INSTRUCTION MANUAL

Serial Number ____________

TYPE

3B4

PLUG-IN UNIT

Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-431

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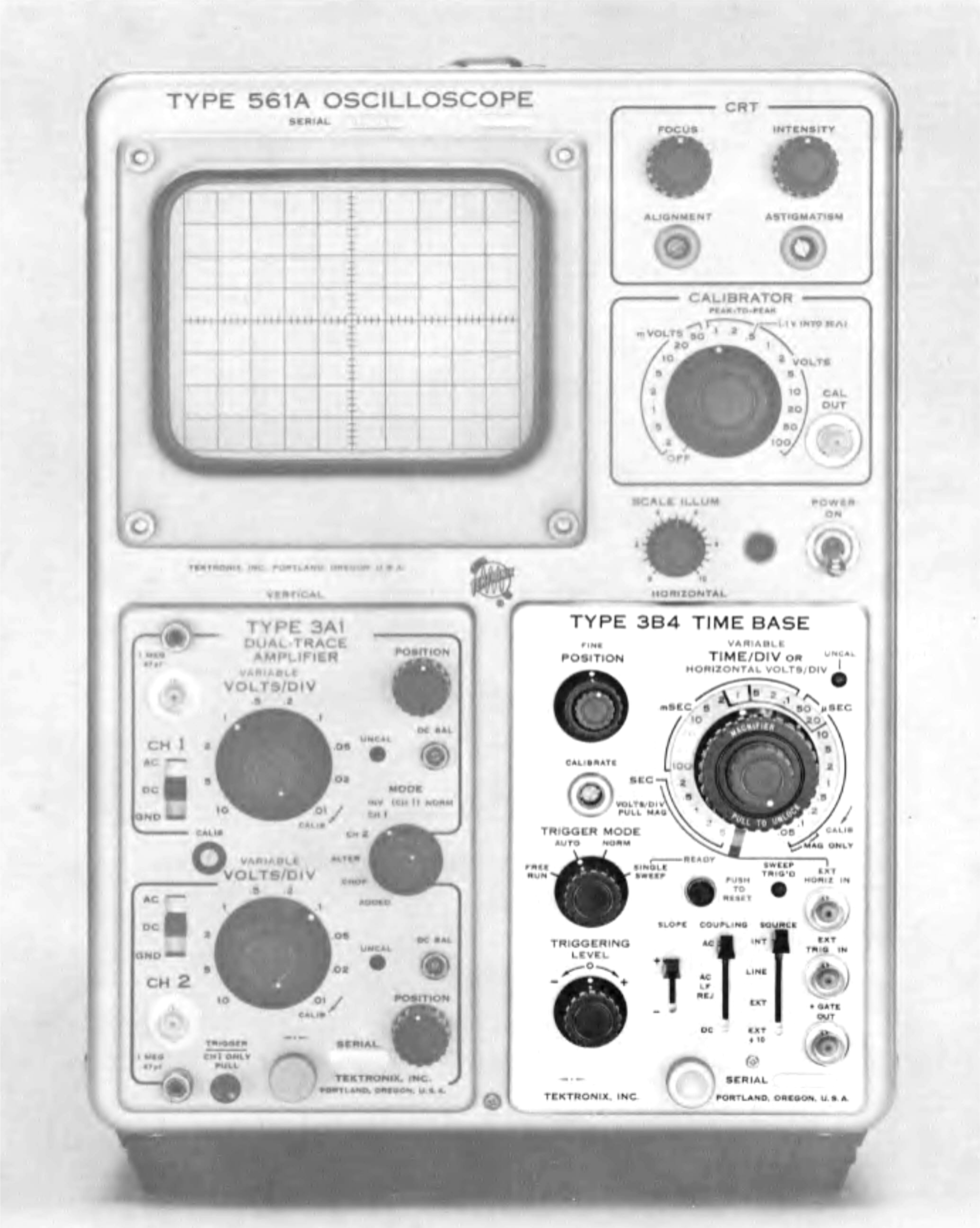

TYPE 561A OSCILLOSCOPE
SERIAL
CRT
FOCUS
INTENSITY
ALIGNMENT
ASTIGMATISM
CALIBRATOR
PEAK-TO-PEAK
mVOLTS
VOLTS
CAL OUT
OFF
SCALE ILLUM
POWER ON
VERTICAL
HORIZONTAL
TYPE 3A1
DUAL-TRACE
AMPLIFIER
VARIABLE
VOLTS/DIV
POSITION
CH 1
AC
DC
GND
UNCAL
DC BAL
MODE
CALIB
CH 2
ALTER
CHOP
ADDED
TRIGGER
CH 1 ONLY
PULL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

SECTION 1
CHARACTERISTICS

Introduction

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

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

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

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

Triggering

Facilities

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

TRIGGERING LEVEL Control Voltage Range (external triggering)

See Table 1-1.

TABLE 1-1

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

NOTE

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

Triggering Sensitivity. See Table 1-2.

