INSTRUCTION MANUAL

TYPE T PLUG-IN

Tektronix, Inc.
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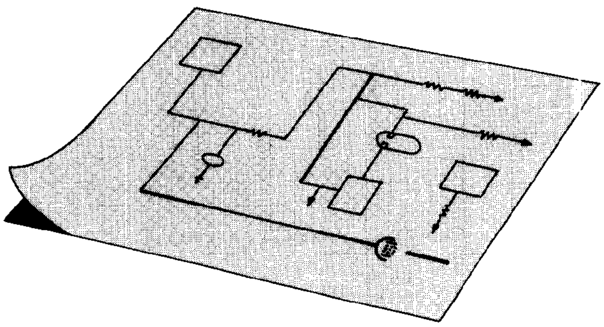
Tektronix International A. G.
Terrassenweg 1A ● Zug, Switzerland ● PH. 042-49192 ● Cable: Tekintag, Zug Switzerland ● Telex 53.574

070-337


STABILITY
TRIGGERING LEVEL
0
−
+
PRESET
PRESET
STABILITY
MAG.
CENTERING
TRIGGERING MODE
TRIGGER SLOPE
AC
AC LF REJECT
LINE
+
−
EXT.
AUTO.
DC
HF SYNC
TRIGGER
INPUT
5X MAGNIFIER
ON
OFF
TYPE T PLUG-IN UNIT
TIME-BASE GENERATOR
SERIAL
VARIABLE
TIME/DIV.
MILLI
SEC
MICRO
SEC
SEC
UNCALIBRATED
CALIBRATED
TEKTRONIX
VERNIER
POSITION
+ GATE
OUT
SAWTOOTH
OUT
TEKTRONIX, INC.
PORTLAND, OREGON, U.S.A.



SECTION 1

CHARACTERISTICS

The Type T Plug-In Unit is a time-base generator developed for use with the Tektronix Type 536 Oscilloscope. The Type T provides a wide range of time-base rates for oscilloscope application. The Type T may also be used in the vertical of other Tektronix convertible oscilloscopes.

Magnifier

Provides a 5-times magnification of the center 2-division portion of the oscilloscope display. It extends the fastest sweep rate to .04 microseconds per division.

Sweep Rates

Twenty-two calibrated rates from .2 μSEC/DIV to 2 SEC/DIV.

Calibration accuracy of the fixed sweep rates will typically be within 1 per cent of full scale and in all cases within 3 per cent.

In addition, continuously variable (uncalibrated) sweep rates are available over the range from approximately 5 SEC/DIV to .2 μSEC/DIV.

Triggering-signal requirements

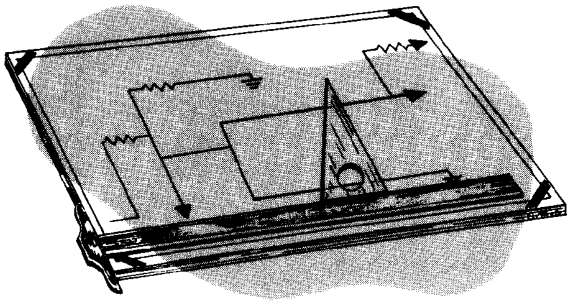
Responds to triggering signals in the range from dc to 5 mc. Accepts external triggering signals in this range having amplitudes from .2 v to 50 v.

Synchronizing-signal requirements

Responds to synchronizing signals in the range from 5 mc to 15 mc. Accepts external synchronizing signals in this range having amplitude from .2 v to 50 v.

Physical Characteristics

Construction - Aluminum alloy chassis.
Finish - Photo-etched anodized panel.
Weight - 11 pounds approx.



SECTION 3

CIRCUIT DESCRIPTION

TIME-BASE TRIGGER

Trigger Input Amplifier

The function of the Time-Base Trigger is to develop the triggering pulse which initiates a cycle of action in the Time-Base Generator. The signal from which the triggering pulse is produced may emanate from either of two sources, as determined by the setting of the TRIGGER SLOPE switch (black knob), SW7010. When the switch is in the +EXT. or -EXT. positions, an external signal is employed in the development of the triggering pulse. In the +LINE or -LINE positions of the switch, a voltage at the power line frequency is used to develop the triggering pulse. To obtain a stable display in either EXT or LINE the triggering waveform should bear a definite time relationship to the observed waveform.

In addition to selecting the source of the triggering signal, switch SW7010 (TRIGGER SLOPE) also selects the polarity of the slope on which triggering will occur.

