INSTRUCTION MANUAL

Serial Number__________

TYPE 67 TIME-BASE

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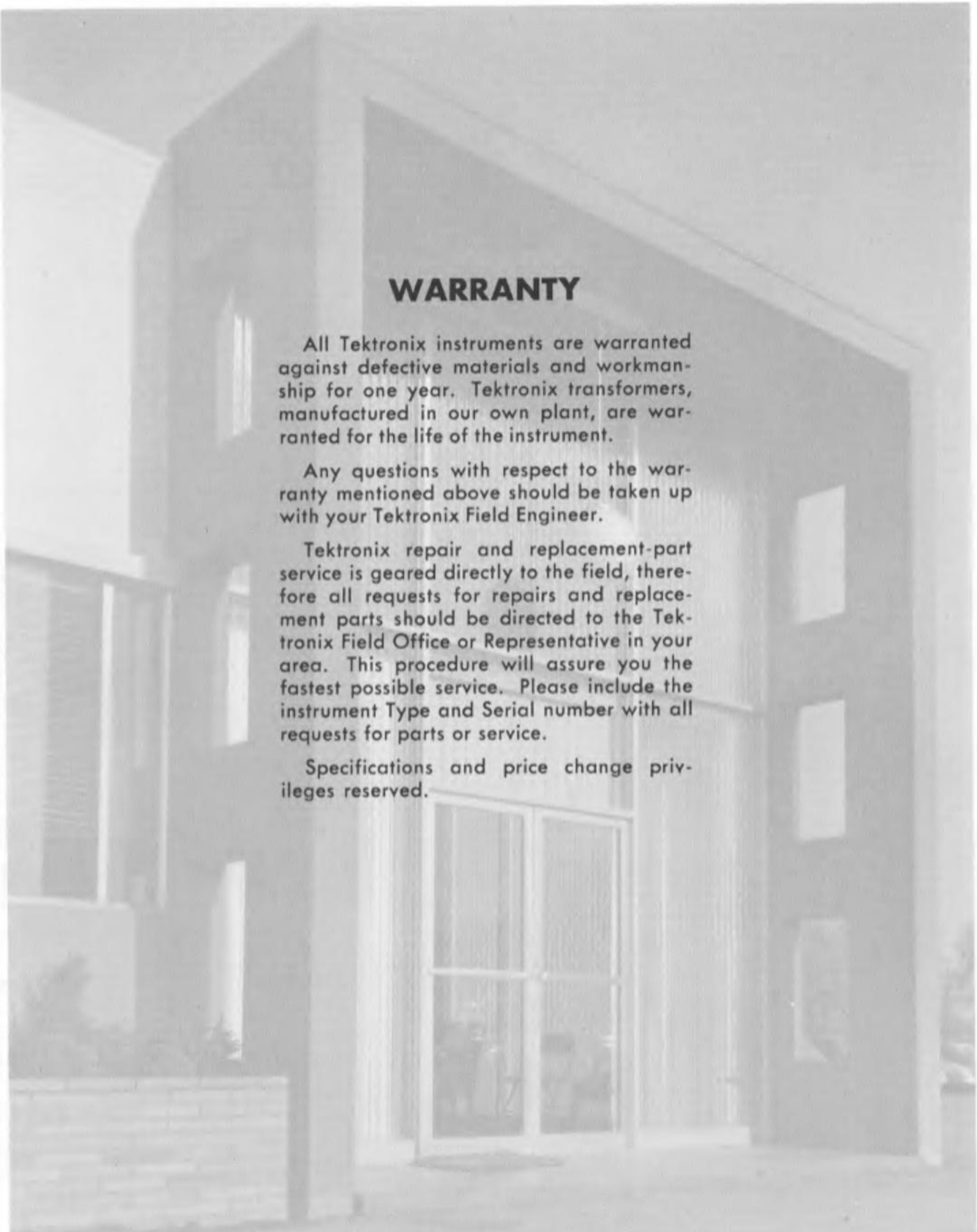

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Fig. 1. Type 67 Time-Base module.

TYPE 67 TIME-BASE

The Tektronix Type 67 Time-Base, Fig. 1, is designed for use with Tektronix Type 560-Series Oscilloscopes. It provides a triggered or free-running sweep at 21 calibrated sweep rates from 1 microsecond per division to 5 seconds per division. When the module is properly calibrated, the accuracy of the sweep rates is within 3% of the indicated value. In addition, a variable control provides continuous sweep rate adjustment (uncalibrated) from 1 microsecond per division to 12 seconds per division. Sweep magnification of 5 is available at all sweep rates. The external input sensitivity is approximately 1 volt per division.

Operating Instructions

Throughout the instructions that follow it is assumed, unless otherwise noted, that the Type 67 is inserted in the right-hand (X-axis) opening of the oscilloscope, thereby providing horizontal deflection of the trace. If it is inserted in the left-hand (Y-axis) opening of the oscilloscope it will provide vertical deflection of the trace and the instructions must be interpreted accordingly. It is further assumed throughout the discussion that there is an amplifier module in the left-hand opening of the oscilloscope.

Front Panel Controls and Connectors

Functions of all front panel controls and connectors are described in Table 1.

TABLE 1

POSITION	Controls horizontal position (when the Type 67 is in the right-hand opening of the oscilloscope) of the display on the crt screen.
CALIBRATION	Adjusts gain to compensate for differences in crt deflection sensitivities.
TIME/DIV.	Selects the desired sweep rate from a choice of 21 calibrated steps. In addition, an EXT. INPUT position is provided for connecting external signals.
VARIABLE (red knob)	Provides a continuous range of sweep rates between the fixed steps of the TIME/DIV. switch. (The sweep rates are calibrated only when the VARIABLE control is set fully clockwise to the CALIBRATED position.) By pulling the VARIABLE control out, 5X magnification of the sweep is obtained.
UNCAL. lamp	Lights when VARIABLE control is off CALIBRATED position to warn operator he is using an uncalibrated sweep rate.
EXT. INPUT	Input connector for application of external signals (TIME/DIV. switch must be in the EXT. INPUT position).
EXT. TRIG.	Input connector for external triggering signal.
STABILITY	Sets voltage level at input to Time-Base Generator to permit proper triggering by Time-Base Trigger.
LEVEL	Selects the voltage level on the triggering signal at which the sweep is triggered. This control also selects automatic triggering (AUTO position) or allows the sweep to free run (FREE RUN position).
SLOPE	Selects whether the sweep starts on the positive-going portion (+ slope) or on the negative-going portion (—slope) of the triggering signal.
COUPLING	Selects coupling of trigger input.
SOURCE	Selects the source of the triggering signal.

Sweep Triggering

In order to obtain a stable display, it is necessary to start the sweep consistently at the same time relative to recurring cycles of the input waveform. The sweep therefore must be triggered by the input signal, or by some signal which bears a fixed time relationship to the input signal. The following instructions tell you how to select and use the proper triggering signal for various applications.

Selecting the Triggering Source

For most applications the sweep can be triggered by the input signal. The only requirement is that the signal be large enough to provide at least one minor graticule division of deflection on the screen at the sensitivity for which the amplifier module in the left-hand opening of the oscilloscope is set. To obtain triggering of the sweep from the input signal, set the SOURCE switch to the INT. position.

Sometimes it is advantageous to trigger the sweep with an external signal. External triggering is especially useful where signals are going to be sampled from several different places within a device. By using external triggering, it is not necessary to reset the triggering controls each time a new waveform is shown. External triggering should also be used with a dual-trace amplifier module in the alternate mode to show the proper time relationship between the two displayed signals. In order to obtain a stable display, it is necessary that the external triggering signal have an amplitude of at least one volt, peak-to-peak, and bear a fixed time relationship to the displayed signal. To use an external signal for triggering the sweep, connect the signal to the EXT. TRIG. connector and set the SOURCE switch to EXT.

When you are observing a signal which bears a fixed time relationship to the line frequency, you may wish to trigger the sweep from the line-frequency signal. To do this, place the SOURCE switch in the LINE position.

Selecting the Trigger Coupling

For most recurrent waveforms, satisfactory triggering will be obtained with the COUPLING switch in the AC SLOW position. However, when triggering from very low frequencies (below about 16 cps), greater triggering sensitivity will be obtained with the COUPLING switch in the DC position. The AC FAST position of the COUPLING switch is used when it is desired to trigger only on the high-frequency component of a signal containing both high- and low-frequency components. It should also be used any time you are using a dual-trace module in the alternate mode with internal triggering.

When using ac coupling, the sweep is triggered when the signal reaches a given amplitude with respect to its dc average. When using dc coupling the sweep is triggered when the signal reaches a given amplitude with respect to zero.

Selecting the Trigger Slope

In most cases, selection of the triggering slope is not critical since triggering on either slope will provide a suitable display. When the SLOPE switch is in the + position, the sweep is triggered on the positive slope of the triggering signal. When the SLOPE switch is in the — position, the sweep is triggered on the negative slope of the triggering signal.

Selecting the Trigger Level

The LEVEL control determines the instantaneous voltage level (ac or dc, depending upon the setting of the COUPLING switch) on the triggering signal at which the sweep is triggered. With the SLOPE switch in the + position, adjustment of the 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 in the — position, adjustment of the LEVEL control makes it possible to trigger the sweep consistently at virtually any point on the negative slope of the triggering signal.

At the extreme clockwise and counterclockwise ends of its range, the LEVEL switch activates, respectively, the FREE RUN and AUTO switches. The effects of these switches are discussed in the following paragraphs.

Automatic Mode of Operation

Setting the LEVEL control to the AUTO position sets the Type 67 up for an automatic mode of triggering which is suitable for most applications. In this mode the triggering signal is ac-coupled, and the triggering level is automatically set such that any external triggering signal of one volt or more, or internal triggering signal which produces one minor graticule division or more of deflection on the crt screen, will trigger the sweep. In the absence of such a triggering signal, the sweep will continue to be triggered automatically at about a 50-cps rate.

Free-Running Mode of Operation

Setting the LEVEL control to the FREE RUN position produces a free-running sweep, independent of any synchronizing signal. The frequency of the free-running sweep is dependent upon the setting of the TIME/DIV. switch. This free-running trace is useful as a base line from which dc measurements may be made.

Magnification of the Sweep

Any portion of the trace can be expanded horizontally by a factor of 5 by pulling the VARIABLE control knob out. To expand a given portion of the trace, set that portion to the center of the graticule by means of the POSITION control, and pull the VARIABLE control knob out.

To determine the true sweep rate in magnified sweep operation, divide the setting of the TIME/DIV. switch by 5. (The VARIABLE control must be turned fully clockwise.)

Setting the CALIBRATION Adjustment

Any time you move the Type 67 from one oscilloscope opening to another, you must adjust the CALIBRATION adjustment to compensate for differences in crt deflection-plate sensitivities. Making this adjustment is also sometimes necessary when the amplifier module used in the same oscilloscope with the Type 67 module is changed. This is because the difference in average deflection plate voltages of the amplifier modules can affect the overall deflection sensitivity of the crt.

To properly set the CALIBRATION adjustment on the Type 67 in an oscilloscope with a line-frequency Calibrator, proceed as follows:

1. Set the TIME/DIV. switch to 5 mSEC and display a Calibrator signal on the screen.

2. Set the CALIBRATION adjustment so that the number of cycles of Calibrator signal occupying 10 graticule divisions is equal to the line frequency times 50 milliseconds. (If the line frequency is 60 cps, there will be 3 cycles displayed in 10 divisions.)

If your oscilloscope does not have a line-frequency Calibrator, you can accomplish the same purpose by displaying the line-frequency waveform and setting the CALIBRATION adjustment for the proper number of cycles.

In the Calibration instructions in this manual, there is another method of setting the CALIBRATION adjustment which is slightly more accurate, but requires the use of a time-mark generator.

