5-16)

REQUIREMENT: Five centimeters (±0.1 centimeter) of horizontal deflection at .1 VOLT with 0.5 volt square-wave input.

PERFORMANCE: Correct _____; not correct _____

☐ 25. Check External Horizontal Bandpass (Page 5-16)

REQUIREMENT: −3 dB point of at least 3 megahertz.

PERFORMANCE: Frequency _____

PERFORMANCE CHECK/ CALIBRATION PROCEDURE

General

The following procedure is arranged so that the Type 11B1 can be calibrated with the least interaction of adjustments and reconnection of equipment. The equipment required pictures identify the test equipment necessary for each group of checks and adjustments. Following the picture is a complete list of front-panel control settings for the Type 11B1. To aid in performing a complete calibration, controls which must be changed for the next step are printed in bold type. Each step following the equipment required picture continues from the equipment setup and control settings used in the preceding step(s) unless otherwise noted. External controls or adjustments of the Type 11B1 referred to in this procedure are capitalized (e.g., TIME/CM). Internal adjustment titles are initial capitalized only (e.g., Ext Horiz Gain).

All waveforms shown in this procedure were taken with a Tektronix Oscilloscope Camera System. The following procedure uses the equipment listed under Test Equipment Required. If equipment is substituted, control settings or equipment setup may need to be altered to meet the requirements of the equipment used. Detailed operating instructions for the test equipment is not given in this procedure. If in doubt as to the correct operation of any of the test equipment, refer to the instruction manual for that unit.

NOTE

This instrument should be calibrated at an ambient temperature of +25°C, ±5°C. The performance of this instrument can be checked at any temperature within the 0°C to +40°C range. If the ambient temperature is outside the given range, see Section 1 for the applicable tolerance.

Preliminary Procedure for Performance Check Only

1. Insert the Type 11B1 in a 647-series indicator oscilloscope.

2. Turn the instrument power on and allow at least 20 minutes warmup before proceeding.

Preliminary Procedure for Complete Calibration

1. Remove the instrument covers from the 647-series indicator oscilloscope.

2. Insert the Type 11B1 in the indicator oscilloscope.

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

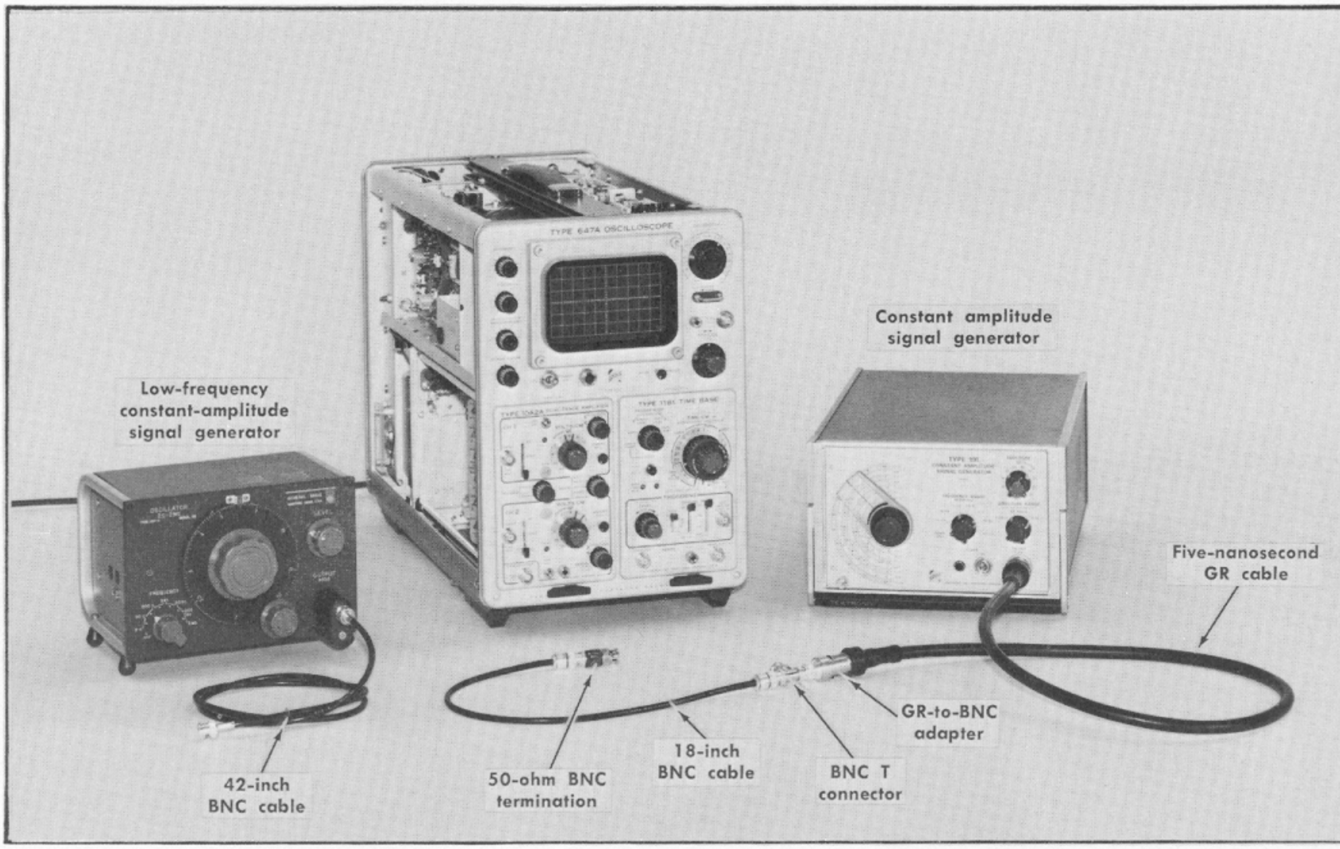


Fig. 5-1. Equipment required for steps 1 through 10.

Indicator Oscilloscope Controls

Intensity	Counterclockwise
Focus	Any position
Astigmatism	Any position
Scale Illum	As desired
Horizontal Position	Midrange
Calibrator	1 Volt

Vertical Plug-In Unit

Mode (if multi-trace)	Ch 1
Trigger	Norm
Input Coupling	DC
Volts/Cm	.5
Variable	Cal
Position	Midrange
Invert	Push in

Type 11B1

TRIGGER MODE	FREE RUN
TIME/CM OR HORIZONTAL VOLTS/CM	EXT HORIZ INPUT
MAGNIFIER	.1 VOLT
VARIABLE	CALIB
LEVEL	Counterclockwise
HF STABILITY	Any position
SLOPE	+
COUPLING	AC
SOURCE	INT

1. Check/Adjust Internal Trigger DC Level

a. Test equipment for steps 1 through 10 is shown in Fig. 5-1.

b. Push the indicator oscilloscope Beam Finder button in and rotate the Intensity control clockwise to display a low-intensity spot the CRT.

c. Again using the Beam Finder to locate the spot, center the spot on the CRT with the vertical and horizontal Position controls.

d. Adjust Focus and Astigmatism controls for a clearly defined spot.

e. Remove the vertical plug-in unit.

f. CHECK — Spot remaines stationary as the COUPLING switch is switched back and forth between AC LF REJ and DC.

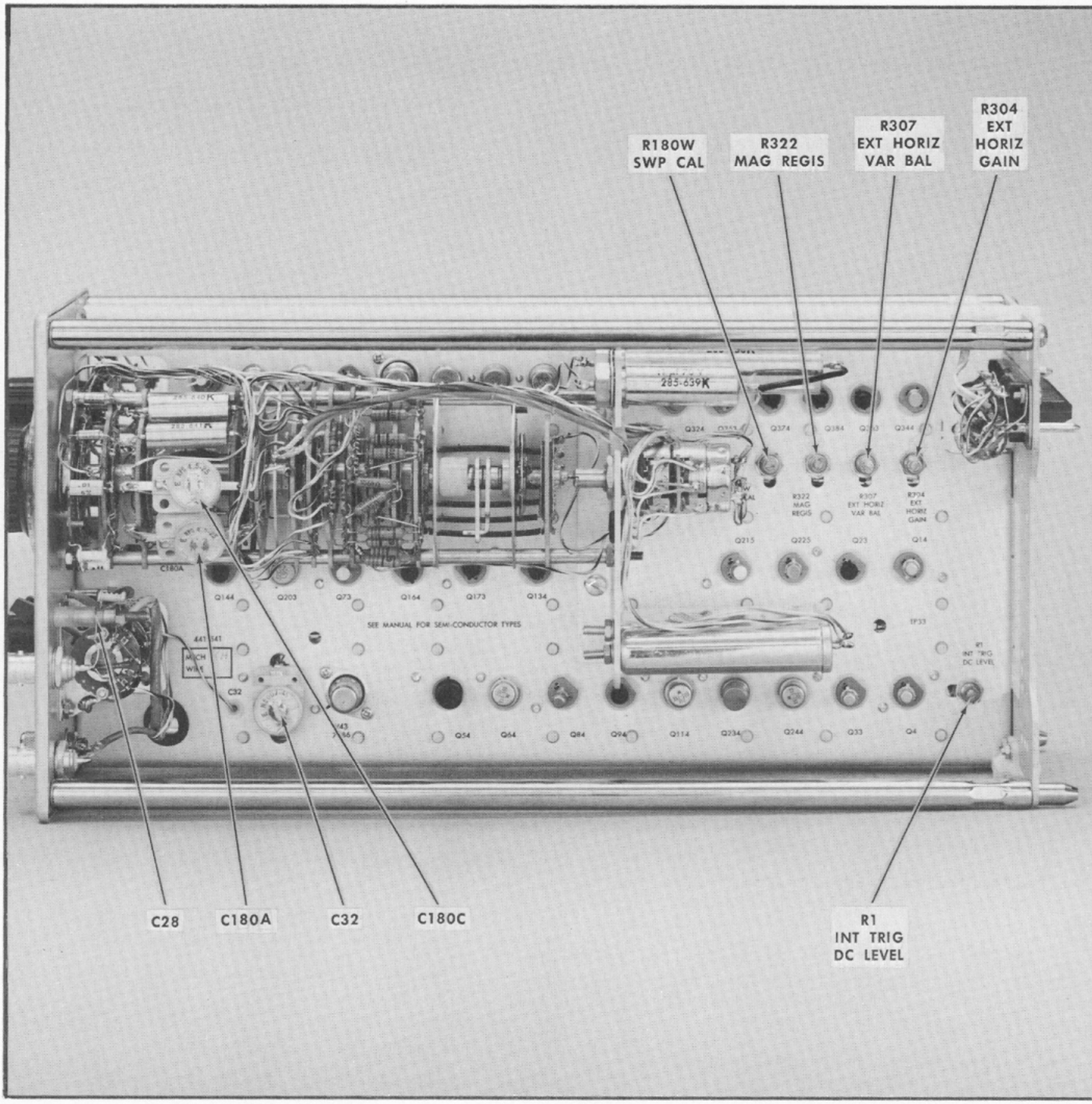


Fig. 5-2. Location of calibration adjustments.

g. ADJUST—Int Trig DC Level, R1 (see Fig. 5-2) so the spot remains stationary as the COUPLING switch is switched back and forth between AC LF REJ and DC.

h. Reset the coupling switch to AC and re-install the vertical plug-in unit.

2. Check Free-Run Operation

a. Change the following control settings:

TIME/CM	.1 μSEC
MAGNIFIER	50 nSEC

b. Check — Free-running trace on the CRT SWEEP FREE RUN indicator is on.

3. Check Internal Triggering Operation

a. Set the TRIGGER MODE switch to AUTO BASE LINE — MANUAL LEVEL.

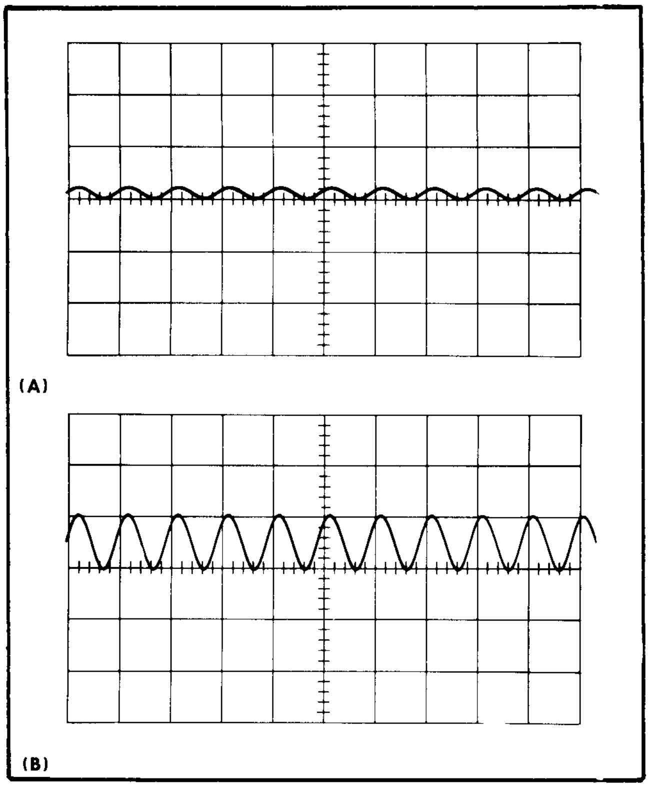


Fig. 5-3 (A) Typical CRT display when checking internal 50 kilohertz triggering, (B) typical CRT display when checking internal 50 megahertz triggering.

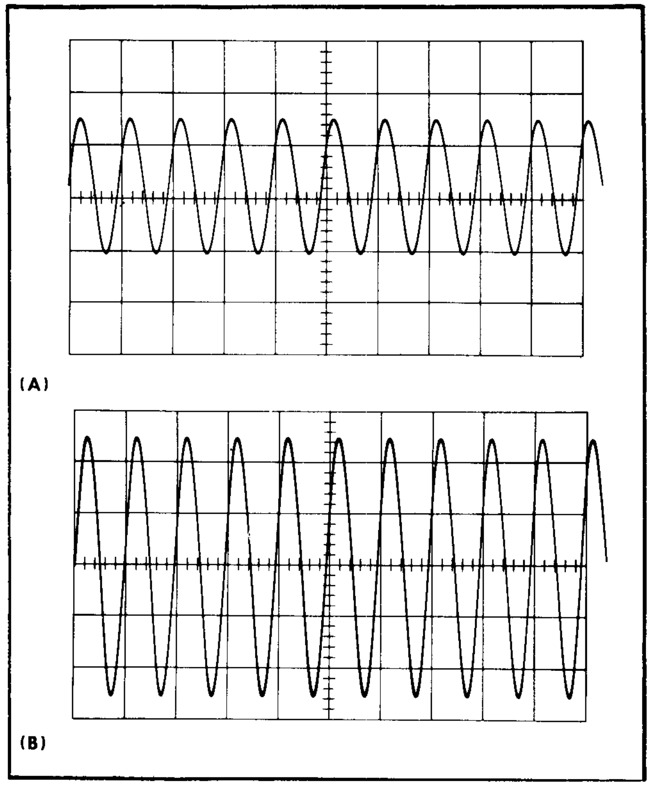


Fig. 5-4. (A) Typical CRT display when checking external 50 kilohertz triggering, (B) typical CRT display when checking external megahertz triggering.

b. Connect the constant amplitude signal generator to the EXT TRIG IN connector through the five-nanosecond GR cable, GR-to-BNC adapter, and BNC T connector. Connect the output of the T connector to the channel 1 input through an 18-inch 50-ohm BNC cable and a 50-ohm BNC termination.

c. Set the constant-amplitude signal generator for a 0.2-centimeter display at 20 megahertz. (Adjust LEVEL for a stable display.)

d. CHECK — Stable CRT display (see Fig. 5-3A) can be obtained with the COUPLING switch set to AC, AC LF REJ and DC (LEVEL control may be adjusted as necessary to obtain stable display).

e. Set the constant-amplitude signal generator for a one-centimeter display at 50 megahertz.

f. Change the MAGNIFIER to 20 nSEC.

g. CHECK — Stable CRT display (see Fig. 5-3B) can be obtained with the COUPLING switch set to AC, AC LF REJ and DC (LEVEL and HF STABILITY controls may be adjusted as necessary to obtain stable display).

4. Check External Triggering Operation

a. Change the following control settings:

Volts/Cm	.05
TIME/CM	20 μSEC
MAGNIFIER	20 μSEC
SOURCE	EXT

b. Set the constant amplitude signal generator for a 2.5-centimeter display (125 millivolt) at 50 kilohertz.

c. CHECK — Stable CRT display (see Fig. 5-4A) can be obtained with the COUPLING switch to AC, AC LF REJ and DC (LEVEL control may be adjusted as necessary to obtain stable display).

d. Set the constant-amplitude signal generator for a 5-centimeter display (250 millivolts) at 50 megahertz.

e. Change the following control setting:

TIME/CM	.1 μSEC
MAGNIFIER	20 nSEC

f. CHECK—Stable CRT display (see Fig. 5-4B) can be obtained with the COUPLING switch set to AC, AC LF REJ and DC (LEVEL and HF STABILITY controls may be adjusted as necessary to obtain stable display).

g. Disconnect the constant amplitude signal generator.

5. Check Low-Frequency Triggering Operation

a. Connect the low-frequency signal generator to the EXT TRIG IN connector through a 42-inch 50-ohm BNC cable and the BNC T connector. Connect the output of the T connector to the channel 1 input connector through the 18-inch 50-ohm BNC cable and the 50-ohm BNC termination.

b. Change the following control settings:

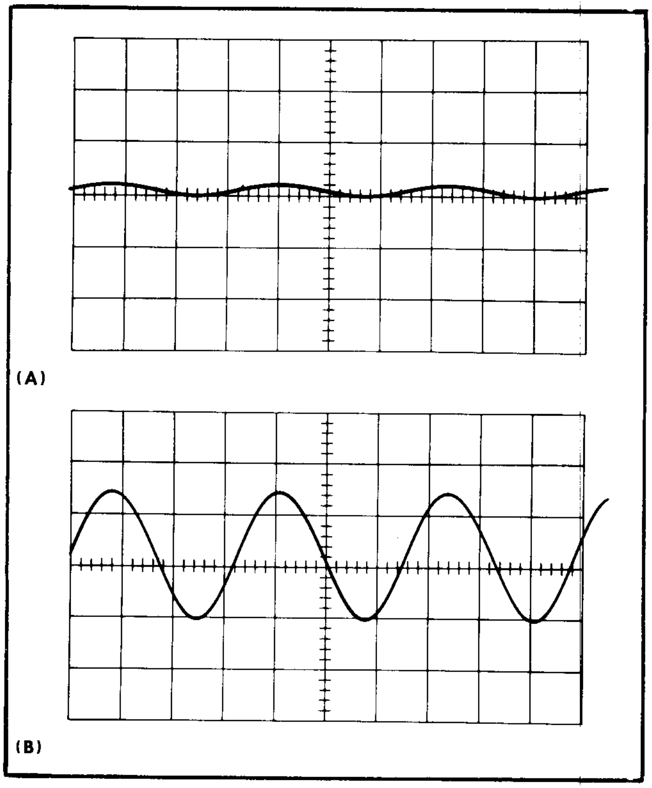


Fig. 5-5. (A) Typical CRT display when checking internal low-frequency triggering at 60 hertz, (B) typical CRT display when checking external low-frequency triggering at 60 hertz.

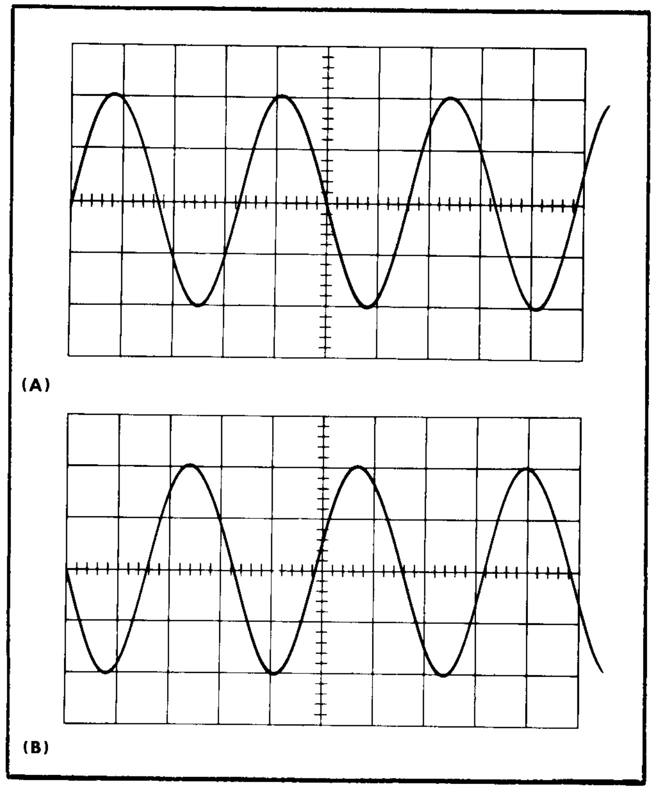


Fig. 5-6. Typical CRT display when checking SLOPE switch operation. (A) SLOPE switch set to +, (B) SLOPE switch set to —.