The Trigger-Input Amplifier V7040 is a polarity-inverting, cathode-coupled amplifier. The output is taken from the plate of V7040A, but the grid of either stage may be connected to the input signal source. When the TRIGGER SLOPE knob is in the -EXT. or -LINE position the grid of V7040B is connected to the input signal source. The grid of V7040A is connected to a dc bias source, adjustable by means of the TRIGGERING LEVEL control. This bias voltage establishes the voltage present at the plate of V7040A under no-signal conditions. When the TRIGGER SLOPE knob is in the +EXT. or +LINE position the grid of V7040A is connected to the input-signal source, and the grid of V7040B is connected to the bias voltage source.

The voltage at the grid of V7040B and the voltage at the plate of V7040A are in phase with each other; that is, they both go through ac zero in the same direction at the same time. By this arrangement, V7040B acts as a cathode-follower, having a gain of approximately .5, and the signal voltage developed across the cathode resistor becomes the input signal for V7040A.

When the switch is moved to either the +EXT. or +LINE position, the grid of V7040A is connected to the input-signal source. With this configuration, the voltage at the plate of V7040A will be 180 degrees out of phase with the input-signal voltage. Thus, depending on the setting of the TRIGGER SLOPE switch (+ or -), the plate of V7040A swing may be in phase, or 180 degrees out of phase with the input-signal voltage.

Schmitt Trigger

The Schmitt Trigger consists of V7350, A and B, connected as a dc-coupled multivibrator. In the quiescent state, ready to receive a signal, V7350A is conducting and its plate is down. This holds the grid of V7350B below cut-off since the circuits are dc-coupled by the voltage divider R7440, R7460 and R7470. With V7350B cut off its plate voltage is up and no output is developed.

A negative-going signal is required at the grid of V7350A to drive the Schmitt Trigger into its other state, at which time a triggering pulse is produced. The signal coupled to the grid of V7350A may contain both positive-and negative-going components.

The negative-going portion of the signal will drive the grid of V7350A in the negative direction and the cathodes of both tubes will follow the grid down. As the grid of V7350A is driven negative the current flow through the tube is restricted, and the voltage at its plate starts to rise. Due to the coupling between the plate of V7350A and grid of V7350B, the rise in voltage at the plate of V7350A carries the grid of V7350B with it.

The cathodes of both tubes are coupled together, and follow the action of the grids. With the grid voltage of V7350B going up, and its cathode voltage going down, V7350B starts to conduct. As soon as V7350B starts to conduct the cathodes of both tubes begin to follow the action of the grid of V7350B; hence the cathode voltages start going up.

With the grid of V7350A down and its cathode up, this tube stops conducting. As V7350B conducts, its plate voltage drops, creating a negative-going step at its output. This transition occurs rapidly, regardless of how slowly the grid signal of V7350A falls.

When the signal applied to the grid of V7350A starts in the opposite direction the action described in the preceding paragraphs reverses itself. That is, V7350A will start to conduct once more, while V7350B is cut off--causing the circuit to revert to its original state.

The operation of the Schmitt Trigger is exactly the same for both + and - positions of the TRIGGER SLOPE switch. However, the polarity at the output of the Trigger Amplifier is reversed between the + and - settings of the TRIGGER SLOPE switch with respect to a certain point on the triggering signal. This causes triggering to occur at different points on the waveform being observed.

When the TRIGGER SLOPE switch is in the + positions triggering occurs on the positive-going portion of the waveform and the display starts at that point. When the TRIGGER SLOPE switch is in the - positions triggering occurs on the negative-going portion of the waveform and the display starts at a point on the negative portion.

The TRIGGERING MODE switch, SW7040, selects the type, or mode, of triggering. In the DC position, the triggering signal is dc-coupled from the TRIGGER INPUT to the Trigger Amplifier, which in turn is dc-coupled to the grid of V7350A the Schmitt Trigger. R7240 isolates the plate circuit of V7040A from the capacitance of the switch; R7250 isolates the grid circuit of V7350 from the capacitance of the switch.

In the AC position of the TRIGGERING MODE switch, capacitor C7020 is connected into the input circuit; this of course, removes any dc component of the waveform. The Trigger-Input Amplifier, however, is still dc-coupled to the Schmitt Trigger stage.

In the AUTO. position of the TRIGGERING MODE switch, the Schmitt Trigger is converted from a bistable configuration to a recurrent configuration. This is accomplished by coupling the grid circuit of V7350B to the grid circuit of V7350A via R7370. In addition, the dc coupling between the Trigger-Input Amplifier and the Schmitt Trigger is removed when the switch is in the AUTO. position.

The addition of R7370 to the circuit causes the Schmitt Trigger to free-run in the absence of a triggering signal. For example, assume the grid of V7350A is just being driven into cut-off. The voltage at the plate of V7350A starts to rise, carrying with it the grid voltage of V7350B. As the voltage at the grid of V7350B rises, V7350B starts to conduct.

