# INSTRUCTION MANUAL

Serial Number _____

# TYPE 2B67 TIME BASE

*Tektronix, Inc.*
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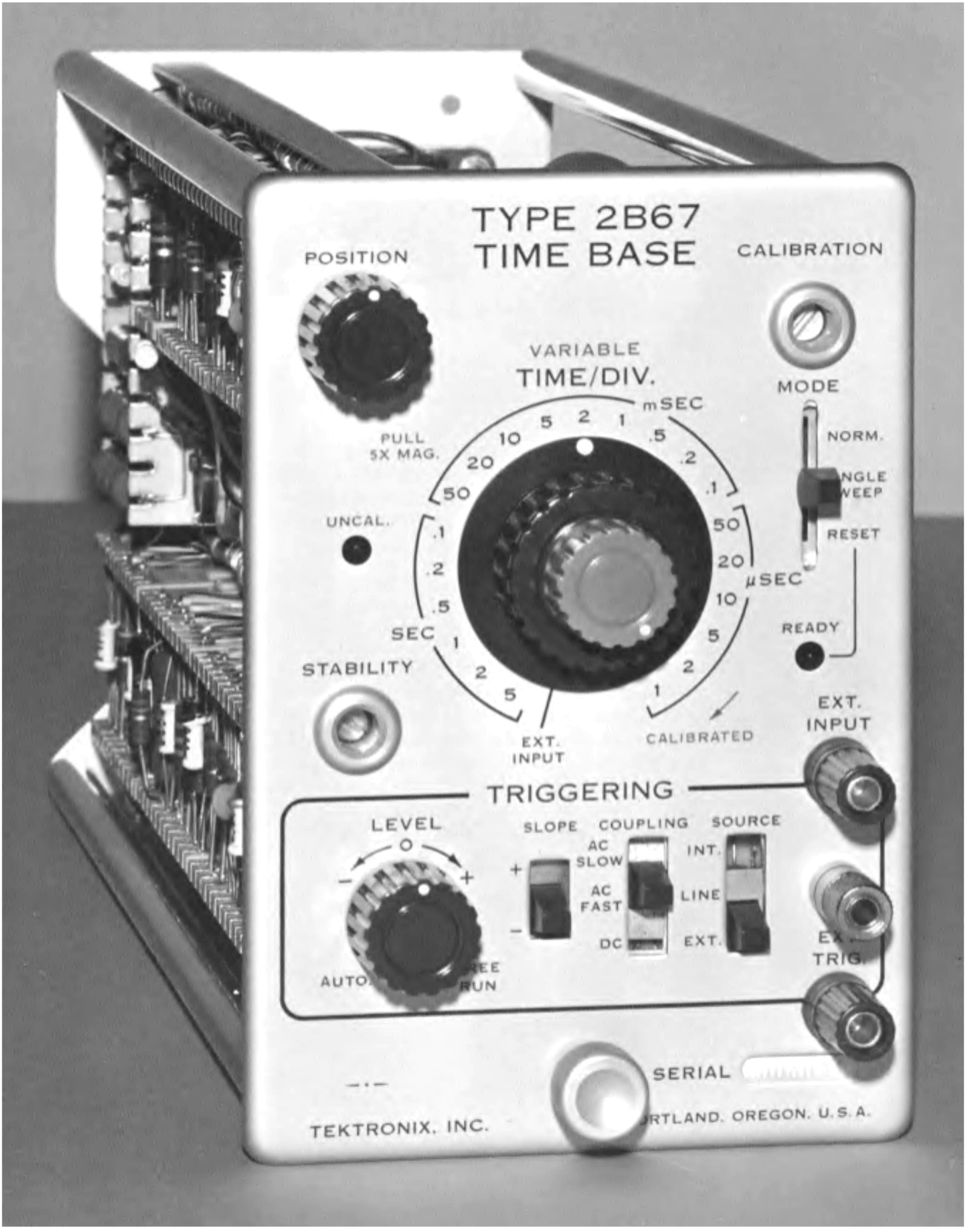
070-366


TYPE 2B67
TIME BASE
POSITION
CALIBRATION
VARIABLE
TIME/DIV.
mSEC
μSEC
SEC
PULL
5X MAG.
UNCAL.
MODE
NORM.
RESET
READY
STABILITY
EXT.
INPUT
CALIBRATED
TRIGGERING
LEVEL
SLOPE
COUPLING
SOURCE
AC
SLOW
AC
FAST
DC
INT.
LINE
EXT.
TRIG.
SERIAL
TEKTRONIX, INC.
RTLAND, OREGON, U.S.A.

# Section 1

# Characteristics

The Tektronix Type 2B67 Time-Base plug-in unit provides time-base deflection for Tektronix 560-Series oscilloscopes. It provides a triggered or free-running sweep, calibrated or continuously variable. The sweep may be triggered internally from either the vertical signal or the power line, or externally. Either repetitive or single-sweep operation may be selected. The Type 2B67 is normally used to provide the horizontal sweep for 560-Series oscilloscopes, but may be used to provide a vertical sweep, if desired. The unit is also provided with an input for external signals.

## Sweep Rates

1 microsecond to 5 seconds per division in 21 calibrated steps. An uncalibrated control provides continuously variable sweep rates to about 3 times the step-switch setting. Calibrated sweep rates are within 3% of step-switch setting; magnified rates are within 5%.

## Magnifier

Provides a 5-times expansion of the center 2 divisions of display, and extends the fastest sweep rate to 0.2 microsecond/division with 1% linearity after the first four divisions.