TABLE 1-2

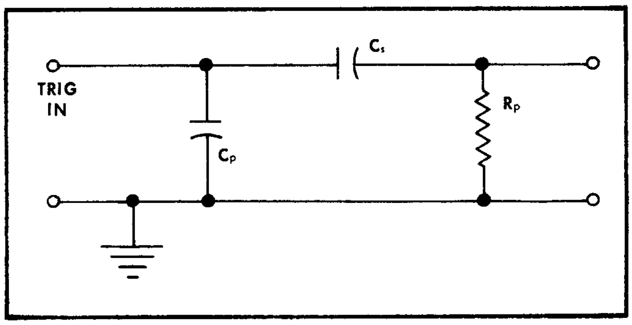
SOURCE	Voltage Range AC	Voltage Range AC LF REJ	Voltage Range DC
INT	1 minor division of deflection 30 cps to 20 mc. Outside these limits requires larger triggering signal.	1 minor division of deflection 30 kc to 20 mc. Outside these limits requires larger triggering signal.	1 minor division of deflection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

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

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

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

TABLE 1-3



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

Sweep

Facilities

TIME/DIV Switch — 0.2 μsec/div to 5 sec/div in 23 steps, 1, 2, 5 sequence. The calibration accuracy (unmagnified) is ±3% from 0.2 μsec/div to 2 sec/div; ±5% at 5 sec/div.

VARIABLE Control — Uncalibrated variable time/div control. Multiplies the sweep time/div of any step of the TIME/DIV switch by a factor variable from 1 to ≥2.5.

POSITION Controls — Coarse horizontal positioning to position any portion of the trace to the center of the crt. The FINE control has a range of about 2 minor divisions.

MAGNIFIER Control — Provides direct readout magnification of the sweep (up to 50×). The magnifier also provides the 0.05 and 0.1 μsec/div sweep rates. Magnified sweep accuracy, ±5% (exception: 5 sec/div). Magnified sweep registration, ±1 minor division.

+ GATE OUT Connector — Provides a +20-volt (±15%) output pulse during sweep time.

Sweep Length — 10.5 ±0.3 major division.

Sweep Amplifier (when used as an external horizontal amplifier)

Facilities

HORIZONTAL VOLTS/DIV Switch — Calibrated volts/div steps of 0.2, 0.5, 1, 2, and 5 volts/div. Accuracy ±3% when calibrated to match the oscilloscope in which used. The amplifier is dc coupled to the EXT HORIZ IN connector.

VARIABLE Control — Multiplies volts/div of any step by a factor variable from 1 to ≥2.5.

EXT HORIZ IN Connector — Input R and C is typically 1 megΩ shunted by 40 pf.

Frequency Response — Dc to 400 kc. Response ≤30% down at 400 kc with the VARIABLE control set to CALIB position.

Maximum Input Voltage — ±20 volts dc, or 20 volts peak ac.

Environmental

Operating

TEMPERATURE — 0° C to +50° C.

ALTITUDE — 10,000 feet maximum.

VIBRATION — 0.015 inch peak-to-peak, (1.9 G,s) for 15 minutes along each axis. Vibration frequency varied from 10-50-10 cps in 1-minute cycles.

Non Operating

TEMPERATURE — —35° C to +60° C.

ALTITUDE — 50,000 feet maximum.

VIBRATION — 0,015 ±0.003 inch total displacement from 10 to 5 cycles.

TRANSIT — Meets National Safe Transit type of test when factory packaged: Vibration for one hour at slightly greater than 1G. 30-inch drops on corners, edges and flat surfaces.

Mechanical

Construction — Aluminum-alloy chassis with chrome-plated side rails. Front panel is photo-etched and anodized.

Dimension (approx.) — 6¼ inches high, 4¼ inches wide, 14½ inches deep (overall).

Net Weight — 4.5 pounds.

Accessories

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

SECTION 3
CIRCUIT DESCRIPTION

Introduction

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

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

Trigger Generator

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

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

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

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

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

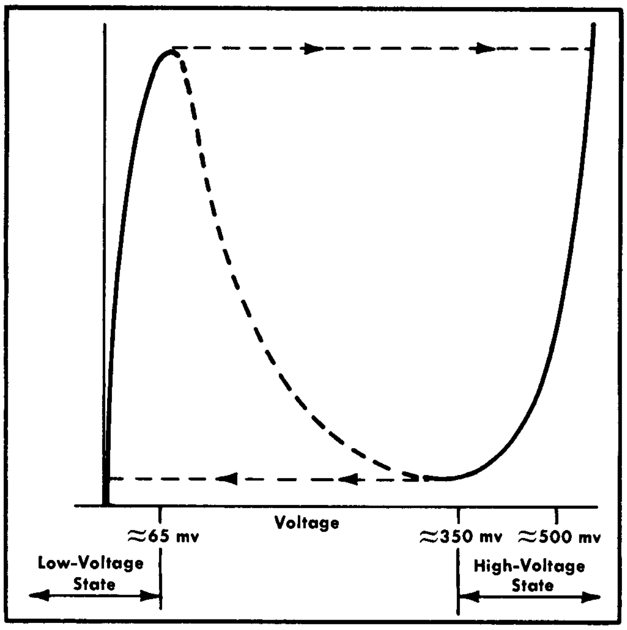


Fig. 3-1. Current-Voltage Characteristics of a Typical Tunnel Diode.

