INSTRUCTION MANUAL

Serial Number _____

TYPE 11B2

TIME BASE

Tektronix, Inc.
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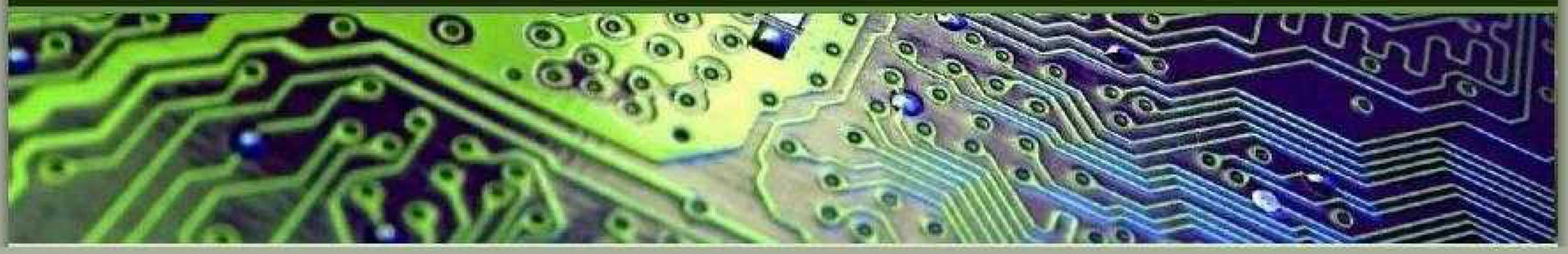

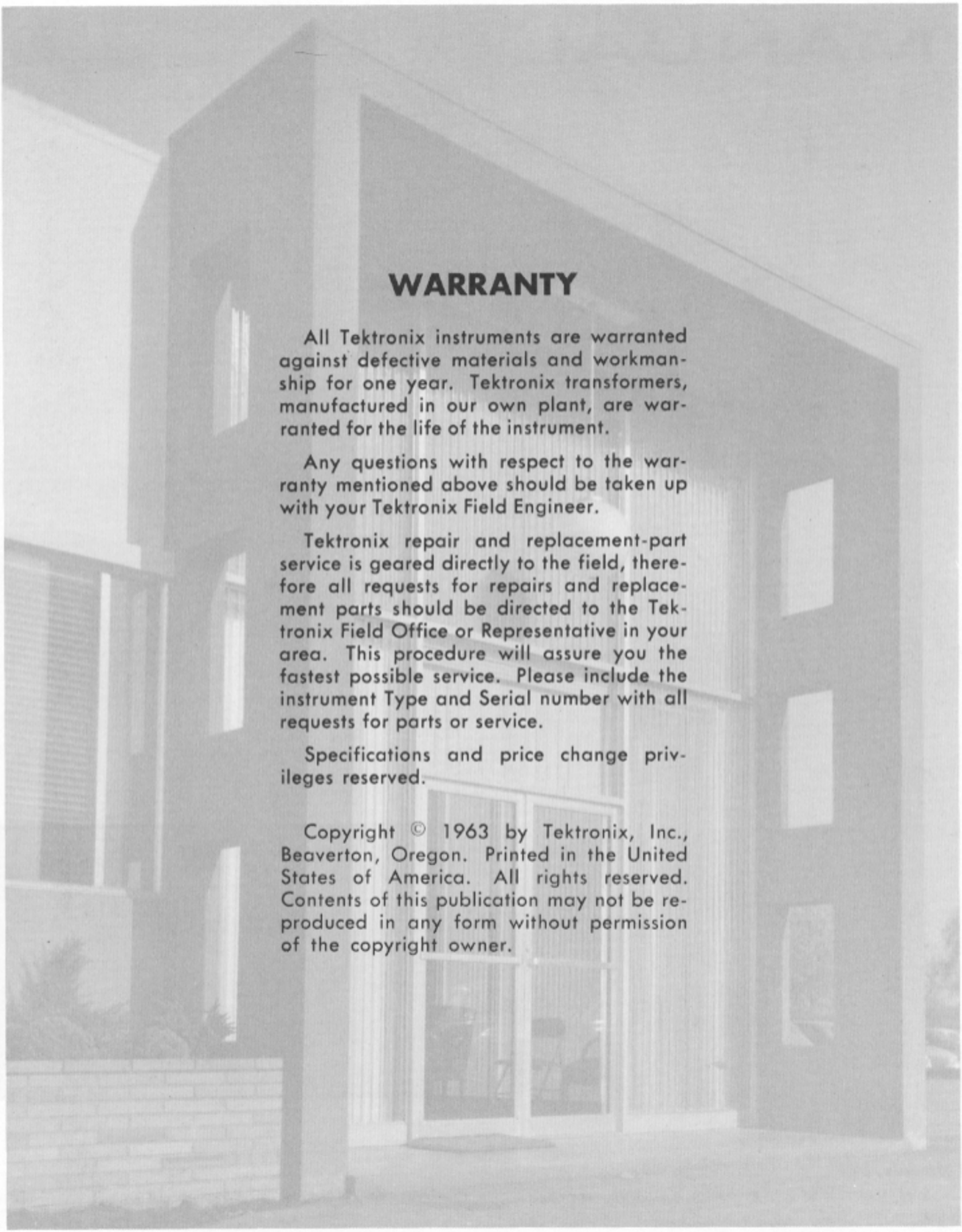

WARRANTY

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.

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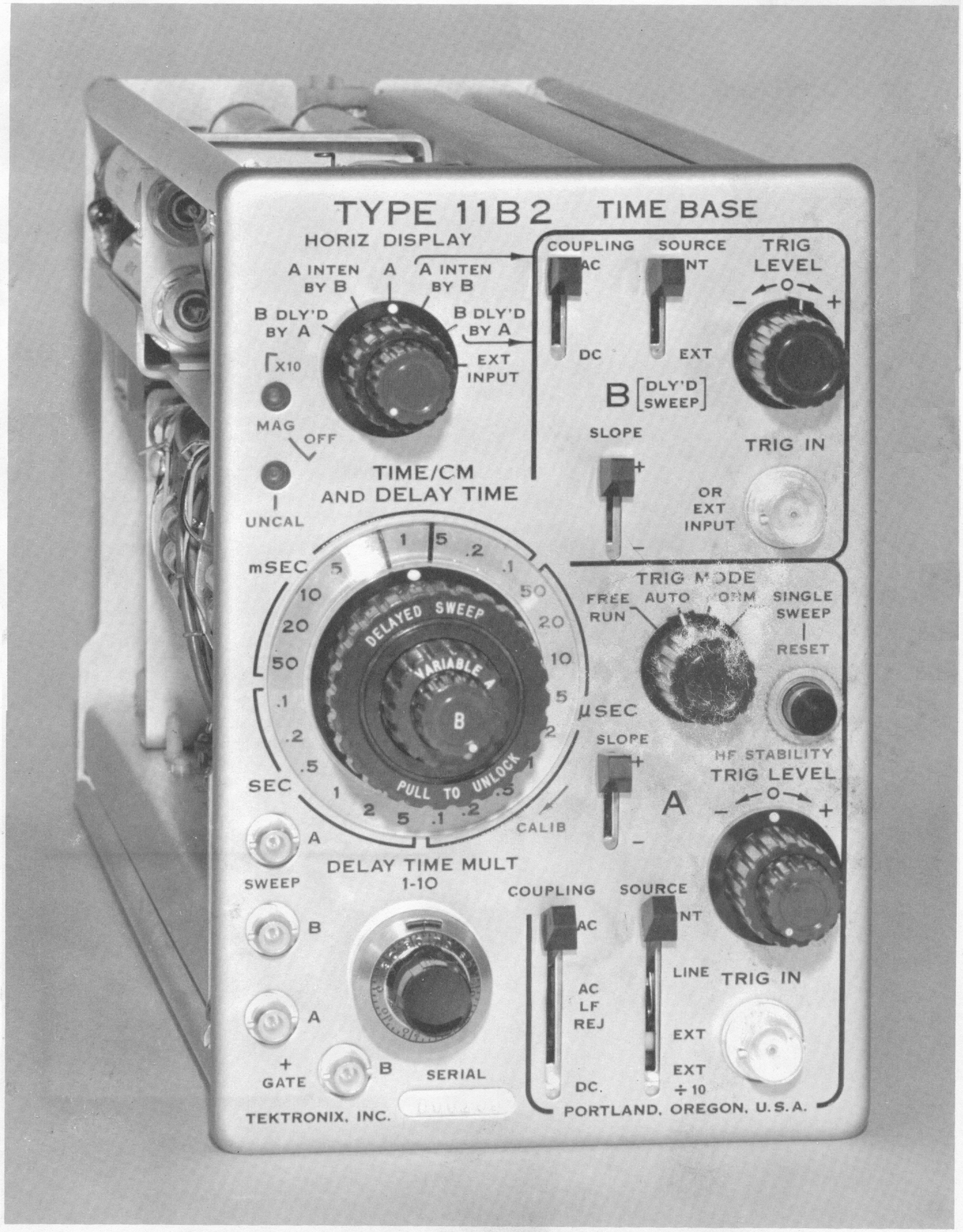
CONTENTS

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 this manual.



The Type 11B2 Time Base plug-in unit.

SECTION 1
CHARACTERISTICS

General Information

The Type 11B2 Time Base plug-in unit is part of a wide-band oscilloscope system designed for operation and storage under severe environmental conditions. The Type 11B2 operates in the right-hand compartment of a Tektronix Type 647 Oscilloscope. The environmental characteristics of the Type 11B2 and Type 647 are the same and are described in Section 1 of the Type 647 instruction manual.

Special circuits incorporated in the Type 11B2 permit an accurate, continuously variable delay of up to 50 seconds in the presentation of a sweep after the receipt of a triggering impulse. This delayed-sweep feature permits highly magnified displays of a small portion of an undelayed sweep, accurate measurement of signal time-jitter, and precise time measurements, as well as many other uses.

The following characteristics apply only when the Type 11B2 is operated in a calibrated oscilloscope such as the Tektronix Type 647

NOTE

Range I and Range II, mentioned in various parts of of this section, refer to the ambient air temperaature ranges that apply for a particular characteristic. Range I is from 0°C to +40°C; Range II from −30°C to +65°C.

HORIZONTAL DEFLECTION

Sources

Sweep Generator A

Sweep Generator B—Delayed, or delayed and triggered

External sources

A Sweep and Delay Generator

24 calibrated steps provide sweep rates from 5 sec to 0.1 μsec/cm. An uncalibrated control provides continuously variable sweep rates between 0.1 μsec/cm and about 12 sec/cm. The sweep magnifier (MAG at X10) extends the fastest calibrated sweep rate to 10 nsec/cm (nanosecond = 10^{-9} second). Panel lamps light when the magnifier is on and when the sweep rates are uncalibrated. When used as a delay generator, Sweep Generator A provides 21 over-lapping, calibrated delay-time ranges from 50 sec to 1 μsec. The three fastest A sweep ranges are not normally used for delay generation.

Accuracy

See Table 1-1.

TABLE 1-1

A TIME/CM and DELAY TIME	Displayed Sweep Rate		[1] Delay	
	Range I	Range II	Range I	Range II
5 SEC — .1 SEC	±3%	+4% −6%	±2.5%	+3% −6%
50 mSEC — .1 μSEC	±1.5%	±2.5%		
50 mSEC — 1 μSEC			±1%	±2%
Added when MAG is set to ×10 up to 50 nsec/cm	±1%	±1.5%		
Added when MAG is set to ×10: 20 nsec/cm and 10 nsec/cm	±2%	±2.5%		

[1] See Section 2, "Non-Triggered Delay Sweep", for additional details.

B Sweep

24 calibrated steps provide delayed sweep rates from 5 sec to 0.1 μsec/cm. An uncalibrated control provides continuously variable sweep rates between 0.1 μsec/cm and about 12 sec/cm. The sweep magnifier (MAG at X10) extends the fastest sweep rate to 10 nsec/cm. Panel lamps light when the magnifier is on and when the sweep rates are uncalibrated.

Accuracy

See Table 1-2.

TABLE 1-2

B TIME/CM	Displayed Sweep Rate	
	Range I	Range II
5 SEC — .1 SEC	±3%	+2% −5%
50 mSEC — .1 μSEC	±1.5%	±2%
Added when MAG switch is set to ×10 up to 50 nsec.	±1%	±1.5%
Added when MAG is set to ×10: 20 nsec/cm and 10 nsec/cm	±2%	±2.5%

External Horizontal Input (to B TRIG OR EXT INPUT connector)

Sensitivity	About 1 volt/cm with MAG switch set to OFF. About 0.1 volt/cm with MAG switch set to X10. A lamp on the front panel next to the MAG switch lights when the X10 position is used.
[2] Bandwidth	Dc to at least 3 mc (—3-db point) with B COUPLING switch set to DC. About 16 cps to at least 3 mc (—3-db points) with B COUPLING switch set to AC.
Input R and C	About 1 megohm paralleled by about 30 pf.

[2] Referenced to 6 cm, centered deflection, at 50 kc.

TRIGGERING

A Sweep

Facilities

SOURCE	Internal, Line, External, and External ÷ 10.
COUPLING	Ac, Ac Low-Frequency Reject, and Dc.
SLOPE	+ or —.
TRIG MODE	Free Run, Automatic, Normal, and Single Sweep.
TRIG LEVEL	See Table 1-6.
HF STABILITY	For jitter reduction at high frequencies.

Internal Triggering Sensitivity (with Type 10A2 plug-in unit)

See Table 1-3.

TABLE 1-3

Frequency	Peak-To-Peak Crt Deflection (Range 1)	
	Typ.	Min.
To 50 kc	1 mm	2 mm
[3] To 50 mc		10 mm

External Triggering Sensitivity

See Table 1-4.

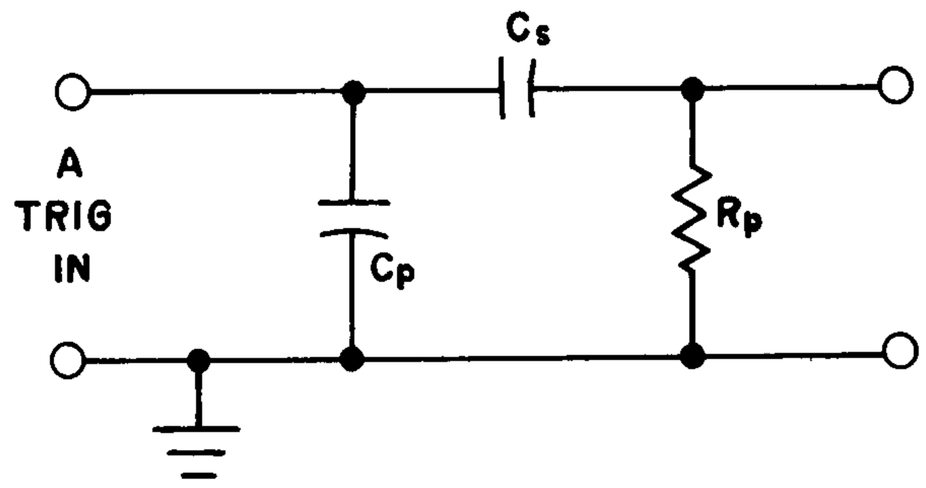
TABLE 1-4

Frequency	Peak-To-Peak Voltage (Range 1)	
	Typ.	Min.
To 50 kc	75 mv	125 mv
[3] To 50 mc	150 mv	250 mv

[3] HF STABILITY control used to minimize jitter above 5 or 10 mc.

A TRIG IN Connector Input Characteristics
See Table 1-5.

TABLE 1-5



SOURCE	COUPLING	C_p (pf)	C_s	R_p (meg Ω)	Max Input Voltage (Peak)
EXT	DC	≈25	shorted	≈1	±75 v
	AC	≈25	≈0.01 μf	≈1	±500 v
	AC LF REJ	≈25	≈100 pf	≈0.091	±500 v
EXT ÷ 10	DC	≈5	shorted	≈10.1	±500 v
	AC	≈5	≈0.01 μf	≈10.1	±500 v
	AC LF REJ	≈5	≈100 pf	≈9.2	±500 v

[4] Maximum usable trigger input voltages are: EXT — ±15 volts peak, EXT ÷ 10 — ±150 volts peak. Trigger input voltages in excess of the above signal levels will cause interference with the normal operation of the trigger generator, sweep generators, and vertical amplifier systems.

A TRIG LEVEL Control Voltage Range (external triggering)
See Table 1-6.

NOTE

The voltage range of the TRIG 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 TRIG LEVEL control voltage range.

TABLE 1-6

SOURCE	COUPLING	Voltage Range	
		Typ.	Min.
EXT	AC, DC, or AC LF REJ	±6.5 v	±5 v
EXT ÷ 10	AC or DC	±65 v	±50 v
	AC LF REJ		±500 v

Automatic Triggering

The A sweep triggering characteristics stated previously also apply for automatic triggering except that the triggering signal frequency must be higher than about 20 cps.

A Single Sweep

Permits only one triggered sweep following each reset pulse. Reset pulse can be supplied internally or externally (see Section 2, "Normal Sweep Operation"). External pulse amplitude must be at least 5 volts peak; risetime must be 10 μsec or less.

B Sweep (triggered after delay)

Facilities

SOURCE	Internal and External.
COUPLING	Ac and Dc.
SLOPE	+ or —.
TRIG LEVEL	See "B TRIG LEVEL Control Voltage Range".

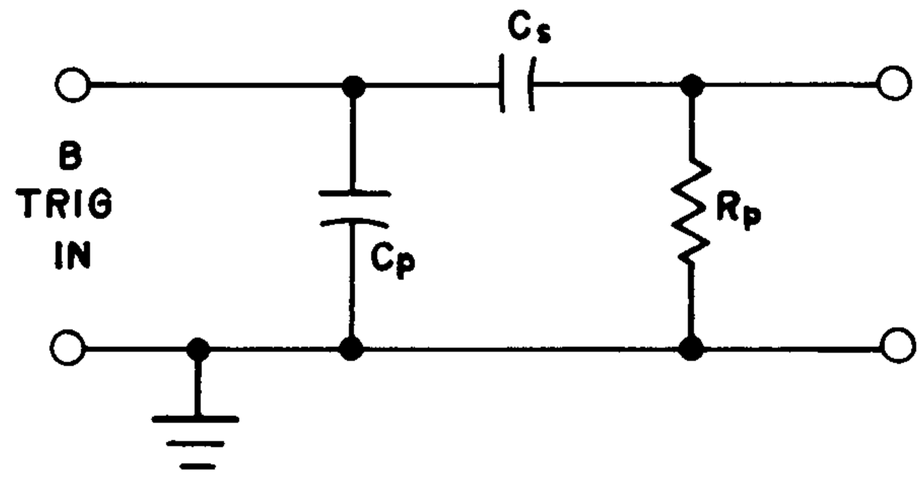
Triggering Sensitivity

Same as for A Sweep.

B TRIG IN Connector Input R and C

See Table 1-7.

TABLE 1-7



COUPLING	C_p (pf)	C_s	R_p (MΩ)	Max. Input Voltage (Peak)
DC	≈30	shorted	≈1	500 v
AC	≈30	≈0.01 μf	≈1	500 v

B TRIG LEVEL Control Voltage Range (external triggering)

Typically ±13 volts, ±10 volts minimum (see NOTE under "A TRIG LEVEL Control Voltage Range").

OUTPUT SIGNALS

+GATE (A and B)

Output Voltage	About +15.2 volts peak into a high resistance load.
Output Resistance	About 1600 ohms.
Output Current	About 9 ma into zero ohms.

SWEEP (A and B)

Output Voltage	About +10 volts peak into a high resistance load.
Output Resistance	About 750 ohms.
Output Current	About 13 ma peak into zero ohms.

MECHANICAL CHARACTERISTICS

Construction

Aluminum-alloy chassis with chrome-plated brass side rails.

Front panel is anodized aluminum.

Dimensions (approx.)

6¼ inches high.

4¼ inches high.

14¾ inches deep (overall).

Accessories

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

SECTION 2

OPERATING INSTRUCTIONS

FIRST-TIME OPERATION

The following control and switch settings for the Type 11B2 can be used for a wide range of measurement applications with maximum convenience for the operator. The operating conditions established by these settings also provide a starting point for the operator who is learning to use the instrument.

HORIZ DISPLAY	A
TRIG MODE	AUTO
A COUPLING	AC
A SOURCE	INT
VARIABLE A (TIME/CM)	CALIB (fully clockwise)
MAG	OFF

The Type 11B2 now provides the time base for a wide range of measurements with vertical deflection signals above about 20 cps. In many cases, only the A TIME/CM switch and A TRIG LEVEL control may require setting for a particular measurement.

The appropriate A TIME/CM 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 1-Kc Calibrator signal, set the A TIME/CM switch to .2 mSEC.

In order to obtain a triggered display of the vertical deflection signal with the control settings mentioned, three conditions must be met:

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

2. The vertical deflection amplitude must be at least one-half centimeter.

3. The A TRIG LEVEL control must be properly adjusted.

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

CONTROL AND SWITCH FUNCTIONS

NOTE

A more complete description of the controls and switches is included at the rear of this section.

TRIGGER A

TRIG MODE — Triggering mode. Selects the manner in which each Time Base A sweep will be initiated:

FREE RUN — Provides recurrent sweeps; the completion of one sweep causes the next sweep to begin.

AUTO — Automatic. 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. Each sweep will be triggered by the signal from the Trigger Generator.

SINGLE SWEEP and RESET — Often used when displays of nonrepetitive signals are photographed. When the RESET lamp is lit, the time base is ready to produce one triggered sweep. When the one sweep is complete, the RESET lamp will not be lit and the time base will no longer be triggerable. Before the cycle can repeat, the RESET button must be pushed or a reset pulse must be applied to pin F of J101 on the rear of the oscilloscope (pin C is ground).

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 — External and external divided-by-ten. Permits external signals applied to the 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 ac triggering signals below about 1000 cps.

DC — Accepts ac and dc triggering signals.

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

TRIG LEVEL — Triggering level. Selects the amplitude point on the triggering signal where sweep triggering will occur.

HF STABILITY — High-frequency stability. Used if necessary with triggering signals above

about 5-10 mc to obtain best display stability. Has no effect at lower triggering signal frequencies.

TIME BASE A

TIME/CM AND DELAY TIME — Provides 24 calibrated display sweep rates and 24 calibrated ranges of time delay for delayed sweep operation. The number bracketed by the two black lines on the clear plastic knob flange is the sweep time per centimeter and the delay time range. To change the sweep rate and delay range, the concentric A flange and B knob must first be interlocked by positioning the dot on the B knob between the two black lines on the flange.

VARIABLE A — Provides continuously variable uncalibrated sweep rates and delay ranges between about 0.4 and 1.0 times that indicated by the TIME/CM AND DELAY TIME switch. Whenever VARIABLE A is not set to CALIB, the UNCAL lamp will light.

DELAY TIME MULT — Delay time multiplier. A continuously variable control that accurately multiplies the delay time indicated by the DELAY TIME switch to a maximum of ten times.

HORIZONTAL DISPLAY

HORIZ DISPLAY

B DLY'D BY A — B sweep delayed by A sweep (to the left of A on the panel). The oscilloscope horizontal deflection is provided by Time Base B. The beginning of B sweep is delayed from the beginning of A sweep by a time equal to the product of the A DELAY TIME switch and DELAY TIME MULT dial settings.

A INTEN BY B — A sweep display intensified by B sweep (to the left of A on the panel). The oscilloscope horizontal deflection is provided by Time Base A. A portion of the display has greater brightness than the remainder. The intensified zone provides a visual check on the relative duration and time-position of the delayed B sweep with respect to A sweep.

A — The oscilloscope horizontal deflection is provided by Time Base A. Delayed sweep is inoperative.

A INTEN BY B and B DLY'D BY A — A sweep display intensified by B sweep and B sweep delayed by A sweep. Same as previously described for A INTEN BY B and B DLY'D BY A. Addition of the arrows indicates that the B [DLY'D SWEEP] triggering controls and switches must be used. Instead of B sweep beginning at the end of the selected delay period, Time Base B becomes triggerable. B sweep must be triggered after the delay period, but before the end of A sweep.

EXT INPUT — External input. External signals applied to the B TRIG IN OR EXT INPUT connector provide horizontal deflection if the B SOURCE switch is set to EXT. The B COUPLING switch provides either ac or dc signal coupling.

MAG — Magnifier. In the X10 position, the one-centimeter segment at the center of an unmagnified crt display is horizontally expanded to full graticule width. Any other one-centimeter segment of the original unmagnified display may then be observed in magnified form by turning the oscilloscope HORIZ POSITION control. The lamp below the X10 designation on the instrument panel lights whenever the magnifier is on.

TRIGGER B (DLY'D SWEEP)

NOTE

For trigger purpose, the SOURCE, COUPLING, and SLOPE switches, and the TRIG LEVEL control operate only when the HORIZ DISPLAY switch is set to either of the delayed sweep positions which have arrows pointing to the trigger B block. The SOURCE and COUPLING switches have additional functions when the HORIZ DISPLAY switch is set to EXT INPUT.

SOURCE — Permits the B sweep triggering signal to be obtained from the vertical plug-in unit (INT) or from the TRIG IN connector (EXT). When external horizontal deflection signals are used, the SOURCE switch must be set to EXT.

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

AC — Rejects dc and attenuates very low-frequency signals.

DC — Accepts ac and dc signals.

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

TRIG LEVEL — Triggering level. Selects the amplitude point on the triggering signal where B sweep triggering will occur.

TIME BASE B (DLY'D SWEEP)

TIME/CM — Provides 24 calibrated delayed-sweep rates. To set the delayed-sweep rate without changing delaying (A) sweep, pull outward on the DELAYED SWEEP knob. Turn the knob at least one position clockwise before allowing it to move inward. DELAYED SWEEP can now be changed independently as long as it is not set to the same position as delaying sweep.

B (variable) — Provides continuously variable uncalibrated B sweep rates between about 0.4 and 1.0 times the rate indicated by the TIME/CM switch. Whenever B is not set to CALIB, the UNCAL lamp will light.

NORMAL SWEEP OPERATION

General Information

The control and switch settings listed previously under "First-Time Operation" establish the basic conditions necessary for most measurements.

The following paragraphs describe in detail each control and switch used in normal sweep operation.

Sweep Triggering

In most cases, it is desirable for a repetitive signal to produce a stationary display on the crt so the waveform can be examined in detail. As a necessary condition 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) each single or repetitive sweep.

The following controls provide complete control over the means of triggering the A sweep.

TRIG MODE

FREE RUN. Free-running operation produces continuously repetitive sweeps, independent of any 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 A or SWEEP A output signal may be used to operate the device under test. The resulting signals displayed on the crt will then be synchronized with the sweep.

AUTO. Automatic triggering is frequently used for ease of operation and because of the reference trace produced in the absence of a triggering signal. It can be used to observe a large variety of signals with ease, requiring little or no resetting of the triggering controls.

Automatic triggering is useful for obtaining stable displays of signals above about 20 cps. In AUTO, the normal condition is for the time base to free run. If a triggering signal is received, the free-running condition 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 milliseconds, a triggered sweep is initiated, and if not, the free-running sweep resumes.

Since the dormant period is limited to about 80 milliseconds, signals having frequencies below about 20 cps cannot produce a triggered sweep in the AUTO mode. For such signals, the NORM mode must be used.

NORM. In the NORM or normal mode, the usual condition is for the time base to be dormant. Each sweep is initiated by the triggering signal.

SINGLE SWEEP. Single sweep is often used when photographing nonrepetitive 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 yield little or no useful information.

The Type 11B2 permits you to obtain a single sweep presentation and eliminate all subsequent sweeps so information is clearly recorded without confusion resulting from multiple traces.

When the TRIG MODE switch is set to SINGLE SWEEP, time base A becomes inoperative. The time base can be "reset" to the triggerable condition by pressing the RESET button or by applying a fast-rise positive-going pulse of about 5-volts amplitude to pin F of J101 on the rear panel of the oscilloscope (pin C is ground). If there is sufficient delay before triggering, the RESET lamp will light to show that time base A 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 will be extinguished.

SOURCE

INT. It is usually convenient 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 particularly useful when the displayed signal will not allow stable 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 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 TRIG LEVEL control range. (The division factor is X100 when ac low-frequency reject coupling is used.)

COUPLING

The trigger A COUPLING switch permits you to accept or reject certain properties of triggering signals. Three means of coupling are provided:

DC. Dc coupling allows the trigger circuits to receive signals of all frequencies and dc levels.

AC. Ac coupling rejects the dc component of triggering signals and attenuates ac signals below about 20 cps.