Time and Frequency Measurements

To measure the time interval between two points on a waveform, proceed as follows:

1. Apply the signal to the input of the amplifier module and set the triggering controls for a stable display. Make sure the VARIABLE control on the Type 67 is in the CALIBRATED position (UNCAL. light out).

2. Measure the horizontal distance, in graticule divisions, between the two points whose interval you wish to find.

3. Multiply the distance obtained in step 2 by the setting of the TIME/DIV. switch. (If the 5X MAG. is on—VARIABLE knob pulled out—divide the result by 5.) This is the time interval between the two points measured.

To determine the frequency of a recurrent waveform, simply take the reciprocal of the time interval between corresponding points on two consecutive cycles of the waveform.

Phase-Shift Measurements

To measure the phase difference between two sine waves, proceed as follows:

1. Adjust the Type 67 for externally triggered operation, and apply one of the sine waves to the input of the amplifier module. (The signal should be ac-coupled to the amplifier module.)

2. Set the TIME/DIV. switch so that at least one cycle of the sine wave is displayed.

3. Vertically center the display, and horizontally position it so that one of the positive slopes crosses the horizontal centerline at the left side of the graticule.

4. Measure the horizontal distance between corresponding points on two consecutive cycles of the waveform.

5. Without making any adjustments to the oscilloscope, disconnect the first sine wave and apply the second to the input of the amplifier module. (Normally, this can be done simply by moving the probe from one signal source to the other.) If there is a phase difference between the two sine waves, you will find that the display has shifted horizontally.

6. Measure the amount of horizontal shift of the display. (You may increase or decrease the deflection sensitivity of the amplifier module, if desired, to make the measurement easier.)

7. Divide the distance measured in step 6 by the distance measured in step 4 and multiply the result by 360°. This is the phase difference between the two sine waves.

Circuit Description

Block Diagram

A block diagram of the Type 67 Time-Base module is shown in Fig. 2. In general, the overall operation of the module is 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. This negative pulse triggers the Time-Base Generator which generates a positive-going sawtooth waveform. This sawtooth is amplified by the Horizontal Amplifier and applied push-pull to the deflection plates of the crt to sweep the electron beam across the screen. After the beam has traveled across the screen, the Time-Base Generator resets itself and awaits the next trigger pulse. If desired, the Time-Base Trigger and Time-Base Generator also can be disconnected (by placing

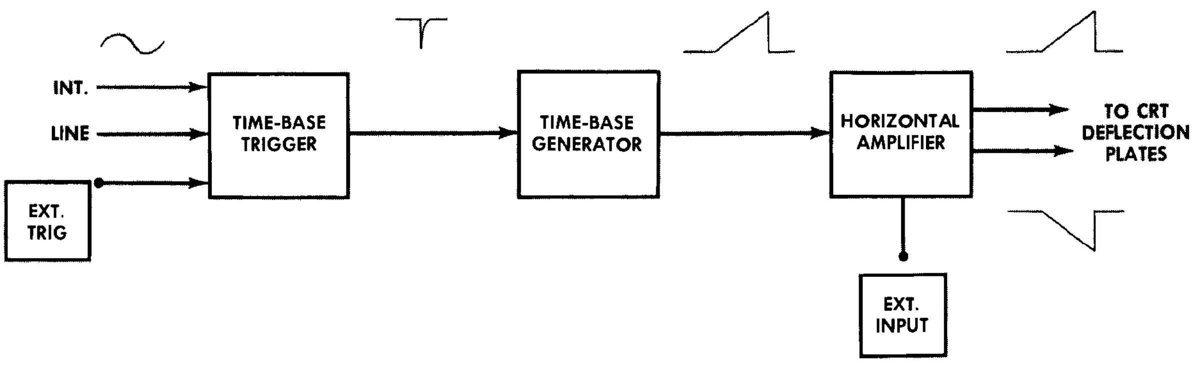


Fig. 2. Type 67 module block diagram.

the TIME/CM switch in the EXT. INPUT position) and an external signal applied directly through the Horizontal Amplifier to the deflection plates of the crt.

The following paragraphs describe the operation of each of the circuits of the Type 67 in detail. During these discussions, you should refer to the schematic diagrams at the rear of this manual.

TIME-BASE TRIGGER

The Time-Base Trigger consists basically of the Trigger Input Amplifier, V24, and the Trigger Multivibrator, V45. The Trigger Input Amplifier amplifies (and when desired, inverts) the incoming triggering signal and applies it to the input grid of the Trigger Multivibrator. The Trigger Multivibrator is a Schmitt circuit which 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 spikes which are applied to the Time-Base Generator. The negative spikes trigger the Time-Base Generator to start the sweep; the positive spikes are clipped by diode action and not used.

Trigger Input Amplifier

The input to the Trigger Input Amplifier, V24, may be selected from one of three sources by means of the SOURCE switch, SW5. When the SOURCE switch is in the INT. position, the signal is obtained from the module 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 of the module.

As will be seen later, the negative spike 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). However, it is desired to start the sweep during either a positive-going or negative-going portion of the incoming triggering signal. To accomplish this, the SLOPE switch, SW20, provides the means for inverting or not inverting, as desired, the triggering signal in the Trigger Input Amplifier.

When the SLOPE switch is in the —position, the incoming triggering signal is applied to the grid of V24A, and V24 becomes a cathode-coupled amplifier. Its output is in phase with its input. Thus, the negative-going portion of the signal at the input to the Trigger Multivibrator corresponds to the negative-going portion of the incoming triggering signal. The negative spike 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 acts as a plate-loaded amplifier. Its ouput is opposite in polarity to its input. Thus, the negative-going portion of the signal at the input of the Trigger Multivibrator corresponds to the positive-going portion of the incoming triggering signal. And, the negative spike at the output of the Time-Base Trigger will occur during a time when the triggering signal is moving in a positive direction.

The LEVEL control, R17, varies the average dc level of the plate of V24B from about +100 volts to +125 volts. This is true whether the SLOPE switch is in the — position or the + position. As will be seen later, the voltage at the plate of V24B must pass through the approximate center of this range (about +112.5 volts) in order to cause the Trigger Multivibrator to change states.

For small triggering signals, R17 is set such that the average dc level of the plate of V24B is close to the center of its range. Then a small triggering signal, as amplified by V24, is sufficient to carry the plate voltage through the 112.5-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 that 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 12.5 volts of swing at the plate of V24B in order to cause the trigger multivibrator to change states.

It should be noted that the voltages given in the foregoing discussion are typical nominals only and will vary somewhat from instrument to instrument and with time.

Trigger Multivibrator

The Trigger Multivibrator, V45, is a typical two-state Schmitt circuit. When the voltage at the grid of V45A is above a certain critical level (neglecting hysteresis) the Trigger Multivibrator is in one state, with V45A conducting and V45B cut off. When the Trigger Multivibrator is in this state, the voltage at its output (plate of V45B) is +300 volts. When the voltage at the grid of V45A is below the critical level (neglecting hysteresis), the Trigger Multivibrator is in the other state, with V45A cut off and V45B conducting. When the Trigger Multivibrator is in this state, the voltage at its 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 level. Thus 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 critical level while moving in a negative direction; the positive-going portion of the square wave occurs when the voltage at the grid of V45A passes the critical level while moving in a positive direction. As mentioned before, only the negative-going portion of the square wave is of significance timewise. By means of the SLOPE switch and the LEVEL control, this point can be made to coincide with virtually any point on the incoming triggering signal.

Actually, the voltage level at the grid of V45A at which the Trigger Multivibrator changes states on a negative-going signal is slightly lower than that at which it changes states on a positive-going signal. The difference between the two levels is the hysteresis of the circuit. To maintain stable triggering, the incoming triggering signal must be large enough that, when it is amplified by the Trigger Input Amplifier, it will have sufficient amplitude to overcome the hysteresis of the Trigger Multivibrator.

It will be seen in the discussion of the Time-Base Generator that not every negative trigger pulse from the Time-Base

Trigger initiates a sweep. During the sweep time, the negative trigger pulses have no effect on the Time-Base Generator. It is only after a sweep has been completed and all circuits have returned to their quiescent states that the Time-Base Generator can be retriggered.

Automatic Triggering Mode

When the LEVEL control is turned fully counterclockwise, the 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 time constant thus formed is such that, in the absence of a triggering signal, the Trigger Multivibrator free-runs at about 50 cps. However, since the triggering signals from the Trigger Input Amplifier are still coupled to the Trigger Multivibrator through C31, any triggering signal over 50 cps in frequency and of sufficient amplitude will produce synchronized operation of the Trigger Multivibrator at the triggering signal frequency. In the absence of any such triggering signal, the sweep continues to be triggered at a 50-cps rate.

TIME-BASE GENERATOR

The Time-Base Generator, upon receipt of a negative trigger pulse, or spike, from the Time-Base Trigger, produces a linearly rising sawtooth voltage which is applied through the Horizontal Amplifier to the crt deflection plates. This causes the electron beam to be deflected across the crt screen and form 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 switched into the circuit by the TIME/DIV. Switch.

Sweep Generation

In the quiescent state—that is, when no sweep is being generated—V135A is conducting and V145A is cut off. The plate of V145A is about —3 volts with respect to ground. The Disconnect Diodes are conducting and clamp both sides of the Timing Capacitor at about —3 volts. With its cathode grounded and its grid at about —3 volts, V161A is conducting heavily and its plate is at about +28 volts.

A negative trigger pulse, arriving at the grid of V135A from the Time-Base Trigger, causes the Sweep-Gating Multivibrator to switch rapidly to its other state. That is, V135A cuts off and V145A conducts. As V145A conducts, the increased current through the common cathode resistor, R144, raises the cathode voltage of the two tubes. This holds V135A in cutoff after the negative trigger pulse has passed. Since V135A is now in cutoff, further trigger pulses arriving at its grid will have no effect on the circuit until after the sweep has been completed and the grid has been returned to its quiescent level by the Hold-Off Circuit. (The positive spikes from the Time-Base Trigger are clipped by D130.)

As V145A conducts, its plate voltage goes down, cutting off the Disconnect Diodes. When the Disconnect Diodes cut off, the plates of the Timing Capacitor are no longer held at —3 volts, and the Timing Capacitor starts to charge toward the instantaneous potential difference between the —100-volt supply and the potential on the cathode of V161B. However, as the lower side of the Timing Capacitor starts to move in a negative direction, it takes the grid of V161A with it. This produces a positive swing at the plate of V161A which is coupled through B167 and V161B to the upper side side of the Timing Capacitor. This positive swing on the upper side tends to prevent the lower side from swinging negatively. It also increases the voltage to which the Timing Capacitor is trying to charge. The effect is to "straighten out" the charging curve by increasing the charging voltage with each increment of charge on the capacitor. Since the gain of V161A is about 150, the potential on the upper side moves about 150 volts with respect to ground while the potential on the lower side moves about one volt. The result is an extremely linear sawtooth at the cathode of V161B, which is applied through the Horizontal Amplifier to the deflection plates of the cathode-ray tube.

The values of the Timing Capacitor C160 and the Timing Resistor R160 are selected by the TIME/DIV. switch to provide the 21 different charging rates and, therefore, 21 calibrated sweep rates. The VARIABLE control, R160Y, permits vernier changes in the value of the Timing Resistor to produce sweep rates between the calibrated steps selected by the TIME/DIV. switch. The UNCAL. lamp, B160W, is lighted whenever the VARIABLE control is moved away from the CALIBRATED position to warn the operator that he is using an uncalibrated sweep rate.

Sweep Length

The sweep length—that is, the total time duration of the sweep for any given sweep rate—is determined by the setting of the SWP. LENGTH adjustment, R176. As the sweep voltage rises at the cathode of V161B, there is a proportionate rise in voltage at the arm of the SWP. LENGTH adjustment. This increases the voltage at the plate, and therefore the 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 the grid of V135A rises to the point where V135A comes out of cutoff, the Sweep-Gating Multivibrator reverts rapidly to its original state, with V135A conducting and V145A cut off. The voltage at the plate of V145A rises, carrying with it the voltage at the plates of the Disconnect Diodes.