The rising voltage at the grid of V7350B is coupled to the grid of V7350A through R7370. The grid of V7350A is prevented from rising immediately by the action of C7240, which must be charged sufficiently to raise the voltage at grid of V7350A above cutoff.

As V7350A starts to conduct, its plate voltage drops, which in turn lowers the voltage at the grid of V7350B. The voltage at the grid of V7350A now starts dropping exponentially toward cutoff. When V7350A reaches cutoff again, the circuit has completed one cycle of its approximately 50-cycle voltage waveform.

The range of voltage at the grid of V7350A between V7350A cutoff and V7350B cutoff, is about 3 volts when the circuit is used in the AUTO. mode. The addition of R7370 increases the voltage range from about 0.5 volts in the AC, AC LF REJECT, or DC mode. Since the grid of V7350A is never more than 3 volts from cutoff, a triggering signal with a peak-to-peak amplitude of 3 volts or more will cause the multivibrator to produce a trigger output prior to the time it would do so under no-signal conditions. Smaller signals will also produce a trigger output, but only if they occur at a time when the sum of the signal voltage and the grid voltage is sufficient to drive the grid of V7350A to cutoff.

When the Schmitt Trigger is in the recurrent configuration just described, the Time Base Generator can be triggered with repetitive signals over a wide range of frequencies, without readjustment. When not receiving triggers, the Schmitt Trigger continues to operate at approximately a 50-cycle rate. Thus, in the absence of triggers, the Time-Base Generator will continue to generate a sawtooth output.

When the TRIGGERING MODE switch is in the HF SYNC position, the Time-Base Trigger is bypassed, and the signal at the TRIGGER INPUT connector is applied directly to the Time-Base Generator. This signal acts as a synchronizing voltage, superimposed on the holdoff waveform, (to be discussed in the section that follows). This synchronizes the Time-Base Generator at a sub-multiple of the triggering-signal frequency. This mode is useful for input signals in the range from 5 megacycles to 20 megacycles.

The time-Base Trigger Produces a negative-going waveform which is coupled to the Time-Base generator. This waveform is differentiated in the grid cirucit of V7650B to produce a sharp negative-going triggering pulse to trigger the Time-Base Generator in the proper time sequence. Positive-going pulses are also produced in the differentiation process, but they are not used in the operation of the Time-Base Generator.

TIME-BASE GENERATOR

The Time-Base Generator consists of three main circuits; a Bistable Multivibrator, a Miller Runup Circuit, and a Hold-Off Circuit. The Bistable Multivibrator consists of V7650B, V7750A and the cathode-follower V7650A. The essential components in the Miller Runup Circuit are the Miller Tube V8110B, the Runup C.F. V8110A, the On-Off Diodes V8020, and the Timing Capacitor C160 and the Timing Resistor R160. The Hold-Off Circuit consists of the Hold-Off Driver V7530B, and Hold-Off Capacitor C180 and the Hold-Off Resistor R180.

In the quiescent state, V7650B of the Bistable Multivibrator is conducting and its plate voltage is down. This cuts off V7750A through the cathode-follower V7650A, the voltage divider R7680-R7690, and the cathode resistor R7710.

Miller Tube

The quiescent state of the Miller Tube is determined by the dc network between plate and grid consisting of the neon lamp B8160, the Runup C.F. V8110A, and the On-Off Diode V8200. The purpose of the dc network is to establish a voltage at the plate of the Miller Tube of such a value that the tube will operate above the knee, and thus over the linear region, of its characteristic curve.

In the absence of signal the grid of the Miller Tube rests at about -3 volts. There is about a 1 1/2 volt drop in the Runup On-Off Diodes, about 18.5-volts bias on the Runup C.F., and about a 55-volt drop across the neon lamp. This establishes a quiescent voltage of about 40 volts at the plate of the Miller Tube.

If the STABILITY control is now advanced, making the grid of V7650B more negative, a point will be reached where a negative-going triggering pulse from the Schmitt Trigger stage will cause the Bistable Multivibrator to switch rapidly to its other state. That is V7650B will be cut off and V7750A will start to conduct. (Any spiking that may occur, during this transition period, is attenuated by the R7790-C7790 network.) As V7750A conducts, its plate voltage, and the voltage at the diode plates, drops. As a result the diodes are cut off, which permits the grid of the Miller Tube and the cathode of the Runup C.F. to seek their own voltages.

As there is no connection to the diodes at this time, the grid of the Miller Tube starts negative, since it is connected to the -150-volt supply through the Timing Resistor R160. The plate of the Miller Tube then starts positive, carrying with it the grid and cathode of the Runup C.F., V8110A. This raises the voltage at the top of the Timing Capacitor C160, which in turn raises the voltage at the grid of the Miller Tube, and prevents it from going negative. The gain of the Miller Tube, as a class A amplifier, is approximately 200. This means that a 150-volt change in plate voltage will maintain the grid voltage constant within three-quarters of a volt.