AC LF REJ. Ac low-frequency reject coupling rejects the dc component of triggering signals and rejects ac signals below about 1000 cps.

In general, ac coupling is used. It will be necessary to dc couple for very low-frequency triggering signals. If line-frequency hum is mixed with the desired high-frequency triggering signal, best results may be obtained using ac low-frequency reject coupling.

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 you wish to display less than one full cycle of the input signal, the SLOPE switch permits you to start the sweep on the desired slope; either rising (+ slope) or falling (— slope).

TRIG LEVEL

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

HF STABILITY

The HF STABILITY control is used only when the triggering signal frequency is above 5 or 10 megacycles, and then only if the triggered sweep display tends to jitter horizontally. In such cases the control may be set for minimum jitter. At lower frequencies the setting of the HF STABILITY control is not important.

Sweep Rates

Time Base A has 24 calibrated sweep rates ranging from 0.1 microsecond per centimeter to 5 seconds per centimeter. Calibrated sweep rates are obtained only when the VARIABLE A control is snapped in the fully clockwise position. The VARIABLE A control and MAG switch, used in conjunction with the TIME/CM switch, permit the sweep rate to be varied continuously between 10 nanoseconds and about 12 seconds per centimeter. (The MAG switch is discussed under "Sweep Magnification".) All sweep rates obtained with the VARIABLE A control in any but the fully clockwise position are uncalibrated. Uncalibrated sweep rates are indicated when the UNCAL lamp is lit. However, this lamp will also light when the B variable control is not set to CALIB.

The sweep-rate value being used appears between the two black lines on the clear plastic flange of the TIME/CM knob. If the DELAYED SWEEP knob is pulled outward, it will disengage from the clear plastic flange. This permits changing the sweep rate of the delayed sweep without a change in the delay time generated by the delaying sweep. Hence, at times you may find that turning the knob will not change the A sweep rate. If this occurs, turn the knob until the indicator dot is between the black lines on the flange. The knob and the flange will then lock together and the A sweep rate can be changed.

Sweep Magnification

Any signal displayed on the oscilloscope can be expanded horizontally 10 times by setting the MAG switch to X10. This switch has the same effect whether the horizontal deflection is produced by one of the time bases in the Type 11B2 or by an external signal passing through the amplifier in the Type 11B2. The lamp next to the X10 panel marking lights whenever the magnifier is turned to X10.

When internal sweeps are used, the magnifier increases the observed sweep rate by 10 times the TIME/CM switch setting. The true sweep rate is then found by multiplying the setting of the TIME/CM switch by 0.1.

The 1-centimeter portion at the horizontal center of the graticule of an unmagnified display is expanded and remains centered in the full 10-centimeter width of the graticule when the magnifier is turned on. Any other 1-centimeter portion of the original unmagnified display can then be observed in magnified form by using the HORIZ POSITION control to position that portion on the crt.

NON-TRIGGERED DELAYED SWEEP

Introduction

The following procedures describe various measurements and other operations that can be performed by using delayed sweep.

First, set the controls and switches as listed in Table 2-1. Then, set the oscilloscope HORIZ POSITION control so the trace begins precisely at the left edge of the graticule. Notice the position of the intensified segment in the trace.

Now set the A DELAY TIME switch to .2 SEC and B TIME/CM switch to 20 mSEC. The intensified segment should be at the same position as with the previous sweep rates.

Connect the SWEEP B output on the Type 11B2 to the vertical plug-in unit input. Notice that the B sweep sawtooth and the intensified segment in the trace start and end at the same time. This display shows that B produces one sweep during each A sweep. The B trigger switches and B TRIG LEVEL control have no effect on the operation.

The A sweep rate is 0.2 second per centimeter and the intensified segment begins 5 centimeters after the beginning of the trace. Hence, the B sweep starts one second after the A sweep (0.2 second per centimeter times 5 centimeters).

The number of centimeters between the beginning of the trace and the beginning of the intensified segment is established by the setting of the DELAY TIME MULT dial. Therefore, with any dial setting, the time difference between the beginning of the A and B sweeps is the product of the A DELAY TIME switch and the DELAY TIME MULT dial settings.

TABLE 2-1

Set the applicable front-panel controls as follows:

Type 11B2

A TRIG MODE	AUTO
A SOURCE	INT
A COUPLING	AC
A SLOPE	+
A TRIG LEVEL	0
A DELAY TIME	1 mSEC
B TIME/CM	.1 mSEC
VARIABLE A (and B)	CALIB
HORIZ DISPLAY	A INTEN BY B non-triggered (to the left of A on the panel)
MAG	OFF
DELAY TIME MULT	5.00

Oscilloscope

1KC CALIBRATOR	10 VOLTS
HORIZ POSITION	Centered
INTENSITY	So both intensity levels in the trace are easily seen

Vertical Unit

VOLTS/CM	5
VARIABLE	CALIB
AC-DC-GND	DC
MODE	CH 1
POSITION	Trace centered
TRIGGER	NORM
PULL TO INVERT	Pushed in

The following procedures describe five common applications of the delayed-sweep feature. The applications include time measurements which are more accurate than those obtained directly from the crt display, and other operations that can only be performed on oscilloscopes having a delayed-sweep feature.

Demonstration 1

Demonstration 1 describes how to measure the time between two pulses; the first of which triggers Time Base A.

Set the Type 11B2 controls as listed in Table 2-1 except as follows:

A DELAY TIME	.1 mSEC
B TIME/CM	1 μSEC

Apply the oscilloscope 1-Kc Calibrator signal to the vertical input. If necessary, adjust the A TRIG LEVEL control to obtain a stable display. The display should consist of about one cycle of the square-wave signal.

Set the DELAY TIME MULT dial so the falling portion of the square wave is intensified. Set the HORIZ DISPLAY switch to B DLY'D BY A non-triggered (to the left of A on the panel). The display should now be a horizontally expanded version of the signal observed in the intensified segment of the previous display.

Set the DELAY TIME MULT dial so the trace starts at about the 50% amplitude level of the falling portion of the square wave. Multiply the DELAY TIME MULT dial reading (e.g. 5.03) by the A DELAY TIME switch setting. The product is the time duration of the square-wave positive-going half cycle.

Accuracy. Determined by the combination of ***ALL*** the following factors:

1. The basic accuracy of time measurements made by using the Time Base A Generator is as stated in Section 1 of this manual. In measurements made directly from the crt, the accuracy figure is the percentage of the total time represented within the 10-centimeter graticule (percent of full scale). However, when the measurement is made by using the sweep-delay feature, the accuracy is a percentage of the time being measured.

2. The effect of sweep-delay system linearity on measurement accuracy depends on the DELAY TIME MULT dial setting used. Inaccuracy due to non-linearity is generally negligible when dial settings above 2.0 or 2.5 are used. It is usually possible to avoid lower dial settings by setting the DELAY TIME switch for the shortest calibrated interval that will provide adequate delay range.

3. The triggering point can affect measurement accuracy, since the triggering signal does not rise instantaneously. For example, if the first portion of a pulse rise triggers the sweep, most of the pulse risetime will be included in the measurement. This is of little concern in measurements such as Demonstration 1 where the risetime is small in relation to the measured time. As the risetime, in relation to the measured time increases, it becomes more important that the triggering point be known. One way to establish a known triggering point is to set the TRIG LEVEL control at one end of the range in which a stable-triggered A intensified by B display is obtained. Most of the signal risetime will be included in the measurement when:

   a. The A trigger SLOPE switch is set to + and TRIG LEVEL control is set to the — end of the triggering range (positive-going signals).

   b. The A trigger SLOPE switch is set to — and TRIG LEVEL control is set to the + end of the triggering range (negative-going signals).

4. The A Trigger Generator, Time Base A Generator, and Time Base B Generator circuits typically require a net total of about 30 to 40 nanoseconds to respond to the signal event which triggers A. This small inherent delay need not be considered unless it is a significant percentage of the time being measured. When necessary, add the net circuit delay time to the measured time.

The method described in Demonstration 1 will provide a time measurement accuracy within 1.5% of reading. Accuracy will be greatest when:

a. DELAY TIME MULT dial settings above 2.0 or 2.5 are used.

b. The event triggering A has a fast risetime.

c. DELAY TIME switch settings of 1 μsec/cm or slower are used.

Demonstration 2

Demonstration 2 describes how to measure the time between two pulses, neither of which triggers A.

Set the Type 11B2 controls as listed in Table 2-1 except as follows:

A DELAY TIME .2 mSEC

Apply the oscilloscope 1-Kc Calibrator signal to the vertical input. If necessary, adjust the A TRIG LEVEL control to obtain a stable display. The display should consist of about two cycles of the square-wave signal. Set the DELAY TIME MULT dial so the square-wave rise located near the center of the display is intensified.

Set the HORIZ DISPLAY switch to B DLY'D BY A non-triggered (to the left of A on the panel). The display should now be a horizontally expanded version of the intensified segment observed in the previous display.

Set the DELAY TIME MULT dial so the 50% amplitude level of the square-wave rise intersects the vertical line at the center of the graticule. Note the exact DELAY TIME MULT dial setting (e.g. 5.04). Turn the DELAY TIME MULT dial clockwise until the 50% amplitude level of the square-wave fall intersects the same vertical graticule line used with the previous dial setting. Again note the exact DELAY TIME MULT dial setting.

Subtract the first dial setting from the second. The product of this difference and the A DELAY TIME switch setting equals the time duration of the square-wave positive-going half cycle (between the 50% amplitude points). In this case, the time duration should be between 0.494 and 0.506 millisecond.

Accuracy. Determined by the combination of ***ALL*** the following factors:

1. The basic accuracy of the A delay time as described in Demonstration 1.

2. The error that the sweep delay system linearity adds to the measurement depends on the numerical difference between the two dial settings used. The error decreases as the numerical difference increases. The time error in this type of measurement is less than 0.15% of the full-scale delay (±0.15% of ten times the A DELAY TIME switch setting). However, this applies only when the DELAY TIME MULT dial settings are separated by at least one full dial turn.

NOTE

When the separation between dial settings is one full dial turn or less, the desired time measurement can often be made more accurately by direct reading from a magnified crt display. See Demonstration 3.

3. The accuracy of time measurements made according to Demonstration 2 is independent of the inherent circuit delays and of the triggering point (discussed in Demonstration 1), provided the A TRIG LEVEL control setting is the same for each of the two dial readings.

The method described in Demonstration 2 provides time measurement accuracy within 1.5% of reading. Accuracy will be greatest when:

a. The numerical difference between the two DELAY TIME MULT dial settings is greatest.

b. DELAY TIME switch settings of 1 μsec/cm or slower are used.

Demonstration 3

Demonstration 3 describes how to accurately magnify any event within a series of events by factors of two to several thousand.

Complex signals often consist of a number of individual events of different amplitudes. Since the trigger circuits of the Type 11B2 are sensitive to signal amplitude, a stable display will normally be obtained only when the sweep is triggered by the event having the greatest amplitude. The B DLY'D BY A non-triggered mode (to the left of A on the HORIZ DISPLAY switch) permits the start of a sweep to be delayed for a selected time after the signal event having the greatest amplitude. Any event within the series of events may then be displayed in magnified form as follows:

Set the Type 11B2 controls as listed in Table 2-1. Apply the oscilloscope 1-Kc Calibrator signal to the vertical input. If necessary, adjust the A TRIG LEVEL control to obtain a stable display. The display should consist of several cycles of the square-wave signal. Set the DELAY TIME MULT dial to intensify one of the positive-going pulses.

Set the HORIZ DISPLAY switch to B DLY'D BY A non-triggered (to the left of A on the panel). The display now contains the same signal information as the intensified trace segment in the previous display, but horizontally expanded (magnified) ten times.

Increase the B sweep rate to 1 microsecond per centimeter. Set the DELAY TIME MULT dial to position a square-wave rise on the crt. The display now provides X1000 magnification over that previously observed with the HORIZ DISPLAY switch in A INTEN BY B.

Slowly turn the DELAY TIME MULT dial. Note that any portion of the square-wave display can be brought into view in magnified form.

The DELAY TIME MULT dial indication corresponds to the number of centimeters between the beginning of the A INTEN BY B trace and the beginning of the intensified trace segment (e.g. 7.00 = 7 centimeters).

The B DLY'D BY A display will probably exhibit some horizontal jitter. The time jitter contributed by the delay system is less than 5 X 10^{-4} times the A DELAY TIME switch setting. Since the sweep rate of the delayed sweep is now 1 microsecond per centimeter, the jitter due to the delay system is less than one-half centimeter.

Accuracy. Depends solely on the displayed B sweep-rate accuracy as listed in Section 1 of this manual.

Demonstration 4

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 11B2 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 sweep free runs.

Set the Type 11B2 controls as listed in Table 2-1 except as follows:

A SOURCE	EXT
DELAY TIME MULT	1.00

Connect the Type 11B2 + GATE B output to the vertical input. The display should consist of a positive-going pulse about 1-centimeter wide. This pulse is available from the Type 11B2 during each A sweep. In a practical application, the pulse would not be applied to the vertical input but to some external device to be tested. The pulse would serve as the trigger pulse or input signal for the external device and the output of the device would be displayed on the oscilloscope. Since the pulse has a known time relationship to each A sweep, the output of the device would provide a stable display on the oscilloscope, as though the oscilloscope were triggered in the normal manner.

Demonstration 5

The Type 11B2 + GATE B output signal can provide a pulse with a variable repetition rate and duty factor.

Set the Type 11B2 controls as follows:

HORIZ DISPLAY	A INTEN BY B non-triggered (to the left of A on the panel)
DELAY TIME MULT	About 0.30
TRIG MODE	FREE RUN

The pulse signal is available at the + GATE B connector. Monitor the signal on another oscilloscope and establish the desired pulse repetition rate by setting the A DELAY TIME switch and VARIABLE A control. Establish the desired duty factor by setting the B TIME/CM switch and variable B control.

The maximum pulse-repetition frequency that can be obtained in this manner is about 130 kc. Maximum duty factor is about 0.9, decreasing to about 0.15 with faster sweep rates.

TRIGGERED DELAYED SWEEP

Complex signals often contain a number of individual events of different amplitudes. Since the trigger circuits in the Type 11B2 are sensitive to signal amplitude, a stable display will normally be obtained only when the sweep is triggered by the event having the greatest amplitude.

The B DLY'D BY A triggered position (to the right of A on the HORIZ DISPLAY switch) provides a means of triggering the sweep by events other than those having the greatest amplitude. The following instructions demonstrate that Time Base B can be triggered by virtually any event within a series of events.

Set the Type 11B2 controls as listed in Table 2-1 except as follows:

B COUPLING	AC
B SOURCE	INT
B SLOPE	+
B TRIG LEVEL	0

Connect the oscilloscope CAL OUT signal to the vertical input. If necessary, adjust the A TRIG LEVEL control to obtain a stable square-wave display.

Turn the DELAY TIME MULT dial about 2 turns in either direction. Notice that the brightened segment in the display moves smoothly across the crt.

Set the DELAY TIME MULT dial so the brightened segment begins about the middle of a pulse top. Set the HORIZ DISPLAY switch to B DLY'D BY A non-triggered (to the left of A) and notice that this display also begins in the middle of a pulse top. Now, set the HORIZ DISPLAY switch to A INTEN BY B triggered (to the right of A). Notice that the brightened segment in the display has shifted to the next pulse on the right. (If the brightened segment is not present, or is unstable, readjust the B TRIG LEVEL control.) Turn the DELAY TIME MULT dial several full turns. The brightened segment in the display should jump from one pulse to the next. Set the HORIZ DISPLAY switch to B DLY'D BY A triggered (to the right of A) and notice that the display now begins within the rising portion of the pulse. With the present display, turning the DELAY TIME MULT dial will cause no change in the display, since all of the 1-Kc Calibrator pulses are the same shape. However, if the input signal consists of a repeating series of dissimilar pulses, turning the dial will provide a triggered display of each pulse in the series (provided the B TRIG LEVEL control is set for triggering on the smallest pulse).

The display is produced in the following manner:

Time Base B produces one sweep during each A sweep. B sweep will begin at some time after the start of A sweep. This time is the total of the A DELAY TIME switch setting multiplied by the DELAY TIME MULT dial setting, plus the time between the end of this delay interval and the next event in the signal which can trigger B.

B sweep occurs only if B is triggered before A sweep ends. If A sweep ends while B sweep is in progress, B sweep will also terminate. If this occurs, a B delayed by A display will not be the full width of the graticule.

EXTERNAL HORIZONTAL DEFLECTION

For special applications, you can produce horizontal deflection with an externally derived signal. This permits you to use the oscilloscope system to plot one function

against another (e.g. Lissajous figures). However, the system is not intended for qualitative phase-angle measurements.

To use an external signal for horizontal deflection, connect the signal to the B TRIG IN OR EXT INPUT connector. Set the HORIZ DISPLAY switch to EXT INPUT and the B SOURCE switch to EXT. The signal can be either ac or dc coupled to the deflection amplifier by setting the B COUPLING switch. The MAG switch can be turned to X10 to increase the horizontal deflection by a factor of 10.

SECTION 3

CIRCUIT DESCRIPTION

General Information

This portion of the instruction manual presents a detailed discussion of the Type 11B2 circuitry. This discussion refers to various block diagrams inserted in the text and to the schematics in Section 5.

A block diagram of the Type 11B2 is also provided in Section 5. The relationship of the circuits in each block to those in other portions of the system is discussed in the detailed description of that block.

TRIGGER GENERATOR

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

Sections A and B of the Trigger Generator operate similarly for sweep triggering; but section B has an alternative function. The input cathode follower in section B is used as an isolation stage when external horizontal deflection signals are used.

The block diagram, Fig. 3-1, shows the basic elements of the Trigger Generator.

The A triggering signal can be selected from three sources: internal, line, or external. External (EXT) triggering signals are connected to the A TRIG IN connector and high-amplitude external signals can be attenuated by setting the A SOURCE switch to EXT ÷ 10. This forms an input divider consisting of R29 and R30A. If the COUPLING switch is set to AC LF REJ, about 100 times attenuation is obtained because R30B parallels R30A.

The line-source signal comes from a divider connected to a low-voltage winding of the oscilloscope power transformer.

The internal-source signal comes from the vertical deflection plug-in unit to the Type 11B2 Internal Trigger Preamp. The Preamp consists of a push-pull driven, single-ended output, paraphase amplifier driving a complementary emitter follower.

The samples of the vertical deflection signal applied to the bases of Q14A and B are of opposite polarity. If, for example, the signal increases the Q14A current, it will decrease the Q14B current. Due to the common-emitter coupling, a current increase through Q14A will compound the current reduction in Q14B. INT TRIG DC LEVEL (R7) is adjusted during calibration so the "no signal" dc voltage delivered to the SOURCE switch will be zero volts when the trace is vertically positioned near the center of the graticule.

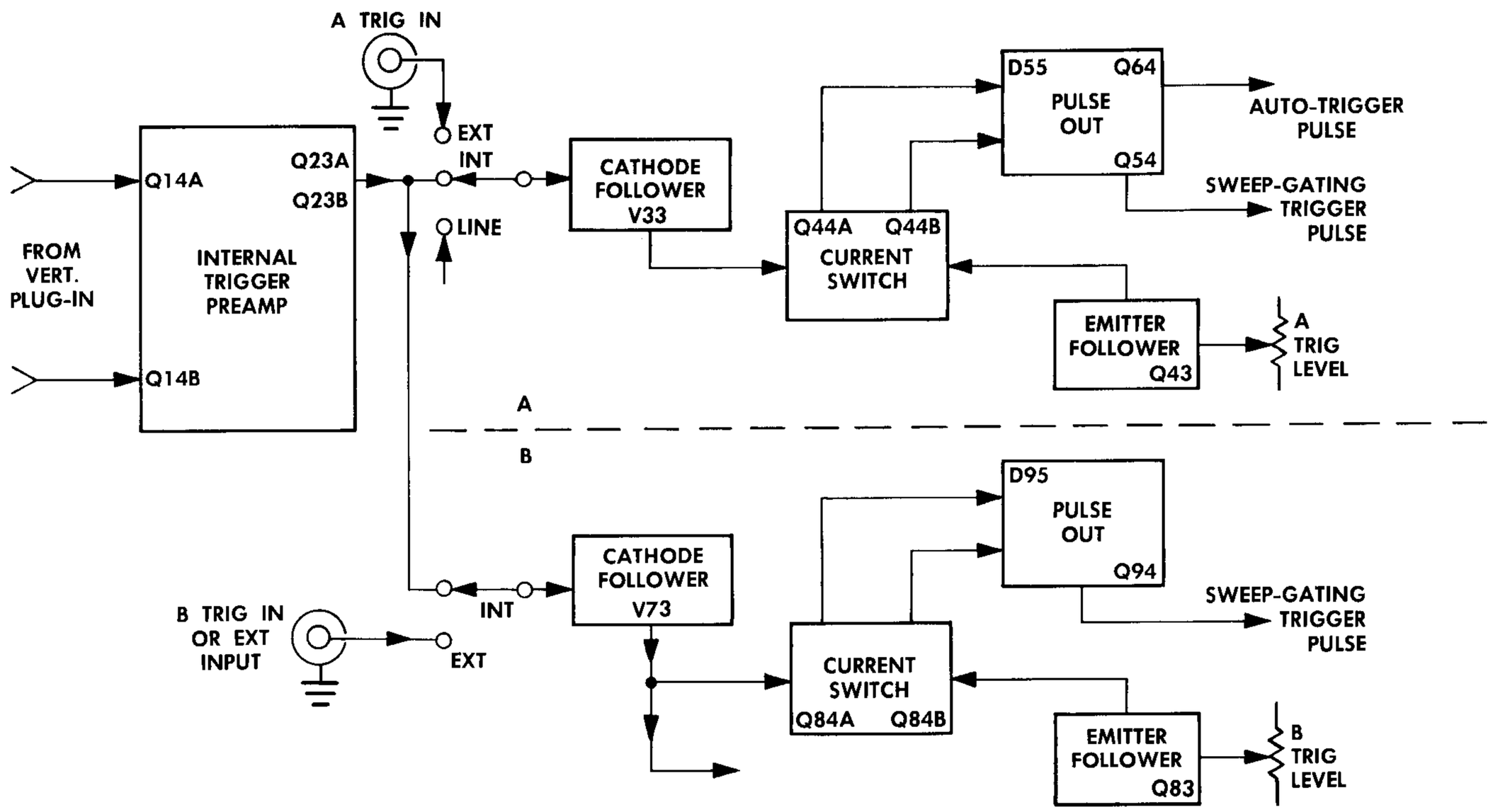


Fig. 3-1. Trigger generator block diagram.

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Circuit Description — Type 11B2

The amplified triggering signal from the paraphase amplifier is applied to the base of Q23A, and in slightly attenuated form, to the base of Q23B. The combined function of Q23A and Q23B is that of an emitter follower, but this special configuration overcomes a common limitation of conventional emitter followers by providing equally fast response for both positive- and negative-going portions of a signal. The output signal is available to both the A and B SOURCE switches.

In the AC position of the COUPLING switch, C30A and R30A provide a coupling time contant such that dc and very low-frequency ac signals are rejected. In the AC LF REJ position, the coupling time constant is decreased so the ac rejection includes somewhat higher frequencies. This rejection is primarily intended to prevent triggering on the dc-level switching information encountered in alternate-trace operation of vertical plug-in units. The signal from the A COUPLING switch is applied to the grid of cathode follower V33. R30C, D30, and D31 protect V33 from triggering signals with excessive amplitude.

The triggering signal from the cathode follower is applied to the base of Q44A. D33 protects Q44A by limiting negative voltage excursions to about —16 volts.

Q44A and Q44B form a sensitive current switch. If the instantaneous triggering signal voltage at the base of Q44A is more positive than the voltage established at the base of Q44B by the TRIG LEVEL control, Q44A will conduct. Unless the base voltages are very nearly equal, the two transistors cannot conduct at the same time due to the common-emitter coupling. Hence, as the positive-going portion of the triggering signal drives the base of Q44A from negative to positive, with respect to the base of Q44B, the current through R44 switches from Q44B to Q44A.

When the SLOPE switch is set to +, Q44A collector current must pass through D45A. The current then divides with the greatest portion passing through tunnel diode D55. This current puts the tunnel diode in its high state (see Fig. 3-2).

When Q44A is off, the tunnel diode is in its low state. With the SLOPE switch set to —, the Q44B collector current controls the tunnel diode. Hence, with the SLOPE switch set to +, the tunnel diode will switch to its high state when Q44A comes into conduction, and with the SLOPE switch to — the tunnel diode will switch to its high state when Q44B comes into conduction.

As is characteristic of a tunnel diode, the transition from the low-voltage state to the high-voltage state occurs very rapidly, no matter how slowly the current increases. Therefore, this switching action of the tunnel diode provides the base of Q54 with a fast-rise, negative-going pulse.

When the tunnel diode suddenly drives the Q54 base negative, Q54 is driven into heavy conduction. While the Q54 steady-state current passes through the high resistance of R53, the very fast-rise base pulse enables Q54 to pass considerable current through C53 and the series combination of C63, Q64, and R61. Due to the short time constants in the Q54 emitter circuit, the Q54 current rapidly decreases to the steady-state level, even though the tunnel diode may remain in the high state. Thus, fast-rise positive-going pulses are developed simultaneously at the collectors of Q54 and Q64.

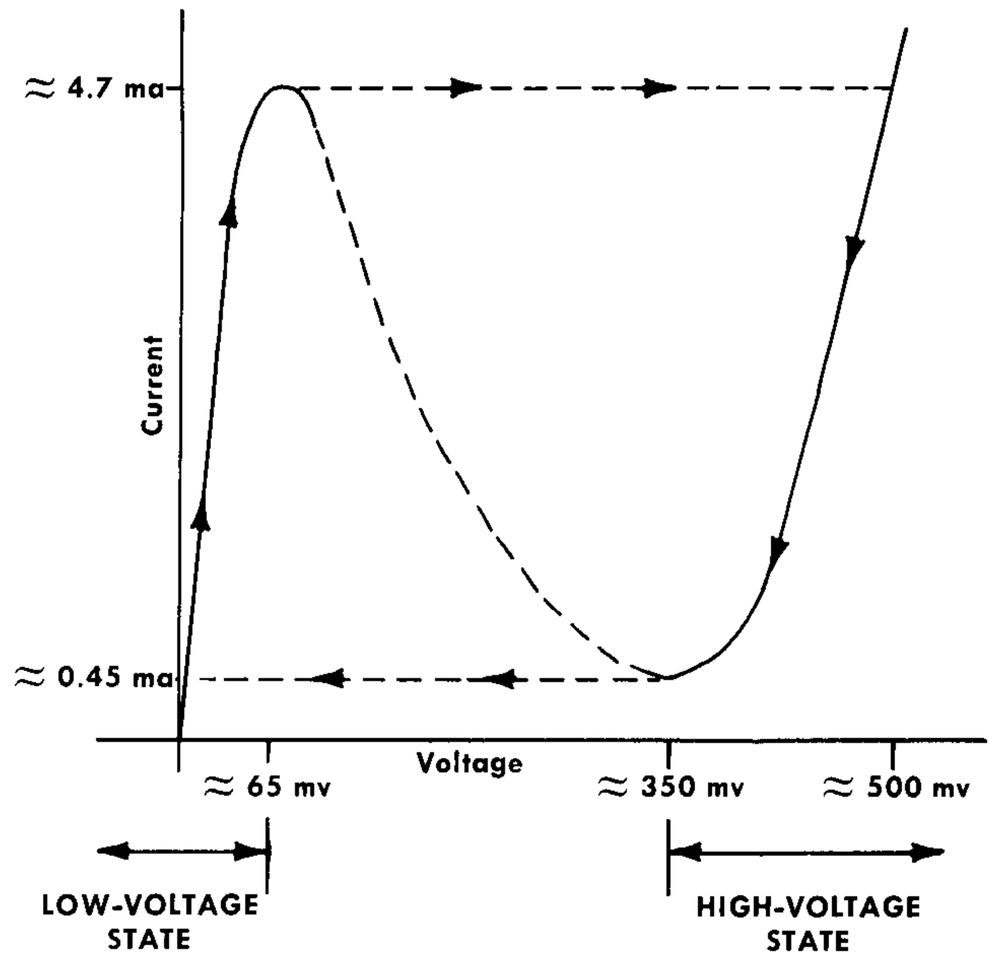

Fig. 3-2. Tunnel diode characteristics.

When the triggering signal resets the tunnel diode to its low state, Q54 turns off, but rapidly recovers to the steady-state conduction level. The output pulses produced at reset have no effect on Sweep Generator A.