Volts/Cm	0.5
TIME/CM	5 mSEC
MAGNIFIER	5 mSEC
COUPLING	AC
SOURCE	INT

c. Set the low-frequency generator for a 0.2-centimeter display at 60 hertz.

d. CHECK—Stable CRT display (see Fig. 5-5A) can be obtained with the COUPLING switch set to AC and DC (LEVEL control may be adjusted as necessary to obtain stable display).

e. Change the following control settings:

Volts/Cm	.05
SOURCE	EXT

f. Set the low-frequency generator for a 3.5-centimeter display (175 millivolts) at 60 hertz.

g. CHECK—Stable CRT display (see Fig. 5-5B) can be obtained with the COUPLING switch set to AC and DC (LEVEL control may be adjusted as necessary to obtain a stable display).

6. Check AC Low-Frequency Reject Operation

a. Change the following control settings:

TIME/CM	20 μSEC
SOURCE	INT
COUPLING	AC LF REJ

b. Set the low-frequency generator for a 0.2-centimeter display at 30 kilohertz.

c. CHECK—Stable CRT display can be obtained with the LEVEL control.

d. Set the low-frequency generator to 60 hertz, without changing the output amplitude.

e. Set the TIME/CM switch to 5 mSEC.

f. Check—Stable CRT display **cannot** be obtained at any setting of the LEVEL control.

7. Check Trigger Slope Operation

a. Set the low-frequency generator for a 4-centimeter display at 60 hertz.

b. Set the COUPLING switch to AC, and adjust the LEVEL control for a stable display.

c. CHECK—CRT display starts on the positive slope of the waveform (see Fig. 5-6A).

d. Set SLOPE switch to —.

e. CHECK—CRT display starts on the negative slope of the waveform (see Fig. 5-6B).

f. Return the SLOPE switch to +.

8. Check Single Sweep Operation

a. Change the following control settings:

TRIGGER MODE	SINGLE SWEEP
LEVEL	Fully clockwise

b. Push the RESET button.

c. CHECK—READY light comes on when RESET button is pressed and remains on.

d. Slowly rotate the LEVEL control counterclockwise until sweep occurs.

e. CHECK—A single-sweep display (one sweep only) is presented when the LEVEL control is in the triggerable region.

READY light turns off at the end of the sweep and remains off until the RESET button is pressed again.

9. Check Auto Base Line—Manual Level Operation

a. Set the TRIGGER MODE switch to AUTO BASE LINE—MANUAL LEVEL.

b. Rotate the LEVEL control fully clockwise.

c. CHECK—CRT display is not triggered. SWEEP FREE RUN indicator lights.

d. Remove the signal from the vertical input connector.

e. CHECK—Free-running trace is displayed on the CRT. SWEEP FREE RUN indicator lights.

f. Reconnect the signal to the vertical input connector.

10. Check Auto Base Line—Auto Level Operation

a. Set the TRIGGER MODE switch toAUTO BASE LINE—AUTO LEVEL.

b. CHECK—CRT display is triggered regardless of LEVEL control setting.

c. Remove the signal from the vertical input connector.

d. CHECK—Free-running trace is displayed on the CRT. SWEEP FREE RUN indicator lights.

e. Disconnect all test equiptment.

NOTES

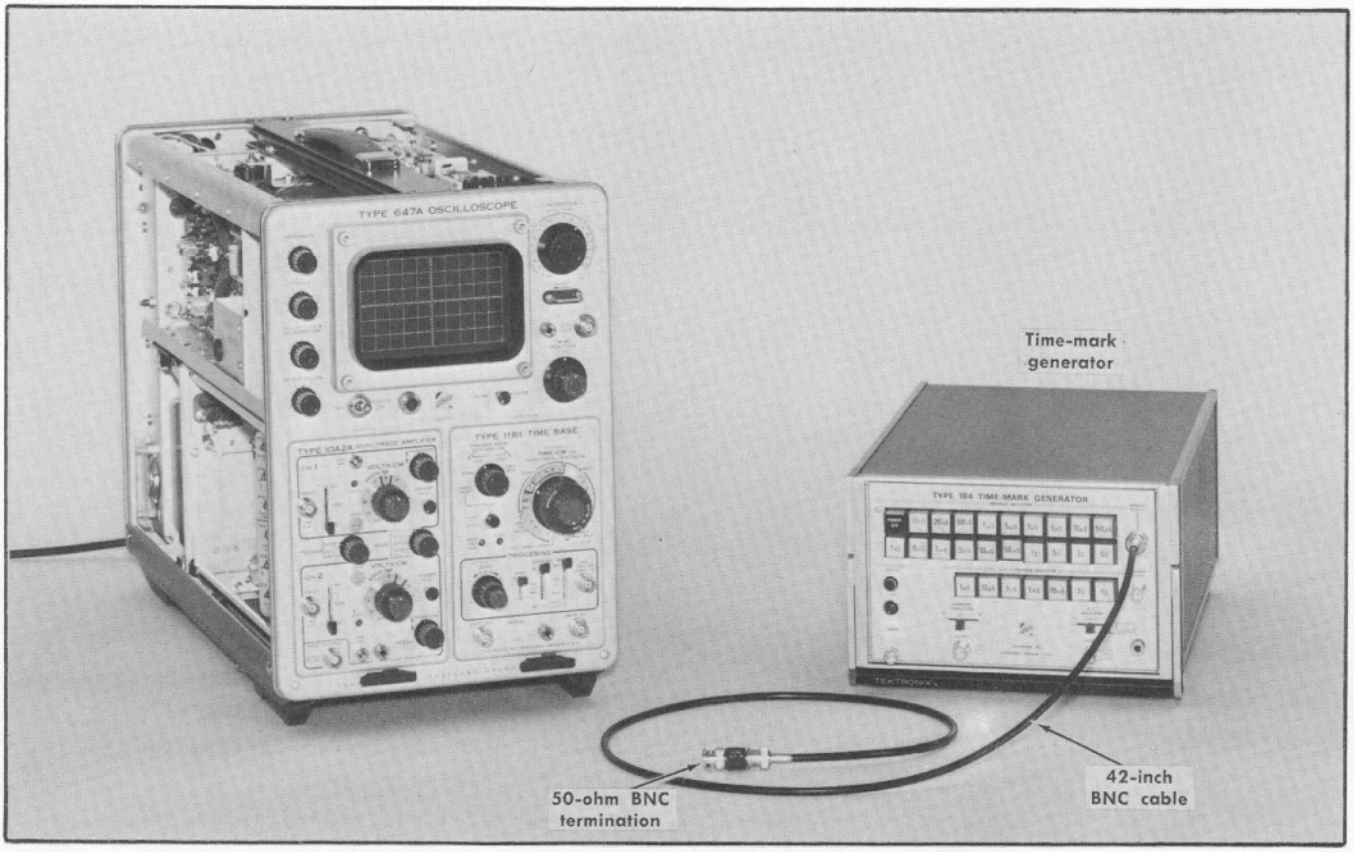


Fig. 5-7. Equipment required for steps 11 through 18.

Indicator Oscilloscope Controls

Intensity	As desired
Focus	Adjusted for well-defined display
Astigmatism	Adjusted for well-defined display
Scale Illum	As desired
Horizontal Position	Midrange

Vertical Plug-in Unit

Mode (if mult-trace)	Ch 1
Trigger	Norm
Input Coupling	DC
Volts/Cm	**.5**
Variable	Cal
Position	Midrange
Invert	Push in

TYPE 11B1

TRIGGER MODE	**AUTO BASE LINE—MANUAL LEVEL**
TIME/CM OR HORIZONTAL VOLTS/CM	5 mSEC
MAGNIFIER	5 mSEC
VARIABLE	CALIB
LEVEL	Any position
HF STABILITY	Any position
SLOPE	+
COUPLING	AC
SOURCE	INT

11. Check Auto Base Line Recovery Time

a. Test equipment for steps 11 through 18 is shown in Fig. 5-7.

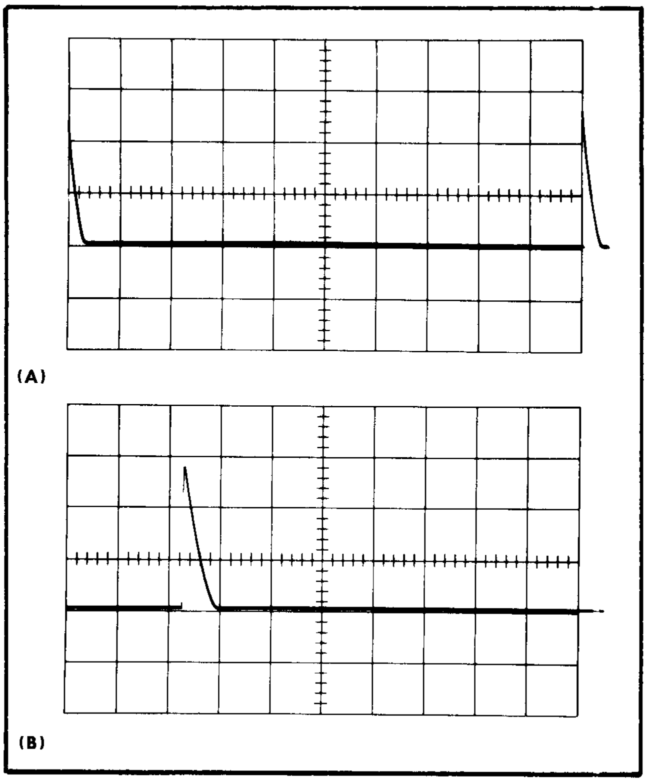


Fig. 5-8. (A) Typical CRT display showing triggered 50 millisecond markers, (B) typical CRT display showing 0.1 second marker triggered, but not at the start of the sweep.

b. Connect the time-mark generator marker output to the channel 1 input connector through a 42-inch 50-ohm BNC cable and a 50 ohm termination.

c. Set the time-mark generator for 50-millisecond markers.

d. CHECK—Stable display can be obtained with the LEVEL control. First marker must be at the start of the sweep (see Fig. 5-8A).

e. Set the time-mark generator for 0.1-second markers.

f. CHECK—Display not stable. If stable display can be obtained, marker must not be at the start of the sweep (see Fig. 5-8B).

12. Check/Adjust Normal Sweep Timing

a. Change the following control settings:

Volts/Cm	0.2
TIME/CM	1 mSEC

b. Apply 1 millisecond markers from the time-marker generator.

c. Position the baseline of the marker display below the viewing area and increase the Intensity control to a visible viewing level.

d. Set the LEVEL control for a stable display.

e. Position the second marker on the second graticule line (see Fig. 5-9A).

f. CHECK—The tenth marker falls on the tenth graticule line, ±0.12 centimeter or 1.5% (see Fig. 5-9A).

g. ADJUST—Swp Cal, R180W (see Fig. 5-9B) so that the tenth marker falls on the tenth graticule line (see Fig. 5-9A).

13. Check Sweep Length

a. With the horizontal position control, position the markers one centimeter to the left (eleventh marker falls on the tenth graticule line).

b. Turn the Intensity down and position the baseline of the marker display within the viewing area.

c. CHECK—The sweep terminates in the last one-half centimeter (the sweep length is 10.5 to 11 centimeters).

d. Position the markers as in Fig. 5-9A and return the Intensity to a visible viewing level.

14. Check Variable Control Range

a. Turn the VARIABLE control fully counterclockwise.

b. CHECK—2.5 (or more) markers are displayed per centimeter UNCAL indicator lights.

c. Return the VARIABLE control to the CALIB position.

15. Check/Adjust Magnified Registration

a. Set the time-mark generator for 0.1 millisecond markers.

b. Pull the MAGNIFIER switch and set to 20 μSEC (×50 magnification).

c. Position the start of the sweep to the center of the CRT with the first marker on the center graticule line.

d. Set the MAGNIFIER switch to 1 mSEC (×1).

e. CHECK—First marker falls on the center graticule line.

f. ADJUST—Mag Regis, R322 (see Fig. 5-9B) to move the first marker to the center graticule line.

g. Repeat steps b through f until the first marker is stationary when the MAGNIFIER is turned from 1 mSEC through 20 μSEC.

16. Adjust High-Speed Timing

PERFORMANCE CHECK NOTE

This step is not applicable to a performance check. Proceed directly to step 17.

a. Set the TIME/CM and MAGNIFIER switches to 1 μSEC.

b. Set the time-mark generator for 1 microsecond markers.

c. Position the second marker to the second graticule line (see Fig. 5-10A).

d. ADJUST—C180C (see Fig. 5-10B) so that the tenth marker falls on the tenth graticule line.

e. Set the TIME/CM and MAGNIFIER switches to .1 μSEC.

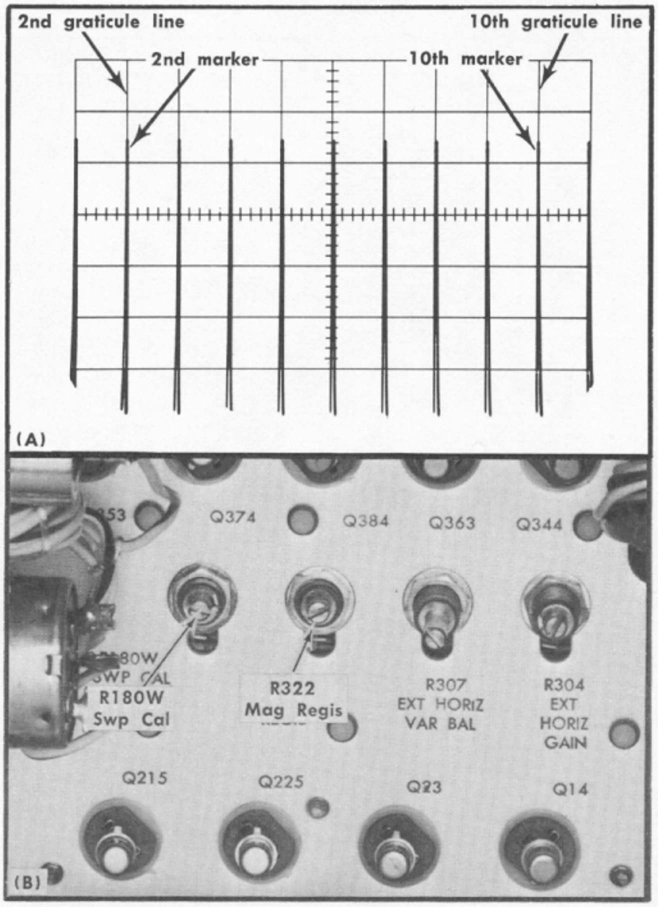


Fig. 5-9. (A) Counting of time markers and graticule lines, (B) location of Swp Cal, R180W, and Mag Regis, R322.

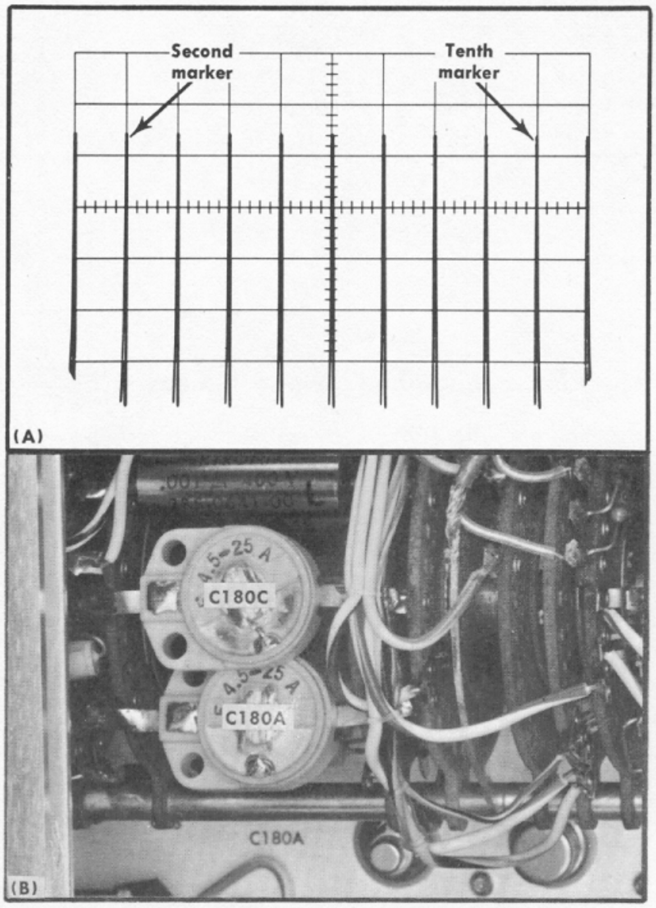


Fig. 5-10. (A) Typical CRT display showing correct high-speed timing, (B) location of C180C, C180A.

f. Set the time-mark generator for 0.1 microsecond markers. (Adjust LEVEL and IF STABILITY controls as necessary.)

g. Position the second marker to the second graticule line (see Fig. 5-10A).

h. ADJUST-C180A (see Fig. 5-10B) so that the tenth marker falls on the tenth graticule line.

17. Check Normal Sweep Timing

a. Set the TIME/CM and MAGNIFIER switches to the sweep rate indicated in the first column of Table 5-1. (Set TRIGGER MODE switch to NORM for sweep rates from .1 SEC to 2 SEC.)

b. Apply time markers as indicated in the second column of Table 5-1.

c. CHECK—All unmagnified sweep rates for correct number of time markers, within the tolerance indicated by Table 5-1. Check sweep timing between the second and tenth graticule lines.

TABLE 5-1

TIME/CM	Time Markers	Check For	Tolerance
.1 μSEC	.1 μsec	1 marker/cm	Within 0.12 cm (1.5%)
.2 μSEC	.1 μsec	2 markers/cm	
.5 μSEC	.5 μsec	1 marker/cm	
1 μSEC	1 μsec	1 marker/cm	
2 μSEC	1 μsec	2 markers/cm	
5 μSEC	5 μsec	1 marker/cm	
10 μSEC	10 μsec	1 marker/cm	
20 μSEC	10 μsec	2 markers/cm	
50 μSEC	50 μsec	1 marker/cm	
.1 mSEC	.1 msec	1 marker/cm	
.2 mSEC	.1 msec	2 markers/cm	
.5 mSEC	.5 msec	1 marker/cm	
1 mSEC	1 msec	1 marker/cm	
2 mSEC	1 msec	2 markers/cm	
5 mSEC	5 msec	1 marker/cm	
10 mSEC	10 msec	1 marker/cm	
20 mSEC	10 msec	2 markers/cm	
50 mSEC	50 msec	1 marker/cm	

.1 SEC	.1 sec	1 marker/cm	Within 0.24 cm (3%)
.2 SEC	.1 sec	2 markers/cm	
.5 SEC	.5 sec	1 marker/cm	
1 SEC	1 sec	1 marker/cm	
2 SEC	1 sec	2 markers/cm	

18. Check Magnified Sweep Timing

a. Set the TIME/CM switch to the sweep rate indicated in the first column of Table 5-2.

b. Set the MAGNIFIER switch to the magnified sweep rate indicated in the second column of Table 5-2.

c. Apply time markers as indicated in the third column of Table 5-2.

d. CHECK—Magnified sweep timing for correct number of time markers, within the given tolerance, as indicated by Table 5-2. Exclude the first 1% of the unmagnified sweep from the measurement area. Check tolerance between the second and tenth graticule lines.