## Triggering Modes

Internal, External, and Line. Trigger coupling may be selected from AC slow, AC fast, and DC, and triggering level and polarity are continuously adjustable. Triggering level may be set to provide free-running or automatically triggered sweeps.

## Triggering Signal Requirements

Internal Triggering: A signal producing two minor divisions of deflection.

External Triggering: A signal from 0.5 volt at dc to 2.0 volts at 2 mc. Sweep will trigger on larger signals, but LEVEL control limit is ±10 volts.

## Single Sweep

Single sweep may be selected, allowing sweep to operate only after manual reset for either triggered or free-running operation.

## External Signal Input

Bandpass: Dc to about 750 kc, ±3 db.

Sensitivity: About 1 volt/division.

## Construction

Aluminum-alloy chassis.

## Finish

Photo-etched anodized aluminum front panel.

# Section 4

# Circuit Description

## Block Diagram

A block diagram of the Type 2B67 Time Base plug-in is shown in Fig. 4-1. In general, the Type 2B67 operates as follows:

A triggering signal (internal, external, or line) is applied to the Time-Base Trigger circuit. The Time-Base Trigger generates a negative trigger pulse coincident with a selected point on each cycle of the triggering signal. The negative pulse triggers the Time-Base Generator which generates a positive-going sawtooth. The sawtooth is amplified by the Horizontal Amplifier and applied push-pull to the crt deflection plates to sweep the beam across the screen. After the beam has travelled across the screen, the Time-Base Generator resets itself and awaits the next trigger. In single-sweep operation, the Time-Base Generator must be reset manually.

In the EXT. INPUT position of the TIME/DIV. switch, the Time-Base Generator is disabled and the output stage of the Horizontal Amplifier is connected to the front-panel EXT. INPUT jack.

## TIME-BASE TRIGGER

The Time-Base Trigger (see schematic) consists of Trigger Input Amplifier V24 and the Trigger Multivibrator V15. The Trigger Input Amplifier amplifies (and, when desired, inverts) the incoming triggering signal and applies it to the Trigger Multivibrator. The Trigger Multivibrator is a Schmitt circuit that is switched from one state to the other by the signal at its input. Its square-wave output is differentiated to form negative and positive pulses that are applied to the Time-Base Generator. The negative pulses trigger the Time-Base Generator to start the sweep; the positive pulses are clipped by diode action and are not used.

### Trigger Input Amplifier

The input to Trigger Input Amplifier V24 may be selected from one of three sources by means of SOURCE switch SW5. When the SOURCE switch is in the INT. position, the signal is obtained from the plug-in unit in the left-hand opening of the oscilloscope. When the SOURCE switch is in the EXT. position, the signal may be obtained from an external source through the EXT. TRIG. connector on the front panel. When the SOURCE switch is in the LINE position, the signal is obtained from one side of the 6.3-volt circuit supplying heater current to the tubes.

The negative pulse at the output of the Time-Base Trigger occurs only when there is a negative-going signal at the input of the Trigger Multivibrator (output of the Trigger Input Amplifier). To start the sweep during either a positive-going or negative-going portion of the incoming triggering signal, SLOPE switch SW20 provides either inverted or in-phase amplification of the triggering signal.

When the SLOPE switch is in the — position, the incoming signal is applied to the grid of V24A, and V24 operates as a cathode-coupled amplifier (output in phase with input). The negative pulse at the output of the Time-Base Trigger will therefore occur during a time when the triggering signal is moving in a negative direction.

When the SLOPE switch is in the + position, the incoming triggering signal is applied to the grid of V24B, and V24B operates as a plate-loaded amplifier (output opposite in polarity to input). The negative pulse at the output of the Time-Base Trigger now occurs during a time when the triggering signal is moving in a positive direction.

LEVEL control R17 varies the average dc level at the plate of V24B from about +102 volts to +123 volts. This is true whether the SLOPE switch is in the — or + position. The voltage at the plate of V24B must shift through the

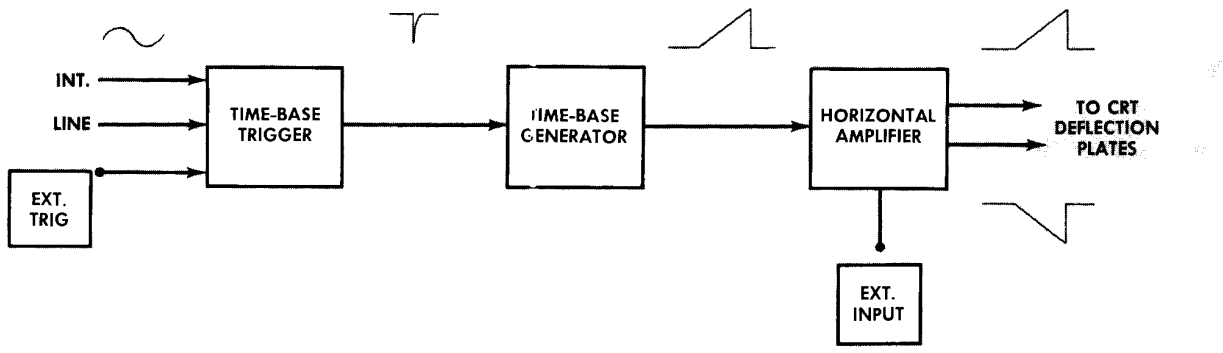



Fig. 4-1. Type 2B67 block diagram.

approximate center of this range (between about 111 and 113 volts) to force the Trigger Multivibrator to change states.