The operation of section B of the Trigger Generator is similar to section A until the signal reaches the cathode circuit of V73. When the HORIZ DISPLAY switch is set to B DLY'D BY A non-triggered, A INTEN BY B non-triggered, or A, the —15-volt source at the ends of R75D and R75F, and the cathode potential of V73, back bias D73 and D74. Hence, no signal passes this point. Current is diverted through R75A to maintain the proper current value through V73. When the HORIZ DISPLAY switch is set to EXT INPUT, D73 remains back biased, but D74 conducts and an external horizontal deflection signal will be passed to the Horizontal Preamp. The network consisting of R73, D75, R75E, and R76, offsets a zero-referenced signal to about +7 volts. This is approximately the voltage at the 50% amplitude point on the A and B sawtooth sweep signals. Thus, if the operator centers the A or B sweep display and then sets the HORIZ DISPLAY switch to EXT INPUT, a display produced by a zero-referenced horizontal deflection signal will also be centered.

With the HORIZ DISPLAY switch set to A INTEN BY B triggered or B DLY'D BY A triggered, D74 is back biased while D73 passes the triggering signal to the base of Q84A.

The remainder of section B is identical to section A, with two exceptions. B Sweep Generator has no automatic triggering circuit; thus section B of the Trigger Generator has no automatic trigger pulse output amplifier. Also, the B TRIG LEVEL control is connected differently. When an external triggering signal is used for section B, the B triggering-level voltage range is about twice that obtained in section A when the A SOURCE switch is set to EXT.

SWEEP GENERATOR A

Sweep Generator A produces four simultaneous output signals (see Fig 3-3.)

1. A positive-going sawtooth that is applied to the Delay Pickoff section of Sweep Generator B, and which can be applied to the Horizontal Preamp by proper setting of the HORIZ DISPLAY switch. The positive-going sawtooth is also available for external use at the SWEEP A front-panel connector.

2. A negative-going crt unblanking pulse having the same duration as the sweep sawtooth rise. Coupled to the oscilloscope Crt Circuit when the Type 11B2 HORIZ DISPLAY switch is set to A or A INTEN BY B (triggered and non-triggered).

3. A positive-going pulse (+ GATE A) having the same duration as the sweep sawtooth rise. Coupled to a front-panel connector for external use.

4. A negative-going multi-trace sync pulse occurring at the end of the sweep sawtooth rise. Coupled to the vertical plug-in unit interconnecting socket. Causes a multi-trace plug-in unit, operating in the alternate mode, to switch channels.

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 Sweep Generator A; that is, the end of one cycle will cause the next cycle to begin. The desired operation is selected by setting the TRIG MODE switch. The four operating modes provided by the TRIG MODE switch are described in Section 2 of this manual.

The block diagram, Fig. 3-3, shows the basic elements of Sweep Generator A.

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

The TRIG MODE switch provides four ways to switch the Sweep-Gating Multi so that the sweep will begin. In NORM, the multi is switched by a pulse from the Trigger Generator. In SINGLE SWEEP, two pulses are required to start *EACH* sweep. First, a pulse from the Reset Amplifier (originating at the RESET pushbutton or from an external device through pin F of J101 on the rear panel of the oscilloscope) resets the Gate-Enable Multi. Then, after reset, the Sweep-Gating Multi can be switched by a pulse from the Trigger Generator. FREE RUN results in recurrent sweeps that are independent of any triggering signal. The retrace portion of one sawtooth switches the multi to begin the next sawtooth.

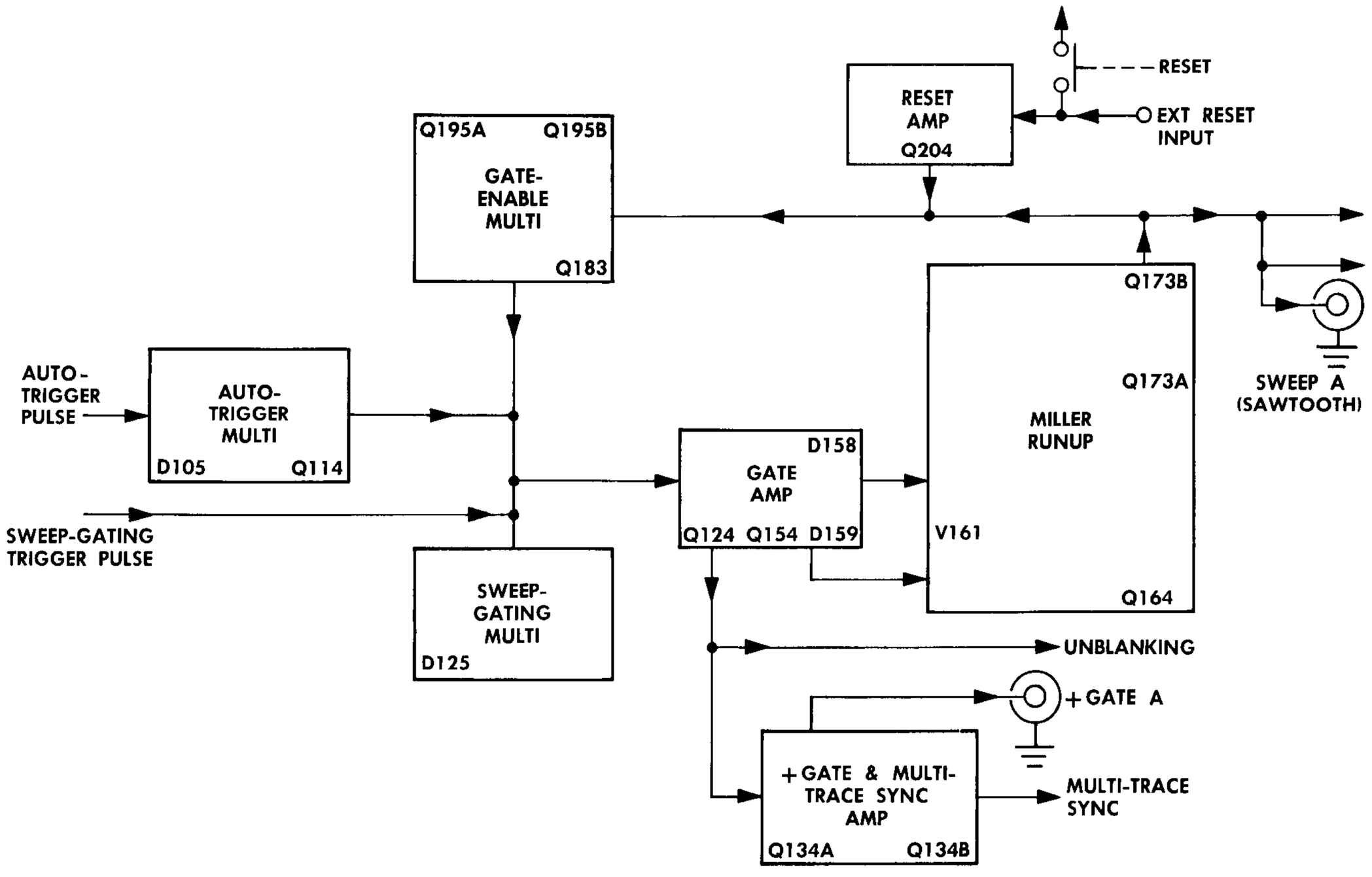

Fig. 3-3. Sweep Generator A block diagram.

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AUTO is a combination of NORM and FREE RUN. If there are no trigger pulses coming from the Trigger Generator, the Auto-Trigger Multi holds the Sweep-Gating Multi in the "free run" condition. When a pulse comes from the Trigger Generator, the Auto-Trigger Multi switches the Sweep-Gating Multi 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 milliseconds, the Sweep-Gating Multi will switch and a sweep will begin. If trigger pulses continue to arrive every 80 milliseconds or less, the Auto-Trigger Multi will remain in the normal condition and each sweep will be a triggered sweep. Whenever the period between trigger pulses exceeds 80 milliseconds, the Auto-Trigger Multi will revert to the free-run condition until the next trigger pulse arrives.

The following description refers to the Sweep Generator A schematic in the back of this manual. The first portion of the description pertains to operation with the TRIG MODE switch set to NORM.

Quiescent Conditions

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

Q195B is conducting and Q195A is cut off. Q195B establishes current through the parallel arrangement of D125, D118, and D121. Tunnel diode D125 is in the low-voltage state (see Fig. 3-2) so that Q124 is off. With Q124 off, the series combination of R124 and R127 is effectively in parallel with R154. Q154 conducts at a level which forward biases Disconnect Diode D159 and diode D158.

The conduction of Q154 through R127 and R124 produces about +6.5 volts at the Q124 collector. This voltage is divided to about zero volts at the unblanking signal output (see Interconnecting Plug schematic). Q134 conducts heavily, but its collector and the + GATE A connector output are clamped at about —0.6 volt by diode D133. Q134B is cut off and the voltage on the multi-trace sync-pulse bus is about +5 volts.

With Disconnect Diode D159 conducting, the grid of V161 is clamped at about zero volts. D158 clamps the sawtooth output bus at about +2.4 volts to provide a stable, repeatable sawtooth starting voltage. This starting voltage can be set during calibration by adjusting DELAY START (R150). The arm of the control is connected to the equivalent point in Sweep Generator B so both will have the same sawtooth starting voltage and will therefore produce sweeps that start at the same point on the crt. The starting voltage is variable over a small range to permit calibration of the DELAY TIME MULT dial.

V161, Q164, and Q173A form a Miller Runup Integrator. The tube and transistors are clamped at moderate conduction levels by D158 and D159. The Q173B emitter voltage is about +1.8 volts, forward biasing D180 and D181. Q183 conducts heavily and reverse biases D183. Q195B is held on by the divider consisting of R184, R185, R199, R193, and R194 paralleled by D193 and Q183.

With the TRIG MODE switch set to NORM, Q114 has no collector supply and the Auto-Trigger Multi is disabled.

Cycle of Operation

A sweep-gating trigger pulse will turn on D120 and turn off D121. The Q195B current does not decrease when D121 cuts off, but is transferred instead to tunnel diode D125, rapidly switching it to its high-voltage state (see Fig. 3-2).

When the tunnel diode switches, Q124 turns on. The negative voltage step at the collector of Q124 provides the oscilloscope crt unblanking signal. Q134A cuts off, forming the rise of the +GATE A connector output signal. Q134B remains cut off.

The negative-going voltage step at the collector of Q124 is applied to the emitter of Q154, turning the transistor off. Thus, Disconnect Diode D159 is rapidly switched off.

When the Disconnect Diode turns off, the current through timing resistor R_t does not cease, but instead begins to charge timing capacitor C_t. As the timing capacitor charges, the grid of V161 goes negative. But the inverted and greatly amplified change at the emitter of Q173A is fed back to the timing capacitor and opposes the grid voltage change. (The positive-going change also turns off D158.) This action persists throughout the sawtooth period and limits the total grid voltage change to less than 0.02 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. D159 is a special diode that exhibits very low leakage under reverse-bias conditions. This characteristic prevents the diode from effectively altering the timing resistance value.

The rate of the sawtooth rise is a function of the RC time constant of the timing resistor and capacitor, and of the voltage magnitude at the negative end of the timing resistor. Increasing the voltage across the timing resistor increases the current into the timing capacitor and therefore increases the sawtooth rate of rise. The voltage across the timing resistor can be varied over about a 9-volt range by adjusting A SWP CAL (R160W) shown on the Timing Switches schematic. R160W is adjusted during calibration to establish the correct absolute rate of sawtooth rise and affects all A sweep rates equally.

The VARIABLE A front-panel control operates in much the same manner as A SWP CAL, but permits a wider variation in sweep rate. This control permits the operator to obtain uncalibrated sweep rates as much as two and one-half times slower than the calibrated rates obtained with the control set fully clockwise.

The sawtooth signal at the emitter of Q173A is available to the Horizontal Preamp through the HORIZ DISPLAY switch, and is applied to the Delay Pickoff circuit and the base of Q173B. The rising voltage at the emitter of Q173B supplies the front-panel A SWEEP connector output signal and charges holdoff capacitor $C_{h\text{-}o}$ through D180 and D181. As the holdoff capacitor charges, the base and emitter of Q183 go more positive. D183 will become forward biased and the positive-going change at the emitter of Q183 will drive the base of Q195B more positive. As the positive-going Q195B base voltage equals and then surpasses the Q195A base voltage, the R195 current switches regeneratively from Q195B to Q195A.

When Q195B turns off, tunnel diode D125 reverts to its low-voltage state. The time duration of the sweep-gating

trigger pulse, which started the cycle of operation, will always be considerably less than the time duration of the sweep. However, once the sweep-gating pulse switches the tunnel diode to its high-voltage state, additional trigger pulses can have no further affect on the operation. The tunnel diode will revert to its low state only when Q195B turns off.

As the tunnel diode reverts to its low state, Q124 turns off. The Q124 collector voltage rises, blanking the oscilloscope crt. Q134A turns on, forming the falling portion of the + GATE A connector output signal and driving Q134B into conduction. C136 quickly discharges and Q134B turns off. Thus, the multi-trace sync pulse is negative-going and has a very short duration.

The positive-going voltage step at the collector of Q124 turns on Q154, forward biasing Disconnect Diode D159. Since the timing capacitor still holds the charge developed during the sweep, D158 remains back-biased. The timing capacitor begins to discharge through D159, Q154, and the series-parallel combination of R154, R124, and R127. D158 will not conduct until the charge is nearly depleted.

The removal of the timing capacitor charge forms the retrace or falling portion of the output sawtooth. As the Q173B emitter voltage falls, D180 becomes back biased. During the sawtooth rise, hold-off capacitor C_{ho} charged through D180, but must now discharge through the high resistance of R180 and R181. Thus, timing capacitor C_t will have discharged, restoring the Miller Runup circuit to the quiescent condition before the Q183 base voltage reaches the quiescent level. This time lag can be varied slightly by adjusting the front-panel HF STABILITY control. The need for this variable time lag is discussed in a later paragraph.

As the hold-off capacitor discharges, the Q183 emitter voltage falls. However, this falling voltage does not immediately cause the R195 current to switch to Q195B. The voltage drop across R193 and R194, produced by the conduction of Q195A, is divided by R199, R185, and R184 and holds off Q195B. When the Q183 emitter voltage becomes low enough to forward bias D193, the added current through R193, R199, R185, and R184, pulls down the Q195B base voltage and switches the R195 current to Q195B. The entire sweep generator is then restored to the quiescent condition described previously.

HF STABILITY control (R181) 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 Q195B turns on after a sawtooth retrace, a very short but sometimes significant amount of time is required for the current through tunnel diode D125 to reach the quiescent level. This recovery time is significant only under the following conditions:

1. When the A sweep rate is faster than about 0.2 microsecond per centimeter.

2. When the triggering frequency is above about 5 megacycles.

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

A display obtained under these conditions may jitter horizontally. The operator can minimize and often eliminate the jitter by resetting the HF STABILITY control. This will either advance or delay the Q195B turn-on time so D125 can stabilize at the quiescent level in an interval between sweep-gating trigger pulses.

FREE RUN Mode. Differs from the NORM mode as follows:

When TRIG MODE is set to FREE RUN, R117 is connected to +15 volts and D118 is reverse biased. The Q195B current that was carried by D118 in NORM operation is now carried by tunnel diode D125. As Q195B turns on following a sawtooth retrace, D125 will switch to its high-voltage state without waiting for a sweep-gating trigger pulse. (Moreover, trigger pulses will have no effect on the overall operation.) Thus, the completion of one sweep causes the next to begin.

AUTO Mode. The basic operation of the Auto-Trigger Multi was described previously in the Sweep Generator A block diagram discussion. The conduction state of the Auto-Trigger Multi determines whether diode D118 will be forward biased or reverse biased. When forward biased, Sweep Generator A operates exactly as described for the NORM mode. When D118 is reverse biased, Sweep Generator A operates as described for the FREE RUN mode.

When C102 has received no trigger pulse for more than 80 milliseconds, tunnel diode D105 will be in its high-voltage state (see Fig. 3-2) and Q114 will be turned off. D114 conducts through R116, reverse biasing D118, and Sweep Generator A free runs. The current paths, static current magnitude, and voltages with the circuit in this condition are shown in Fig. 3-4.

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

When a current pulse is applied to C102, D102 conducts by diverting current from tunnel diode D105. The tunnel diode rapidly switches to its low-voltage state, driving Q114 into saturation. The Q114 collector drops to about —14 volts, reverse biasing D114, and D118 turns on. (It is probable that D118 will turn on while a "free-run initiated" A sweep is in progress. If this occurs, Sweep Generator A will complete the sweep and can become triggerable at the end of the usual sweep hold-off period.)

As Q114 goes into saturation, the greater portion of its collector current passes through R114 and begins to discharge C114. The voltage across C114 decreases and D113 begins to conduct, decreasing the current through R112. The R106 current no longer carried by R112 is diverted to tunnel diode D105, switching it to its high-voltage state. (By this time, the auto-trigger pulse current through D102 will have subsided.) Q114 turns off, but C114 must recharge for the Q114 collector voltage to rise. Hence, D114 remains off and D118 remains on.

As Q114 turns off, C114 begins to charge through R114 and R116 in parallel with R113. When the voltage at the junction of C114 and R114 reaches about —7 volts, D113 turns off and C114 continues to charge through R114 and R116.

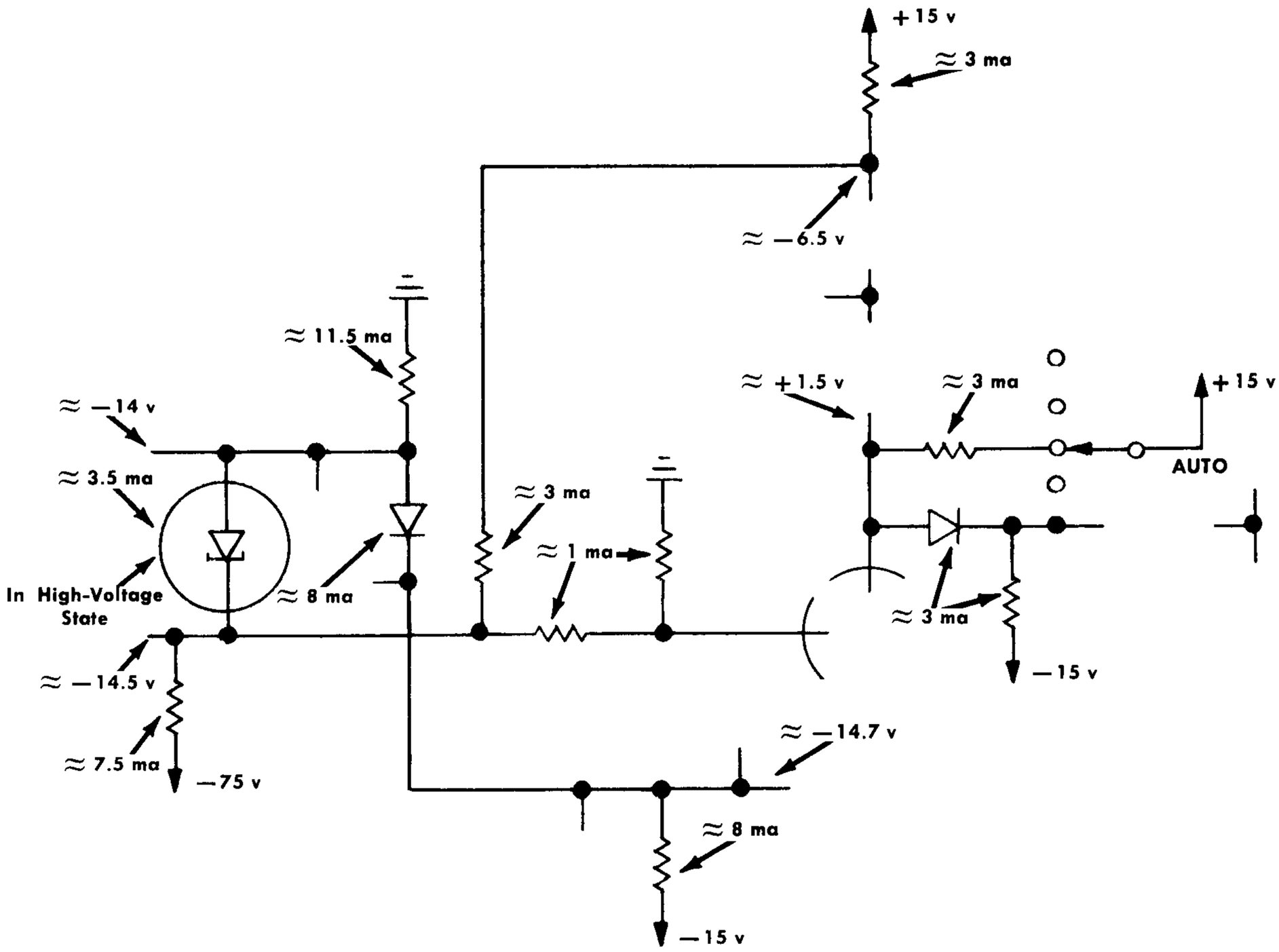


Fig. 3-4. Auto Trigger Multi static conditions.

D114 will turn on when the Q114 collector reaches about zero volts. D118 will then turn off and Sweep Generator A is returned to the free-running condition.

As stated previously, the Auto-Trigger Multi probably will turn on diode D118 while a free-run initiated A sweep is in progress. Hence, Sweep Generator A cannot become triggerable until the end of the hold-off period for this sweep. But from then on, every A sweep will be a triggered sweep if the repetition rate of the auto-trigger and sweep-gating trigger pulses is greater than about 20 pulses per second.

If an auto-trigger pulse arrives at C102 after tunnel diode D105 has reset to its high state, but before C114 has completely recharged, D105 will again switch to its low state. Q114 will turn on and discharge the partially recharged C114 as discussed previously. Additional auto-trigger pulses that may arrive while the tunnel diode is in its low state will have no significant effect on the circuit. But pulses that arrive while the tunnel diode is in its high state will switch the diode back to its low state if the D113 current has decreased sufficiently. Thus, auto-trigger pulses with a repetition rate greater than about 20 pulses per second will repeatedly switch the multi, preventing C114 from charging enough to turn on D114. With D114 turned off continuously, Sweep Generator A will operate exactly as it does in the NORM mode. The negative-going pulse following each positive-going auto-trigger pulse has no effect on the Auto-Trigger Multi except that it discharges C102 through D103.

SINGLE SWEEP Mode. As described previously in the NORM mode discussion, the retrace portion of a sawtooth normally allows discharging hold-off capacitor C_{h-o} to pull down the Q183 base to near zero volts. D193 would then conduct and turn on Q195B. However, in the SINGLE SWEEP mode, R182 is connected to +15 volts, forming a divider with R180 and R181. This divider stops the hold-off capacitor discharge at about +4.5 volts. Thus, the Q183 emitter does not drop far enough to cause D193 to conduct, and Q195B does not turn on. D180 becomes reverse biased, but D181 in series with the divider remains on.

Since Q195B does not turn on following a sweep, Sweep Generator A becomes locked in an inoperative state. With Q195A on, Q184 is held off and RESET lamp B186 is not lit, indicating the inoperative state of the generator.

The generator can be reset to the operative state either by pressing the RESET button or by applying a positive-going pulse to pin F of J101 on the rear panel of the oscilloscope.

In SINGLE SWEEP mode, Q204 is normally off. The RESET button is connected to a divider consisting of R189A and R189B. When the RESET button is pressed, neon lamp

B200 fires, supplying a fast-rise turn-on pulse to Q204. The negative-going pulse at the collector of Q204 is applied to the base of Q183. (At this time, D181 serves its only purpose; it is reverse biased by the pulse so that the hold-off capacitor will not pass the pulse to ground.) The pulse pulls down the Q183 emitter and turns on D193. Q195B and Q184 turn on and RESET lamp B186 lights to indicate that the generator is ready to be triggered. At the end of one conventionally-triggered sweep, the generator will again become inoperative.

An externally applied reset pulse can turn on Q204. The pulse must have a reasonably fast rise for adequate energy to pass through C204.

SWEEP GENERATOR B

Sweep Generator B produces the same output signals as Sweep Generator A, except for a multi-trace sync pulse.

The principle difference between Sweep Generators A and B is that Sweep Generator B can produce no more than one sawtooth for each A sawtooth and only while the A sawtooth is in progress. The A sawtooth signal, applied to Sweep Generator B through the Delay Pickoff circuit, controls this operation.

B sweep cannot begin until the A sawtooth has reached an amplitude (which represents a certain amount of time from the beginning of the A sweep) selected by setting the DELAY TIME MULT dial. If non-triggered delayed sweep is used, B sweep will begin at the selected A sawtooth amplitude. But if triggered delayed sweep is used, B sweep will begin *AFTER* the A sweep sawtooth reaches the selected amplitude when a B sweep-gating trigger pulse is applied. However, if a sweep-gating trigger pulse has not been applied to Sweep Generator B before the end of A sweep, B will not produce a sawtooth. Regardless of whether triggered or non-triggered delayed sweep is used, if B sweep is in progress when A sweep ends, the retrace portion of the A sawtooth will cause Sweep Generator B to reset to the quiescent condition.

The block diagram in Fig. 3-5 shows the basic elements of Sweep Generator B.

The Sweep Generator A sawtooth output is permanently connected to the base of Q214A. When Sweep Generator A is in the quiescent condition, the conditions in Sweep Generator B are as follows:

DELAY TIME MULT can be set so the Q214B base voltage will equal the instantaneous A sawtooth voltage at any point along the sawtooth (except for the sawtooth portion which produces approximately the first 3 millimeters of deflection and the portion which produces deflection beyond 10 centimeters). Hence, Q214A will be off and Q214B will be on.

When Q214A is off, the voltage at its collector and therefore at the base of Q219 will be about +17 volts. Since the emitter of Q219 is clamped at about +15.6 volts, Q219 is off. With Q219 off, Q295A and B have no current source and are also off. When Q295B is off, tunnel diode D225 is in its low-voltage state and cannot be switched to its high-voltage state by a sweep-gating trigger pulse. Thus, the remainder of Sweep Generator B is in a quiescent condition similar to that described previously for Sweep Generator A.

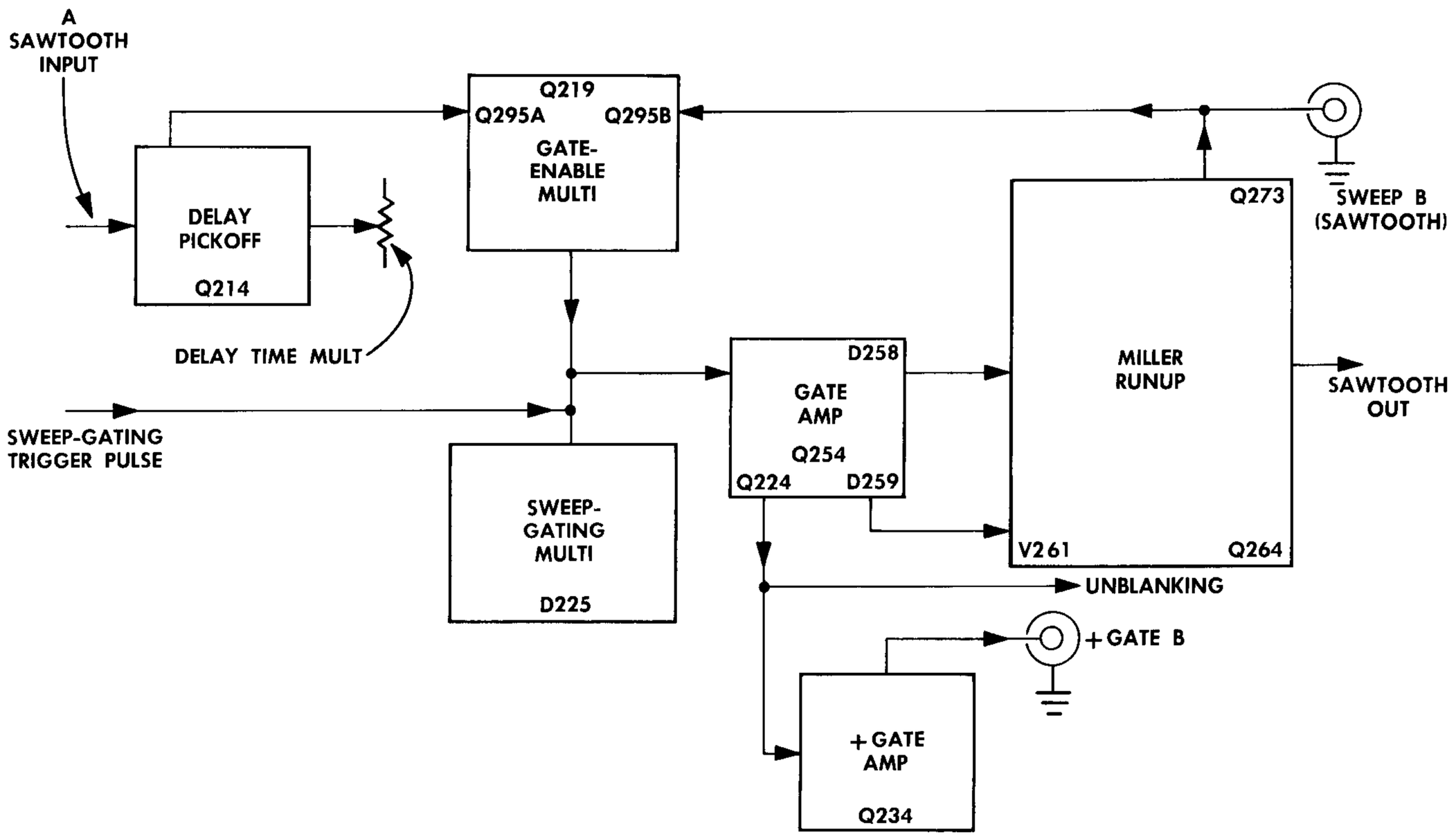


Fig. 3-5. Sweep Generator B block diagram.