TABLE 5-2

TIME/CM	Magnifier	Time Markers	Check For	Tolerance
.5 μSEC	10 nSEC	10 nsec	1 cycle/cm	Within 0.28 cm
.5 μSEC	20 nSEC	20 nsec	1 cycle/cm	
.5 μSEC	50 nSEC	50 nsec	1 cycle/cm	Within 0.2 cm
.5 μSEC	.1 μSEC	.1 μsec	1 marker/cm	
.5 μSEC	.2 μSEC	.1 μsec	2 markers/cm	
20 μSEC	.5 μSEC	.5 μsec	1 marker/cm	
20 μSEC	1 μSEC	1 μsec	1 marker/cm	
20 μSEC	2 μSEC	1 μsec	2 markers/cm	
20 μSEC	5 μSEC	5 μsec	1 marker/cm	
20 μSEC	10 μSEC	10 μsec	1 marker/cm	
1 mSEC	20 μSEC	10 μsec	2 markers/cm	
1 mSEC	50 μSEC	50 μsec	1 marker/cm	
1 mSEC	.1 mSEC	.1 msec	1 marker/cm	
1 mSEC	.2 mSEC	.1 msec	2 markers/cm	
1 mSEC	.5 mSEC	.5 msec	1 marker/cm	
50 mSEC	1 mSEC	1 msec	1 marker/cm	
50 mSEC	2 mSEC	1 msec	2 markers/cm	
50 mSEC	5 mSEC	5 msec	1 marker/cm	
50 mSEC	10 mSEC	10 msec	1 marker/cm	
50 mSEC	20 mSEC	10 msec	2 markers/cm	

e. Disconnect all test equipment.

NOTES

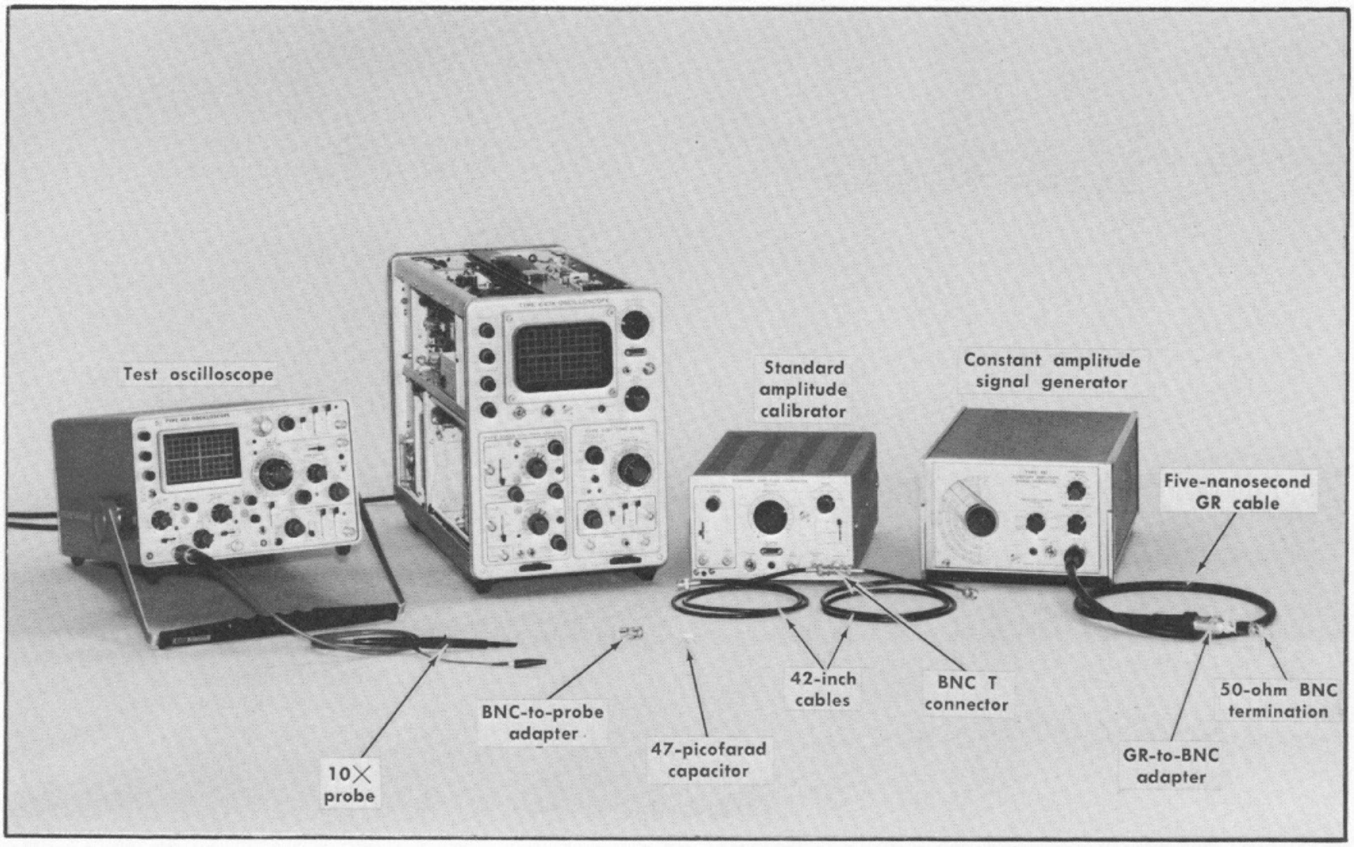


Fig. 5-11. Equipment required for steps 19 through 25.

Indicator Oscilloscope Controls

Intensity	As desired
Focus	Adjusted for well-defined display
Astigmatism	Adjusted for well-defined display
Scale Illum	As desired
Horizontal Position	Midrange

Vertical Plug-in Unit

Mode (if multi-trace)	Ch 1
Trigger	Norm
Input Coupling	DC
Volts/Cm	0.2
Variable	Cal
Position	Midrange
Invert	Pushed in

TYPE 11B1

TRIGGER MODE	**FREE RUN**
TIME/CM OR HORIZONTAL VOLTS/CM	**.1 μSEC**
MAGNIFIER	**.1 μSEC**
VARIABLE	CALIB
LEVEL	Any position
HF STABILITY	Any position
SLOPE	+
COUPLING	AC
SOURCE	INT

19. Check Alternate Trace Sync Pulse

a. Test equipment for steps 19 through 25 is shown in Fig. 5-11. (The 47-picofarad capacitor is not required when completing performance check only.)

PERFORMANCE CHECK NOTE

This step is not applicable to a performance check. Proceed directly to step 20.

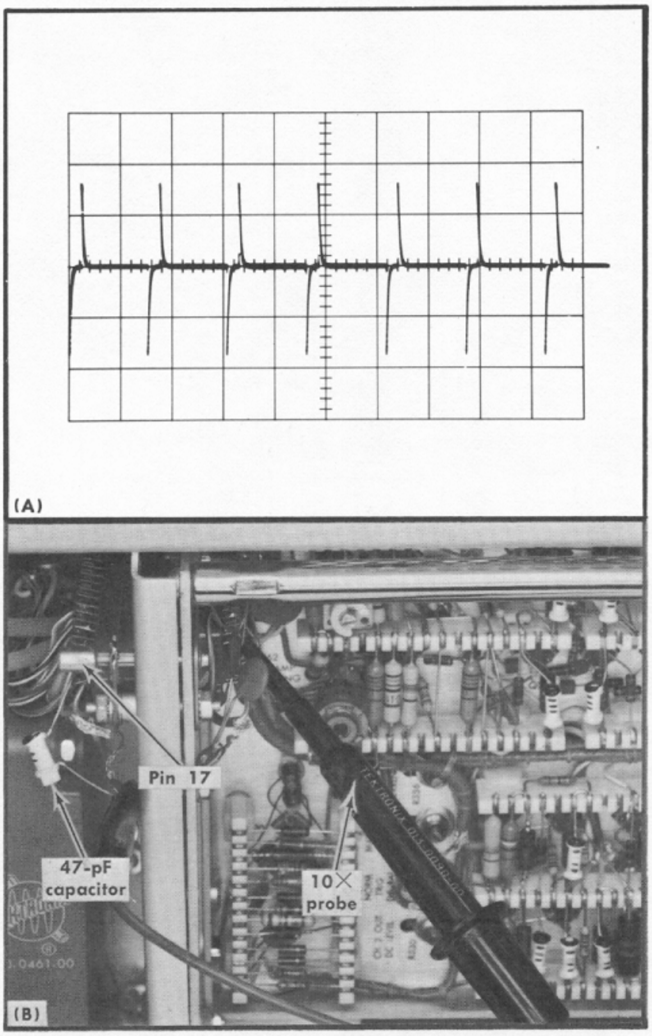


Fig. 5-12. (A) Typical test oscilloscope display of alternate trace sync pulse, (B) test connections for checking alternate trace sync pulse.

b. Turn the insturment power off.

c. Connect a 47-Picofarad 10% capacitor from pin 17 of the indictor oscilloscope vertical plug-in to ground.

d. Turn the instrument power on.

e. Set the test oscilloscope controls as follows:

Volts/div	10 mV
Input Coupling	AC
Time/div	5 μsec
Triggering	
Slope	—
Coupling	AC
Source	Int

f. Connect the test oscilloscope 10× probe to pin 17 of the vertical plug-in connector (see Fig. 5-12B).

g. CHECK—Test oscilloscope display for alternate trace sync pulse of approximately 350 millivolts peak to peak (see Fig. 5-12A).

h. Remove the probe and the 47 picofarad capacitor.

20. Check Sweep Output

a. Set the Type 11B1 TIME/DIV and MAGNIFIER switches to 5 μSEC.

b. Set the test oscilloscope controls as folllows:

Volts/div	0.5 V
Input Coupling	AC
Time/div	20 μsec
Triggering	
Slope	+
Coupling	AC
Source	Int

c. Connect the test oscilloscope 10× probe to the SWEEP OUT connector, using the BNC-to-probe adapter.

d. CHECK—Test oscilloscope display for positive-going ramp waveform 10 volts in amplitude, ±1 volt (see Fig. 5-13A).

21. Check +Gate Output

a. Remove the BNC-to-probe adapter and 10× probe from the SWEEP OUT connector and connect to the + GATE OUT connector.

b. CHECK—Test oscilloscope display for square wave 14.5 volts in amplitude, ±1.5 volts (see Fig. 5-13B).

c. Remove the probe and BNC-to-probe adapter.

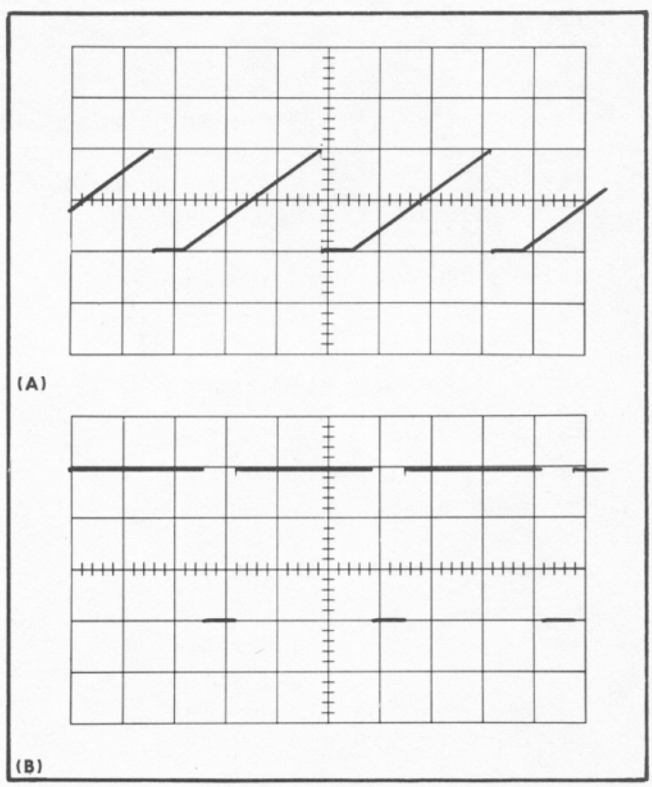


Fig. 5-13. Test oscilloscope display of (A) sweep output waveform, (B) + gate output waveform.

22. Check/Adjust External Horizontal Variable Balance

a. Change the following control settings:

TIME/CM OR HORIZONTAL VOLTS/CM	EXT HORIZ INPUT
MAGNIFIER	.1 VOLT

b. Push the indicator oscilloscope Beam Finder button in and set the Intensity control to display a low-intensity spot on the CRT.

c. Again using the Beam Finder to locate the spot, center the spot on the CRT with the vertical and horizontal position controls.

d. Rotate the VARIABLE control to the fully counterclockwise position.

e. CHECK—Spot is located at the center of the CRT when the VARIABLE control is in the fully counterclockwise position. Some spot movement may occur as the VARIABLE control is turned through the middle of its range.

f. ADJUST—Ext Horiz Var Bal, R307 (see Fig. 5-14) to position spot at the center of the CRT when the VARIABLE control is in the fully counterclockwise position. Some spot movement may occur as the VARIABLE control is turned through the middle of its range.

g. Repeat the adjustment procedure until the position of the spot is the same at both extremes of the VARIABLE control.

23. Check/Adjust External Horizontal Compensation

a. Change the following control settings:

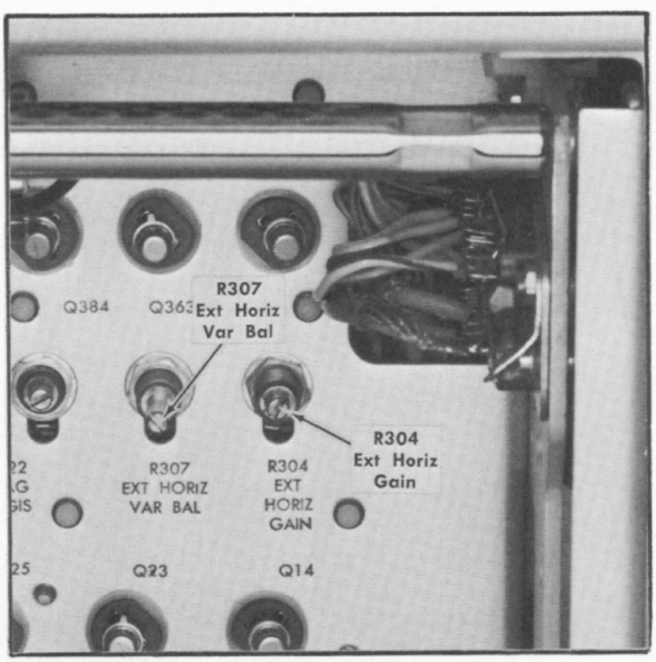


Fig. 5-14. Location of Ext Horiz Var Bal, R307, and Ext Horiz Gain, R304.

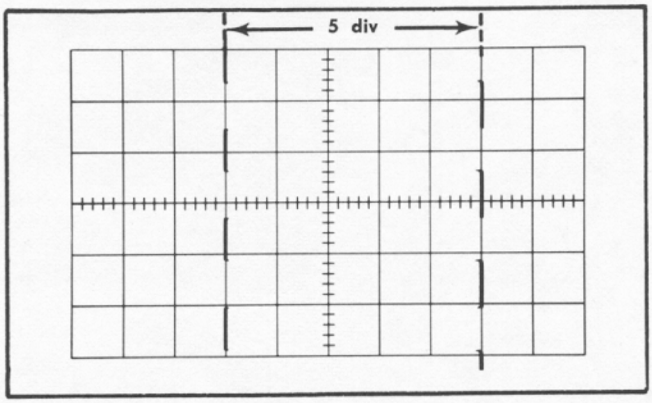


Fig. 5-15. Typical CRT display when checking external horizontal input.

MAGNIFIER	1 VOLT
VARIABLE	CALIB
COUPLING	DC
SOURCE	EXT
Volts/Cm	0.1

b. Change the test oscilloscope controls as follows:

Time/div	0.5 msec
Trigger Source	Ext

c. Connect a 10× probe from the indicator oscilloscope vertical plug-in input to the test oscilloscope sweep output connector, using the BNC-to-probe adapter.

d. Connect a BNC T connector to the standard amplitude calibrator output. Connect one side of the T connector to the EXT TRIG OR HORIZ IN connector, using a 42-inch BNC cable. Connect the other side of the T connector to the test oscilloscope external trigger input, using a 42-inch BNC cable.

e. Set the standard amplitude calibrator for a 5-volt square wave output.

f. Obtain an externally triggered trace on the test oscilloscope, producing a horizontally-deflected square wave on the CRT of the indicator oscilloscope (see Fig. 5-15).

g. CHECK—Square corner on the display square wave.

h. ADJUST—C32 (see Fig. 5-16) for the best square corner on the displayed square wave.

i. Center the display horizontally on the CRT.

j. Change the COUPLING switch to AC.

k. CHECK—Display shifts to the left half of the CRT.

l. Change the following control settings:

MAGNIFIER	.1 VOLT
COUPLING	DC
SOURCE	EXT ÷ 10

m. Return the display to the center of the CRT with the horizontal position control.

n. CHECK—Square corner on the displayed waveform.

o. ADJUST—C28 (see Fig. 5-16) for the best square corner on the displayed square wave.

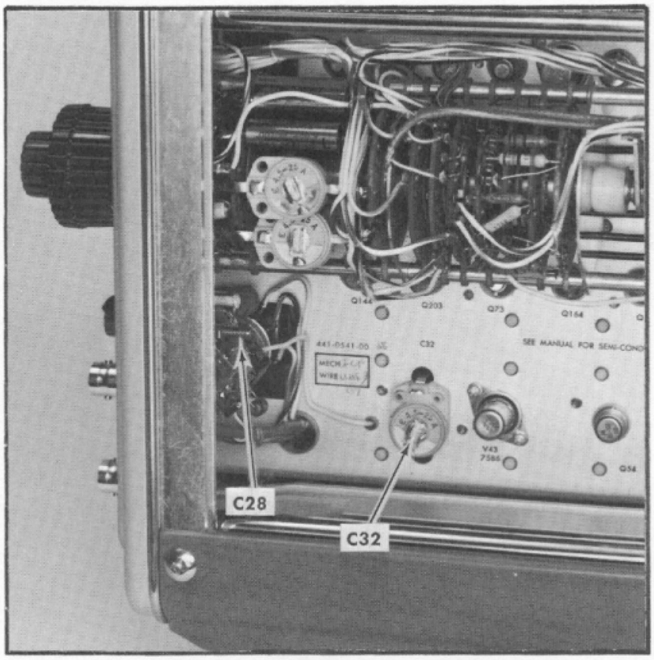


Fig. 5-16. Location of C28 and C32.

24. Check/Adjust External Horizontal Gain

a. Change the SOURCE switch to EXT.

b. Set the standard amplitude calibrator to 0.5 volt.

c. Trigger the test oscilloscope externally on the calibrator signal.

d. CHECK—CRT display for 5 centimeters of horizontal deflection, ±0.1 centimeter.

e. ADJUST—Ext Horiz Gain, R304 (see Fig. 5-14) for 5 centimeters of horizontal deflection.

f. Change the MAGNIFIER switch to 2 VOLTS.

g. Set the standard amplitude calibrator to 10 volts.

h. CHECK—CRT display for 5 centimeters of horizontal deflection, ±0.1 centimeter.

i. Disconnect all test equipment.

25. Check External Horizontal Bandpass

a. Change the MAGNIFIER to .5 VOLT.

b. Connect the output of the constant-amplitude signal generator to the EXT TRIG OR HORIZ IN connector, through the 5-nanosecond GR cable, GR-to-BNC adapter, and 50-ohm BNC termination.

c. Set the signal generator frequency to 50 kilohertz.

d. Adjust the signal generator amplitude for an 8 centimeter trace, positioned between the second and tenth graticule lines.

e. Increase the frequency of the constant amplitude signal generator until the trace reduces in length to 5.6 centimeters.

f. CHECK—The frequency of the signal generator must be at least 3 megahertz.

g. Set the TIME/CM switch to 1 mSEC to free-run the sweep.

This completes the performance check/calibration of the Type 11B1. Disconnect all test equipment and replace the instrument covers.

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
inc	incandescent

int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
P/O	part of
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
S or SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

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 or model 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.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description					S/N Range

Bulbs

Ckt. No.	Tektronix Part No.	Description		S/N Range
B124	150-030	Neon, NE-2V	SWEEP FREE RUN	
B180	150-030	Neon, NE-2V	UNCAL	
B234†	260-518	Switch w/red Indicator light	READY	
B241	150-030	Neon, NE-2V		

Capacitors

Tolerance ±20% unless otherwise indicated.