V152B starts conducting and forms a discharge path for the Timing Capacitor, which brings the grid of V161A quickly back up to its quiescent level. The rise in voltage at the grid of V161A causes the tube to conduct more, so that the plate voltage drops, carrying with it the grid and cathode of V161B. When the voltage at the cathode of V161B returns to about —3 volts, V152A conducts, clamping the voltage at this point. The circuit has now returned to its quiescent level and is ready for the next trigger.

Hold-Off

The Hold-Off Circuit prevents the Time-Base Generator from being triggered until after the Miller Runup Circuit has stabilized in the quiescent condition following the previous sweep. It does this by holding the grid of V135A positive enough to keep the tube in conduction for a given period after the completion of a sweep.

During sweep time, the rising voltage at the cathode of V152C charges the Hold-Off Capacitor, C160. Then, at the end of the sweep, the voltage at the plate of V152C drops suddenly, cutting off the tube. The cathode of V152C, however, is held up by the charge on the Hold-Off Capacitor which must discharge through the Hold-Off Resistor, R181. This holds the grid and cathode of V145B and the grid of V135A high enough to hold V135A in conduction for a length of time determined by the time constant of the Hold-Off Capacitor and the Hold-Off Resistor. The amount of hold-off time required is determined, in general, by the sweep rate. For this reason, the TIME/DIV. switch changes the amount of capacitance in the Hold-Off Circuit simultaneously with that of the Timing Circuit.

Sweep Stability

The STABILITY adjustment, R111, regulates the quiescent dc level at the grid of V135A. This potentiometer (a front-panel screwdriver adjustment) 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 pulse from the Time-Base 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 V135A cuts off upon decay of the hold-off voltage and the next sweep is initiated immediately (no trigger pulse 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. control. (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 in the Time-Base Trigger free run.)

Unblanking

The positive rectangular pulse appearing at the cathode of V135B during sweep time is applied as an unblanking pulse to the cathode-ray tube of the oscilloscope. Action of this pulse on the crt circuit is discussed in detail in the oscilloscope instruction manuals. It should be noted that, when the TIME/DIV. switch is in the EXT. INPUT position, the Sweep-Gating Multivibrator is disabled, and there is no current through V135A or V145A. Therefore, the cathode of V135B is held at about +125 volts and the crt is continuously unblanked.

Blanking and unblanking is controlled only by the module in the right-hand oscilloscope opening. Thus, if the Type 67 module is inserted in the left-hand opening (producing a vertical trace), the trace will not be blanked between sweeps.

HORIZONTAL AMPLIFIER

The Horizontal Amplifier consists of the Input Cathode Follower (V333A), the Second Cathode Follower (V333B), two Driver Cathode Followers (V353A and V353B), 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. The POSITION control, R323, supplies a manually adjustable dc voltage to the grid of V333A for positioning the trace on the screen of the cathode-ray tube.

The CALIBRATION adjustment, R334, varies the sawtooth amplitude at the grid of V333B. This provides a means of calibrating the displayed 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 which converts the single-ended input to a push-pull output. The push-pull output is coupled through pins 17 and 21 of the plug-in connector 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 which 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.

The SWP/MAG. REGIS. adjustment, R346, is adjusted to cancel the average dc level of the negative feedback voltage from V374A. This, in effect, insures that the voltage at the grid of V353A equals the voltage at the cathode of V333B when the electron beam is in the center of the screen and SW341 is open. This, in turn, assures that 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 and is converted to push-pull for application to the cathode-ray tube deflection plates. 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.

Troubleshooting

General maintenance and troubleshooting information is contained in the oscilloscope manuals. In the following discussion, it is assumed that you have already read that information and have definitely isolated a trouble to the Type 67 by the procedures described there.

First, remove the right-hand side panel of the oscilloscope and check to see if there is heater glow in all of the tubes. Replace any in which there is no heater glow. If there is still no heater glow in any tube, trace out its heater circuit to find the trouble.

If there is heater glow in all tubes, remove the Type 67 and inspect it closely for damaged or burned components, loose wires, broken switches, etc., which could cause trouble. If visual inspection does not reveal the source of trouble, insert the module in the left-hand opening of the oscilloscope and remove the left-hand side panel. This will allow access to the wiring and components of the module.

The Type 67 will produce a vertical sweep when it is inserted in the left-hand opening of the oscilloscope. For troubleshooting purposes you do not need a module in the right-hand opening (except to check triggering and blanking circuits). If, for some reason, you do not wish to exchange positions of modules for troubleshooting work, you may use a plug-in extension, Tektronix part no. 013-034, which allows the module to be operated while extended partially out of the front of the oscilloscope.

The following troubleshooting information is divided into two major sections, Circuit Isolation and Circuit Troubleshooting. It is intended that you will refer first to Circuit Isolation to determine which major circuit (Time-Base Trigger, Time-Base Generator, or Horizontal Amplifier) the trouble is in. Then you should refer to Circuit Troubleshooting for instructions on troubleshooting that particular circuit. In each case, the information is further divided according to the symptoms the trouble presents to the operator.

CIRCUIT ISOLATION

This portion of the troubleshooting information tells you how to isolate trouble to one of the major circuits of the Type 67. After you have so isolated the trouble, refer to Circuit Troubleshooting for instructions on troubleshooting that particular circuit.

NOTE

In the case of insufficient horizontal deflection, nonlinear sweep, or improper sweep timing, check the supply voltages in the Indicator Unit first, especially the high voltage.

No Sweep

If you cannot obtain a properly triggered sweep on the screen, set the LEVEL control to FREE RUN. If you obtain a free-running sweep which can be turned off and on with the LEVEL control, the trouble is in the Time-Base Trigger. If you do not obtain a free-running sweep, set the TIME/DIV. switch to EXT. INPUT and adjust the POSITION controls. If a spot appears, set the TIME/DIV. switch to 10 mSEC and observe the neon bulb, B167, in the plate circuit of V161A. If there is a pulsating glow in B167, the Time-Base Generator is functioning properly and the trouble is in the Horizontal Amplifier. If there is no glow in B167, the trouble is in one of the components connected to it. If there is a steady glow (not pulsating) in B167, the trouble is elsewhere in the Time-Base Generator. If no spot appears when the TIME/DIV. switch is placed in the EXT. INPUT position, the trouble is in the Horizontal Amplifier.

If you have a free-running trace at all positions of the LEVEL control (TIME/DIV. switch not in the EXT. INPUT position), the trouble is in the Time-Base Generator.

Insufficient Horizontal Deflection

This condition can be the fault of either the Time-Base Generator or the Horizontal Amplifier. To determine the faulty circuit, proceed as follows:

Set the TIME/DIV. switch to .5 SEC and the LEVEL control to FREE RUN. Connect a voltmeter between pin 8 of V161B and ground (negative voltmeter lead to ground). The voltage at this point should rise linearly from zero to +150 volts ±15% in about 5 seconds and then drop quickly to zero. If it does, the Time-Base Generator is functioning properly and the trouble is in the Horizontal Amplifier. No voltage variations at pin 8 of V161B, or a significantly smaller variation, indicates that the trouble is in the Time-Base Generator.

Nonlinear Sweep

This condition can be caused by nonlinear amplification in the Horizontal Amplifier or by the generation of a nonlinear sawtooth in the Time-Base Generator.

Set the TIME/DIV. switch to .5 mSEC and the LEVEL control to FREE RUN. Connect a 10X probe between pin 8 of V161B and the INPUT connector of an amplifier module in the other opening of the oscilloscope. Set the VOLTS/DIV. switch on the amplifier module to 5 VOLTS. A diagonal trace should now be displayed on the screen. If the slope of the trace is constant, the nonlinearity is being produced by the Time-Base Generator. If the slope of the trace is not constant, the nonlinearity is being produced by one of the cathode follower stages in the Horizontal Amplifier.

Improper Sweep Timing

If the sweep timing is off in some, but not all, positions of the TIME/DIV. switch, one of the timing resistors or capacitors has changed in value. By comparing the switch positions with the Timing Switch schematic diagram, you will be able to tell which components are common to these positions.

If the timing is off in all positions of the TIME/DIV. switch, the Horizontal Amplifier or the Miller Runup Tube, V161A, is probably faulty. Replace V161 before troubleshooting the Horizontal Amplifier.

CIRCUIT TROUBLESHOOTING

This portion of the troubleshooting information tells you how to locate a defective stage within a given circuit. Once the faulty stage is known, you should first replace the tube or tubes. If this does not eliminate the trouble, replace the original tubes and check the rest of the circuit by voltage measurements, waveform tracing, and resistance checks. Typical voltage and waveforms to be encountered at various points throughout the module are shown on the schematic diagrams at the rear of this manual. Resistance checks will normally be point-to-point measurements whose value can be approximated from the schematic diagram.

All voltages should be measured with a 20,000-ohms-per-volt or better voltmeter.

Troubleshooting the Time-Base Trigger

If a trouble has been isolated to the Time-Base Trigger, set the LEVEL control to AUTO (and the TIME/DIV. switch to some position other than EXT. INPUT). If a trace appears, the trouble is in the Trigger Input Amplifier or in the trigger input circuitry. First, change V24. If this does not eliminate the trouble, check the rest of the stage by voltage and resistance measurements.

If a trace does not appear when the LEVEL control is set to AUTO (but it does when the LEVEL control is set to FREE RUN), the trouble is in the Trigger Multivibrator. First change V45. If this does not eliminate the trouble, check the rest of the stage by voltage and resistance measurements.

Troubleshooting the Time-Base Generator

No Horizontal Sweep. If the Time-Base Generator is not producing a sawtooth waveform when the LEVEL control is set to FREE RUN, some defect in the circuit is causing the output to remain at some fixed voltage. A clue to the cause of this trouble can be obtained by measuring the voltage at the plate (pin 6) of the Miller Runup tube, V161A.

The voltage reading obtained at the plate of V161A will probably be approximately +250 volts, or approximately +30 volts. A reading of +250 volts indicates that the Miller Runup Circuit has run up and has not been reset, while a reading of +30 volts indicates that the Miller Runup Circuit is not being allowed to run up. The condition that exists will depend on the type of trouble. The two conditions of plate voltage are handled separately in the following paragraphs.

High voltage at the plate of V161A indicates the tube is cut off. If this is the case, instantaneously ground the grid (pin 2) of the tube while monitoring the plate voltage. If the tube is functioning, the plate voltage will drop to about +6 volts. (Do not hold the grid grounded for more than an instant.) If V161A is found to be good, measure the voltage at its grid. If this voltage is more than about 5 or 6 volts negative with respect to ground, V152B is probably not conducting. In this case, check V152 and R147.

If the voltage at the grid of V161A is not more negative than about —5 or —6 volts (it should be about —4 volts), measure the voltage at the cathode (pin 8) of V161B. If this voltage is greater than +200 volts, the Runup Cathode Follower stage may be assumed to be operating correctly. If this voltage is lower than about +200 volts, the stage is defective and its grid and cathode circuits should be checked.

If the Runup Cathode Follower is found to be operating properly, measure the voltage at the cathode (pin 8) of V145B. If this voltage is more positive than about —45 volts, the trouble is in the Sweep-Gating Multivibrator. The voltage divider in the cathode circuit of V135B is particularily critical.

If the voltage at the cathode of V145B is more negative than about —55 volts, the trouble is in the Hold-Off Circuit.

Low voltage at the plate of V161A indicates that the tube is conducting heavily and is not being allowed to perform its normal run-up operation. If this trouble exists at only a few positions of the TIME/DIV. switch, the trouble is probably in the Sweep-Gating Multivibrator.

Check the voltage at the grid (pin 2) of V135A. If the voltage at this point is in the vicinity of —65 volts or lower (more negative), the Sweep-Gating Multivibrator is faulty.