The Timing Capacitor starts charging with current from the -150-volt bus. Since the voltage at the grid of the Miller Tube remains essentially constant, the voltage drop across the Timing Resistor, and hence the charging current through it, remains essentially constant. Thus, C160 charges linearly, and the voltage at the cathode of the Runup C.F. V8110A rises linearly. Any departure from a linear rise in the voltage at this point will produce a change in the voltage at the grid of the Miller Tube in such a direction as to correct for the error.

Timing Components

The linear rise in the voltage at the cathode of V8110A is used to provide the output sawtooth, or Time-Base. Timing Capacitor C160 and Timing Resistor R160 are selected by means of the TIME/DIV. switch (SW160). The Timing Resistor determines the current that charges the Timing Capacitor. By means of the TIME/DIV. switch, both the size of the capacitor being charged and the current charging the capacitor can be selected to cover a wide range of sawtooth slopes (time-bases). For high-rate time bases the bootstrap capacitor, C8140, helps supply the current to charge the stray capacitance at the plate of the Miller Tube which permits the plate voltage to rise at the required rate.

If uncalibrated time-bases are desired, the VARIABLE TIME/DIV. control may be turned away from the calibrated position. This control, R8320, varies the time-base rate from approximately 5 SEC/DIV. to .2 μSEC/DIV. Switch SW8300 is ganged with the variable control in such a way that the UNCALIBRATED light comes on when the control is turned away from the CALIBRATED position.

As explained previously, the time-base rate (the rate at which the spot moves across the face of the crt) is determined by the timing circuit components, C160 and R160. The length of the time-base (the distance the spot moves across the face of the crt), however, is determined by the setting of the Sweep Length/Sawtooth Amplitude control, R8260. As the time-base voltage rises linearly at the cathode of V8110A, there will be a linear rise in voltage at the arm of the Sweep Length/Sawtooth Amplitude control R8260. This will increase the voltage at the grid and cathode of V7530A, and at the grid and cathode of V7530B. As the voltage at the cathode of V7530B rises, the voltage at the grid of V7650B will rise. When the voltage at this point is sufficient to bring V7650B out of cutoff, the multivibrator circuit will rapidly revert to its original state with V7650B conducting and V7750A cut off.

The voltage at the plate V7750A rises, carrying with it the voltage at the diode plate, V8020B. The diode then conducts and provides a discharge path for C160 through R7780 and R7770, and through the resistance in the cathode circuit of V8110A. The plate voltage of the Miller Tube now falls linearly, under feedback conditions essentially the same as when it generated the time base portion of the waveform, 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 at 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 time-base sawtooth, during which time the crt beam returns rapidly to its starting point.

Hold-Off Circuit

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

During the trace portion of the sawtooth the Hold-Off Capacitor C180 charges through V7530A, as a result of the rise in voltage at the cathode of V7580A. At the same time, the grid of V7650B is being pulled up, through the Hold-Off C.F. V7650B, until V7650B comes out of cut-off and starts conducting. As mentioned previously, this is the action that initiates the retrace. At the start of the retrace interval C180 starts discharging through the Hold-Off Resistor. The time constant of this circuit is long enough, however, so that during the retrace interval, (and for a short period of time after the completion of the retrace) V7530B holds the grid of V7650B high enough so that it cannot be triggered. However, when C180 discharges to the point that V7530B is cutoff, it loses control over the grid of V7650B and the grid returns to the point established by the STABILITY control. The hold-off time required is determined by the size of the timing components. For this reason the TIME/DIV. switch changes the time constant of the Hold-Off Circuit simultaneously with the change of Timing Capacitors.

Stability Controls

The STABILITY control R7500 regulates the dc level at the grid of V7650B. In use, this control is adjusted so that the grid voltage is just high enough to prevent the circuit from free-running. Adjusted in this manner, a sawtooth will be produced only when a negative-going trigger from the Schmitt Trigger can drive the stage into cut-off. For convenience, a PRESET STABILITY control can be connected into the circuit via switch SW7500. In the PRESET position a fixed negative dc voltage is obtained from R7520 and applied to the grid of V7650B. This control, which is adjustable from the front panel of the Type T, can be used in most triggering applications of the instrument. Where triggering may be critical, however, the variable STABILITY control should be used.

Output Waveform

The positive pulse appearing at the cathode of V7650A is coupled through the GATE OUT C.F. V7750B to the front-panel +GATE OUT connector, and is also used to automatically supply the unblanking pulse when used with the Tektronix Type 536 Oscilloscope.