Tolerance of all electrolytic capacitors as follows (with exceptions):

3 V — 50 V = —10%, +250%
51 V — 350 V = —10%, +100%
351 V — 450 V = —10%, + 50%

Ckt. No.	Tektronix Part No.	Description					S/N Range
C4	283-080	0.022 μf	Cer		25 v		
C5	283-080	0.022 μf	Cer		25 v		
C15	281-516	39 pf	Cer		500 v	10%	
C21	281-518	47 pf	Cer		500 v		
C23	283-080	0.022 μf	Cer		25 v		
C26	283-078	0.001 μf	Cer		500 v		
C27	281-542	18 pf	Cer		500 v	10%	
C28	281-027	0.7-3 pf	Tub.	Var			
C30A	283-068	0.01 μf	Cer		500 v		
C30B	281-523	100 pf	Cer		350 v		
C31	283-068	0.01 μf	Cer		500 v		
C32	Use 281-010	4.5-25 pf	Cer	Var			
C37	283-068	0.01 μf	Cer		500 v		
C42	283-079	0.01 μf	Cer		250 v		
C45	283-079	0.01 μf	Cer		250 v		
C47	283-081	0.1 μf	Cer		25 v		
C51	290-162	22 μf	EMT		35 v	20%	
C56	283-080	0.022 μf	Cer		25 v		
C58	283-081	0.1 μf	Cer		25 v		
C62	283-078	0.001 μf	Cer		500 v		
C66	283-080	0.022 μf	Cer		25 v		
C82	283-010	0.05 μf	Cer		50 v		
C83	281-516	39 pf	Cer		500 v	10%	
C88	281-525	470 pf	Cer		500 v		
C93	Use 281-0528-00	82 pf	Cer		500 v	10%	

†Furnished as a unit with SW234.

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
C102	281-543	270 pf	Cer		500 v	10%	
C104	283-078	0.001 μf	Cer		500 v		
C109	283-080	0.022 μf	Cer		25 v		
C114	290-189	33 μf	EMT		35 v	10%	
C128	281-525	470 pf	Cer		500 v		
C136	281-542	18 pf	Cer		500 v	10%	
C140	281-518	47 pf	Cer		500 v		
C142	283-081	0.1 μf	Cer		25 v		
C149	281-516	39 pf	Cer		500 v	10%	
C163	290-139	180 μf	EMT		6 v	20%	
C165	281-523	100 pf	Cer		350 v		
C173	281-546	330 pf	Cer		500 v	10%	
C180A	281-010	4.5-25 pf	Cer	Var			
C180B	283-097	84 pf	Cer		1000 v	2%	
C180C	281-010	4.5-25 pf	Cer	Var			
C180D	283-097	84 pf	Cer		1000 v	2%	
C180E	use *295-0082-00	0.001 μf	Timing Series				
C180F	use *295-0082-00	0.01 μf	Timing Series				
C180G	use *295-0082-00	0.1 μf	Timing Series				
C180H	use *295-0082-00	1 μf	Timing Series				
C180J	use *295-0082-00	10 μf	Timing Series				
C180R	281-525	470 pf	Cer		500 v		
C182	283-079	0.01 μf	Cer		250 v		
C185	281-509	15 pf	Cer		500 v	10%	
C186	281-523	100 pf	Cer		350 v		
C200A	281-525	470 pf	Cer		500 v		
C200B	281-536	0.001 μf	Cer		500 v	10%	
C200C	285-598	0.01 μf	PTM		100 v	5%	
C200D	290-188	0.1 μf	EMT		20 v		
C200E	290-183	1 μf	EMT		35 v	10%	
C200F	290-167	10 μf	EMT		15 v	20%	
C212	283-080	0.022 μf	Cer		25 v		
C226	281-549	68 pf	Cer		500 v	10%	
C229	281-523	100 pf	Cer		350 v		
C234	285-629	0.047 μf	PTM		100 v		
C240	285-622	0.1 μf	PTM		100 v		
C241	281-543	270 pf	Cer		500 v	10%	
C242	281-524	150 pf	Cer		500 v		
C246	281-525	470 pf	Cer		500 v		
C247	283-079	0.01 μf	Cer		250 v		
C251	290-135	15 μf	EMT		20 v	20%	
C270	281-543	270 pf	Cer		500 v	10%	
C302	281-518	47 pf	Cer		500 v		
C326	281-573	11 pf	Cer			10%	100-189
C326	281-509	15 pf	Cer		500 v	10%	190-up
C333	283-081	0.1 μf	Cer		25 v		
C343	283-078	0.001 μf	Cer		500 v		

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C346	281-573	11 pf	Cer		10%	100-189
C346	281-509	15 pf	Cer	500 v	10%	190-up
C389	283-078	0.001 μf	Cer	500 v		100-459X
C406	283-080	0.022 μf	Cer	25 v		
C416	283-080	0.022 μf	Cer	25 v		

Diodes

Ckt. No.	Tektronix Part No.	Description		S/N Range
D38	*152-045	Silicon	Selected from 1N622A	100-519
D38	152-0246-00	Silicon	Low leakage 0.25 w, 40 v	520-up
D39	*152-045	Silicon	Selected from 1N622A	100-519
D39	152-0246-00	Silicon	Low leakage 0.25 w, 40 v	520-up
D43	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D44	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D46	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D47	152-139	Zener	1N751 .4 w, 5.1 v, 10%	100-729
D47	152-0279-00	Zener	1N751A .4 w, 5.1 v, 5%	730-up
D52	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D54	152-141	Silicon	1N4152	100-779
D54	152-0141-02	Silicon	1N4152	780-up
D55	*152-153	Silicon	Replaceable by 1N4244	
D56	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D64	152-141	Silicon	1N4152	100-779
D64	152-0141-02	Silicon	1N4152	780-up
D65	*152-153	Silicon	Replaceable by 1N4244	
D66	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D80	*152-153	Silicon	Replaceable by 1N4244	
D85	*152-125	Tunnel	Selected TD3A 4.7 MA	
D88	*152-153	Silicon	Replaceable by 1N4244	
D89	*152-153	Silicon	Replaceable by 1N4244	
D102	*152-153	Silicon	Replaceable by 1N4244	100-739
D102	152-0065-00	Silicon	HD5000	740-799
D102	*152-0322-00	Silicon	Tek Spec	800-919
D102	152-0065-00	Silicon	HD5000	920-up
D103	*152-153	Silicon	Replaceable by 1N4244	
D104	152-141	Silicon	1N4152	100-779
D104	152-0141-02	Silicon	1N4152	780-up
D105	*152-125	Tunnel	Selected TD3A 4.7 MA	
D113	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D114	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D122	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D130	*152-153	Silicon	Replaceable by 1N4244	
D131	*152-153	Silicon	Replaceable by 1N4244	
D135	*152-125	Tunnel	Selected TD3A 4.7 MA	
D144	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D163	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D165	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D166	*152-161	GaAs diffused w/axial lead		100-939
D166	*152-0249-00	Silicon	Assembly, Tek made	940-up
D172	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D183	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D200	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D201	Use *152-0185-00	Silicon	Replaceable by 1N4152	

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description		S/N Range
D203	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D213	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D242	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D324	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D349	Use *152-0185-00	Silicon	Replaceable by 1N4152	
D412	152-123	Zener	T.C. 1N935A .4 w, 9.1 v, 5%	

Inductors

Ckt. No.	Tektronix Part No.	Description	S/N Range
L4	276-528	Core, Ferramic Suppressor	
L31	*108-287	Reed Drive Single	
L35	*108-287	Reed Drive Single	
L36	*108-287	Reed Drive Single	
L85	*108-112	0.3 μh	
L126	*108-147	2.2 μh	
L311	276-528	Core, Ferramic Suppressor	
L318	276-528	Core, Ferramic Suppressor	
L338	276-528	Core, Ferramic Suppressor	
L389	276-0507-00	Core, Ferramic Suppressor	X460-up

Transistors

Ckt. No.	Tektronix Part No.	Description
Q4	*151-108	Replaceable by 2N2501
Q14	*151-108	Replaceable by 2N2501
Q23	*151-108	Replaceable by 2N2501
Q33	*151-133	Selected from 2N3251
Q54	*151-103	Replaceable by 2N2219
Q64	*151-103	Replaceable by 2N2219
Q73	*151-126	Replaceable by 2N2484
Q84	*151-083	Selected from 2N964
Q94	Use 151-0131-00	2N964
Q114	*151-103	Replaceable by 2N2219
Q124	*151-096	Selected from 2N1893
Q134	*151-108	Replaceable by 2N2501
Q144	*151-108	Replaceable by 2N2501
Q154	*151-108	Replaceable by 2N2501
Q164	151-107	2N967
Q173	151-107	2N967
Q181	*151-127	Selected from 2N2369
Q193	*151-103	Replaceable by 2N2219
Q203	*151-087	Selected from 2N1131
Q215	*151-133	Selected from 2N3251
Q225	*151-133	Selected from 2N3251
Q234	*151-096	Selected from 2N1893
Q244	*151-103	Replaceable by 2N2219
Q303	*151-103	Replaceable by 2N2219
Q313	*151-087	Selected from 2N1131

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q324	Use *050-224	Replacement Kit	100-189
Q324	*151-133	Selected from 2N3251	190-up
Q333	*151-087	Selected from 2N1131	
Q344	Use *050-224	Replacement Kit	100-189
Q344	*151-133	Selected from 2N3251	190-up
Q353	151-108	Replaceable by 2N2501	
Q363	*151-108	Replaceable by 2N2501	
Q374	*151-108	Replaceable by 2N2501	
Q384	*151-108	Replaceable by 2N2501	

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Part No.	Value	Wattage	Type		Tolerance	Notes / S/N Range
R1	311-326	10 k		Var			INT TRIG DC LEVEL
R2	316-392	3.9 k	1/4 w				
R3	315-101	100 Ω	1/4 w			5%	
R4	302-391	390 Ω	1/2 w				
R5	316-330	33 Ω	1/4 w				
R7	323-191	953 Ω	1/2 w		Prec	1%	
R12	315-101	100 Ω	1/4 w			5%	
R14	323-161	464 Ω	1/2 w		Prec	1%	
R15	316-100	10 Ω	1/4 w				
R16	322-094	93.1 Ω	1/4 w		Prec	1%	
R17	323-191	953 Ω	1/2 w		Prec	1%	
R20	303-153	15 k	1 w			5%	
R21	321-225	2.15 k	1/8 w		Prec	1%	
R22	323-313	17.8 k	1/2 w		Prec	1%	
R23	316-471	470 Ω	1/4 w				
R26	315-751	750 Ω	1/4 w			5%	
R27	316-470	47 Ω	1/4 w				
R28	319-037	9 meg	1/4 w		Prec	2%	100-619
R28	325-0021-00	9 meg	1/4 w		Prec	1%	620-up
R29	322-481	1 meg	1/4 w		Prec	1%	
R30	322-385	100 k	1/4 w		Prec	1%	
R31	301-181	180 Ω	1/2 w			5%	
R32	322-470	768 k	1/4 w		Prec	1%	
R33	322-420	232 k	1/4 w		Prec	1%	
R35	301-181	180 Ω	1/2 w			5%	
R36	301-181	180 Ω	1/2 w			5%	
R37	301-105	1 meg	1/2 w			5%	
R38	316-470	47 Ω	1/4 w				
R39	316-470	47 Ω	1/4 w				
R42	316-221	220 Ω	1/4 w				
R43	305-512	5.1 k	2 w			5%	
R44	302-472	4.7 k	1/2 w				
R45	316-104	100 k	1/4 w				

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R47	302-472	4.7 k	½ w				
R48	316-104	100 k	¼ w				
R49	303-103	10 k	1 w			5%	
R50	321-181	750 Ω	⅛ w		Prec	1%	
R51	316-103	10 k	¼ w				
R52	323-404	158 k	½ w		Prec	1%	
R53	321-413	196 k	⅛ w		Prec	1%	
R54	308-273	6.5 k	5 w		WW	2%	
R56	321-161	464 Ω	⅛ w		Prec	1%	
R58	316-330	33 Ω	¼ w				
R62	316-220	22 Ω	¼ w				
R66	321-161	464 Ω	⅛ w		Prec	1%	
R73	301-683	68 k	½ w			5%	
R74	316-101	100 Ω	¼ w				
R75	315-272	2.7 k	¼ w			5%	
R76	315-822	8.2 k	¼ w			5%	
R77	316-102	1 k	¼ w				
R78†	311-272	5 k		Var		LEVEL	
R79	316-681	680 Ω	¼ w				
R80	323-332	28 k	½ w		Prec	1%	
R81	321-224	2.1 k	⅛ w		Prec	1%	
R82	321-153	383 Ω	⅛ w		Prec	1%	
R83	316-220	22 Ω	¼ w				
R84	323-321	21.5 k	½ w		Prec	1%	
R85	315-750	75 Ω	¼ w			5%	
R88	315-222	2.2 k	¼ w			5%	
R89	321-245	3.48 k	⅛ w		Prec	1%	
R91	Use 316-0470-00	47 Ω	¼ w				
R93	301-223	22 k	½ w			5%	
R94	315-242	2.4 k	¼ w			5%	
R104	316-471	470 Ω	¼ w				
R105	315-112	1.1 k	¼ w			5%	
R106	323-281	8.25 k	½ w		Prec	1%	
R109	316-330	33 Ω	¼ w				
R110	321-105	121 Ω	⅛ w		Prec	1%	
R111	321-303	14 k	⅛ w		Prec	1%	
R112	321-229	2.37 k	⅛ w		Prec	1%	
R113	321-271	6.49 k	⅛ w		Prec	1%	
R114	315-471	470 Ω	¼ w			5%	
R116	321-250	3.92 k	⅛ w		Prec	1%	
R122	316-392	3.9 k	¼ w				
R123	321-258	4.75 k	⅛ w		Prec	1%	
R124	316-224	220 k	¼ w				
R125	316-473	47 k	¼ w				
R126	316-331	330 Ω	¼ w				

†Furnished as a unit with R201.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description						S/N Range
R128	315-101	100 Ω	¼ w				5%	
R129	321-243	3.32 k	⅛ w			Prec	1%	
R130	321-258	4.75 k	⅛ w			Prec	1%	
R134	315-112	1.1 k	¼ w				5%	
R136	315-112	1.1 k	¼ w				5%	
R140	321-250	3.92 k	⅛ w			Prec	1%	
R141	322-341	34.8 k	¼ w			Prec	1%	
R142	316-101	100 Ω	¼ w					
R143	323-171	590 Ω	½ w			Prec	1%	
R144	315-162	1.6 k	¼ w				5%	
R145	321-173	619 Ω	⅛ w			Prec	1%	
R149	316-472	4.7 k	¼ w					
R154	315-122	1.2 k	¼ w				5%	
R156	315-621	620 Ω	¼ w				5%	
R162	323-184	806 Ω	½ w			Prec	1%	
R163	Use 321-121	178 Ω	⅛ w			Prec	1%	
R164	315-512	5.1 k	¼ w				5%	
R165	316-101	100 Ω	¼ w					
R171	315-392	3.9 k	¼ w				5%	
R172	316-473	47 k	¼ w					
R173	316-101	100 Ω	¼ w					
R179A† }	311-439	20 k		Var	VARIABLE		(TIME/CM)	
R179B† }		500 Ω					(EXT HORIZ INPUT)	
R180A	323-654	75 k	½ w			Prec	½%	
R180B	323-654	75 k	½ w			Prec	½%	
R180C	315-392	3.9 k	¼ w				5%	
R180D	323-653	221 k	½ w			Prec	¼%	
R180E	323-657	750 k	½ w			Prec	.1%	
R180F	323-655	750 k	½ w			Prec	½%	
R180G	323-655	750 k	½ w			Prec	½%	
R180H	323-656	1.5 meg	½ w			Prec	½%	
R180J	309-440	3.74 meg	½ w			Prec	1%	
R180K	309-441	7.5 meg	½ w			Prec	1%	
R180R	316-470	47 Ω	¼ w					
R180T	316-182	1.8 k	¼ w					
R180W	311-328	1 k		Var			SWP CAL	
R180X	316-184	180 k	¼ w					
R181	316-470	47 Ω	¼ w					
R182	316-221	220 Ω	¼ w					
R183	316-471	470 Ω	¼ w					
R184	323-315	18.7 k	½ w			Prec	1%	
R185	316-220	22 Ω	¼ w					
R186	316-101	100 Ω	¼ w					
R187	316-220	22 Ω	¼ w					

†Furnished as a unit with SW179.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R189	305-752	7.5 k	2 w			5%	
R193	315-751	750 Ω	1/4 w			5%	
R194	315-333	33 k	1/4 w			5%	
R200	315-124	120 k	1/4 w			5%	
R201†	311-272	5 k		Var		HF STABILITY	
R202	315-153	15 k	1/4 w			5%	
R203	316-393	39 k	1/4 w				
R211	321-207	1.4 k	1/8 w		Prec	1%	
R212	321-255	4.42 k	1/8 w		Prec	1%	
R215	321-171	590 Ω	1/8 w		Prec	1%	
R216	321-189	909 Ω	1/8 w		Prec	1%	
R225	324-305	14.7 k	1 w		Prec	1%	
R226	316-101	100 Ω	1/4 w				
R227	316-221	220 Ω	1/4 w				
R228	315-113	11 k	1/4 w			5%	
R229	321-225	2.15 k	1/8 w		Prec	1%	
R231	321-225	2.15 k	1/8 w		Prec	1%	
R232	322-357	51.1 k	1/4 w		Prec	1%	
R234	316-225	2.2 meg	1/4 w				
R235	316-473	47 k	1/4 w				
R236	316-473	47 k	1/4 w				
R238	316-564	560 k	1/4 w				
R239	316-333	33 k	1/4 w				
R241	316-104	100 k	1/4 w				
R243	316-473	47 k	1/4 w				
R244	316-223	22 k	1/4 w				
R245	316-104	100 k	1/4 w				
R246	316-473	47 k	1/4 w				
R247	316-103	10 k	1/4 w				
R249	316-104	100 k	1/4 w				
R251	316-330	33 Ω	1/4 w				
R302	315-331	330 Ω	1/4 w			5%	
R303	301-512	5.1 k	1/2 w			5%	
R304	311-097	200 Ω	1/2 w	Var		EXT HORIZ GAIN	
R307	311-095	500 Ω		Var		EXT HORIZ BAL	
R308	316-471	470 Ω	1/4 w				
R309	315-511	510 Ω	1/4 w			5%	
R311	316-275	2.7 meg	1/4 w				
R313	301-563	56 k	1/2 w			5%	
R321	324-317	19.6 k	1 w		Prec	1%	
R322	311-328	1 k		Var		MAG REGIS	
R324	315-753	75 k	1/4 w			5%	
R326	316-101	100 Ω	1/4 w				

†Furnished as a unit with R78.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R330	315-473	47 k	¼ w		5%	
R331	315-821	820 Ω	¼ w		5%	
R332	315-682	6.8 k	¼ w		5%	
R333	301-334	330 k	½ w		5%	
R334	301-563	56 k	½ w		5%	
R340A	325-002	2.67 k	⅛ w	Prec	.1%	
R340B	322-653	1.335 k	¼ w	Prec	½%	
R340C	322-652	1.068 k	¼ w	Prec	½%	
R340D	322-651	661 Ω	¼ w	Prec	½%	
R340E	322-650	533 Ω	¼ w	Prec	½%	
R340F	322-649	266 Ω	¼ w	Prec	½%	
R340G	322-648	133 Ω	¼ w	Prec	½%	
R340H	322-647	106 Ω	¼ w	Prec	½%	
R340J	322-646	66 Ω	¼ w	Prec	½%	
R340K	322-645	52.5 Ω	¼ w	Prec	½%	
R341	324-317	19.6 k	1 w	Prec	1%	
R343	321-181	750 Ω	⅛ w	Prec	1%	
R344	315-753	75 k	¼ w		5%	
R346	316-101	100 Ω	¼ w			
R353	324-285	9.09 k	1 w	Prec	1%	
R355	321-319	20.5 k	⅛ w	Prec	1%	
R363	324-285	9.09 k	1 w	Prec	1%	
R365	321-319	20.5 k	⅛ w	Prec	1%	
R371	321-097	100 Ω	⅛ w	Prec	1%	
R374	323-373	75 k	½ w	Prec	1%	
R375	321-289	10 k	⅛ w	Prec	1%	
R381	321-097	100 Ω	⅛ w	Prec	1%	
R384	323-373	75 k	½ w	Prec	1%	
R385	321-289	10 k	⅛ w	Prec	1%	
R388	315-102	1 k	¼ w		5%	
R389	315-473	47 k	¼ w		5%	
R401	321-239	3.01 k	⅛ w	Prec	1%	
R402	316-822	8.2 k	¼ w			
R403	321-273	6.81 k	⅛ w	Prec	1%	
R405	303-200	20 Ω	1 w		5%	
R412	305-332	3.3 k	2 w		5%	
R415	316-472	4.7 k	¼ w			
R416	316-472	4.7 k	¼ w			

Switches

	Unwired	Wired		
SW29	260-615		Lever	SOURCE
SW30	260-594		Lever	COUPLING
SW31	260-552		Reed	
SW32	260-592		Rotary	TRIGGER MODE
SW35	260-552		Reed	

Switches *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description		S/N Range
SW36	260-552	Reed		
SW50	260-472	Lever	SLOPE	
SW179†	311-439		CALIB	
SW180	260-593 *262-635	Rotary	TIME/CM	
SW234††	260-518	w/red Indicator Light	PUSH TO RESET	

Electron Tubes

V43	Use *157-0121-00	7586, Checked
V183	Use *157-0121-00	7586, Checked

†Furnished as a unit with R179A and R179B.
††Furnished as a unit with B234.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

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.

