PRELIMINARY

INSTRUCTION MANUAL

TYPE 565
DUAL-BEAM OSCILLOSCOPE

TEKTRONIX ®

This is a preliminary instruction manual. It is not complete, and it may contain minor errors. We will send you the permanent instruction manual just as soon as it is ready. Be sure to complete and send in the attached card so that we can send the manual directly to the user of the instrument.

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SECTION 1

CHARACTERISTICS

The Type 565 is a dual-beam oscilloscope; essentially two oscilloscopes in one cabinet. Two internal horizontal and two plug-in vertical deflection systems permit independent operation of the two cathode-ray tube beams. Either of the two time-base generators can control the sweep of either or both of the beams.

Both vertical deflection systems utilize Tektronix Series 2 and some Series 3 plug-in units. The choice of plug-in units depends on the application; they need not be the same type.

Special circuits in the Type 565 Oscilloscope permit an accurate, continuously variable delay in the presentation of a sweep from 1 microsecond to 50 seconds after receipt of a triggering impulse. This feature permits observation of a small portion of the normal sweep, accurate measurement of signal jitter, precise time measurement, and many other uses.

Vertical Deflection System

The characteristics of both vertical channels are those of the plug-in units used. The cathode-ray tube vertical deflection plate capacities are equalized at 16 picofarads to assure accuracy in the plug-in unit measurements.

Horizontal Deflection System

Sweep Rates -- Time Base 'A' and Time Base 'B'

1 microsecond to 5 seconds per division in 21 accurately calibrated steps. An uncalibrated control permits sweep rates to be varied continuously between 1 microsecond and about 12 seconds per division. Calibrated sweep rates are accurate within 3%.

10X Magnifier -- (Upper and Lower Beam)

Provides a horizontal magnification of 10 at the center 1-centimeter portion of the crt display. Extends the fastest sweep rate for either beam to 0.1 microsecond per division. Magnified sweep rates are accurate within 5%.

Trigger Signal Sources -- Time Base 'A' and Time Base 'B'

Upper or Lower Beam vertical signal, external signals, or power line signal.

Triggering Modes -- Time Base 'A' and Time Base 'B'

AC, AC Fast, DC, and Automatic.

Triggering Signal Requirements

Internal -- Depends upon the plug-in unit. Typically, signals to 1 megacycle which produce 0.3 major division vertical deflection will provide stable triggering. For frequencies above 1 megacycle, increased signal amplitude is required.

External -- A signal of less than 1 volt to at least 15 volts, peak, to 1 megacycle. For frequencies above 1 megacycle, increased minimum signal voltage is required. Sweeps will trigger on greater signals, but the LEVEL control operates over a ±15-volt range, minimum.

Delayed Sweep

Sweep delay continuously variable from less than 0.5 microsecond to at least 120 seconds, uncalibrated. Calibrated delay continuously variable between 1 microsecond and 50 seconds. Calibrated delay within 3% of indicated delay and incremental delay accuracy within 0.5% at all Time Base 'A' sweep rates and DELAY INTERVAL dial settings between 1.00 and 10.00. With Time Base 'A' sweep rates of 10 microseconds per division and slower, same accuracy is obtained with DELAY INTERVAL dial settings between 0.50 and 10.00. Delay jitter is less than one part in 20,000.

External Horizontal Inputs -- Upper and Lower Beams

Deflection Factor -- About 0.1 volt to about 10 volts per division, continuously variable.

Frequency Response -- Dc to at least 350 kc (- 3 db) at maximum sensitivity.

Input Resistance -- About 100 kilohms.

Cathode Ray Tube

Type -- T565P(x), aluminized.

Phosphor -- (x) -- Type P2 normally supplied; P31 is recommended for fast sweep rate, low duty cycle applications. P1, P7, and P11 phosphors optional.

Internal Unblanking

Dc coupled to blanking deflection plates.

Intensity Modulation -- Upper and Lower Beam

Ac coupled to crt control grids through rear panel input jacks.

Dual-Trace Chopped Blanking

Provides trace blanking during chopped mode switching time of multitrace vertical plug-in units.

Accelerating Potential

About 4,100 volts.

Useable Viewing Area

10 by 10 centimeters. 10-centimeter total vertical deflection consists of 8 centimeters for each beam with 6 centimeters common to both beams.