For small triggering signals, R17 is set so the average dc level at the plate of V24B is close to the center of its range. Then a small triggering signal, amplified by V24, is sufficient to carry the plate voltage through the approximate 112-volt point. When a large triggering signal is applied, and it is desired to trigger on an extreme positive or negative point of it, R17 is set so V24B is well into saturation, or cutoff, depending on whether triggering is desired on a negative or positive point on the signal and on a negative or positive slope. In this case, the triggering signal must be large enough to overcome the saturation or cutoff of V24B and produce an additional 10.5 volts of swing at the plate of V24B to force the Trigger Multivibrator to change states.

It should be noted that the voltages given in the foregoing discussion are nominal only, and will vary somewhat between instruments and with use.

## Trigger Multivibrator

Trigger Multivibrator V45 is a two-state Schmitt circuit. When the voltage at the grid of V45A exceeds a certain level (about 113 volts) V45A conducts and V45B cuts off. In this state, the voltage at the output (plate of V45B) is −300 volts. When the voltage at the grid of V45A drops below a lower level (about 111 volts) V45A cuts off and V45B conducts. In this state, the voltage at the output is about +280 volts. The transition from one state to the other occurs very rapidly, regardless of how slowly the voltage at the input passes the critical levels (111 and 113 volts). The output of the Trigger Multivibrator is a 20-volt square wave. The negative-going portion of the square wave occurs when the voltage at the grid of V45A passes the lower critical level in a negative direction; the positive-going portion of the square wave occurs when the voltage at the grid of V45A passes the upper critical level in a positive direction. Only the negative-going portion of the square wave is used by the Time-Base Generator. By means of the SLOPE switch and the LEVEL control, this portion can be made to coincide with nearly any point on the incoming triggering signal.

The voltage level at the grid of V45A at which the Trigger Multivibrator changes states on a negative-going signal is slightly lower than the level at which it changes states on a positive-going signal. The difference between the two levels is called the "hysteresis" of the circuit. To maintain stable triggering, the incoming triggering signal must be large enough (after amplification in V24) to exceed the hysteresis.

## Automatic Triggering Mode

When the LEVEL control is turned fully counterclockwise, AUTO. switch SW17 is activated and converts the Trigger Multivibrator from a bistable configuration to an astable (free-running) configuration. This is accomplished by coupling the grid circuit of V45A to the grid circuit of V45B via R40. The resulting time constant, in the absence of a triggering signal, causes the Trigger Multivibrator to free-run at about 50 cps. However, since signals from the Trigger Input Amplifier are still coupled to the Trigger Multivibrator through C31, any signal over 50 cps and of sufficient amplitude will synchronize the Trigger Multivibrator at the signal frequency. In the absence of a triggering signal, the sweep continues to be triggered at a 50-cps rate.

# TIME-BASE GENERATOR

The square-wave output of the Trigger Multivibrator is differentiated by C130-R130 to form negative and positive pulses. The negative pulses are the triggers which generate the sweep; the positive pulses are clipped by D130.

When the Time-Base Generator receives a trigger, it produces a linearly rising sawtooth voltage which is applied through the Horizontal Amplifier to the crt deflection plates. This deflects the electron beam across the screen and forms the sweep. The amplitude of the sawtooth is about 150 volts. Its rate of rise is controlled by the values of the Timing Capacitor and Timing Resistor.

The main circuits in the Time-Base Generator are the Sweep-Gating Multivibrator V135-V145A, the Miller Runup Circuit V161, and the Hold-Off Circuit V145B.

## Sweep Generation

In the quiescent state—that is, when no sweep is being generated—V135A is conducting and V145A is cut off (MODE switch in NORM. position). The plate of V145A is at about −3 volts with respect to ground. Disconnect Diodes V152 are conducting and clamp the Timing Capacitor in the sweep discharged condition. The plate of V161A is at about +28 volts.

A negative trigger applied to the grid of V135A, from the Time-Base Trigger, will force the Sweep-Gating Multivibrator to rapidly switch states. That is, V135A cuts off and V145A conducts. This is similar to the operation of the Trigger Multivibrator. Subsequent triggers arriving at the grid of V135A have no effect on the circuit until after the sweep is completed and the multivibrator switches back to its original state.

As V145A conducts, its plate voltage drops, cutting off the Disconnect Diodes. The Timing Capacitor then starts to charge toward the instantaneous potential difference between the −100-volt supply and the cathode of V161B. As the lower side of the Timing Capacitor starts to move in a negative direction, the grid of V161A moves with it. This produces a positive swing at the plate of V161A which is coupled through B167 and V161B to the upper side of the Timing Capacitor. This tends to prevent the lower side from moving negative, and increases the voltage to which the Timing Capacitor is trying to charge. The effect is to "straighten out" the charging curve by maintaining the charging current through the Timing Resistor with increasing charge on the capacitor. The result is an essentially linear sawtooth at the cathode of V161B, which is applied through the Horizontal Amplifier to the deflection plates of the crt.

The values of Timing Capacitor C160 and Timing Resistor R160 are selected by TIME/DIV. switch SW160. VARIABLE control R160Y allows additional resistance to be inserted in series with the Timing Resistor, which reduces the charging current and decreases the slope of the sawtooth. UNCAL. lamp B160W lights whenever the VARIABLE control is moved from the CALIBRATED position.