Ⓐ

At the beginning of an A sawtooth, the base of Q214A will be less positive than the base of Q214B. But at a selected point along the sawtooth rise, this situation will reverse and the R215 current will switch from Q214B to Q214A. The voltage at the collector of Q214A and the base of Q219 will drop, turning on Q219. Because of its large emitter resistor, Q219 becomes a stable source of about 6 ma for the transistors connected to its collector.

The Q295B base voltage is less positive than that of Q295A; therefore, Q295B turns on and holds off Q295A by common-emitter coupling. Depending on the setting of the HORIZ DISPLAY switch, one of three things can now happen:

1. If set to A, R296C will conduct nearly all of the Q295B collector current. The current change through tunnel diode D225 wil be insignificant and Sweep Generator B will remain inoperative and insenstive to sweep-gating trigger pulses.

2. If set to A INTEN BY B triggered or B DLY'D BY A triggered, tunnel diode D225 will be in its low-voltage state, but conducting enough of the Q295B collector current so a sweep-gating trigger pulse will switch it to its high-voltage state.

3. If set to A INTEN BY B non-triggered, B DLY'D BY A non-triggered, or EXT INPUT, R296A will carry very little of the Q295B collector current, and tunnel diode D225 will switch to its high state immediately when Q295B turns on.

The remainder of Sweep Generator B is nearly identical to portions of Sweep Generator A; thus, the Sweep Generator A circuit description applies also to Sweep Generator B.

The B unblanking signal can be one of two amplitudes depending on the setting of the HORIZ DISPLAY switch (see the Interconnecting Plug schematic). When either B DLY'D BY A position is used, the display brightness will be about the same as obtained using the A position. When either A INTEN BY B position is used, the B unblanking signal will brighten the A trace for the duration of the B sweep.

As the B sawtooth rises, D273 (connected to the emitter of Q273) becomes forward biased and the Q295B base voltage begins to rise. As the Q295B base voltage surpasses the Q295A base voltage, the Q219 collector current switches to Q295A. Tunnel diode D225 reverts to its low-voltage state and Sweep Generator B resets as described for Sweep Generator A. (Sweep Generator B needs no hold-off capacitor since it cannot produce another sweep during the present A sweep.) The coupling between the collector of Q295A and the base of Q295B prevents the sawtooth retrace from turning on Q295B.

During the A sawtooth retrace, the R215 current will switch from Q214A to Q214B. The Q214A collector voltage will rise, turning off Q219. Thus, both sweep generators are returned to their quiescent conditions described previously.

If the A sweep retrace occurs while B sweep is in progress, Q219, rather than the B sawtooth rise, will turn off Q295B. If this occurs, tunnel diode D225 will revert to its low state and the B sweep retrace will begin before the sawtooth has reached its usual amplitude.

HORIZONTAL PREAMP

The Horizontal Preamp input signal can come from Sweep Generator A, Sweep Generator B, or from an external source, depending on the HORIZ DISPLAY switch setting. The push-pull output of the preamp connects to the input of the oscilloscope horizontal amplifier through pins 8 and 9 of the interconnecting plug. The operator can increase the preamp gain ten times by setting the MAG switch to X10.

The block diagram in Fig. 3-6 shows the basic subcircuits of the Horizontal Preamp. Q343 provides a signal-voltage offset and a constant source impedance to Q344. Q313 couples the horizontal positioning voltage to Q324 and provides a low source impedance. Q324 and Q344 form a paraphase amplifier.

Refer to the Horizontal Preamp schematic in the back of this manual. This description assumes that the Horizontal Preamp input signal is the Sweep Generator A sawtooth.

The sawtooth swings symmetrically around approximately +7 volts dc. Zener diodes D340 and D341 negatively offset the signal by about 18 volts. Zener diode D342 establishes a fixed voltage across R343 so that D340 and D341 are provided with a stable holding-current. Thus, the signal at the base of Q344 swings symmetrically around approximately —11 volts dc, with peak voltages of about —6 and —16 volts.

The oscilloscope HORIZ POSITION controls provide the means for varying the Q324 base voltage between about —4 and —18 volts; a range which exceeds the peak voltages of the signal at the base of Q344.

Transistors Q344 and Q324 operate as a paraphase amplifier with degenerative emitter coupling. The resistance between the emitters and the —75-volt supply is quite high. Because of this high resistance, the total current through the two transistors is nearly constant and the input signal only reapportions the current. For example, an increase in current through Q344 would be offset by a nearly equal decrease in current through Q324. MAG REGIS (R339) is set during calibration to balance the output currents when Q344 and Q324 have equal emitter voltages.

The effective resistance between the base of Q344 and the stable voltage at the base of Q324 (via the degenerative emitter circuit) is much lower than the resistance to the —75-volt supply. Thus, Q344 can be considered as an emitter follower with the base circuit of Q324 acting as the signal ground point. The input signal voltage divides proportionally between the internal emitter resistance of Q344, the degenerative emitter coupling network, and the internal emitter resistance of Q324.

Since the internal emitter resistances of Q344 and Q324 are essentially equal, the two transistors receive base-emitter drive signals of essentially equal magnitude, but opposite phase. The ratio of the degenerative emitter-coupling resistance to the internal emitter resistances determines the magnitude of the base-emitter drive signals and therefore determines the magnitude of collector current swing of both Q344 and Q324. The resistance between the emitters is about 2.5 kΩ when the MAG switch is set to OFF and about 250 Ω when set to X10. These resistances are

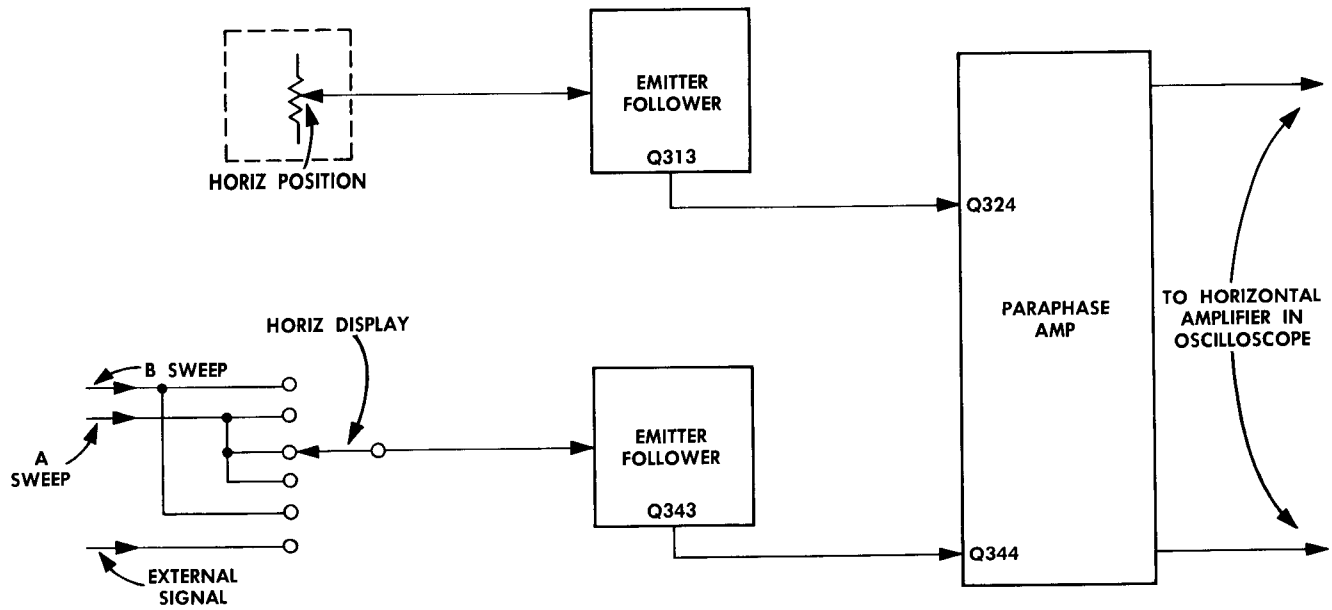


Fig. 3-6. Horizontal Preamp block diagram.

set during calibration to provide two precise current gain-factors which differ by a factor of ten-to-one.

The collectors of Q344 and Q324 are near ground potential and connected to the low-impedance input of the oscilloscope horizontal amplifier. Because of this low input impedance, the Horizontal Preamp of the Type 11B2 provides a current output at an essentially fixed voltage.

NOTES

SECTION 4

MAINTENANCE AND CALIBRATION

Introduction

Maintenance of the Type 11B2 is similar to that of the oscilloscope and is therefore described in the oscilloscope instruction manual.

The Type 11B2 is a stable instrument which will provide many hours of trouble-free operation. However, to insure measurement accuracy, it is suggested that you recalibrate the instrument after each 500 hours of operation, or every six months if used intermittently. It will also be necessary to recalibrate certain sections of the instrument when tubes, transistors, or other components are replaced.

This section of the manual contains two procedures: a calibration and verification procedure and an abridged adjustment procedure. In the 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. To further identify the calibration steps, an asterisk (*) precedes the step number. 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, adjustments must be completed in the order given and none should be skipped. Remember that you can be certain of proper overall operation only when all steps in the procedure have been completed.

The abridged adjustment procedure contains only the information necessary to adjust all seven internal calibration potentiometers without any test equipment. The only items required are an oscilloscope in which to install the Type 11B2, a vertical plug-in unit for the oscilloscope, an adjustment tool, and a 15-inch coaxial cable fitted with BNC connectors. The oscilloscope crystal-controlled 1-Kc Calibrator provides the required accurate time reference.

Adjustment of the four variable timing capacitors which control the accuracy of the six fastest sweep rates of each sweep generator is not described in this procedure since a timing standard other than the oscilloscope 1-Kc Calibrator would be required.

The abridged adjustment procedure, complete with a list of initial control settings and other necessary information is located at the end of this section. Extra copies of the abridged procedure may be obtained from your Tektronix Field Engineer.

NOTE

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

CALIBRATION AND VERIFICATION

Equipment Required

1. Oscilloscope such as the Tektronix Type 647. This procedure assumes that the oscilloscope has been calibrated independently. If this is not the case, refer to the oscilloscope instruction manual for information about calibrating the Type 11B2 and the oscilloscope as a system.

2. Tektronix 10-Series vertical plug-in unit such as the Type 10A2. This unit need not be calibrated, but must operate in all respects.

3. Constant-amplitude sine-wave generator such as the Tektronix Type 190A or 190B. Required characteristics: (a) output frequencies of 50 kc, 3 mc, and 50 mc, (b) output voltage adjustable 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.

4. Tektronix 50 Ω BNC termination, part no. 011-049.

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

6. Tektronix P6006 or P6008 Probe.

7. Time-mark generator such as the Tektronix Type 180A. Markers required at 1 and 5 seconds; 100, 10, and 1 milliseconds; 100, 50, 10, 5 and 1 microseconds; 5, 10, and 50-mc sine wave. All outputs should have a time accuracy of at least 0.01%.

8. Coaxial cables, fittings, and adjustment tools as required.

Preliminary Instructions

1. Remove the access panel from the right-hand side of the oscilloscope.

2. Set the controls and switches as follows:

Oscilloscope

INTENSITY	Low brightness
1KC CALIBRATOR	1 VOLTS

Type 11B2

HORIZ DISPLAY	EXT INPUT
MAG	OFF
B COUPLING	AC
B SOURCE	INT
B SLOPE	+
B TRIG LEVEL	0
A and B TIME/CM	5 mSEC
VARIABLE A	CALIB
B (variable)	CALIB

TRIG MODE	FREE RUN
A SLOPE	+
A COUPLING	DC
A SOURCE	INT
A TRIG LEVEL	0
DELAY TIME MULT	0.30

Vertical Plug-In Unit

NOTE
If a multi-trace plug-in unit is used, use channel 1.

MODE	CH 1
VOLTS/CM	.5
VARIABLE	CALIB
AC-DC-GND	DC
PULL TO INVERT	Pushed in
POSITION	Spot centered
TRIGGER	NORM

3. Apply power to the instruments and allow several minutes for warmup before beginning calibration.

NOTE
Photographs on a foldout page following the schematics in the back of this manual show the location of each calibration adjustment control and test point.

Procedure

*1. Adjust INT TRIG DC LEVEL (R7)

a. Remove the vertical plug-in unit.

b. Move B COUPLING switch back and forth between AC and DC, and adjust INT TRIG DC LEVEL (R7) so the spot on the crt remains stationary.

c. Reset B COUPLING switch to AC and reinstall the vertical plug-in unit.

2. Check A Free-Run Mode

a. Set HORIZ DISPLAY switch to A.

b. With TRIG MODE switch set to FREE RUN, check for a trace on crt.

3. Check A Normal Mode

a. Set TRIG MODE switch to NORM, and check for no trace on the the crt.

b. Set:

A SOURCE switch to LINE
A COUPLING switch to AC

c. Connect a X10 probe between the vertical input and a source of a power-line frequency sine-wave signal (such as pin 30, ≈ 6.3 volts ac, of the horizontal interconnecting plug in the oscilloscope).

d. Check that a triggered display can be obtained by adjusting the A TRIG LEVEL control. Note whether the display begins within the rising or falling portion of the sine wave.

e. Set A SLOPE switch to — and repeat step (d). The display should begin within the opposite portion of the sine wave (rise or fall) from that noted in step (d).

f. Disconnect the probe.

4. Check A Single-Sweep Mode

a. Set:

A TRIG LEVEL control to 0
A SLOPE switch to +
A and B TIME/CM switch to 50 mSEC
TRIG MODE switch to SINGLE SWEEP

b. Set A SOURCE switch to EXT and check that the RESET lamp is not lit and that there is no trace on the crt.

c. Push the RESET button.

d. Check that the RESET lamp is lit.

e. While watching the crt, set A SOURCE switch to LINE. Sweep Generator A should produce only one sweep on the crt and the RESET lamp should extinguish.

f. Set A SOURCE switch to EXT.

g. Set the oscilloscope 1KC CALIBRATOR to 5 VOLTS.

h. Momentarily connect the calibrator output to pin F of J101 on the rear panel of the oscilloscope.

i. Repeat steps (d) and (e).

5. Check A Automatic Mode

a. Set:

A SOURCE switch to EXT
A and B TIME/CM switch to 10 μSEC
TRIG MODE switch to AUTO

b. Connect the constant-amplitude sine-wave generator to the A TRIG IN connector. Terminate the generator with a Tektronix 50 Ω BNC termination unit (part no. 011-049), using a UHF to BNC adapter (part no. 103-032).

c. Set the generator for a 125-millivolt peak-to-peak output at 50 kc. (When a Tektronix Type 190A or 190B is used, a 125-millivolt peak-to-peak output across the termination is obtained when the attenuator is set to 0.5 volt and the meter indicates 5 volts on the 10-volt scale.)

d. Connect a Tektronix P6006 or P6008 Probe between the vertical input and the terminal on the rear of the A TRIG IN connector or the bottom of the 9.1-megohm resistor on the A SOURCE switch. Connect the probe-body ground lead to the Type 11B2 chassis.

e. Set the vertical plug-in VOLTS/CM switch to .01.

f. Check that a stable sine-wave display can be obtained by setting the A TRIG LEVEL control with the A SLOPE switch set to either + or —.

g. Repeat step (f) with A COUPLING switch set to AC LF REJ and then to DC.

h. Change the generator frequency to 50 mc and output amplitude to 250 millivolts peak-to-peak. (With a Tektronix Type 190A or 190B, set the attenuator to 0.5 volt and use a meter indication of 10 volts.)

NOTE

The input amplitude may be vertified with a sampling oscilloscope system by using a probe such as the Tektronix P6034. This probe should be connected in parallel with the probe used in step (d) and should be left connected through step (j).

i. Set:
A and B TIME/CM switch to .1 μSEC
MAG switch to X10
A COUPLING switch to AC

j. Repeat step (f). It may be necessary to use the HF STABILITY control to obtain a stable display.

k. Disconnect the probe and move the generator connection to the vertical input.

l. Set:
A SOURCE switch to INT
MAG switch to OFF
A and B TIME/CM switch to 20 μSEC
VOLTS/CM switch (vertical plug-in) to 2

m. Set the generator to 50 kc and reduce the output amplitude for 2 mm of deflection. Check that the A TRIG LEVEL control will stabilize the display.

n. Set:
A and B TIME/CM switch to .1 μSEC
MAG switch to X10
VOLTS/CM switch (vertical plug-in) to .5

o. Set the generator frequency to 50 mc and change the output amplitude as required for 10 mm of deflection. Check that the A TRIG LEVEL control will stabilize the display. (It may be necessary to use the HF STABILITY control.)

p. Disconnect the generator.

q. Set:
A SOURCE switch to EXT ÷ 10
A and B TIME/CM switch to 1 mSEC
MAG switch to OFF
VOLTS/CM switch (vertical plug-in) to 2
1KC CALIBRATOR switch (oscilloscope) to 5 VOLTS

r. Connect the oscilloscope calibrator output to the A TRIG IN connector and to the vertical input.

s. Check that a stable display can be obtained by setting the A TRIG LEVEL control.

t. Remove the signal connections.

6. Check B External Triggering Sensitivity

a. Set:
A SOURCE switch to INT
B SOURCE switch to EXT
A TIME/CM switch to 50 μSEC
B TIME/CM switch to 10 μSEC
HORIZ DISPLAY switch to A INTEN BY B (triggered)
VOLTS/CM switch (vertical plug-in) to .01

b. Connect the sine-wave generator to the B TRIG IN connector, see step 5b.

c. Connect a Tektronix P6006 or P6008 Probe between the vertical input and the solder connection on the rear of the B TRIG IN connector. Connect the probe-body ground lead to the Type 11B2 chassis. Do not use a plug-in extension between the Type 11B2 and the oscilloscope.

d. Set the generator for a 50-kc output at 125 millivolts peak-to-peak as described in step 5c.

e. Set A TRIG LEVEL control for a stable display.

f. Check that a stable intensified zone can be obtained near the left end of the display by setting the B TRIG LEVEL control.

g. Set B SLOPE switch to — and repeat step (f).

h. Set:
A TIME/CM switch to .5 μSEC
B TIME/CM switch to .1 μSEC
MAG switch to X10

i. Change the generator frequency to 50 mc and output amplitude to 250 millivolts peak-to-peak. (With a Type 190A or 190B, set the attenuator to 0.5 volt and use a meter indication of 10 volts.)

j. Set A TRIG LEVEL and HF STABILITY controls as required for a stable display.

k. Set HORIZ DISPLAY switch to B DLY'D BY A (triggered).

l. Check that a stable display can be obtained by setting the B TRIG LEVEL control.

m. Set:
B SLOPE switch to +
B COUPLING switch to DC

n. Repeat step (l).

o. Disconnect the probe.

7. Check B Internal Triggering Sensitivity

a. Set:
B SOURCE switch to INT
B COUPLING switch to AC
HORIZ DISPLAY switch to A INTEN BY B (triggered)
MAG switch to OFF
A TIME/CM switch to 50 μSEC
B TIME/CM switch to 10 μSEC
VOLTS/CM switch (vertical plug-in) to 1

b. Move the generator connection to the vertical input.

c. Change the genrator frequency to 50 kc and reduce the output amplitude for 2 mm of deflection.

d. Set A TRIG LEVEL control for a stable display.

e. Check that a stable intensified zone can be obtained near the left end of the display by setting the B TRIG LEVEL control.

f. Set:
A and B TIME/CM switch to .1 μSEC
MAG switch to X10
VOLTS/CM switch (vertical plug-in) to .2

g. Change the generator frequency to 50 mc and set the output amplitude for 10 mm of vertical deflection.

h. Set A TRIG LEVEL and HF STABILITY controls for a stable display.

i. Set HORIZ DISPLAY switch to B DLY'D BY A (triggered).

j. Check that a stable display can be obtained by setting the B TRIG LEVEL control.

k. Disconnect the input signal.

l. Reset:
MAG switch to OFF
A SLOPE switch to +

8. Adjust DELAY START (R150) and A SWP CAL (R160W)

a. Set:
TRIG MODE switch to AUTO
A COUPLING switch to AC
A TIME/CM switch to 1 mSEC
B TIME/CM switch to 2 μSEC
DELAY TIME MULT dial to 1.00
HORIZ DISPLAY switch to A INTEN BY B (non-triggered)
VOLTS/CM switch (vertical plug-in) to 2
INTENSITY control for normal brightness

b. Apply 1-millisecond markers to the vertical input.

c. Set A TRIG LEVEL control for a triggered display.

d. Set INTENSITY control so the small brightened spot near the left end of the trace is easily seen.

e. Adjust DELAY START (R150) so the peak of the 1st marker (not counting the marker at the left end of the trace) is intensified.

f. Set DELAY TIME MULT dial to 9.00.

g. Adjust A SWP CAL (R160W) so the peak of the 9th marker (not counting the marker at the left end of the trace) is intensified.

h. If necessary, repeat steps (e) and (g) until the effects of adjustment interaction are minimized.

i. Set:
HORIZ DISPLAY switch to B DLY'D BY A (non-triggered)
DELAY TIME MULT dial to 1.00
B TIME/CM switch to 10 μSEC

j. Adjust DELAY START (R150) so the trace begins near the base of the leading edge of the time marker displayed on the crt.

k. Set DELAY TIME MULT dial to 9.00.

l. Adjust A SWP CAL (R160W) so the trace begins near the base of the leading edge of the time marker displayed on the crt.

m. Repeat steps (i) through (l) until there is no further improvement.

9. Check Delay Linearity

a. Using the same setup as in step 8, turn DELAY TIME MULT dial clockwise to about (2.00) until the marker peak is at the left end of the trace.

b. Check that DELAY TIME MULT dial indicates (2.00), ±0.015.

c. Repeat steps (a) and (b) for each major digit on the DELAY TIME MULT dial: 3.00 through 8.00 The tolerance at each setting is ±0.015.

10. Check Delay-Time Jitter

a. Set B TIME/CM switch to 1 μSEC.

b. With 1-millisecond time markers applied to the vertical input, set DELAY TIME MULT dial near 9.00 to position the rise of a marker near the center of the graticule.

c. Check that the marker jitters horizontally 0.5 centimeter or less.

d. Repeat steps (b) and (c) with DELAY TIME MULT dial set near 1.00.

*11. Adjust NORM GAIN (R331)

a. Set HORIZ DISPLAY switch to A.

b. Adjust NORM GAIN (R331) for 1 marker/cm. Refine this adjustment so the 1st and 9th markers are aligned with the 1st and 9th major graticule lines. (The marker at the beginning of the trace and the line at the extreme left edge of the graticule are each counted as 0.)

*12. Adjust MAG GAIN (R334)

a. Set MAG switch to X10. Check that the MAG lamp on the front panel of the Type 11B2 is lit.

b. Apply 100-microsecond markers to the vertical input.

c. If necessary, set A TRIG LEVEL control for a stable display.

d. Adjust MAG GAIN (R334) for 1 marker/cm. Refine this adjustment so markers are exactly aligned with the 1st and 9th major graticule lines.

*13. Adjust MAG REGIS (R339)

a. Apply 5-millisecond time markers to the vertical input.

b. With MAG switch to X10, set HORIZ POSITION control so that the peak of the marker nearest the center of the expanded trace is at the exact center of the graticule.

c. Set MAG switch to OFF.

d. Adjust MAG REGIS (R339) so the peak of the center time marker is again positioned to the exact center of the graticule.

e. If necessary, repeat steps (b) through (d) until there is no further improvement.

f. Reset MAG switch to OFF.

14. Check A Sweep Length: 10.5—11.0 cm

a. Apply 1-millisecond markers to the vertical input.

b. Set HORIZ POSITION control so the 1st marker is aligned with the 0 graticule line. (This will put 1 centimeter of the trace outside the left edge of the graticule.)

c. Check that the right-hand end of the trace is within the last one-half centimeter of the graticule.

15. Check VARIABLE A Range and UNCAL Lamp

a. Apply 10-millisecond markers to the vertical input.

b. Set HORIZ POSITION control so the 0 marker is aligned with the 0 graticule line.

c. Slowly turn VARIABLE A control counterclockwise. The distance between markers should decrease smoothly. With VARIABLE A control fully counterclockwise, there should be 4 centimeters or less between markers.

d. Check that the UNCAL lamp is lit.

e. Reset VARIABLE A control to CALIB.

16. Check A Delay-Time Ranges: 10 μSEC—5 SEC

a. Set:
A TIME/CM switch to (10 μSEC)
B TIME/CM switch to (.5 μSEC)
HORIZ DISPLAY switch to A INTEN BY B (non-triggered)
TRIG MODE switch to NORM

b. Apply (10-microsecond) markers to the vertical input.

c. Set A TRIG LEVEL control for a triggered display.

d. Check for (1) marker/cm and that markers can be simultaneously aligned with the 1st and 9th graticule lines. (With a 10-microsecond/cm sweep rate, the tolerance for exact marker alignment at the 9th line, when a marker is aligned with the 1st line, is ±1.2 mm.)

e. Set INTENSITY control so both brightness levels in the display are easily seen.

f. Set DELAY TIME MULT dial so the 1st marker is intensified.

g. Set HORIZ DISPLAY switch to B DLY'D BY A (non-triggered).

h. Set DELAY TIME MULT dial so the trace begins during the marker rise. Record the exact DELAY TIME MULT dial indication.

i. Set DELAY TIME MULT dial near 9.00 so the trace again begins during the marker rise. Record the exact DELAY TIME MULT dial indication.

j. Subtract the first dial indication from the second. The difference should be 8.00 (±0.08 when the A sweep rate is 10 microseconds/cm).

k. Repeat steps (a) through (j) for each A sweep rate listed in Table 4-1.

TABLE 4-1

Step A		Step B	Step D		Step J
A TIME/CM	B TIME/CM	Time Marker	Markers Per Cm	Tol. (mm)	DELAY TIME MULT Tol.
10 μSEC	.5 μSEC	10 μsec	1	±1.2	±0.08
20 μSEC	.5 μSEC	10 μsec	2	±1.2	±0.08
50 μSEC	2 μSEC	50 μsec	1	±1.2	±0.08
.1 mSEC	5 μSEC	100 μsec	1	±1.2	±0.08
1 mSEC	50 μSEC	1 msec	1	±1.2	±0.08
10 mSEC	.5 mSEC	10 msec	1	±1.2	±0.08
.1 SEC	5 mSEC	100 msec	1	±2.4	±0.20
1 SEC	50 mSEC	1 sec	1	±2.4	±0.20
2 SEC	50 mSEC	1 sec	2	±2.4	±0.20
5 SEC	.2 SEC	5 sec	1	±2.4	±0.20

l. Reset TRIG MODE switch to AUTO.

*17. Adjust A Sweep Rates and Delay Time: 5 μSEC-.1 μSEC

a. Set:
A TIME/CM switch to 1 μSEC
B TIME/CM switch to .1 μSEC
HORIZ DISPLAY switch to A INTEN BY B (non-triggered)

b. Apply 1-microsecond markers to the vertical input.

c. Set A TRIG LEVEL control for a triggered display.

d. Adjust C160C for 1 marker/cm.

e. Check the adjustment of C160C by using steps 16e through 16j.

f. If step 16j indicates an error greater than ±0.08 on the DELAY TIME MULT dial, readjust C160C.

g. Repeat steps 16f through 16j until the dial indicates an error less than ±0.08. Be certain that the requirement of step 17d is retained.

h. Set:
A and B TIME/CM switch to .5 μSEC
HORIZ DISPLAY switch to A

i. Horizontally position the marker that is about 2 centimeters from the beginning of the trace to the line that is 1 centimeter from the left edge of the graticule.

j. Adjust C160A for 1 marker/2 cm. Refine the adjustment so markers can be exactly aligned with the 1st and 9th graticule lines.

k. Set A and B TIME/CM switch to .2 μSEC.

l. Apply 5-mc markers (sine waves) to the vertical input and obtain a triggered display.

m. Check for 1 marker/cm and that the 1st and 9th markers can be simultaneously aligned with the 1st and 9th graticule lines. With this sweep rate, the tolerance for exact marker alignment at the 9th centimeter line, when a marker is aligned with the 1st centimeter line, is ±1.2 mm.

n. Set A and B TIME/CM switch to .1 μSEC.

o. Apply 10-mc markers (sine waves) to the vertical input and obtain a triggered display.

p. Repeat step (m).