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

Sweep Generator

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

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

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

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

4. A negative-going multi-trace sync pulse. This pulse is applied to the vertical plug-in unit interconnecting socket. The pulse is used to switch channels in a multi-trace plug-in unit when operating in the alternate mode.

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

The Sweep Gating circuit is an electronic switch that drives the Disconnect circuit to switch the Disconnect Diodes on and off. When the Disconnect Diodes are switched off, the Miller Runup Integrator begins to produce a sawtooth that is fed back through the Lockout circuit to the Sweep Gating circuit. When the sawtooth reaches the desired amplitude, the Lockout circuit resets the Sweep Gating tunnel diode, the Disconnect Diodes are switched back on, and the Miller Runup resets to form the retrace or falling portion of the sawtooth. Following a short stabilization period, the Sweep Generator is ready to repeat the sequence.

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

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

2. In SINGLE SWEEP, two pulses are required to start each sweep. First, a pulse from the Reset circuit (originating at the RESET pushbutton) resets the Lockout Multi. Then, after reset, the Sweep Gating circuit can be switched by a pulse from the Trigger Generator.

3. FREE RUN results in recurrent sweeps that are independent of any triggering signal. The switching of the Lockout Multi at the end of the holdoff period makes available enough current to switch the tunnel diode in the Sweep Gating circuit.

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

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

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

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

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

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

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

The negative-going step from Q154 reverse biases Disconnect diode D155 as previously explained. When D155 cuts off, the current through Timing Resistor R160 does not cease, but instead begins to charge Time Capacitor C160 (see Timing Switch schematic). As the timing capacitor charges, the grid of V161A goes negative. The tube amplifies the change in grid voltage and the inverted and greatly amplified change is applied to the grid of cathode follower V173A, which in turn couples the positive going voltage back to the timing capacitor and opposes the change in grid voltage of V161A. (The positive going voltage also reverse biases D161 and cuts off Q164). This action persists throughout the sawtooth period and limits the total change of grid voltage of V161A to less than 0.5 volt. Since the voltage drop across the timing resistor is held nearly constant, the current through the resistor is essentially a fixed value. This fixed current flows into the timing capacitor, producing a linearly increasing voltage (sawtooth) across the capacitor. The rate of the sawtooth rise is a function of the RC time constant of C160 and R160 and the voltage applied. D155 is a special diode that exhibits very low leakage under reverse-bias conditions. This characteristic prevents the diode from effectively altering the timing resistance value.

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

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

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

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

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

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

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

TRIGGERING LEVEL control R16B permits the operator to vary slightly the time between the completion of a sweep and the instant when the sweep generator again becomes triggerable. As Q135 turns off at the end of holdoff time, a very short but sometimes significant amount of time is required for the current through tunnel diode D143 to reach its quiescent level. When the relationship between the sweep rate and triggering frequency is such that the sweep gating trigger pulse tends to trigger each new sweep while the tunnel diode current is approaching the quiescent level, the display may jitter horizontally. The operator can minimize and often eliminate the jitter by slightly adjusting the TRIGGERING LEVEL control.