A banana plug, mounted at the rear of the Type T Plug-In, connects to a banana jack mounted within the Type 536 Oscilloscope when the Type T is used in the HORIZONTAL channel. For use in the VERTICAL channel of the Type 536, or for use in other plug-in type Tektronix oscilloscopes, the +GATE OUT connector can be connected to the oscilloscope EXT CRT CATHODE, or INTENSITY MOD INPUT connector, to provide crt unblanking. The positive pulse at the +GATE OUT connector starts at ground and rises to approximately +30 volts. The starting time and duration of the pulse is coincident with the starting time and duration of the sawtooth time-base waveform.

The sawtooth time-base waveform at the cathode of V8110A, in addition to driving the horizontal amplifier of the oscilloscope, is also coupled through the cathode follower V7940B and to the SAWTOOTH OUT connector on the front panel of the Type T Plug-In Unit. This provides a 150-volt linear rise in voltage, starting at zero volts with respect to ground.

5X Magnifier

The sawtooth waveform appearing at the cathode of the Runup C.F. V8110A has an amplitude of approximately 150 volts, far in excess of that needed to drive the horizontal amplifier of the Type 536 Oscilloscope. The amplitude of the sawtooth waveform is reduced to approximately one volt, peak-to-peak, by the voltage divider formed by R8400 and R8460.

The 5X MAGNIFIER switch, SW8420, changes the ratio of the voltage divider formed by R8400 and R8460 by substituting R8420 and R8430. This change in the voltage divider increases the amplitude of the output sawtooth from one volt to approximately 5 volts. The setting of R8430, Mag. Gain Adj. determines the exact output level in the magnified position. The MAG. CENTERING control, R8480, determines the position of the start of the time-base on the crt screen.

IMPORTANT:
ALL CIRCUIT VOLTAGES WERE OBTAINED WITH A 20,000Ω/V VOM. ALL READINGS ARE IN VOLTS.

VOLTAGE & WAVEFORM AMPLITUDE MEASUREMENTS ARE NOT ABSOLUTE. THEY MAY VARY BETWEEN INSTRUMENTS AS WELL AS WITHIN THE INSTRUMENT ITSELF DUE TO NORMAL MANUFACTURING TOLERANCES AND TRANSISTOR AND VACUUM TUBE CHARACTERISTICS.

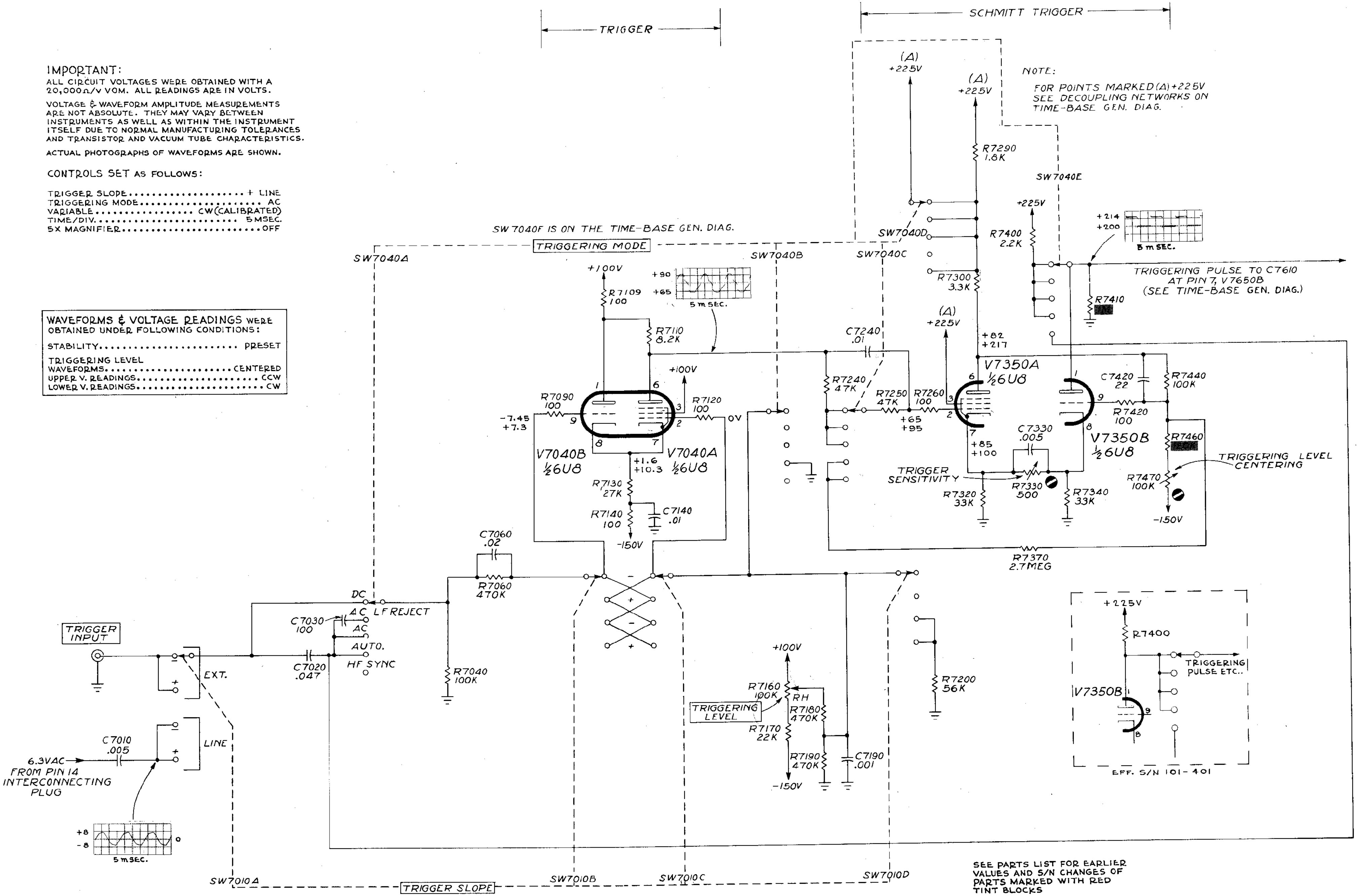
ACTUAL PHOTOGRAPHS OF WAVEFORMS ARE SHOWN.