If the voltage at the grid of V135A is more positive than —65 volts, measure the voltage at the grid (pin 9) of V145B. If the voltage at this point is —70 volts or lower (more negative), the Hold-Off Circuit is faulty. If the voltage at the grid of V145B is more positive than about —70 volts, the Runup Cathode Follower circuit is faulty.

Nonlinear Sweep. A nonlinear sweep will be generated if the current charging the Timing Capacitor does not remain constant. If the nonlinearity occurs at all sweep rates, a defective Miller Runup tube is probably the cause. If the nonlinearity occurs only at certain sweep rates, the cause is probably a defective timing resistor or capacitor. A defective C165 can also cause the sweep to be nonlinear at the faster sweep rates.

Constant Free-Running Trace. If the free-running trace cannot be turned off with the LEVEL control, the Sweep-Gating Multivibrator is at fault. The most probable cause is a change in resistance in either of the grid circuits or in the cathode circuit.

Insufficient Horizontal Deflection. If the horizontal trace starts at the left-hand side of the oscilloscope screen, but does not extend to the right-hand side, the Hold-Off Circuit is resetting the Sweep-Gating Multivibrator before the sweep is completed. If the sweep cannot be adjusted to normal length with the SWP. LENGTH adjustment, R176, the resistances in the cathode circuit of V161B should be checked.

Troubleshooting the Horizontal Amplifier

No Spot or Trace. If you are unable to obtain a trace on the screen but it has been determined that the Time-Base Generator is working properly, place the TIME/DIV. switch in the EXT. INPUT position and adjust the POSITION control. If a spot appears, the trouble lies between the input to the Horizontal Amplifier (top of R320) and the cathode of V353A. To further isolate the trouble, set the TIME/DIV. switch to 5 SEC and ground the following points in the order listed: grid (pin 7) of V353A; cathode (pin 3) of V333B; grid (pin 2) of V333B; cathode (pin 8) of V333A; grid (pin 7) of V333A; and cathode (pin 8) of V161B. Each time you ground one of these points, a spot should appear on the screen. When you ground a point and no spot appears, the trouble lies between that point and the previous point tested. If the spot does not appear when you ground the grid of V353A (the first point tested), the trouble lies in V353A.

If a spot does not appear when the TIME/DIV. switch is set to EXT. INPUT, short the two grids (pins 2 and 7 of V374 together. If a spot now appears, the trouble is in V353B or associated circuitry; if a spot does not appear, the trouble is in the Output Amplifier.

Insufficient Deflection. If the gain of the Horizontal Amplifier decreases, the timing will no longer correspond to the calibrated values indicated by the TIME/DIV. switch.

If the change in gain is only slight, as indicated by improper timing and a slightly decreased sweep length, the amplifier can usually be recalibrated. However, since the gain of the Horizontal Amplifier regulates the timing of the sweep, care must be taken to insure that the gain adjustments are accurately made. Refer to the Calibration Section of this manual if it is necessary to adjust the gain of the Horizontal Amplifier. (Also check the Indicator Unit power-supply voltages, including the high voltage.)

If the decrease in gain is more pronounced, or if there is no deflection at all, check for defective components that can affect the gain but not the balance of the circuit. Such components, in addition to tubes, are R334, R342, and R375.

Nonlinear Sweep. You can isolate a stage producing nonlinear amplification within the Horizontal Amplifier by much the same method as used for isolating nonlinear amplification to the Horizontal Amplifier. First, set the TIME/DIV. switch to .5 mSEC and the LEVEL control to FREE RUN. Set the VOLTS/DIV. switch on the amplifier module in the other oscilloscope opening to 5 VOLTS and the AC-DC-GND switch to AC. Connect a 10X probe between the INPUT connector of the amplifier module and pin 8 of V353A, then pin 3 of V333, and then pin 8 of V333. When each connection is made you should obtain a straight line extending from lower left to upper right on the screen. (The slope of the line will vary from one connection to the next.) When you reach the point where the line is not straight when you make the connection, the stage following is the one producing the nonlinear amplification.

Calibration

Calibration of the Type 67 is performed with the module inserted in the right-hand (X-axis) opening of a Type 560 or Type 561 Oscilloscope. An amplifier module must be inserted in the left-hand (Y-axis) opening. In order to maintain its high degree of accuracy and linearity, it is recommend that the Type 67 be calibrated after each 500 hours of operation or about every six months, whichever comes sooner.

Apparent trouble in the instrument can be caused by improper calibration of one or more circuits. Therefore, if trouble appears in the instrument, you should first make sure it is not due to improper calibration before proceeding with more detailed troubleshooting. Also, each of the calibration adjustments should be checked, and adjusted as necessary, whenever a component has been changed.

Because of interaction among some of the adjustments, it is recommended that you perform the calibration in the order presented. Single adjustments should not be made. Front-panel controls not mentioned in a given step are assumed to be in the position they were in at the end of the previous step. Some of the adjustments affect the position of the crt display; therefore, it will be necessary to reposition the display with the POSITION control to keep the time markers properly aligned with the graticule lines.

To obtain access to all of the adjustments referred to in this procedure, the right-hand side panel of the oscilloscope must be removed. Fig. 3 shows the internal adjustments of the Type 67 module as viewed from the right side.

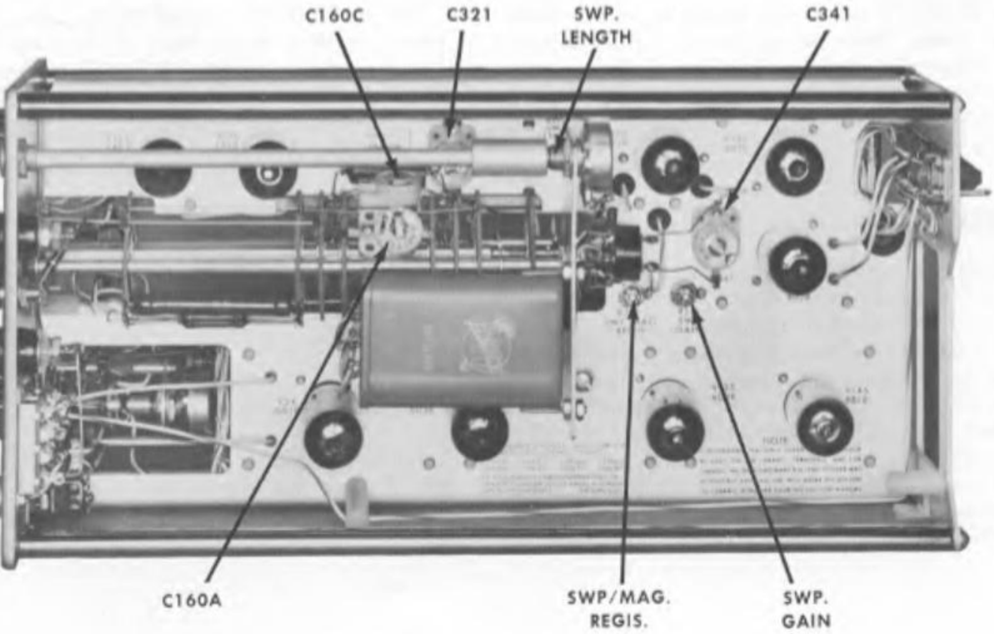


Fig. 3. Type 67 module internal calibration adjustments.

Equipment Required

The following equipment is required for a complete calibration of the Type 67 Time-Base module:

1. Time mark generator, with time markers at 1 and 10 microseconds, and at 1 and 5 milliseconds, accuracy at least 1% (Tektronix Type 180 or 180A Time-Mark Generator recommended).

2. Coaxial cable suitable for applying the output of the time-mark generator to the INPUT connector of the amplifier module.

3. Low-capacity calibration tool (Tektronix Part No. 003-000 or 003-001 recommended).

Initial Setup

Set the front-panel controls on the Type 67 module as follows:

TIME/DIV.	.1 mSEC
VARIABLE*	CALIBRATED and pushed in (5X MAG. OFF)
LEVEL	AUTO
SLOPE	+
COUPLING	AC SLOW
SOURCE	INT.

STABILITY Adjustment

Ground the input of the amplifier module in the left-hand opening of the oscilloscope. Set the STABILITY adjustment (front-panel screwdriver adjustment) fully counterclockwise. Next, turn the STABILITY adjustment clockwise until a trace appears on the screen. Note the position of the adjustment. Advance the adjustment farther clockwise until the trace brightens. Finally, set the adjustment approximately midway between the position where the trace first appears and the position where it brightens.

CALIBRATION Adjustment

Set the TIME/DIV. switch to 5 mSEC and turn the 5X MAG. on (pull out the VARIABLE knob). Apply 1-millisecond markers to the input of the amplifier module and adjust for approximately four divisions of vertical deflection. Position the display so that the approximate center of the trace is observed. Set the CALIBRATION adjustment (front-panel screwdriver adjustment) for exactly one marker per major graticule division on the screen.

* The VARIABLE control must remain in the CALIBRATED position for all timing adjustments. The UNCAL. light will be lighted if the control is not in the CALIBRATED position.

SWP. GAIN Adjustment

Turn the 5X MAG. off (push in the VARIABLE knob) and apply 5-millisecond markers to the amplifier module. Adjust the SWP. GAIN adjustment for exactly one marker per major graticule division.

SWP. LENGTH Adjustment

Adjust the SWP. LENGTH adjustment for a total sweep length of about 10.5 divisions.

SWP/MAG. REGIS. Adjustment

Turn the 5X MAG. on and position the trace so that the first time marker is aligned with the vertical centerline of the graticule. Turn the 5X MAG. off. Adjust the SWP/MAG. REGIS. adjustment so that the first time marker is again aligned with the vertical centerline of the graticule.

10-, 20-, and 50-Microsecond/Division Sweep Rates

Set the TIME/DIV. switch to 50 μSEC and turn the 5X MAG. on. Apply 10-microsecond markers to the input of the amplifier module. Position the trace so that the last 11 markers at the right-hand end of the trace are displayed on the screen. (The LEVEL control may have to be moved from the AUTO position and adjusted for a stable display.) Adjust C160C for one marker per major graticule division.

Set the TIME/DIV. switch to 10 μSEC and apply 1-microsecond markers to the input of the amplifier module. Position the display so that the first 21 markers at the left-hand end of the trace are displayed. Adjust C321 for two markers per major graticule division.