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

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

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

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

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

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

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

Horizontal Amplifier

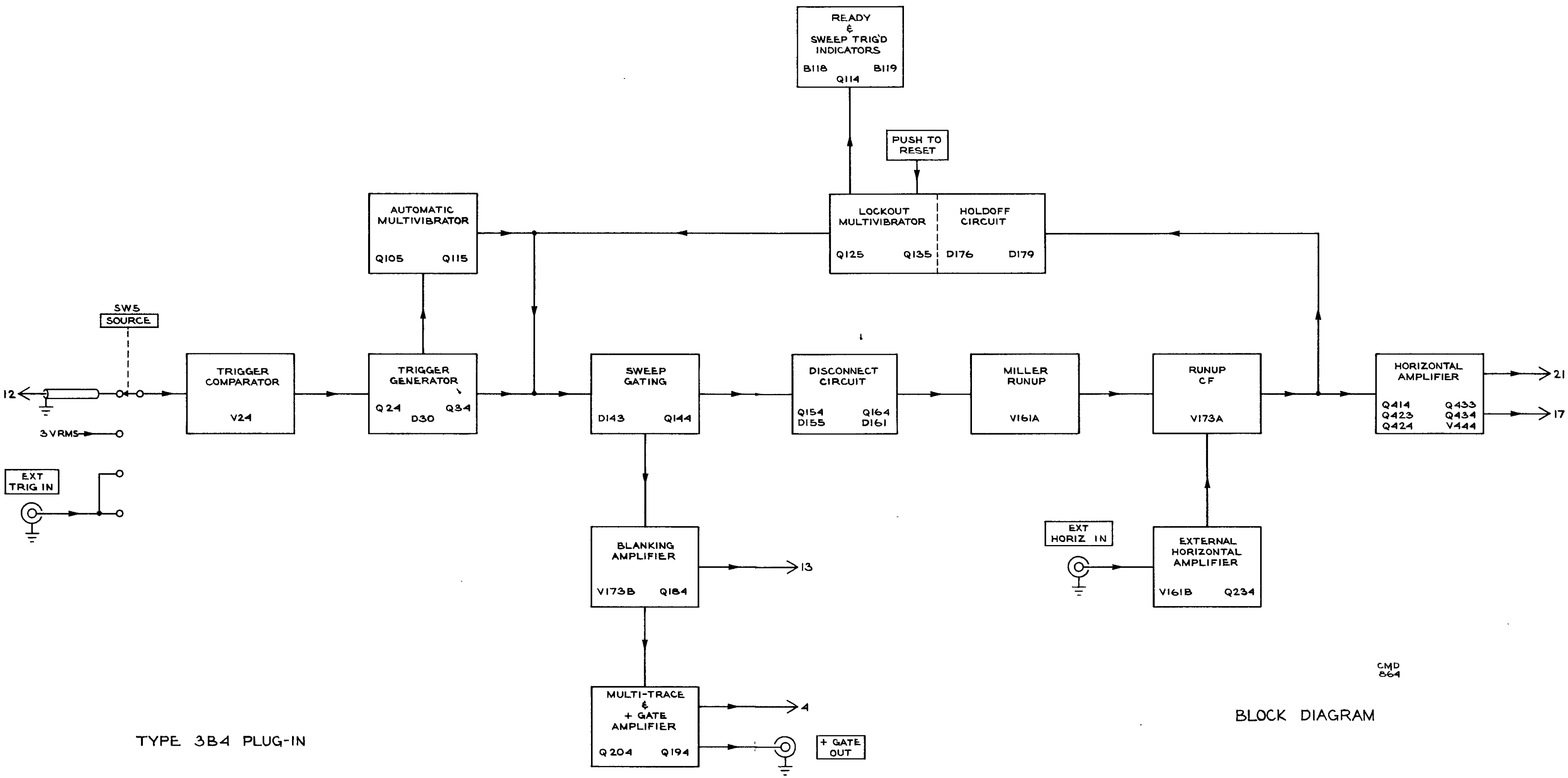
The block diagram in Section 5 shows the basic arrangement of the horizontal amplifier circuits. The input to the Horizontal Amplifier proper is taken from the output of cathode follower V173A in the Miller Runup circuit. Normally, the signal input to the Horizontal Amplifier is the sweep ramp voltage.