CONTROLS SET AS FOLLOWS:

TRIGGER SLOPE	+ LINE
TRIGGERING MODE	AC
VARIABLE	CW(CALIBRATED)
TIME/DIV.	5 MSEC.
5X MAGNIFIER	OFF

WAVEFORMS & VOLTAGE READINGS WERE OBTAINED UNDER FOLLOWING CONDITIONS:

STABILITY	PRESET
TRIGGERING LEVEL	
WAVEFORMS	CENTERED
UPPER V. READINGS	CCW
LOWER V. READINGS	CW



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

TYPE T PLUG-IN UNIT

AA1

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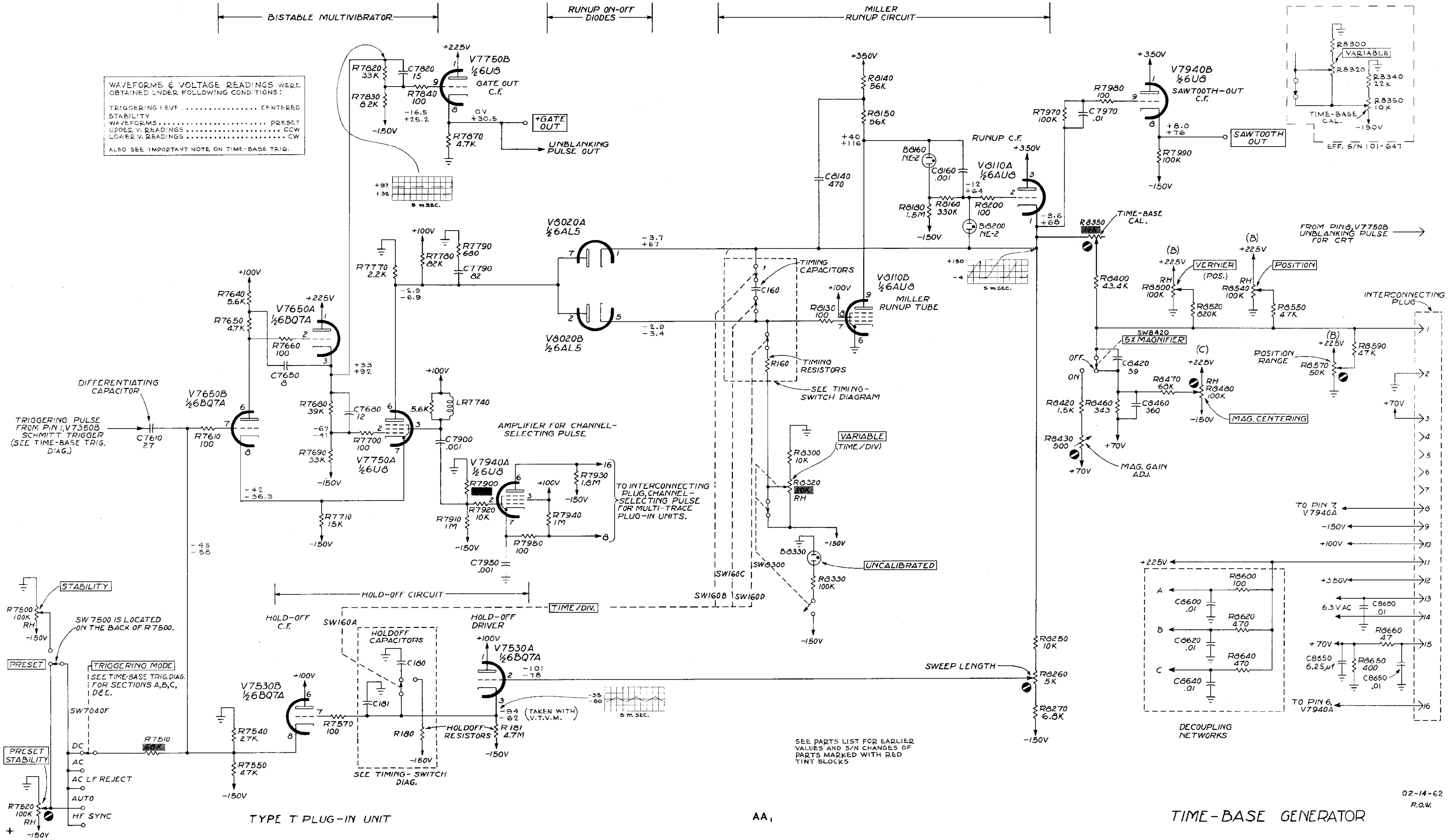
R.O.W.

