INSTRUCTION MANUAL

Serial Number ____________

TYPE 3B4 PLUG-IN UNIT

Tektronix, Inc.
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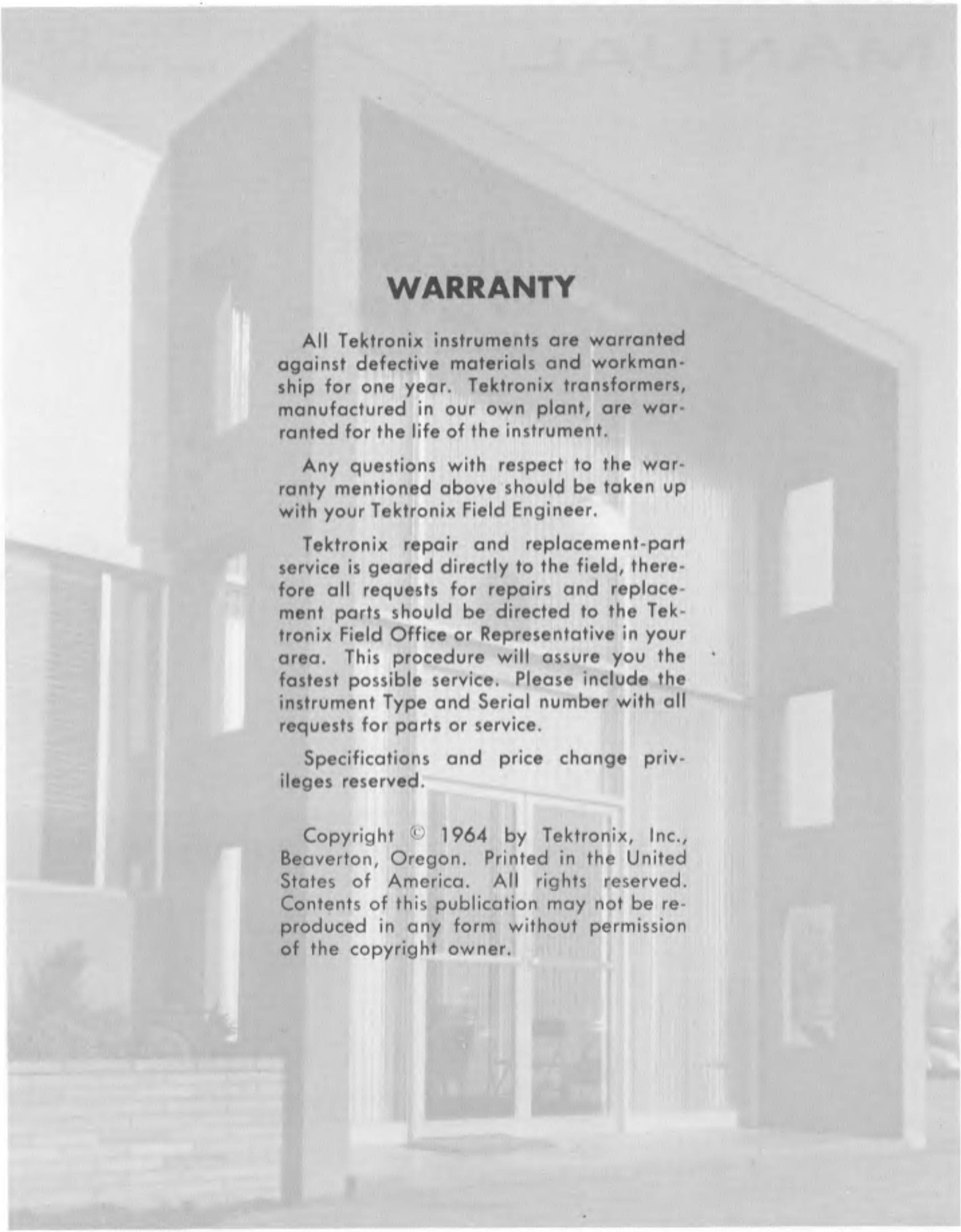


WARRANTY

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.

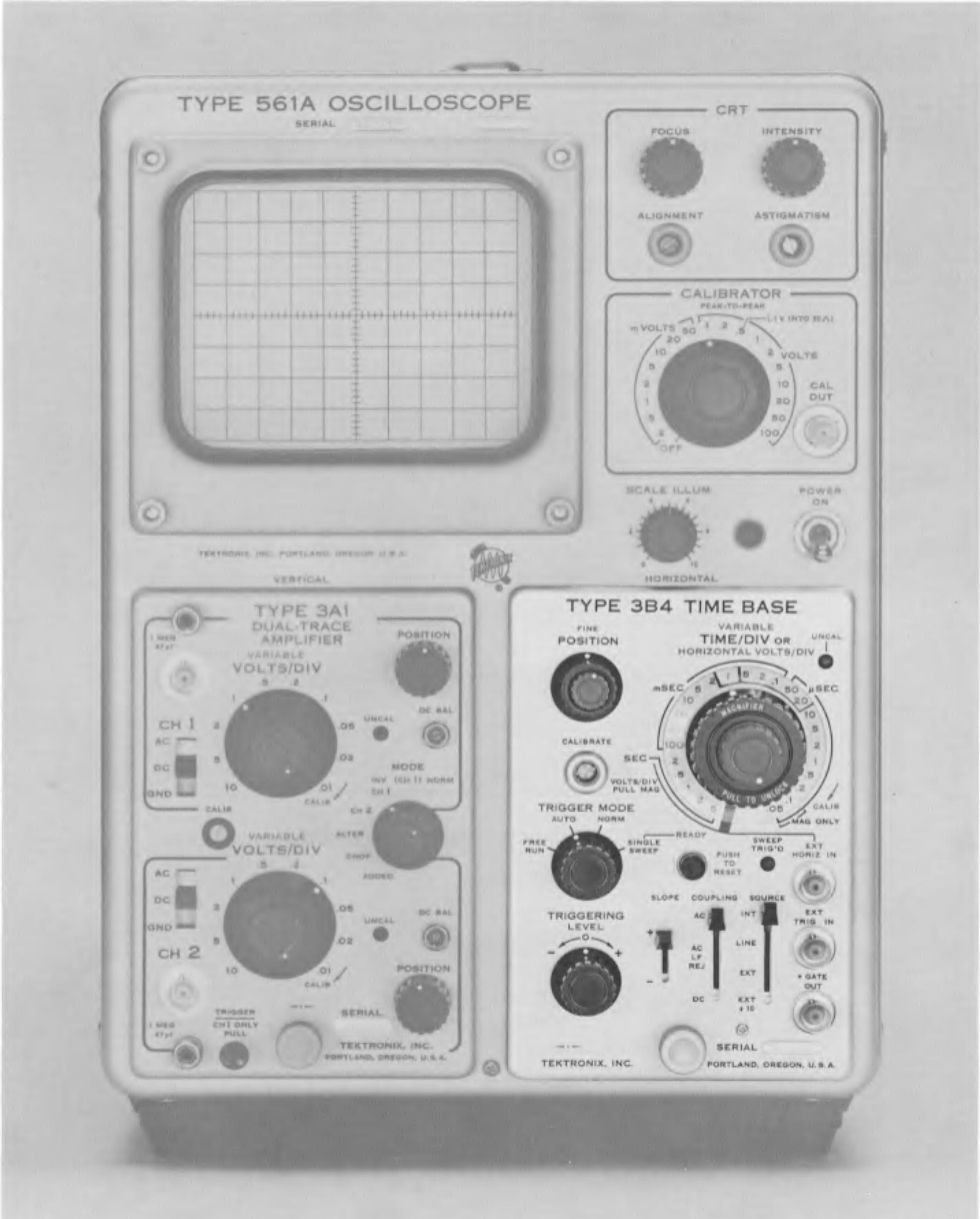
Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

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

A list of abbreviations and symbols used in this manual will be found on page 5-1. Change information, if any, is located at the rear of the manual.


TYPE 561A OSCILLOSCOPE
SERIAL
CRT
FOCUS
INTENSITY
ALIGNMENT
ASTIGMATISM
CALIBRATOR
PEAK-TO-PEAK
m VOLTS
VOLTS
CAL OUT
OFF
SCALE ILLUM
POWER ON
VERTICAL
HORIZONTAL
TYPE 3A1
DUAL-TRACE
AMPLIFIER
VARIABLE
VOLTS/DIV
POSITION
CH 1
AC
DC
GND
UNCAL
DC BAL
MODE
CALIB
CH 2
ALTER
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CH 1 ONLY
PULL
SERIAL
TEKTRONIX, INC.
PORTLAND, OREGON, U.S.A.
TYPE 3B4 TIME BASE
FINE
POSITION
VARIABLE
TIME/DIV OR
HORIZONTAL VOLTS/DIV
UNCAL
mSEC
μSEC
SEC
MAGNIFIER
PULL TO UNLOCK
CALIBRATE
VOLTS/DIV
PULL MAG
CALIB
MAG ONLY
TRIGGER MODE
AUTO
NORM
FREE RUN
SINGLE SWEEP
READY
PUSH TO RESET
SWEEP TRIG'D
EXT HORIZ IN
SLOPE
COUPLING
SOURCE
AC
AC LF REJ
DC
INT
LINE
EXT
EXT ÷ 10
EXT TRIG IN
+ GATE OUT
TRIGGERING
LEVEL
TEKTRONIX, INC.
SERIAL
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SECTION 1
CHARACTERISTICS

Introduction

The Type 3B4 Time Base plug-in unit is designed to be used primarily with the Tektronix Type 561A Oscilloscope system; however, it can also be used with the other 560-Series systems that use 3B-Series plug-in units such as the Type 564 and Type 567. As part of an oscilloscope system, the Type 3B4 is used as an accurate time base generator or as a calibrated amplifier for externally generated deflection signals.

When used with the 567 or RM567, the 3B4 provides a time-base, but does not activate the digital readout circuitry. In the 565 or RM565, the 3B4 provides a vertical time-base for raster applications but does not provide retrace blanking.

The Type 3B4 provides calibrated sweep rates from 0.05 μsec/div to 5 sec/div in 25 calibrated steps. A five-step, direct-reading magnification feature provides magnification up to 40× or 50×, depending on the sweep rate to which magnification is applied. When the Type 3B4 is used as an amplifier for externally generated deflection signals, the magnifier provides five steps of deflection sensitivity, from 0.2 volts/div to 5 volts/div. In addition, a variable control provides uncalibrated sweep rates and deflection sensitivities between the calibrated steps. By using the variable control, uncalibrated sweep rates from 0.05 μsec/div to approximately 12.5 sec/div and deflection sensitivites from 0.2 volts/div to approximately 12.5 volts/div are available. Uncalibrated operation is indicated by a neon lamp.

Normally, the Type 3B4 is inserted in the right-hand compartment (operator's right, oscilloscope's left) of the oscilloscope and in this position provides horizontal deflection. When used with the Type 561A, the Type 3B4 can be inserted into the left-hand compartment of the oscilloscope to provide a time base that runs vertically on the crt screen. Due to differences in the horizontal and vertical deflection plate sensitivities, the Type 3B4 must be calibrated for vertical deflection use if accuracy is required in such application. This manual is written with the assumption that the Type 3B4 will normally be used to provide horizontal deflection signals in a Type 561A.

Triggering

Facilities

TRIGGER MODE Switch	Free Run, Auto, Normal, and Single Sweep
TRIGGERING LEVEL Control	See Tables 1-1 and 1-2.
SLOPE Switch	+ or −
COUPLING Switch	Ac, Ac Low-Frequency Reject, and Dc
SOURCE Switch	Internal, Line, External, and External ÷ 10

TRIGGERING LEVEL Control Voltage Range (external triggering)

See Table 1-1.

TABLE 1-1

SOURCE	COUPLING	Voltage Range Typical	Voltage Range Minimum
EXT	AC, DC or AC LF REJ	±19 v	±15 v
EXT ÷ 10	AC or DC	±190 v	
	AC LF REJ		±150 v

NOTE

The voltage range of the TRIGGERING LEVEL control indicates the maximum external peak voltage that will permit triggering at any amplitude point on the signal. Signals with greater amplitudes can be used and will provide triggering, but the range of trigger-point selection is still limited to the TRIGGERING LEVEL control voltage range.

Triggering Sensitivity. See Table 1-2.

TABLE 1-2

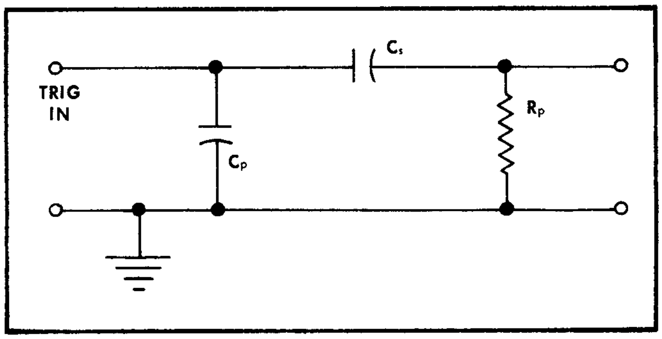
SOURCE	Voltage Range AC	AC LF REJ	DC
INT	1 minor division of deflection 30 cps to 20 mc. Outside these limits requires larger triggering signal.	1 minor division of deflection 30 kc to 20 mc. Outside these limits requires larger triggering signal.	1 minor division of deflection dc to 20 mc (with trace vertically centered). Above 20 mc requires larger triggering signal.
EXT	0.5 v 30 cps to 20 mc. Outside these limits requires larger triggering signal.	0.5 v 30 kc to 20 mc. Outside these limits requires larger triggering signal.	0.5 v dc to 20 mc. (with trace vertically centered). Above 20 mc requires larger triggering signal.

Automatic Triggering. In this mode of operation a bright-line sweep is displayed automatically in the absence of a trigger. The sweep triggering characteristics stated previously also apply for automatic triggering except that the triggering signal must be higher than about 20 cps. The TRIGGERING LEVEL control operates when a triggering signal is present.

Single Sweep. This feature permits only one triggered sweep following each reset pulse. The reset pulse is generated by pressing the PUSH TO RESET button. The triggering characteristics stated previously apply.

EXT TRIG IN Connector Input Characteristics. See Table 1-3.

TABLE 1-3



SOURCE	COUPLING	C_p (pf)	C_s	R_p (Meg Ω) Max	Input Voltage Peak
EXT	DC	≈20	shorted	≈1	±75
	AC	≈20	≈0.01 μf	≈1	±500
	AC LF REJ	≈20	≈100 pf	≈0.09	±500
EXT ÷ 10	DC	≈5	shorted	≈10	±500
	AC	≈5	≈0.01 μf	≈10	±500
	AC LF REJ	≈20	≈100 pf	≈1	±500

Sweep

Facilities

TIME/DIV Switch	0.2 μsec/div to 5 sec/div in 23 steps, 1, 2, 5 sequence. The calibration accuracy (unmagnified) is ±3% from 0.2 μsec/div to 2 sec/div; ±5% at 5 sec/div.
VARIABLE Control	Uncalibrated variable time/div control. Multiplies the sweep time/div of any step of the TIME/DIV switch by a factor variable from 1 to ≥2.5.
POSITION Controls	Coarse horizontal positioning to position any portion of the trace to the center of the crt. The FINE control has a range of about 2 minor divisions.
MAGNIFIER Control	Provides direct readout magnification of the sweep (up to 50×). The magnifier also provides the 0.05 and 0.1 μsec/div sweep rates. Magnified sweep accuracy, ±5% (exception: 5 sec/div). Magnified sweep registration, ±1 minor division.
+ GATE OUT Connector	Provides a +20-volt (±15%) output pulse during sweep time.
Sweep Length	10.5 ±0.3 major division.

Sweep Amplifier (when used as an external horizontal amplifier)

Facilities

HORIZONTAL VOLTS/DIV Switch	Calibrated volts/div steps of 0.2, 0.5, 1, 2, and 5 volts/div. Accuracy ±3% when calibrated to match the oscilloscope in which used. The amplifier is dc coupled to the EXT HORIZ IN connector.
VARIABLE Control	Multiplies volts/div of any step by a factor variable from 1 to ≥2.5.
EXT HORIZ IN Connector	Input R and C is typically 1 megΩ shunted by 40 pf.
Frequency Response	Dc to 400 kc. Response ≤30% down at 400 kc with the VARIABLE control set to CALIB position.
Maximum Input Voltage	±20 volts dc, or 20 volts peak ac.

Environmental

Operating

TEMPERATURE	0° C to +50° C.
ALTITUDE	10,000 feet maximum.
VIBRATION	0.015 inch peak-to-peak, (1.9 G,s) for 15 minutes along each axis. Vibration frequency varied from 10-50-10 cps in 1-minute cycles.

Non Operating

TEMPERATURE	—35° C to +60° C.
ALTITUDE	50,000 feet maximum.
VIBRATION	0,015 ±0.003 inch total displacement from 10 to 5 cycles.
TRANSIT	Meets National Safe Transit type of test when factory packaged: Vibration for one hour at slightly greater than 1G. 30-inch drops on corners, edges and flat surfaces.

Mechanical

Construction	Aluminum-alloy chassis with chrome-plated side rails. Front panel is photo-etched and anodized.
Dimension (approx.)	6¼ inches high, 4¼ inches wide, 14½ inches deep (overall).
Net Weight	4.5 pounds.

Accessories

Information on accessories for use with this instrument is included at the rear of the mechanical parts list.

SECTION 2
OPERATING INSTRUCTIONS

Front-Panel Controls and Connectors

See Fig. 2-1.

NOTE

A more complete description of the controls and connectors is included under "Standard Sweep Operation" later in this section.

TRIGGER MODE Switch — Selects the manner in which the Time Base sweeps are initiated. For example:

- FREE RUN — In this position, recurrent sweeps are provided. The completion of one sweep causes the next to begin.
- AUTO — Automatic sweep. Permits each sweep to be triggered when the triggering-signal repetition rate is about 20 cps or greater. For lower repetition rates or in the absence of a triggering signal, the sweeps are recurrent, as in the FREE RUN position.
- NORM — Normal method of operation. Each sweep is triggered by the signal from the internal trigger generator.
- SINGLE SWEEP and PUSH TO RESET — Often used when displays of non-repetitive signals are photographed. When the lamp inside the PUSH TO RESET button is lit, the time base is ready to produce one triggered sweep.

SOURCE — Selects the source of the triggering signal:

- INT — Internal. Obtains the sweep triggering signal from the vertical plug-in unit.
- LINE — Obtains the sweep triggering signal from a low-voltage winding on the oscilloscope power transformer.
- EXT and EXT ÷ 10 — Permits external signals applied to the EXT TRIG IN connector to be used for sweep triggering. High-amplitude triggering signals can be attenuated by using the EXT ÷ 10 position.

COUPLING — Permits acceptance or rejection of some triggering signal characteristics:

- AC — Rejects dc and attenuates very low-frequency ac triggering signals.
- AC LF REJ — Ac low-frequency reject. Rejects dc and discriminates against low-frequency ac triggering signals. The 30% down point is 17 kc.
- DC — Accepts ac and dc triggering signals.

SLOPE (+ or —) — Determines whether triggering will occur during the positive-going (+) or negative-going (—) portion of the triggering signal.

TRIGGERING LEVEL — Selects the amplitude point on the triggering signal where triggering will occur.

TIME/DIV OR HORIZONTAL VOLTS/DIV — Provides 23 calibrated display sweep rates (unmagnified). See Fig. 2-1. The number opposite the dot on the MAGNIFIER knob skirt always indicates the sweep time per centimeter as long as the VARIABLE control is in the CALIB position. The number bracketed by the two heavy black lines on the clear plastic knob flange is the **unmagnified** sweep time per division. 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 heavy black lines on the flange. When the flange is positioned so that the two black lines bracket the EXT HORIZ IN position, any signal connected to the EXT HORIZ IN connector is applied to the horizontal amplifier. In this position of the switch, the amplified externally generated signal provides horizontal deflection.

MAGNIFIER — Provides magnification of the time base display up to 40× or 50× in five direct-reading steps (Magnification of the four fastest **unmagnified** sweep rates is limited to 0.05 μsec/div). For example, at 10× magnification, the 5 minor division segment at the center of an unmagnified crt display is horizontally expanded to full graticule width. Any other 5 minor division segment of the original unmagnified display may then be observed in magnified form by turning the POSITION controls. To determine the degree 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 about 0.4 and 1.0 times that indicated by the TIME/DIV switch. Whenever the VARIABLE knob is not set to CALIB, the UNCAL lamp lights. When the TIME/DIV switch is set to the EXT HORIZ IN position, the VARIABLE knob provides ≈ 2.5:1 change in horizontal amplifier sensitivity.