Graticule Markings

Marked in 10 vertical and 10 horizontal 1-centimeter divisions. 2-millimeter markings on the vertical centerline and on the horizontal centerlines of both the Upper and Lower Beam; 4 centimeters from top and bottom.

Graticule Illumination

Variable edge lighting.

Amplitude Calibrator

Output Signal

Square waves at about 1,000 cycles.

Output Voltage

1 millivolt to 100 volts in decade steps.

Accuracy

Peak-to-peak amplitude within 3% of indicated voltage.

Other Characteristics

Output Signals Available

Maximum current drain from the following rear-panel output connectors must not exceed 2 milliamps:

DEL'D TRIG. OUT

At least 8 volts in amplitude, occurring at the end of the delay interval ('A' TIME/DIV. multiplied by DELAY INTERVAL dial setting).

'A' + GATE OUT

An approximate 20-volt peak-to-peak pulse with same duration as 'A' sweep.

'B' + GATE OUT

An approximate 20-volt peak-to-peak pulse with same duration as 'B' sweep.

UPPER and LOWER HORIZ. SIG. OUT

An approximate 5-volt, sawtooth, dc-coupled, when the horizontal deflection is produced by either time-base generator.

A dc-coupled signal of at least 0.05 volt per major division of horizontal deflection when the deflection is produced by an external signal.

UPPER and LOWER VERT. SIG. OUT.

Dc coupled*. Depends on plug-in unit in respect to signal amplitude, dc level, and frequency response.

Signal amplitude is typically 2 to 4 volts per major division of displayed signal.

Dc signal level is within about ±20 volts when beam is positioned within vertical limits of graticule.

CAMERA POWER (on front panel)

Front-panel connector providing 6.3 volts ac from power transformer, fused at 1 amp.

Power Supplies

Electronically regulated for stable operation with as much as -10% to +7% variation from design-center line voltage.

Line Voltage Requirements

Usually 117 volts rms design-center. Changes can be made in the internal wiring to permit operation from design-center line voltages of 110, 125, 220, 234, or 248 volts.

Line Frequency

50 to 60 cycles.

*Except when using a Type 2A50 Plug-In Unit.

Power Consumption

Maximum of about 630 watts.

Ventilation

Forced filtered air. Thermal relay interrupts instrument power in the event of overheating.

Construction

Aluminum-alloy chassis and photo-etched, anodized front panel. Standard model has a four-piece, blue vinyl finished cabinet. Rack mount model has six removable access panels.

Dimensions

	Standard	Rack Mount
Width	17 inches	19 inches
Height	13 1/2 inches	12 1/4 inches
Depth	23 3/8 inches	22 inches
Weight	62 pounds	67 pounds

SECTION 2

OPERATING INSTRUCTIONS

Introduction

The Type 565 Oscilloscope is an extremely versatile instrument. To make full use of the instrument, it is necessary for you to understand the operation of each control. This portion of the manual is intended to provide you with this basic information. If you are familiar with other Tektronix Oscilloscopes, you should have very little difficulty in understanding the operation of the Type 565. The function of many controls on the Type 565 is the same as the function of corresponding controls on other Tektronix instruments.

Function of Controls and Switches

Upper Beam

These controls are located on the left half of the front panel.

UPPER HORIZ. DISPLAY	Provides selection between 'A' TIME BASE, 'B' TIME BASE, and EXT. signal sources for horizontal deflection of the Upper Beam.
EXT. HORIZ GAIN	Functions only when the UPPER HORIZ. DISPLAY switch is in the EXT. position. Permits variation of the external

	horizontal input deflection sensitivity between approximately 0.1 and 10 volts per division.
POSITION	Used to move the display horizontally. This is a combination course and vernier control. About 55° vernier adjustment is available at any position of the control.
10X MAG.	Expands a one-centimeter segment of the display to ten times normal width. The segment of the normal display positioned to the center of the crt will be displayed. When the 10X MAG. is used, the sweep rate is ten times faster than that indicated by the TIME/DIV. switch.
FOCUS	Adjusted in conjunction with the ASTIG. control to obtain sharpest possible trace definition.
ASTIG.	(see FOCUS)
INTENSITY	Allows variation of trace brightness.