## Sweep Length

The length of the sweep (the distance the spot moves across the crt) is determined by the setting of the SWP. LENGTH control R176. As the sweep voltage rises linearly at the cathode of V161B there will be a linear rise in voltage at the arm of the SWP. LENGTH control. This will increase the voltage at the plate and cathode of V152C and at the grid and cathode of V145B. As the voltage at the cathode of V145B rises, the voltage at the grid of V135A also rises. When the voltage at this point is sufficient to bring V135A out of cutoff, the Sweep-Gating Multivibrator will rapidly revert to its original state with V135A conducting and V145A cutoff. The voltage at the plate of V145A then rises, carrying with it the voltage at the plates of the Disconnect Diodes. As V152B conducts it provides a discharge path for C160 through R147 and the resistance in the cathode circuit of V161B. The plate voltage of the Miller Tube then falls linearily, under feedback conditions essentially the same as when it generated the sweep except for a reversal of direction. The resistance through which C160 discharges is much less than that of the Timing Resistor (through which it charges). The capacitor current for this period will therefore be much larger than during the sweep portion, and the plate of the Miller Tube will return rapidly to its quiescent voltage. This produces the retrace portion of the sweep sawtooth during which time the crt beam returns rapidly to its starting point.

## Hold-Off

The Hold-Off Circuit prevents the Time-Base Generator from being triggered during the retrace interval. That is, the hold-off allows a finite time for the circuits to regain a state of equilibrium after the completion of a sweep.

During the trace portion of the sweep sawtooth the Hold-Off Capacitor charge through V152C as a result of the rise in voltage at the cathode of V161B. At the same time the grid of V135A is being pulled up, through V145B, until V135A starts conducting. This is the action that initiates the retrace. At the start of the retrace interval the Hold-Off Capacitor starts discharging through Hold-Off Resistor R181. The time constant of this circuit is long enough, however, so that during the retrace interval (and for a short period after the completion of the retrace) the Hold-Off Capacitor holds the grid of V135A high enough so that it cannot be triggered. However, when the Hold-Off Capacitor discharges to the point that V145B cuts off, it loses control over the grid of V135A and this grid returns to the level established by the STABILITY control. The hold-off time required is determined by the size of the Timing Capacitor. For this reason the TIME/DIV. switch changes the time constant of the Hold-Off Circuit simultaneously with the change of Timing Capacitors.

## Sweep Stability

The divider consisting of the STABILITY control R111, R112, and R113 sets the quiescent dc level at the grid of V135A. R111 is adjusted so that the quiescent voltage at the grid of V135A is just high enough (with the FREE RUN switch open) to hold V135A in conduction. In this case a sweep can be produced only when a negative trigger drives V135A into cutoff. Turning the LEVEL control fully clockwise closes the FREE RUN switch and shorts out R111. This places a more negative voltage on the grid of V135A such that this tube cuts off upon decay of the hold-off voltage and the next sweep is initiated immediately (no trigger is necessary). The result is a free-running sweep whose period is the total of the sweep time plus the hold-off time at any given setting of the TIME/DIV. switch. (This is compared to a fixed repetition rate of about 50 cps when the LEVEL control is turned fully counterclockwise to the AUTO. position to make the Trigger Multivibrator free run.)

## Sweep Lockout

The Sweep Lockout circuit consists of transistor Q124 and associated components.

With the MODE switch at NORM., the base of Q124 and the anode of D126 are grounded. The emitter of Q124 has no ground return, and both emitter and collector are negative with respect to the base. Some current (about 0.4 ma) flows through the base-collector junction of Q124, setting the collector at about —80 volts. This reverse biases D124, since the grid of V135A runs between about —25 and —58 volts. When V135A conducts (grid at about —25 volts) the plate voltage is about +14 volts.

Placing the MODE switch to SINGLE SWEEP changes Q124 from a grounded-base to a grounded-emitter configuration. READY lamp B124 conducts and holds the collector of Q124 at about —55 to —60 volts. Conduction through R126 forward biases D126 and connects the base of Q124 to the plate of V135A. This reverse biases Q124 and "arms" the sweep . . . that is, V135A is ready to be triggered.

The next trigger to arrive at the grid of V135A will force the Sweep-Gating Multivibrator to switch states (V135A cut off; V145A conducting) and start a sweep. At the completion of the sweep, V135A again conducts and its plate voltage drops below ground. This forward biases Q124 (through D126) and drives it into saturation. Collector current then pulls up the collector of Q124 and the grid of V135A (through D124) to near ground. This extinguishes READY lamp B124 and drives V135A hard into saturation. With V135A in saturation, it is insensitive to incoming triggers and the sweep is "locked out".

Depressing the MODE switch to RESET transfers V135A plate current from the base of Q124 to ground. Current through R126 and D126 raises the base of Q124 slightly positive, which reverse biases Q124. The reduction in collector current then lets the grid of V135A fall to its "ready-to-be-triggered" level. The READY lamp then fires to indicate the sweep is again "armed", waiting for a trigger.

## Unblanking

The positive rectangular pulse appearing at the cathode of V135B during sweep time is applied as an unblanking pulse to the crt. Action of this pulse on the crt circuit is discussed in detail in the oscilloscope instruction manuals. Blanking and unblanking is controlled only by the plug-in in the right-hand oscilloscope opening. Thus, if the Type 2B67 is inserted in the left-hand opening (producing a vertical trace), the trace will not be blanked between sweeps.

When the TIME/DIV. switch is in the EXT. INPUT position, the Sweep-Gating Multivibrator is disabled. The cathode of V135B rests at about +125 volts and the crt is continuously unblanked.

## HORIZONTAL AMPLIFIER

The Horizontal Amplifier consists of the Input CF V333A, the Second CF V333B, Driver CF V353A, and the Output Amplifier V374.