18. Check 10-Nanosecond/Cm Sweep Rate (.1 μsec/cm with MAG switch to X10)

a. Set MAG switch to X10.

b. Apply 50-mc markers (sine waves) to the vertical input.

c. Set A TRIG LEVEL and HF STABILITY controls for a stable, triggered display.

d. Check for 1 marker/2 cm and that markers can be simultaneously aligned with the 1st and 9th graticule lines. The tolerance for exact marker alignment at the 9th line, when a marker is aligned with the 1st line, is ±2.8 mm.

NOTE

The accuracy of the 10 nanosecond/cm sweep rate depends, to a large degree, on the high-frequency response of the main horizontal amplifier in the oscilloscope.

e. Reset MAG switch to OFF.

*19. Adjust B SWP CAL (R260W)

a. Set:
HORIZ DISPLAY switch to B DLY'D BY A (non-triggered)
A TIME/CM switch to 2 mSEC
B TIME/CM switch to 1 mSEC
DELAY TIME MULT dial to 0.30

b. Apply 1-millisecond markers to the vertical input.

c. Set A TRIG LEVEL control for a stable display.

d. Set HORIZ POSITION control so the marker nearest the left end of the trace is aligned with the 1st graticule line.

e. Adjust B SWP CAL (R260W) for 1 marker/cm. Refine the adjustment so markers can be simultaneously aligned with the 1st and 9th graticule lines.

20. Check B Sweep Length: 10.2—10.7 Cm

a. Set DELAY TIME MULT dial near 0.50 so the trace begins at a marker peak.

b. With a stable display of 1-millisecond markers, set HORIZ POSITION control so the 1st marker is one and one-half minor divisions to the right of the 0 graticule line.

c. Check that the right-hand end of the trace is within the last one-half centimeter of the graticule.

d. Horizontally center the display.

21. Check B (Variable) Control Range and UNCAL Lamp

a. Set B TIME/CM switch to .1 mSEC.

b. With a stable display of 1-millisecond markers, slowly turn B (variable) control counterclockwise. The distance between markers should decrease smoothly. With B (variable) control fully counterclockwise, there should be 4 centimeters or less between markers.

c. Check that the UNCAL lamp is lit.

d. Reset B (variable) control to CALIB.

22. Check B Sweep Rates: 10 μSEC—5 SEC

a. set:
VARIABLE A control to midrange
A and B TIME/CM switch to (10 μSEC)
TRIG MODE switch to NORM
DELAY TIME MULT dial to 0.30

b. Apply (10-microsecond) markers to the vertical input.

c. Set A TRIG LEVEL control for a stable display.

d. Check for (1) marker/cm and that markers can be simultaneously aligned with the 1st and 9th graticule lines. (With a 10 microsecond/cm sweep rate, the tolerance for exact marker alignment at the 9th line, when a marker is aligned with the 1st line, is ±1.2 mm)

e. Repeat steps (a) through (d) for each B sweep rate listed in Table 4-2.

TABLE 4-2

Step A	Step B	Step D	
A and B TIME/CM	Time Marker	Markers Per Cm	Tol. (mm)
10 μSEC	10 μsec	1	±1.2
20 μSEC	10 μsec	2	±1.2
50 μSEC	50 μsec	1	±1.2
.1 mSEC	100 μsec	1	±1.2
1 mSEC	1 msec	1	±1.2
10 mSEC	10 msec	1	±1.2
.1 SEC	100 msec	1	±2.4
1 SEC	1 sec	1	±2.4
2 SEC	1 sec	2	±2.4
5 SEC	5 sec	1	±2.4

f. Reset TRIG MODE switch to AUTO.

*23. Adjust B Sweep Rates: 5 μSEC—.1 μSEC

a. Set:
VARIABLE A control to midrange
A and B TIME/CM switch to 1 μSEC

b. Apply 1-microsecond markers to the vertical input.

c. Set A TRIG LEVEL control for a stable display.

d. Adjust C260C for 1 marker/cm. Refine this adjustment so that markers can be simultaneously aligned with the 1st and 9th graticule lines.

e. Set A and B TIME/CM switch to .5 μSEC.

f. Adjust C260A for 1 marker/2cm. Refine this adjustment so that markers can be simultaneously aligned with the 1st and 9th graticule lines.

24. Check B Sweep Rates: .2 μSEC and .1 μSEC

a. Set A and B TIME/CM switch to .2 μSEC.

b. Apply 5-mc markers (sine waves) to the vertical input.

c. If necessary, set A TRIG LEVEL and HF STABILITY controls for a stable display.

d. Check for 1 marker/cm and that the 1st and 9th markers can be simultaneously aligned with the 1st and 9th graticule lines. The tolerance for exact marker alignment at the 9th line, when a marker is aligned with the 1st line, is ±1.2 mm.

e. Set A and B TIME/CM switch to .1 μSEC.

f. Apply 10-mc markers (sine waves) to the vertical input.

g. Repeat steps (c) and (d).

h. Reset VARIABLE A control to CALIB.

i. Disconnect the input signal.

25. Check External Horizontal Deflection Sensitivity

a. Set:
A and B TIME/CM switch to 1 mSEC
INTENSITY control to 0
HORIZ DISPLAY switch to EXT INPUT
B COUPLING switch to DC
B SOURCE switch to EXT
1KC CALIBRATOR switch to 5 VOLTS

b. Connect oscilloscope calibrator output to B TRIG IN OR EXT INPUT connector.

c. Set INTENSITY control to obtain a display. The display should consist of two spots or short horizontal lines.

d. Check that the peak-to-peak horizontal deflection is between 4.5 and 5.5 centimeters.

e. Set 1KC CALIBRATOR switch to .5 VOLTS.

f. Horizontally center the display.

g. Set MAG switch to X10.

h. Repeat step (d).

i. Disconnect the input signal.

26. Check External Horizontal Frequency Response

a. Set MAG switch to OFF.

b. Connect the constant-amplitude sine-wave generator to B TRIG IN OR EXT INPUT connector. Terminate the generator with a Tektronix 50 Ω termination (part no. 011-049), using a UHF to BNC adapter (part no. 103-032).

c. Set the generator frequency to 50 kc and output amplitude to produce 4 centimeters peak-to-peak horizontal deflection.

d. Without changing the output amplitude, increase the generator frequency to 3 mc.

e. Check that the peak-to-peak horizontal deflection is at least 2.8 centimeters.

f. Disconnect the generator.

g. Reset:
HORIZ DISPLAY switch to A
MAG switch to OFF
INTENSITY control for normal trace

27. (Optional) Check Alternate-Trace Vertical Operation

a. Set TRIG MODE switch to FREE RUN.

b. Set the vertical plug-in unit (e.g. Type 10A2) switches for alternate-trace operation.

c. Check that the appropriate number of traces are obtained.

28. Check +GATE and SWEEP Connector Output Signals

a. Set:
TRIG MODE switch to FREE RUN
A TIME/CM switch to .5 μSEC
B TIME/CM switch to .2 μSEC
DELAY TIME MULT dial to 0.30
HORIZ DISPLAY switch to A INTEN BY B (non-triggered)
VOLTS/CM switch (vertical plug-in) to 5

b. If the sensitivity of the vertical plug-in unit is known to be correct, use it to check for the following output voltages. Otherwise, use a separate oscilloscope.
+ GATE A ≈ 15 v
+ GATE B ≈ 15 v
SWEEP A ≈ 10 v
SWEEP B ≈ 10 v

NOTES

Abridged Adjustment Procedure

Introduction

This procedure contains only the information necessary to adjust the seven internal calibration potentiometers without test equipment. The time-accuracy of these adjustments is derived from the oscilloscope crystal-controlled 1-Kc Calibrator. Adjustment of the four variable timing capacitors which establish the accuracy of the six fastest sweep rates of each sweep generator is not described here because a timing standard other than the 1-Kc Calibrator would be required.

Preliminary Instructions

1. Remove the access panel from the right-hand side of the oscilloscope.

2. Set the controls and switches as follows:

Oscilloscope

INTENSITY	Low brightness
1 KC CALIBRATOR	1 VOLTS

Type 11B2

HORIZ DISPLAY	EXT INPUT
MAG	OFF
B SOURCE	INT
A TIME/CM	1 mSEC
VARIABLE A	CALIB
B TIME/CM	1 μSEC
(variable) B	CALIB
TRIG MODE	AUTO
A SLOPE	+
A COUPLING	AC
A SOURCE	INT
DELAY TIME MULT	1.00

Vertical Plug-In Unit

VOLTS/CM	.5
VARIABLE	CALIB
AC-DC-GND	AC
POSITION	Spot centered
MODE	CH 1
TRIGGER	NORM
PULL TO INVERT	Pushed in

3. Apply power to the instrument and allow several minutes for warmup.

Procedure

1. Adjust INT TRIG DC LEVEL (R7)

a. Remove the vertical plug-in unit.

b. Move B COUPLING switch back and forth between AC and DC, and adjust INT TRIG DC LEVEL (R7) so the spot on the crt remains stationary.

c. Reset B COUPLING switch to AC and reinstall the vertical plug-in unit.

2. Adjust DELAY START (R150) and A SWP CAL (R160W)

a. Set:
HORIZ DISPLAY switch to A INTEN BY B (non-triggered)
INTENSITY control for normal brightness

b. Connect the oscilloscope 1-Kc Calibrator signal to the vertical input.

c. Set A TRIG LEVEL control for a triggered display.

d. Set INTENSITY control so the small brightened spot near the left end of the trace is easily seen.

e. Adjust DELAY START (R150) so the rise of the 1st pulse (not counting the pulse at the extreme left end of the trace) is intensified.

f. Set DELAY TIME MULT dial to 9.00.

g. Adjust A SWP CAL (R160W) so the rise of the 9th pulse (not counting the pulse at the extreme left end of the trace) is intensified.

h. If necessary, repeat steps (e) and (g) until the effects of adjustment interaction are minimized.

i. Set:
HORIZ DISPLAY switch to B DLY'D BY A (non-triggered)
DELAY TIME MULT dial to 1.00
B TIME/CM switch to 10 μSEC

j. Adjust DELAY START (R150) so the pulse rise is at the left end of the trace.

k. Set DELAY TIME MULT dial to 9.00.

l. Adjust A SWP CAL (R160W) so the pulse rise is at the left end of the trace.

m. Repeat steps (i) through (l) until no further improvement can be made.

3. Adjust NORM GAIN (R331)

a. Set HORIZ DISPLAY switch to A.

b. Adjust NORM GAIN (R331) for 1 pulse/cm. Refine this adjustment so the rise of the 1st and 9th pulses are aligned with the 1st and 9th graticule lines. (The pulse rise at the beginning of the trace and the line at the extreme left edge of the graticule are each counted as number 0.)

4. Adjust MAG GAIN (R334)

a. Set:
A and B TIME/CM switch to 10 mSEC
MAG switch to X10

b. Adjust MAG GAIN (R334) for 1 pulse/cm. Refine this adjustment so pulse rise can be exactly aligned with the 1st and 9th graticule lines.

5. Adjust MAG REGIS (R339)

a. Set A and B TIME/CM switch to .1 mSEC.

b. With MAG switch set to X10, set HORIZ POSITION control so that the pulse fall near the center of the expanded trace is at the exact center of the graticule.

c. Set MAG switch to OFF.

d. Adjust MAG REGIS (R339) so the peak of the 0 pulse is again positioned to the exact center of the graticule.

e. If necessary, repeat steps (b) through (d) until no further improvement can be made.

f. Reset MAG switch to OFF.

6. Adjust B SWP CAL (R260W)

a. Set:

HORIZ DISPLAY switch to B DLY'D BY A (non-triggered)
A TIME/CM switch to 2 mSEC
B TIME/CM switch to 1 mSEC
DELAY TIME MULT dial to 0.30

b. Set HORIZ POSITION control so the pulse rise nearest the left end of the trace is aligned with the 1st graticule line.

c. Adjust B SWP CAL (R260W) for 1 pulse/cm. Refine the adjustment so pulse rises can be simultaneously aligned with the 1st and 9th graticule lines.

SECTION 5
PARTS LIST AND SCHEMATICS

PARTS ORDERING INFORMATION

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

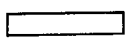
Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information 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.

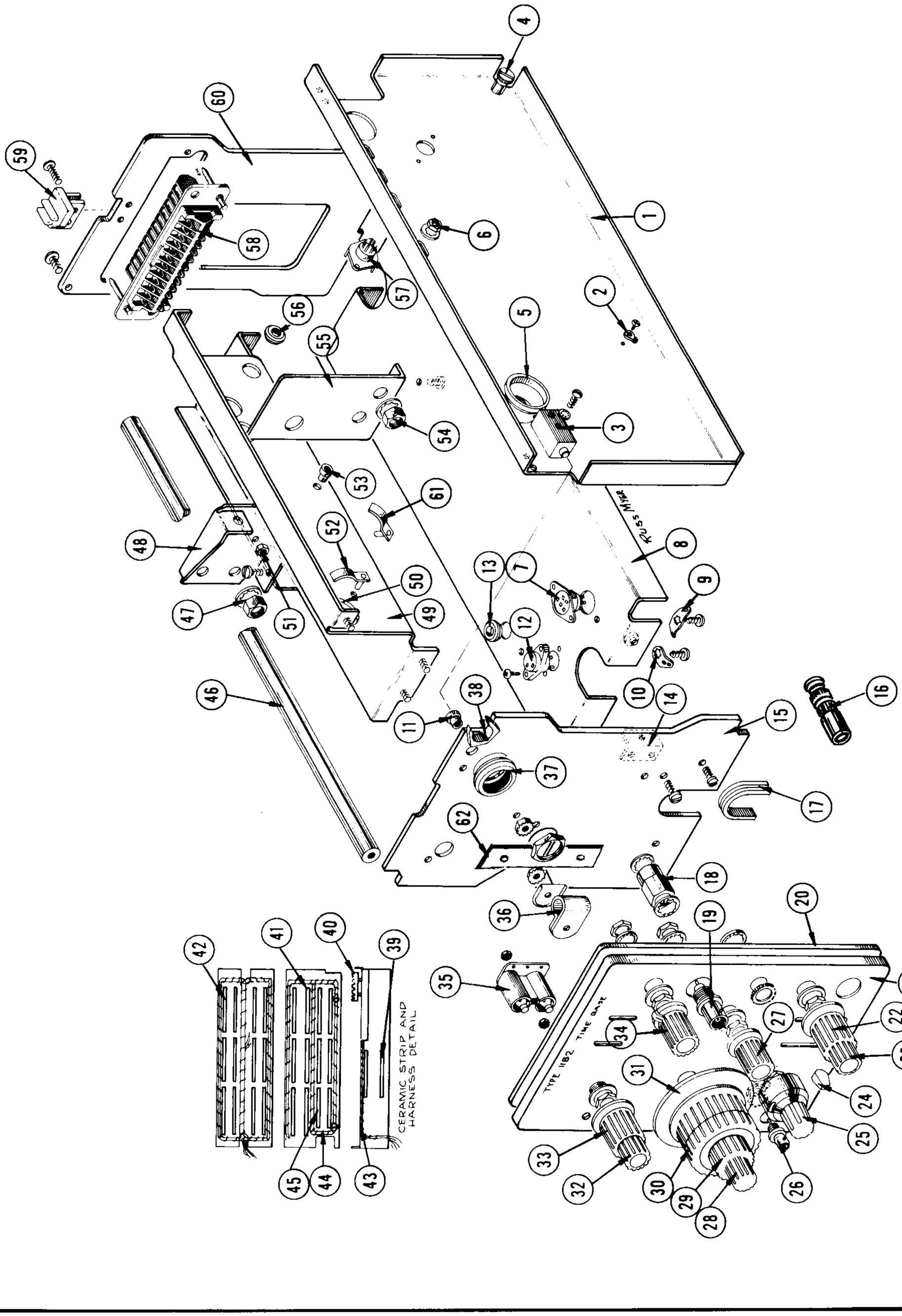
ABBREVIATIONS AND SYMBOLS

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	mjlli, 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



EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	441-0486-00			1	CHASSIS, B time base
2	210-0259-00			3	LUG, solder #2
	213-0113-00			3	SCREW, thread forming, 2-32 x 5/16 inch RHS, phillips
3	214-0340-00			2	PIN, hinge
	- - - - - -			-	Mounting Hardware For Each: (not included)
	211-0016-00			2	SCREW, 4-40 x 5/8 inch RHS
	210-0004-00			2	LOCKWASHER, steel, internal #4
4	214-0329-00			2	FASTENER, retractable screw, assembly
5	348-0050-00			2	GROMMET, nylon
6	- - - - - -			-	Pot Mounting Hardware For Each:
	210-0583-00			1	NUT, hex, brass, 1/4-32 x 5/16 inch
	210-0940-00			1	WASHER, steel
7	136-0101-00			3	SOCKET, 5 pin
	- - - - - -			-	Mounting Hardware For Each: (not included)
	213-0055-00			2	SCREW, thread forming, 2-56 x 3/16 inch PHS
8	441-0488-00			1	CHASSIS, A time base
	- - - - - -			-	Mounting Hardware For Each: (not included)
	211-0504-00			4	SCREW, 6-32 x 1/4 inch BHS
9	210-0204-00			1	LUG, solder, DE6
	213-0044-00			1	SCREW, thread cutting, 5-32 x 3/16 inch PHS
10	210-0201-00			9	LUG, solder, SE4
	213-0044-00			9	SCREW, thread cutting, 5-32 x 3/16 inch PHS
11	358-0210-00			2	BUSHING, nylon
12	136-0161-00	100	959	38	SOCKET, transistor
	136-0181-00	960		38	SOCKET, 3 pin transistor
	- - - - - -			-	Mounting Hardware For Each: (not included)
	213-0113-00	100	959	2	SCREW, thread forming, 2-32 x 5/16 inch RHS, phillips
	354-0234-00	960		1	RING, locking, transistor socket
13	348-0003-00			1	GROMMET, rubber, 5/16 inch
14	406-0908-00			2	BRACKET, chassis latch
	- - - - - -			-	Mounting Hardware For Each: (not included)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch BHS
15	387-0779-00			1	PLATE, bulkhead, alum
16	- - - - - -			1	ADAPTER, connector, BSM to BNC (See Standard Accessories)
17	358-0215-00			3	BUSHING, black plastic
18	- - - - - -			-	Switch Mounting Hardware For Each:
	210-0494-00			1	NUT, hex, alum, 3/8-32 x 1/2 x 11/16 inch
	210-0012-00			1	LOCKWASHER, steel, pot, internal, 3/8 x 1/2 inch
	210-0013-00			1	LOCKWASHER, steel, internal, 3/8 x 11/16 inch
19	131-0106-00			2	CONNECTOR, chassis mount, BNC, 1 contact
	- - - - - -			-	Each Includes:
	210-0413-00			1	NUT, hex, brass, 3/8-32 x 1/2 inch
	210-0012-00			1	LOCKWASHER, steel, pot, internal, 3/8 x 1/2 inch
20	387-0778-00			1	PLATE, subpanel, front
21	333-0750-00			1	PANEL, front
22	366-0249-00			1	KNOB, TRIG LEVEL, charcoal
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
23	366-0255-00			1	KNOB, HF STABILITY, red
	- - - - - -			-	Includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch HSS

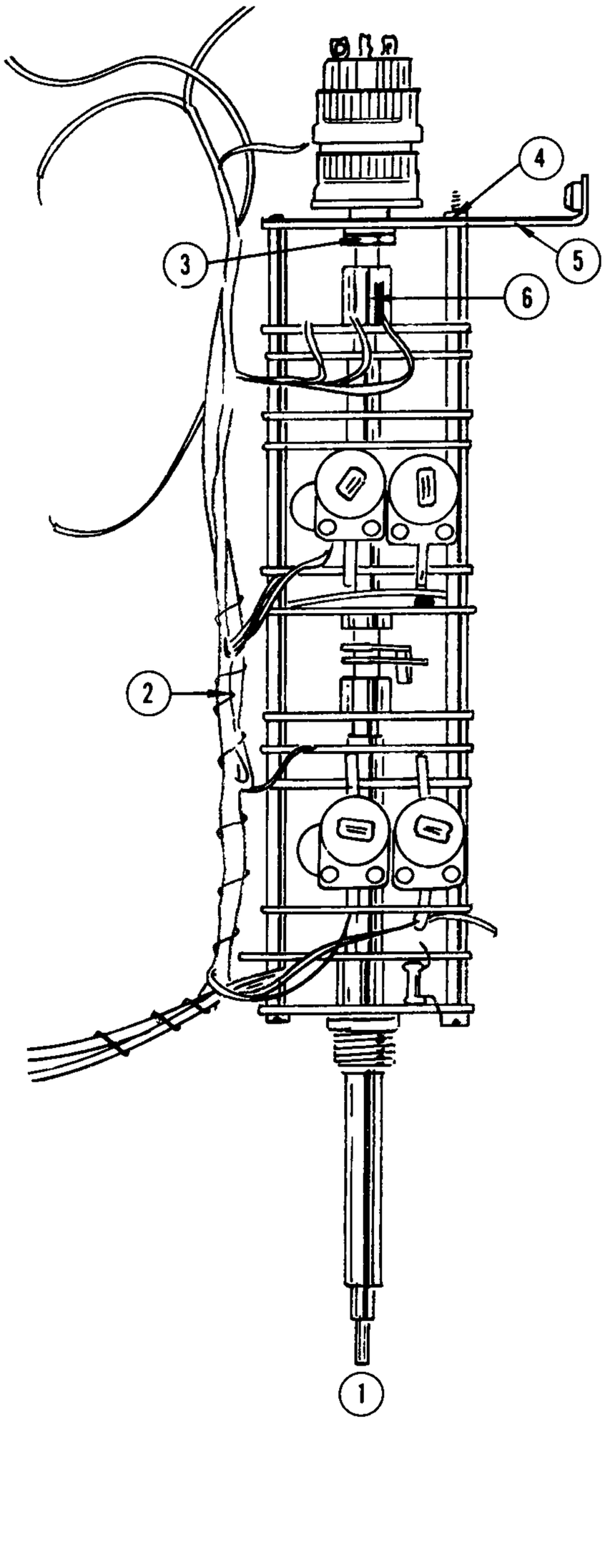
EXPLODED VIEW *(Cont'd)*

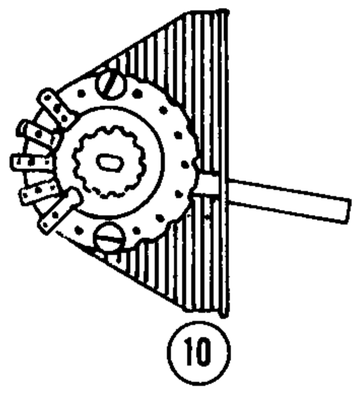
REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
24	366-0215-00	100	849	6	KNOB, lever switch
	366-0215-01	850		6	KNOB, lever switch
25	331-0096-00	100	579	1	DIAL, with charcoal knob
	331-0139-00	580		1	DIAL, with charcoal knob
	- - - - - -			-	Includes:
	213-0022-00			1	SCREW, set, 4-40 x 3/16 inch HSS
26	131-0282-00			4	CONNECTOR, bulkhead receptacle
	- - - - - -			-	Mounting Hardware For Each: (not included)
	210-0583-00			1	NUT, hex, brass, 1/4-32 x 3/16 inch
	210-0046-00			1	LOCKWASHER, steel
	210-0223-00			1	LUG, solder, 1/4 inch
27	366-0220-00			1	KNOB, TRIG MODE, charcoal
	- - - - - -			-	Includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch HSS
28	366-0232-00			1	KNOB, variable B, red
	- - - - - -			-	Includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch HSS
29	366-0222-00			1	KNOB, VARIABLE A, red
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
30	366-0194-00			1	KNOB, TIME/CM AND DELAY TIME, charcoal
	- - - - - -			-	Includes:
	213-0022-00			2	SCREW, set, 4-40 x 3/16 inch HSS
31	331-0092-00			1	KNOB, dial window
32	366-0140-00			1	KNOB, MAG, red
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
33	366-0250-00			1	KNOB, HORIZ DISPLAY, charcoal
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
34	366-0220-00			1	KNOB, TRIG LEVEL, charcoal
	- - - - - -			-	Includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch HSS
35	352-0064-00			1	HOLDER, double neon
	- - - - - -			-	Mounting Hardware: (not included)
	211-0031-00			1	SCREW, 4-40 x 1 inch FHS
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 inch
36	343-0004-00			2	CLAMP, cable, 5/16 inch plastic
	- - - - - -			-	Mounting Hardware For Each: (not included)
	210-0863-00			1	WASHER, steel, "D" type #10
	210-0458-00			1	NUT, steel, 8-32 x 11/32 inch
37	348-0006-00			1	GROMMET, rubber, 3/4 inch
38	343-0093-00			4	CLAMP, plug-in rod
	- - - - - -			-	Mounting Hardware For Each: (not included)
	211-0094-00			1	SCREW, 4-40 x 1/2 inch PHS
39	124-0154-00			2	STRIP, ceramic, 20 notches, 3 x 7/16 inch
	- - - - - -			-	Mounting Hardware For Each: (not included)
	361-0009-00			2	SPACER, nylon
40	124-0149-00			2	STRIP, ceramic, 7 notches, 1 5/32 x 7/16 inch
	- - - - - -			-	Mounting Hardware For Each: (not included)
	361-0007-00			2	SPACER, nylon

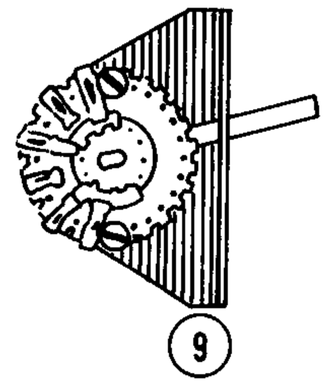
EXPLODED VIEW *(Cont'd)*

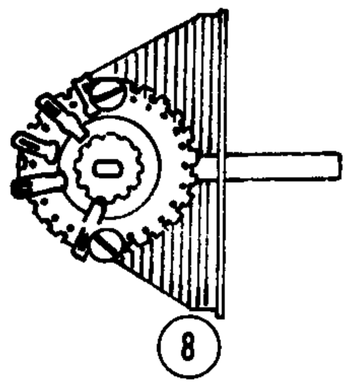
REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
41	124-0154-00			10	STRIP, ceramic, 20 notches, 3 x 7/16 inch
	- - - - - -			-	Mounting Hardware For Each: (not included)
	361-0007-00			2	SPACER, nylon
42	124-0154-00			12	STRIP, ceramic, 20 notches, 3 x 7/16 inch
	- - - - - -			-	Mounting Hardware For Each: (not included)
	361-0007-00			2	SPACER, nylon
43	179-0820-00			1	CABLE, harness, horizontal amplifier
44	179-0756-00			1	CABLE, harness, B chassis
45	124-0146-00			2	STRIP, ceramic, 16 notches, 2 7/16 x 7/16 inch
	- - - - - -			-	Mounting Hardware For Each: (not included)
	361-0007-00			2	SPACER, nylon
46	384-0615-00			4	ROD, spacer, hex tubing, 12 1/4 inch long
	- - - - - -			-	Mounting Hardware For Each: (not included)
	212-0044-00			2	SCREW, 8-32 x 1/2 inch
	214-0370-00			2	PIN, locating, 15/16 inch long, with 8-32 thread
47	- - - - - -			-	Capacitor Mounting Hardware For Each:
	210-0524-00			1	NUT, hex, steel, 5/16-23 x 1/2 x 3/16 inch
	210-0018-00			1	LOCKWASHER, steel, 5/16 inch
48	406-0906-00			1	BRACKET, capacitor mounting
	- - - - - -			-	Mounting Hardware: (not included)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch BHS
49	441-0487-00			1	CHASSIS, horizontal amplifier
	- - - - - -			-	Mounting Hardware: (not included)
	211-0504-00			3	SCREW, 6-32 x 1/4 inch BHS
	210-0457-00			3	NUT, steel, 6-32 x 5/16 inch
50	348-0050-00			2	GROMMET, nylon
51	- - - - - -			-	Capacitor Mounting Hardware For Each:
	210-0457-00			4	NUT, steel, 6-32 x 5/16 inch
52	343-0089-00			2	CLAMP, cable, size "D", delrin snap
53	348-0031-00			1	GROMMET, polypropylene, snap-in, 1/4 inch
54	- - - - - -			-	Capacitor Mounting Hardware For Each:
	210-0524-00			1	NUT, hex, steel, 5/16-24 x 1/2 x 3/16 inch
	210-0018-00			1	LOCKWASHER, steel, 5/16 inch
55	- - - - - -			1	BRACKET, time/cm switch, alum (see switch page)
56	348-0003-00			1	GROMMET, rubber, 5/16 inch
57	136-0078-00			1	SOCKET, No.704 BC, subminiature
	- - - - - -			-	Mounting Hardware: (not included)
	213-0055-00			2	SCREW, thread forming, 2-56 x 3/16 inch PHS
58	131-0096-00			1	CONNECTOR, chassis mount, 32 contact
	- - - - - -			-	Mounting Hardware: (not included)
	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS
	210-0003-00	X360		2	LOCKWASHER, external, #4
	210-0201-00			2	LUG, solder, SE4
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 inch
59	351-0063-00			2	GUIDE, shoe, white delrin
	- - - - - -			-	Mounting Hardware For Each: (not included)
	211-0013-00			2	SCREW, 4-40 x 3/8 inch RHS
	210-0004-00			2	LOCKWASHER, steel, internal #4
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 inch
60	387-0777-00			1	PLATE, rear, alum
61	343-0088-00	X603		3	CLAMP, cable, size "C"
	- - - - - -			-	mounting hardware for each: (not incl w/clamp)
	361-0007-00			1	SPACER, nylon
62	343-0117-00	X603		1	CLAMP, switch support
	- - - - - -			-	mounting hardware: (not included w/clamp)
	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS

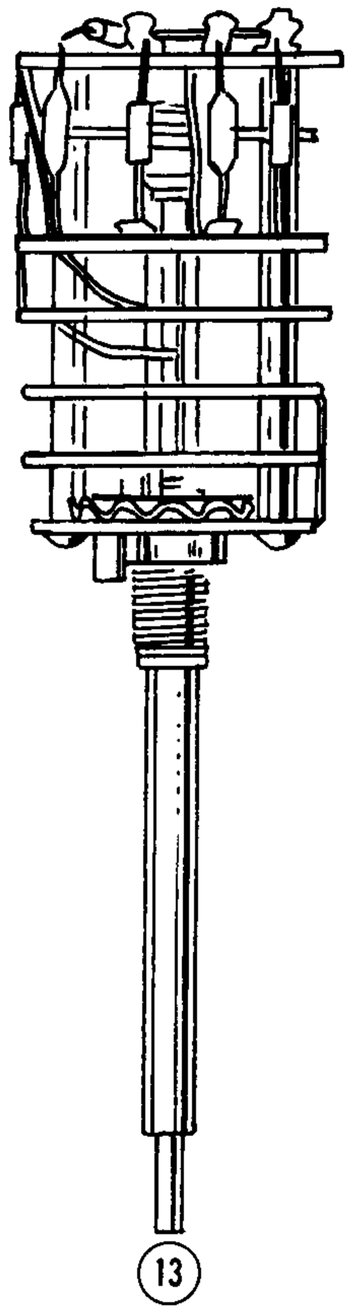
SWITCHES

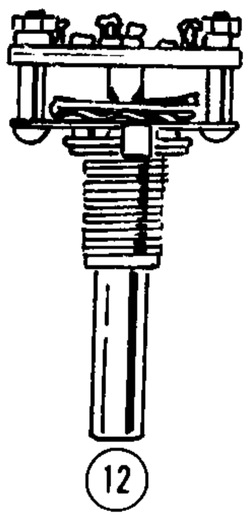


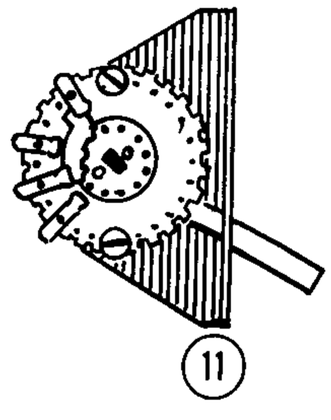












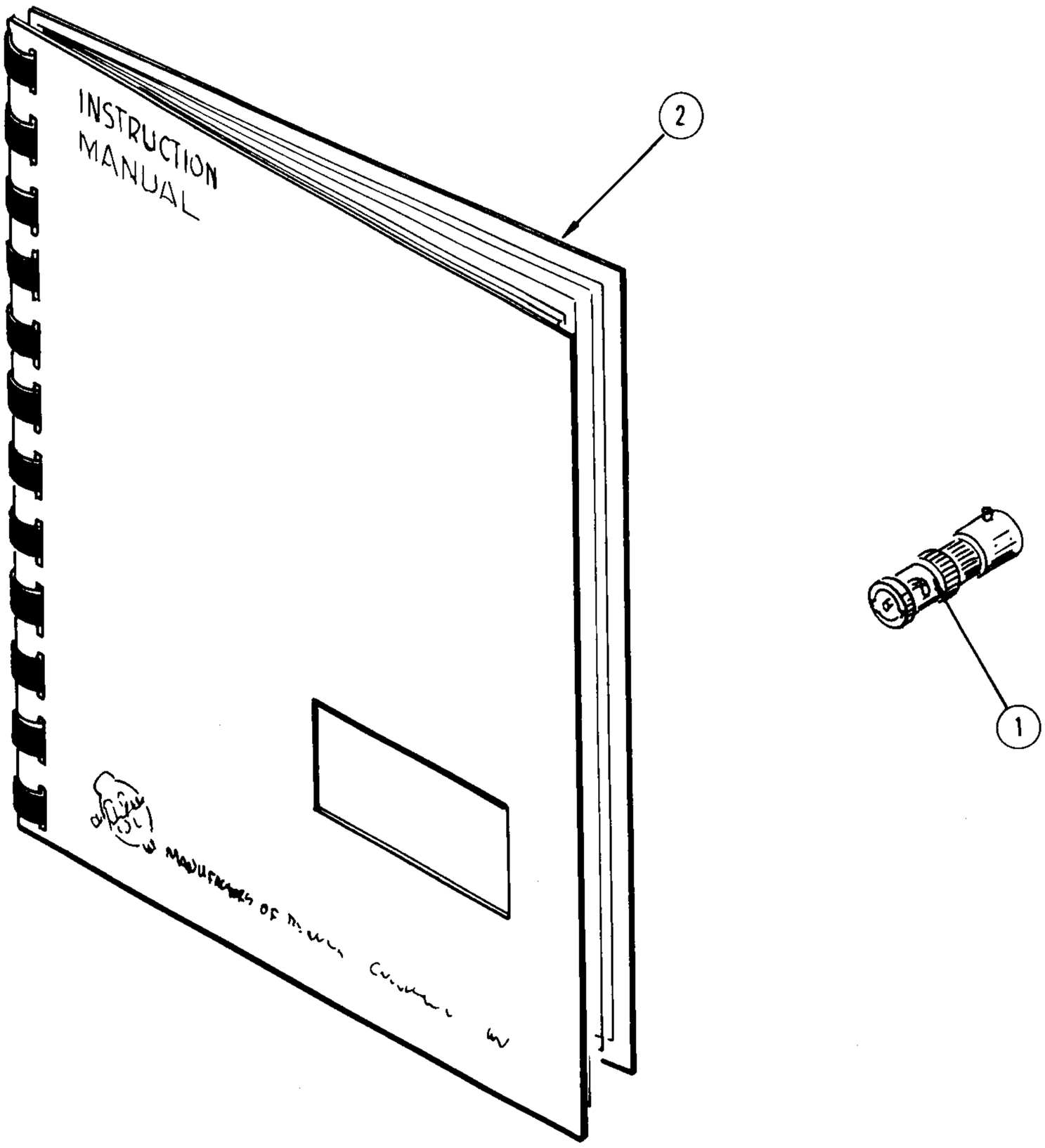
SWITCHES

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	262-0567-00			1	SWITCH, TIME/CM, wired
	. . . . .			.	Includes:
	260-0543-00			1	SWITCH, TIME/CM, unwired
2	179-0757-00			1	CABLE, harness
3	210-0413-00			2	NUT, hex, brass, 3/8-32 x 1/2 inch
	210-0012-00			1	LOCKWASHER, steel, pot, internal, 3/8 x 1/2 inch
	210-0840-00	X1605		2	WASHER, flat, 0.390 ID x 9/16 inch OD
	426-0289-00	X1605		1	MOUNT, plastic
	211-0097-00	X1605		2	SCREW, 4-40 x 5/16 inch, PHS
	210-0004-00	X1605		4	LOCKWASHER, internal, #4
	210-0406-00	X1605		2	NUT, hex, 4-40 x 3/16 inch
4	210-0407-00			2	NUT, hex, brass, 6-32 x 1/4 inch
	210-0006-00			2	LOCKWASHER, steel, internal #6
5	406-0907-00	100	569	1	BRACKET, alum.
	407-0069-00	570		1	BRACKET, alum.
	387-0986-00	X570	1604	1	PLATE, switch, alum.
	387-0986-01	1605		1	PLATE, switch, alum.
	. . . . .			.	Mounting Hardware: (not included)
	211-0504-00	X570		2	SCREW, 6-32 x 1/4 in. BHS
	210-0803-00	X570		4	WASHER, 6L x 3/8 in.
6	376-0032-00			1	COUPLING, switch shaft
	. . . . .			.	Includes:
	213-0004-00			2	SCREW, set, 6-32 x 3/16 inch HSS
	. . . . .			.	Switch Mounting Hardware: (not included)
	210-0579-00			2	NUT, mounting, switch, 5/8-24 x 3/4 inch
	210-0049-00			1	LOCKWASHER, steel, internal, 5/8 inch ID
	210-0979-00	X550		1	WASHER, flat, steel, 5/16 OD x .630 inch ID
	211-0504-00			2	SCREW, 6-32 x 1/4 inch BHS
7	260-0518-00			1	SWITCH, push, RESET SPST with red indicator light
	. . . . .			.	Mounting Hardware: (not included)
	210-0012-00			1	LOCKWASHER, steel, pot, internal, 3/8 x 1/2 inch
	210-0978-00			1	WASHER, flat, steel, 3/8 ID x 1/2 inch OD
	210-0590-00			1	NUT, hex, steel, 3/8-32 x 7/16 inch
8	260-0519-00			1	SWITCH, lever, COUPLING A
	. . . . .			.	Mounting Hardware: (not included)
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 inch
	210-0004-00			2	LOCKWASHER, steel, internal #4
9	260-0474-00	100	459	1	SWITCH, lever, SOURCE B
	260-0640-00	460		1	SWITCH, lever, SOURCE B
	. . . . .			.	Mounting Hardware: (not included)
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 inch
	210-0004-00			2	LOCKWASHER, steel, internal #4
10	260-0546-00			1	SWITCH, lever, SOURCE A
	. . . . .			.	Mounting Hardware: (not included)
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 inch
	210-0004-00			2	LOCKWASHER, steel, internal #4
11	260-0472-00			3	SWITCH, lever, SLOPE A, SLOPE B, COUPLING B
	. . . . .			.	Mounting Hardware For Each: (not included)
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 inch
	210-0004-00			2	LOCKWASHER, steel, internal #4
12	260-0545-00			1	SWITCH, TRIG MODE
	. . . . .			.	Mounting Hardware: (not included)
	358-0029-00	100	649X	1	BUSHING, brass, hex, 3/8-32 x 13/32 inch
	210-0013-00	100	649X	1	LOCKWASHER, steel, internal, 3/8 x 11/16 inch
	210-0494-00	100	649X	1	NUT, hex, alum, 3/8-32 x 1/2 x 11/16 inch
	210-0413-00	X650		1	NUT, hex, brass, 3/8-32 x 1/2 inch
	210-0012-00			1	LOCKWASHER, steel, pot, internal, 3/8 x 1/2 inch

SWITCHES *(Cont)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
13	262-0568-00			1	SWITCH, HORIZ DISPLAY, wired
	- - - - - -			-	switch includes:
	260-0544-00			1	SWITCH, HORIZ DISPLAY, unwired
	407-0111-00	X603		1	BRACKET, switch
	348-0002-00	X603		1	GROMMET, 1/4 inch
	385-0109-00	X603		2	ROD, nylon
	211-0008-00	X603		2	SCREW, 4-40 x 1/4 inch BHS
	. . . . .			.	Mounting Hardware: (not included)
	358-0029-00			1	BUSHING, brass, hex, 3/8-32 x 13/32 inch
	210-0413-00			2	NUT, hex, brass, 3/8-32 x 1/2 inch
	210-0840-00			2	WASHER, steel
	210-0012-00	100	602	1	LOCKWASHER, steel, pot, internal, 3/8 x 1/2 inch
	210-0013-00	603		1	LOCKWASHER, internal, 3/8 x 11/16 inch
	211-0008-00	X603		2	SCREW, 4-40 x 1/4 inch BHS
	210-0801-00	X603		2	WASHER, 5s x 9/32 inch

STANDARD ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	103-0036-00			1	ADAPTER, BNC female to BSM female
2	070-0377-00			2	MANUAL, instruction

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NOTES

ELECTRICAL PARTS

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description			S/N Range
		Bulbs			
B160X	150-030	Neon, NE-2V			
B186†	260-518	Neon, NE-2V			RESET
B200	150-030	Neon, NE-2V			
B330	150-030	Neon, NE-2V			
		Capacitors			

Tolerance ±20% unless otherwise indicated.

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

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

C12	283-080	.022 μf	Cer	25 v		
C14	283-080	.022 μf	Cer	25 v		
C15	281-516	39 pf	Cer	500 v	10%	
C21	281-518	47 pf	Cer	500 v		
C23	283-078	.001 μf	Cer	500 v		
C25	283-080	.022 μf	Cer	25 v		
C26	283-080	.022 μf	Cer	25 v		
C27	281-542	18 pf	Cer	500 v	10%	
C29	281-557	1.8 pf	Cer	500 v		100-1669
C29	281-0529-00	1.5 pf	Cer	500 v	±0.25 pF	1670-up
C30A	283-068	.01 μf	Cer	500 v		
C30B	281-523	100 pf	Cer	350 v		
C30C	281-525	470 pf	Cer	500 v		
C32	283-079	.01 μf	Cer	250 v		
C43	283-080	.022 μf	Cer	25 v		
C44C	283-078	.001 μf	Cer	500 v		
C44D	283-078	.001 μf	Cer	500 v		
C46	283-080	.022 μf	Cer	25 v		
C53	281-603	39 pf	Cer	500 v	5%	
C54	281-525	470 pf	Cer	500 v		
C63	281-549	68 pf	Cer	500 v	10%	100-959
C63	281-0528-00	82 pf	Cer	500 v	10%	960-up
C70A	283-068	.01 μf	Cer	500 v		
C70C	281-525	470 pf	Cer	500 v		
C72	283-079	.01 μf	Cer	250 v		
C75A	283-078	.001 μf	Cer	500 v		
C76	283-079	.01 μf	Cer	250 v		
C83	283-080	.022 μf	Cer	25 v		
C84C	283-078	.001 μf	Cer	500 v		
C84D	283-078	.001 μf	Cer	500 v		
C86	283-080	.022 μf	Cer	25 v		
C93	281-603	39 pf	Cer	500 v	5%	

†Furnished as a unit with SW201.

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C94	281-525	470 pf	Cer		500 v	
C102	281-543	270 pf	Cer		500 v	10%
C104	283-078	.001 μf	Cer		500 v	
C109	283-080	.022 μf	Cer		25 v	
C114	290-189	33 μf	EMT		35 v	10%
C122	281-525	470 pf	Cer		500 v	
C127	281-542	18 pf	Cer		500 v	10%
C130	281-518	47 pf	Cer		500 v	
C132	283-081	.1 μf	Cer		25 v	
C136	281-516	39 pf	Cer		500 v	10%
C153	290-139	180 μf	EMT		6 v	
C156	281-523	100 pf	Cer		350 v	
C160A	281-010	4.5-25 pf	Cer	Var		
C160B	283-097	84 pf	Cer		1000 v	2%
C160C	281-010	4.5-25 pf	Cer	Var		
C160D	283-097	84 pf	Cer		1000 v	2%
C160F	Use *295-082	.001 μf	Timing Series			
C160G		.01 μf				
C160H		.1 μf				
C160J		1 μf				
C160K		10 μf				
C160R	281-525	470 pf	Cer		500 v	
C162	283-079	.01 μf	Cer		250 v	
C165	281-577	14 pf	Cer		500 v	5%
C169	283-078	.001 μf	Cer		500 v	
C170	290-135	15 μf	EMT		20 v	
C171	283-079	.01 μf	Cer		250 v	
C180D	281-525	470 pf	Cer		500 v	
C180F	281-536	.001 μf	Cer		500 v	10%
C180G	285-598	.01 μf	PTM		100 v	5%
C180H	290-188	.1 μf	EMT		35 v	10%
C180J	290-183	1 μf	EMT		35 v	10%
C180K	290-167	10 μf	EMT		15 v	
C186	285-629	.047 μf	PTM		100 v	
C191	283-080	.022 μf	Cer		25 v	
C198	281-549	68 pf	Cer		500 v	10%
C199	281-523	100 pf	Cer		350 v	
C200	285-622	.1 μf	PTM		100 v	
C201	281-543	270 pf	Cer		500 v	10%
C202	281-524	150 pf	Cer		500 v	
C203	281-525	470 pf	Cer		500 v	
C204	281-543	270 pf	Cer		500 v	10%
C207	283-078	.001 μf	Cer		500 v	100-1839
C207	283-0079-00	0.01 μf	Cer		250 v	1840-up
C210	290-137	100 μf	EMT		30 v	
C213	283-080	.022 μf	Cer		25 v	
C222	281-525	470 pf	Cer		500 v	

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
C227	281-542	18 pf	Cer		500 v 10%	
C230	281-518	47 pf	Cer		500 v	
C232	283-081	.1 μf	Cer		25 v	
C253	283-080	.022 μf	Cer		25 v	
C256	281-523	100 pf	Cer		350 v	
C260A	281-010	4.5-25 pf	Cer	Var		
C260B	283-097	84 pf	Cer		1000 v 2%	
C260C	281-010	4.5-25 pf	Cer	Var		
C260D	283-097	84 pf	Cer		1000 v 2%	
C260F, C260G, C260H, C260J, C260K	Use *295-082	.001 μf, .01 μf, .1 μf, 1 μf, 10 μf	Timing Series			
C260R	281-525	470 pf	Cer		500 v	
C262	283-079	.01 μf	Cer		250 v	
C265	281-577	14 pf	Cer		500 v 5%	
C270	283-081	.1 μf	Cer		25 v	
C271	283-081	.1 μf	Cer		25 v	
C291	283-080	.022 μf	Cer		25 v	
C310	283-081	.1 μf	Cer		25 v	
C320	283-080	.022 μf	Cer		25 v	
C340	Use 283-0081-00	.1 μf	Cer		25 v	
C409	283-079	.01 μf	Cer		250 v	
C410	283-080	.022 μf	Cer		25 v	
C411	283-080	.022 μf	Cer		25 v	
C414	283-079	.01 μf	Cer		250 v	

Diodes

D30	Use 152-0246-00	Silicon Low Leakage	0.25 w, 40 v
D31	Use 152-0246-00	Silicon Low Leakage	0.25 w, 40 v
D33	Use *152-0185-00	Silicon Replaceable by 1N3605	
D44A	152-0141-00	Silicon 1N3605	
D44B	152-0141-00	Silicon 1N3605	
D44C	*152-075	Germanium Tek Spec	
D44D	*152-075	Germanium Tek Spec	
D45A	Use *152-0185-00	Silicon Replaceable by 1N3605	
D45B	Use *152-0185-00	Silicon Replaceable by 1N3605	
D55	*152-125	Tunnel Selected TD3A 4.7 ma	
D56	Use *152-153	Silicon, Replaceable by 1N4244	
D57	*152-153	Silicon, Replaceable by 1N4244	
D70	Use 152-0246-00	Silicon Low Leakage	0.25 w, 40 v
D71	Use 152-0246-00	Silicon Low Leakage	0.25 w, 40 v
D73	Use *152-0185-00	Silicon Replaceable by 1N3605	
D74	Use *152-0185-00	Silicon Replaceable by 1N3605	

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
D75	152-139	Zener 1N751 5.1 v	
D84A	152-141	Silicon 1N3605	
D84B	152-141	Silicon 1N3605	
D84C	*152-075	Germanium Tek Spec	
D84D	*152-075	Germanium Tek Spec	
D85A	Use *152-0185-00	Silicon Replaceable by 1N3605	
D85B	Use *152-0185-00	Silicon Replaceable by 1N3605	
D95	*152-125	Tunnel Selected TD3A 4.7 ma	
D96	Use *152-153	Silicon, Replaceable by 1N4244	
D102	Use 152-065	Silicon, HD5000	
D103	Use *152-153	Silicon, Replaceable by 1N4244	
D104	152-141	Silicon 1N3605	
D105	*152-125	Tunnel Selected TD3A 4.7 ma	
D113	Use *152-0185-00	Silicon Replaceable by 1N3605	
D114	Use *152-0185-00	Silicon Replaceable by 1N3605	
D118	Use *152-0185-00	Silicon Replaceable by 1N3605	
D120	Use *152-153	Silicon, Replaceable by 1N4244	
D121	Use *152-153	Silicon, Replaceable by 1N4244	
D125	*152-125	Tunnel Selected TD3A 4.7 ma	
D133	Use *152-0185-00	Silicon Replaceable by 1N3605	
D155	Use *152-0185-00	Silicon Replaceable by 1N3605	
D158	Use *152-0185-00	Silicon Replaceable by 1N3605	
D159	Use *152-161	Ga-As diffused w/axial leads	
D163	Use *152-0185-00	Silicon Replaceable by 1N3605	
D180	Use *152-0185-00	Silicon Replaceable by 1N3605	
D181	Use *152-0185-00	Silicon Replaceable by 1N3605	
D183	Use *152-0185-00	Silicon Replaceable by 1N3605	
D193	Use *152-0185-00	Silicon Replaceable by 1N3605	
D200	Use *152-0185-00	Silicon Replaceable by 1N3605	
D214A,B	*152-151	Diode Assembly	
D219	Use *152-0185-00	Silicon Replaceable by 1N3605	
D220	Use *152-153	Silicon, Replaceable by 1N4244	
D221	Use *152-153	Silicon, Replaceable by 1N4244	
D225	*152-125	Tunnel Selected TD3A 4.7 ma	
D233	Use *152-0185-00	Silicon Replaceable by 1N3605	
D255	Use *152-0185-00	Silicon Replaceable by 1N3605	
D258	Use *152-0185-00	Silicon Replaceable by 1N3605	
D259	Use *152-161	Ga-As diffused w/axial leads	
D263	Use *152-0185-00	Silicon Replaceable by 1N3605	
D273	Use *152-0185-00	Silicon Replaceable by 1N3605	
D293	Use *152-0185-00	Silicon Replaceable by 1N3605	
D321	Use *152-0185-00	Silicon Replaceable by 1N3605	
D340	152-123	Zener 1N935A 9.1 v	
D341	152-123	Zener 1N935A 9.1 v	
D342	152-034	Zener 1N753 6.2 v	

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
D346	Use *152-0185-00	Silicon Replaceable by 1N3605	
D407	152-123	Zener 1N935A 9.1 v	

Inductors

L14	Use 276-507	Core, Ferramic Suppressor	
L43A	Use 276-507	Core, Ferramic Suppressor	
L43B	Use 276-507	Core, Ferramic Suppressor	
L45	*108-112	.3 μh	
L46	*108-170	.5 μh	
L83A	Use 276-507	Core, Ferramic Suppressor	
L83B	Use 276-507	Core, Ferramic Suppressor	
L85	*108-112	.3 μh	
L86	*108-170	.5 μh	
L125	*108-147	2.2 μh	
L225	*108-147	2.2 μh	100-959X
L320	Use 276-507	Core, Ferramic Suppressor	

Resistors

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

R7	311-326	10 k		Var	INT TRIG DC LEVEL
R9	316-392	3.9 k	¼ w		
R10	315-101	100 Ω	¼ w		5%
R11	315-101	100 Ω	¼ w		5%
R12	316-330	33 Ω	¼ w		
R13	323-161	464 Ω	½ w	Prec	1%
R14	302-391	390 Ω	½ w		
R15	321-101	110 Ω	⅛ w	Prec	1%
R16	323-191	953 Ω	½ w	Prec	1%
R17	323-191	953 Ω	½ w	Prec	1%
R19	316-100	10 Ω	¼ w		
R20	303-153	15 k	1 w		5%
R21	321-225	2.15 k	⅛ w	Prec	1%
R22	323-313	17.8 k	½ w	Prec	1%
R23	315-751	750 Ω	¼ w		5%
R24	316-472	4.7 k	¼ w		
R25	316-472	4.7 k	¼ w		
R26	316-471	470 Ω	¼ w		
R27	316-470	47 Ω	¼ w		
R28	302-100	10 Ω	½ w		

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description			S/N Range
R29	301-915	9.1 meg	½ w	5%	
R30A	301-105	1 meg	½ w	5%	
R30B	316-104	100 k	¼ w		
R30C	302-105	1 meg	½ w		
R30D	316-470	47 Ω	¼ w		
R31	316-470	47 Ω	¼ w		
R32	316-471	470 Ω	¼ w		
R33	305-912	9.1 k	2 w	5%	
R40	315-102	1 k	¼ w	5%	
R41†	311-272	5 k	Var	A TRIG LEVEL	
R42A	315-822	8.2 k	¼ w	5%	
R42B	315-821	820 Ω	¼ w	5%	
R43	316-683	68 k	¼ w		
R44	305-682	6.8 k	2 w	5%	
R45	315-750	75 Ω	¼ w	5%	
R46	316-470	47 Ω	¼ w		
R47	316-100	10 Ω	¼ w		
R53	323-321	21.5 k	½ w Prec	1%	
R54	315-222	2.2 k	¼ w	5%	
R55	321-245	3.48 k	⅛ w Prec	1%	
R61	316-101	100 Ω	¼ w		100-959
R61	316-0470-00	47 Ω	¼ w		960-up
R63	301-223	22 k	½ w	5%	
R64	315-242	2.4 k	¼ w	5%	
R70A	302-100	10 Ω	½ w		
R70B	301-105	1 meg	½ w	5%	
R70C	302-105	1 meg	½ w		
R70D	316-470	47 Ω	¼ w		
R71	316-470	47 Ω	¼ w		
R72	316-471	470 Ω	¼ w		
R73	305-512	5.1 k	2 w	5%	
R75A	302-472	4.7 k	½ w		
R75C	302-472	4.7 k	½ w		
R75D	316-104	100 k	¼ w		
R75E	301-362	3.6 k	½ w	5%	
R75F	316-104	100 k	¼ w		
R76	303-103	10 k	1 w	5%	
R80	315-621	620 Ω	¼ w	5%	
R81	311-117	5 k	Var	B TRIG LEVEL	
R82A	315-273	27 k	¼ w	5%	
R82B	315-332	3.3 k	¼ w	5%	
R82C	315-332	3.3 k	¼ w	5%	
R83	316-683	68 k	¼ w		
R84	305-682	6.8 k	2 w	5%	
R85	315-750	75 Ω	¼ w	5%	

†Furnished as a unit with R181.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R86	316-470	47 Ω	¼ w			
R87	316-100	10 Ω	¼ w			
R93	323-321	21.5 k	½ w	Prec	1%	
R94	315-222	2.2 k	¼ w		5%	
R95	321-245	3.48 k	⅛ w	Prec	1%	
R104	316-471	470 Ω	¼ w			
R105	301-112	1.1 k	½ w		5%	
R106	323-281	8.25 k	½ w	Prec	1%	
R109	316-330	33 Ω	¼ w			
R110	321-105	121 Ω	⅛ w	Prec	1%	
R111	321-303	14 k	⅛ w	Prec	1%	
R112	321-229	2.37 k	⅛ w	Prec	1%	
R113	321-271	6.49 k	⅛ w	Prec	1%	
R114	315-471	470 Ω	¼ w		5%	
R116	Use 321-245	3.48 k	⅛ w	Prec	1%	
R117	316-392	3.9 k	¼ w			
R118	321-258	4.75 k	⅛ w	Prec	1%	
R120	321-258	4.75 k	⅛ w	Prec	1%	
R122	315-101	100 Ω	¼ w		5%	
R123	321-243	3.32 k	⅛ w	Prec	1%	
R124	301-112	1.1 k	½ w		5%	
R125	316-331	330 Ω	¼ w			
R127	315-112	1.1 k	¼ w		5%	
R130	321-250	3.92 k	⅛ w	Prec	1%	
R131	322-341	34.8 k	¼ w	Prec	1%	
R132	316-101	100 Ω	¼ w			
R133	315-162	1.6 k	¼ w		5%	
R134	323-171	590 Ω	½ w	Prec	1%	
R135	321-173	619 Ω	⅛ w	Prec	1%	
R136	316-472	4.7 k	¼ w			
R138	315-122	1.2 k	¼ w		5%	
R139	315-621	620 Ω	¼ w		5%	
R150	311-405	10 k		Var	DELAY START	
R151	315-472	4.7 k	¼ w		5%	
R152	323-184	806 Ω	½ w	Prec	1%	
R153	321-131	226 Ω	⅛ w	Prec	1%	
R154	315-392	3.9 k	¼ w		5%	
R155	315-512	5.1 k	¼ w		5%	
R156	316-101	100 Ω	¼ w			
R158	316-101	100 Ω	¼ w			
R160A	323-654	75 k	½ w	Prec	½%	
R160B	323-654	75 k	½ w	Prec	½%	
R160C	315-392	3.9 k	¼ w		5%	
R160D	323-653	221 k	½ w	Prec	½%	
R160E	323-657	750 k	½ w	Prec	.1%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R160F	323-655	750 k	½ w		Prec	½%
R160G	323-655	750 k	½ w		Prec	½%
R160H	323-656	1.5 meg	½ w		Prec	½%
R160J	309-440	3.74 meg	½ w		Prec	1%
R160K	309-441	7.50 meg	½ w		Prec	1%
R160L	309-442	22.6 meg	½ w		Prec	1%
R160R	316-470	47 Ω	¼ w			
R160T	316-182	1.8 k	¼ w			
R160V†	311-402	20 k		Var		VARIABLE A
R160W	311-404	1 k		Var	WW	A SWP CAL
R160X	316-184	180 k	¼ w			
R160Y	316-223	22 k	¼ w			
R161	316-470	47 Ω	¼ w			
R162	316-221	220 Ω	¼ w			
R163	315-471	470 Ω	¼ w			5%
R164	323-315	18.7 k	½ w		Prec	1%
R165	316-220	22 Ω	¼ w			
R168	304-223	22 k	1 w			
R170	316-100	10 Ω	¼ w			
R171	316-470	47 Ω	¼ w			
R172	316-220	22 Ω	¼ w			
R173	316-220	22 Ω	¼ w			
R174	301-183	18 k	½ w			5%
R176	316-470	47 Ω	¼ w			
R177	316-471	470 Ω	¼ w			
R178	315-751	750 Ω	¼ w			5%
R179	315-333	33 k	¼ w			5%
R180	315-124	120 k	¼ w			5%
R181††	311-272	5 k		Var		HF STABILITY
R182	316-153	15 k	¼ w			
R183	302-393	39 k	½ w			
R184	322-357	51.1 k	¼ w		Prec	1%
R185	321-225	2.15 k	⅛ w		Prec	1%
R186	316-225	2.2 meg	¼ w			
R187	316-473	47 k	¼ w			
R188	316-473	47 k	¼ w			
R189A	316-564	560 k	¼ w			
R189B	316-333	33 k	¼ w			
R190	321-207	1.4 k	⅛ w		Prec	1%
R191	321-257	4.64 k	⅛ w		Prec	1%
R193	321-171	590 Ω	⅛ w		Prec	1%
R194	321-189	909 Ω	⅛ w		Prec	1%
R195	324-305	14.7 k	1 w		Prec	1%
R196	315-113	11 k	¼ w			5%
R197	316-221	220 Ω	¼ w			

†Furnished as a unit with SW160V.