Assembly and/or Component
  Detail Part of Assembly and/or Component
  mounting hardware for Detail Part
    Parts of Detail Part
    mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears 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.

Mounting hardware must be purchased separately, unless otherwise specified.

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 or model 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.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

SECTION 7
MECHANICAL PARTS LIST

FIG. 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5 Description
1-1	333-0790-00			1	PANEL, front
-2	387-0899-00			1	PLATE, sub-panel
-3	366-0173-00			1	KNOB, charcoal—TRIGGER MODE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-4	260-0592-00			1	SWITCH, unwired—TRIGGER MODE
	- - - - - -			-	mounting hardware: (not included w/switch)
-5	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-6	366-0269-00			1	KNOB, charcoal—TIME/CM
	- - - - - -			-	knob includes:
	213-0022-00			2	SCREW, set, 4-40 x 3/16 inch, HSS
-7	331-0132-00			1	DIAL
	- - - - - -			-	dial includes:
	213-0022-00			2	SCREW, set, 4-40 x 3/16 inch, HSS
-8	366-0038-00			1	KNOB, red—VARIABLE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-9	262-0635-00			1	SWITCH, wired—TIME/CM
	- - - - - -			-	switch includes:
	260-0593-00			1	SWITCH, unwired
-10	384-0314-00			1	ROD, extension
	376-0014-00			1	COUPLING, wire
	361-0233-00	X880		1	RESTRAINT, shaft coupling
	361-0234-00	X880		1	RESTRAINT, shaft coupling
-11	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-12	406-0992-00			1	BRACKET, switch
-13	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-14	210-0018-00			1	LOCKWASHER, 5/16 inch
-15	210-0524-00			1	NUT, hex., 5/16-24 x 1/2 inch
-16	- - - - - -			1	CAPACITOR, (Timing)
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-17	210-0006-00			2	LOCKWASHER, internal, #6
-18	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
-19	348-0003-00			1	GROMMET, rubber, 5/16 inch
-20	348-0055-00			1	GROMMET, plastic, split
	- - - - - -			-	mounting hardware: (not included w/switch)
-21	210-0049-00			1	LOCKWASHER, internal, 5/8 inch
-22	210-0579-00			1	NUT, hex., 5/8-24 x 3/4 inch
-23	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS

FIG. 1 EXPLODED *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-24	366-0138-00			1	KNOB, charcoal—LEVEL
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-25	366-0255-00			1	KNOB, red—HF STABILITY
	- - - - - -			-	knob includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch, HSS
-26	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-27	366-0215-00	100	209	1	KNOB, lever—SLOPE
	366-0215-01	210		1	KNOB, lever—SLOPE
-28	260-0472-00			1	SWITCH, lever—SLOPE
	- - - - - -			-	mounting hardware: (not included w/switch)
	220-0413-00			2	NUT, hex., 4-40 x 3/16 x 0.500 inch long
-29	366-0215-00	100	209	1	KNOB, lever—COUPLING
	366-0215-01	210		1	KNOB, lever—COUPLING
-30	260-0594-00			1	SWITCH, lever—COUPLING
	- - - - - -			-	mounting hardware: (not included w/switch)
-31	220-0413-00			2	NUT, hex., 4-40 x 3/16 x 0.500 inch long
-32	366-0215-00	100	209	1	KNOB, lever—SOURCE
	366-0215-01	210		1	KNOB, lever—SOURCE
-33	260-0615-00			1	SWITCH, lever—SOURCE
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-34	129-0035-00			1	ASSEMBLY, ground post
	- - - - - -			-	assembly includes:
	355-0507-00			1	STEM
	200-0103-00			1	CAP
	210-0046-00			1	LOCKWASHER, internal, 0.261 ID x 0.400 inch OD
-35	210-0455-00			1	NUT, hex., 1/4-28 x 3/8 inch
-36	131-0106-00			3	CONNECTOR, coaxial, 1-contact, BNC w/hardware
-37	352-0052-00			1	HOLDER, capacitor
-38	378-0541-00			2	FILTER, light, lens
-39	352-0064-00			1	HOLDER, dual neon
	- - - - - -			-	mounting hardware: (not included w/holder)
	211-0109-00			1	SCREW, 4-40 x 7/8 inch, FHS
	210-0406-00			1	NUT, hex., 4-40 x 3/16 inch

FIG. 1 EXPLODED *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-40	260-0518-00			1	SWITCH, push, w/red light, w/hardware
-41	210-0259-00			6	LUG, solder, #2
	- - - - - -			-	mounting hardware for each: (not included w/lug)
-42	213-0055-00			1	SCREW, thread forming, 2-32 x $^3/_{16}$ inch, PHS
-43	210-0201-00			21	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
-44	213-0044-00			1	SCREW, thread cutting, 5-32 x $^3/_{16}$ inch, PHS
-45	348-0055-00			1	GROMMET, plastic, $^1/_4$ inch
-46	- - - - - -			5	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-47	210-0223-00			1	LUG, solder, $^1/_4$ ID x $^7/_{16}$ inch OD, SE
-48	210-0940-00			1	WASHER, flat, $^1/_4$ ID x $^3/_8$ inch OD
-49	210-0583-00			1	NUT, hex., $^1/_4$-32 x $^5/_{16}$ inch
-50	136-0181-00			32	SOCKET, transistor, 3 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-51	354-0234-00			1	RING, transistor socket
-52	136-0101-00			2	SOCKET, 5 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-53	213-0055-00			2	SCREW, thread forming, 2-32 x $^3/_{16}$ inch, PHS
-54	- - - - - -			1	CAPACITOR, variable
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-55	214-0153-00			1	FASTENER, snap, douple prong
-56	348-0063-00			2	GROMMET, rubber, $^1/_2$ inch
-57	441-0541-00			1	CHASSIS
	- - - - - -			-	mounting hardware: (not included w/chassis)
	210-0457-00			2	NUT, keps, 6-32 x $^5/_{16}$ inch
	211-0538-00			2	SCREW, 6-32 x $^5/_{16}$ inch, FHS
	211-0559-00			1	SCREW, 6-32 x $^3/_8$ inch, FHS
-58	211-0504-00			2	SCREW, 6-32 x $^1/_4$ inch, PHS
	211-0507-00			1	SCREW, 6-32 x $^5/_{16}$ inch, PHS
-59	384-0615-00			4	ROD, spacer
-60	212-0041-00			2	SCREW, 8-32 x $^1/_2$ inch, RHS
-61	214-0370-00			2	PIN, guide
-62	131-0096-00			1	CONNECTOR, 32 contact, male
	- - - - - -			-	mounting hardware: (not included w/connector)
-63	211-0008-00			2	SCREW, 4-40 x $^1/_4$ inch, PHS
	210-0004-00			1	LOCKWASHER, internal, #4
-64	210-0201-00			1	LUG, solder, SE #4
	210-0406-00			2	NUT, hex., 4-40 x $^3/_{16}$ inch

FIG. 1 EXPLODED *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-65	351-0063-00			1	GUIDE, shoe
	- - - - - -			-	mounting hardware: (not included w/guide)
-66	211-0012-00			1	SCREW, 4-40 x 3/16 inch, PHS
	210-0004-00			1	LOCKWASHER, internal, #4
-67	210-0406-00			1	NUT, hex., 4-40 x 3/16 inch
-68	387-0777-00			1	PLATE, rear
-69	179-0854-00			1	CABLE HARNESS
-70	124-0147-00			2	STRIP, ceramic, 7/16 inch x 13 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0007-00			2	SPACER, plastic, 0.063 inch high
-71	124-0146-00			22	STRIP, ceramic, 7/16 inch x 16 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0007-00			2	SPACER, plastic, 0.063 inch high
-72	260-0552-00			1	SWITCH, reed
					STANDARD ACCESSORIES
	070-0424-01			2	MANUAL, instruction (not shown)

SECTION 8
DIAGRAMS

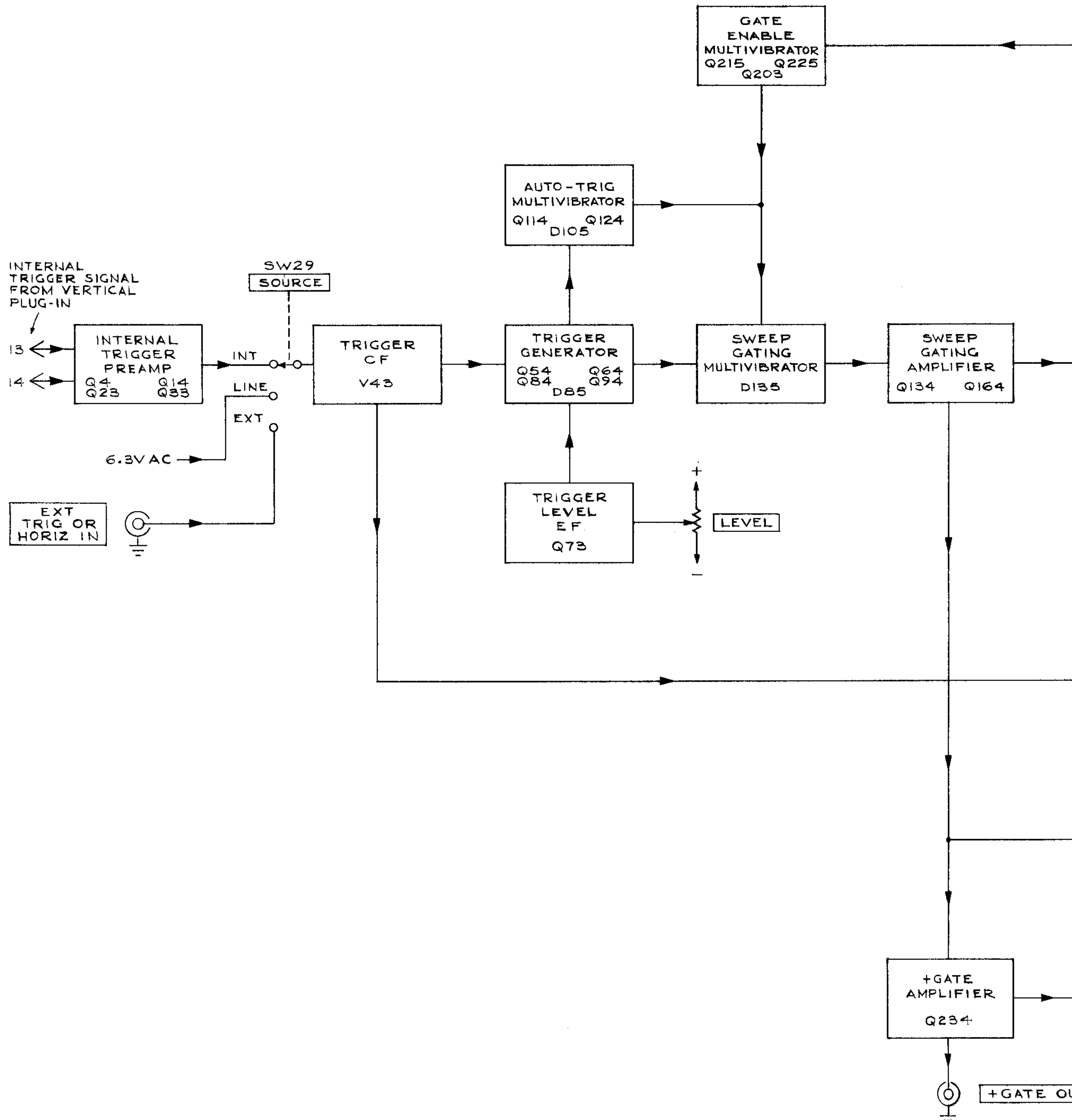
The following symbols are used on the diagrams:

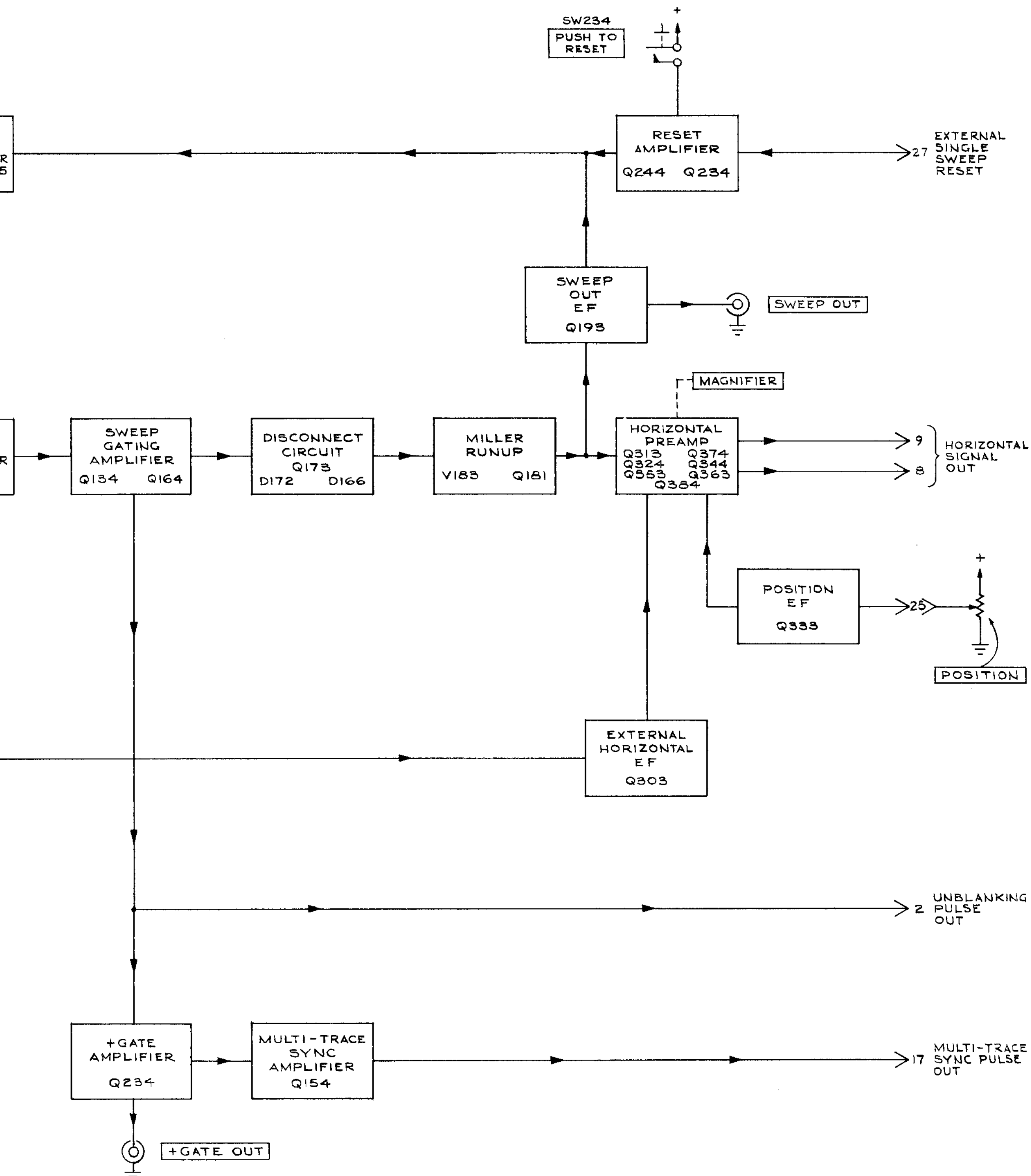
 Screwdriver adjustment

 Front-, side- or rear-panel control or connector

 Clockwise control rotation in direction of arrow

Refer to indicated diagram


GATE ENABLE MULTIVIBRATOR Q215 Q225 Q203
AUTO-TRIG MULTIVIBRATOR Q114 Q124 D105
INTERNAL TRIGGER SIGNAL FROM VERTICAL PLUG-IN
SW29
SOURCE
13
14
INTERNAL TRIGGER PREAMP Q4 Q14 Q23 Q33
INT
LINE
EXT
TRIGGER CF V43
TRIGGER GENERATOR Q54 Q64 Q84 Q94 D85
SWEEP GATING MULTIVIBRATOR D135
SWEEP GATING AMPLIFIER Q134 Q164
6.3V AC
EXT TRIG OR HORIZ IN
TRIGGER LEVEL EF Q73
+
−
LEVEL
+GATE AMPLIFIER Q234
+GATE OU



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BLOCK DIAGRAM

IMPORTANT

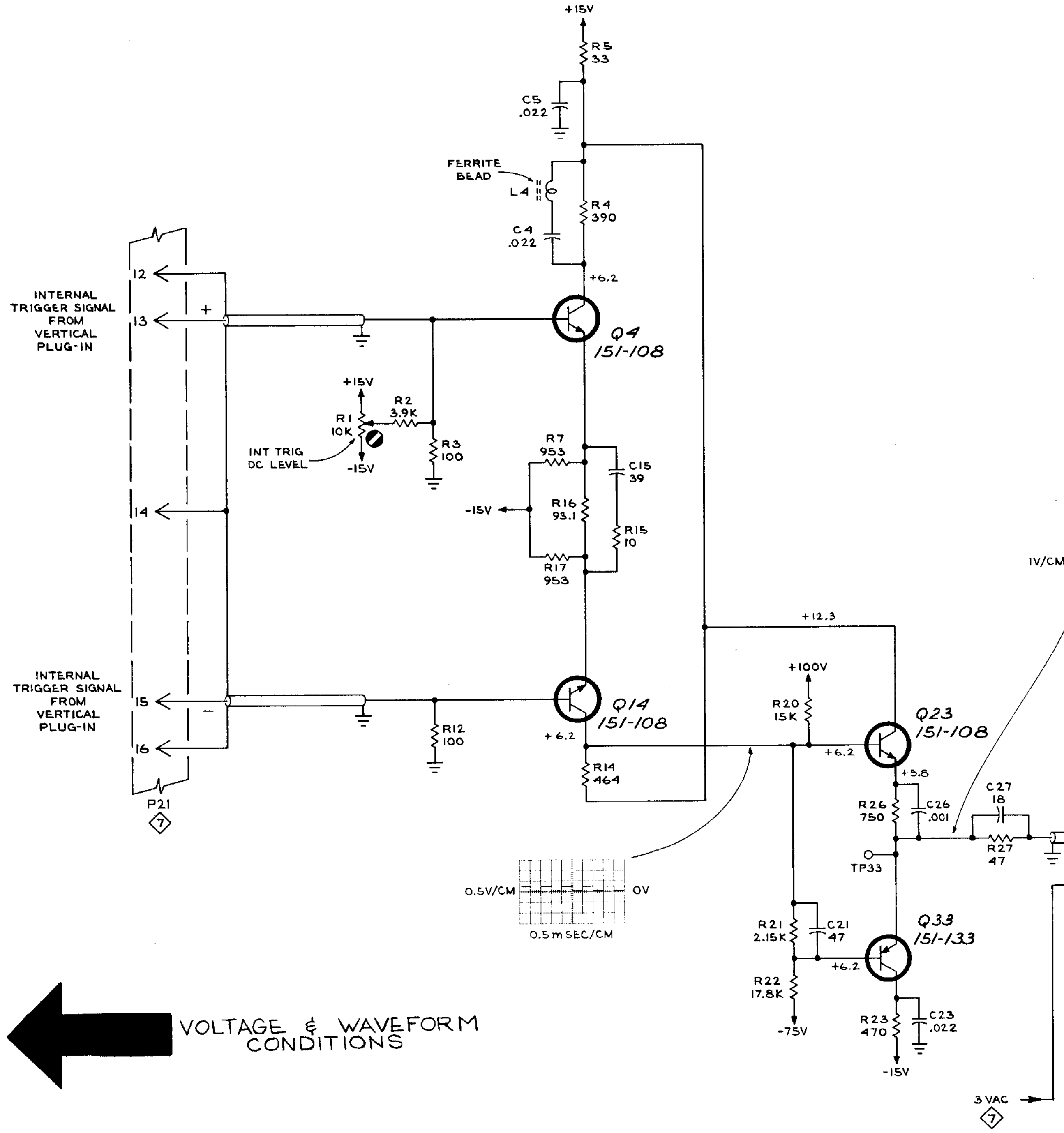
The waveform photographs and the voltages shown on the schematics were obtained with a Tektronix Type 454 oscilloscope using a P6047 (10X) Probe. Other equivalent systems may be used. The Type 11B1 was part of an oscilloscope system consisting of a Tektronix Type 647A Oscilloscope, Type 10A2A vertical plug-in, and the Type 11B1.