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

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

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

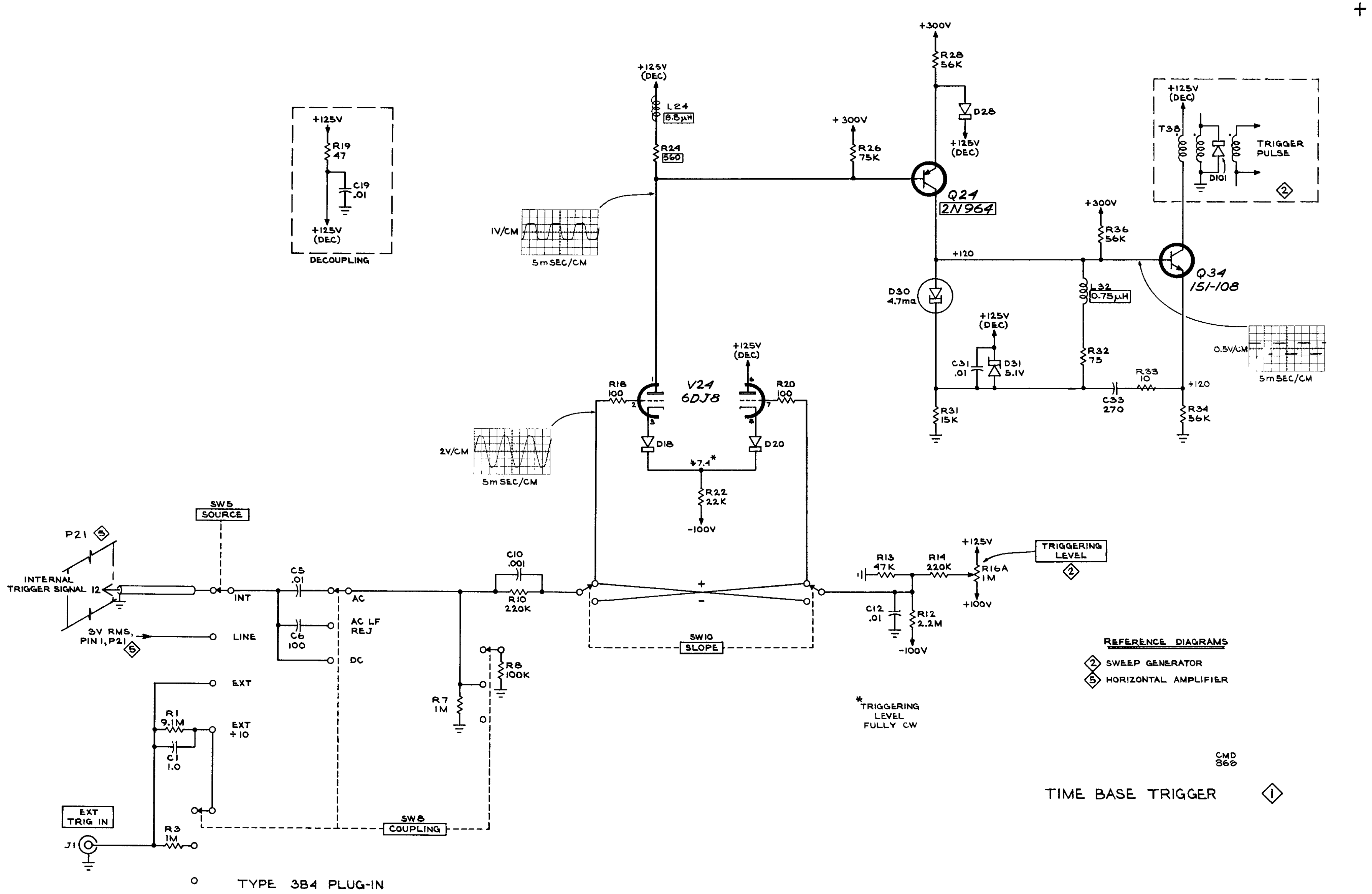
The output of Q414 is applied to the input of a paraphase amplifier consisting of Q424, Q434, Q423, Q433, and associated circuit elements. The two transistors in each side of the paraphase amplifier are compound connected to achieve the high effective gain needed to make the stage gain dependent only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