STANDARD SWEEP OPERATION

The control and switch settings listed under "First-Time Operation" later in this section establish the basic conditions necessary for most measurements. In many applications, it is desirable for a repetitive signal to produce a stationary

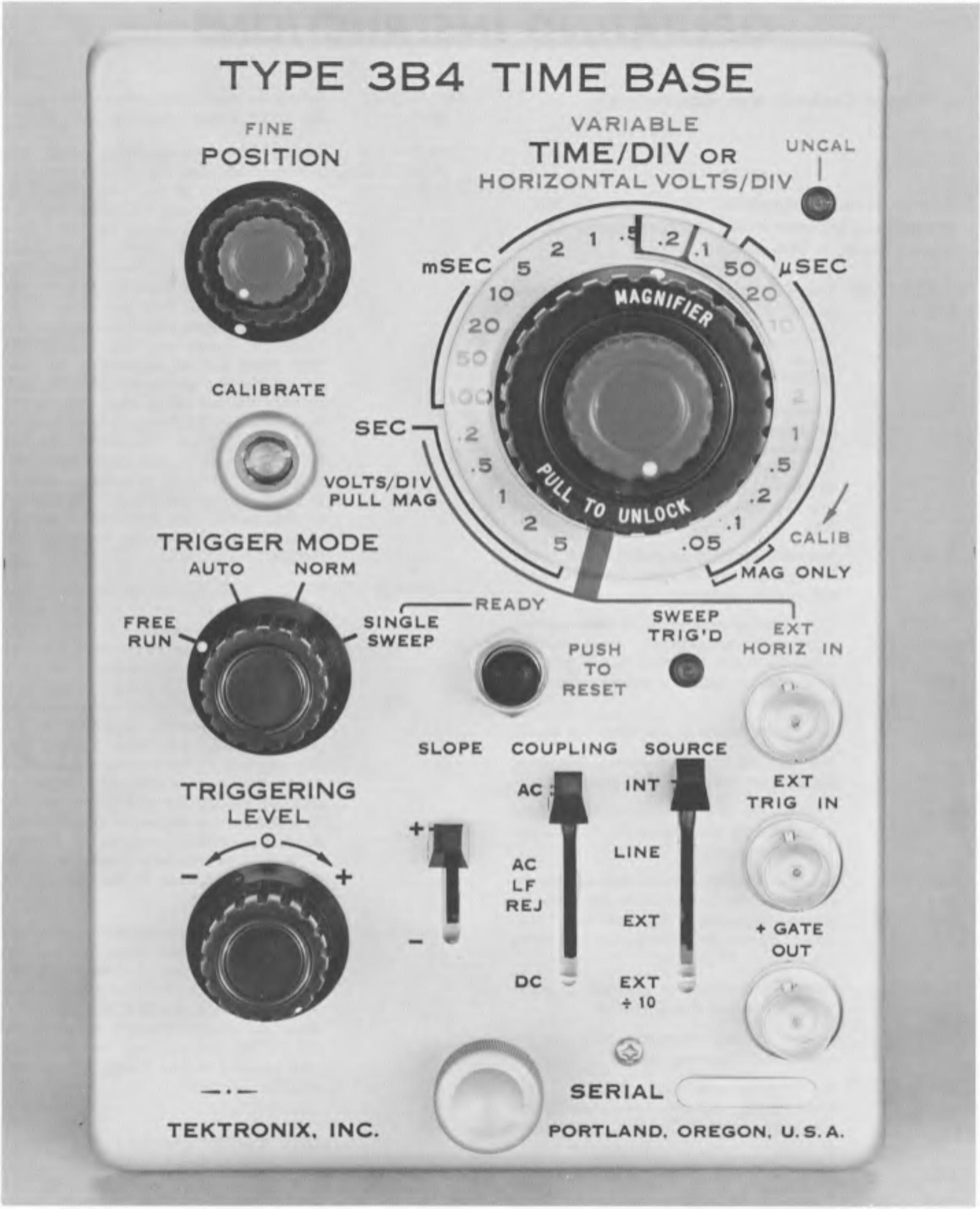


Fig 2-1. Front Panel Controls and Connectors.

display on the crt so the waveform can be examined in detail. For this type of display, the start of each sweep must bear a definite fixed-time relationship to the events in the input signal. This can be accomplished by using the displayed signal or another related signal to start (trigger) single or repetitive sweeps. The following is a detailed description of the control and switch settings which provide complete control over the means of triggering the sweep. It is assumed that the oscilloscopes system is a Tektronix Type 561A.

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 does the AUTO position. This method of operation is useful in applications where a device under test requires a trigger or input signal. The front-panel +GATE OUT signal may be used to operate the device under test. The resulting signal displayed on the crt will then be synchronized with the sweep.

AUTO. This position is frequently used for ease of operation and because of the reference trace produced in the absence of a triggering signal. The time base free runs without the application of a trigger. If a triggering signal is received, the free running is interrupted, but this first event in the signal does not trigger a sweep. If the first signal event is followed by a second event within about 80 msec, a triggered sweep is initiated, and if not, the free running resumes. Since the dormant period is limited to about 80 msec, signal frequencies below about 20 cps cannot produce a triggered sweep in the AUTO mode. For such signals, the NORM mode of operation is used.

With the SOURCE switch set to INT and the TRIGGER MODE switch set to AUTO, the sweep will trigger on any signal that will trigger the NORM mode (about 1 minor division of deflection) so long as the triggering signal is above about 20 cps. When operating in the AUTO mode, it is necessary to adjust the TRIGGERING LEVEL control to lock the sweep with the triggering signal.

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

SINGLE SWEEP. Single sweep is often used when photographing non-reptitive 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 jumbled mixture of many different waveforms and would yeild little or no useful information. The Type 3B4 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 nonrepetitive traces.

When the TRIGGER MODE switch is set to SINGLE SWEEP, the time base becomes inoperative. The time base can be "reset" to the triggerable condition by pressing the RESET button. If there is sufficient delay before triggering, the RESET lamp will light to show that the time base is ready to be triggered. When the time base has been triggered and one sweep completed, the time base again becomes inoperative and the lamp extinguishes.

SOURCE

INT. It is usually easiest to obtain the sweep triggering signal internally (INT) from the vertical deflection system.

LINE. If the displayed signal frequency is related to the power-line frequency, the line source can be used. This source is useful when the displayed signal does not allow internal triggering.

EXT. External triggering is often used when signal tracing in amplifiers, phase-shift networks, and wave-shaping circuits. The signal from a single point in the circuit can be connected to the EXT TRIG IN connector through a signal probe or a cable. With this signal triggering the sweep, it is possible to observe the shaping, amplification, and time relationship of a signal at various points in the circuit without resetting the triggering controls.

EXT. ÷ 10. The only difference between external (EXT) and external divided-by-10 (EXT ÷ 10) is that the latter attenuates the external triggering signal. Attenuation of high-amplitude external triggering signals is desirable to broaden the TRIGGERING LEVEL control range.

DC. Dc coupling allows the trigger circuits to receive signals of all frequencies from dc upward. It is best to dc couple for very low-frequency signals (below about 20 cps).

AC. Ac coupling rejects the dc component of triggering signals and increasingly attenuates ac triggering signals as the frequency decreases. This position of the coupling switch is not normally used for triggering signals below about 20 cps, but this is the most used position of the switch.

AC LF REJ. Ac low-frequency reject coupling rejects the dc component of triggering signals and increasingly attenuates ac signals as frequency decreases (30% down point 17 kc). If line-frequency hum is mixed with a desired high-frequency triggering signal, best results are obtained by using this position of the COUPLING switch.

Ac low-frequency reject coupling should also be used when triggering internally from multi-trace plug-in units operated in the alternate-trace mode (unless the "trigger from a single channel only" feature of the plug-in is used). For additional information, see the multi-trace vertical plug-in unit instruction manual.

SLOPE

Sweeps can be triggered during either the rising or falling portion of the triggering signal. When the display consists of several cycles of the input signal, either setting of the SLOPE switch may be used. However, if it is desired to display less than one full cycle of the input signal, the SLOPE switch permits the sweep to start on either the rising (+ slope) or falling (— slope).

TRIGGERING LEVEL

The TRIGGERING LEVEL control determines the instantaneous voltage on the triggering signal at which the sweep is triggered. (This instantaneous voltage can also include a dc level if the COUPLING switch is set to DC.) With the SLOPE switch at +, adjusting the TRIGGERING LEVEL control makes it possible to trigger the sweep consistently at virtually any point on the positive slope of the triggering signal. Likewise, with the SLOPE switch at —, adjusting the TRIGGERING LEVEL control makes it possible to trigger at virtually any point on the negative slope of the triggering signal.

TIME/DIV OR HORIZONTAL VOLTS/DIV

The Time Base has 23 calibrated sweep rates ranging from 0.2 μsec/div to 5 sec/div (unmagnified). See Fig. 2-2. The number opposite the dot on the MAGNIFIER knob indicates the sweep time per division as long as the VARIABLE control is in the CALIB position. The **unmagnified** sweep rate value being used appears between the two black lines on the clear plastic flange of the TIME/DIV control. The VARIABLE control and MAGNIFIER switch, used in conjunction with the TIME/DIV switch, permit the sweep rate to be varied continuously between 50 nsec/div and about 12.5 sec/div. The MAGNIFIER switch is discussed under "MAGNIFIER". All sweep rates obtained with the VARIABLE control in any but the fully clockwise position are uncalibrated. Uncalibrated sweep rates are indicated when the UNCAL lamp is lit.

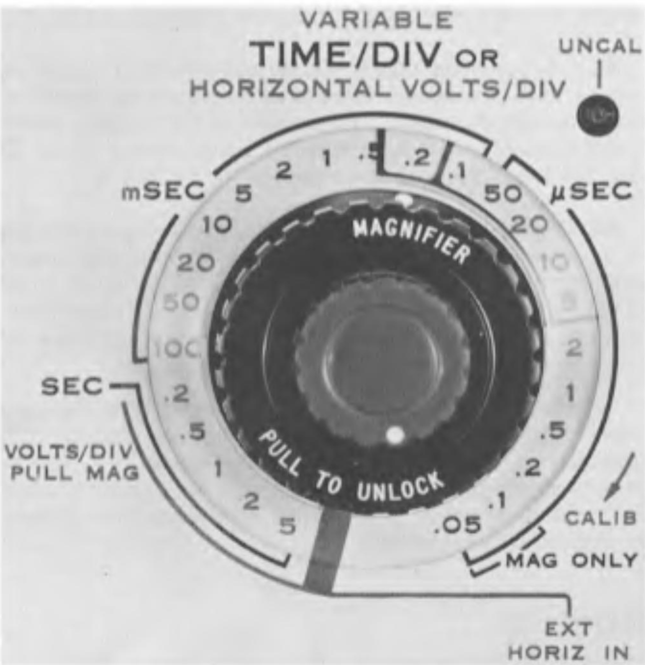


Fig. 2-2. TIME/DIV OR HORIZONTAL VOLTS/DIV and MAGNIFIER KNOBS.

When the flange is positioned so that the two heavy black lines bracket the EXT HORIZ IN position the horizontal amplifier input is connected to the EXT HORIZ IN connector and accepts external horizontal deflection signals. In this mode of operation, five ranges of horizontal deflection sensitivity are available. The five sensitivity ranges are from 0.2 volts/div to 5 volts/div.

To position the TIME/DIV switch to the EXT HORIZ IN position, turn the MAGNIFIER knob until the dot on the knob is positioned between the two black lines on the clear plastic flange. Turn the knob until the two black lines on the flange bracket the position marked "EXT HORIZ IN". The external horizontal deflection sensitivity may now be selected by pulling the MAGNIFIER knob outward to unlock it, then, while holding the knob out, turn it to the desired volt/div position.

MAGNIFIER

The sweep ranges between 5 sec/div and 2 μsec/div can be magnified up to 40× or 50× in 5 steps. The degree of magnification is the ratio between the indicated magnified rate (number opposite the dot on the skirt of the MAGNIFIED knob) and the indicated unmagnified rate (number bracketed by two black lines on the clear plastic flange). Since the magnified display rate is always direct reading, it is seldom necessary to determine the actual magnifying factor used.

Above 2 μsec/div the number of steps of magnification decrease until at the .2 μSEC setting of the TIME/DIV switch only two steps of magnification are available. The .2 μSEC postion is the highest sweep rate to which the TIME/DIV switch can be set, but by the use of the two additional magnified positions, and effective sweep rate of 50 nSEC/DIV is obtained.

FIRST-TIME OPERATION

The following control and switch settings for the Type 3B4 can be used for a wide range of measurements. The operating conditions established by these settings also provide a starting point for the operator who is learning to use the instrument.

TRIGGER MODE	AUTO
COUPLING	AC
SOURCE	INT
VARIABLE (TIME/DIV)	CALIB (fully clockwise)
MAGNIFIER	Locked to TIME/DIV switch

The Type 3B4 now provides the time base for measurements of vertical deflection signals above about 20 cps. In many cases, only the TIME/DIV switch and the TRIGGERING LEVEL control require readjustment when progressing from one measurement to the next.

The appropriate TIME/DIV switch setting depends on the frequency of the applied signal and the type of measurement. For example, to observe about 2 cycles of the oscilloscope 60 cycle Calibrator signal, set the TIME/DIV switch to 5 mSEC.

The following conditions must exist to obtain a triggered display of the vertical deflection signal with the preceding control settings:

1. The frequency of the vertical deflection signal must be about 20 cps or greater (below 20 cps, the TRIGGER MODE switch must be set to NORM).

2. At 50 kc the vertical deflection amplitude must be at least 1 minor division. See Table 1-2.

3. The TRIGGERING LEVEL control must be properly adjusted.

If the first two conditions are met, a stable display will be obtained with the TRIGGERING LEVEL control set near zero. When the observed deflection amplitude is a fraction of a division, the range of adjustment is relatively narrow but broadens with increased vertical deflection.

Operating Techniques

The following procedures are designed to acquaint the operator with the functions of the various controls on the Type 3B4.

Example 1, Time Measurement: This example explains how to measure the time of one-half cycle of the calibrator square-wave output. Set the Type 3B4 controls as outlined in Table 2-1.

TABLE 2-1

Typical Control Settings For Time Measurements

Control	Settings
TRIGGER MODE	AUTO
TIME/DIV	1 mSEC
MAGNIFIER	1 mSEC
SLOPE	(−)
COUPLING	AC
SOURCE	INT
VARIABLE	CALIB

With the controls set as outlined in Table 2-1, apply a 2-volt signal from the calibrator to the input of the vertical plug-in amplifier. Set the VOLTS/DIV switch on the vertical plug-in for 4 divisions of vertical deflection. Turn the vertical plug-in POSITION control until the vertical deflection extends 2 divisions above and 2 divisions below the horizontally scribed centerline. Turn the POSITION and FINE controls until the 50% point on the positive half-cycle of the square wave starts 1 division from the left edge of the graticule. With the equipment properly calibrated, the 50% point on the trailing edge of the halfcycle occurs 8.33 divisions to the right of the 50% point of the leading edge. Since the TIME/DIV switch is set to 1 mSEC, the positive half-cycle of the square wave is 8.33 msec long.

Example 2, Risetime Check: At the completion of the measurement listed in Example 1, unlock the MAGNIFIER knob by pulling it out, then, while holding it out, set it to the 20 μSEC position. Using the POSITION control, position the leading edge of the positive half-cycle at the vertically-scribed centerline. Using the POSITION and FINE controls, carefully reposition the leading edge until the 10% point on the pulse crosses the horizontally-scribed centerline 2 minor graticule divisions up from the start of the pulse. After the leading edge of the pulse is properly positioned, note the position of the 90% point of the rise. Since there is no easy point of reference from which to read, use the POSITION control of the vertical plug-in amplifier to move the 90% point down to the horizontally-scribed centerline. The 90% point will intersect the horizontally-scribed centerline less than one major graticule division to the right of the vertically-scribed centerline, thus providing a 10% to 90% risetime of less than 20 μsec.

Example 3, Type 3B4 Used as a Trigger Source: Ordinarily, the signal to be displayed is also used to trigger the oscilloscope. In some instances, it may be desirable to reverse this situation. The sweep-related output pulses, available at the front panel of the Type 3B4 can be used as the input or triggering signal for external devices. The output signal of the external device will then produce a stable display while the oscilloscope free runs. For this type of operation, set the controls on the Type 3B4 as listed in Table 2-1 except set the TRIGGER MODE switch to FREE RUN. Connect the Type 3B4 +GATE OUT output to the external device to be triggered. Since the external device is now being triggered with a signal that has a fixed time relationship to the oscilloscope sweep, the output of the external device will produce a stable display on the oscilloscope, as though the oscilloscope were triggered in the normal manner.

Example 4, External Horizontal Deflection: For special applications, it is possible to produce horizontal deflection with an externally derived signal. This permits the oscilloscope system to be used to plot one function against another (e.g. Lissajous figures). However, the system is not intended for precise phase-angle measurements.

To use an external signal for horizontal deflection, connect the signal to the EXT HORIZ IN connector. Set the TIME/DIV OR HORIZONTAL VOLTS/DIV switch to EXT HORIZ IN.

Sensitivity of the horizontal deflection system is changed by changing the MAGNIFIER switch when using external horizontal deflection. To change sensitivity, pull the MAGNIFIER knob out to unlock it, then set it to the selected position of the SEC OR EXT VOLTS positions.

NOTES

SECTION 3
CIRCUIT DESCRIPTION

Introduction

This section contains the theory of operation of the various circuits in the Type 3B4. The discussions are supported by the block diagram and schematics in Section 5. The relationship of the circuits in a particular block to those in other portions of the system is discussed in the description of that block.

The block diagram in Section 5 shows the basic elements of the Type 3B4. The Trigger Generator blocks select and shape triggering signals and apply trigger pulses to the Sweep Generator blocks. The Sweep Generator generates a linear-ramp horizontal deflection voltage, and in addition, adapts externally generated signals to provide horizontal deflection when such operation is desired. From the Sweep Generator blocks, the horizontal deflection signals are applied to the Horizontal Amplifier, where they are split in phase and amplified sufficiently to provide the degree of magnification being used.

Trigger Generator

For best triggering stability, the Sweep Generator requires trigger pulses that are representative of the triggering frequency but with greater wave-shape consistency than the signals generally encountered. The Trigger Generator converts the triggering signal into a pulse having a consistently fast risetime while retaining the characteristic repetition frequency of the triggering signal. The converted pulse is then used to trigger the Sweep Generator, which generates the time base.

The signal to be used for triggering is selected by means of SOURCE switch SW5 (see Trigger Generator schematic) from one of three sources: the vertical plug-in (INT); a low-voltage winding on the oscilloscope power transformer (LINE); or from an external signal applied to EXT TRIG IN connector J1 (EXT).

COUPLING switch SW8 selects which of the three input coupling methods is to be used; ac, ac with low frequencies rejected, or dc. From the COUPLING switch, the signal is applied through SLOPE switch SW10 to one side of a long-tailed comparator circuit (V24 and associated circuit elements) used as a trigger recognizer.

In operation, V24A in the comparator is kept cut off by V24B until the selected point on the triggering signal occurs. With SLOPE switch SW10 in the + position, TRIGGERING LEVEL control R16A applies conducting bias to V24B. With V24B conducting, the current flow through R22 develops a voltage which keeps V24A cut off. When the triggering signal goes positive to the selected trigger point, V24A starts to conduct and cuts off V24B. If the SLOPE switch is set to —, TRIGGERING LEVEL control R16A is set to deliver cutoff bias to V24A while V24B is permitted to conduct due to its grid being grounded through R10 and R7. As the triggering signal goes negative, it reaches a point where it cuts off V24B. With V24B cut off, V24A is forced into conduction by virtue of the —100 volts applied to its cathode through R22.

During the time that V24A is cut off and the comparator is waiting for the proper triggering conditions to occur, current flow through R24 and R26 develops cutoff bias for Q24 since the emitter of Q24 is strapped to the +125 volt supply through diode D28. When the comparator is switched by the triggering signal and V24A starts to conduct, the conduction of V24A reverses the current flow through R24 and applies conducting bias to Q24. Also during the time the comparator is waiting to be switched, tunnel diode D30 is biased to its low voltage state (see Fig. 3-1) by the voltage developed across R32 and L32. When Q24 is biased into conduction by the switching of the comparator, the conduction of Q24 provides about 2.5 ma of current to D30 which causes D30 to switch to its high voltage state.

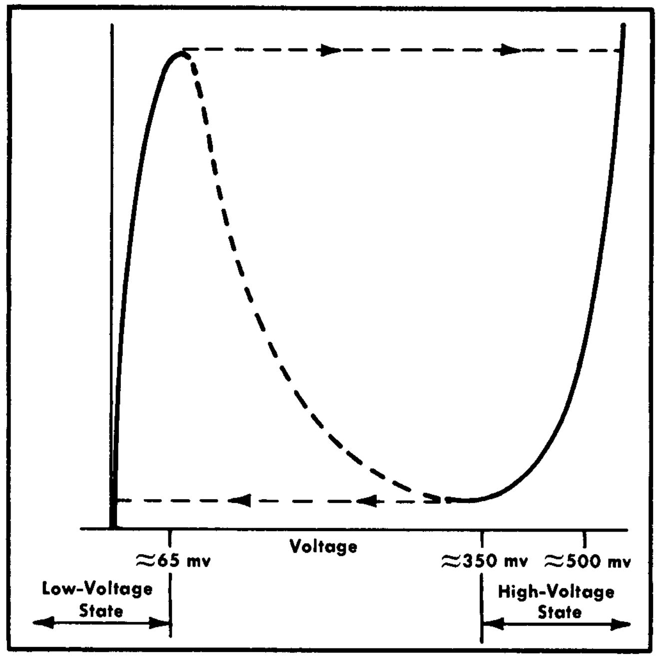


Fig. 3-1. Current-Voltage Characteristics of a Typical Tunnel Diode.

The switching of a tunnel diode from its low voltage state to its high voltage state is extremely fast. When D30 switches to its high voltage state due to the turning on of Q24, the jump in voltage across D30 appears on the base of Q34. Q34 is normally conducting, and the sudden increase in its base to emitter voltage causes a corresponding increase in current. The sudden demand for current by Q34 is met by drawing current from C33. Since the time constant of the circuit is short, the current increase through Q34 is in the nature of a sharp pulse. The pulse is coupled out through T38 of the Sweep Generator.

Sweep Generator

Outputs and Triggering. When the TIME/DIV OR HORIZONTAL VOLTS/DIV switch is set to any of the TIME/DIV positions, the Sweep Generator (see Block Diagram) produces four simultaneous output signals:

1. A positive-going sawtooth that is applied to the Horizontal Amplifier.

2. A negative-going crt unblanking pulse with the same time duration as the sweep sawtooth rise. This pulse is coupled to the oscilloscope crt.

3. A positive-going pulse with the same duration as the sweep. This pulse is coupled to the front-panel +GATE OUT connector for external use.

4. A negative-going multi-trace sync pulse. This pulse is applied 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 four operating modes provided by the TRIGGER MODE switch are described in Section 2 of this manual.

The Sweep Gating circuit is an electronic switch that drives the Disconnect circuit to switch the Disconnect Diodes on and off. When the Disconnect Diodes are switched off, the Miller Runup Integrator begins to produce a sawtooth that is fed back through the Lockout circuit to the Sweep Gating circuit. When the sawtooth reaches the desired amplitude, the Lockout circuit resets the Sweep Gating tunnel diode, the Disconnect Diodes are switched back 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.

Operating Modes. The TRIGGER MODE switch provides four ways to switch the Sweep Gating circuit so that the sweep begins:

1. In NORM, the Sweep Gating circuit is switched by a pulse from the Trigger Generator.

2. In SINGLE SWEEP, two pulses are required to start each sweep. First, a pulse from the Reset circuit (originating at the RESET pushbutton) resets the Lockout Multi. Then, after reset, the Sweep Gating circuit 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 switching of the Lockout Multi at the end of the holdoff period makes available enough current to switch the tunnel diode in the Sweep Gating circuit.

4. The AUTO 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 msec, the Sweep Gating circuit switches and a sweep begins. If trigger pulses continue to arrive every 80 msec or less, the Auto Trigger Multi remains in the "normal" condition and each sweep is a triggered sweep. Whenever the period between trigger pulses exceeds 80 msec, the Auto Trigger Multi reverts to the free-run condition until the next trigger pulse arrives.

Circuit operation in each of the modes is described in the following paragraphs. While reading the discussion, reference should be made to the Sweep Generator schematic in Section 5.