Signal input to the Type 10A2A at the time the waveform photographs were taken was the 1-kc square-wave output of the Type 647A calibrator. Internal triggering of the Type 11B1 was used except for those photographs where line triggering is specified. No signal input was applied while making the voltage measurements.

Voltage and waveform amplitudes are not absolute, but may vary within the instrument or between instruments.

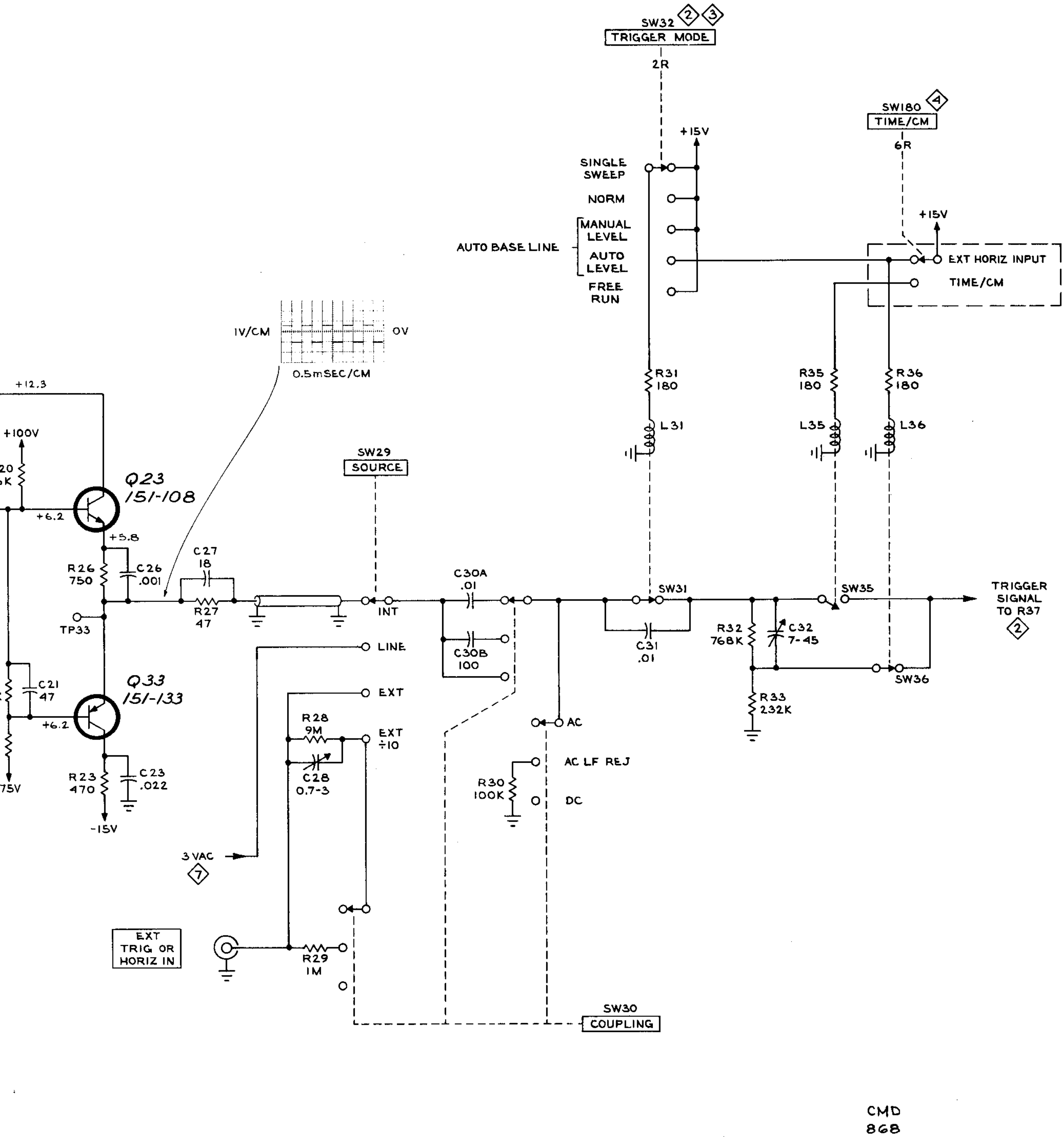
The Type 11B1 control settings for all measurements are as follows unless otherwise noted:

TIME/CM OR HORIZONTAL VOLTS/CM	1 mSEC
MAGNIFIER	1 mSEC
VARIABLE	CALIB
COUPLING	AC
SOURCE	INT
SLOPE	+
LEVEL	0
HF STABILITY	0
TRIGGER MODE	NORM



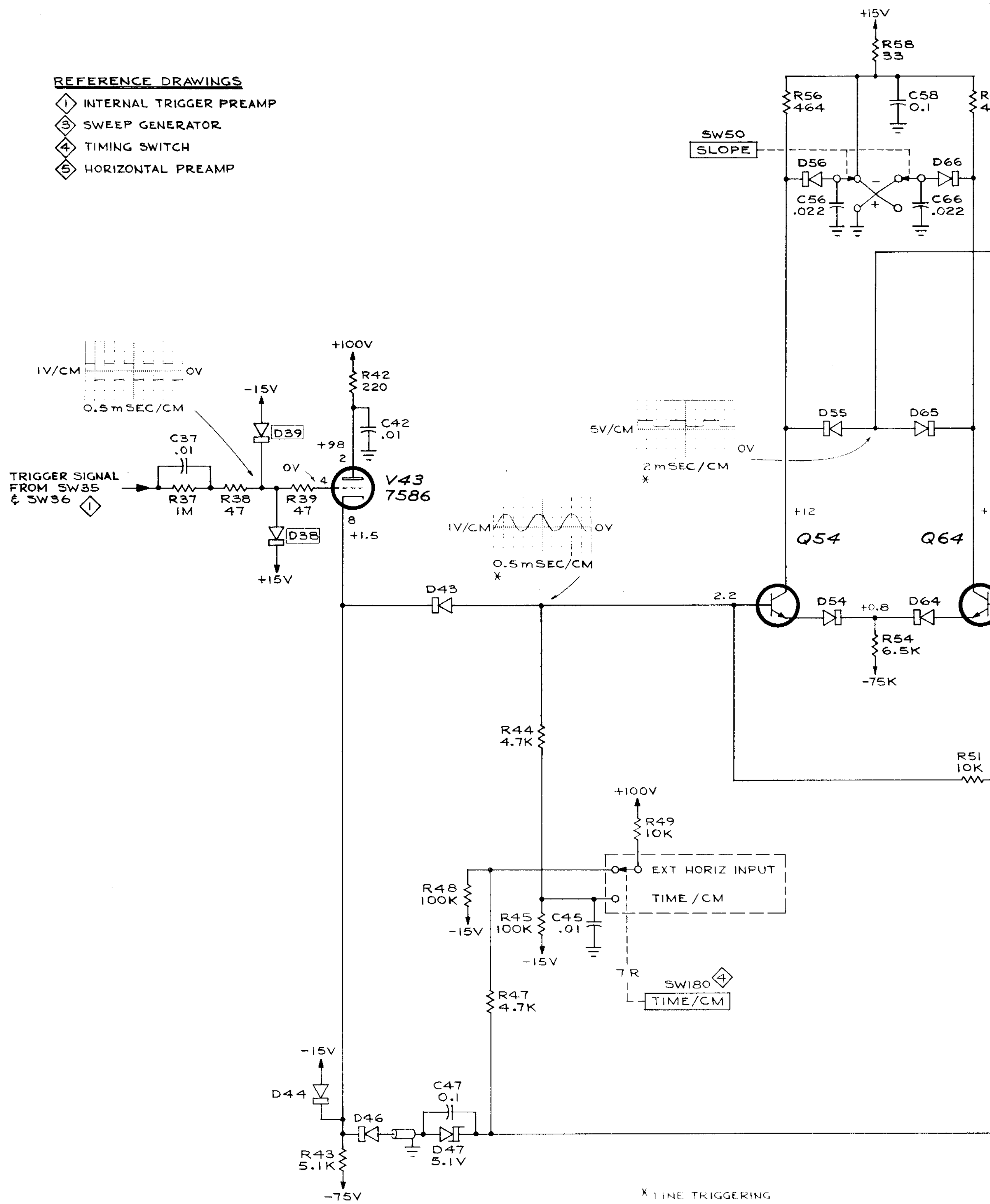
REFERENCE DRAWINGS

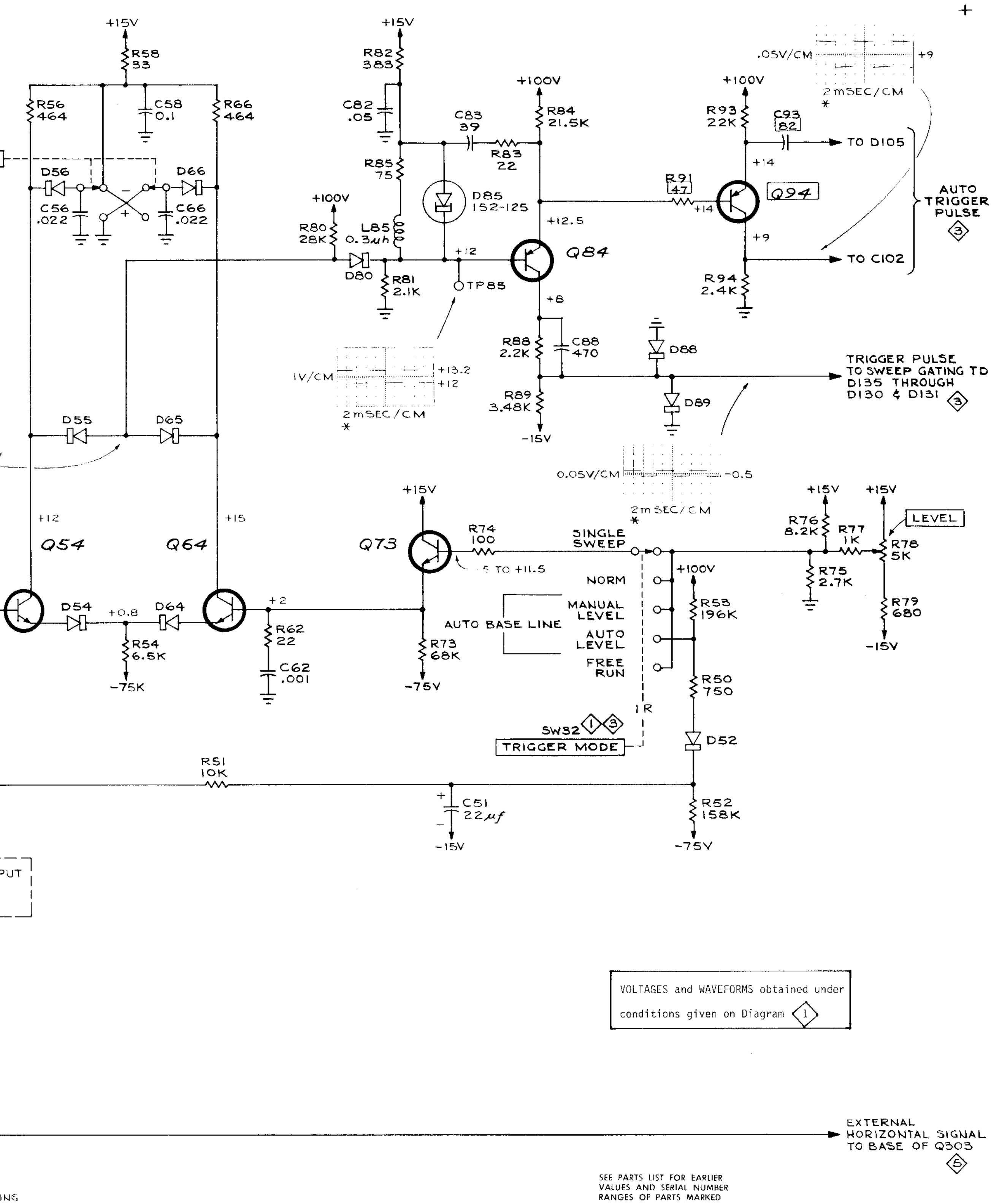
- ⟨2⟩ TRIGGER GENERATOR
- ⟨3⟩ SWEEP GENERATOR
- ⟨4⟩ TIMING SWITCH
- ⟨7⟩ INTERCONNECTING PLUG



INTERNAL TRIGGER PREAMP 1

B


REFERENCE DRAWINGS
1 INTERNAL TRIGGER PREAMP
3 SWEEP GENERATOR
4 TIMING SWITCH
5 HORIZONTAL PREAMP
+15V
R58 33
R56 464
C58 0.1
SW50 SLOPE
D56
D66
C56 .022
C66 .022
1V/CM
0V
0.5mSEC/CM
-15V
+100V
R42 220
C42 .01
D39
C37 .01
TRIGGER SIGNAL FROM SW35 & SW36 1
R37 1M
R38 47
R39 47
+98
V43 7586
D38
+1.5
+15V
D55
D65
5V/CM
2mSEC/CM
+12
Q54
Q64
D43
2.2
D54
+0.8
D64
R54 6.5K
-75K
R44 4.7K
R51 10K
+100V
R49 10K
EXT HORIZ INPUT
TIME / CM
R48 100K
-15V
R45 100K
C45 .01
SW180 4
TIME/CM
R47 4.7K
D44
C47 0.1
D46
D47 5.1V
R43 5.1K
-75V
* LINE TRIGGERING



VOLTAGES and WAVEFORMS obtained under conditions given on Diagram 1

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

MRH
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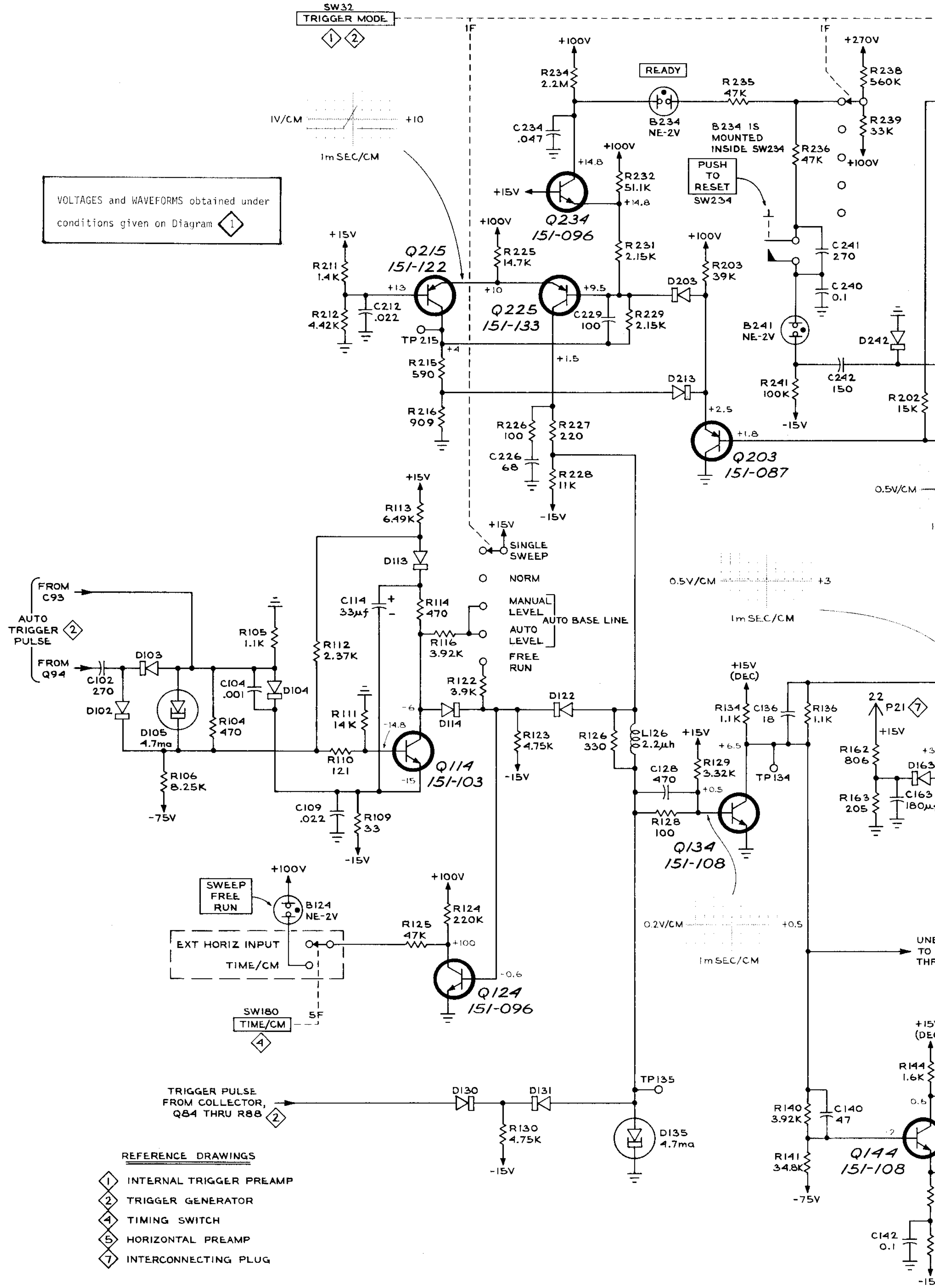
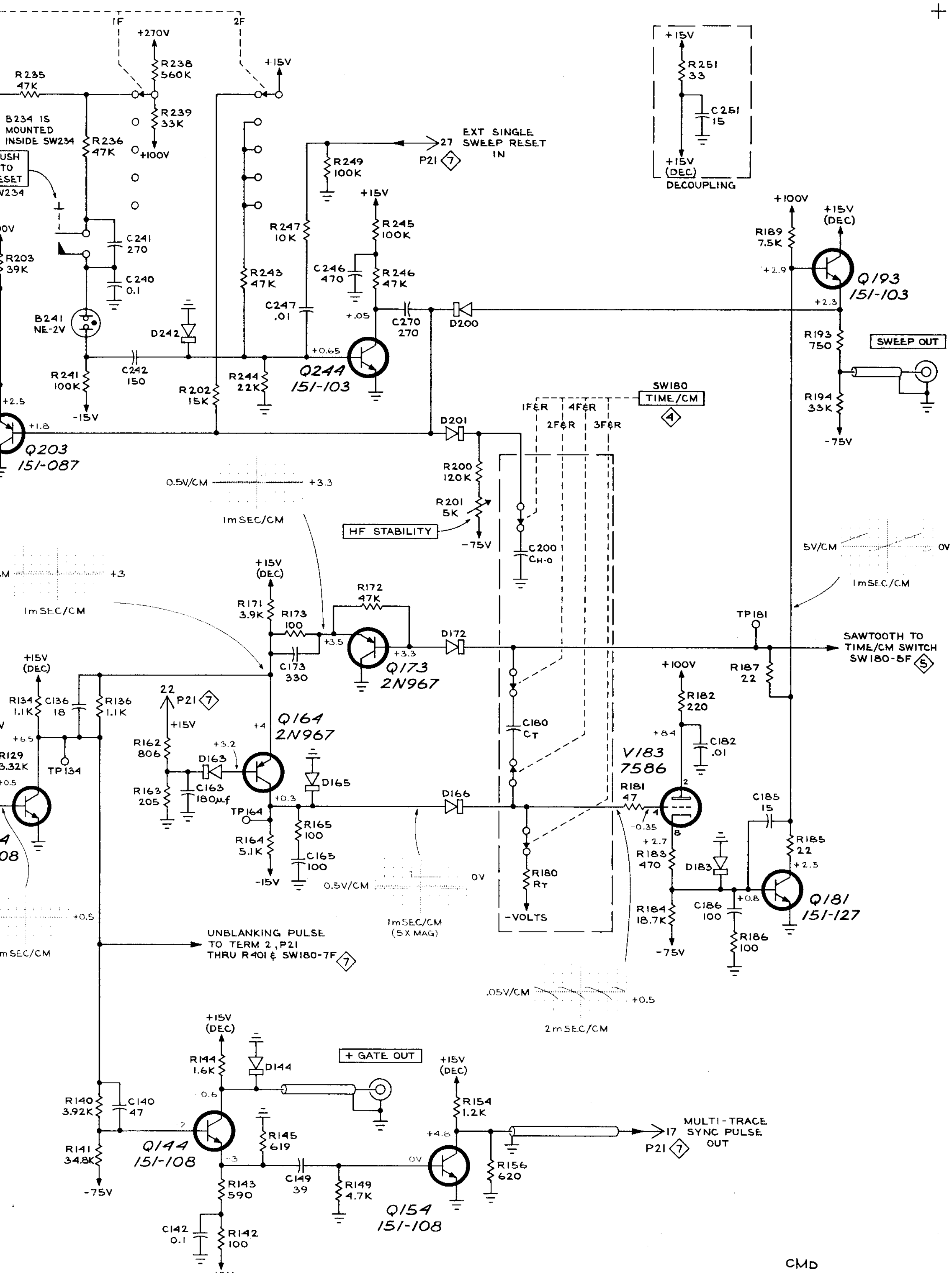
D