The sweep sawtooth from the Time-Base Generator is coupled to the grid of V333A via the frequency-compensated voltage divider R320-R321. POSITION control R323 supplies a manually adjustable dc voltage to the grid of V333A for positioning the trace on the crt.

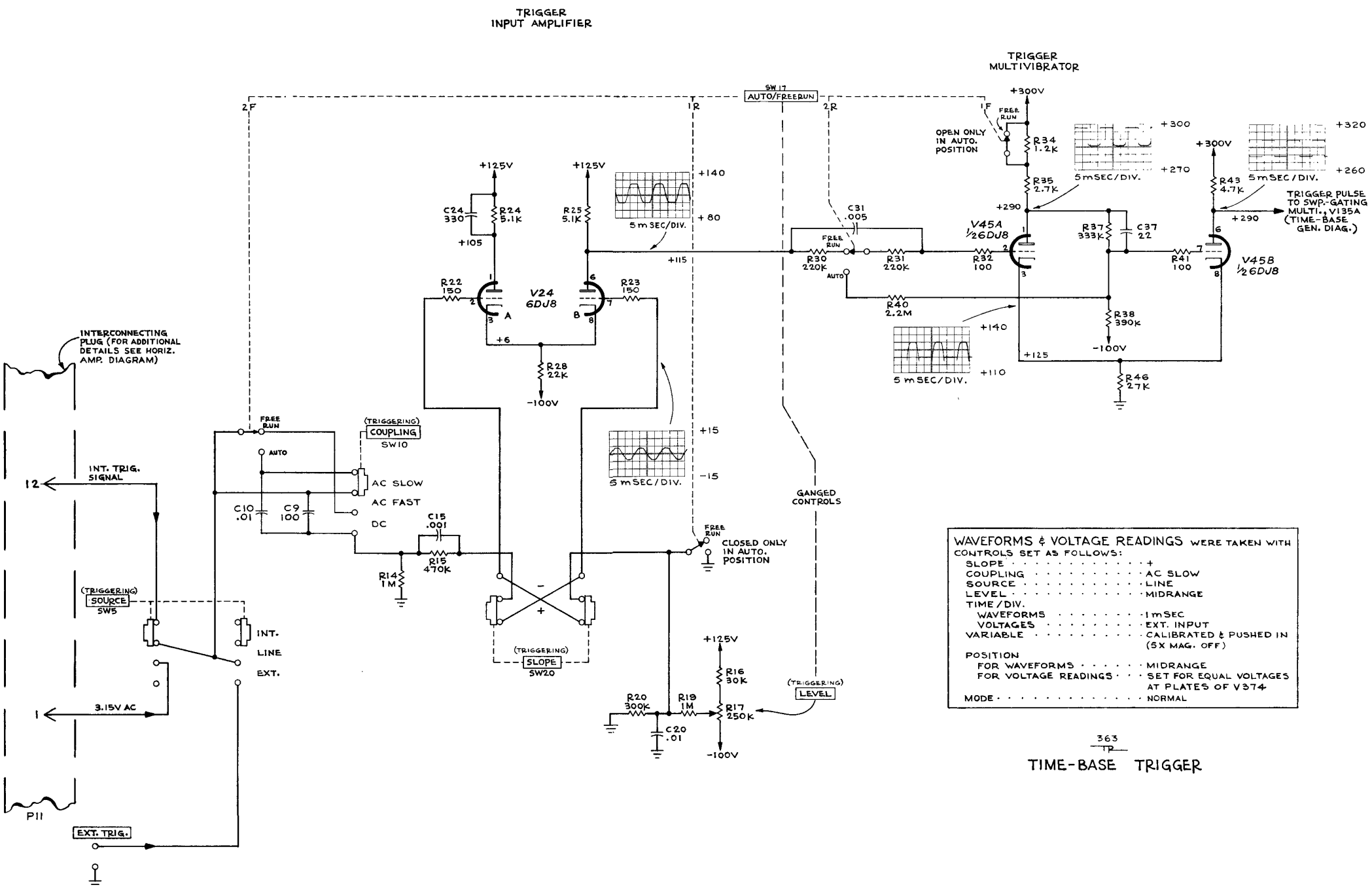
CALIBRATION adjustment R334 varies the sawtooth amplitude at the grid of V333B and provides a means for calibrating the sweep rate.

The output of V333B is coupled through R341 and R342 (in parallel with C341) to the grid of V353A. The cathode of V353A, in turn, drives the grid of V374A. V374 is a cathode-coupled paraphase amplifier that converts the single-ended input to a push-pull output. The push-pull output is applied through pins 17 and 21 of the interconnecting plug to the crt deflection plates.

Negative feedback from the plate of V374A to the grid circuit of V353A develops a voltage across R341 and R342 that attenuates the signal from the cathode of V333B by a factor of five. When SW341 is closed (5X MAG. on), R341 and R342 are shorted out and the sweep rate, as seen at the crt deflection plates, is effectively magnified five times.

SWP./MAG. REGIS. adjustment R346 is adjusted to set the voltage at the grid of V353A equal to the voltage at the cathode of V333B when the electron beam is in the center of the crt and the 5X MAG. switch is open. With this configuration the center of the trace will not move as SW341 is opened and closed (5X MAG. turned off and on).

The EXT. INPUT position of the TIME/DIV. switch allows the application of external signals through the EXT. INPUT connector on the front panel. The external signal is applied directly to the Output Amplifier. When the TIME/DIV. switch is in the EXT. INPUT position, the POSITION control varies the dc voltage at the grid of V353B. This, in turn, sets the grid level of V374B.