NORM, Quiescent Conditions. In the quiescent state, that is, when the sweep generator is triggerable and is waiting for a trigger pulse, the circuit conditions are as follows:

Q125 in the Lockout Multi is conducting and holds Q135 cut off. With Q135 cut off, the current flow through R143, R144, and R145 is about 3.8 ma, which is enough to bias tunnel diode D143 close to the point where it will switch to its high voltage state. With D143 in its low voltage state, Q144 is cut off. Since no current is flowing through Q144, its collector voltage is positive and forward biases Q154 and Q164. The conduction of Q154 forward biases Disconnect diode D155 and provides turn on bias for V161A in the Miller Runup circuit. The conduction of V161A establishes the operating point of cathode follower V173A. Diode D161, transistor Q164, and associated circuit elements form a feedback loop with the Miller circuit which under quiescent conditions clamps the sawtooth output bus at about +4 volts to provide a stable, repeatable sawtooth starting voltage.

Since Q144 is cut off under quiescent conditions, its collector voltage cuts off Q184. With Q184 cut off, its collector voltage cuts off V173B and Q194, permitting Q204 to conduct, blanking the crt and setting the voltage on the +GATE OUT connector to zero.

NORM, Sweep Triggered. When a trigger pulse is received from the Trigger Generator circuit, the trigger pulse supplies enough additional current to make tunnel diode D143 switch to its high voltage state. Once D143 switches to its high voltage state, the 3.8 ma current supplied to it is sufficient to keep it in its high voltage state when the trigger pulse ends.

The switching of D143 to its high voltage state biases Q144 into conduction, its collector voltage goes in a negative direction and cuts off Q154. When Q154 cuts off, the voltage on its collector goes negative and reverse biases Disconnect diode D155 but applies conduction bias to Q184. Q184 conducts, removes the negative voltage from the grid of V173B and at the same time biases Q194 into conduction. V173B unblanks the crt; Q194 generates a negative-going pulse whose positive going trailing edge can be used to switch channels in a multi-trace vertical plug-in unit. Since Q194 also cuts off Q204 at this time, the collector voltage of Q204 goes positive and generates the +GATE OUT pulse.

The negative-going step from Q154 reverse biases Disconnect diode D155 as previously explained. When D155 cuts off, the current through Timing Resistor R160 does not cease, but instead begins to charge Time Capacitor C160 (see Timing Switch schematic). As the timing capacitor charges, the grid of V161A goes negative. The tube amplifies the change in grid voltage and the inverted and greatly amplified change is applied to the grid of cathode follower V173A, which in turn couples the positive going voltage back to the timing capacitor and opposes the change in grid voltage of V161A. (The positive going voltage also reverse biases D161 and cuts off Q164). This action persists throughout the sawtooth period and limits the total change of grid voltage of V161A to less than 0.5 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. The rate of the sawtooth rise is a function of the RC time constant of C160 and R160 and the voltage applied. D155 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.

Since the rate of the sawtooth rise is a function of the RC time and the voltage applied, decreasing the voltage across the timing resistor decreases the current into the timing capacitor and therefore decreases the sawtooth rate of rise. The voltage across the timing resistor can be varied by turning the VARIABLE front panel control (R160W) shown on the Timing Switch schematic. This control permits the operator to obtain uncalibrated sweep rates at least two and one half times slower than the calibrated rates obtained with the control set in the CALIB position.

The sawtooth signal at the cathode of V173A is applied to the Horizontal Amplifier, and through R171 and D176 is also applied to the Holdoff circuit. The rising sawtooth voltage charges Holdoff capacitor C175 A—F. A point is finally reached where D179 is reverse biased and D178 is forward biased. Forward biasing D178 permits the sawtooth voltage to turn on Q135 in the Lockout Multi.

When Q135 conducts, it resets tunnel diode D143 to its low voltage state, turns off Q144, and ends the sweep. At this time the unblanking pulse and the +GATE OUT pulse are also terminated since V173B and Q194 are cut off by cutting off Q144 and Q184.

The time duration of the trigger pulses from the Trigger Generator, which switch D143 to its high voltage state and start the cycle of operation, will always be considerabley less than the time duration of the sweep. However, once a sweep-gating trigger pulse switches D143 to its high-voltage state, additional trigger pulses can have no further effect on the operation. The tunnel diode reverts to its low-voltage state only when Q135 turns on.

The positive-going voltage step at the collector of Q144 that occurs when the Lockout Multi is switched and cuts Q144 off at the end of the sweep turns on Q154. The conduction of Q154 forward biases disconnect diode D155. Since the timing capacitor still holds the charge developed during the sweep, D161 remains back-biased. The timing capacitor begins to discharge through the current paths associated with R171 and R401. D161 does not conduct until the charge on the timing capacitor is nearly depleted.

The removal of the charge from the timing capacitor forms the retrace or falling portion of the output sawtooth. As the cathode voltage of V173A falls, D176 becomes reverse biased. During the sawtooth rise, holdoff capacitor C175 A—F charges through D176, but must now discharge through the high resistance of R175, R177, and R179. Thus while the timing capacitor discharges rapidly, restoring the Miller Run-up circuit to quiescent conditions, the charge on the holdoff capacitor reverse biases D179 and the Lockout Multi cannot reset until the charge in the holdoff capacitor decreases.

When the sweep ends and the voltage on the cathode of V173A returns to its quiescent level, the voltage at the wiper arm of R173 is negative and reverse biases D178; D179 is reverse biased by the charge on the holdoff capacitor, and with both diodes non-conducting, Q135 remains in conduction. With Q315 conducting, D143 remains in its low voltage state and the sweep generator cannot be triggered since Q135 robs all the current from D143. Q135 remains in conduction until the charge on the holdoff capacitor is removed by current through R175 and R177. When the charge decreases to the point where D179 becomes forward biased, the negative going voltage is applied to the base of Q135 and causes the Lockout Multi to switch. Q125 becomes the conducting transistor and cuts off Q135. The entire sweep generator is now restored to quiescent conditions.

TRIGGERING LEVEL control R16B 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 Q135 turns off at the end of holdoff time, a very short but sometimes significant amount of time is required for the current through tunnel diode D143 to reach its quiescent level. 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, the display may jitter horizontally. The operator can minimize and often eliminate the jitter by slightly adjusting the TRIGGERING LEVEL control.

FREE RUN Mode. When the TRIGGER MODE switch is set to FREE RUN, sweep gating tunnel diode D143 is connected through L139, R116, and the TRIGGER MODE switch to +125 volts. This current path provides approximately 2.2 ma, which added to the aprroximately 3.8 ma through R144 and R145 is enough to bias D143 to its high voltage state. The high voltage state of D143 biases Q144 into conduction and starts the sweep as in the normal mode. When the sweep ramp voltage reaches the desired voltage, the Lockout Multi switches and Q135 robs all the current from D143, which resets D143 to its low voltage state and ends the sweep. At the end of holdoff time, the Lockout Multi resets and Q135 is cut off. Again there is sufficient current to bias D143 to its high voltage state, and a new sweep commences. Thus the completion of one cycle of operation causes the next to begin, and trigger pulses have no affect on the overall operation.

AUTO Mode. AUTO mode of operation is a combination of NORM and FREE RUN. If there are no trigger pulses coming from the Trigger Generator, the Sweep Generator and sweep gating tunnel diode D143 operate as if the TRIGGER MODE switch were in FREE RUN. The Auto Multi (Q105 and Q115) biases sweep gating tunnel diode D143 into its high voltage state, initiating a sweep. When the sweep reaches its peak value (as set by the SWEEP LENGTH control) the Lockout Multi switches and resets D143 to its low voltage state. The resetting of D143 ends the sweep. At the end of holdoff time, the Lockout Multi resets and again permits D143 to switch to its high voltage state, again initiating a sweep. The cycle repeats as long as no triggering signals are being received.

The arrival of a trigger pulse from the Trigger Generator switches the monostable Auto Multi to its unstable state, making Q105 the conducting transistor. The conduction of

Q105 immediately removes the current through R115 from D143. This biases D143 to 3.8 ma and the circuit operates as if the TRIGGER MODE switch were in the NORM position. The Auto Multi remains in its unstable state for approximately 80 milliseconds or less. If a second trigger pulse is received during the time the Auto Multi is in its unstable mode, it switches sweep gating diodes D143 via D141 and initiates a sweep. This second trigger pulse also signals the Auto Multi to stay in its unstable state for an additional 80 milliseconds. As long as incoming trigger pulses arrive at intervals shorter than about 80 milliseconds, the sweep is triggered and operates as if the TRIGGER MODE switch were set to NORM. If the interval between incoming trigger pulses is longer than 80 milliseconds, the Auto Multi has time to return to its stable state, and the Sweep Generator resumes free-run operation. For this reason, the AUTO mode should not be used where the interval between trigger pulses exceeds 80 milliseconds.

Since the arrival of just one trigger pulse does not start a sweep, but merely removes the circuit from a free running condition, it is probable that the trigger pulse which switches the Auto Trigger Multi will arrive while a free-run intiated sweep is in progress. In this case the Sweep Generator cannot become triggerable until the end of the holdoff period for the sweep in progress, but from then on, every sweep will be a triggered sweep if the reptition rate of the incoming trigger pulse is greater than about 20 pulses per second. Whenever the period between trigger pulses exceeds 80 milliseconds, the Auto Trigger Multi reverts to its stable state and C105 charges up. With C105 charged, enough current is again available through R115 to switch D143 and free run the Sweep Generator.

The Auto Trigger Mutli incidentally controls the circuit which lights the single sweep READY and SWEEP TRIG'D lamps. In both the AUTO and NORM modes, the switching of the Auto Trigger Multi cuts off Q114. As the collector of Q114 rises toward the +125 volt source, the voltage increase lights the SWEEP TRIG'D lamp (B119).

SINGLE SWEEP Mode. As previously explained in the NORM Mode discussion, the Lockout Multi switches when the holdoff capacitor discharges after the retrace portion of the sweep. After the holdoff capacitor discharges down to where D179 becomes forward biased, the current through R175, R177, R124, R126 and R127 applies cutoff bias to Q135. However, in the SINGLE SWEEP mode of operation, R177 is connected to +125 volts, which serves to keep D179 reverse biased at all times. As the TRIGGER MODE switch is turned from NORM position to the SINGLE SWEEP position, switching transients trigger the sweep. As the sweep runs up, D178 becomes forward biased and makes Q135 the conducting transistor of the Lockout Multi. Since the +125 volts connected to R177 keeps D179 reverse biased, the Lockout Multi stays locked up with Q135 conducting. The conduction of Q135 diverts all current from D143 so that it cannot switch and start a sweep. To unlock the Lockout Multi, it is necessary to press the PUSH TO RESET switch (SW135). Pressing the PUSH TO RESET switch applies —100 volts through R137 to C136. When the voltage across C136 becomes great enough to fire neon bulb B135, the current through B135 and R135 generates a negative pulse which is coupled through C135 to the Base of Q135. The negative pulse cuts off Q135 and switches the Lockout Multi. With Q135 cut off, the current through R144 and R145 arms D143 so that it will switch to its high state whenever a trigger pulse is applied. The current through Q125 forward biases Q114 and turns on the READY lamp. The Sweep Generator will now deliver a single sweep upon the application of a trigger pulse.

Horizontal Amplifier

The block diagram in Section 5 shows the basic arrangement of the horizontal amplifier circuits. The input to the Horizontal Amplifier proper is taken from the output of cathode follower V173A in the Miller Runup circuit. Normally, the signal input to the Horizontal Amplifier is the sweep ramp voltage. However, when the TIME/DIV OR HORIZONTAL VOLTS/DIV switch is set to the EXT HORIZ IN position, the signal on the grid of V173A is taken from the External Horizontal Amplifier consisting of V161B and Q234.

As shown on the Sweep Generator schematic, the high impedance EXT HORIZ IN input is applied to cathode follower V161B which in turn drives common base amplifier Q234. Coupling between the input cathode follower and the common base stage is by means of a resistor string which includes the EXT HORIZ GAIN and VARIABLE controls. The EXT HORIZ GAIN control is a screwdriver adjustable control that is set during calibration. The VARIABLE control is an uncalibrated front panel control that permits the operator to decrease the sensitivity of any of the five SEC OR EXT VOLTS steps over a range from 1:1 to ≈ 2.5:1.

Referring to the Horizontal Amplifier schematic in Section 5, the input from the Miller Runup cathode follower is applied through R401, R402, and D411 to the base of input transistor Q414. SWP CAL control R402 provides a means of adjusting the amount of signal drive to the Horizontal Amplifier. Front panel FINE and POSITION controls apply dc voltages to the base of Q414, which in turn establishes the operating points of the transistors in the output stages of the Horizontal Amplifier. (Changing the dc level around which the transistors operate changes the position of the sweep on the crt screen.) Diodes D413, D414, and D415 protect Q414 from excessively large signals when externally generated horizontal input signals are used.

The output of Q414 is applied to the input of a paraphase amplifier consisting of Q424, Q434, Q423, Q433, and associated circuit elements. The two transistors in each side of the paraphase amplifier are compound connected to achieve the high effective gain needed to make the stage gain dependent only upon the coupling resistors between the two sides of the paraphase. The coupling network between the two sides of the paraphase include the SWP MAG REGIS resistor R422, the ×50 MAG GAIN resistor R447, and the MAG resistors R340A to R340R. The coupling resistance value is about 920 Ω when no magnification is used (×1) and is decreased to about 20 Ω for ×50 magnification (see Magnifier Switch Schematic).

The output of the paraphase amplifier drives the cathodes of a grounded-grid, push-pull connected twin triode (V444A and V444B). The push-pull output of the twin triode is applied through pins 17 and 21 of the interconnecting plug to the horizontal deflection plates of the crt.

SECTION 4

MAINTENANCE AND CALIBRATION

PREVENTIVE MAINTENANCE

Cleaning. Cleaning should precede calibration since the cleaning process could alter the setting of certain calibration controls.

Clean the instrument by vacuum and/or dry, low-pressure compressed air (high velocity air could damage certain components). Hardened dirt may be removed with a dry, soft paint brush, cotton-tipped swab, or a cloth dampened with water and a mild detergent solution (such as Kelite or Spray White). Abrasive cleaners should not be used. Pay special attention to high-voltage circuits where conductive dust may create leakage paths.

Lubrication. The contacts on the plug-in interconnecting jack and plug should be lightly lubricated with an oil of the type used on switch contacts. To extend the life of the contacts, clean and relubricate if the oil becomes contaminated with abrasive dust. Keep a very light coating of grease (Beacon No. 325 or equivalent) on the rotary-switch detents.

Visual Inspection. After cleaning, the instrument should be carefully inspected for such defects as poor connections, broken or damaged ceramic terminal strips, improperly seated tubes or transistors, and heat damaged parts. The remedy for most visible defects is obvious; however, overheating is only a symptom of unseen defects or improper operation, and unless the cause of overheating is determined before parts are replaced, the damage may be repeated.

Tube and Transistor Checks. Periodic preventive maintenance checks on the tubes and transistors used in the instrument are not recommended. The circuits within the instrument generally provide the most satisfactory means of checking tube or transistor performance. Performance of the circuits is thoroughly checked during recalibration so that substandard tubes and transistors will usually be detected at this time.

Recalibration. To insure accurate measurements, the instrument calibration should be checked after each 500 hours of operation or every six months if used intermittently. Complete calibration instructions are contained later in this section.

The calibration procedure is helpful in isolating major troubles in the instrument. Moreover, minor troubles not apparent during regular operation may be revealed and corrected during calibration.

CORRECTIVE MAINTENANCE

General Information. Certain parts in the instrument are most easily replaced if definite procedures are followed as outlined in the following paragraphs.

Many electrical components are mounted in a particular way to reduce or control stray capacitance and inductance. When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance at high frequencies. After repair, portions of the instrument may require recalibration.

Soldering. Special silver-bearing solder is used to establish a bond to the ceramic terminal strips in Tektronix instruments. This bond may be broken by repeated use of ordinary tin-lead solder or by excessive heating. We recommend solder containing about 3% silver. Silver-bearing solder is usually available locally or may purchased in one-pound rolls through your Tektronix Field Engineer or Field Office. Order by part number 251-514.

Because of the shape of the ceramic-strip terminals it is recommended that a soldering iron with a wedge-shaped tip be used. A wedge-shaped tip allows the heat to be concentrated on the solder in the terminals and reduces the amount of heat required. It is important to use as little heat as possible while producing a full-flow joint.

The following procedure is recommended for removing or replacing components mounted on ceramic strips:

1. Use a 50- to 75-watt soldering iron.

2. Maintain a clean tip, properly tinned with solder containing about 3% silver.

3. Use long-nose pliers for a heat sink. Attach pliers between the component and the point where heat is applied.

4. Apply heat directly to the solder in the terminal without touching the ceramic. Do not twist the iron in the notch as this may chip or break the ceramic strip.

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

6. Do not attempt to fill the notch on the strip with solder; instead apply only enough solder to cover the wires adequately and form a small fillet on the wire. Overfilling the notches may result in cracked terminal strips. If the lead extends beyond the solder joint, clip the excess as close to the joint as possible. Remove all wire clippings from the chassis.

Standard Parts. Many components in the instrument are standard electronic parts available locally. However, all parts can be obtained through your Tektronix Field Engineer or Field Office. Before purchasing or ordering, consult the Parts List (Section 5) to determine the value, tolerance, and ratings required.

Special Parts. Some parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured for Tektronix to our specifications. These and most mechanical parts should be ordered directly from Tektronix Field Engineer or Field Office. See "Parts Ordering Information" and "Special Notes and Symbols" on the first page of Section 5.

Ceramic Strip Replacement. Unsolder all connections, then use a 3/8" diameter by 3" long plastic or hardwood dowel and a small (2 to 4 oz.) mallet to knock the stud pins out of the chassis. Place one end of the dowel on the end of the stud pin protruding through the chassis and rap the opposite end of the dowel smartly with the mallet. When both studs of the strip to be removed have been loosened in this fashion, the strip is removed as a unit. The spacers will probably come out with the studs. If not, they can be pulled out separately. An alternate method of removing the terminal strip is to use diagonal cutters to cut off the side of the stud that holds the ceramic strip. The ceramic strip is removed and the studs pulled from the chassis with a pair of pliers. Replacement ceramic strips are supplied with studs and spacers and the old studs need not be salvaged.

When the damaged strip and stud assembly has been removed, place new spacers in the holes in the chassis. Using the mallet and dowel, tap the new stud pins down thoroughly in the spacers. Be sure that these pins are driven completely through the spacers. You may wish to cut off any portion of the stud pin that protrudes through the spacers with a pair of diagonal cutters. Fig. 4-1 shows how the parts of the ceramic terminal strip fit together.

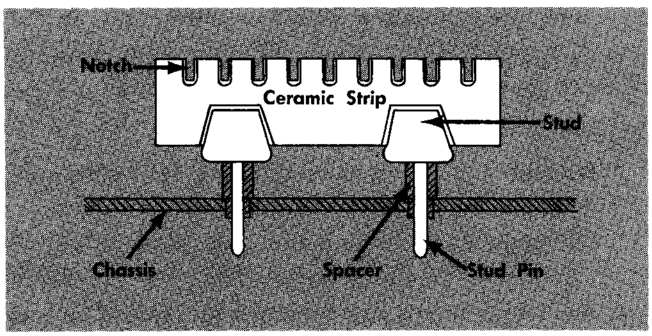


Fig. 4-1. Ceramic strip assembly.

Switch Replacement. Individual wafers normally are not replaced in switch assemblies. Relpacement switches may be ordered from Tektronix either unwired or with the associated wires and components attached. See Parts List, Section 5.

When soldering leads to a switch, do not let solder flow around and beyond the terminal rivet as this may destroy the contact spring tension.

Troubleshooting Techniques. If the instrument is not operating, attempt to isolate the trouble by a quick operational and visual check. Make sure that any apperent trouble is actually due to a malfunction within the Type 3B4 and not to improper control settings or to a fault elsewhere in the oscilloscope system. Instructions for the operation of the Type 3B4 are contained in Section 2 of this manual. (Operaing instructions for the other components of the oscilloscope system will be found in the instruction manuals for the individual components.)

Check the settings of all controls on the Type 3B4 and on the associated components of the oscilloscope system. A control set to the wrong position may cause what appears to be a trouble symptom. Operate the controls to see what effect, if any, they have on the trouble symptom. The normal or abnormal operation of each particular control helps in establishing the nature of the trouble. If a spare Type 3B4 is available, substitute the spare for the suspect unit and check for proper operation of the oscilloscope system. This is the best way to determine if the trouble is definitely in the Type 3B4.

If spare Type 3B4 units are not available, and the trouble symptoms are not definite, check the resistances at the pins of the interconnecting plug. Table 4-1 lists the normal resistances to ground for each pin. Typical voltages at various points inside the Type 3B4 and significant waveforms are shown on the various schematics in Section 5. The voltages shown may vary slightly from instrument to instrument.

TABLE 4-1

Interconnecting plug resistances to ground.

Terminal Number	Resistance to Ground	Use
1	80 Ω	6.3 AC
2	80 Ω	6.3 AC
3	Inf	Unused
4	5 K to 20 K[1]	Multi trace sync pulse
5	0 Ω	GND
6	21.5 K	+300 V unregulated supply
7	Inf	Unused
8	Inf	Unused
9	0 Ω	GND
10	20 K	+ 300 V supply
11	Inf	Unused
12	1 meg[2]	Int trigger signal[2]
13	10 K to 20 K[1]	Unblanking pulse
14	4.8 K to 9.5 K[1]	+125 V supply
15	4.8 K to 9.5 K[1]	+125 V supply
16	50 Ω	—12.2 V supply
17	27 K[1]	Output
18	50 K	Sawtooth drive
19	0 Ω	GND
20	7 K to 11.5 K[1]	+125 V unregulated supply
21	26 K[1]	Output
22	0 Ω	GND
23	8.5 K to 11 K[1]	—100 V supply
24	Inf	Unused

[1] **These readings depend upon the polarity of the meter leads and in some cases upon the resistance range used.**

[2] **Trigger COUPLING switch must be set to DC.**

All readings taken with a 20,000 Ω/v multimeter.

All wiring used in the Type 3B4 is color coded to facilitate circuit tracing. In addition, all regulated power-supply leads are coded with specific color combinations for easy identification. In general, three stripes are placed on the wires which supply regulated power. The code used is the standard EIA number-color code. The first color (widest stripe) indicates the first number of the voltage on that lead. The second color indicates the second number of the lead voltage, and the third color is a multiplier. The method is similar to that used in color coding resistors. Thus, the +100-

volt leads are coded brown, black, brown. The voltage is positive if the body color of the wire is white and negative if the body color of the wire is tan.