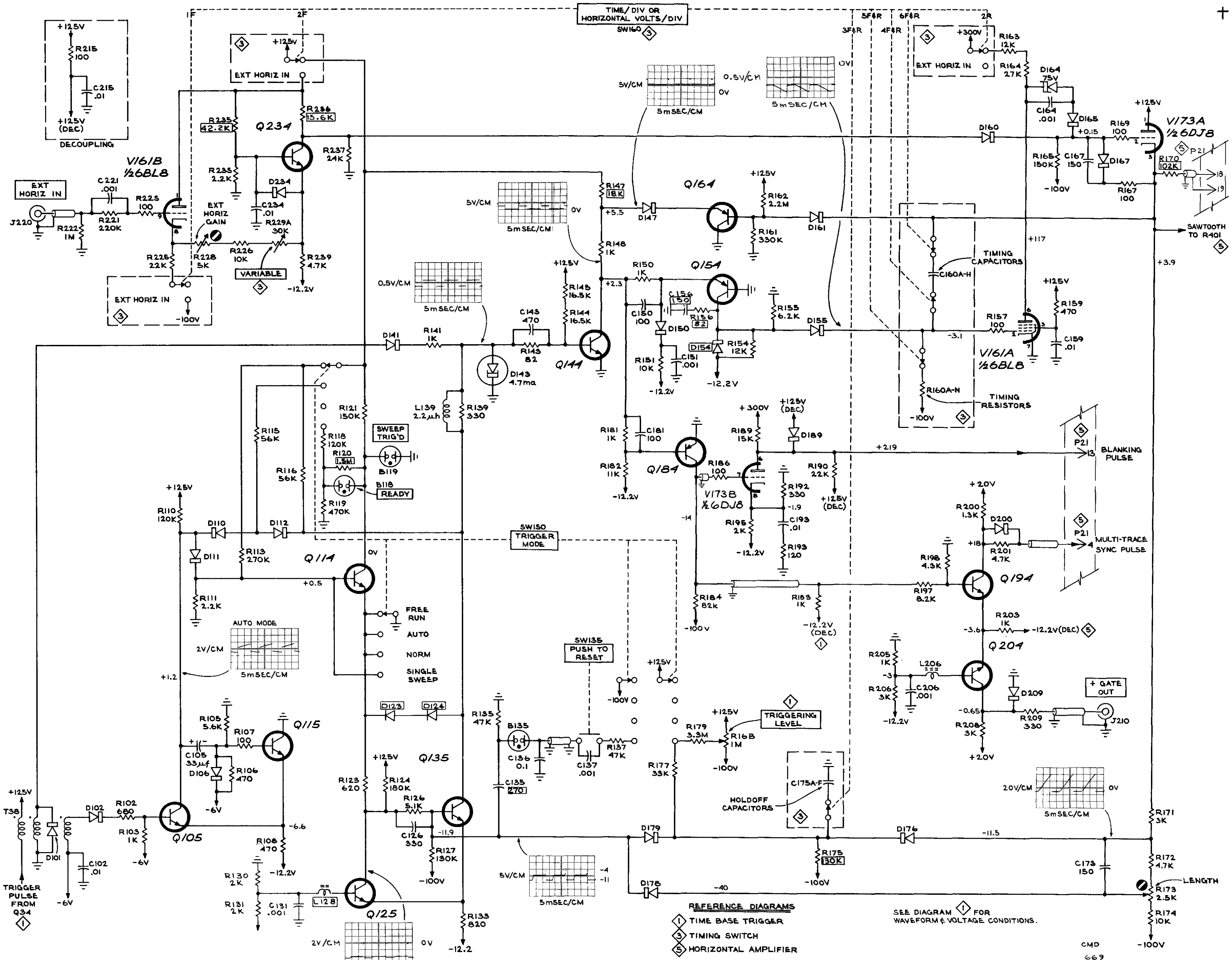
The output of the paraphase amplifier drives the cathodes of a grounded-grid, push-pull connected twin triode (V444A and V444B). The push-pull output of the twin triode is applied through pins 17 and 21 of the interconnecting plug to the horizontal deflection plates of the crt.