TRIGGER GENERATOR 2



REFERENCE DRAWINGS

- 1 INTERNAL TRIGGER PREAMP
- 2 TRIGGER GENERATOR
- 4 TIMING SWITCH
- 5 HORIZONTAL PREAMP
- 7 INTERCONNECTING PLUG



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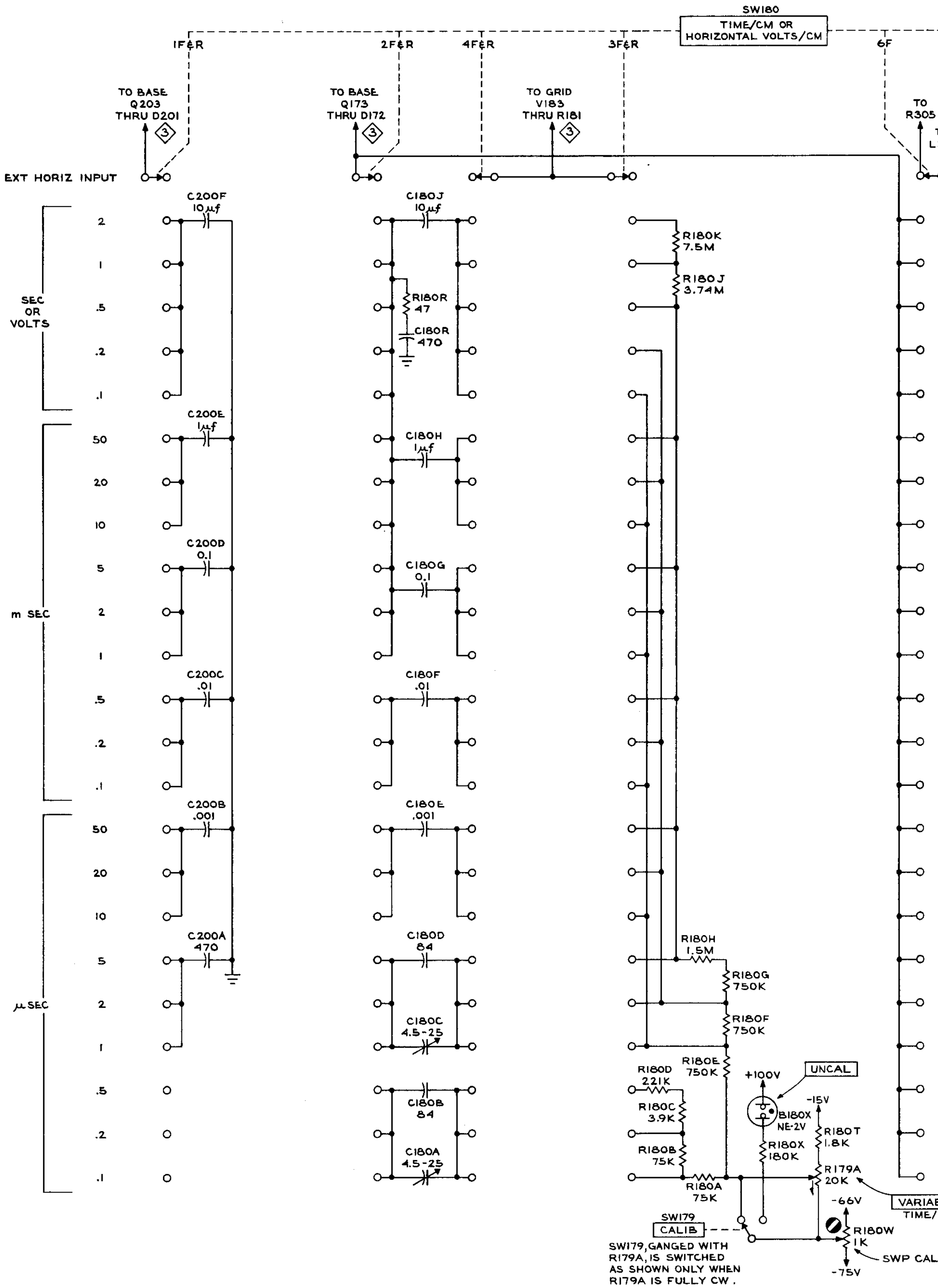
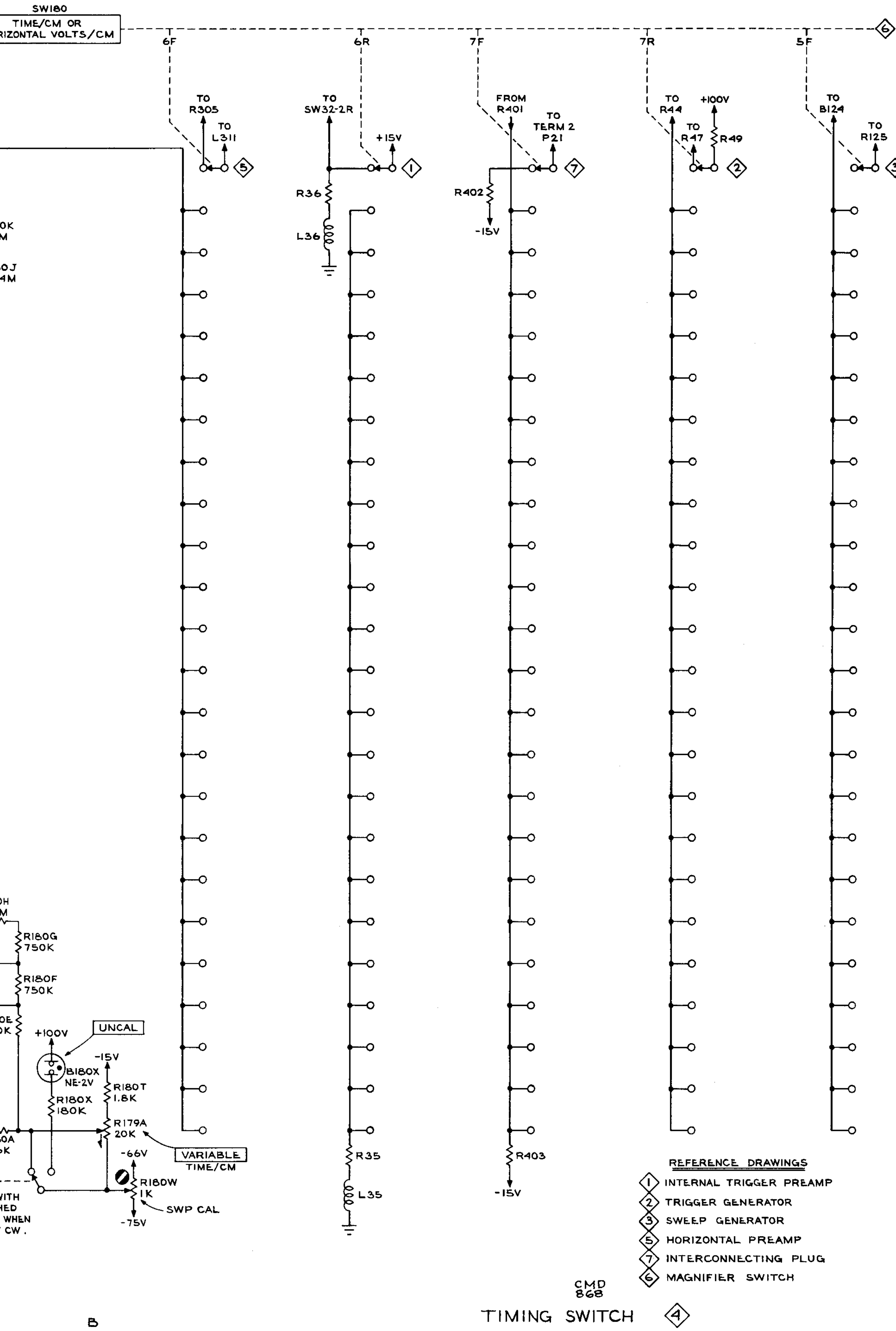
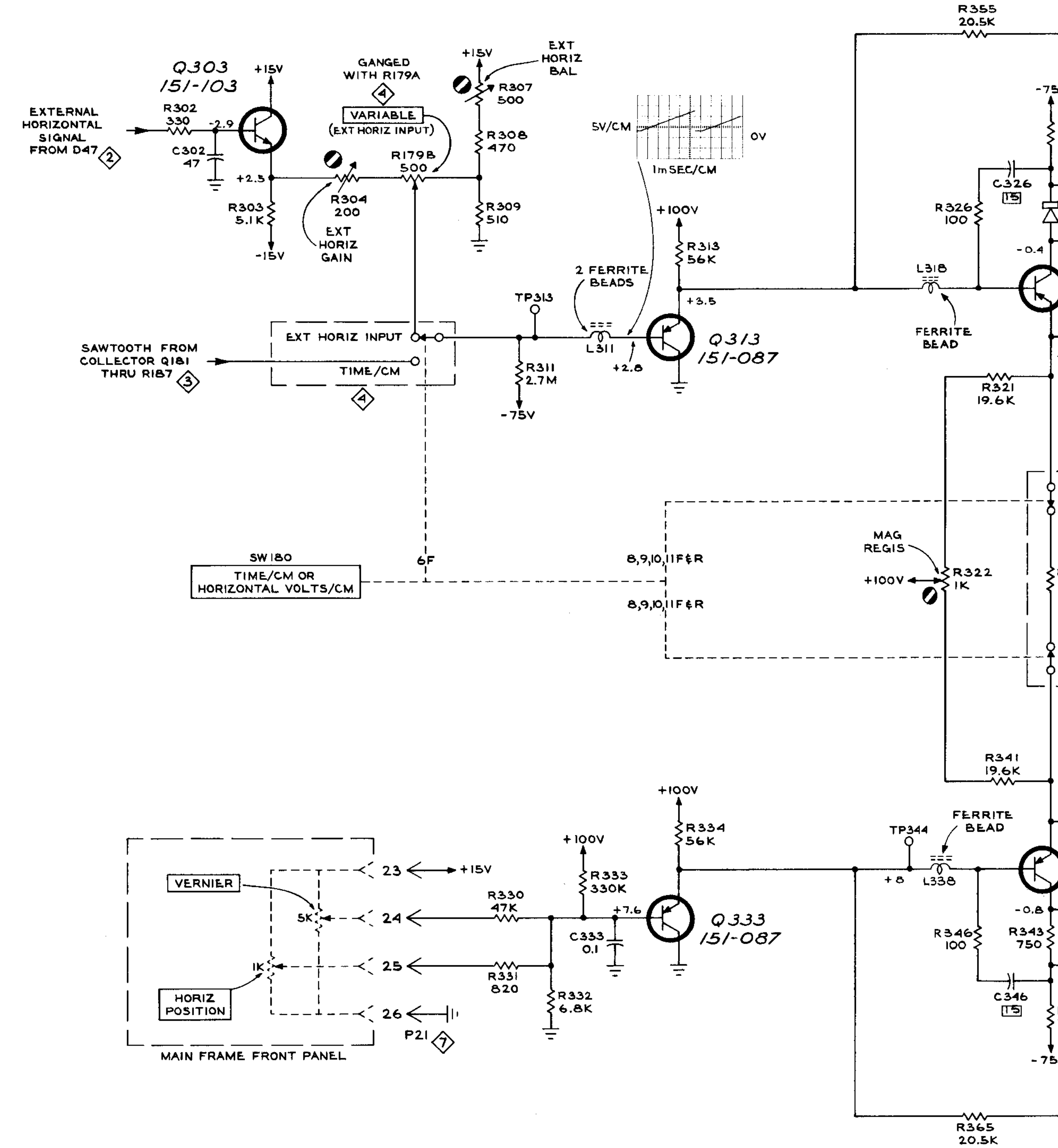
SWEEP GENERATOR 3



TYPE 11B1 PLUG-IN

B


SW180
TIME/CM OR
RIZONTAL VOLTS/CM
6F
6R
7F
7R
5F
TO R305
TO L311
TO SW32-2R
+15V
FROM R401
TO TERM 2 P21
TO R44
+100V
TO R47
R49
TO B124
TO R125
R36
L36
R402
-15V
R180G 750K
R180F 750K
+100V
UNCAL
B180X NE-2V
-15V
R180T 1.8K
R180X 180K
R179A 20K
VARIABLE TIME/CM
-66V
R180W 1K
SWP CAL
-75V
R35
L35
R403
-15V
REFERENCE DRAWINGS
1 INTERNAL TRIGGER PREAMP
2 TRIGGER GENERATOR
3 SWEEP GENERATOR
5 HORIZONTAL PREAMP
7 INTERCONNECTING PLUG
6 MAGNIFIER SWITCH
CMD 868
TIMING SWITCH 4
B