TIME-BASE TRIGGER



TYPE T PLUG-IN UNIT

AA1

TIME-BASE GENERATOR

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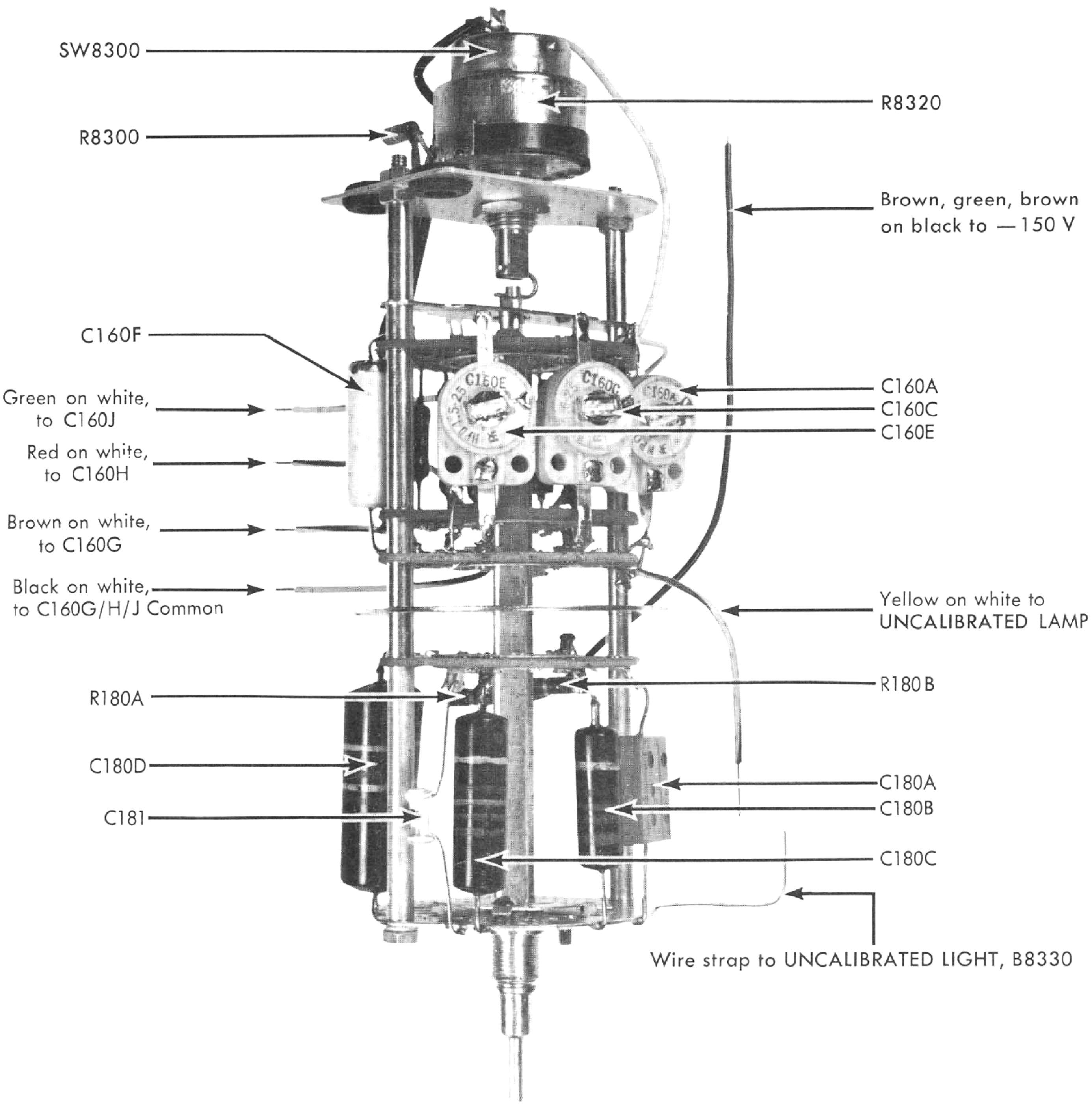