Most troubles that occur in Tektronix instruments result from the failure of vacuum tubes or semiconductors. Once the trouble has been isolated to a particular area or circuit, check the tubes and semiconductors in the trouble area. Remember that when tubes or semiconductors fail, associated circuit componts can be damaged.

Tube or transistor tester checks on the tubes or transistors used in the Type 3B4 are not recommended. Testers may indicate a tube or transistor to be defective when it is operating satisfactorily in a circuit, or may fail to indicate tube or transistor defects which affect the performance of the circuits. It is recommended that tubes and transistors be checked by substitution. If the tube or transistor is good, return it to its socket. Unnecessary replacement of tubes or transistors is not only expensive but may also result in needless recalibration of the instrument.

CALIBRATION AND VERIFICATION

Recalibrate the Type 3B4 after each 500 hours of operation, or every six months if used intermittently. It may also be necessary to recalibrate certain sections of the instrument when tubes, transistors, or other components are replaced. Do not preset the internal adjustments. Presetting internal adjustments makes it necessary to completely recalibrate the instrument.

The following portion of this manual presents a calibration and verification procedure. The title of each numbered step begins either with "Adjust" or "Check", thereby identifying the step function as calibration or verification. The steps are identified in this manner because any or all groups of numbered "Checks" can be skipped without disrupting the continuity of the procedure. However, all adjustments must be completed in the order given and none should be skipped. Remember that proper overall operation is assured only when all steps in the procedure have been completed and all adjustments have been made as accurately as possible.

Steps 14, 15, 17, 21 and 26 may be used as an abridged adjustment procedure for adjusting all internal calibration potentiometers and sweep calibration capacitors.

NOTE

The performance standards described in this section of the manual are provided strictly as guides to calibration of the Type 3B4 and should not be construed as advertised performance specifications. However, if the Type 3B4 performs within the guide tolerances given in the calibration procedure, it will also perform as listed in the Characteristic section of this manual.

Equipment Required

1. Oscilloscope such as the Tektronix Type 561A. This procedure assumes that the power supply voltages in the oscilloscope are correct.

2. Tektronix 3-Series vertical plug-in unit such as the 3A1. This unit should be calibrated and operating in all respects.

3. Audio oscillator with output frequencies from 30 cps to 30 kc, 30 volts amplitude.

4. Constant-amplitude sine-wave generator such as the Tektronix Type 190A or 190B. Required characteristics: (a) output frequencies from 50 kc to 20 mc, (b) output voltage variable from about 0.3 volt to 4.0 volts peak-to-peak when terminated in 50 Ω, and (c) provisions for maintaining constant amplitude (manually or automatically) with a change in frequency.

5. Time-mark generator such as the Tektronix Type 180A. Markers required at 1 and 5 sec; 100, 50, 10, and 1 msec; 100, 50, 10, 5, and 1 μsec; 5, 10, and 50 mc sine wave. All outputs should have a time accuracy of at least 0.1%.

6. Three 50 Ω coax cables with BNC type connectors (Tektronix Part No. 012-057).

7. Tektronix 50 Ω BNC termination Part No. 011-049, 2 required.

8. UHF-BNC adapter, for connecting the Type 190A or 190B to the BNC termination (UG-255/U).

9. Plug-in extension, Tektronix Part No. 013-034.

1. Check Multi-Trace Operation

Set:

3A1 Controls	Setting
CH 1	
VOLTS/DIV	0.1
VARIABLE	CALIB
POSITION	Centered
AC DC GND	GND
MODE	ALTER
CH 2	
VOLTS/DIV	0.05
VARIABLE	CALIB
POSITION	Centered
AC DC GND	GND
3B4 Controls	**Setting**
TRIGGER MODE	FREE RUN
POSITION	Centered

Procedure:

Rotate the Type 561A INTENSITY control clockwise until the two traces appear. Set the Type 561A FOCUS control for minimum trace width. Rotate the Type 3B4 TIME/DIV switch through all sweep rates and check for 2 traces in each position.

2. Check TRIGGERING LEVEL Control Zero Set

Set:

3A1 Controls	Setting
MODE	CH 1
All other controls	unchanged

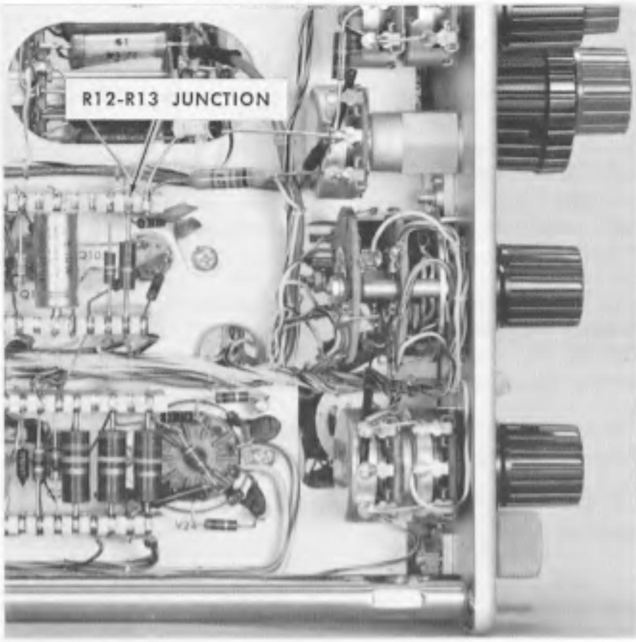


Fig. 4-2. Location of R12 and R13.

Procedure:

Remove the Type 3B4 from the Type 561A oscilloscope. Connect the Type 3B4 to the Type 561A by means of the plug-in extension (Tektronix part number 013-034). Connect the voltmeter positive lead to the junction of R12 and R13 (see Fig. 4-2) in the Type 3B4. Adjust the Type 3B4 TRIGGERING LEVEL for a reading of zero volts on the voltmeter. The knob index dot on the TRIGGERING LEVEL should be positioned at the front panel 0 when the voltmeter reads zero volts. If the control knob reads other than 0, loosen the set screw holding the control knob to the TRIGGERING LEVEL potentiometer. Return the knob index dot to the front panel 0 without changing the TRIGGERING LEVEL potentiometer. Check that the voltmeter continues to read zero. Tighten the TRIGGERING LEVEL knob set screw. Check that the voltmeter reads zero volts when the knob index dot is set at the front panel 0 position.

Reinstall the Type 3B4 in the oscilloscope.

3. Check Low Frequency Trigger Response

Set:

3A1 Controls	Setting
AC DC GND	AC
All Others	Unchanged
3B4 Controls	**Setting**
TIME/DIV	10 μSEC
TRIGGER MODE	FREE RUN
SOURCE	EXT
COUPLING	AC

Procedure:

Obtain a trace on the crt.

Connect a BNC "T" connector to the Type 3B4 EXT TRIG IN connector.

Connect a coax cable from the audio oscillator to the BNC "T" connector.

Connect a coax cable from the remaining side of the BNC "T" connector to the Type 3A1 CH 1 input.

Adjust the audio oscillator for 5 major divisions of deflection (500 mv) at 30 cycles.

Change the Type 3B4 TIME/DIV switch to 10 mSEC.

Change the Type 3B4 TRIGGER MODE switch to NORM.

Using the TRIGGERING LEVEL control, check for proper external triggering (both AC and DC COUPLING and + and — SLOPE) with a 500 millivolt, 30 cycle input signal.

Check to see that the setting of the TRIGGERING LEVEL control is on the + side of 0 for a triggered waveform of + SLOPE and on the — side of 0 for a waveform of — SLOPE.

Change the COUPLING switch to AC LF REJ. It should not be possible to trigger the Type 3B4 on a 500-millivolt 30 cycle signal in the AC LF REJ position of the COUPLING switch.

4. Check EXT ÷ 10 Position of the SOURCE switch

Set:

3A1 Controls	Setting
CH 1 VOLTS/DIV	1.0
3B4 Controls	**Setting**
SOURCE Switch	EXT ÷ 10

Procedure:

Adjust the Audio Oscillator for 5 major divisions of deflection (5 volts) of 30 cycle signal.

Repeat Step 3 using the new value of input voltage.

5. Check Internal Low Frequency Triggering

Set:

3B4 Controls	Setting
SOURCE Switch	INT

Procedure:

Set the audio oscillator output to give 0.5 minor division of deflection of 30 cycle signal.

Repeat Step 3 using this new setting of the SOURCE switch and audio oscillator output.

6. Check External Triggering Level Range

Set:

3A1 Controls	Setting
CH 1 VOLTS/DIV	10

Type 190B Controls	Setting
RANGE SELECTOR	50 kc
3B4 Controls	Setting
SOURCE	EXT
TIME/DIV	1 mSEC
MAGNIFIER	1 mSEC
COUPLING	DC
SLOPE	—

Procedure:

Set the audio oscillator to give 3 major divisions of 1 kc signal (30 volts).

Rotate the Type 3B4 TRIGGERING LEVEL control. Check to see that the sweep does not trigger at either extreme position of the control.

Change the SLOPE switch to +. Rotate the Type 3B4 TRIGGERING LEVEL control and check that the sweep does not trigger at either extreme position of the control.

7. Check Triggering in the AC LF REJ position of the COUPLING switch

Set:

3A1 Controls	Setting
CH 1 VOLTS/DIV	0.1
3B4 Controls	Setting
TRIGGER MODE	FREE RUN
COUPLING	AC LF REJ
SOURCE	EXT
TIME/DIV	10 μSEC

Procedure:

Set the audio oscillator to give 5 major divisions of deflection (500 millivolts) at 30 kc signal.

Change the Type 3B4 TRIGGER MODE switch to NORM.

Check that a stable display can be obtained by carefully rotating the TRIGGERING LEVEL control.

8. Check Line Triggering

Set:

3A1 Controls	Setting
CH 1 VOLTS/DIV	5
3B4 Controls	Setting
TIME/DIV	10 mSEC
SOURCE	LINE
COUPLING	AC

Procedure:

Apply line voltage (available at the tip of the fuse holder in the Type 561A) through a 10× probe to the CH 1 input of the Type 3A1.

With the TRIGGER MODE switch set to NORM, it should be possible to obtain a triggered display by adjusting the TRIGGERING LEVEL control. Polarity of the triggered waveform must correspond to the setting of the SLOPE switch.

Remove the probe from the Type 561A fuse holder.

9. Check High Frequency Trigger Response

Set:

3A1 Controls	Setting
CH 1 VOLTS/DIV	.05
3B4 Controls	Setting
TRIGGER MODE	FREE RUN
TIME/DIV	.2 μSEC
MAGNIFIER	.2 μSEC
SOURCE	EXT
Type 190B Controls	Setting
RANGE SELECTOR	50 kc

Procedure:

Remove the Audio Oscillator coax cable from the BNC "T" connector and connect the Type 190B ATTENUATOR to the "T" connector. Insert a 50 Ω termination (Tektronix Part No. 011-049) between the "T" connector and the EXT TRIG IN connector.

Adjust the Type 190B ATTENUATOR and OUTPUT AMPLITUDE for 3 major divisions of deflection.

NOTE

The specified bandpass of the Type 3A1 Dual Trace Amplifier is 10 mc. To check the external triggering high frequency response, it is necessary to use a constant amplitude sine wave generator, using the Type 3A1 to set the amplitude at some frequency much lower than 10 mc (e.g. 50 kc).

Change the Type 190B RANGE SELECTOR and RANGE IN MEGACYCLES to give a 20 mc output signal.

Change the Type 3B4 TIME/DIV switch to .2 μSEC.

Change the Type 3B4 TRIGGER MODE switch to NORM.

With 150 millivolts of 20 mc signal applied to the EXT TRIG IN connector, check triggering in AC, AC LF REJ, and DC, both + and — positions of the SLOPE switch.

10. Check EXT ÷ 10 High Frequency Triggering

Set:

3B4 Controls	Setting
SOURCE	EXT ÷ 10
TRIGGER MODE	FREE RUN
3A1 Controls	Setting
CH 1 VOLTS/DIV	.5

Procedure:

Using the Type 190B ATTENUATOR and OUTPUT AMPLITUDE obtain a display of 3 major divisions (1.5 volts) of 50 kc signal.

Change the Type 190B RANGE SELECTOR and RANGE IN MEGACYCLES for a 20 mc signal.

Change the Type 3B4 TRIGGER MODE switch to NORM.

Check triggering in AC, AC LF REJ and DC, in both + and — positions of the SLOPE switch.

11. Check Internal High Frequency Triggering

Set:

3B4 Controls	Setting
TRIGGER MODE	FREE RUN
SOURCE	INT

Procedure:

Using the Type 190B ATTENUATOR and OUTPUT AMPLITUDE controls, obtain a vertical display of 1 minor division of 20 mc signal.

Change the Type 3B4 TRIGGER MODE switch to NORM.

Check triggering in AC, AC LF REJ and DC in both + and — positions of the SLOPE switch.

Change the Type 3B4 TRIGGER MODE switch to FREE RUN and set the COUPLING switch to DC.

Using the Type 3A1 CH 1 POSITION control, position the display at the top of the graticule.

Change the Type 3B4 TRIGGER MODE switch to NORM.

Set the TRIGGERING LEVEL control for a stable display.

Check triggering in both the + and — positions of the SLOPE switch.

Change the Type 3B4 TRIGGER MODE switch to FREE RUN.

Position the display at the bottom of the graticule.

Change the Type 3B4 TRIGGER MODE switch to NORM.

Check triggering in both the + and — positions of the SLOPE switch.

12. Check Auto Trigger Operation

Set:

3B4 Controls	Setting
COUPLING	AC
SOURCE	INT
TRIGGER MODE	AUTO
TIME/DIV	10 μSEC
Type 180A Controls	Setting
	50 MILLISECOND markers

Procedure:

Connect a coax cable from the Type 180A MARKERS jack to the Type 3A1 CH 1 input connector.

Set the Type 3A1 VOLTS/DIV switch to give approximately two major divisions of deflection.

Position the display so the start of the trace is near the center of the graticule.

Rotate the TRIGGERING LEVEL control to obtain a stable display of a portion of the leading edge of the marker.

Change the Type 180A to 100 Millisecond markers.

Note that the sweep will not trigger on 100 millisecond markers as it did on 50 millisecond markers.

13. Check Single Sweep Operation

Set:

3B4 Controls	Setting
TRIGGER MODE	NORM
TIME/DIV	100 mSEC

Procedure:

Using the TRIGGERING LEVEL control, obtain a stable display.

Change the Type 3B4 TIME/DIV switch to 1 SEC.

Change the Type 180A to 1 second markers.

Observe the display for several traces and note that it is triggered correctly.

Change the TRIGGER MODE switch to SINGLE SWEEP.

Wait until the READY light extinguishes and the SWEEP TRIG'D light is lit.

Press the PUSH TO RESET button and observe the crt; a single display should occur.

After the single display, the ready light should extinguish and the SWEEP TRIG'D light should light.

NOTE

The SWEEP TRIG'D indicator lights when the Sweep Generator is triggered by the Trigger Generator. At slow trigger signal repetition rates, this is indicated by the light flashing each time a trigger is applied to the Sweep Generator. At faster triggering signal repetition rates the light appears to remain on at all times. During Single Sweep Operation the SWEEP TRIG'D light is locked out during the time that the Lockout Multi is armed.

14. Adjust Sweep Calibration

Set:

3A1 Controls	Setting
MODE	CH 1
CH 1 VOLTS/DIV	2
POSITION	Centered

3B4 Controls	Setting
TIME/DIV	1 mSEC
SOURCE	INT
COUPLING	AC
SLOPE	+
TRIGGER MODE	AUTO

Procedure:

Apply 1 millisecond markers from the Type 180A to the CH 1 input.

Use the Type 3B4 POSITION and FINE controls to align the first time mark (not the zero mark, see Fig. 4-3) with the second graticule line.

Adjust the CALIBRATE control (front-panel screwdriver adjustable control) until the first and ninth time markers are centered on the second and tenth graticule lines. The maximum allowable error for this step is ±3% over the center 8 major divisions, however, it is usually possible to calibrate much more accurately than this.

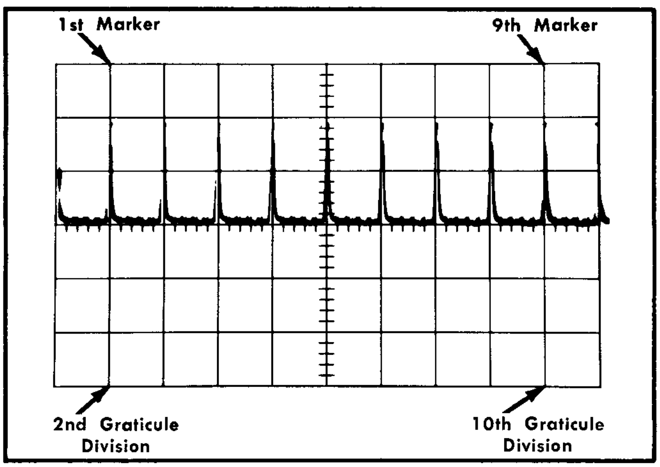


Fig. 4-3. Counting of time markers and graticule divisions.

NOTE

The CALIBRATE adjustment provides a range of ±10% when the horizontal deflection sensitivity of the crt is 18.6 v/div. If the crt horizontal deflection sensitivity is other than 18.6 v/div, the + and — percentages differ.

15. Adjust Magnifier Calibration and Sweep Magnifier Registration

Set:

3B4 Controls	Setting
MAGNIFIER	20 μSEC
Other Controls	unchanged

Procedure:

Apply 10 microsecond markers from the Type 180A to the Type 3A1 CH 1 input. Using the Type 3B4 POSITION and FINE controls, align the markers with graticule major division lines.

Adjust the ×50 MAG GAIN adjustment (R447) for 2 time marks per major division. The maximum allowable error for this step is ±5% over the center eight major divisions, however, it is usually possible to calibrate much more accurately than this.

Using the Type 3B4 POSITION and FINE controls, position the first time marker on the graticule center line. Switch the Type 3B4 MAGNIFIER switch to 1 mSEC and adjust the SWP MAG REGIS (R422) so that the first marker again falls on the center graticule line.

NOTE

The CALIBRATE, ×50 MAG GAIN, and SWP MAG REGIS adjustments interact. Repeat Step 14 and then Step 15 until all three controls are accurately adjusted.

16. Check 2 mSEC and 5 mSEC Timing Accuracy

Set:

3B4 Controls	Setting
TIME/DIV	2 mSEC
MAGNIFIER	2 mSEC

Procedure:

Apply 1 millisecond markers from the Type 180A and check for 2 marks per major division. Maximum allowable error is ±3% (1.2 minor divisions).

Switch the TIME/DIV and MAGNIFIER switches to 5 mSEC.

Apply 5 millisecond markers from the Type 180A and check for 1 mark per major division. Maximum allowable error is ±3%.

17. Adjust Sweep Length

Set:

3B4 Controls	Setting
TIME/DIV	1 mSEC

Procedure:

Apply 1 millisecond and 100 microsecond markers simultaneously from the Type 180A. Position the display to the left with the POSITION control so that the 10th (not counting the first marker on the left—see Fig. 4-3) large (millisecond) marker is one major division in from the right side of the graticule. Adjust LENGTH control R173 for 5 small (100 microsecond) markers following the 10th large marker.

18. Check Variable Time Per Division

Procedure:

With the Type 3B4 TIME/DIV and MAGNIFIER switches set to 1 mSEC, apply 1 millisecond markers only from the Type

180A. Position the display for 1 marker per major division. Rotate the VARIABLE control from the CALIB position to the full counterclockwise position and check for 5 or more markers per two major divisions. Note that the UNCAL light illuminates whenever the VARIABLE control is switched from the UNCAL position.

19. Check Timing Accuracy of Magnified Sweep

Procedure:

Set controls and check timing over center 8 major divisions of graticule as listed in Table 4-2. Maximum allowable error is 5% (2 minor divisions).

TABLE 4-2

TIME/DIV Setting	MAGNIFIER Setting	TYPE 180A Signal	Marks per cm
1 mSEC	.5 mSEC	500 μSEC	1
1 mSEC	.2 mSEC	100 μSEC	2
1 mSEC	.1 mSEC	100 μSEC	1
1 mSEC	50 μSEC	50 μSEC	1
1 mSEC	20 μSEC	10 μSEC	2
5 mSEC	2 mSEC	1 mSEC	2
5 mSEC	.2 mSEC	100 μSEC	2
2 mSEC	.5 mSEC	500 μSEC	1
2 mSEC	50 μSEC	50 μSEC	1

20. Check Slow and Medium Sweep Timing

Procedure

Set controls and check timing as listed in Table 4-3. Maximum allowable error 3% (1.2 minor divisions).

Leave the MAGNIFIER switch locked to the TIME/DIV switch. (The 1, 2, and 5 mSEC/DIV settings are omitted from the table. They are checked in Steps 15 and 16.)

TABLE 4-3

TIME/DIV Setting	TYPE 180A Signal	Marks Per div
.1 mSEC	100 μSEC	1
.2 mSEC	100 μSEC	2
.5 mSEC	500 μSEC	1
10 mSEC	10 mSEC	1
20 mSEC	10 mSEC	2
50 mSEC	50 mSEC	1
Change TRIGGER MODE to NORM		
.1 SEC	100 mSEC	1
.2 SEC	100 mSEC	2
.5 SEC	500 mSEC	1
1 SEC	1 SEC	1
2 SEC	1 SEC	2

Change the Type 3B4 TIME/DIV switch to 5 SEC.

Change the Type 180A to 5 second markers. Check the display for 1 marker per major division. Maximum allowable error ±5% (2 minor divisions) between the 2nd and 10th graticule marks.

21. Adjust Fast Sweep Timing

Procedure:

Change the Type 180A to 10 microsecond markers.

Change the Type 3B4 TIME/DIV switch to 10 μSEC and adjust the TRIGGERING LEVEL for a stable display.

Position the first marker on the second graticule mark as shown in Fig. 4-3.

Adjust C160 for 1 time marker per division.

Change the Type 180A to deliver a 5 mc sinewave.

Change the Type 3B4 TIME/DIV switch to .2 μSEC.

Position the first cycle on the second graticule line. Adjust C160A for 1 cycle per major division.

22. Check Fast Sweep Rate Timing Accuracy

Procedure:

Using the outputs listed in the first column of Table 4-4, set the TIME/DIV switch as listed in the second column and check for the proper number of markers as listed in the third column. The allowable error is 1.2 minor divisions over the center eight major divisions.