TYPE 3B4 PLUG-IN

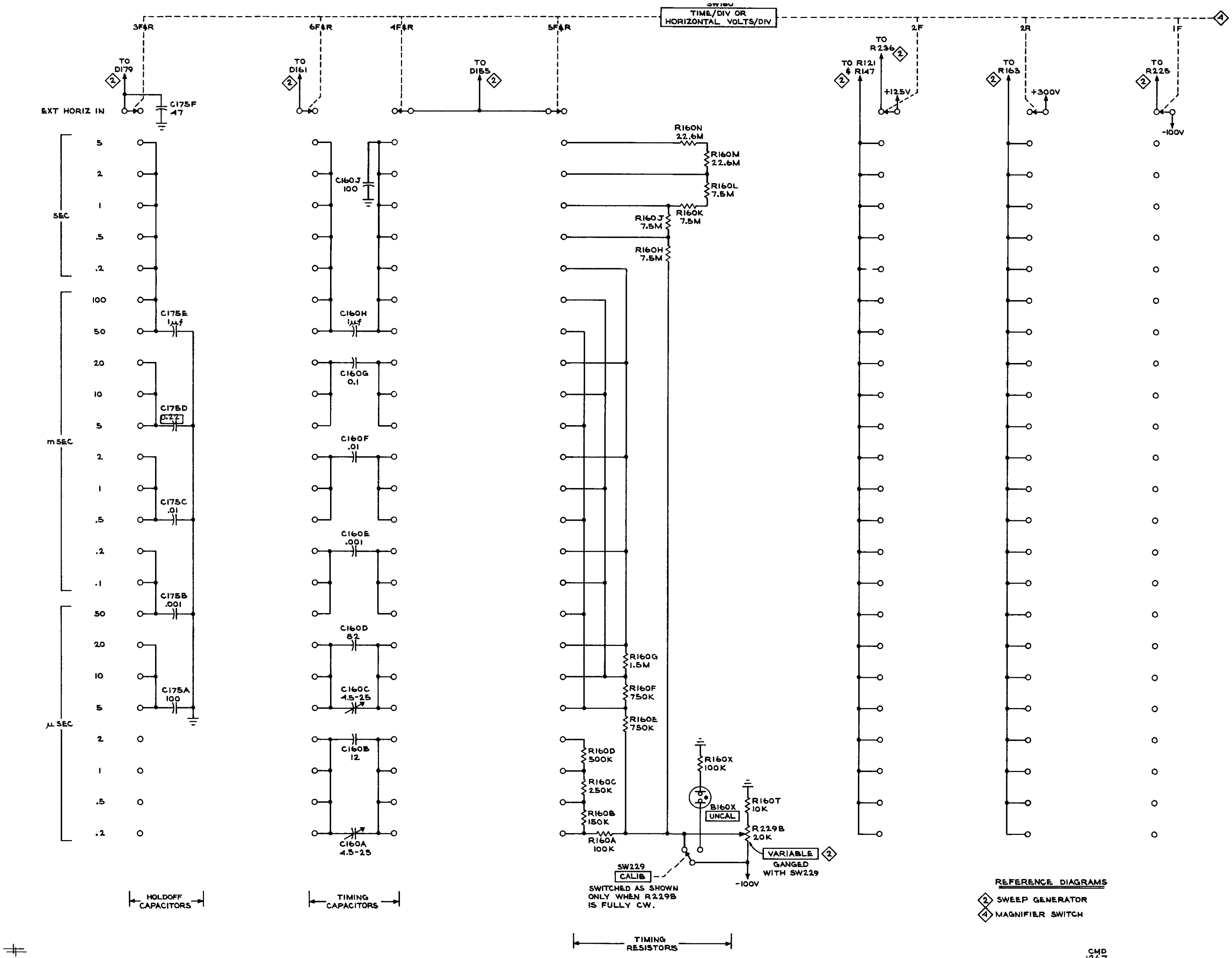
BLOCK DIAGRAM


+125V
R19
47
C19
.01
+125V
(DEC)
DECOUPLING
+125V
(DEC)
L24
6.8µH
R24
560
1V/CM
5mSEC/CM
+300V
R28
56K
D28
+125V
(DEC)
+ 300V
R26
75K
Q24
2N964
+300V
R36
56K
+120
Q34
151-108
D30
4.7ma
L32
0.75µH
+125V
(DEC)
C31
.01
D31
5.1V
R32
75
R33
10
+120
C33
270
R31
15K
R34
56K
0.5V/CM
5mSEC/CM
+125V
(DEC)
T38
TRIGGER
PULSE
D101
2
R18
100
V24
6DJ8
+125V
(DEC)
R20
100
2V/CM
5mSEC/CM
D18
D20
+7.4*
R22
22K
-100V
SW5
SOURCE
P21
5
INTERNAL
TRIGGER SIGNAL
12
INT
C5
.01
AC
C10
.001
R10
220K
+
-
SW10
SLOPE
C6
100
AC LF
REJ
DC
3V RMS,
PIN 1, P21
5
LINE
EXT
R8
100K
R7
1M
R1
9.1M
EXT
÷10
C1
1.0
EXT
TRIG IN
J1
R3
1M
SW8
COUPLING
R13
47K
R14
220K
+125V
R16A
1M
TRIGGERING
LEVEL
2
+100V
C12
.01
R12
2.2M
-100V
REFERENCE DIAGRAMS
2 SWEEP GENERATOR
5 HORIZONTAL AMPLIFIER
*TRIGGERING
LEVEL
FULLY CW
CMD
866
TIME BASE TRIGGER
1
TYPE 3B4 PLUG-IN