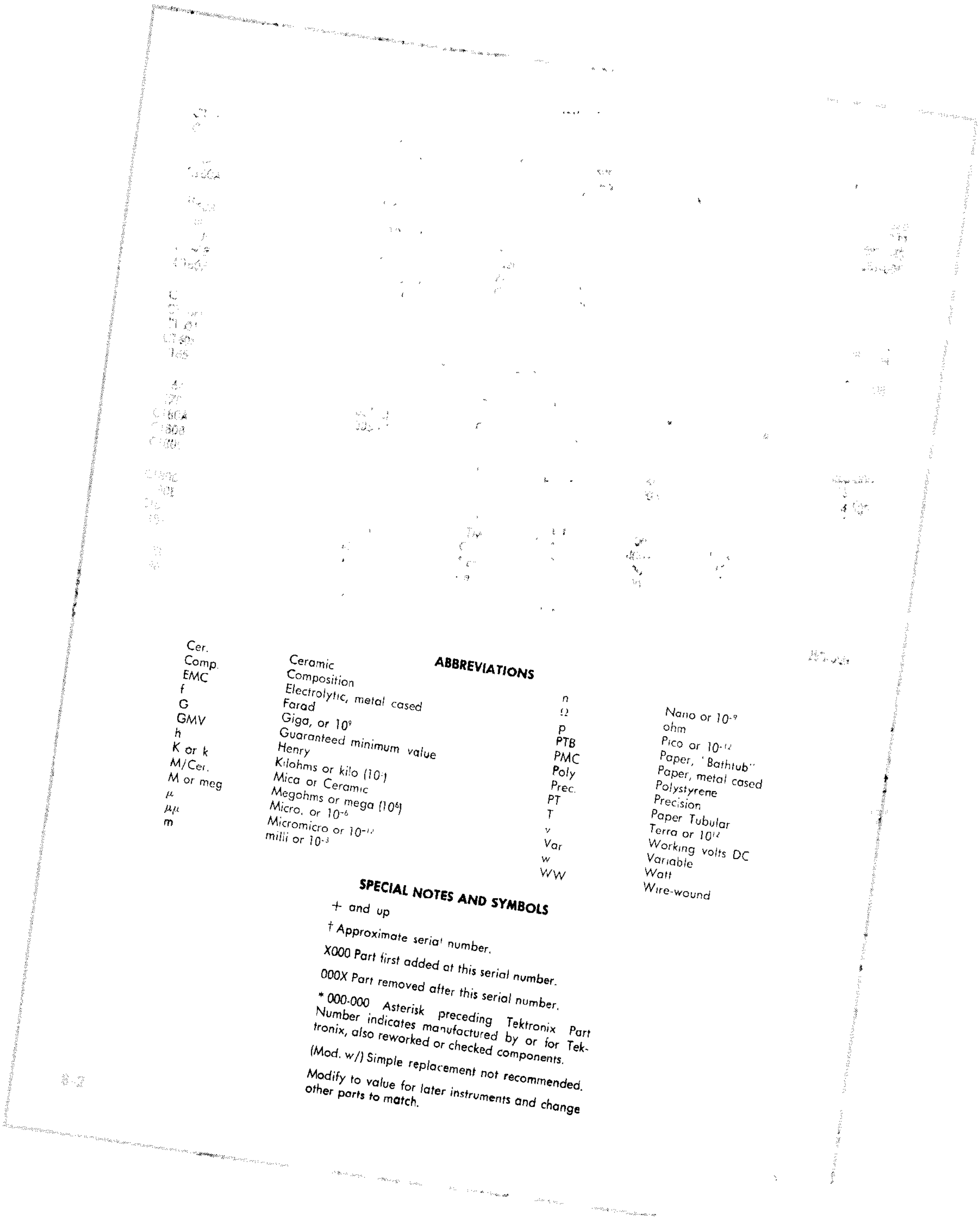
1-, 2-, and 5-Microsecond/Division Sweep Rates

Set the TIME/DIV. switch to 5 μSEC and the POSITION control to midrange. Adjust C160A for one marker per major graticule division.

Linearity Adjustment

Set the TIME/DIV. switch to 1 μSEC and turn the 5X MAG. off. Position the display so that the first time marker is aligned with the vertical centerline of the graticule. Adjust C341 for one marker per major graticule division.

PARTS LIST *and* DIAGRAMS



ABBREVIATIONS

Cer.	Ceramic	n	Nano or 10^{-9}
Comp.	Composition	Ω	ohm
EMC	Electrolytic, metal cased	p	Pico or 10^{-12}
f	Farad	PTB	Paper, "Bathtub"
G	Giga, or 10^{9}	PMC	Paper, metal cased
GMV	Guaranteed minimum value	Poly	Polystyrene
h	Henry	Prec.	Precision
K or k	Kilohms or kilo (10^{3})	PT	Paper Tubular
M/Cer.	Mica or Ceramic	T	Terra or 10^{12}
M or meg	Megohms or mega (10^{6})	v	Working volts DC
μ	Micro, or 10^{-6}	Var	Variable
μμ	Micromicro or 10^{-12}	w	Watt
m	milli or 10^{-3}	WW	Wire-wound

SPECIAL NOTES AND SYMBOLS

+ and up

† Approximate serial number.

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, also reworked or checked components.

(Mod. w/) Simple replacement not recommended. Modify to value for later instruments and change other parts to match.

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MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

HOW TO ORDER PARTS

Replacement parts are available through your local Tektronix Field Office.

Improvements in Tektronix instruments are incorporated as soon as available. Therefore, when ordering a replacement part it is important to supply the part number including any suffix, instrument type, serial number, plus a modification number where applicable.

If the part you have ordered has been improved or replaced, your local Field Office will contact you if there is a change in part number.

PARTS LIST
Type 67

Values are fixed unless marked Variable.

Ckt. No.	S/N Range	Description					Tektronix Part Number

Bulbs

B160W	NE-2	150-002
B161	NE-2	150-002
B167	NE-2	150-002

Capacitors

Tolerance ±20% unless otherwise indicated.

C9	100 pf	Cer.		350 v		281-523
C10	.01 μf	Discap		500 v		283-002
C15	.001 μf	Discap		500 v		283-000
C20	.01 μf	Discap		150 v		283-003
C24	330 pf	Cer.		500 v	±10%	281-546
C31	.005 μf	Discap		500 v		283-001
C37	22 pf	Cer.		500 v	±10%	281-511
C113	.001 μf	Discap		500 v		283-000
C130	47 pf	Cer.		500 v		281-518
C134	10 pf	Cer.		500 v	±10%	281-504
C141	5.6 pf	Cer.		500 v	±10%	281-544
C147	470 pf	Cer.		500 v		281-525
C160A	3-12 pf	Cer.	Var.			281-007
C160B	82 pf	Cer.		500 v	±10%	Use 281-574
C160C	4.5-25 pf	Cer.	Var.			281-010
C160D	.001 μf			Mylar	±½%	*291-008
C160E	.01 μf			Mylar Timing Series	±½%	*291-029
C160F	.1 μf					
C160G	1 μf					
C165	100 pf	Cer.		350 v		281-523
C167	.001 μf	Discap		500 v		283-000
C320	15 pf	Cer.		500 v	±10%	281-509
C321	4.5-25 pf	Cer.	Var.			281-010
C334	22 pf	Cer.		500 v		281-510
C341	4.5-25 pf	Cer.	Var.			281-010
C348	3.3 pf	Cer.			±0.25 pf	281-534
C361	.01 μf	Discap		500 v		283-002
C356	.01 μf	Discap		150 v		283-003
C397	.1 μf	Discap		500 v		283-008

Diodes

D130	T12G	152-008

Resistors

Tolerance ±20% unless otherwise indicated.

						Tektronix Part Number
R14	1 meg	½ w				302-105
R15	470 k	½ w				302-474
R16	30 k	½ w			±5%	301-303
R17	250 k		Var.		LEVEL	311-206
R19	1 meg	½ w			±5%	301-105
R20	300 k	½ w			±5%	301-304
R22	150 Ω	½ w				302-151
R23	150 Ω	½ w				302-151
R24	5.1 k	½ w			±5%	301-512
R25	5.1 k	½ w			±5%	301-512
R28	22 k	1 w			±5%	303-223
R30	220 k	½ w				302-224
R31	220 k	½ w				302-224
R32	100 Ω	½ w				302-101
R34	1.2 k	½ w				302-122
R35	2.7 k	½ w				302-272
R37	333 k	½ w		Prec.	1%	309-139
R38	390 k	½ w		Prec.	1%	309-056
R40	2.2 meg	½ w				302-225
R41	100 Ω	½ w				302-101
R43	4.7 k	½ w				302-472
R46	27 k	1 w				304-273
R111	15 k		Var.		STABILITY	311-112
R112	15 k	½ w			±5%	301-153
R113	18 k	½ w			±5%	301-183
R130	4.7 k	½ w			±5%	301-472
R131	100 Ω	½ w				302-101
R134	13.5 k	½ w		Prec.	1%	309-263
R135	13.5 k	½ w		Prec.	1%	309-263
R137	100 Ω	½ w				302-101
R138	8.2 k	½ w				302-822
R141	33 k	1 w		Prec.	1%	310-070
R143	16.69 k	½ w		Prec.	1%	309-231
R144	15 k	1 w		Prec.	1%	310-115
R146	100 Ω	½ w				302-101
R147	1.5 k	½ w				302-152
R149	8.2 k	½ w				302-822
R160A	666.6 k	½ w		Prec.	1%	309-007
R160B	666.6 k	½ w		Prec.	1%	309-007
R160C	2 meg	½ w		Prec.	1%	309-023
R160D	6.67	½ w		Prec.	1%	309-351
R160F	6.67	½ w		Prec.	1%	309-351
R160H	20 meg	2 w		Prec.	1%	310-583
R160W	47 k	½ w				302-473
R160X	10 k	½ w				302-103
R160Y†	20 k		Var.		VARIABLE	311-166
R161	100 Ω	½ w				302-101
R165	68 k	½ w				302-683
R166	68 k	½ w				302-683
R167	1 meg	½ w				302-105

† Concentric with SW341. Furnished as a unit.

Resistors *(continued)*

						Tektronix Part Number
R168	47 k	½ w				302-473
R174	27 k	1 w			5%	303-273
R176	5 k		Var.		SWP. LENGTH	311-195
R178	11 k	½ w			5%	Use 301-113
R181	4.7 meg	½ w				302-475
R320	1.8 meg	½ w		Prec.	1%	309-020
R321	1.11 meg	½ w		Prec.	1%	309-015
R323	2 x 50 k		Var.		POSITION	311-111
R326	240 k	½ w			±5%	301-244
R330	100 Ω	½ w				302-101
R332	18 k	1 w				304-183
R333	10 k	½ w			±5%	301-103
R334	10 k		Var.		CALIBRATION	311-191
R336	100 Ω	½ w				302-101
R338	39 k	½ w				302-393
R341	50 k	.2 w	Var.		SWP. GAIN	311-125
R342	82 k	½ w		Prec.	1%	309-043
R344	180 k	½ w		Prec.	1%	309-279
R345	47 k	½ w				302-473
R346	50 k	.2 w	Var.		SWP/MAG REGIS.	311-125
R348	400 k	½ w		Prec.	1%	309-126
R350	100 Ω	½ w				302-101
R352	39 k	½ w				302-393
R355	1.5 meg	½ w			±5%	301-155
R356	43 k	½ w			±5%	301-433
R357	100 Ω	½ w				302-101
R359	39 k	½ w				302-393
R360	1 meg	½ w				302-105
R361	470 k	½ w				302-474
R370	100 Ω	½ w				302-100
R371	100 Ω	½ w				302-100
R373	30 k	8 w		WW	±5%	308-105
R375	12 k	2 w			±5%	305-123
R377	35 k	8 w		WW	±5%	308-191
R390	150 Ω	½ w			±5%	301-151
R391	150 Ω	½ w			±5%	302-151
R397	47 Ω	½ w				302-470

Switches

SW5	Slide/DPTT	SOURCE		260-251
SW10	Slide/SPTT	COUPLING		260-316
SW17	Rotary	AUTO	*262-372	260-353
SW20	Slide/DPDT	SLOPE		260-212
SW160	Rotary	TIME/DIV.	*262-371	260-352
SW341†		5X MAG		311-166

Vacuum Tubes

V24	6DJ8	154-187
V45	6DJ8	154-187
V135	6DJ8	154-187
V145	*6BL8	154-278
V152	6BC7	154-232

†Concentric with R160Y. Furnished as a unit.

Vacuum Tubes *(continued)*

		Tektronix Part Number
V161	6BL8 *	154-278
V333	6DJ8	154-187
V353	6DJ8	154-187
V374	6DJ8	154-187

* ECF80 may be substituted.