TABLE 4-4

Type 180A	TIME/DIV	Marks/Div
5 Mc Sinewave	.2 μSEC	1 cycle/div
1 microsecond	.5 μSEC	1 mark/2 div
1 microsecond	1 μSEC	1 mark/div
1 microsecond	2 μSEC	2 marks/div
5 microsecond	5 μSEC	1 mark/div
10 microsecond	10 μSEC	1 mark/div
10 microsecond	20 μSEC	2 marks/div
50 microsecond	50 μSEC	1 mark/div

23. Check Magnified Fast Sweep Rates

Set:

3B4 Controls	Setting
TIME/DIV	.2 μSEC
MAGNIFIER	.05 μSEC

Procedure:

Apply a 10 mc sine wave from the Type 180A to the CH 1 input.

Adjust the Type 3B4 TRIGGERING LEVEL for a stable display.

Check the magnified fast sweep rates at the start, middle, and end of the sweep, excluding the specified portion at the start of the sweep as listed in Table 4-5; at the end of the sweep, exclude everything outside the 9th major division of the **unmagnified** sweep.

Check the other sweep magnification combinations as listed in Table 4-5. Maximum allowable error is 2 minor divisions.

TABLE 4-5

TIME/DIV	MAGNI-FIER	TYPE 180A	Exclude	Cycles/DIV
.2 μSEC	.05 μSEC	10 mc	2 cycles	1 cycle/2 div
.2 μSEC	.1 μSEC	10 mc	10 cycles	1
.5 μSEC	.05 μSEC	10 mc	10 cycles	1 cycle/2 div
.5 μSEC	.1 μSEC	10 mc	10 cycles	1
.5 μSEC	.2 μSEC	10 mc	10 cycles	2
1 μSEC	.05 μSEC	10 mc	10 cycles	1 cycle/2 div
1 μSEC	.1 μSEC	10 mc	10 cycles	1
1 μSEC	.2 μSEC	10 mc	10 cycles	2
1 μSEC	.5 μSEC	1 μSEC	2 markers	1 mark/2 div
2 μSEC	.05 μSEC	10 mc	10 cycles	1 cycle/2 div
2 μSEC	.1 μSEC	10 mc	10 cycles	1
2 μSEC	.2 μSEC	10 mc	10 cycles	2
2 μSEC	.5 μSEC	1 μSEC	2 markers	1 mark/2 div
2 μSEC	1 μSEC	1 μSEC	2 markers	1 mark/div
5 μSEC	.1 μSEC	10 mc	10 cycles	1
5 μSEC	.2 μSEC	5 mc	8 cycles	1
5 μSEC	.5 μSEC	1 μSEC	2 markers	1 mark/2 div
5 μSEC	1 μSEC	1 μSEC	2 markers	1 mark/1 div
5 μSEC	2 μSEC	1 μSEC	2 markers	2 marks/div

24. Check +GATE OUT

Procedure:

Remove the input cable from the Type 3A1 CH 1 input connector.

Set the Type 3B4 TRIGGER MODE switch to FREE RUN and connect a test oscilloscope 10× probe to the + GATE OUT connector of the Type 3B4. Check that the output amplitude of the + GATE pulse is 20 volts ±10%.

25. Check +GATE Interval

Procedure:

Turn the Type 3B4 TRIGGERING LEVEL control to 0. With the test oscilloscope probe still connected to the +GATE OUT connector, measure the time between +GATE pulses as listed in Table 4-6.

TABLE 4-6

TIME/DIV	+GATE INTERVAL
0.2 μSEC—2.0 μSEC	4.5—8.5 μSEC
5.0 μSEC—20 μSEC	9.5—13.5 μSEC
50 μSEC—0.2 mSEC	60—110 μSEC
0.5 mSEC—2.0 mSEC	450—700 μSEC
5.0 mSEC—20 mSEC	4.5—13.5 mSEC
50 mSEC—5 SEC	45—65 mSEC

NOTE

The time interval between +GATE pulses includes holdoff time and re-cycle time. For this reason the term "+GATE INTERVAL" is used here instead of "holdoff time". The TRIGGERING LEVEL control provides a 5% to 10% variation in the +GATE interval.

26. Adjust External Horizontal Gain

Procedure:

Turn the Type 3B4 TIME/DIV switch to EXT HORIZ IN. Pull out the MAGNIFIER knob and set the index dot to .2 SEC OR EXT VOLTS.

Apply 1 volt (±0.3%) square wave signal to the Type 3B4 EXT HORIZ IN connector. The frequency of the square wave should be between 50 cycles and 2 kc.

NOTE

Any error in the amplitude of the square wave signal will be added to the 3% tolerance of the Type 3B4. For this reason it is important that the the voltage of the calibrating signal used for this step be accurate within ±0.3%.

Adjust EXT HORIZ GAIN control R228 for 5 major divisions of deflection, ±0.5 minor divisions.

27. Check External Horizontal Attenuator Accuracy

With the equipment set up as in Step 26, apply the voltages listed in the first column of Table 4-7 and check for the proper deflection in each setting of the EXT VOLTS positions of the MAGNIFIER knob listed.

TABLE 4-7

EXT VOLTS setting	Square Wave Voltage ±0.3%	Deflection in major divisions	Maximum Allowable error
.2 VOLTS	1 VOLT	5	.75 minor div
.5 VOLTS	2 VOLTS	4	.6 minor div
1 VOLT	5 VOLTS	5	.75 minor div
2 VOLTS	10 VOLTS	5	.75 minor div
5 VOLTS	20 VOLTS	4	.6 minor div

28. Check External Horizontal VARIABLE Attenuator

Procedure:

With the equipment set up as in Step 27, set the MAGNIFIER knob to the 2 volt position of the SEC OR EXT VOLTS range. Apply a 10-volt square wave signal to the EXT HORIZ IN connector.

Rotate the VARIABLE control fully counterclockwise. Check for 2 major divisions or less of horizontal deflection.

29. Check Horizontal Position Range

Procedure:

Turn the MAGNIFIER knob to the 5 EXT VOLTS position. Increase the square wave input to 20 volts. Using the POSITION control, it should be possible to position the display off the crt fact at either end.

Turn the FINE control fully clockwise. With the POSITION control, position the right hand end of the display on a major graticule line. Now rotate the FINE control fully counterclockwise; the display should shift frem 0.9 to 1.4 major division.

30. Check External Horizontal Bandpass

Set:

3B4 Controls	Setting
TIME/DIV	EXT HORIZ IN
VARIABLE	CALIB
MAGNIFIER	.2 EXT VOLTS

Type 190B Controls	Setting
RANGE SELECTOR	50 KC

Procedure:

Connect the Type 190B Attenuator to the Type 3B4 EXT HORIZ IN connector. Adjust the Type 190B ATTENUATOR and OUTPUT AMPLITUDE controls for a horizontal deflection of 8 major divisions.

Change the Type 190B RANGE SELECTOR switch to .35 to .75 MEGACYCLES.

Turn the Type 190B RANGE IN MEGACYCLES control until the crt display shrinks to 5.6 major divisions (30% down points). Check that the Type 190B RANGE IN MEGACYCLES dial reads .40 megacycles or above.

SECTION 5
PARTS LIST and DIAGRAMS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix Field Office.

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 including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix Field Office will contact you concerning any change in part number.

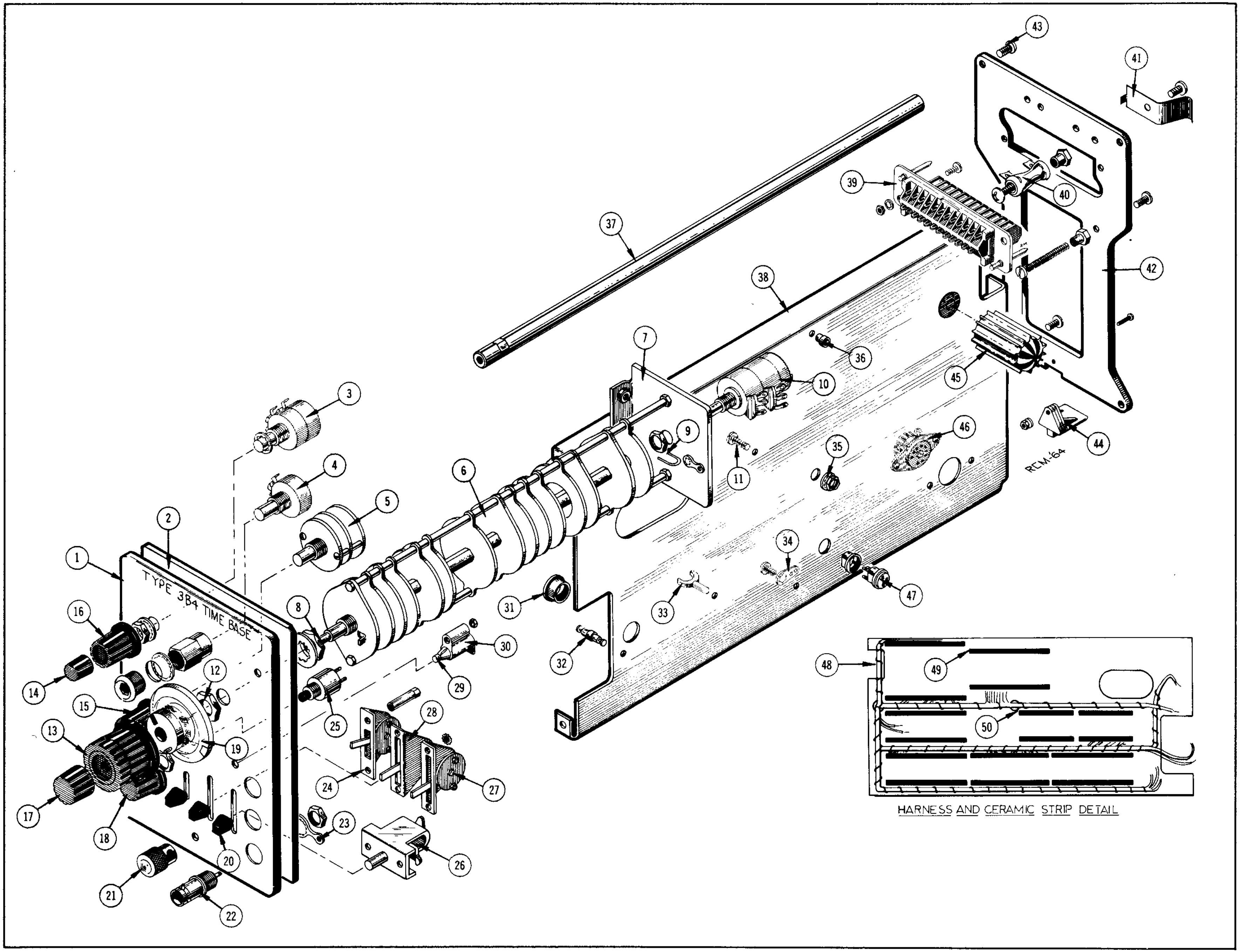
ABBREVIATIONS AND SYMBOLS

a or amp	amperes
BHS	binding head steel
C	carbon
cer	ceramic
cm	centimeter
comp	composition
cps	cycles per second
crt	cathode-ray tube
CSK	counter sunk
dia	diameter
div	division
EMC	electrolytic, metal cased
EMT	electroyltic, metal tubular
ext	external
f	farad
F & I	focus and intensity
FHS	flat head steel
Fil HS	fillister head steel
g or G	giga, or 10^9
Ge	germanium
GMV	guaranteed minimum value
h	henry
hex	hexagonal
HHS	hex head steel
HSS	hex socket steel
HV	high voltage
ID	inside diameter
incd	incandescent
int	internal
k or K	kilohms or kilo (10^3)
kc	kilocycle
m	milli, or 10^{-3}
mc	megacycle
mm	millimeter
meg or M	megohms or mega (10^6)
met.	metal
μ	micro, or 10^{-6}
n	nano, or 10^{-9}
Ω	ohm
OD	outside diameter
OHS	oval head steel
p	pico, or 10^{-12}
PHS	pan head steel
piv	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
Prec	precision
PT	paper tubular
PTM	paper or plastic, tubular, molded
RHS	round head steel
rms	root mean square
sec	second
Si	silicon
S/N	serial number
t or T	tera, or 10^{12}
TD	toroid
THS	truss head steel
tub.	tubular
v or V	volt
Var	variable
w	watt
w/	with
w/o	without
WW	wire-wound

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number.
000X	Part removed after this serial number.
*000-000	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, or reworked or checked components.
Use 000-000	Part number indicated is direct replacement.
	Internal screwdriver adjustment.
	Front-panel adjustment or connector.

EXPLODED VIEW



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EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
1	333-0843-00	100	1051	1	PANEL, front
	333-0843-01	1052		1	PANEL, front
	- - - - - -			-	mounting hardware: (not included w/panel)
	213-0055-00			1	SCREW, thread forming, 2-32 x 3/16 inch, PHS
2	387-0974-00			1	PLATE, sub-panel
3	- - - - - -			2	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
4	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0494-00			1	NUT, hex, 3/8-32 x 1/2 x 11/16 inch
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	358-0010-00			1	BUSHING, 3/8-32 x 9/16 inch
5	260-0623-00			1	SWITCH, unwired — TRIGGER MODE
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
6	262-0669-00			1	SWITCH, wired — TIME/CM
	- - - - - -			-	switch includes:
	260-0624-00	100	7819	1	SWITCH, unwired — TIME/CM
	260-0624-01	7820		1	SWITCH, unwired — TIME/CM
	- - - - - -			-	switch includes:
7	406-0882-00			1	BRACKET, switch
	- - - - - -			-	mounting hardware: (not included w/bracket)
	210-0017-00			1	LOCKWASHER, internal, spring, #5
	210-0203-00			1	LUG, solder, #6 long
	210-0449-00			2	NUT, hex., 5-40 x 1/4 inch
8	384-0321-00			1	ROD, switch
9	376-0014-00			1	COUPLING, pot
	361-0233-00	X5900		1	RESTRAINT, shaft coupling
	361-0234-00	X5900		1	RESTRAINT, shaft coupling
10	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
	- - - - - -			-	mounting hardware: (not included w/switch)
11	211-0504-00			2	SCREW, 6-32 x 1/4 inch, BHS
12	210-0579-00			1	NUT, hex., 5/8-24 x 3/4 inch
	210-0049-00			1	LOCKWASHER, internal, 5/8 inch
13	366-0269-00			1	KNOB, large charcoal — TIME/CM
	- - - - - -			-	knob includes:
	213-0022-00			2	SCREW, set, 4-40 x 3/16 inch, HSS
14	366-0255-00	100	3549	1	KNOB, small red — FINE
	366-0140-00	3550		1	KNOB, red — FINE
	- - - - - -			-	knob includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch, HSS

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
15	366-0173-00			1	KNOB, charcoal—TRIGGER MODE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
16	366-0138-00	100	3549	1	KNOB, charcoal—POSITION
	366-0175-00	3550		1	KNOB, charcoal—POSITION
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
17	366-0038-00			1	KNOB, small red—VARIABLE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
18	366-0173-00			1	KNOB, charcoal—TRIGGERING LEVEL
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
19	331-0132-00			1	DIAL, window knob
	- - - - - -			-	dial includes:
	213-0022-00			2	SCREW, set, 4-40 x 3/16 inch, HSS
20	366-0215-00	100	789	3	KNOB, lever
	366-0215-01	790		3	KNOB, lever
21	366-0109-00			1	KNOB, plug-in securing
	- - - - - -			-	knob includes:
	213-0005-00			1	SCREW, set, 8-32 x 1/8 inch
22	131-0106-00			3	CONNECTOR, chassis mounted, 1 contact, BNC
23	210-0255-00			3	LUG, solder
24	260-0472-00			1	SWITCH, lever—SLOPE
	- - - - - -			-	mounting hardware: (not included w/switch)
	220-0413-00			2	NUT, switch, 4-40 x 3/16 x .500 inch long
25	260-0518-00			1	SWITCH, push-pull w/red indicator light
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0590-00			1	NUT, hex, 3/8-32 x 7/16 inch
26	214-0052-00			1	FASTENER, pawl right w/stop
	- - - - - -			-	mounting hardware: (not included w/fastener)
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
27	260-0615-00			1	SWITCH, lever—SOURCE
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
28	260-0594-00			1	SWITCH, lever—COUPLING
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
29	378-0541-00			2	FILTER, lens, neon indicator light
30	352-0067-00			2	HOLDER, single neon
	- - - - - -			-	mounting hardware for each: (not included w/holder)
	211-0031-00	100	1279	1	SCREW, 4-40 x 1 inch, FHS
	211-0109-00	1280		1	SCREW, 4-40 x 7/8 inch, FHS
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
31	348-0063-00			3	GROMMET, plastic, 1/2 inch
32	131-0182-00			2	CONNECTOR, terminal feedthru
	- - - - - -			-	mounting hardware for each: (not included w/connector)
	358-0135-00			1	BUSHING, teflon

EXPLODED VIEW (Cont'd)

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
-33	426-0121-00	100	8819	1	MOUNT, toroid
	355-0046-00	8120		1	STUD, plastic
	- - - - - -			-	mounting hardware: (not included w/mount or stud)
	361-0007-00			1	SPACER, nylon, .063 inch
-34	210-0201-00			9	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
	213-0044-00			1	SCREW, thread cutting, 5-32 x $^3/_{16}$ inch, PHS
-35	- - - - - -			4	POT, miniature
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0940-00			1	WASHER, $^1/_4$ ID x $^3/_8$ inch OD
	210-0583-00			1	NUT, hex, $^1/_4$-32 x $^5/_{16}$ inch
-36	348-0031-00			1	GROMMET, snap-in
-37	384-0615-00			4	ROD, frame
	441-0579-00			1	CHASSIS, plug-in
	- - - - - -			-	mounting hardware: (not included w/chassis)
	211-0507-00			3	SCREW, 6-32 x $^5/_{16}$ inch, BHS
	211-0538-00			3	SCREW, 6-32 x $^5/_{16}$ inch, FHS
	210-0457-00			2	NUT, keps, 6-32 x $^5/_{16}$ inch
-39	131-0149-00			1	CONNECTOR, chassis mounted, 24 contact
	- - - - - -			-	mounting hardware: (not included w/connector)
	211-0008-00			2	SCREW, 4-40 x $^1/_4$ inch, BHS
	210-0004-00			1	LOCKWASHER, internal, #4
	210-0201-00			1	LUG, solder, SE #4
	210-0206-00			2	NUT, hex, 4-40 x $^3/_{16}$ inch
-40	- - - - - -			2	RESISTOR, 5 watt
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
	211-0544-00			1	SCREW, 6-32 x $^3/_4$ inch, THS
	210-0478-00			1	NUT, hex, resistor mounting
	211-0507-00			1	SCREW, 6-32 x $^5/_{16}$ inch, BHS
-41	214-0276-00			2	SPRING, ground
	- - - - - -			-	mounting hardware for each: (not included w/spring)
	211-0507-00			1	SCREW, 6-32 x $^5/_{16}$ inch, BHS
-42	387-0647-00			1	PLATE, rear
	- - - - - -			-	mounting hardware: (not included w/plate)
-43	212-0044-00			4	SCREW, 8-32 x $^1/_2$ inch, RHS
-44	351-0037-00			1	GUIDE, plug-in
	- - - - - -			-	mounting hardware: (not included w/guide)
	211-0012-00			1	SCREW, 4-40 x $^3/_8$ inch, BHS
	210-0004-00			1	LOCKWASHER, internal, #4
	210-0406-00			1	NUT, hex, 4-40 x $^3/_{16}$ inch
-45	337-0649-00			1	SHIELD, heat dissipating
-46	136-0015-00			4	SOCKET, STM9G
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	213-0044-00			2	SCREW, thread cutting, 5-32 x $^3/_{16}$ inch, PHS

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
47	136-0181-00			19	SOCKET, 3 pin transistor
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, locking, transistor socket
48	179-0924-00			1	CABLE HARNESS, chassis
49	124-0145-00			12	STRIP, ceramic, 7/16 inch x 20 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, nylon, .313 inch
50	124-0147-00			4	STRIP, ceramic, 7/16 inch x 13 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, nylon, .313 inch
					STANDARD ACCESSORIES
	070-0431-00			2	MANUAL, instruction (not shown)

ELECTRICAL PARTS

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description					S/N Range
		Bulbs					
B118†	260-518	Switch w/red Indicator Light				READY	
B119	150-027	Neon, NE-23				SWEEP TRIG'D	100-1279
B119	150-0030-00	Neon, NE-2V				SWEEP TRIG'D	1280-up
B135	150-027	Neon, NE-23					
B160X	150-027	Neon, NE-23				UNCAL	100-1279
B160X	150-0030-00	Neon, NE-2V				UNCAL	1280-up

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Description					S/N Range
C1	281-538	1 pf	Cer		500 v		
C5	283-013	0.01 μf	Cer		1000 v		
C6	281-523	100 pf	Cer		350 v		
C10	283-000	0.001 μf	Cer		500 v		
C12	283-003	0.01 μf	Cer		150 v		
C19	283-003	0.01 μf	Cer		150 v		
C31	283-003	0.01 μf	Cer		150 v		
C33	283-084	270 pf	Cer		1000 v	5%	
C102	283-003	0.01 μf	Cer		150 v		
C105	290-189	33 μf	EMT		35 v	10%	
C126	281-546	330 pf	Cer		500 v	10%	
C131	283-000	0.001 μf	Cer		500 v		
C135	Use 281-543	270 pf	Cer		500 v	10%	
C136	283-057	0.1 μf	Cer		200 v		
C137	283-000	0.001 μf	Cer		500 v		
C143	283-032	470 pf	Cer		500 v	5%	
C150	281-523	100 pf	Cer		350 v		
C151	283-000	0.001 μf	Cer		500 v		
C156	281-0524-00	150 pF	Cer		500 v		X5300-up
C159	283-003	0.01 μf	Cer		150 v		
C160A	281-010	4.5-25 pf	Cer	Var			
C160B	281-508	12 pf	Cer		500 v		
C160C	281-010	4.5-25 pf	Cer	Var			
C160D	281-574	82 pf	Cer		500 v	10%	
C160E, C160F, C160G, C160H	*295-080	0.001 μf, 0.01 μf, 0.1 μf, 1 μf	Timing Series				
C160J	281-523	100 pf	Cer		350 v		
C164	283-000	0.001 μf	Cer		500 v		
C167	281-524	150 pf	Cer		500 v		
C173	281-524	150 pf	Cer		500 v		
C175A	281-530	100 pf	Cer		500 v	10%	

†Furnished as a unit with SW135.