WAVEFORMS & VOLTAGE READINGS WERE TAKEN WITH CONTROLS SET AS FOLLOWS:

| | |
|---|---|
| SLOPE | + |
| COUPLING | AC SLOW |
| SOURCE | LINE |
| LEVEL | MIDRANGE |
| TIME/DIV. | |
| WAVEFORMS | 1 mSEC |
| VOLTAGES | EXT. INPUT |
| VARIABLE | CALIBRATED & PUSHED IN (5X MAG. OFF) |
| POSITION | |
| FOR WAVEFORMS | MIDRANGE |
| FOR VOLTAGE READINGS | SET FOR EQUAL VOLTAGES AT PLATES OF V374 |
| MODE | NORMAL |

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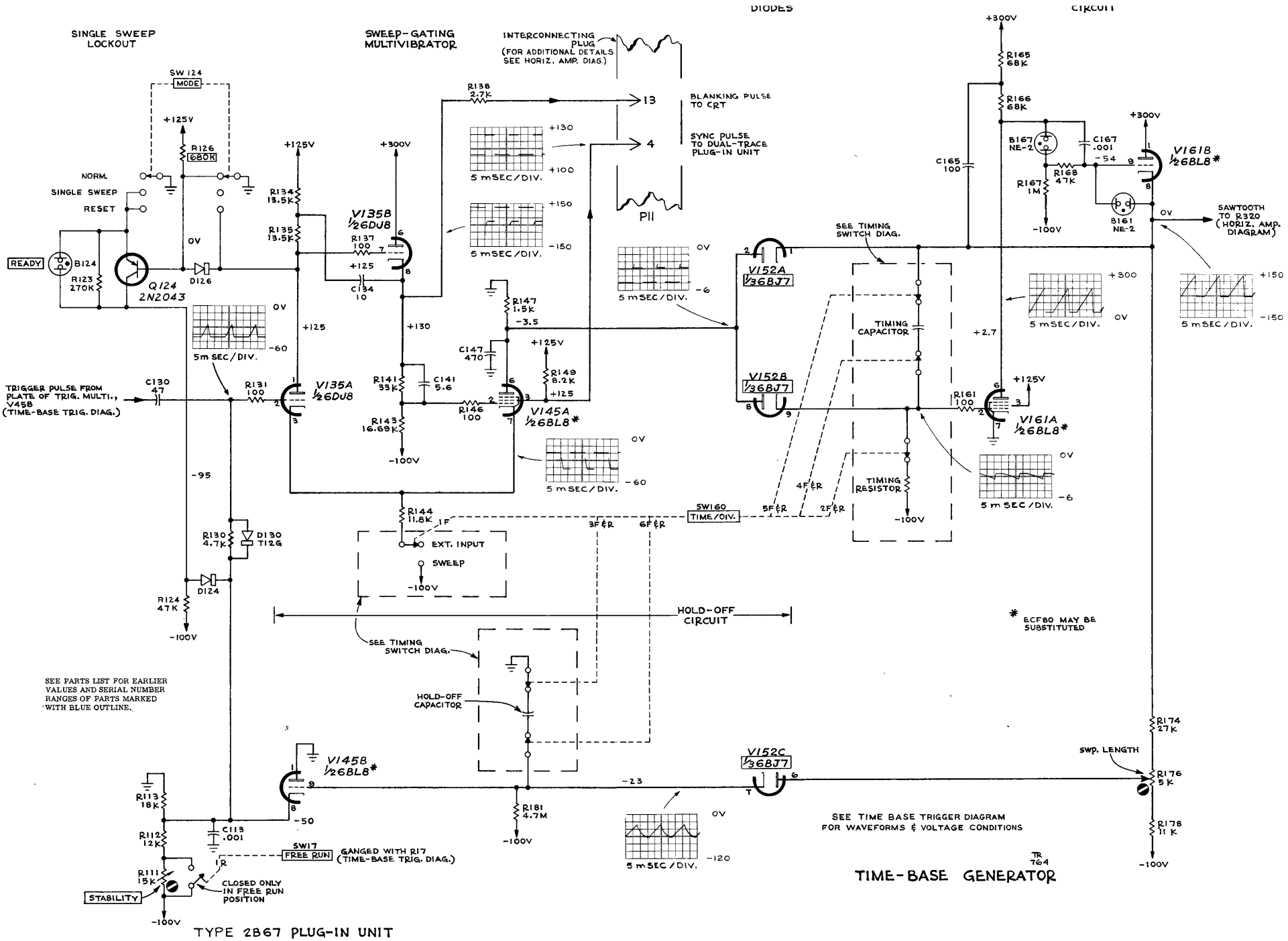
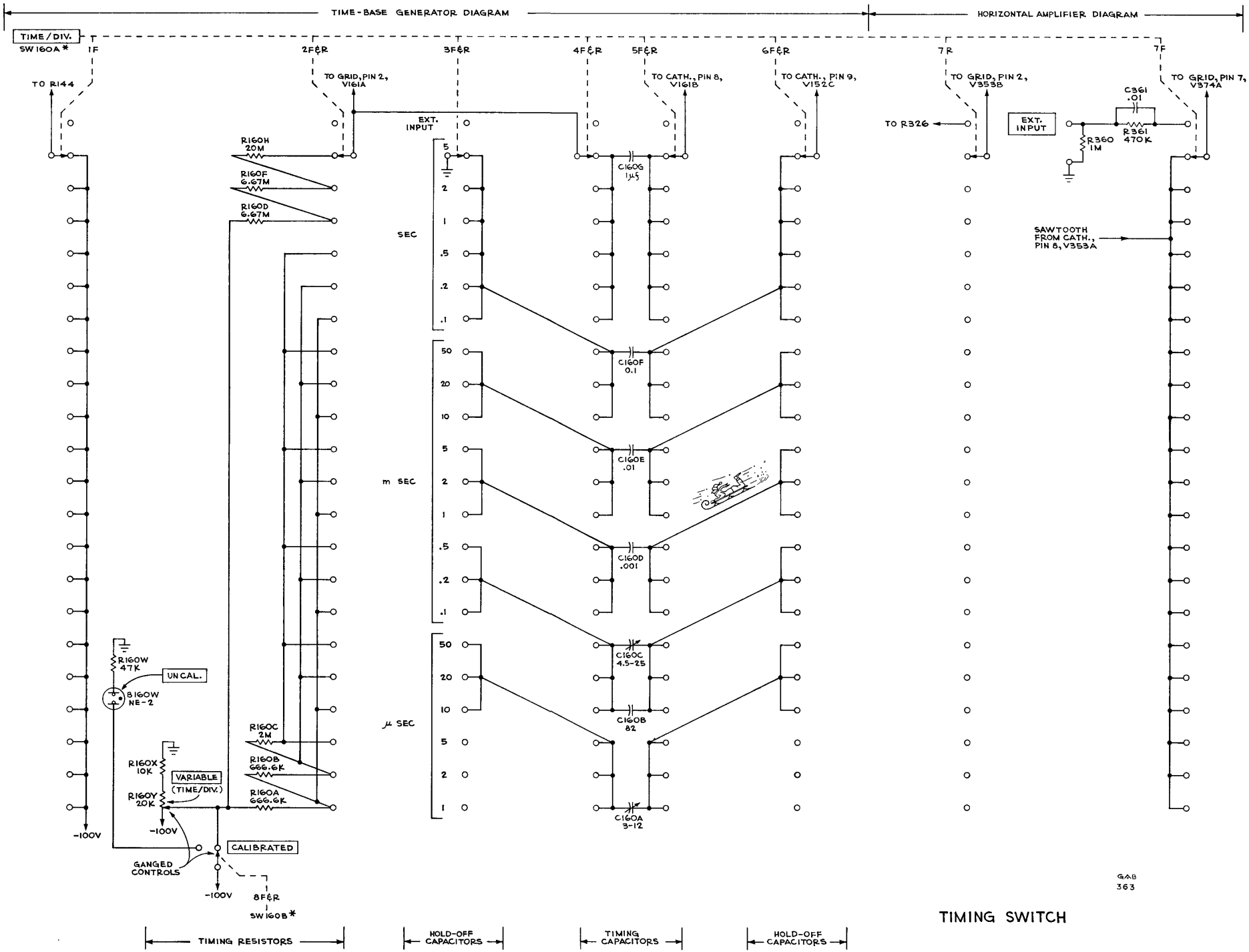
TR