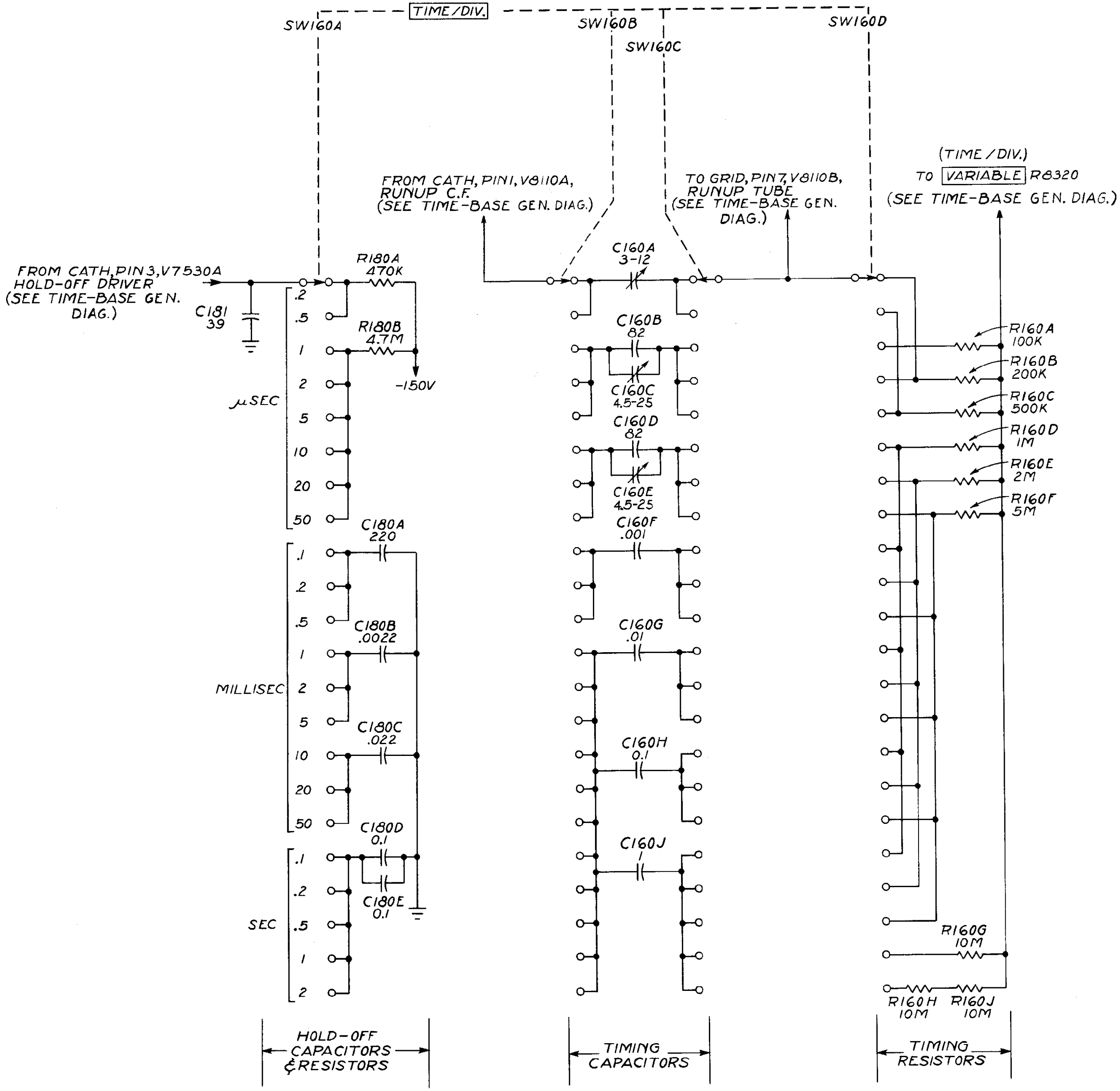
R.O.W.



TIME/DIV. SWITCH & VARIABLE CONTROL



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R.O.W.

TYPE T PLUG-IN UNIT

AA

TIMING SWITCH
(TIME/DIV.)