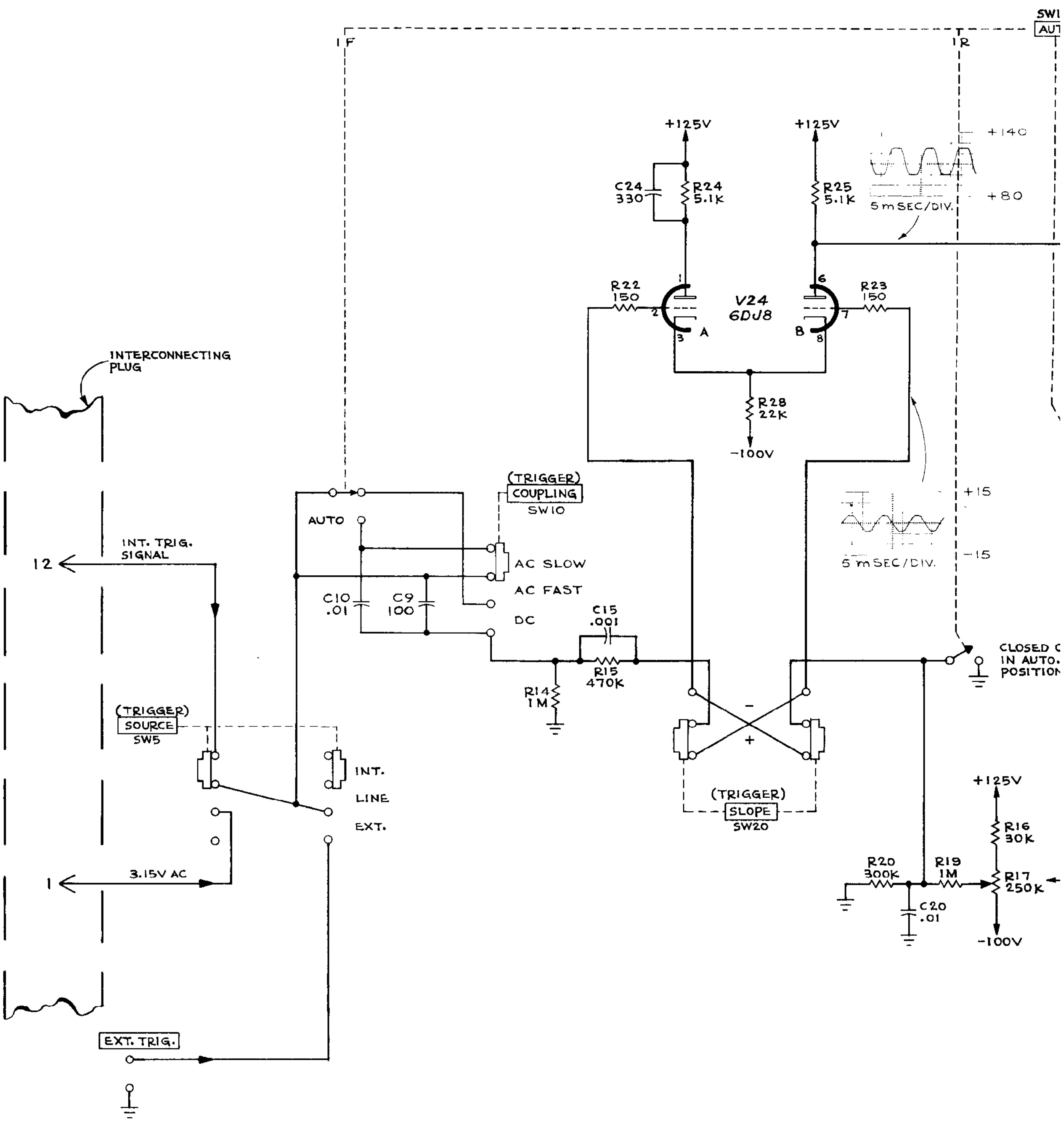
Type 67
Mechanical Parts List

	Tektronix Part Number
BRACKET, SWITCH	406-613
BUSHING, 3/8-32 x 9/16 x .412	358-010
BUSHING, FOR 5-WAY BINDING POST	358-036
CABLE, HARNESS	179-460
CABLE, HARNESS ATTENUATOR SWITCH	179-508
CAP, POT 1" DIA. x .390 HI	200-247
CHASSIS	441-332
CLAMP, #20 WIRE FOR NEON BULBS	343-043
CONNECTOR, CHAS. MT. 24 CONT. MALE	131-149
COUPLING, 1 DG. W/2 TAPPED HOLES 1/2 DIA.	376-007
COUPLING, POT. WIRE STEEL	376-014
FASTENER, PAWL RIGHT W/STOP	214-052
FASTENER, SNAP DOUBLE PRONGED	214-153
GROMMET, RUBBER 1/4	348-002
GROMMET, RUBBER 5/16	348-003
GROMMET, RUBBER 1/2	348-005
GROMMET, POLYPROPYLENE SNAP-IN	348-031
GUIDE, DELRIN 5/8 x 13/16 W/3/16 TRACK	351-037
HOLDER, NEON BULB SINGLE	352-008
LOCKWASHER, INT. #4	210-004
LOCKWASHER, INT. #6	210-006
LOCKWASHER, INT. #10	210-010
LOCKWASHER, POT INT. 3/8 x 1/2	210-012
LOCKWASHER, POT INT. 3/8 x 11/16	210-013
LUG, SOLDER SE6 W/2 WIRE HOLES	210-202
LUG, SOLDER SE10 LONG	210-206
LUG, SOLDER 1/4 HOLE LOCK ROUND PERIMETER	210-223
KNOB, SMALL RED, 1/8 HOLE PART WAY	366-038
KNOB, SMALL BLACK, 1/4 HOLE PART WAY	366-044
KNOB, LARGE BLACK, 17/64 HOLE THRU	366-058
KNOB, PLUG-IN SECURING 9/16 x 5/8	366-109
NUT, HEX 4-40 x 3/16	210-406
NUT, HEX 6-32 x 1/4	210-407
NUT, HEX 3/8-32 x 1/2	210-413

Mechanical Parts List *(continued)*

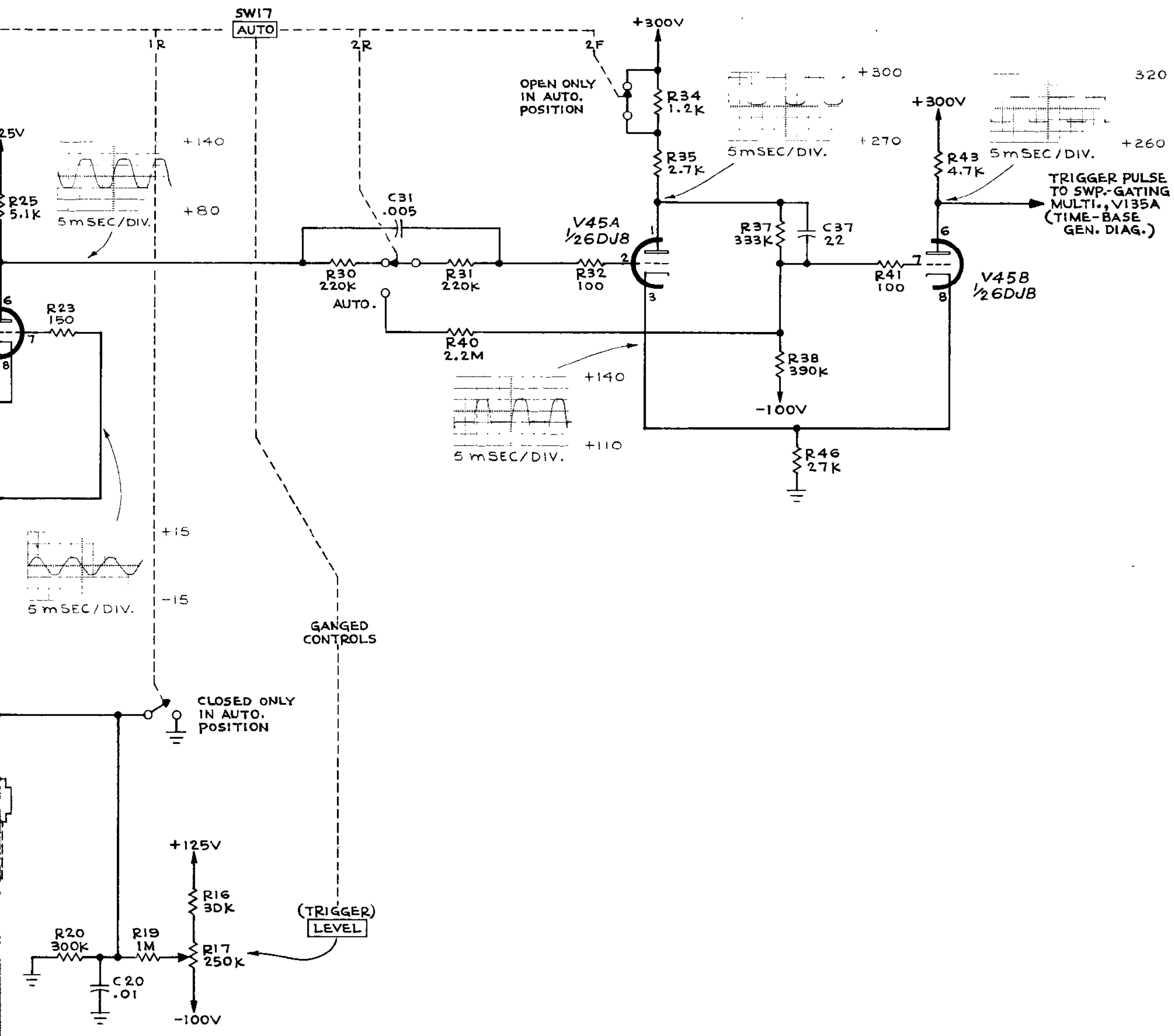
	Tektronix Part Number
NUT, HEX 10-32 x 3/8 x 1/8	210-445
NUT, HEX 5-40 x 1/4	210-449
NUT, HEX 1/4-28 x 3/8 x 3/32	210-455
NUT, HEX 3/8-32 x 1/2 x 11/16	210-494
PANEL, FRONT	333-623
PLATE, FRONT	387-580
PLATE, REAR	387-581
POST, BINDING 5-WAY STEM AND CAP ASS'Y (FLUTED)	129-036
POST, BINDING ASS'Y OF 355-507 & 200-182	129-051
ROD, 1/4 x 6 5/8	384-215
ROD, EXT. .125 OD x 3/4 x .081 x 8 1/4 LG.	384-226
ROD, FRAME 3/8 x 12 1/4 TAPPED 8-32 BOTH ENDS	384-566
ROD, DELRIN 5/16 x 5/8 MTG. HOLE 3/8 ONE END W/#44 CROSS HOLE	385-134
ROD, DELRIN 5/16 x 2 1/4 MTG. HOLE 3/8 ONE END W/3 #44 CROSS HOLES	385-137
SCREW, 4-40 x 1/4 BHS	211-008
SCREW, 4-40 x 3/8 RHS	211-013
SCREW, 4-40 x 1 FHS	211-031
SCREW, 6-32 x 1/4 BHS	211-504
SCREW, 6-32 x 5/16 BHS	211-507
SCREW, 8-32 x 1/2 FHS 100°, PHILLIPS	212-043
SCREW, 8-32 x 1/2 RHS	212-044
SCREW, THREAD CUTTING 6-32 x 3/8 TRUSS HS PHILLIPS	213-041
SCREW, THREAD CUTTING 5-32 x 3/16 PHS PHILLIPS	213-044
SCREW, SET 4-40 x 1/8 HSS ALLEN HEAD	213-048
SOCKET, STM9G	136-015
SPACER, NYLON MLD. 5/32 FOR CERAMIC STRIP	361-007
STRIP, CERAMIC 3/4 x 4 NOTCHES, CLIP MTD.	124-088
STRIP, CERAMIC 3/4 x 11 NOTCHES, CLIP MTD.	124-091
WASHER, STEEL, 6L x 3/8	210-803
WASHER, STEEL, .390 x 9/16	210-840

TRIGGER
INPUT AMPLIFIER



TYPE 67 PLUG-IN UNIT

A1



WAVEFORMS TAKEN WITH CONTROLS SET AS FOLLOWS:

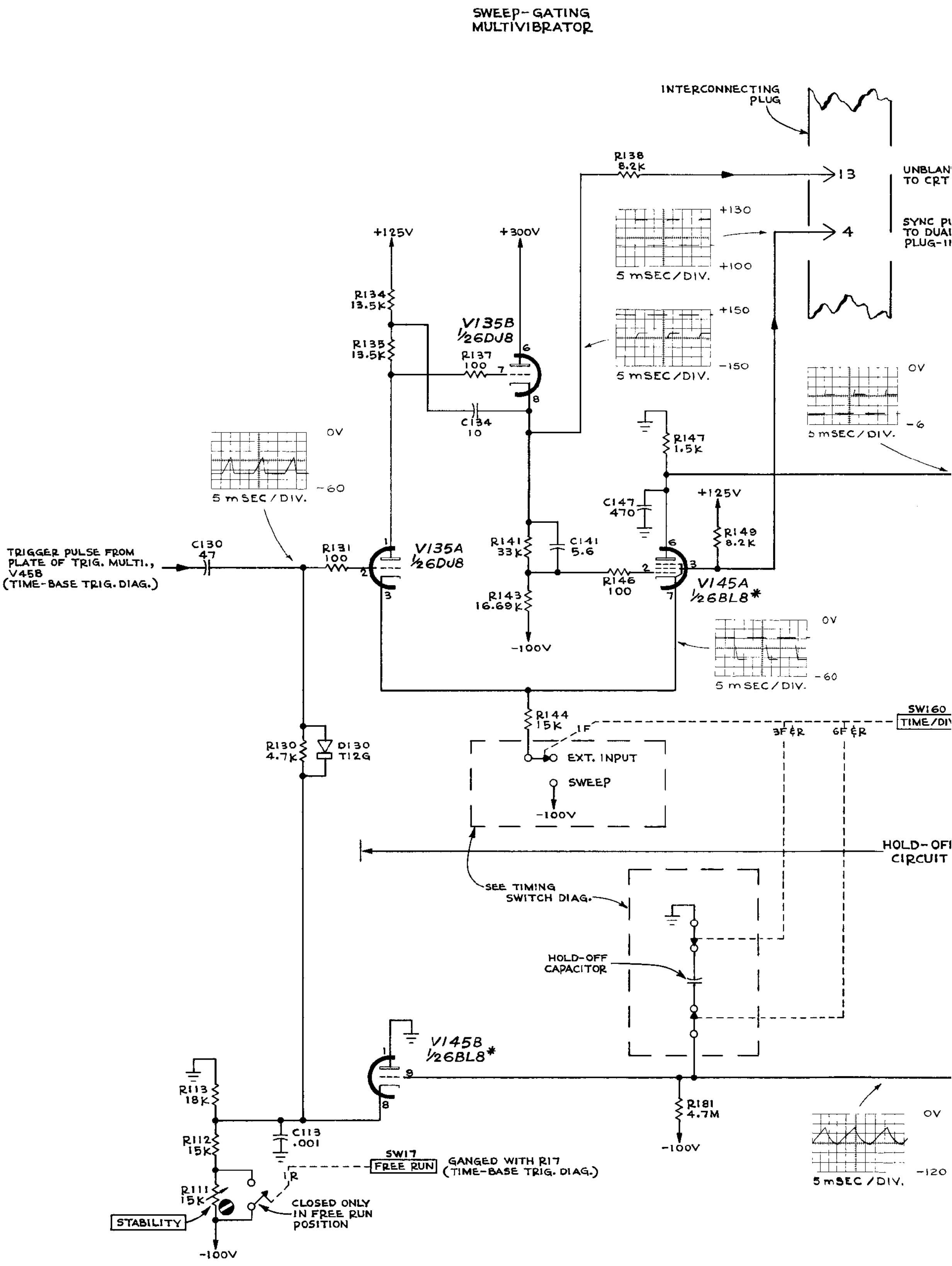
- LEVEL · · · · · · · · · · MIDRANGE
- SLOPE · · · · · · · · · · +
- COUPLING · · · · · · · · AC SLOW
- SOURCE · · · · · · · · · LINE