# TIME-BASE TRIGGER


DIODES
CIRCUIT
SINGLE SWEEP LOCKOUT
SWEEP-GATING MULTIVIBRATOR
INTERCONNECTING PLUG (FOR ADDITIONAL DETAILS SEE HORIZ. AMP. DIAG.)
BLANKING PULSE TO CRT
SYNC PULSE TO DUAL-TRACE PLUG-IN UNIT
SAWTOOTH TO R320 (HORIZ. AMP. DIAGRAM)
SW 124
MODE
NORM.
SINGLE SWEEP
RESET
READY
B124
R123 270K
Q124 2N2043
D126
R126 680K
+125V
+300V
R134 13.5K
R135 13.5K
V135B 1/2 6DU8
R137 100
C134 10
R138 2.7K
R147 1.5K
C147 470
R149 8.2K
R141 33K
C141 5.6
R146 100
R143 16.69K
V145A 1/2 68L8*
V135A 1/2 6DU8
C130 47
R131 100
TRIGGER PULSE FROM PLATE OF TRIG. MULTI., V45B (TIME-BASE TRIG. DIAG.)
R144 11.8K
R130 4.7K
D130 T12G
D124
R124 47K
EXT. INPUT
SWEEP
SW160 TIME/DIV.
1F
3F'ER
6F'ER
4F'ER
5F'ER
2F'ER
HOLD-OFF CIRCUIT
SEE TIMING SWITCH DIAG.
HOLD-OFF CAPACITOR
V152A 1/2 68J7
V152B 1/2 68J7
V152C 1/2 68J7
TIMING CAPACITOR
TIMING RESISTOR
R165 68K
R166 68K
R167 1M
R168 47K
C165 100
C167 .001
B167 NE-2
8161 NE-2
V161B 1/2 68L8*
V161A 1/2 68L8*
R161 100
+2.7
R174 27K
SWP. LENGTH
R176 5K
R178 11K
R181 4.7M
V145B 1/2 68L8*
R113 18K
R112 12K
C113 .001
R111 15K
STABILITY
SW17 FREE RUN
GANGED WITH R17 (TIME-BASE TRIG. DIAG.)
CLOSED ONLY IN FREE RUN POSITION
5 mSEC/DIV.
* ECF80 MAY BE SUBSTITUTED
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.
SEE TIME BASE TRIGGER DIAGRAM FOR WAVEFORMS & VOLTAGE CONDITIONS
TR 764
TIME-BASE GENERATOR
TYPE 2B67 PLUG-IN UNIT