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C175B	283-000	0.001 μf	Cer	500 v		
C175C	Use 285-695	0.01 μf	PTM	200 v	10%	
C175D	285-572	0.1 μf	PTM	200 v		100-3429
C175D	285-0633-00	0.22 μf	PTM	100 v	10%	3430-up
C175E	285-576	1 μf	PTM	100 v	10%	
C175F	281-519	47 pf	Cer	500 v	10%	
C181	281-523	100 pf	Cer	350 v		
C193	283-079	0.01 μf	Cer	250 v		
C206	283-000	0.001 μf	Cer	500 v		
C215	283-003	0.01 μf	Cer	150 v		
C221	283-000	0.001 μf	Cer	500 v		
C234	283-003	0.01 μf	Cer	150 v		
C401	281-626	3.3 pf	Cer	200 v	5%	
C411	283-000	0.001 μf	Cer	500 v		
C414	283-010	0.05 μf	Cer	50 v		X130-up
C435	290-134	22 μf	EMT	15 v		
C451	281-518	47 pf	Cer	500 v		X130-4209X
C458	283-002	0.01 μf	Cer	500 v		
C461	283-079	0.01 μf	Cer	250 v		
C464	283-000	0.001 μf	Cer	500 v		
C465	283-000	0.001 μf	Cer	500 v		
C466	283-026	0.2 μf	Cer	25 v		
C467	283-026	0.2 μf	Cer	25 v		
C469	283-079	0.01 μf	Cer	250 v		

Diodes

Ckt. No.	Tektronix Part No.	Description	S/N Range
D18	Use *152-0185-00	Silicon Replaceable by 1N4152	
D20	Use *152-0185-00	Silicon Replaceable by 1N4152	
D28	Use *152-0185-00	Silicon Replaceable by 1N4152	
D30	*152-125	Tunnel Selected TD 3A 4.7 MA	
D31	152-139	Zener 1N751 0.4 w, 5.1 v, 10%	100-2929
D31	152-0279-00	Zener 1N751A 0.4 w, 5.1 v, 5%	2930-up
D101	Use *152-0185-00	Silicon Replaceable by 1N4152	
D102	Use *152-0185-00	Silicon Replaceable by 1N4152	
D106	*152-075	Germanium Tek Spec	
D110	Use *152-0185-00	Silicon Replaceable by 1N4152	
D111	Use *152-0185-00	Silicon Replaceable by 1N4152	
D112	Use *152-0185-00	Silicon Replaceable by 1N4152	
D123	*152-0185-00	Silicon Replaceable by 1N4152	X3130-up
D124	*152-0185-00	Silicon Replaceable by 1N4152	X3130-up
D141	Use *152-0185-00	Silicon Replaceable by 1N4152	
D143	*152-125	Tunnel Selected TD 3A	
D147	Use *152-0185-00	Silicon Replaceable by 1N4152	
D150	Use *152-0185-00	Silicon Replaceable by 1N4152	
D154	152-0008-00	Germanium	X1040-up
D155	Use *152-0249-00	Silicon Assembly	
D160	*152-061	Silicon Tek Spec	
D161	*152-061	Silicon Tek Spec	
D164	152-091	Zener 1N982 0.4 w, 75 v, 10%	100-2929
D164	152-0286-00	Zener 1N982B 0.4 w, 75 v, 5%	2930-up
D165	*152-107	Silicon Replaceable by 1N647	

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
D167	Use *152-0185-00	Silicon Replaceable by 1N4152	
D176	*152-061	Silicon Tek Spec	
D178	*152-061	Silicon Tek Spec	
D179	*152-061	Silicon Tek Spec	
D189	*152-061	Silicon Tek Spec	
D200	Use *152-0185-00	Silicon Replaceable by 1N4152	
D209	*152-061	Silicon Tek Spec	
D234	Use *152-0185-00	Silicon Replaceable by 1N4152	
D411	Use *152-0185-00	Silicon Replaceable by 1N4152	
D413	Use *152-0185-00	Silicon Replaceable by 1N4152	
D414	152-172	Zener 1N970A 0.4 w, 24 v, 10%	100-2929
D414	152-0265-00	Zener 1N970B 0.4 w, 24 v, 5%	2930-up
D415	Use *152-0185-00	Silicon Replaceable by 1N4152	
D420	Use *152-0185-00	Silicon Replaceable by 1N4152	
D423	Use *152-0185-00	Silicon Replaceable by 1N4152	
D430	Use *152-0185-00	Silicon Replaceable by 1N4152	
D433	Use *152-0185-00	Silicon Replaceable by 1N4152	
D462	152-060	Zener 1N3027A 1 w, 20 v, 10%	100-2929
D462	152-0291-00	Zener 1N3027B 1 w, 20 v, 5%	2930-up

Inductors

Ckt. No.	Tektronix Part No.	Description	S/N Range
L24	*108-057	8.8 μh	X150-1569X
L32	*108-057	8.8 μh	100-1569
L32	*108-0332-00	0.75 μh	1570-up
L128	276-0507-00	Core, Ferramic Suppressor	X4319-up
L139	*108-147	2.2 μh	
L206	276-528	Core, Ferramic Suppressor	100-4318
L206	276-0507-00	Core, Ferramic Suppressor	4319-up
L415	276-0507-00	Core, Ferramic Suppressor	X4210-up
L423	276-0507-00	Core, Ferramic Suppressor	X4210-up
L433	276-0507-00	Core, Ferramic Suppressor	X4210-up

Transistors

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q24	Use 151-131	2N964	100-4209
Q24	151-0188-00	2N3906	4210-up
Q34	*151-108	Replaceable by 2N2501	100-4209
Q34	151-0190-00	2N3904	4210-up
Q105	*151-108	Replaceable by 2N2501	100-4209
Q105	151-0190-00	2N3904	4210-up
Q114	*151-096	Selected from 2N1893	
Q115	*151-108	Replaceable by 2N2501	100-4209
Q115	151-0190-00	2N3904	4210-up
Q125	*151-103	Replaceable by 2N2219	100-4209
Q125	151-0190-00	2N3904	4210-4318
Q125	151-0224-00	2N3692	4319-up
Q135	*151-103	Replaceable by 2N2219	100-4209
Q135	151-0190-00	2N3904	4210-up
Q144	*151-108	Replaceable by 2N2501	100-4209
Q144	151-0190-00	2N3904	4210-up
Q154	151-107	2N967	100-3969
Q154	151-0188-00	2N3906	3970-up
Q164	*151-087	Selected from 2N1131	100-4209
Q164	151-0188-00	2N3906	4210-up
Q184	151-135	2N2635	100-4209
Q184	151-0188-00	2N3906	4210-up
Q194	*151-103	Replaceable by 2N2219	100-4209
Q194	151-0190-00	2N3904	4210-up
Q204	*151-103	Replaceable by 2N2219	100-4209

Transistors *(cont)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q204	151-0190-00	2N3904	4210-4318
Q204	151-0224-00	2N3692	4319-up
Q234	*151-096	Selected from 2N1893	
Q414	*151-133	Selected from 2N3251	100-4209
Q414	151-0188-00	2N3906	4210-up
Q423	*151-134	Replaceable by 2N2905	
Q424	*151-103	Replaceable by 2N2219	100-4209
Q424	151-0190-00	2N3904	4210-up
Q433	*151-134	Replaceable by 2N2905	
Q434	*151-103	Replaceable by 2N2219	100-4209
Q434	151-0190-00	2N3904	4210-up

Resistors

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

Ckt. No.	Tektronix Part No.	Value	Wattage	Type	Tolerance	S/N Range
R1	315-915	9.1 meg	1/4 w		5%	
R3	301-105	1 meg	1/2 w		5%	
R7	301-105	1 meg	1/2 w		5%	
R8	315-104	100 k	1/4 w		5%	
R10	316-224	220 k	1/4 w			
R12	301-225	2.2 meg	1/2 w		5%	
R13	315-473	47 k	1/4 w		5%	
R14	315-224	220 k	1/4 w		5%	
R16A,B	311-217	2 x 1 meg		Var	TRIGGERING LEVEL	
R18	316-101	100 Ω	1/4 w			
R19	316-470	47 Ω	1/4 w			
R20	316-101	100 Ω	1/4 w			
R22	303-223	22 k	1 w		5%	
R24	Use 315-561	560 Ω	1/4 w		5%	
R26	303-753	75 k	1 w		5%	
R28	303-563	56 k	1 w		5%	
R31	305-153	15 k	2 w		5%	
R32	315-750	75 Ω	1/4 w		5%	
R33	315-100	10 Ω	1/4 w		5%	100-1569X
R34	302-563	56 k	1/2 w			
R36	303-563	56 k	1 w		5%	
R102	315-681	680 Ω	1/4 w		5%	
R103	315-102	1 k	1/4 w		5%	
R105	315-562	5.6 k	1/4 w		5%	
R106	316-471	470 Ω	1/4 w			
R107	316-101	100 Ω	1/4 w			
R108	315-471	470 Ω	1/4 w		5%	
R110	315-124	120 k	1/4 w		5%	
R111	316-222	2.2 k	1/4 w			
R113	316-274	270 k	1/4 w			
R115	301-563	56 k	1/2 w		5%	
R116	301-563	56 k	1/2 w		5%	
R118	315-124	120 k	1/4 w		5%	
R119	316-474	470 k	1/4 w			
R120	302-155	1.5 meg	1/2 w			X130-up
R121	316-154	150 k	1/4 w			
R123	315-621	620 Ω	1/4 w		5%	
R124	315-184	180 k	1/4 w		5%	
R126	315-512	5.1 k	1/4 w		5%	
R127	315-134	130 k	1/4 w		5%	
R130	315-202	2 k	1/4 w		5%	

Resistors (Cont'd)

Ckt. No.	Tektronix Part No.	Description					S/N Range
R131	315-202	2 k	¼ w			5%	
R133	315-821	820 Ω	¼ w			5%	
R135	316-473	47 k	¼ w				
R137	316-473	47 k	¼ w				
R139	316-331	330 Ω	¼ w				
R141	315-102	1 k	¼ w			5%	
R143	315-820	82 Ω	¼ w			5%	
R144	323-310	16.5 k	½ w		Prec	1%	
R145	323-310	16.5 k	½ w		Prec	1%	
R147	303-223	22 k	1 w			5%	100-1569
R147	303-0183-00	18 k	1 w			5%	1570-up
R148	315-102	1 k	¼ w			5%	
R150	315-102	1 k	¼ w			5%	
R151	316-103	10 k	¼ w				
R154	316-123	12 k	¼ w				
R155	315-622	6.2 k	¼ w			5%	
R156	315-0820-00	82 Ω	¼ w			5%	X5300-up
R157	316-101	100 Ω	¼ w				
R159	316-471	470 Ω	¼ w				
R160A	309-260	100 k	½ w		Prec	1%	
R160B	309-049	150 k	½ w		Prec	1%	
R160C	309-109	250 k	½ w		Prec	1%	
R160D	309-140	500 k	½ w		Prec	1%	100-9019
R160D	323-0740-00	500 k	½ w		Prec	1%	9020-up
R160E	309-010	750 k	½ w		Prec	1%	
R160F	309-010	750 k	½ w		Prec	1%	
R160G	309-017	1.5 meg	½ w		Prec	1%	
R160H	309-399	7.5 meg	½ w		Prec	1%	100-2839
R160H	309-0441-00	7.5 meg	½ w		Prec	1%	2840-up
R160J	309-399	7.5 meg	½ w		Prec	1%	
R160K	309-399	7.5 meg	½ w		Prec	1%	
R160L	309-399	7.5 meg	½ w		Prec	1%	
R160M	309-442	22.6 meg	½ w		Prec	1%	
R160N	309-442	22.6 meg	½ w		Prec	1%	
R160T	302-103	10 k	½ w				
R160X	315-104	100 k	¼ w			5%	
R161	316-334	330 k	¼ w				
R162	316-225	2.2 meg	¼ w				
R163	303-123	12 k	1 w			5%	
R164	305-273	27 k	2 w			5%	
R165	316-154	150 k	¼ w				
R167	316-101	100 Ω	¼ w				
R169	316-101	100 Ω	¼ w				
R170	323-0386-00	102 k	½ w		Prec	1%	X740-up
R171	301-302	3 k	½ w			5%	
R172	301-472	4.7 k	½ w			5%	
R173	311-086	2.5 k	0.5 w	Var		LENGTH	
R174	305-103	10 k	2 w			5%	
R175	Use 323-396	130 k	½ w		Prec	1%	
R177	316-333	33 k	¼ w				
R179	316-335	3.3 meg	¼ w				
R181	315-102	1 k	¼ w			5%	
R182	315-113	11 k	¼ w			5%	
R183	315-102	1 k	¼ w			5%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R184	302-823	82 k	½ w				
R186	316-101	100 Ω	¼ w				
R189	308-108	15 k	5 w		WW	5%	
R190	304-223	22 k	1 w				
R192	315-331	330 Ω	¼ w			5%	
R193	315-121	120 Ω	¼ w			5%	
R195	315-202	2 k	¼ w			5%	
R197	315-822	8.2 k	¼ w			5%	
R198	315-432	4.3 k	¼ w			5%	
R200	315-132	1.3 k	¼ w			5%	
R201	316-472	4.7 k	¼ w				
R203	315-102	1 k	¼ w			5%	
R205	315-102	1 k	¼ w			5%	
R206	315-302	3 k	¼ w			5%	
R208	315-302	3 k	¼ w			5%	
R209	316-331	330 Ω	¼ w		Prec	1%	
R215	316-101	100 Ω	¼ w		Prec	1%	
R221	316-224	220 k	¼ w		Prec	1%	
R222	316-105	1 meg	¼ w		Prec	1%	
R223	316-101	100 Ω	¼ w			5%	
R225	303-223	22 k	1 w			5%	
R226	316-103	10 k	¼ w				
R228	311-067	5 k	0.2 w	Var		EXT HORIZ GAIN	
R229A†	311-481	30 k		Var		VARIABLE	
R229B†		20 k					
R233	315-222	2.2 k	¼ w			5%	
R235	301-433	43 k	½ w			5%	100-2929
R235	323-0349-00	42.2 k	½ w		Prec	1%	2930-up
R236	305-153	15 k	2 w			5%	100-2929
R236	308-0320-00	15.6 k	3 w		WW	1%	2930-up
R237	303-243	24 k	1 w			5%	
R239	315-472	4.7 k	¼ w			5%	
R340A	322-193	1 k	¼ w		Prec	1%	
R340B	321-161	464 Ω	⅛ w		Prec	1%	
R340C	321-151	365 Ω	⅛ w		Prec	1%	
R340D	321-119	160 Ω	⅛ w		Prec	1%	
R340E	307-110	3 Ω	¼ w			5%	
R340F	321-129	215 Ω	⅛ w				
R340J	307-103	2.7 Ω	¼ w				
R340K	321-083	71.5 Ω	⅛ w				
R340L	323-044	28 Ω	½ w				
R340M	321-027	18.7 Ω	⅛ w				
R340P	309-449	4.6 Ω	½ w		Prec	1%	
R401	Use 323-0341-00	34.8 k	½ w		Prec	1%	
R402	311-315	20 k		Var		SWP CAL	
R403	323-374	76.8 k	½ w		Prec	1%	
R405	301-275	2.7 k	½ w			5%	

† Furnished as a unit with SW229.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R406†	311-478	1 meg		Var		POSITION	100-3549
R406†	311-0478-01	1 meg		Var		POSITION	3550-up
R408	323-368	66.5 k	½ w		Prec	1%	
R409†	311-478	150 k		Var		POSITION	100-3549
R409†	311-0478-01	150 k		Var		POSITION	3550-up
R411	323-385	100 k	½ w		Prec	1%	
R413	321-285	9.09 k	⅛ w		Prec	1%	
R415	316-274	270 k	¼ w				
R416	305-103	10 k	2 w			5%	
R421	308-319	4.5 k	3 w		WW	1%	
R422	311-404	1 k		Var	WW	SWP MAG REGIS	
R423	315-471	470 Ω	¼ w			5%	
R426	316-0394-00	390 k	¼ W				X8605-up
R431	308-319	4.5 k	3 w		WW	1%	
R433	315-471	470 Ω	¼ w			5%	
R434	316-270	27 Ω	¼ w				
R435	316-101	100 Ω	¼ w				
R436	316-0394-00	390 k	¼ W				X8605-up
R437	316-101	100 Ω	¼ w				
R439	308-111	6 k	8 w		WW	5%	100-2099
R439	308-0111-01	6 k	8 w		WW	5%	2100-up
R442	316-101	100 Ω	¼ w				
R444	308-111	6 k	8 w		WW	5%	100-2099
R444	308-0111-01	6 k	8 w		WW	5%	2100-up
R446	321-039	24.9 Ω	⅛ w		Prec	1%	
R447	311-258	100 Ω		Var		X50 MAG GAIN	
R448	321-039	24.9 Ω	⅛ w		Prec	1%	
R449	315-331	330 Ω	¼ w			5%	
R451	316-101	100 Ω	¼ w				X130-4209X
R455	302-151	150 Ω	½ w				
R456	302-151	150 Ω	½ w				
R458	307-103	2.7 Ω	¼ w			5%	
R459	308-107	1 k	5 w		WW	5%	
R460	308-003	2 k	5 w		WW	5%	
R461	307-103	2.7 Ω	¼ w			5%	
R462	305-822	8.2 k	2 w			5%	
R464	301-910	91 Ω	½ w			5%	
R467	316-220	22 Ω	¼ w				
R469	307-103	2.7 Ω	¼ w			5%	

Switches

	Unwired	Wired			
SW5	260-615		Lever	SOURCE	
SW8	260-594		Lever	COUPLING	
SW10	260-472		Lever	SLOPE	
SW130	260-623	*262-668	Rotary	TRIGGER MODE	
SW135††	260-518		Push-Pull	PUSH TO RESET	
SW160	260-624	*262-669	Rotary	TIME/DIV OR HORIZONTAL VOLTS/DIV	100-7819
SW160	260-0624-01	*262-0669-00		TIME/DIV OR HORIZONTAL VOLTS/DIV	7820-up
SW229†††		311-481		CALIB	

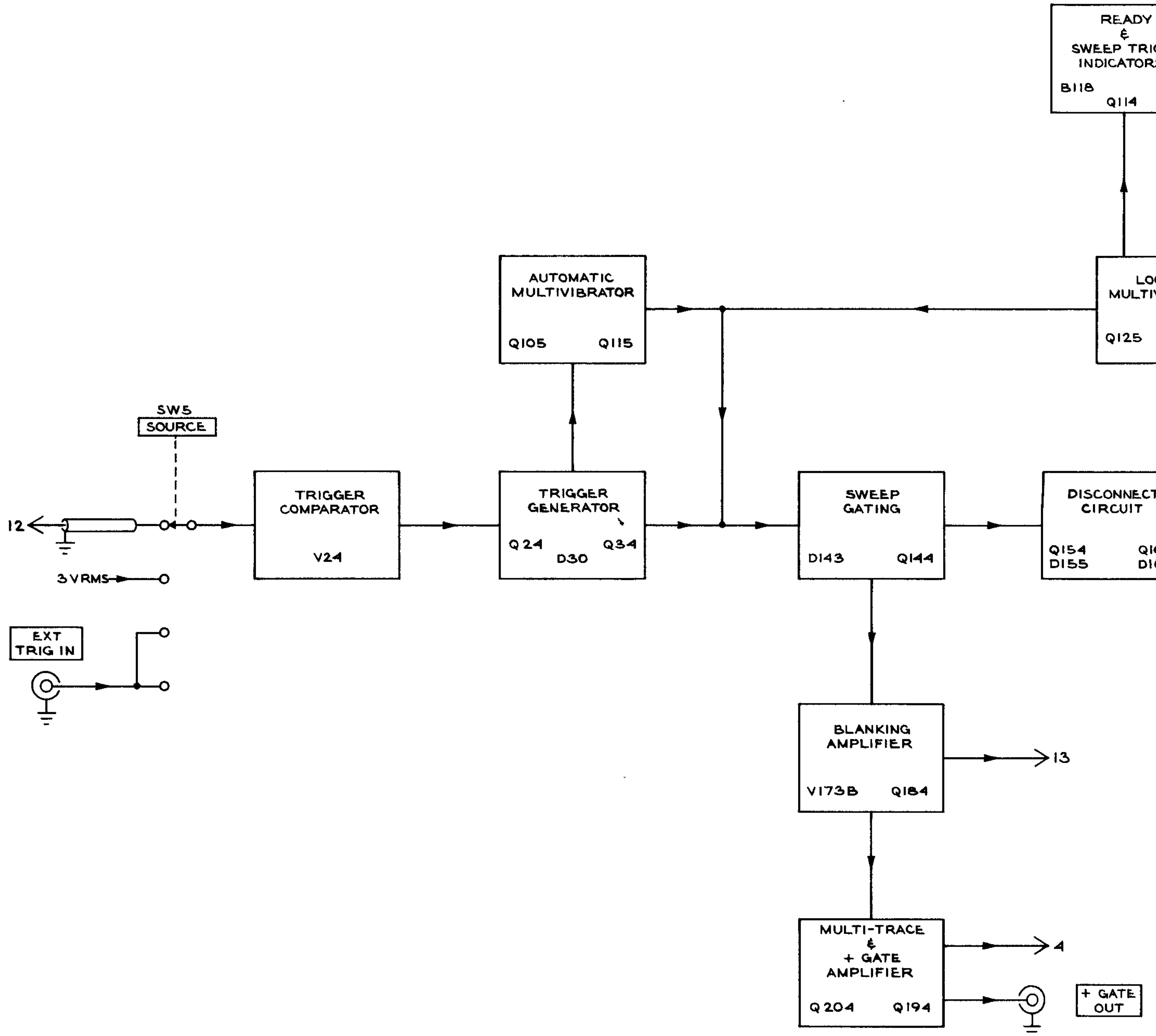
†R406 and R409 furnished as a unit.
††Furnished as a unit with B118.
†††Furnished as a unit with R229A,B.