††Furnished as a unit with R41.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R198	316-101	100 Ω	¼ w			
R199	321-225	2.15 k	⅛ w	Prec	1%	
R200	316-104	100 k	¼ w			
R201	316-473	47 k	¼ w			
R202	316-472	4.7 k	¼ w			100-1839
R202	316-0223-00	22 k	¼ w			1840-up
R203	316-104	100 k	¼ w			
R204	316-102	1 k	¼ w			
R207	316-103	10 k	¼ w			
R208	316-104	100 k	¼ w			
R210	Use 322-130	221 Ω	¼ w	Prec	1%	
R211	311-386	2 k		Var	WW	DELAY TIME MULT 1-10
R212	323-639	1.1 k	½ w		Prec	½%
R213	322-124	191 Ω	¼ w		Prec	1%
R214	301-625	6.2 meg	½ w			5%
R215	323-333	28.7 k	½ w		Prec	1%
R217	316-473	47 k	¼ w			
R218	316-102	1 k	¼ w			
R219	323-302	13.7 k	½ w		Prec	1%
R220	321-258	4.75 k	⅛ w		Prec	1%
R222	315-101	100 Ω	¼ w			5%
R223	321-243	3.32 k	⅛ w		Prec	1%
R224	301-112	1.1 k	½ w			5%
R225	316-331	330 Ω	¼ w			100-959
R225	316-0470-00	47 Ω	¼ w			960-up
R227	315-112	1.1 k	¼ w			5%
R230	321-250	3.92 k	⅛ w		Prec	1%
R231	322-341	34.8 k	¼ w		Prec	1%
R232	316-101	100 Ω	¼ w			
R233	315-162	1.6 k	¼ w			5%
R234	323-171	590 Ω	½ w		Prec	1%
R235	321-173	619 Ω	⅛ w		Prec	1%
R251	315-682	6.8 k	¼ w			5%
R252	321-201	1.21 k	⅛ w		Prec	1%
R253	321-143	301 Ω	⅛ w		Prec	1%
R254	Use 315-0472-00	4.7 k	¼ w			5%
R255	315-512	5.1 k	¼ w			5%
R256	316-101	100 Ω	¼ w			
R258	316-101	100 Ω	¼ w			
R259	316-220	22 Ω	¼ w			
R260A	323-654	75 k	½ w		Prec	½%
R260B	323-654	75 k	½ w		Prec	½%
R260C	315-392	3.9 k	¼ w			5%
R260D	323-653	221 k	½ w		Prec	½%
R260E	323-657	750 k	½ w		Prec	.1%
R260F	323-655	750 k	½ w		Prec	½%
R260G	323-655	750 k	½ w		Prec	½%

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R260H	323-656	1.5 meg	½ w		Prec ½%	
R260J	309-440	3.74 meg	½ w		Prec 1%	
R260K	309-441	7.50 meg	½ w		Prec 1%	
R260L	309-442	22.6 meg	½ w		Prec 1%	
R260R	316-470	47 Ω	¼ w			
R260T	316-182	1.8 k	¼ w			
R260V†	311-402	20 k		Var		Variable B
R260W	311-328	1 k		Var		B SWP CAL
R260Y	316-223	22 k	¼ w			
R261	316-470	47 Ω	¼ w			
R262	316-221	220 Ω	¼ w			
R263	315-471	470 Ω	¼ w			5%
R264	323-315	18.7 k	½ w		Prec 1%	
R265	316-220	22 Ω	¼ w			
R268	305-752	7.5 k	2 w			5%
R270	316-101	100 Ω	¼ w			
R271	316-100	10 Ω	¼ w			
R274	315-751	750 Ω	¼ w			5%
R275	315-333	33 k	¼ w			5%
R290	321-207	1.4 k	⅛ w		Prec 1%	
R291	321-257	4.64 k	⅛ w		Prec 1%	
R293	315-123	12 k	¼ w			5%
R294	321-261	5.11 k	⅛ w		Prec 1%	
R296A	315-113	11 k	¼ w			5%
R296C	316-222	2.2 k	¼ w			
R296E	321-245	3.48 k	⅛ w		Prec 1%	
R297	322-349	42.2 k	¼ w		Prec 1%	
R298	321-257	4.64 k	⅛ w		Prec 1%	
R307	Use 316-333	33 k	¼ w			
R308	321-193	1 k	⅛ w		Prec 1%	
R310	323-321	21.5 k	½ w		Prec 1%	
R311	316-183	18 k	¼ w			
R313	302-223	22 k	½ w			
R321	Use 316-184	180 k	¼ w			
R323	321-291	10.5 k	⅛ w		Prec 1%	
R324	Use 323-324	23.2 k	½ w		Prec 1%	
R330	316-104	100 k	¼ w			
R331	311-095	500 Ω		Var		NORM GAIN
R332	321-231	2.49 k	⅛ w		Prec 1%	
R333	321-097	100 Ω	⅛ w		Prec 1%	
R334	311-169	100 Ω	½ w	Var		MAG GAIN
R335	322-133	237 Ω	¼ w		Prec 1%	
R337	324-289	10 k	1 w		Prec 1%	

†Furnished as a unit with SW260V.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R338	324-289	10 k	1 w		Prec 1%	
R339	311-328	1 k		Var		MAG REGIS
R340	Use 322-357	51.1 k	¼ w		Prec 1%	
R341	316-471	470 Ω	¼ w			
R342	Use 321-247	3.65 k	⅛ w		Prec 1%	
R343	304-822	8.2 k	1 w			
R344	Use 323-324	23.2 k	½ w		Prec 1%	
R345	321-291	10.5 k	⅛ w		Prec 1%	
R346	Use 316-184	180 k	¼ w			
R407	305-202	2 k	2 w		5%	
R409	307-103	2.7 Ω	¼ w		5%	
R410	303-200	20 Ω	1 w		5%	
R411	303-200	20 Ω	1 w		5%	
R414	307-103	2.7 Ω	¼ w		5%	
R420	321-239	3.01 k	⅛ w		Prec 1%	
R421	315-181	180 Ω	¼ w		5%	
R422	321-273	6.81 k	⅛ w		Prec 1%	
R423	316-273	27 k	¼ w			
R426	315-183	18 k	¼ w		5%	100-359
R426	315-0303-00	30 k	¼ w		5%	360-up
R427	315-393	39 k	¼ w		5%	100-359
R427	315-0683-00	68 k	¼ w		5%	360-up
R428	321-237	2.87 k	⅛ w		Prec 1%	
R429	321-271	6.49 k	⅛ w		Prec 1%	

Switches

	Unwired	Wired			
SW30A	260-546		Lever	SOURCE	
SW30B	260-519		Lever	COUPLING	
SW30C	260-472		Lever	SLOPE	
SW70A	Use *050-211		Lever	SOURCE	100-459
SW70A	260-640		Lever	SOURCE	460-up
SW70B	260-472		Lever	COUPLING	
SW70C	260-472		Lever	SLOPE	
SW116	260-545		Rotary	TRIG MODE	
SW160A,B	260-543	*262-567	Rotary	TIME/CM	
SW160V†	311-402				
SW201††	260-518		Push	RESET	
SW260V†††	311-402				
SW300A, SW300B	260-544	*262-568	Rotary	HORIZ DISPLAY MAG	

Transistors

Q14A	*151-108	Replaceable by 2N2501
Q14B	*151-108	Replaceable by 2N2501
Q23A	*151-108	Replaceable by 2N2501
Q23B	Use *151-133	Selected from 2N3251
Q43	*151-087	Replaceable by 2N1131

†Furnished as a unit with R160V.

††Furnished as a unit with B186.

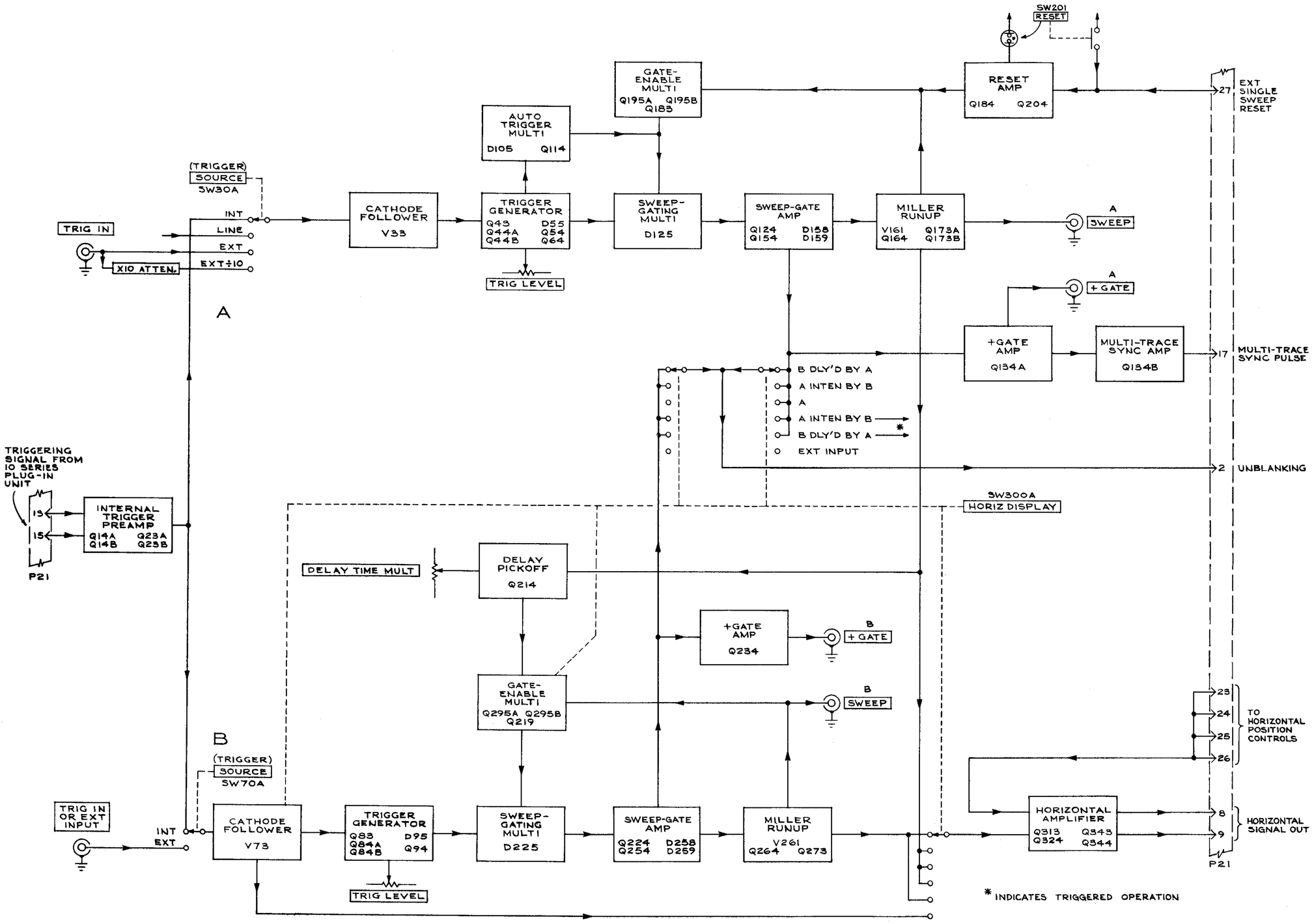
†††Furnished as a unit with R260V.

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q44A	*151-103	Replaceable by 2N2219	
Q44B	*151-103	Replaceable by 2N2219	
Q54	Use *151-133	Selected from 2N3251	
Q64	151-107	2N967	100-959
Q64	151-0131-00	2N964	960-up
Q83	*151-087	Selected from 2N1131	
Q84A	*151-103	Replaceable by 2N2219	
Q84B	*151-103	Replaceable by 2N2219	
Q94	Use *151-133	Selected from 2N3251	
Q114	*151-103	Replaceable by 2N2219	
Q124	*151-108	Replaceable by 2N2501	
Q134A	*151-108	Replaceable by 2N2501	
Q134B	*151-108	Replaceable by 2N2501	
Q154	151-107	2N967	
Q164	*151-127	Selected from 2N2369	
Q173A	*151-108	Replaceable by 2N2501	
Q173B	*151-103	Replaceable by 2N2219	
Q183	*151-087	Selected from 2N1131	
Q184	*151-096	Selected from 2N1893	
Q195A	Use *050-224	Replacement Kit	100-569
Q195A	*151-133	Selected from 2N3251	570-up
Q195B	Use *050-224	Replacement Kit	100-569
Q195B	*151-133	Selected from 2N3251	570-up
Q204	*151-103	Replaceable by 2N2219	
Q214	*151-104	Replaceable by 2N2913	
Q219	Use *151-133	Selected from 2N3251	
Q224	*151-108	Replaceable by 2N2501	
Q234	*151-108	Replaceable by 2N2501	
Q254	151-107	2N967	
Q264	*151-127	Selected from 2N2369	
Q273	*151-103	Replaceable by 2N2219	
Q295A	*151-087	Selected from 2N1131	
Q295B	Use *050-0262-00	Replacement Kit	100-959
Q295B	*151-0087-00	Selected from 2N1131	960-up
Q313	*151-103	Replaceable by 2N2219	
Q324	*151-108	Replaceable by 2N2501	
Q343	*151-103	Replaceable by 2N2219	
Q344	*151-108	Replaceable by 2N2501	

Electron Tubes

V33	Use *154-0306-02	7586, aged
V73	Use *154-0306-02	7586, aged
V161	Use *154-0306-02	7586, aged
V261	Use *154-0306-02	7586, aged



TYPE 11B2 PLUG-IN

A

MRH
1163

BLOCK DIAGRAM

INTERNAL TRIGGER PREAMP

SW30C SLOPE — R47 — C44C — C44D — EFF S/N 101-1710

+15V R12 33 — C12 .022 — R13 464 — R20 15K — +100V — +8.5 — Q23A 151-108 — R23 750 — C27 18 — C23 .001 — R27 47 — TP23 0V — C21 47 — R21 2.15K — R22 17.8K — -75V — Q23B 151-133 — C26 .022 — R26 470 — -15V

6.3V P21 ⑥ 30 — R24 4.7K — R25 4.7K — C25 .022 — 93Ω

SW30A SOURCE: INT / LINE / EXT / EXT ÷10 / TRIG IN — R29 9.1M — C29 1.5 — R28 10

SW30B COUPLING: AC / AC LF REJ / DC — C30A .01 — C30B 100 — 93Ω — C30C 470 — R30A 1M — R30C 1M — R30B 100K — R30D 47 — R31 47 — D30 — D31 — -15V — +15V

+100V — R32 470 — C32 .01 — V33 7586 — +1.6

SW30C SLOPE — C44C .001 — C44D .001 — R47 10 — R46 47 — C53 39 — C46 .022 — R53 21.5K — R45 75 — L45 0.3μh — D55 4.7mA — Q54 151-133 — +14 +14.5 — TP54 — L46 0.5μh — R63 22K — TO D105 ② — C63 82 — R61 100 — Q64 2N967 — +9.2 — TRIGGER PULSE TO C102 ② — R64 2.4K

D44C D44D — D45A D45B — C54 470 — R54 2.2K — D56 — -0.37 — R55 3.48K — D57 — -15V — TRIGGER PULSE TO D120 ②

-15V — D33 — R33 9.1K — -75V — Q44A 151-103 — Q44B 151-103 — D44A D44B — +0.3 +6.5 — R44 6.8K — -75V

+100V — R43 68K — FERRITE BEADS L43B L43A — C43 .022 — -5.6 +7.8 — Q43 151-087 — +15V — R42A 8.2K — R42B 820 — R40 1K — R41 5K — TRIG LEVEL — -15V

(AMPLITUDE VARIES WITH VERT. DEFLECTION AMPLITUDE) .05V/CM .2mSEC/CM

P21 ⑥ 16 15 14 18 12 — INTERNAL TRIGGER SIGNAL — Q14B 151-108 — R11 100 — R16 953 — R19 10 — R15 110 — -15V — C15 39 — R17 953 — Q14A 151-108 — FERRITE BEAD L14 — R14 390 — C14 .022 — +15V — R7 10K — R9 3.9K — R10 100 — -15V — INT TRIG DC LEVEL

(AMPLITUDE VARIES WITH VERT. DEFLECTION AMPLITUDE) .2/CM .2mSEC/CM

(AMPLITUDE VARIES WITH VERT. DEFLECTION AMPLITUDE) .05V/CM .2mSEC/CM

TRIG IN OR EXT INPUT — J70 — R70A 10 — INT / EXT — C70A .01 AC / DC — C70C 470 — R70C 1M — R70B 1M — R70D 47 — R71 47 — D70 — D71 — -15V — +15V — SW70A SOURCE

SW70B COUPLING: AC / DC — +100V — R72 470 — C72 .01 — V73 7586 — +1.6

SW300A HORIZ DISPLAY: 1R / B DLY'D BY A / A INTEN BY B / A / A INTEN BY B / B DLY'D BY A / EXT INPUT — +100V — R76 10K — C76 .01 — R75A 4.7K — C75A .001 — R75C 4.7K — R75D 100K — -15V — R75E 3.6K — R75F 100K — -15V

SW70C SLOPE — C84C .001 — C84D .001 — R87 10 — R86 47 — C93 39 — C86 .022 — R93 21.5K — R85 75 — L85 0.3μh — D95 4.7mA — Q94 151-133 — +14 +14.5 — TP94 — L86 0.5μh — SW70C SLOPE — R87 — C84C — C84D — EFF S/N 101-1710

D84C D84D — D85A D85B — +1 +7.2 — C94 470 — R94 2.2K — D96 — -0.4 — R95 3.48K — -15V — TRIGGER PULSE TO D220 ③

D73 — D74 — D75 5.1V — 50Ω — EXTERNAL HORIZONTAL SIGNAL TO HORIZONTAL DISPLAY SWITCH SW300A-2R ④ — R73 5.1K — -75V — (AMPLITUDE VARIES WITH TRIG LEVEL CONTROL SETTING) .1V/CM .2mSEC/CM

Q84A 151-103 — Q84B 151-103 — D84A D84B — R84 6.8K — -75V

+100V — R83 68K — FERRITE BEADS L83B L83A — C83 .022 — Q83 151-087 — -3.6 +8 — -15V — INT / EXT — +15V — R82A 27K — R82B 3.3K — R82C 3.3K — R81 5K — TRIG LEVEL — R80 620 — -15V

.1V/CM .2mSEC/CM

* INDICATES TRIGGERED OPERATION

REFERENCE DRAWINGS
- ② SWEEP GENERATOR A
- ③ SWEEP GENERATOR B
- ④ HORIZONTAL PREAMP
- ⑥ INTERCONNECTING PLUG

IMPORTANT

ALL CIRCUIT VOLTAGES WERE OBTAINED WITH A 20,000Ω/V VOM AND VERTICAL PLUG-IN UNIT REMOVED.
ALL WAVEFORMS WERE OBTAINED WITH THE 1 KC CALIBRATOR SIGNAL APPLIED TO VERTICAL INPUT AND INTERNALLY TRIGGERING BOTH SWEEP GENERATORS.
VOLTAGES AND WAVEFORM AMPLITUDES ARE NOT ABSOLUTE, BUT MAY VARY WITHIN THE INSTRUMENT OR BETWEEN INSTRUMENTS.
ACTUAL PHOTOGRAPHS OF WAVEFORMS ARE SHOWN.

TYPE 11B2 CONTROL SETTINGS FOR ALL MEASUREMENTS ARE AS FOLLOWS UNLESS OTHERWISE NOTED:

HORIZ. DISPLAY	A INTEN BY B (TRIGGERED)
MAG	OFF
B COUPLING	AC
B SOURCE	INT
B SLOPE	+
A TIME/CM	1 mSEC
VARIABLE A	CALIB
B TIME/CM	.5 mSEC
VARIABLE B	CALIB
A SLOPE	+
A COUPLING	AC
A SOURCE	INT
DELAY TIME MULT.	1.00

TYPE 11B2 PLUG-IN

WAVEFORMS & VOLTAGE READINGS WERE OBTAINED UNDER FOLLOWING CONDITIONS:

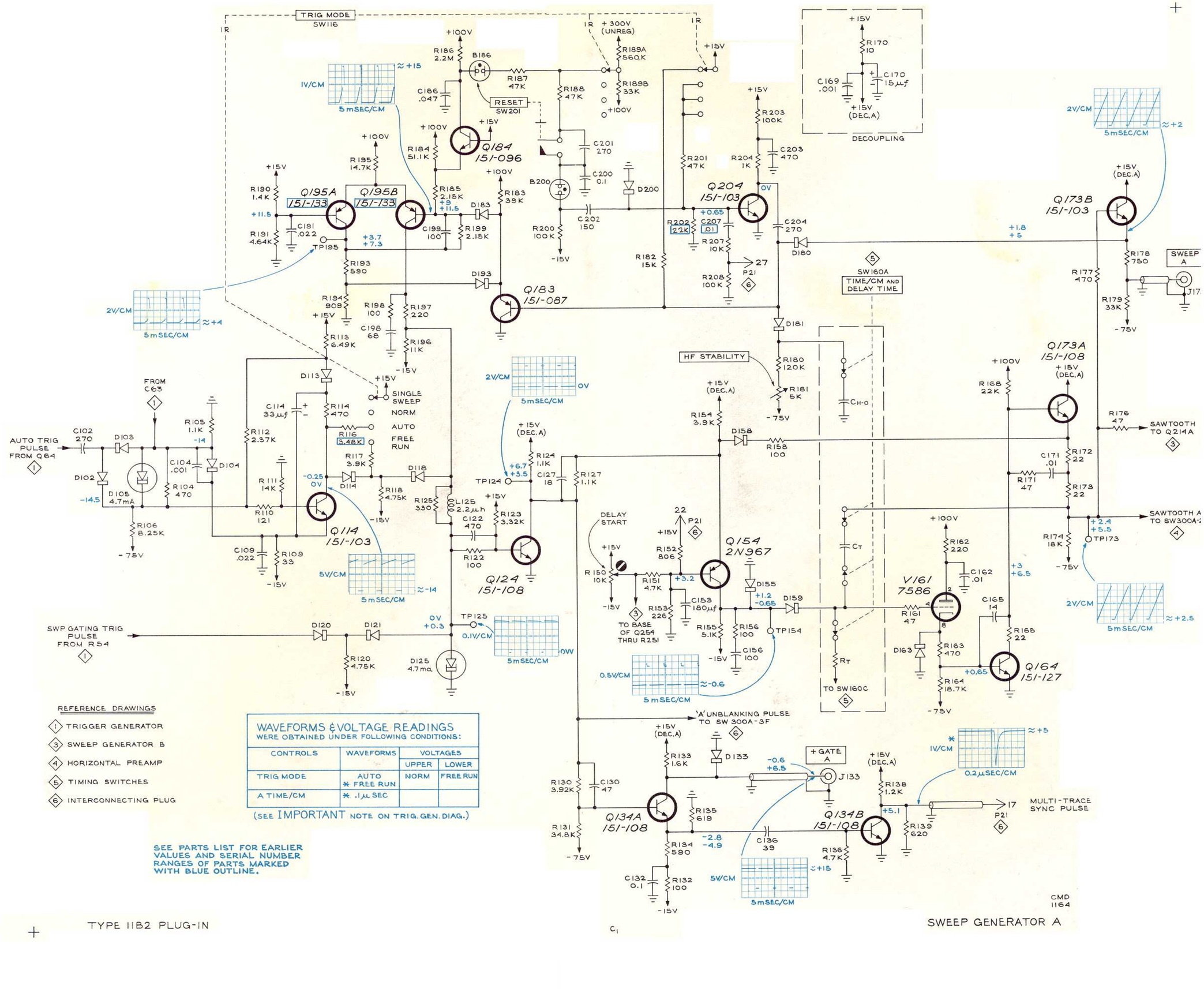
CONTROLS	WAVEFORMS	VOLTAGES	
		"UPPER"	"LOWER"
'A' TRIG LEVEL	0	CCW	CW
'B' TRIG LEVEL	0	CCW	CW
TRIG MODE	NORM	NORM	NORM

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

866 MR4

TRIGGER GENERATOR

D2



REFERENCE DRAWINGS

1. TRIGGER GENERATOR
3. SWEEP GENERATOR B
4. HORIZONTAL PREAMP
5. TIMING SWITCHES
6. INTERCONNECTING PLUG

WAVEFORMS & VOLTAGE READINGS
WERE OBTAINED UNDER FOLLOWING CONDITIONS:

CONTROLS	WAVEFORMS	VOLTAGES	
		UPPER	LOWER
TRIG MODE	AUTO * FREE RUN	NORM	FREE RUN
A TIME/CM	* .1 μ SEC		

(SEE IMPORTANT NOTE ON TRIG. GEN. DIAG.)