TYPE 67 A TIME-BASE TRIG

12-08-60
TR

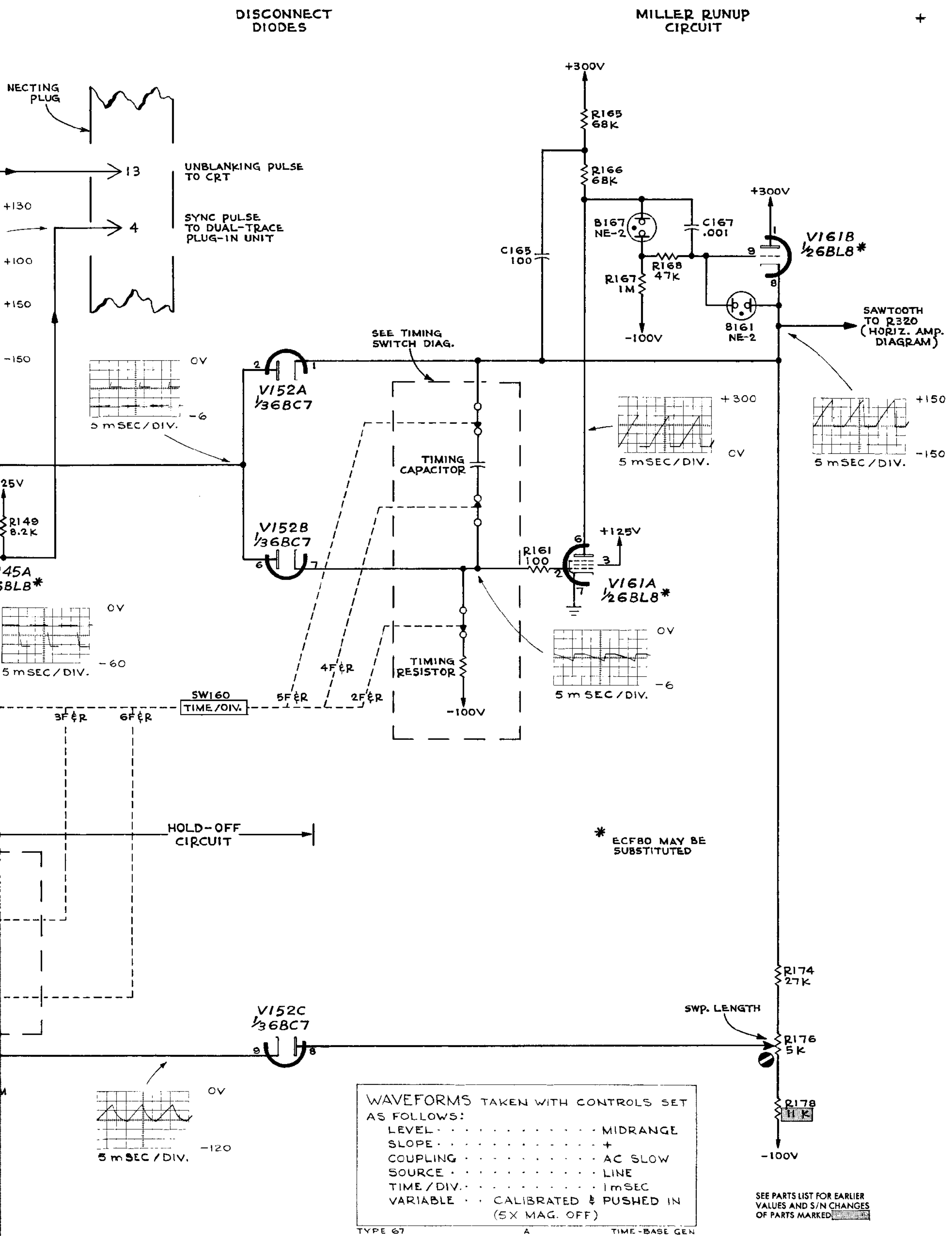
A₁

TIME-BASE TRIGGER



TYPE 67 PLUG-IN UNIT

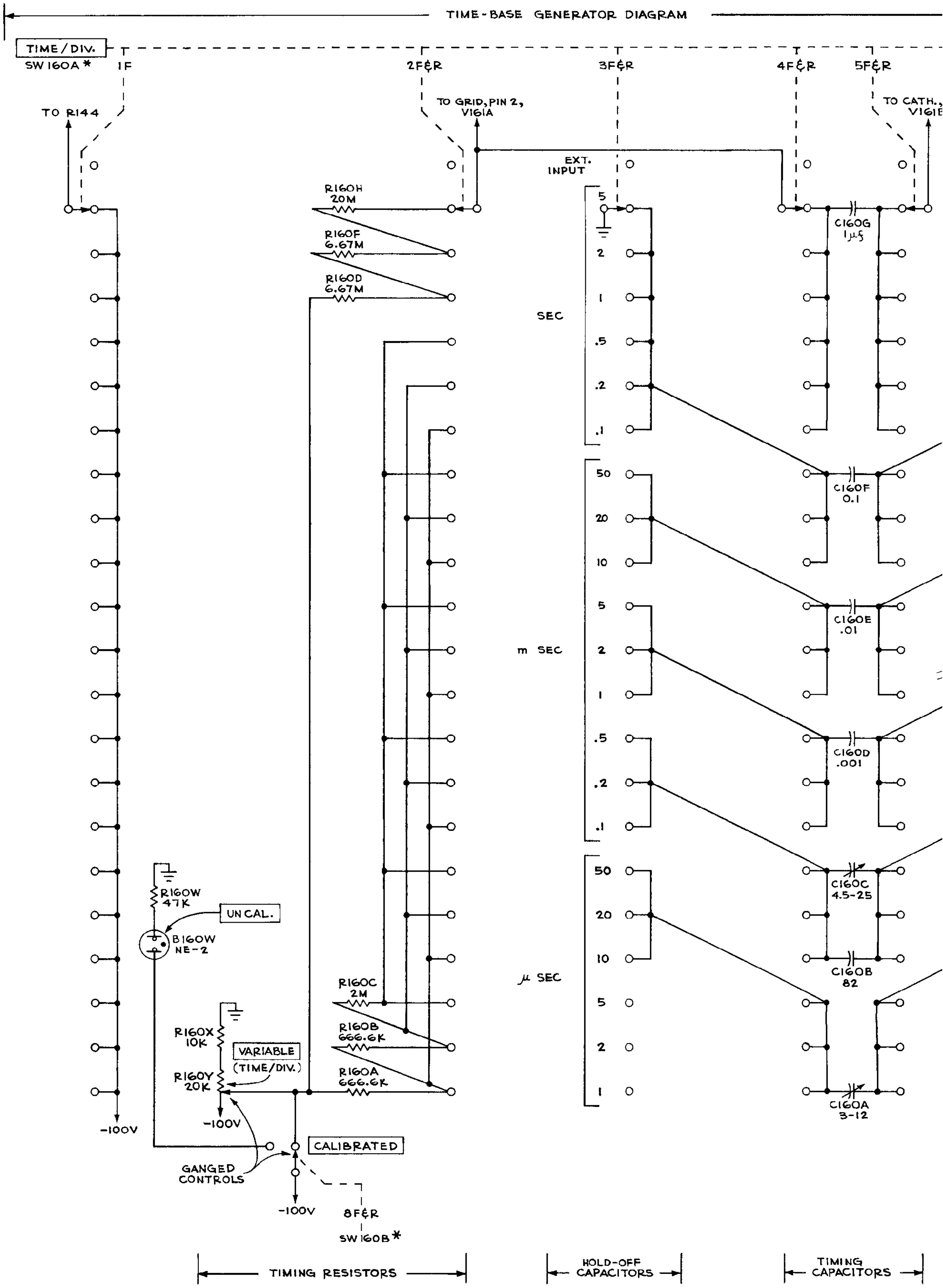
B



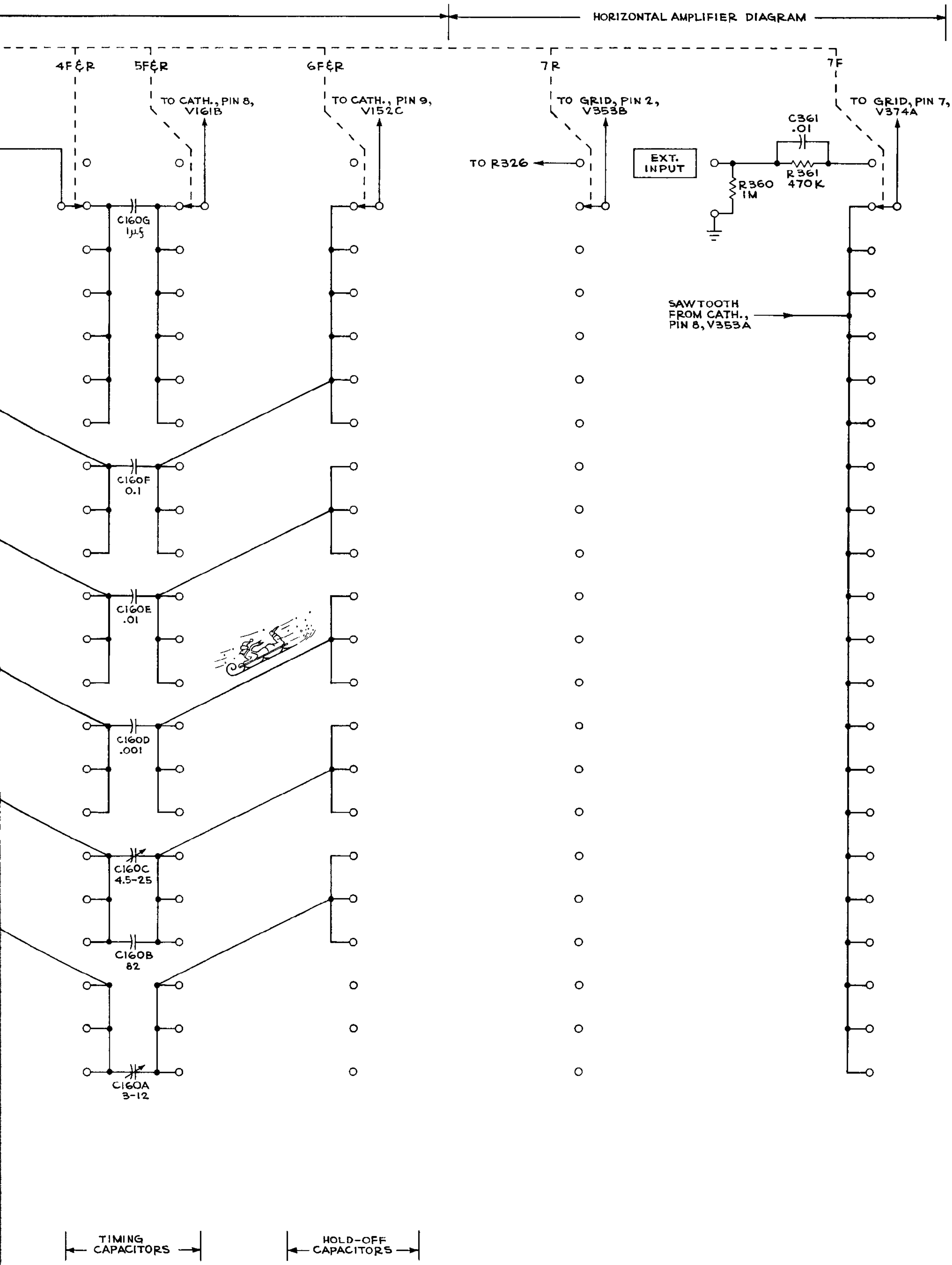
7-19-61
TP

B

TIME-BASE GENERATOR



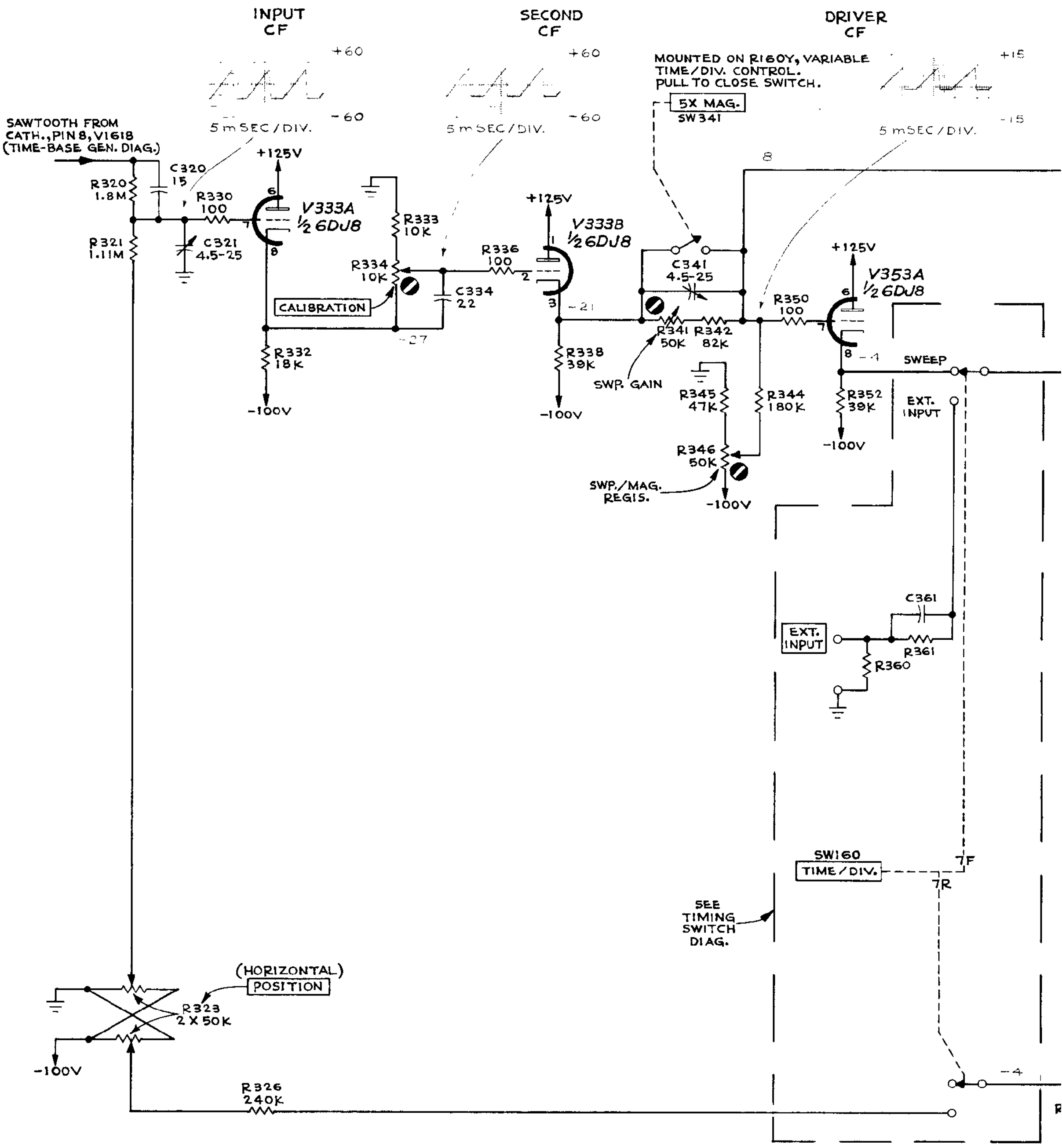
TYPE 67 PLUG-IN UNIT



GAB
4 - 7 - 61

A1

TIMING SWITCH



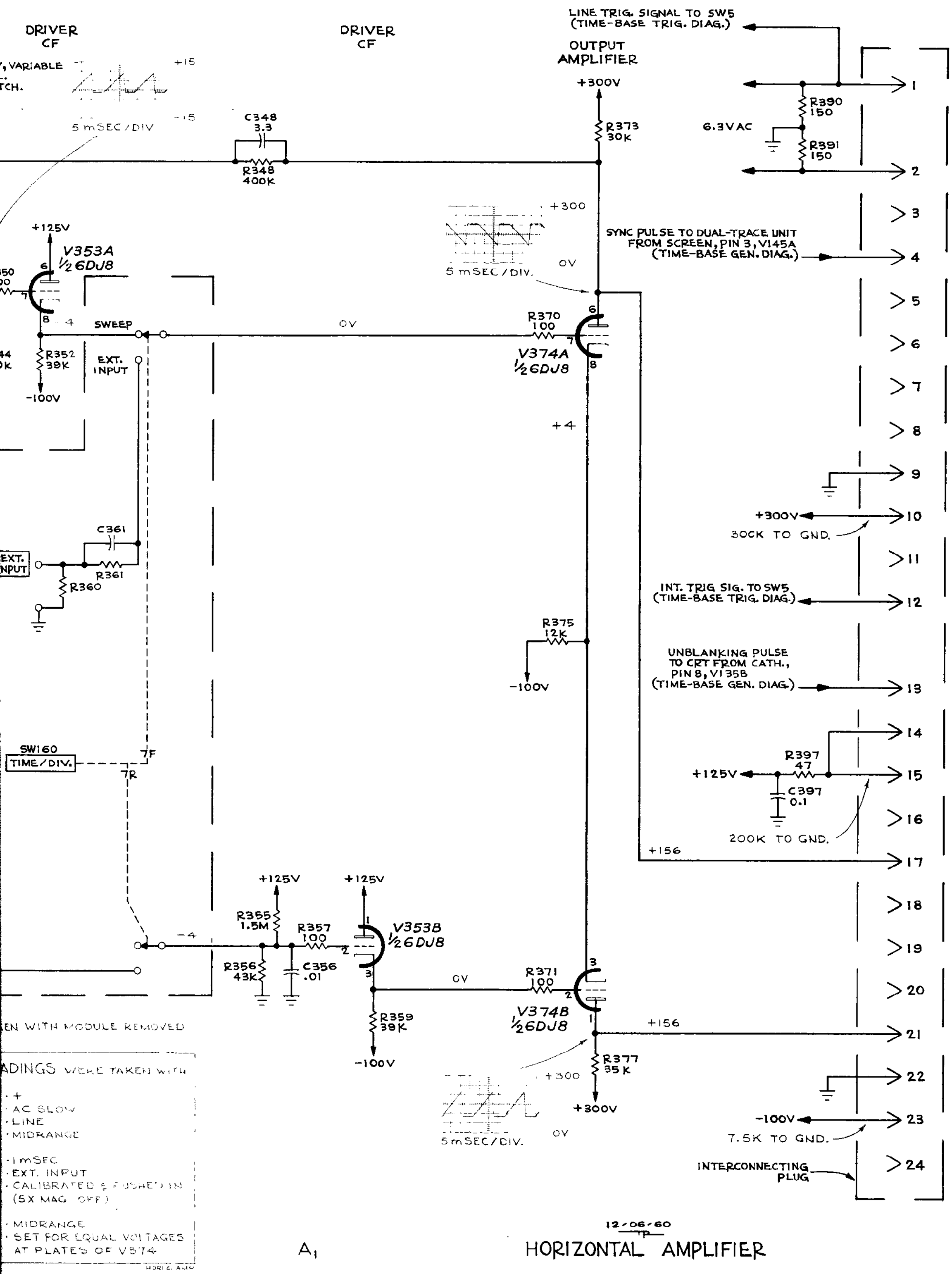
RESISTANCE READINGS TAKEN WITH MODULE REMOVED FROM OSCILLOSCOPE

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.

TYPE 67 PLUG-IN UNIT

TYPE 67 HORIZ AMP



12-06-60

A1

HORIZONTAL AMPLIFIER