Transformer

Ckt. No.	Tektronix Part No.	Description	S/N Range
T38	*120-278	Toroid, 3-8 Turn Winding	

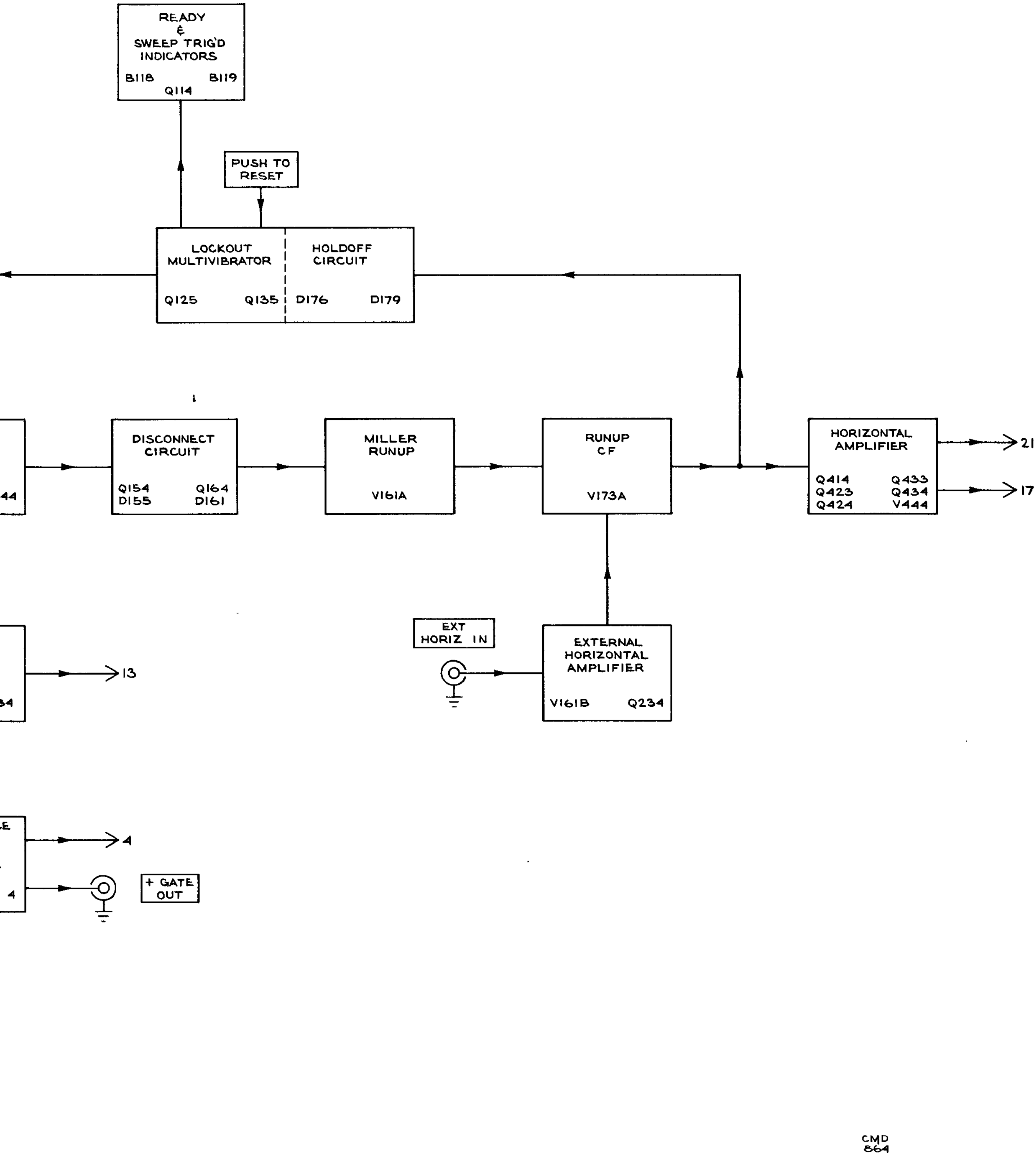
Electron Tubes

V24	154-187	6DJ8	
V161	154-278	6BL8	
V173	154-187	6DJ8	
V444	154-340	7119	



TYPE 3B4 PLUG-IN

A



BLOCK DIAGRAM

IMPORTANT:

All waveform photographs and quiescent voltages shown on the Type 3B4 schematics were taken from the crt of a Tektronix Type 543A/CA oscilloscope system. A 10X attenuator probe was used, and all units were calibrated.

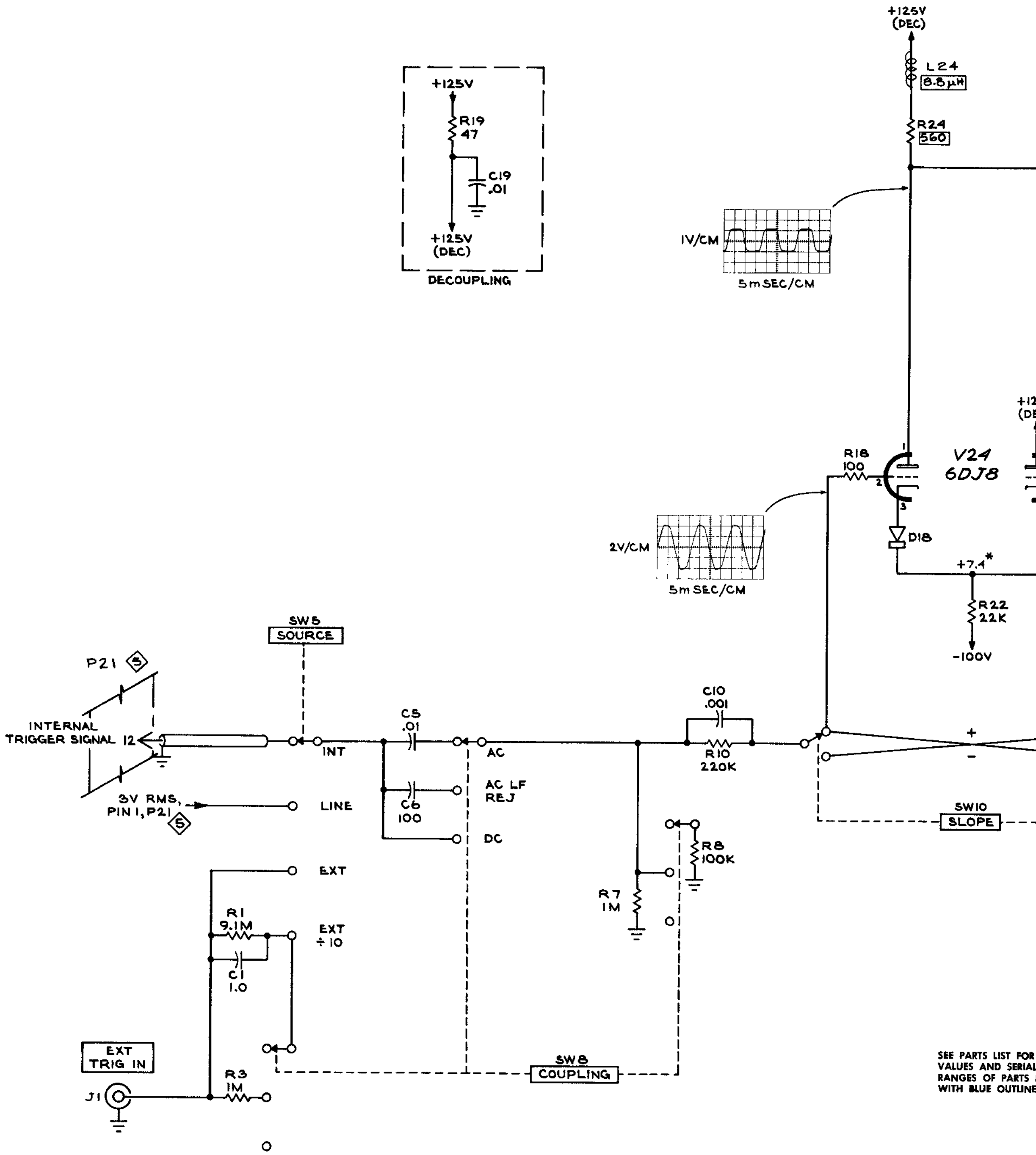
WAVEFORMS:

The settings of the Type 543A TIME/CM and the Type CA VOLTS/CM switches used in obtaining the waveforms are printed adjacent to the individual waveforms. AC coupling of the Type CA was used except for those waveform photographs where the 0 volt level is called out at the side of the photograph. The Type 3B4 TIME/DIV switch was set to 1 mSEC, the SOURCE switch to LINE, the COUPLING to AC, and the SLOPE to + for all photographs.

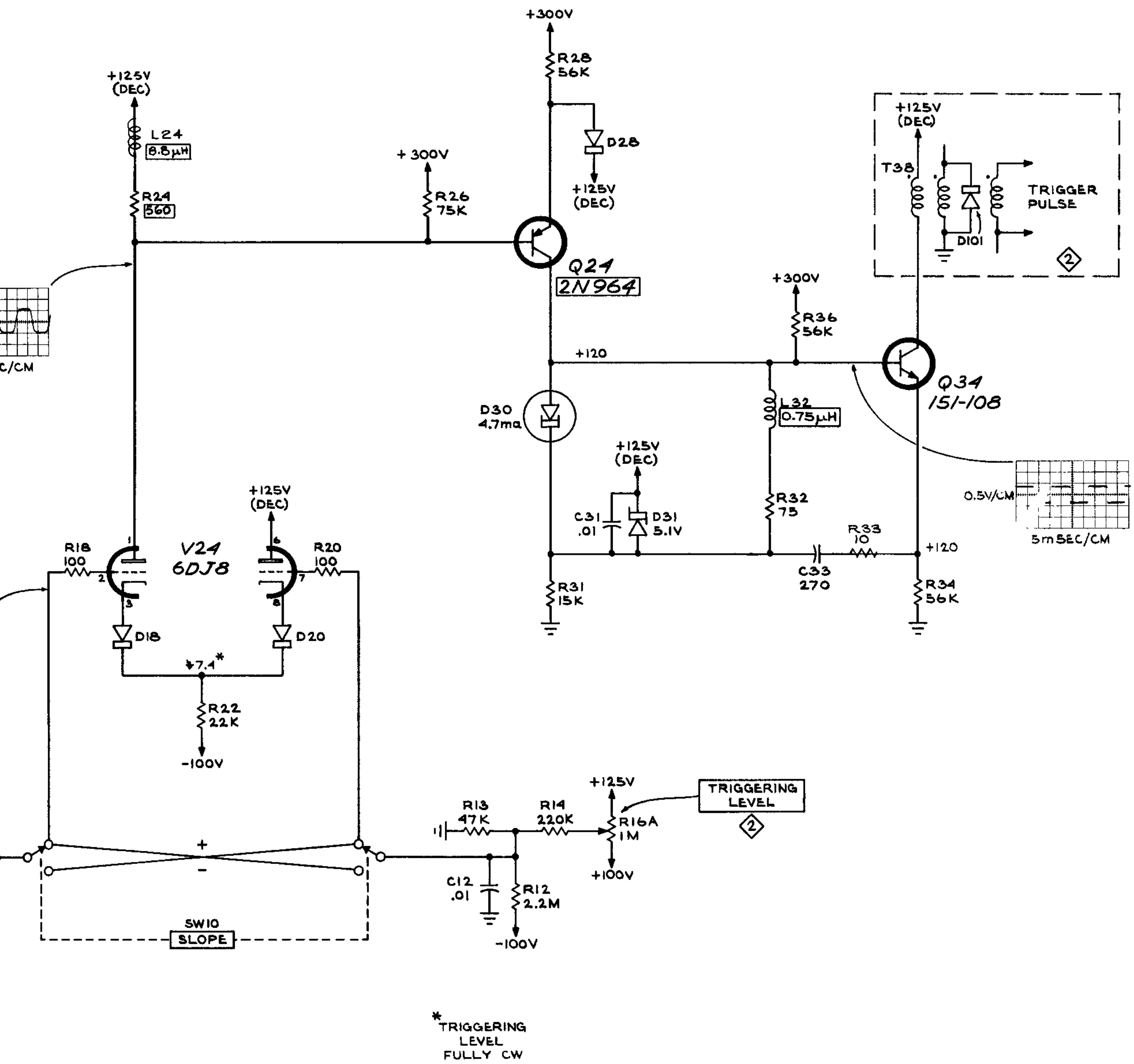
VOLTAGES:

In making the voltage measurements, the Type 3B4 SOURCE switch was set to EXT and the Type 3B4 was in its quiescent state (not triggered). The POSITION and FINE controls were set as for a centered trace. The TRIGGERING LEVEL control was centered for all voltage measurements except for the measurement at the junction of D18 and D20.

The voltages shown on the schematics are not absolute, but may vary slightly due to normal manufacturing tolerances.



TYPE 3B4 PLUG-IN



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

REFERENCE DIAGRAMS

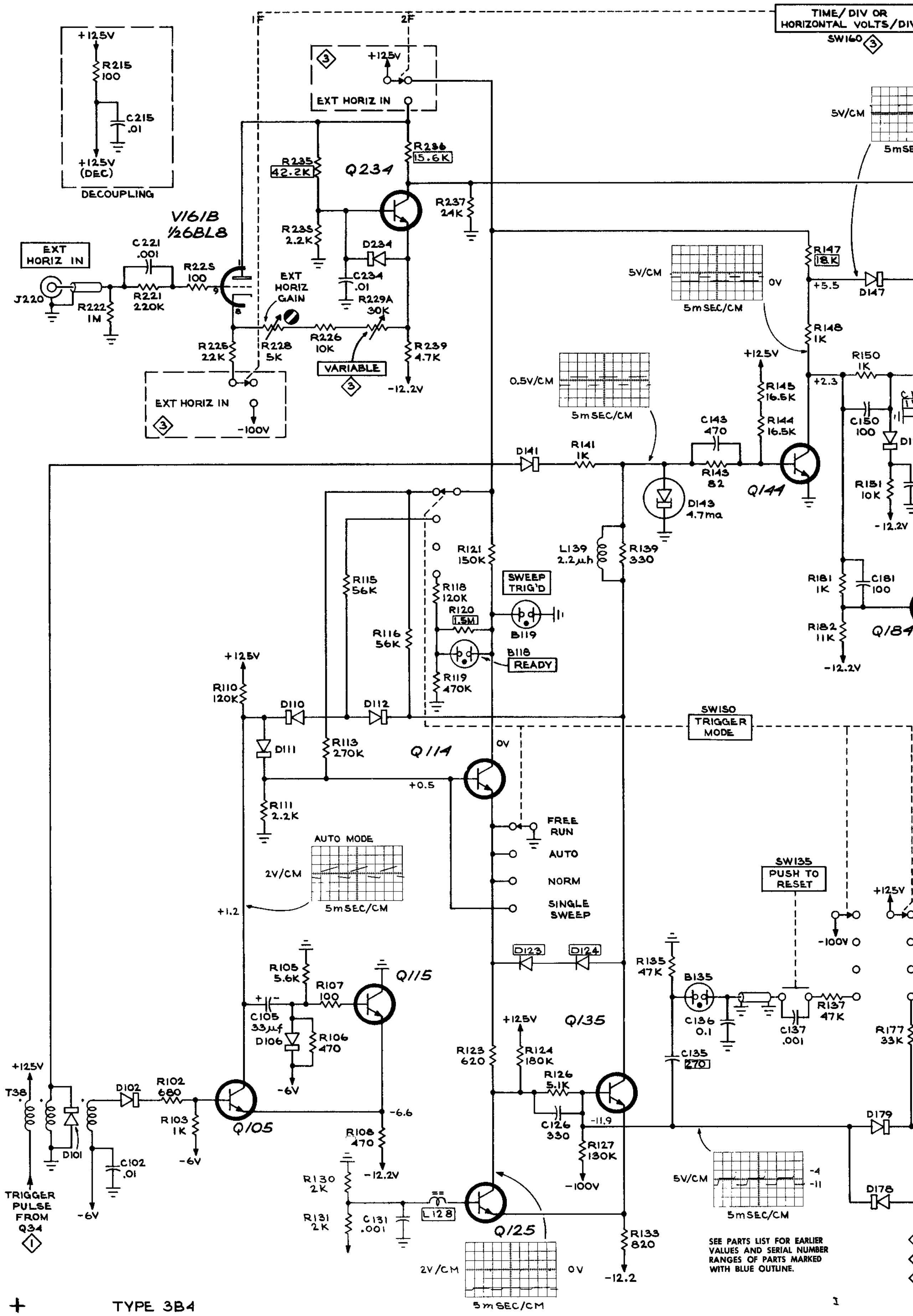
2 SWEEP GENERATOR

5 HORIZONTAL AMPLIFIER

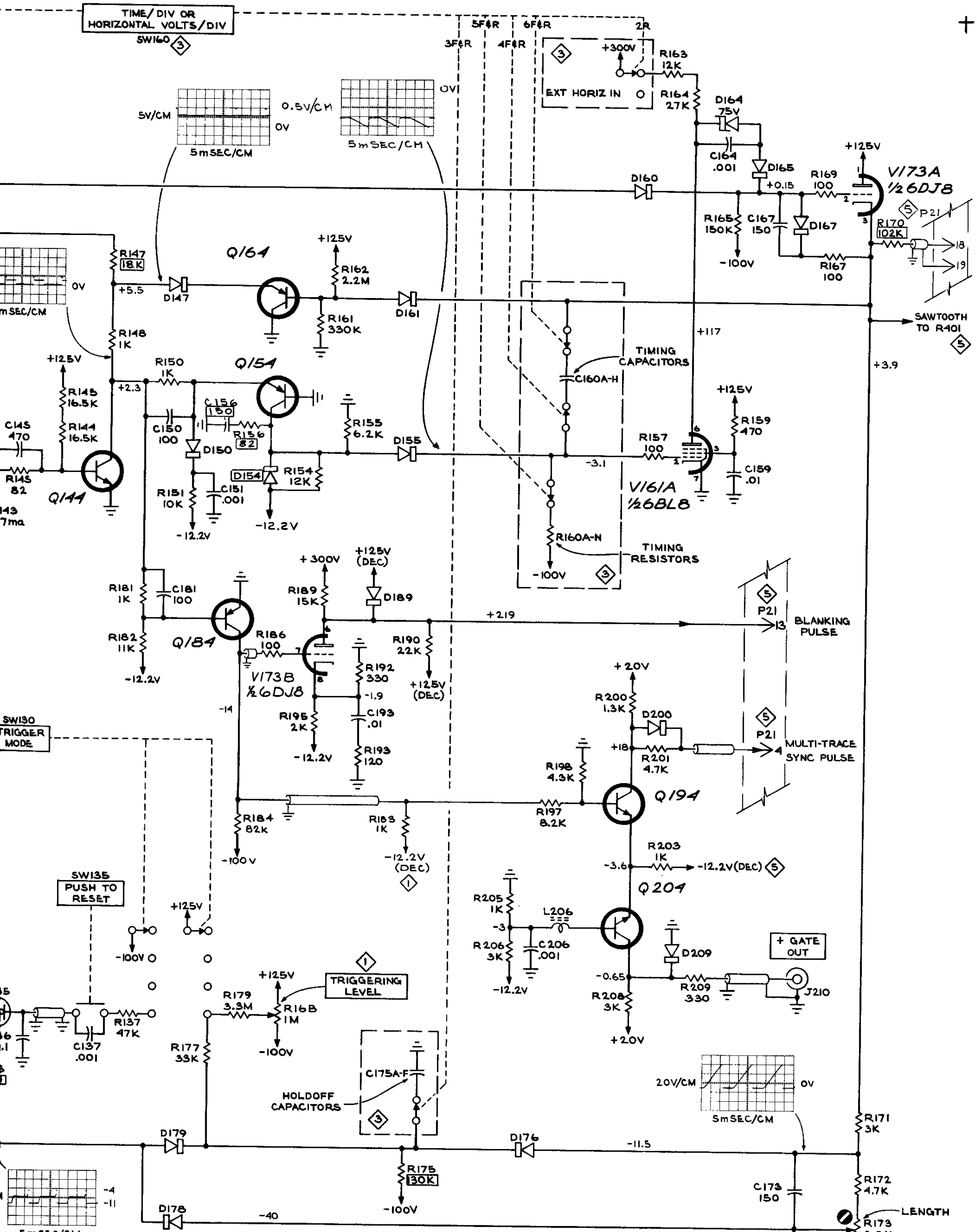
CMD
866

TIME BASE TRIGGER 1

D_1


TIME/DIV OR HORIZONTAL VOLTS/DIV
SW160
DECOUPLING
+125V
R215 100
C215 .01
+125V (DEC)
EXT HORIZ IN
J220
C221 .001
R221 220K
R222 1M
R225 100
V161B ½6BL8
EXT HORIZ GAIN
R228 5K
R226 10K
R229A 30K
VARIABLE
R225 22K
R235 42.2K
R235 2.2K
Q234
D234
C234 .01
R236 15.6K
R237 24K
R239 4.7K
-12.2V
-100V
R147 18K
D147
R148 1K
+5.5
+2.3
R150 1K
C150 100
R151 10K
R145 16.5K
R144 16.5K
C143 470
R143 82
Q144
D143 4.7ma
D141
R141 1K
L139 2.2μh
R139 330
R121 150K
R118 120K
R120 1.5M
R119 470K
SWEEP TRIG'D
B119
B118
READY
R115 56K
R116 56K
R181 1K
C181 100
R182 11K
Q184
R110 120K
D110
D111
D112
R113 270K
R111 2.2K
Q114
+0.5
0V
SW150 TRIGGER MODE
FREE RUN
AUTO
NORM
SINGLE SWEEP
AUTO MODE
2V/CM
5mSEC/CM
5V/CM
0.5V/CM
+1.2
R105 5.6K
R107 100
Q115
C105 33μf
D106
R106 470
-6V
D123
D124
R135 47K
B135
C136 0.1
C137 .001
R137 47K
SW135 PUSH TO RESET
R177 33K
C135 270
Q135
R123 620
R124 180K
R126 5.1K
C126 330
R127 130K
-11.9
-100V
D179
D178
-4
-11
T38
D101
D102
R102 680
R103 1K
Q105
C102 .01
R108 470
-6.6
-12.2V
TRIGGER PULSE FROM Q34
R130 2K
R131 2K
C131 .001
L128
Q125
R133 820
-12.2
2V/CM
0V
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

TYPE 3B4



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

REFERENCE DIAGRAMS

1 TIME BASE TRIGGER

3 TIMING SWITCH

5 HORIZONTAL AMPLIFIER

SEE DIAGRAM 1 FOR WAVEFORM & VOLTAGE CONDITIONS.