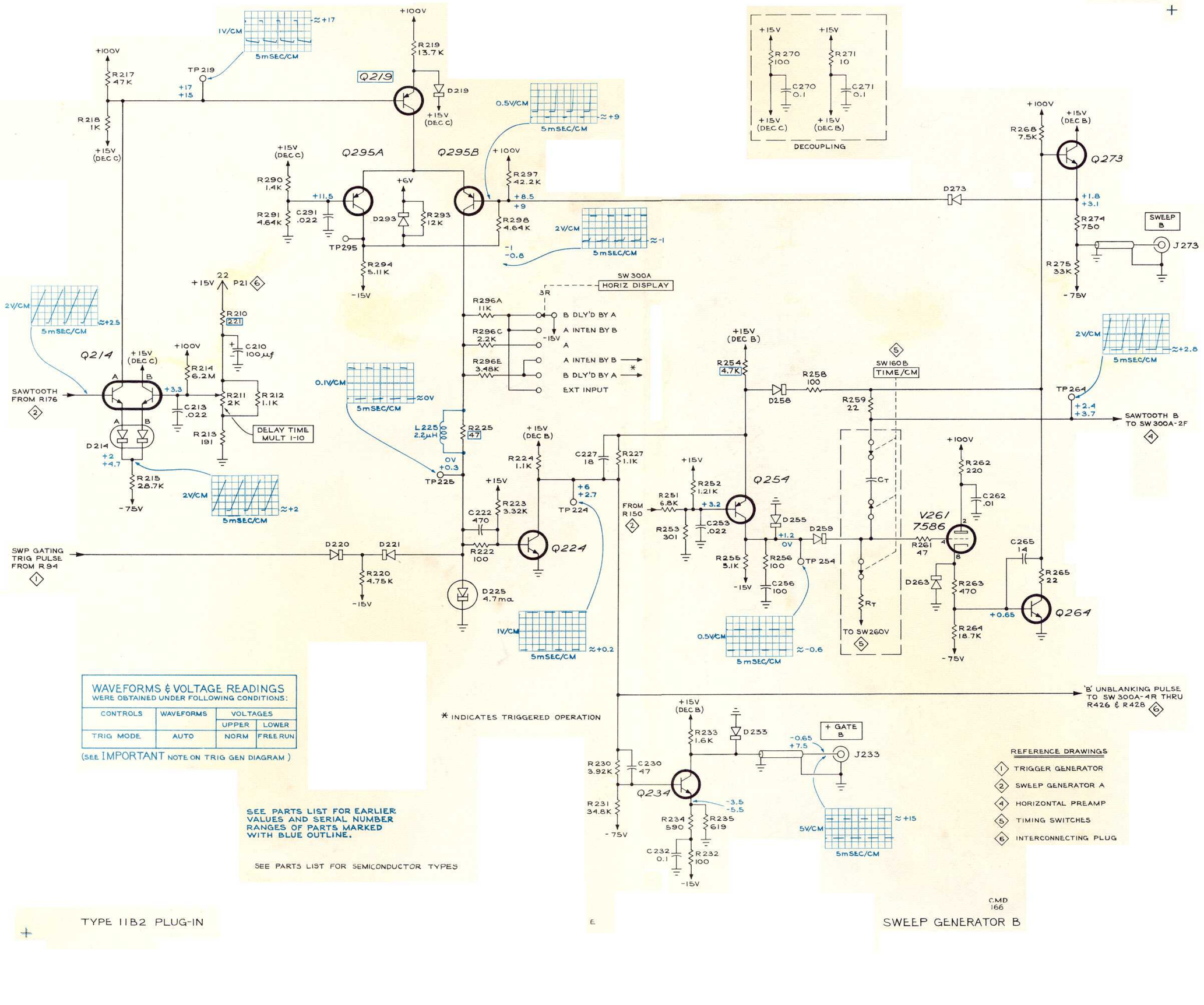
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

TYPE 11B2 PLUG-IN

SWEEP GENERATOR A

CMD 1164

C1



WAVEFORMS & VOLTAGE READINGS WERE OBTAINED UNDER FOLLOWING CONDITIONS:			
CONTROLS	WAVEFORMS	VOLTAGES	
		UPPER	LOWER
TRIG MODE	AUTO	NORM	FREE RUN

(SEE IMPORTANT NOTE ON TRIG GEN DIAGRAM)

* INDICATES TRIGGERED OPERATION

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

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

REFERENCE DRAWINGS

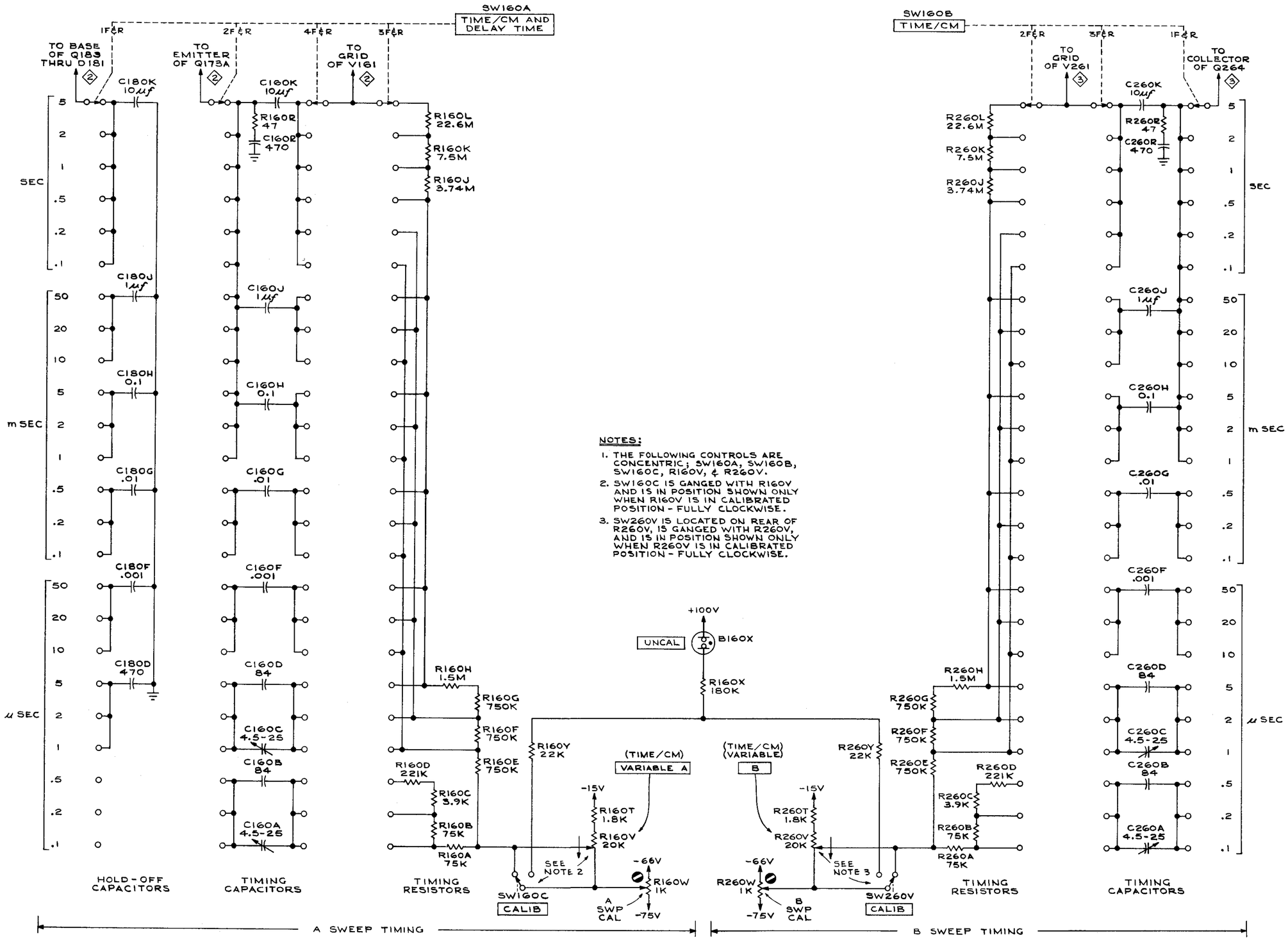
1. TRIGGER GENERATOR
2. SWEEP GENERATOR A
4. HORIZONTAL PREAMP
5. TIMING SWITCHES
6. INTERCONNECTING PLUG

TYPE 11B2 PLUG-IN

E

CMD 166

SWEEP GENERATOR B



NOTES:

1. THE FOLLOWING CONTROLS ARE CONCENTRIC; SW160A, SW160B, SW160C, R160V, & R260V.
2. SW160C IS GANGED WITH R160V AND IS IN POSITION SHOWN ONLY WHEN R160V IS IN CALIBRATED POSITION - FULLY CLOCKWISE.
3. SW260V IS LOCATED ON REAR OF R260V, IS GANGED WITH R260V, AND IS IN POSITION SHOWN ONLY WHEN R260V IS IN CALIBRATED POSITION - FULLY CLOCKWISE.

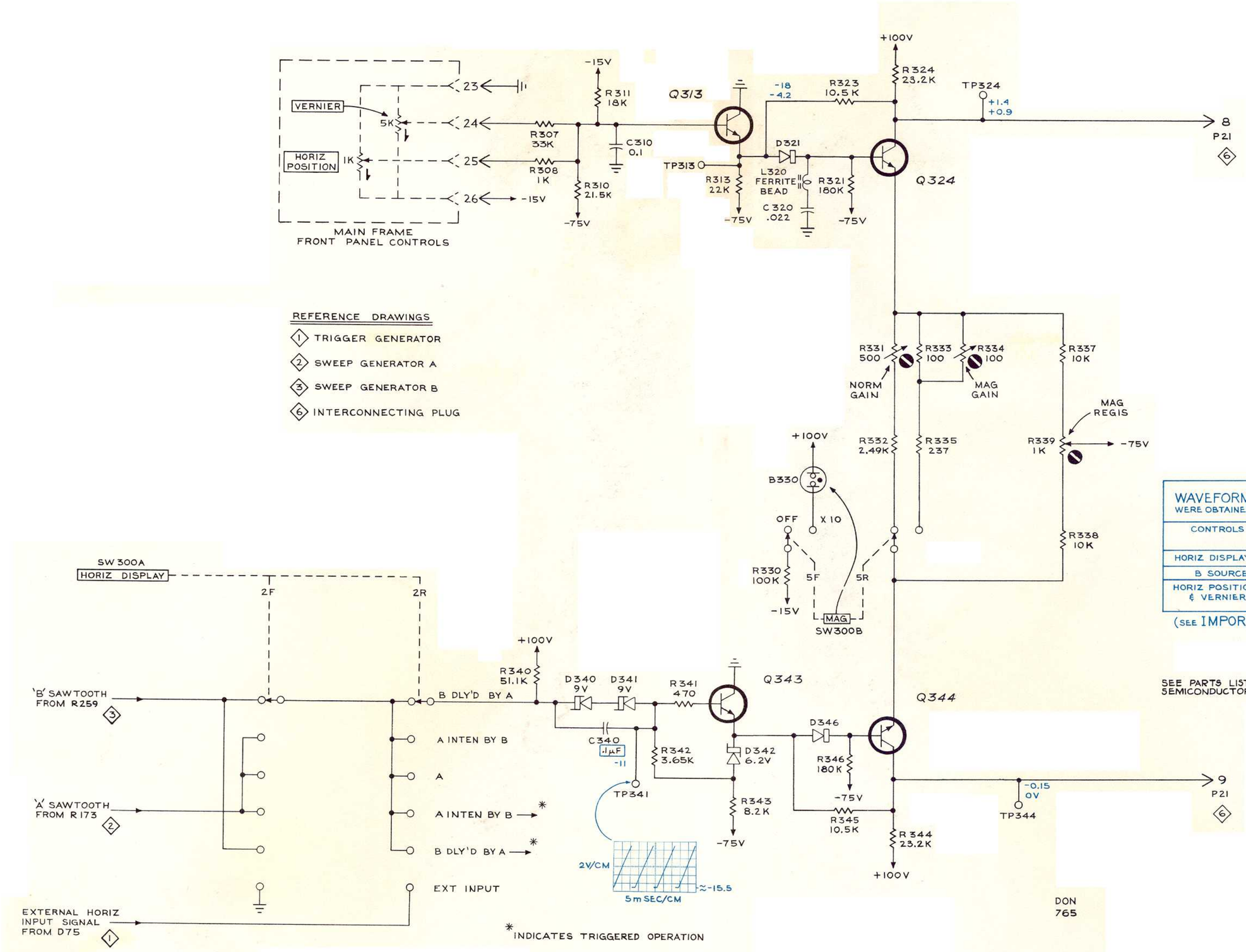
REFERENCE DRAWINGS:

② SWEEP GENERATOR A

③ SWEEP GENERATOR B

MRH
1163

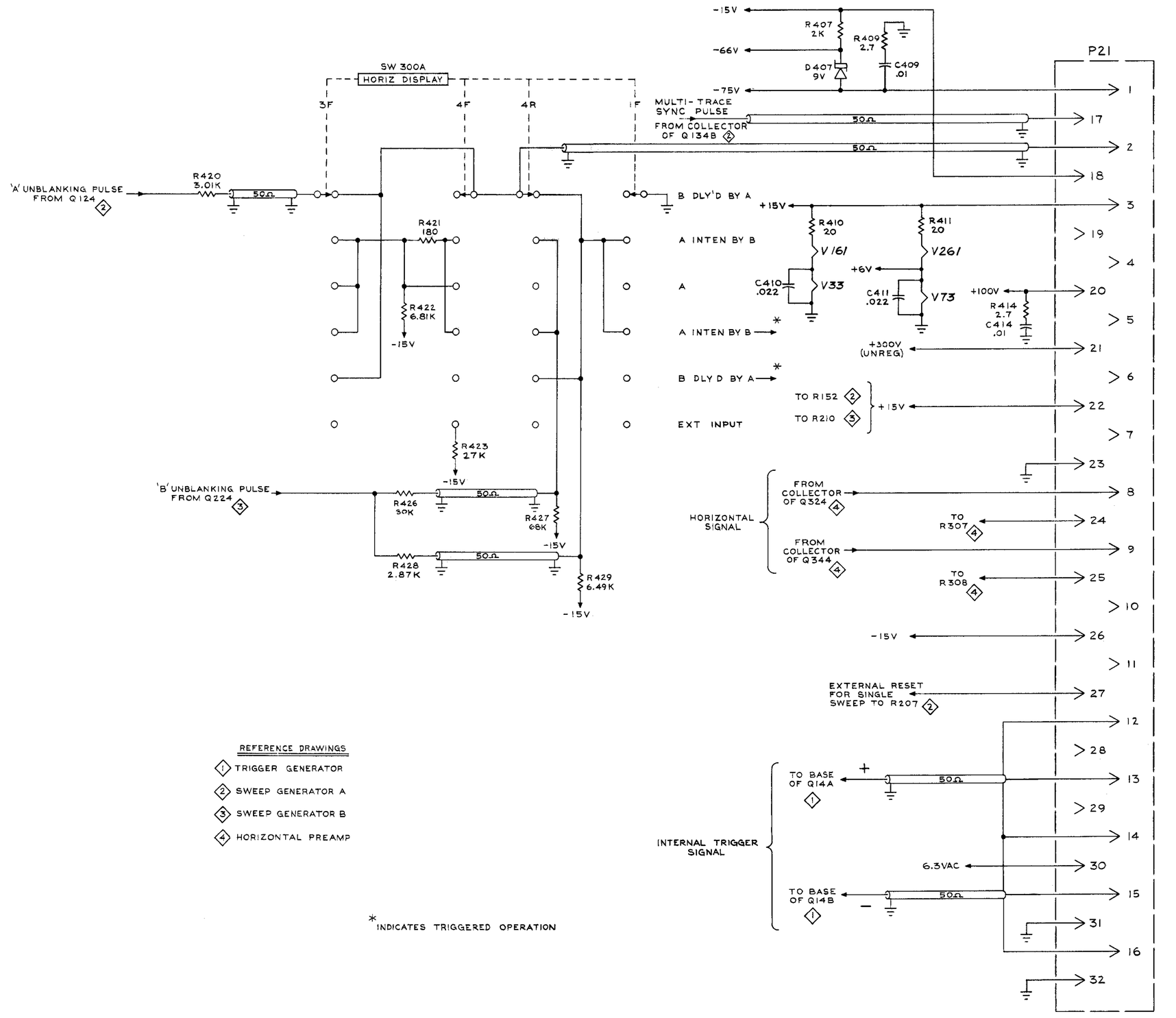
TIMING SWITCHES



TYPE 11B2 PLUG-IN

B2

HORIZONTAL PREAMP



REFERENCE DRAWINGS

1. TRIGGER GENERATOR
2. SWEEP GENERATOR A
3. SWEEP GENERATOR B
4. HORIZONTAL PREAMP

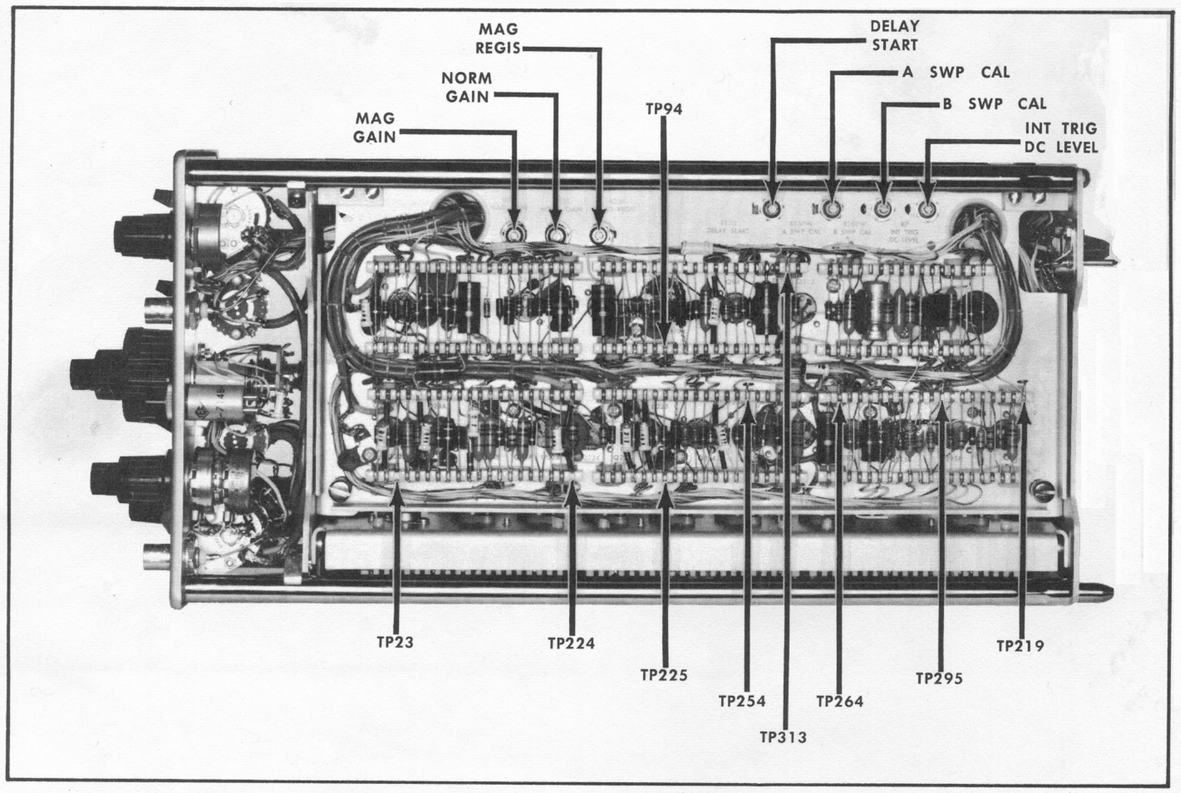
* INDICATES TRIGGERED OPERATION

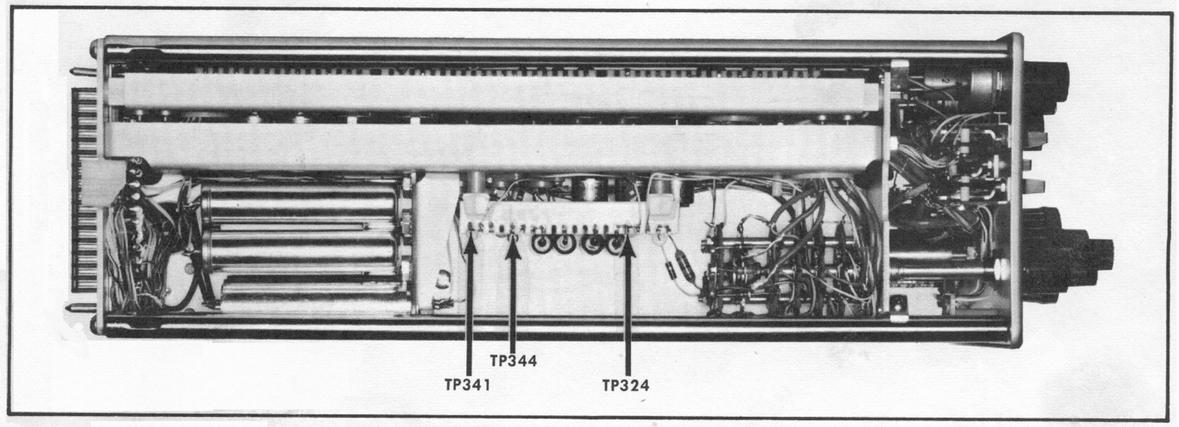
TYPE 11B2 PLUG-IN

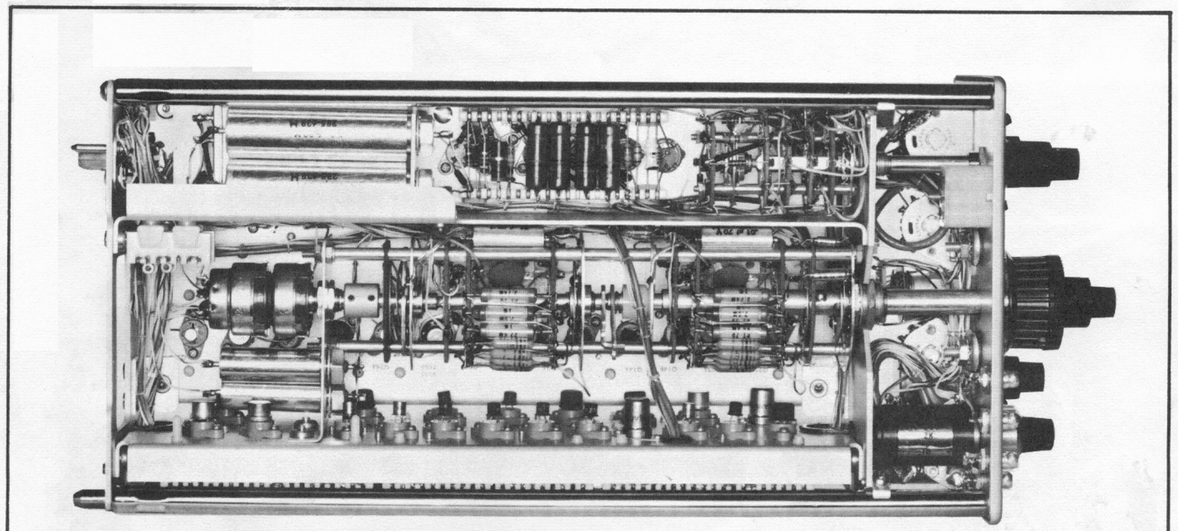
A1

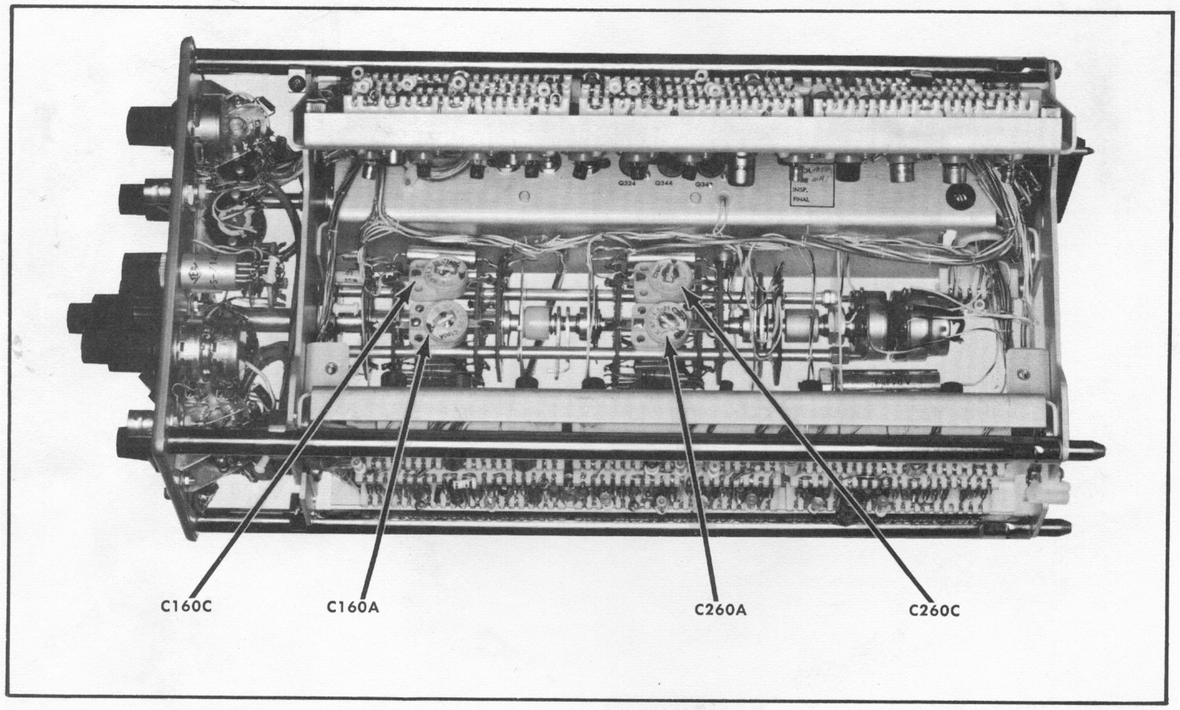
INTERCONNECTING PLUG

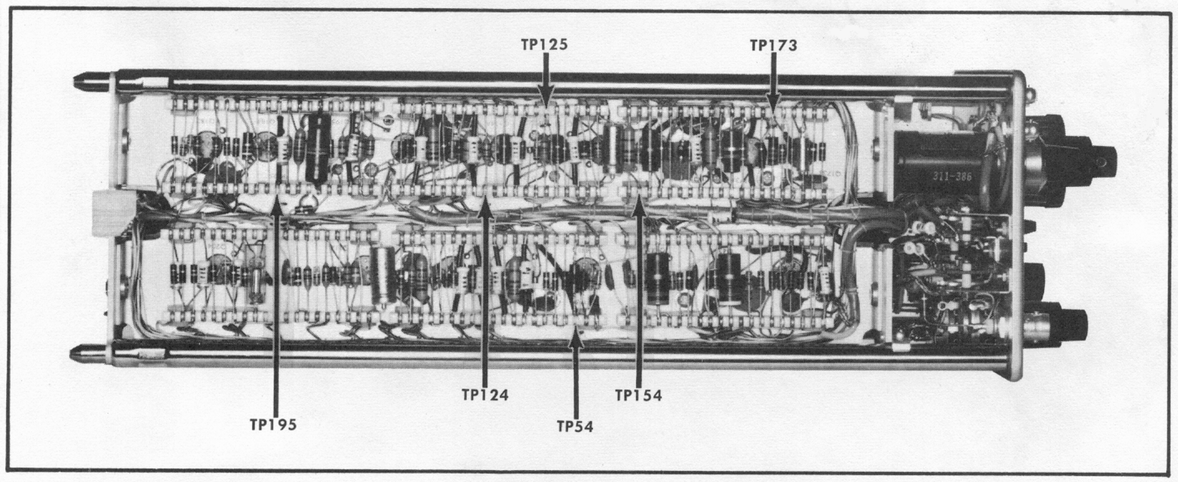
DON 1163


MAG REGIS
NORM GAIN
MAG GAIN
TP94
DELAY START
A SWP CAL
B SWP CAL
INT TRIG DC LEVEL
TP23
TP224
TP225
TP254
TP313
TP264
TP295
TP219


TP344
TP341
TP324




C160C
C160A
C260A
C260C


TP125
TP173
TP195
TP124
TP54
TP154

MANUAL CHANGE INFORMATION

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

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

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