TYPE 3B4

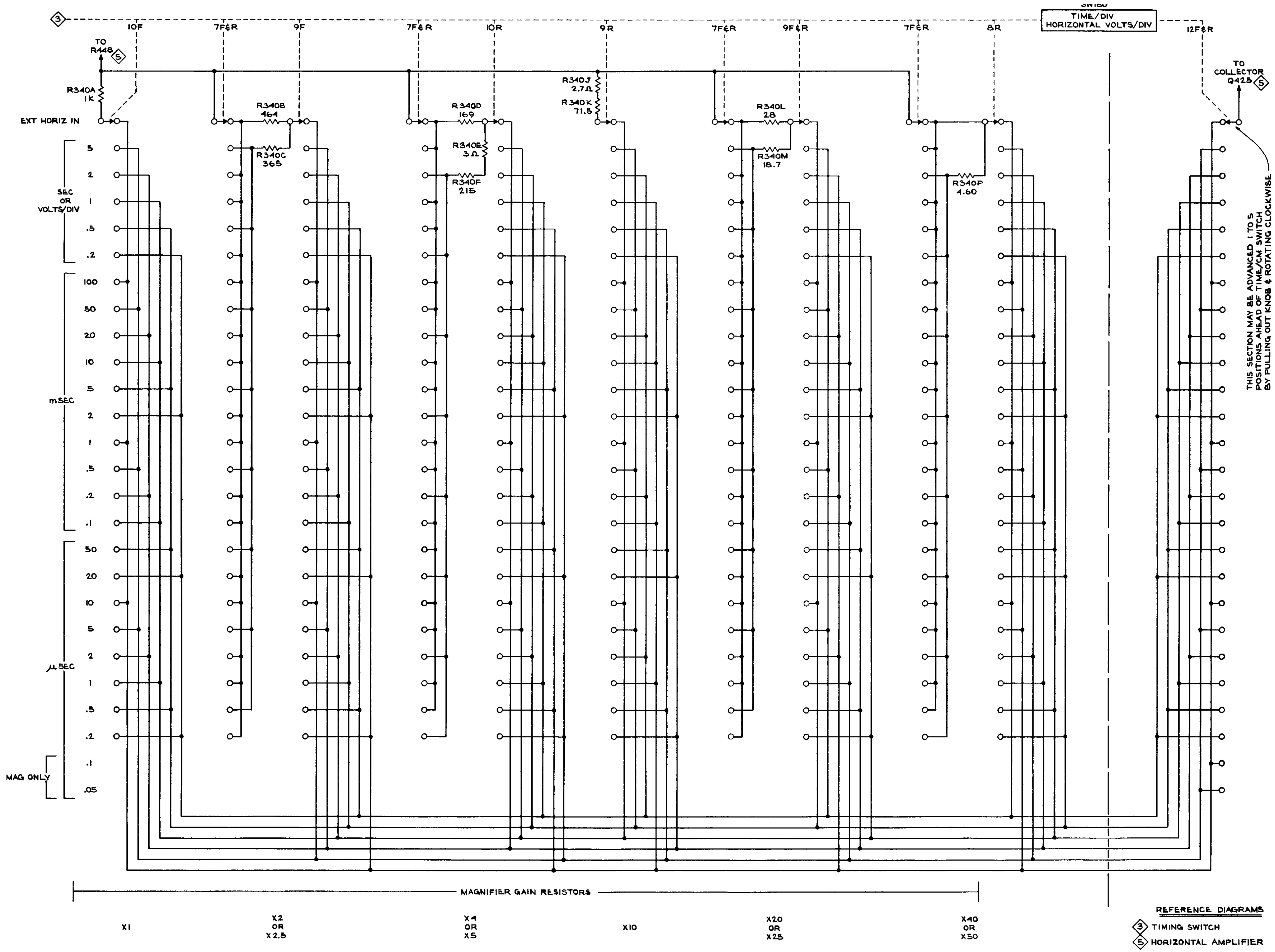
SWEEP GENERATOR 2



TYPE 3B4 PLUG-IN

TIMING SWITCH CMD 1267

3

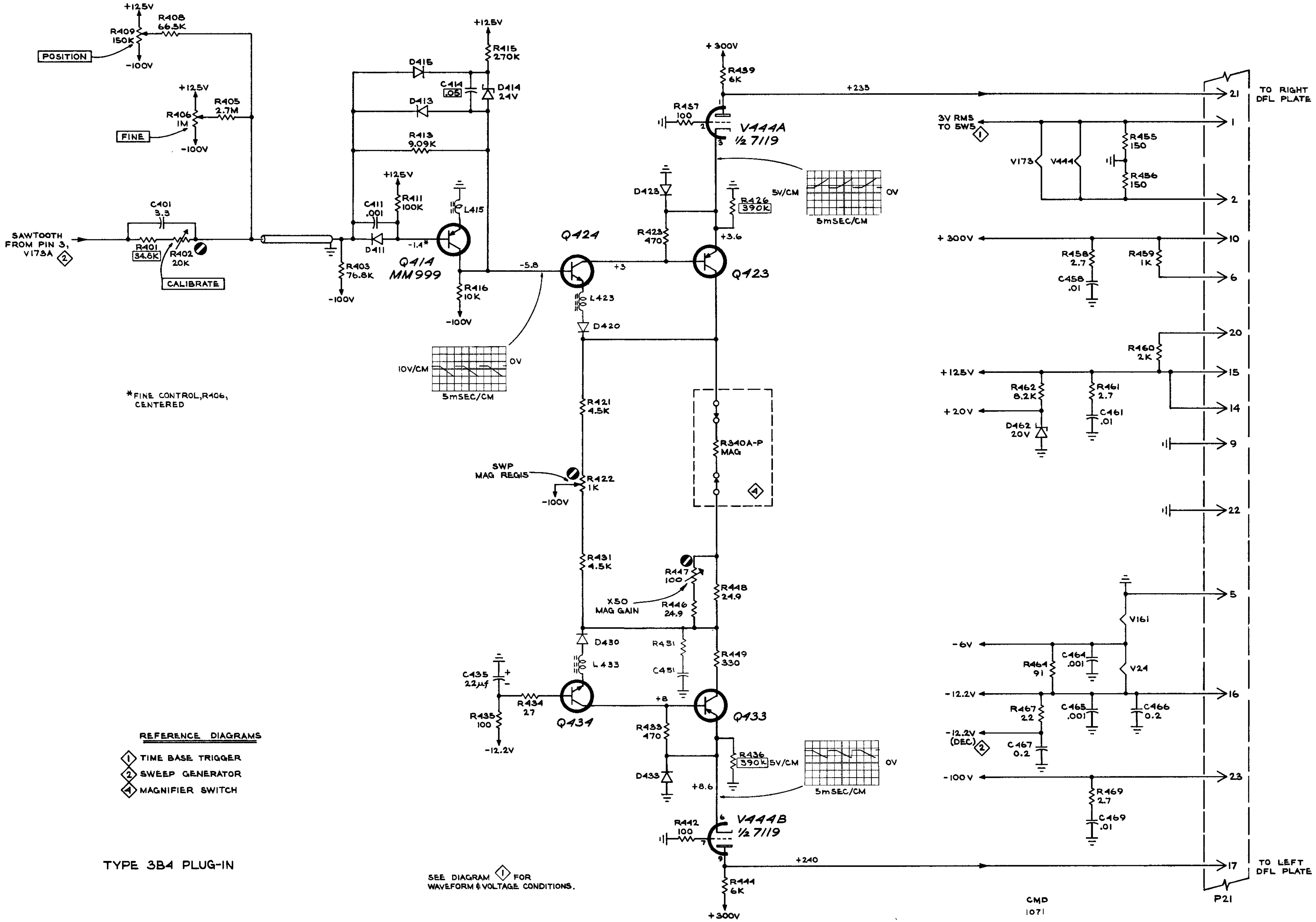


TYPE 3B4 PLUG-IN

CMD 864

MAGNIFIER SWITCH 4

A



REFERENCE DIAGRAMS

- 1 TIME BASE TRIGGER
- 2 SWEEP GENERATOR
- 4 MAGNIFIER SWITCH

TYPE 3B4 PLUG-IN

SEE DIAGRAM 1 FOR
WAVEFORM & VOLTAGE CONDITIONS.

CMD
1071

HORIZONTAL AMPLIFIER 5