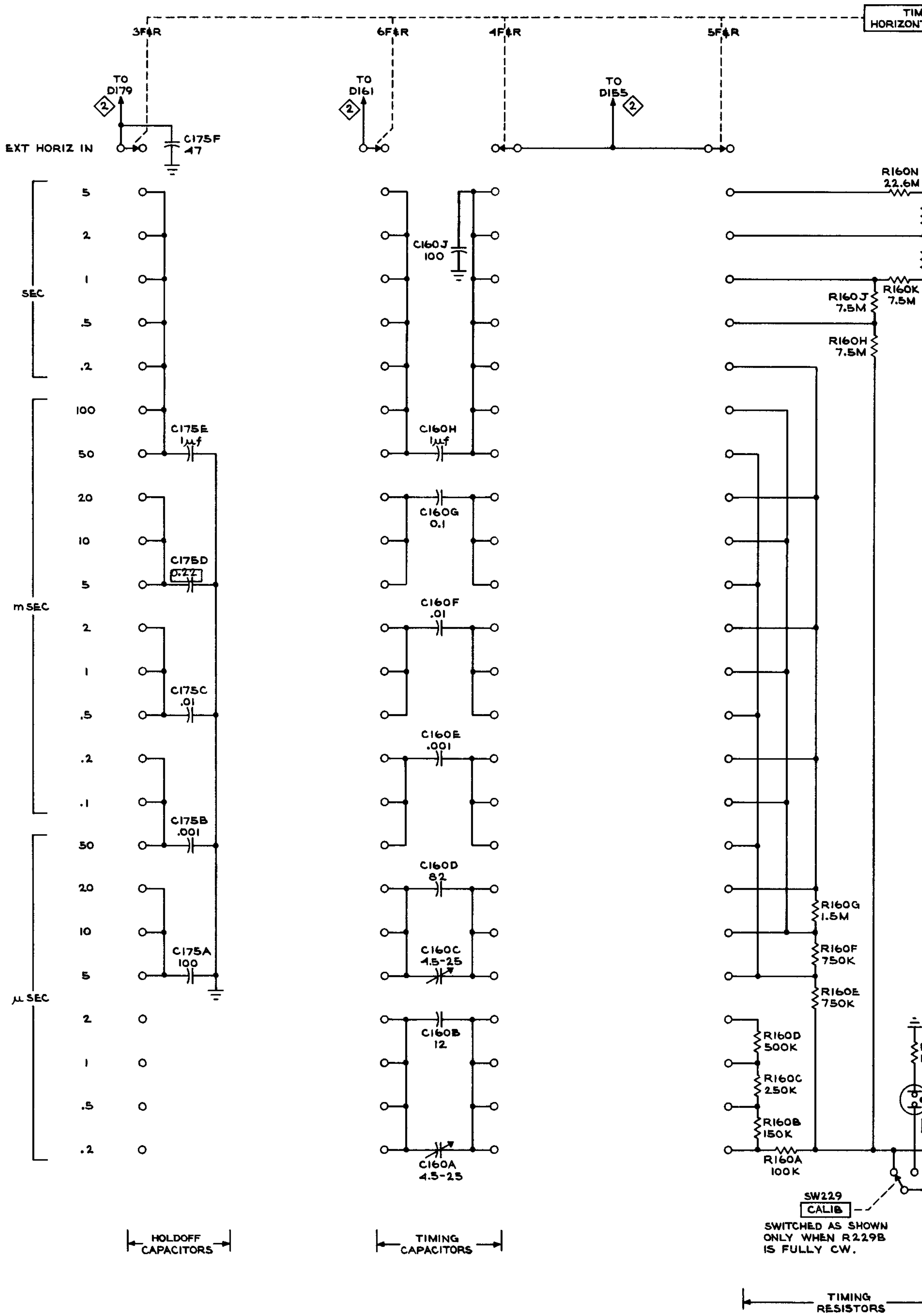
R174 10K

-100V

CMD 669

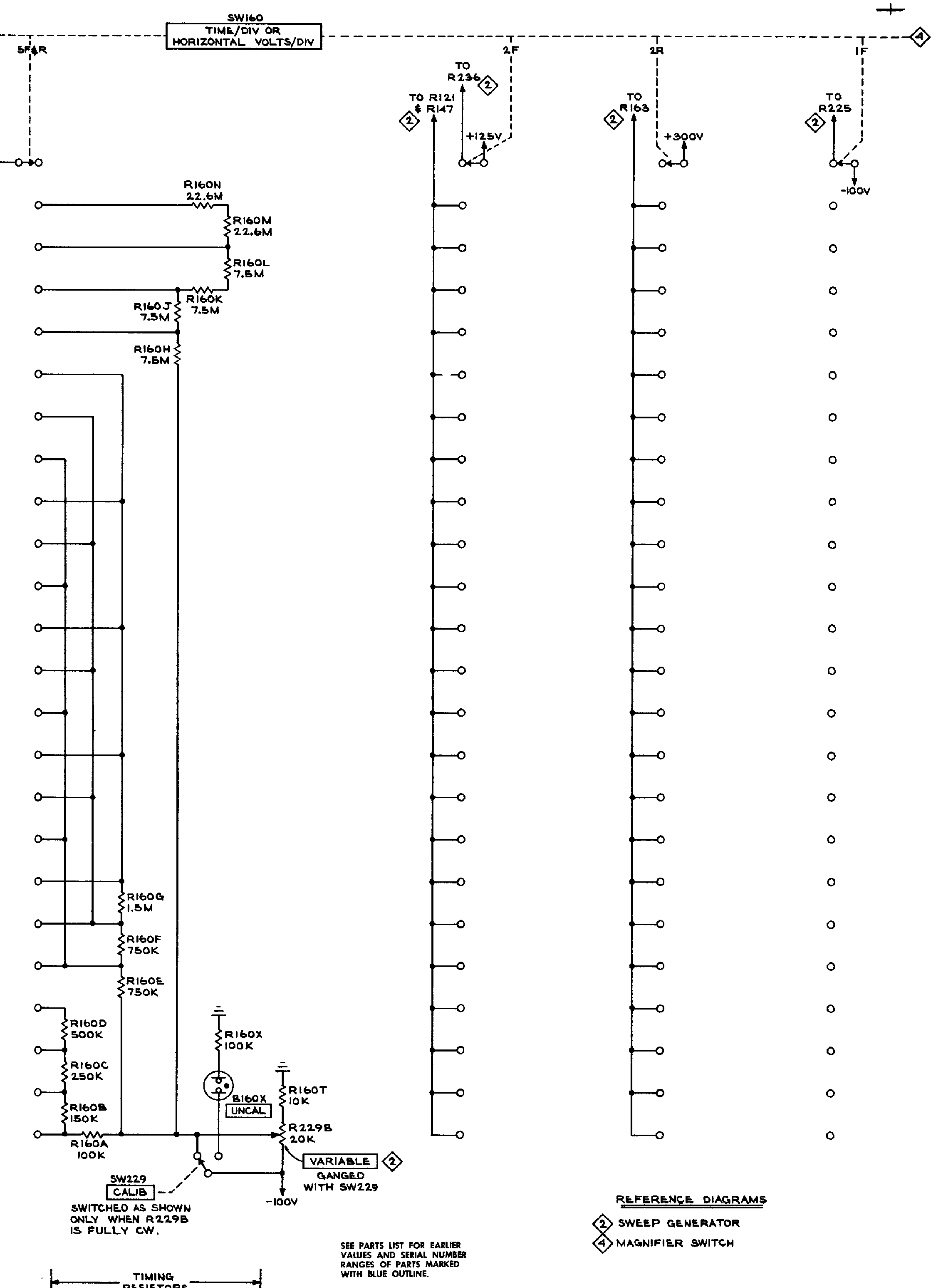
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

SWEEP GENERATOR 2



TYPE 3B4 PLUG-IN

B



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

REFERENCE DIAGRAMS

2 SWEEP GENERATOR

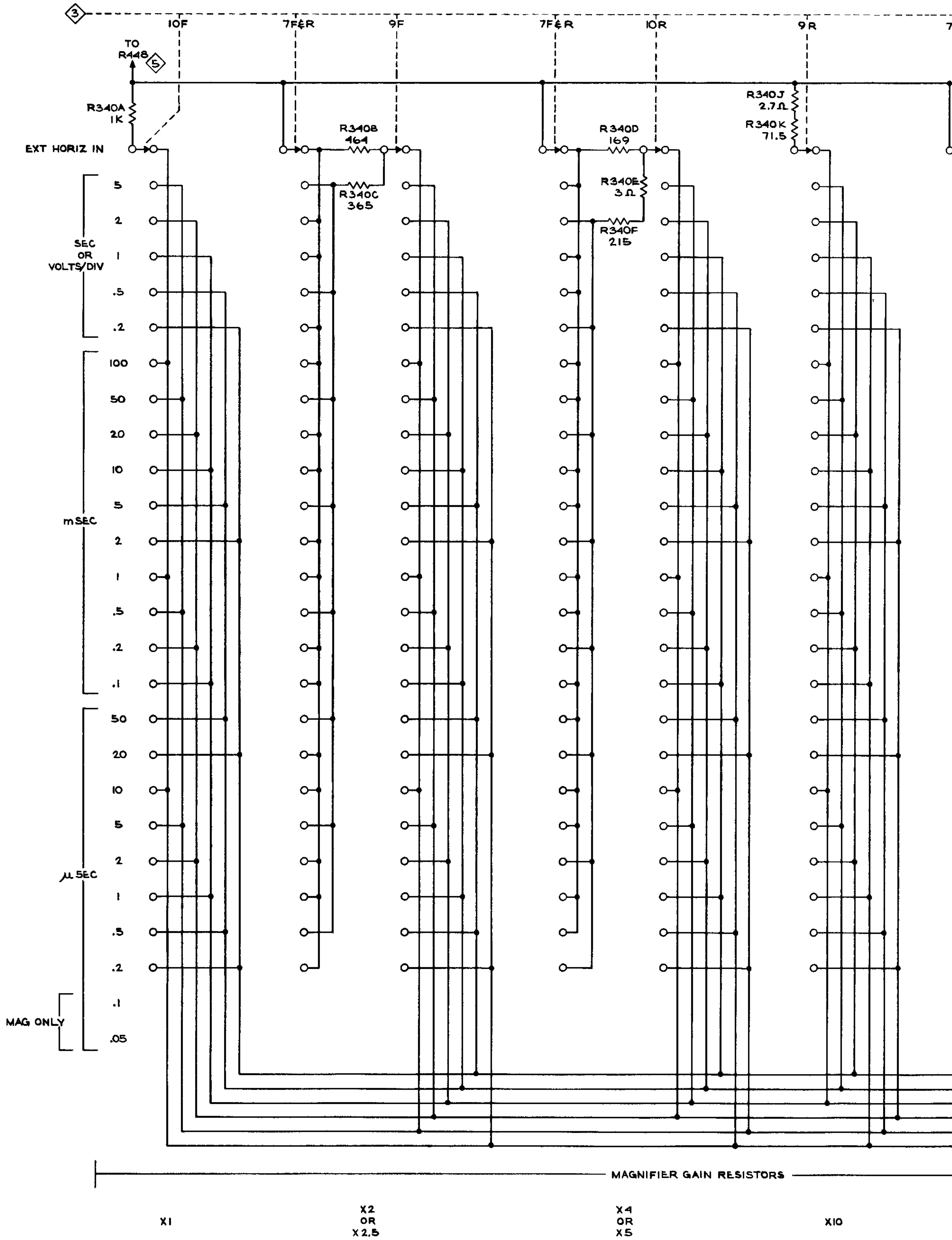
4 MAGNIFIER SWITCH

CMD
1267

TIMING SWITCH

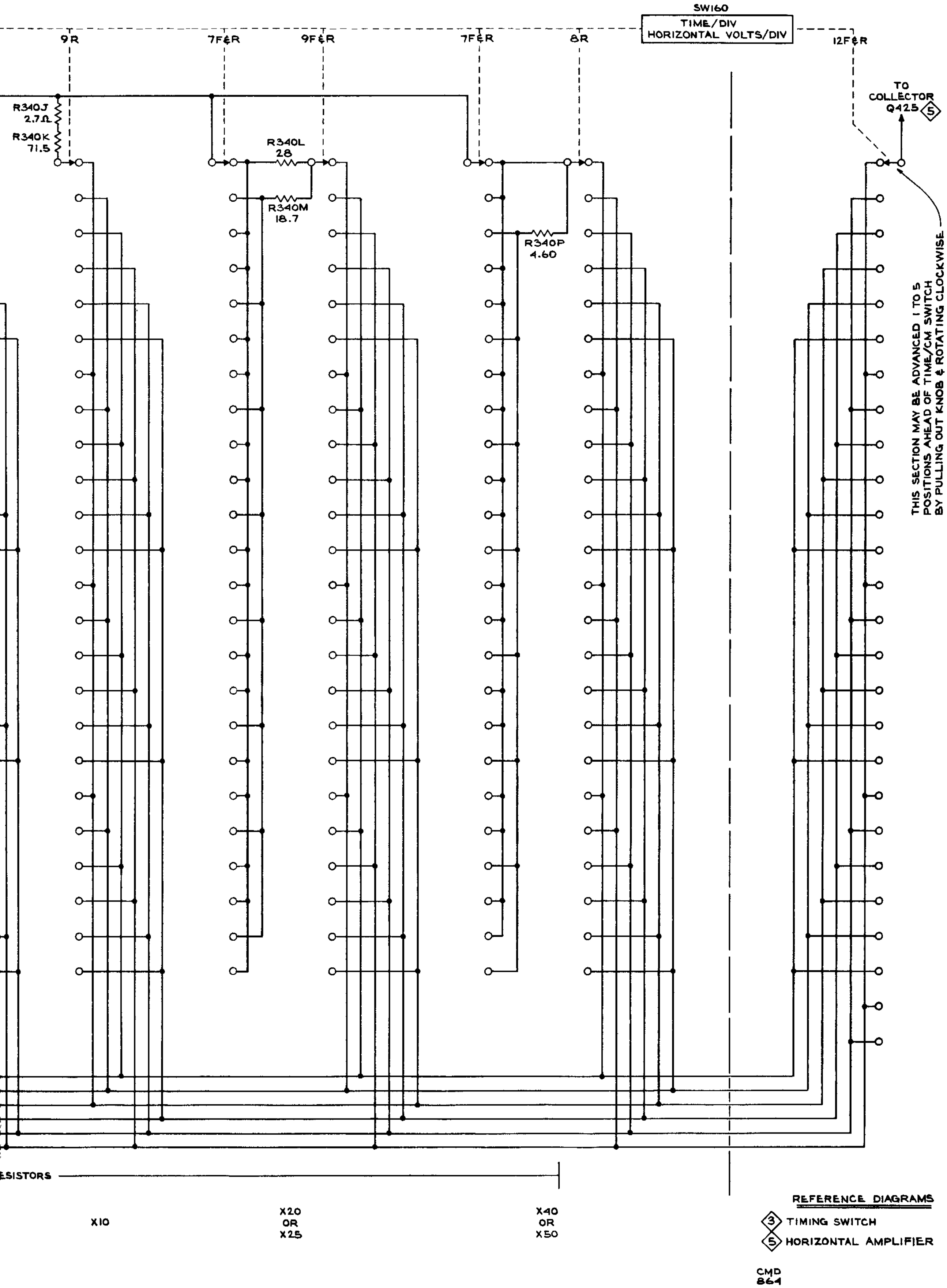
3

B



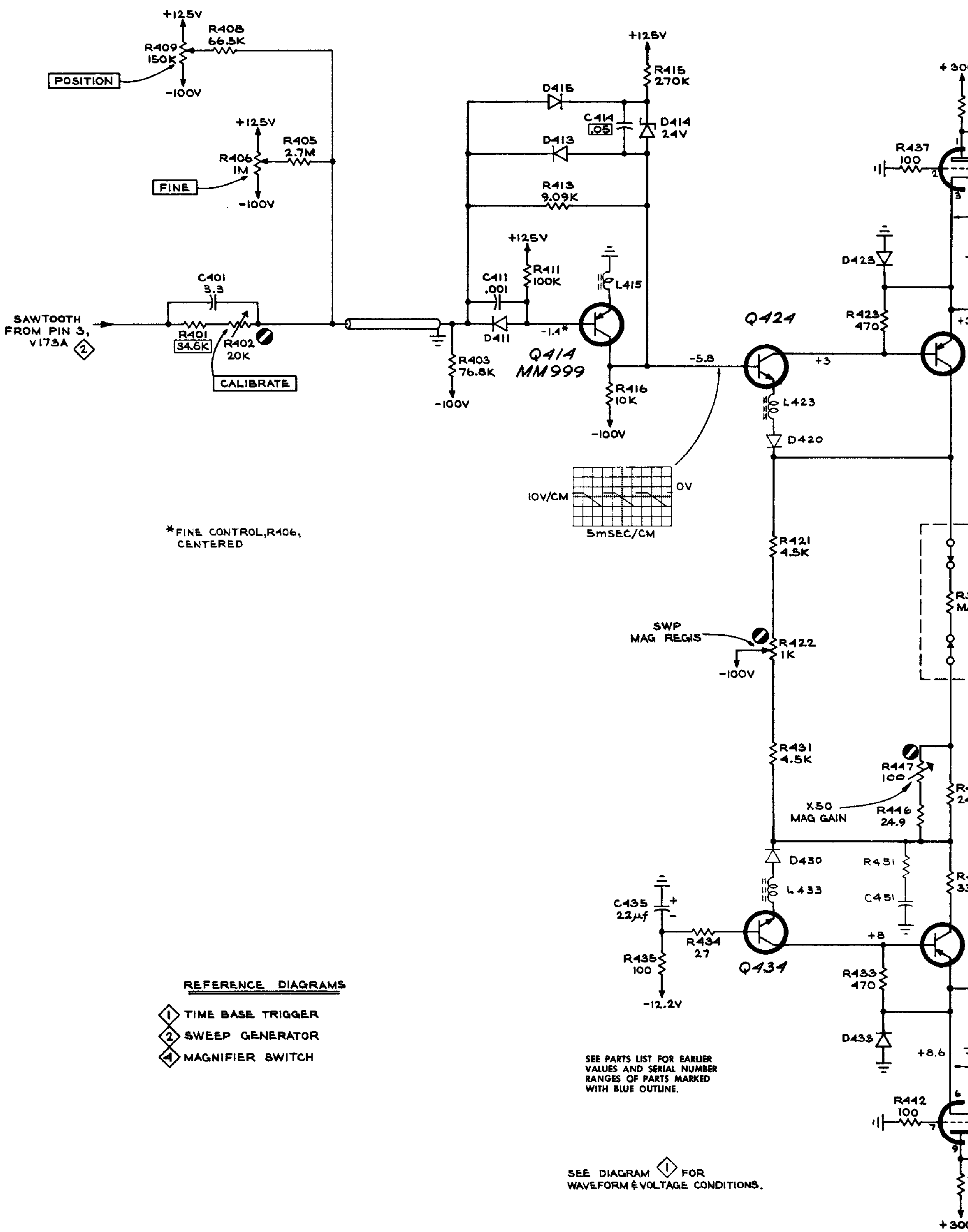
TYPE 3B4 PLUG-IN

A



MAGNIFIER SWITCH 4

A



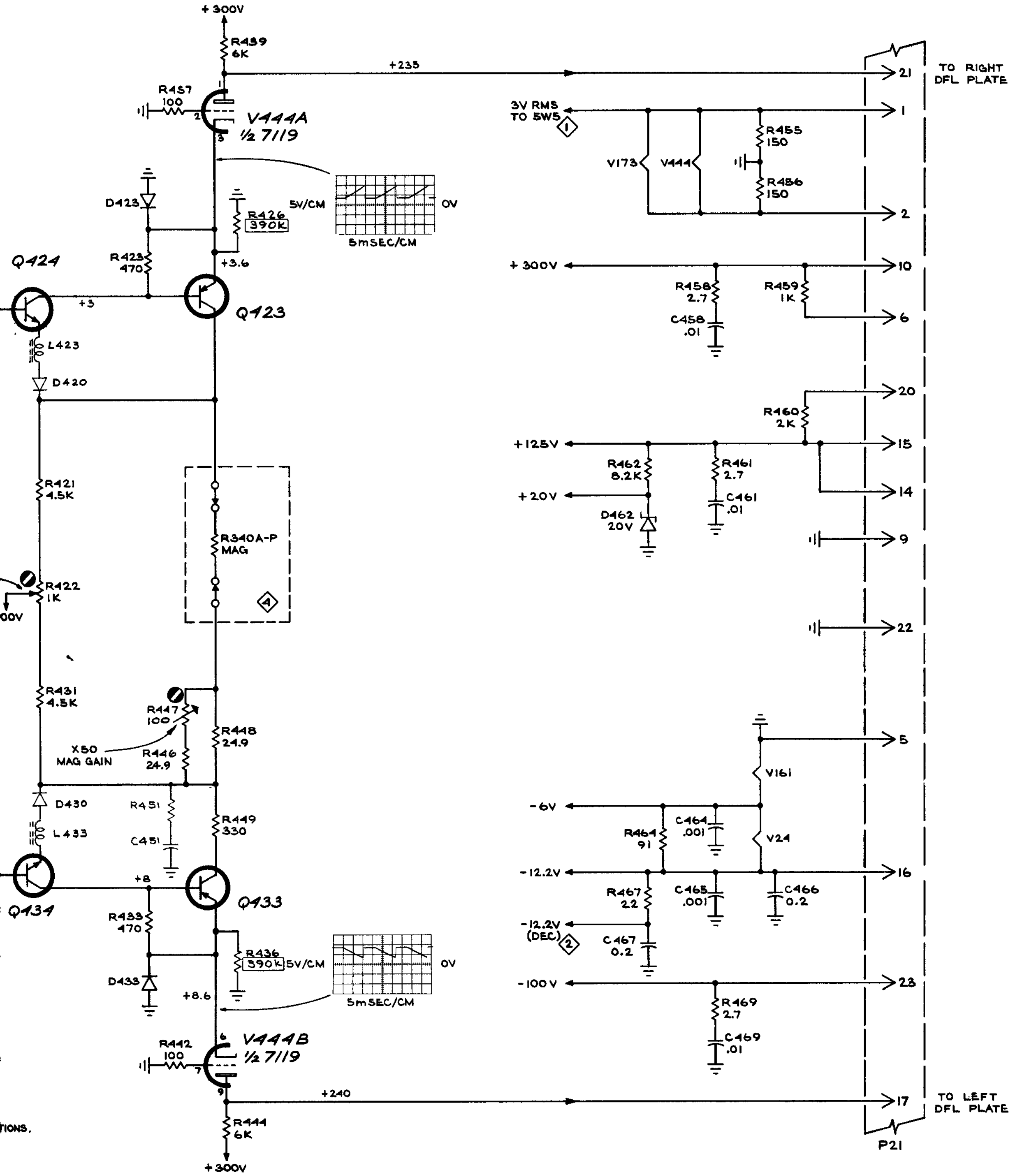
*FINE CONTROL, R406, CENTERED

REFERENCE DIAGRAMS

1 TIME BASE TRIGGER
2 SWEEP GENERATOR
4 MAGNIFIER SWITCH

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

SEE DIAGRAM 1 FOR WAVEFORM & VOLTAGE CONDITIONS.



CMD
1071

HORIZONTAL AMPLIFIER ⑤

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. If it does not, your manual is correct as printed.