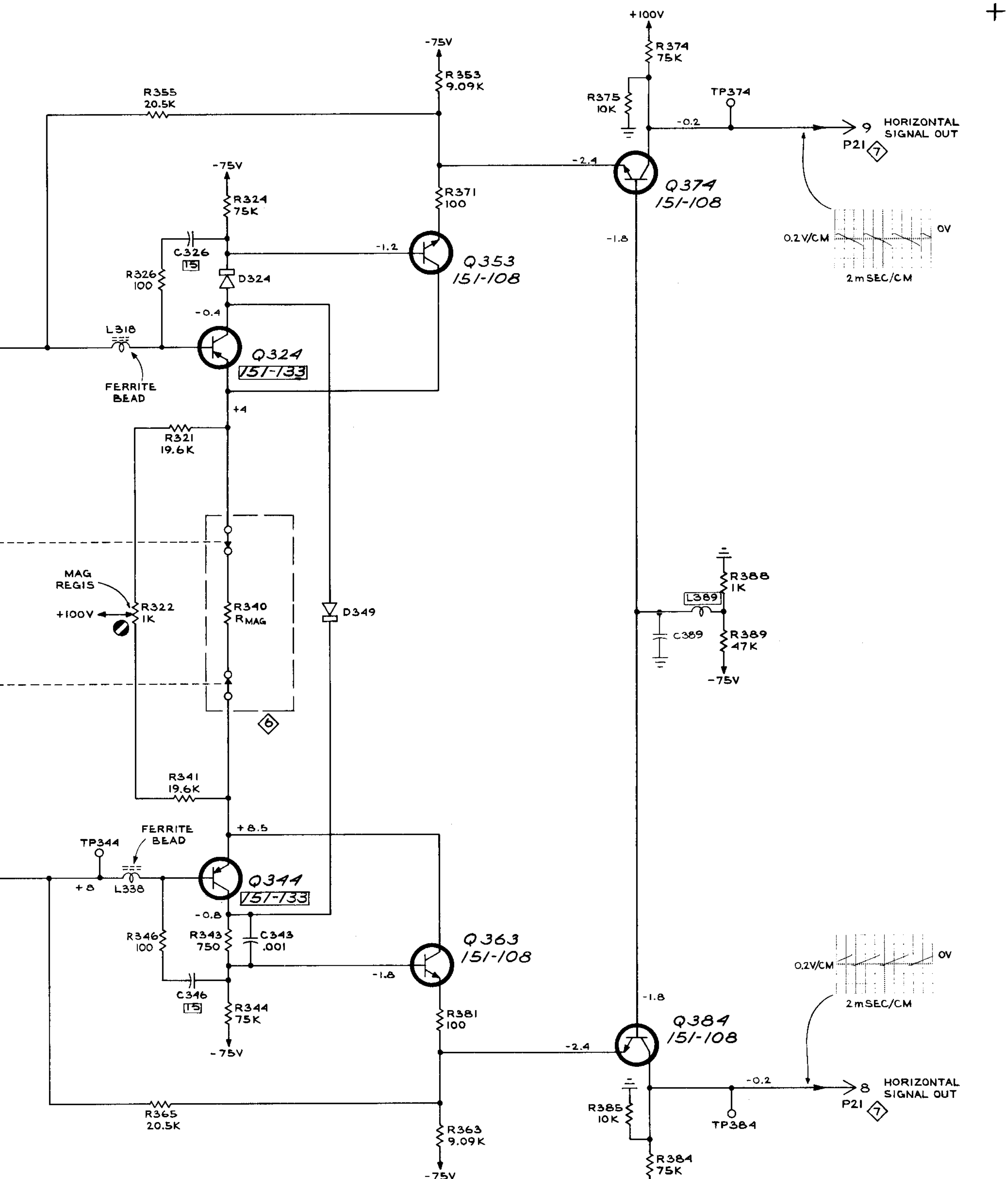
REFERENCE DRAWINGS

- 2 TRIGGER GENERATOR
- 3 SWEEP GENERATOR
- 4 TIMING SWITCH
- 6 MAGNIFIER SWITCH
- 7 INTERCONNECTING PLUG

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

VOLTAGES and WAVEFORMS obtained unc
conditions given on Diagram 1

D



VOLTAGES and WAVEFORMS obtained under conditions given on Diagram ⟨1⟩

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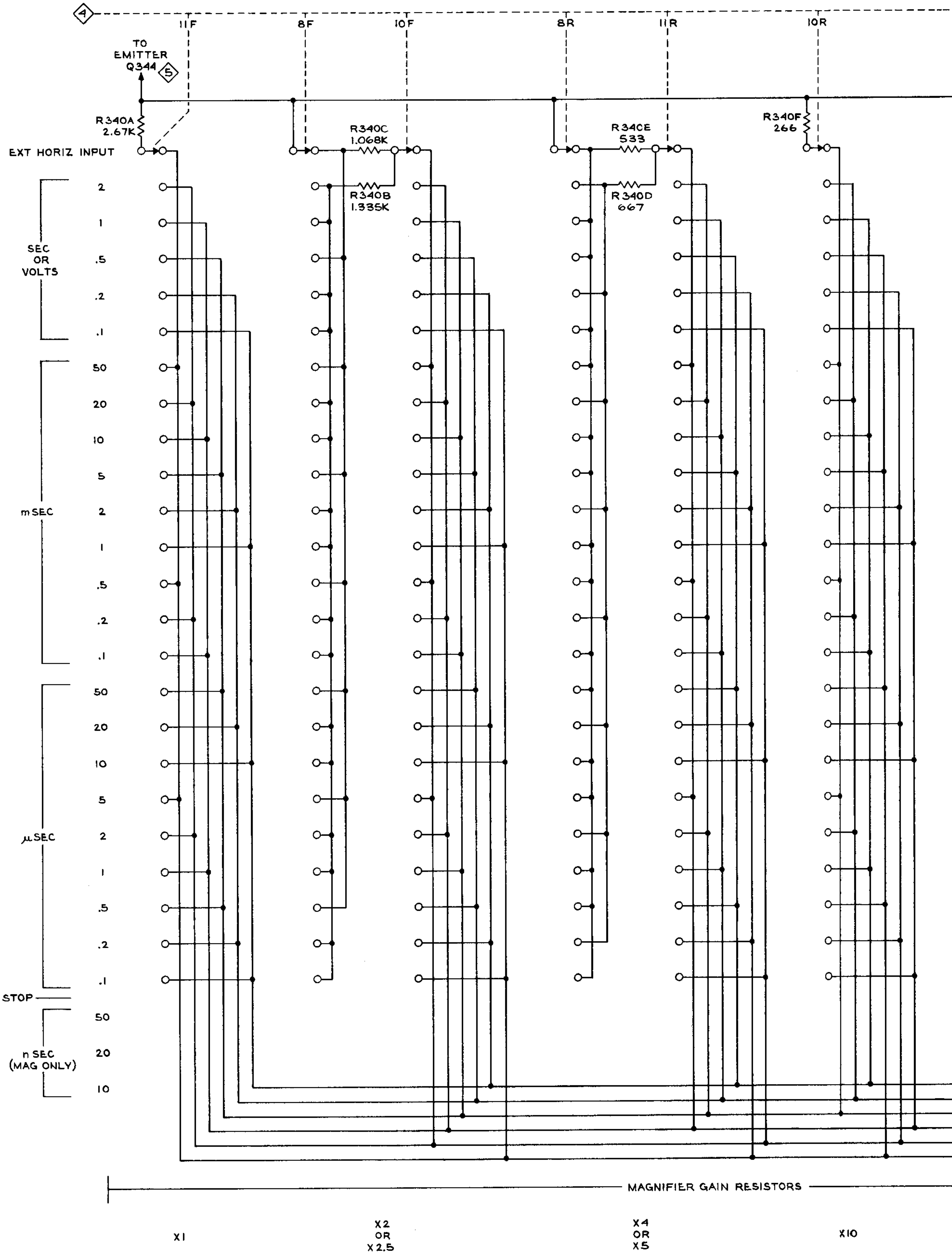
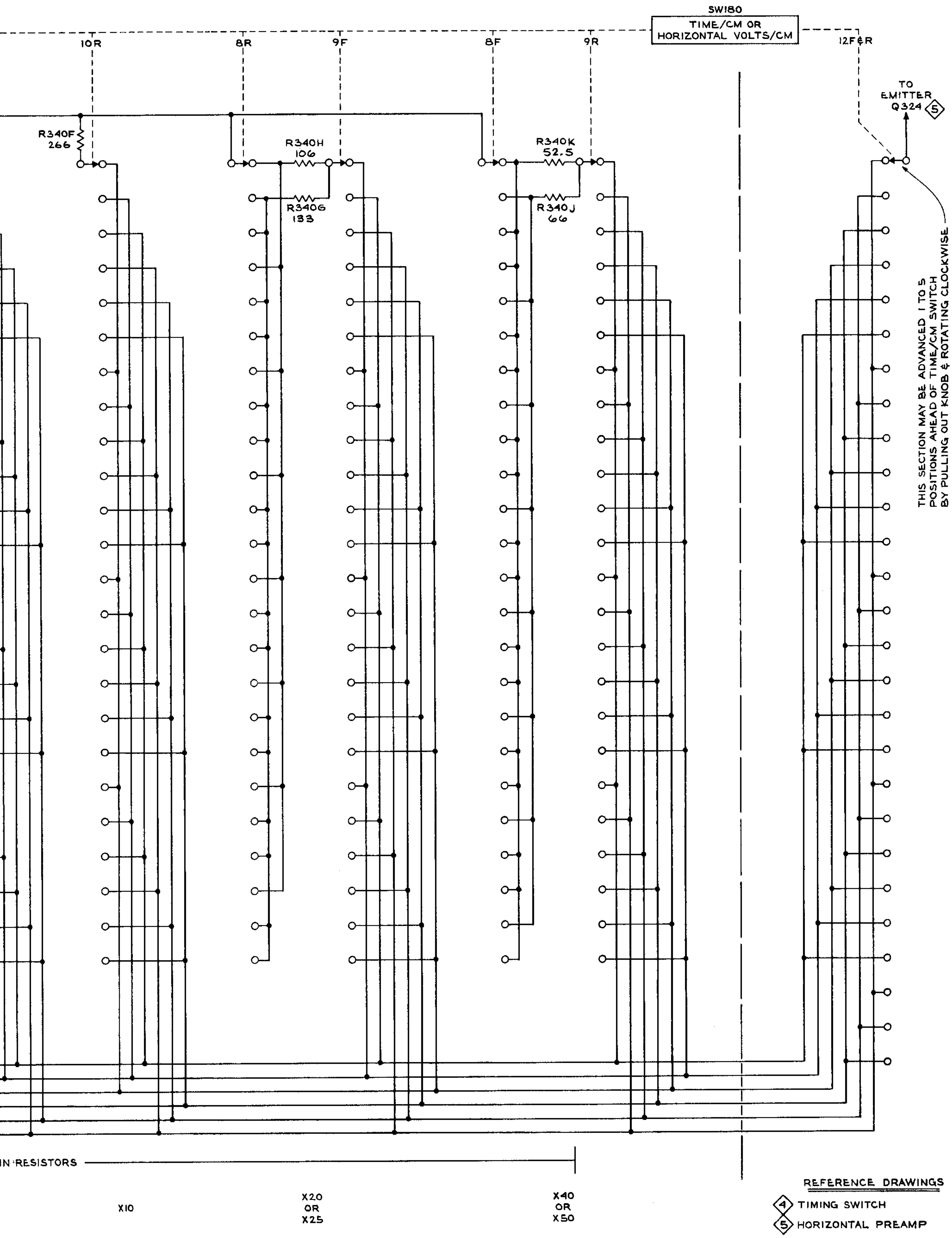
D

HORIZONTAL PREAMP ⟨5⟩


4
11F
8F
10F
8R
11R
10R
TO EMITTER Q344
5
R340A 2.67K
R340C 1.068K
R340B 1.335K
R340E 533
R340D 667
R340F 266
EXT HORIZ INPUT
SEC OR VOLTS
2
1
.5
.2
.1
mSEC
50
20
10
5
2
1
.5
.2
.1
μSEC
50
20
10
5
2
1
.5
.2
.1
STOP
n SEC (MAG ONLY)
50
20
10
MAGNIFIER GAIN RESISTORS
X1
X2 OR X2.5
X4 OR X5
X10



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MAGNIFIER SWITCH 6

B

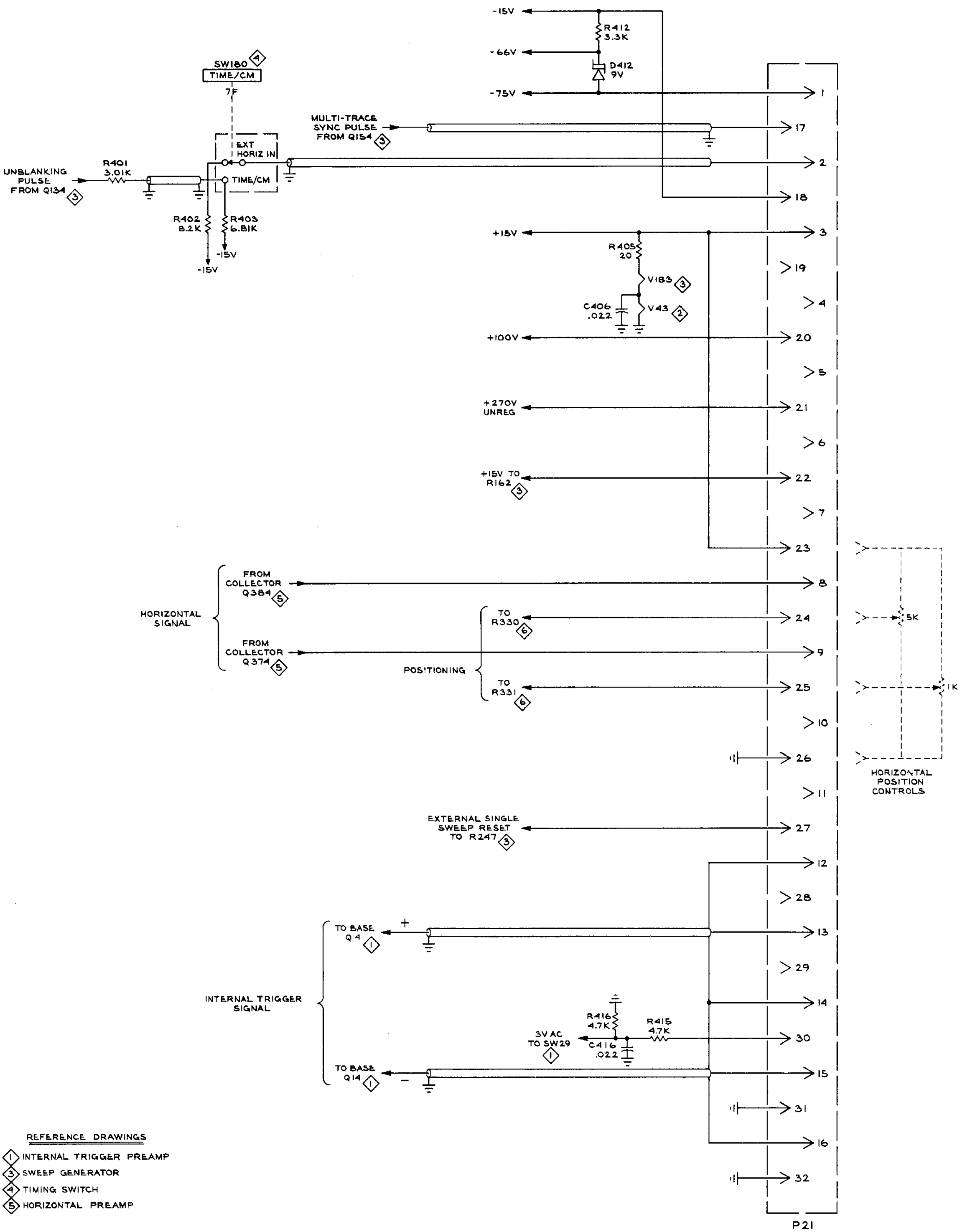
INTERCONNECTING PLUG

Resistances to ground with 11B1 removed from oscilloscope. Use 1 K scale of 20,000 Ω/v ohmmeter, except as noted.

11B1 Front-Panel Control Settings

TIME/CM	1 MSEC
VARIABLE	CALIB
MAGNIFIER	1 MSEC
TRIGGER MODE	AUTO MANUAL
SOURCE	INT
COUPLING	AC
SLOPE	+
LEVEL	0

Function	Amphenol	Approx. Resistance When meter lead is (+)	(—)	Scale
—75 V	1	2.1 k	2.1 k	
Unblanking	2	2.6 k	2.6 k	
+15 V	3	35 Ω	35 Ω	×1
Unused	4, 5, 6, 7	inf	inf	
+ Output	8	3 k	8.5 k	
— Output	9	3 k	8.5 k	
Unused	10, 11	inf	inf	
Shield	12, 14, 16	0	0	
Int. Trigger Input	13, 15	100 Ω	100 Ω	
Alt. Trace Sync. Pulse	17	420 Ω	420 Ω	
—15 V	18	650 Ω	650 Ω	
Unused	19	inf	inf	
+100	20	3.7 k	3.3 k	
+270	21	600 k	600 k	×10 k
+15 V (isolated)	22	75 Ω	90 Ω	×10
+15 V	23	35 Ω	35 Ω	×10
C. T. Position Vernier	24	50 k	50 k	
C. T. Position	25	3.5 k	7 k	
Ground	26	0	0	
Ext. Reset	27	100 k	100 k	
Unused	28, 29	inf	inf	
6 VAC for Line Trig.	30	9 k	9 k	
Ground	31, 32	0	0	



REFERENCE DRAWINGS

1 INTERNAL TRIGGER PREAMP
3 SWEEP GENERATOR
4 TIMING SWITCH
5 HORIZONTAL PREAMP

CMD
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FIG. 1 EXPLODED

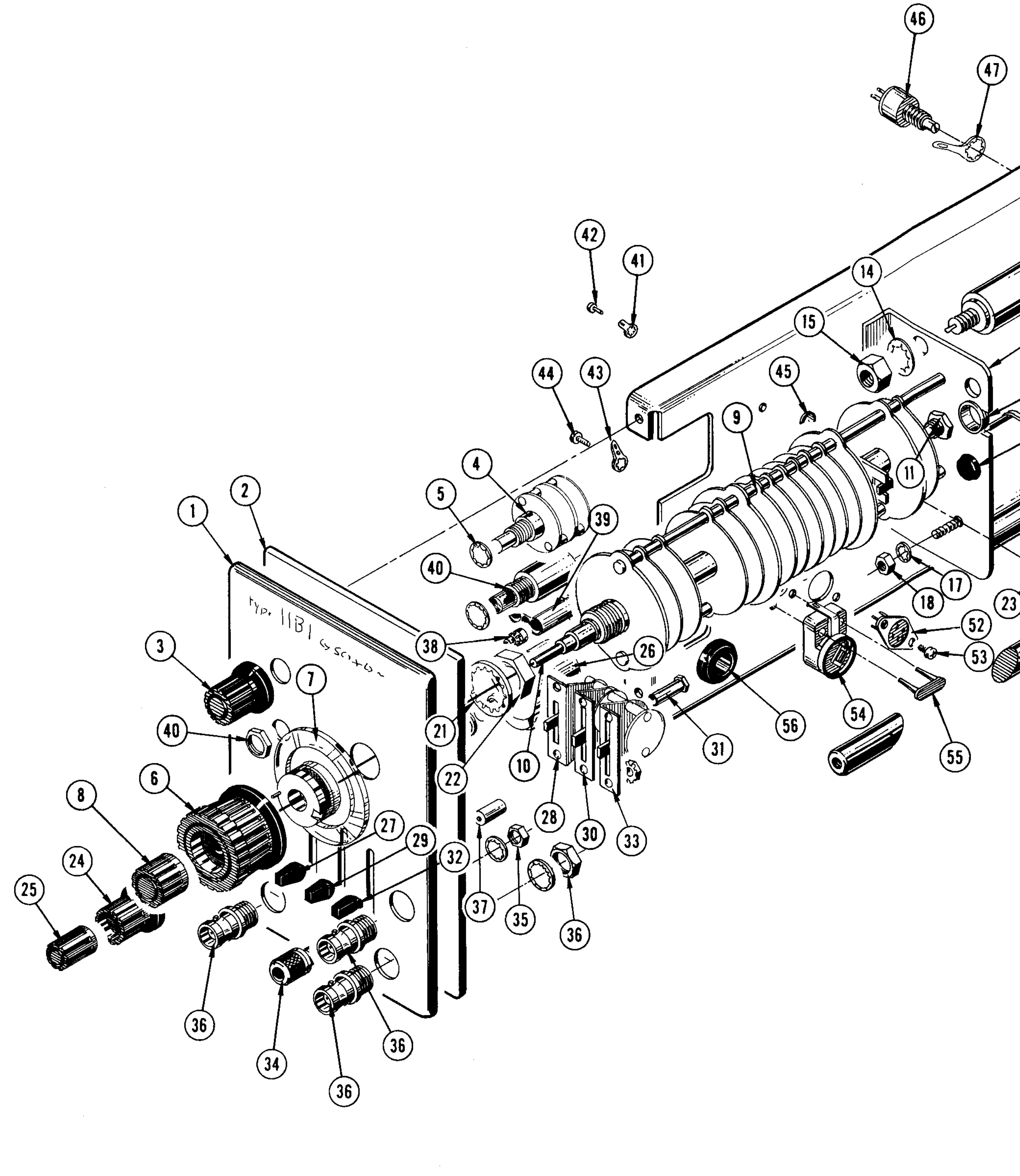
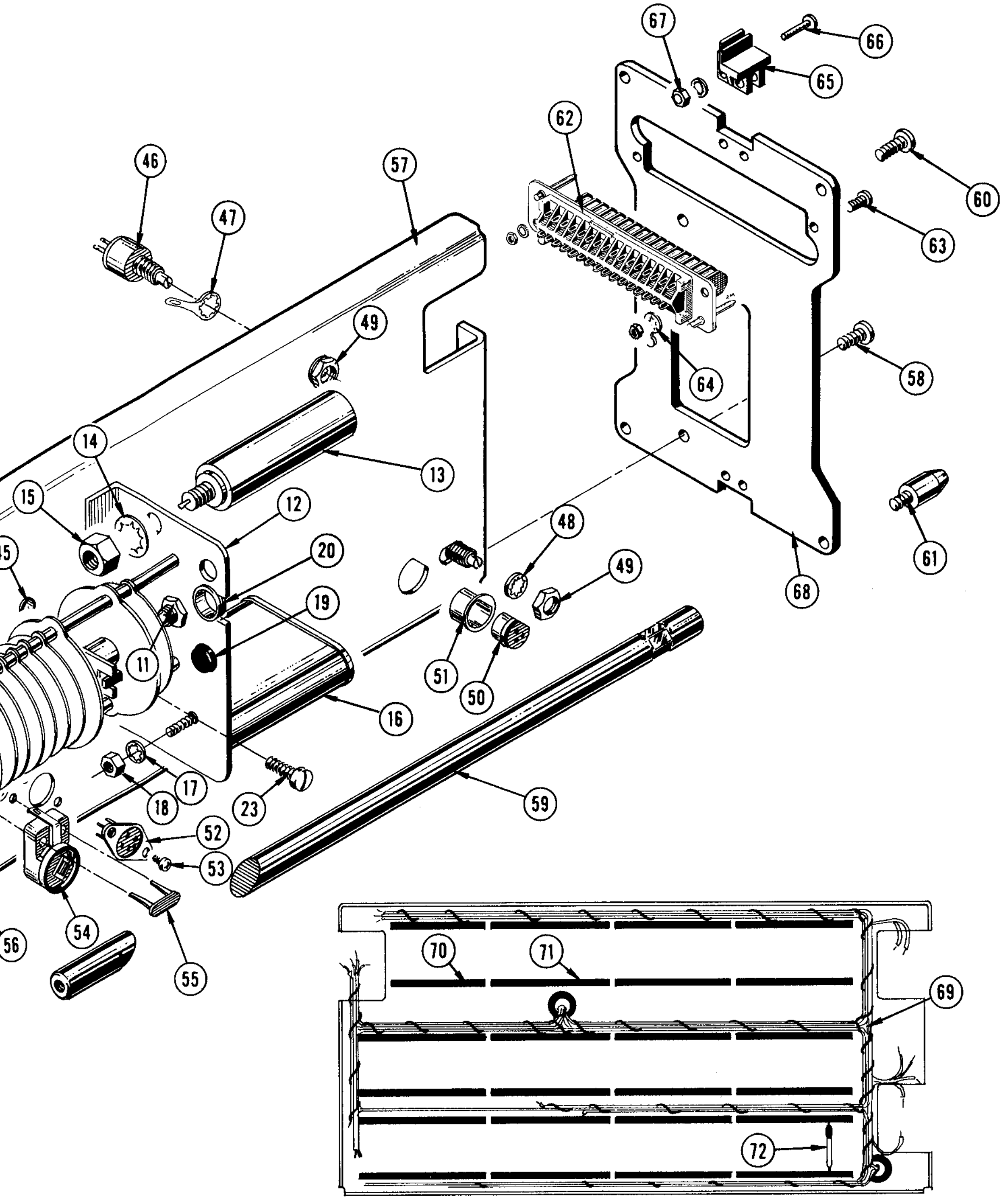


FIG. 1 EXPLODED



MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.