GAB
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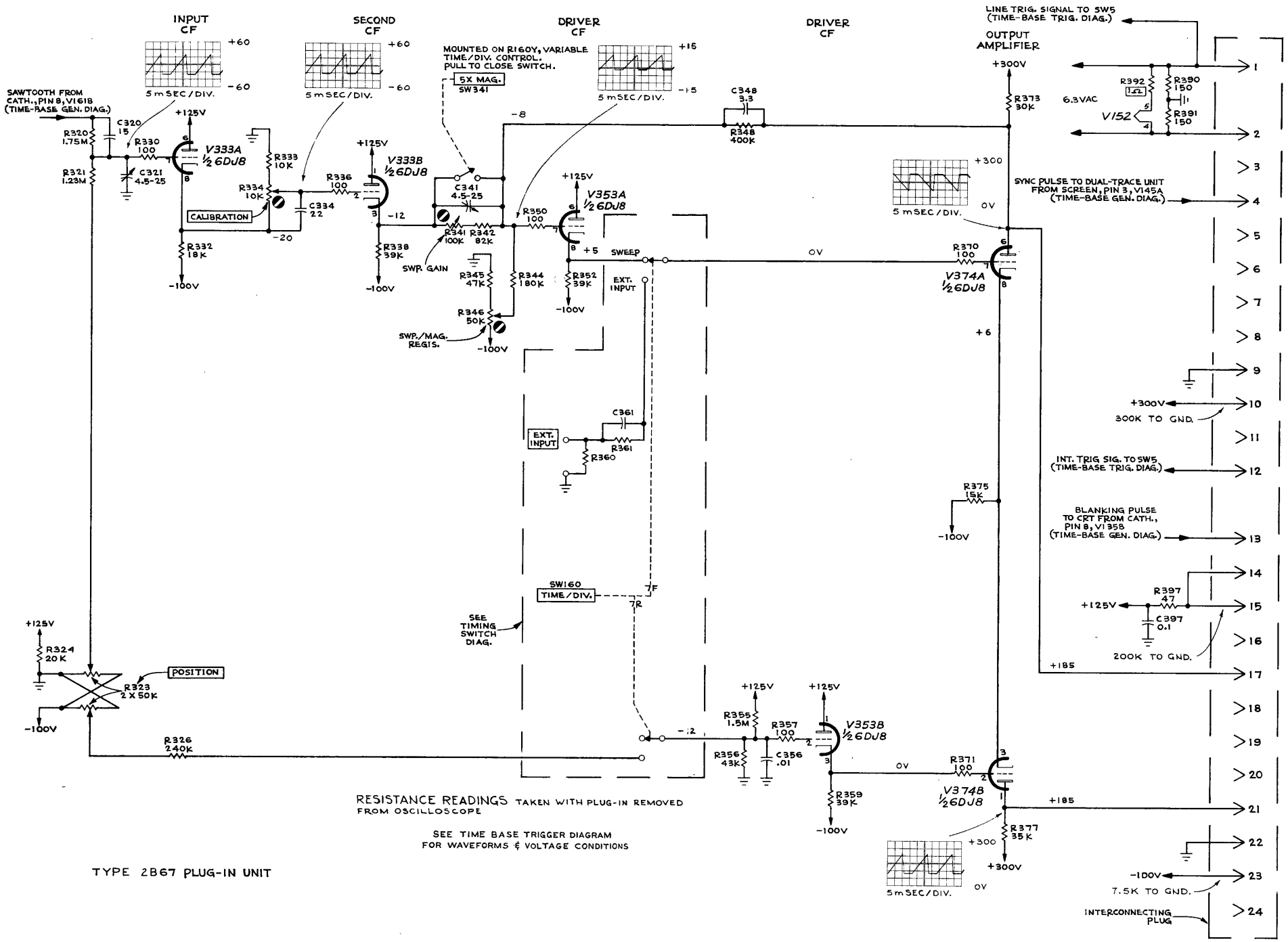
TIMING SWITCH


INPUT CF
SECOND CF
DRIVER CF
DRIVER CF
OUTPUT AMPLIFIER
LINE TRIG. SIGNAL TO SW5 (TIME-BASE TRIG. DIAG.)
SAWTOOTH FROM CATH., PIN 8, V1618 (TIME-BASE GEN. DIAG.)
5 mSEC/DIV.
MOUNTED ON R160Y, VARIABLE TIME/DIV. CONTROL. PULL TO CLOSE SWITCH.
5X MAG. SW341
V333A ½6DJ8
V333B ½6DJ8
V353A ½6DJ8
V353B ½6DJ8
V374A ½6DJ8
V374B ½6DJ8
V152
6.3VAC
CALIBRATION
SWP. GAIN
SWP./MAG. REGIS.
SWEEP
EXT. INPUT
SW160 TIME/DIV.
SEE TIMING SWITCH DIAG.
POSITION
SYNC PULSE TO DUAL-TRACE UNIT FROM SCREEN, PIN 3, V145A (TIME-BASE GEN. DIAG.)
+300V
300K TO GND.
INT. TRIG SIG. TO SW5 (TIME-BASE TRIG. DIAG.)
BLANKING PULSE TO CRT FROM CATH., PIN 8, V1358 (TIME-BASE GEN. DIAG.)
200K TO GND.
7.5K TO GND.
INTERCONNECTING PLUG
RESISTANCE READINGS TAKEN WITH PLUG-IN REMOVED FROM OSCILLOSCOPE
SEE TIME BASE TRIGGER DIAGRAM FOR WAVEFORMS & VOLTAGE CONDITIONS
TYPE 2B67 PLUG-IN UNIT
HORIZONTAL AMPLIFIER
764 TP
B