Lower Beam

These controls are located on the right half of the front panel and are identical to those provided for the Upper Beam.

Time Base 'A'

TRIGGER

UPPER BEAM - LOWER BEAM	Functions only when the EXT.-INT.-LINE switch is in the INT. position. Selects between the Upper Beam and Lower Beam vertical channel signals as the source of triggering signal.
EXT.-INT.-LINE	Provides a selection of triggering signal sources; external (EXT.) from TRIG. IN connector, internal (INT.) from either Upper or Lower Beam vertical channel, or a sample of the power line waveform (LINE).
COUPLING (AC-AC FAST-DC)	Allows acceptance or rejection of some characteristics of triggering signals. AC rejects dc and very low frequency ac signals. AC FAST rejects signals below about 1 kc. DC accepts all frequencies and dc.

SLOPE (+ -)	Determines whether the sweep will trigger on the positive going or negative going portion of a signal.
LEVEL (AUTO. - FREE RUN)	A three function control. Except at the extreme clockwise and counterclockwise positions, it operates as a triggering LEVEL control. LEVEL selects the amplitude point on the triggering signal at which the sweep will trigger. AUTO. (automatic) overrides the function of the COUPLING switch and LEVEL control and selects AC coupling and 'O' level. In the absence of a triggering signal, a reference trace is displayed on the crt. FREE RUN permits the sweep to free run at all times.
STABILITY	A screwdriver adjustment which makes the time-base generator susceptible to pulses from the trigger circuits.
TIME/DIV.	Selects the rate at which the beam moves across the crt.

VARIABLE — An uncalibrated control which provides sweep rates other than those included on the TIME/DIV. switch. Rates to less than 0.4 that indicated by the TIME/DIV. switch can be obtained.

Delay Interval

'A' TIME/DIV. MULT. (1-10) — Used with 'A' TIME/DIV. to determine the delay interval between the start of 'A' sweep and the delayed trigger pulse. This pulse is fed to a rear-panel output connector and to the 'B' MODE switch. With the proper setting of the 'B' MODE switch, this pulse can either (a) start 'B' sweep (STARTS AFTER DELAY INTERVAL) or (b) make 'B' sweep susceptible to trigger pulses (TRIGGERABLE AFTER DELAY INTERVAL).

Time-Base 'B'

Controls identical to those for Time-Base 'A' are provided, plus the following controls:

'B' MODE — Selects the type of operation that Time Base 'B' will perform. In the NORMAL TRIGGER position, the operation is identical to that of Time Base 'A'. TRIGGERABLE AFTER DELAY INTERVAL and STARTS AFTER DELAY INTERVAL are explained previously under "Delay Interval". MANUAL TRIGGER and SINGLE SWEEP function as follows:

MANUAL TRIGGER — Overrides all Time Base 'B' trigger controls. The beam will sweep across the crt once each time the MANUAL TRIGGER button is pushed.

SINGLE SWEEP — Permits Time Base 'B' to move the beam across the crt once each time the SINGLE SWEEP button is pushed. Pushing the button does not start the sweep; it permits the trigger circuit to do so.

Amplitude Calibrator

PEAK-TO-PEAK VOLTS — Selects output voltage from the available decade steps, .001 volt to 100 volts. It also permits turning off the Amplitude Calibrator.

Other Controls

TRACE ALIGNMENT	Used to rotate the deflection planes of the crt to coincide with the graticule markings.
SCALE ILLUM.	Adjusts the brightness of the graticule markings.
POWER	Ac line switch.

First Time Operation

The following information is intended to help you prepare your Type 565 Oscilloscope for first-time use. It is also suggested that a quick-check, similar to these nine steps, be performed each day before beginning measurements. Whenever plug-in units are exchanged, steps 7 and 8 must be checked.

1. Install plug-in units.
2. Set front-panel controls as follows:

	Upper Beam	Lower Beam
INTENSITY	counterclockwise	counterclockwise
POSITION (horiz.)	centered	centered
10X MAG.	off (pushed in)	off (pushed in)
HORIZ. DISPLAY	'A' TIME BASE	'B' TIME BASE
Plug-In Units		
VOLTS/DIV.	.05	.05

	Upper Beam	Lower Beam
VARIABLE	CALIBRATED	CALIBRATED
AC-DC-GND.	AC	AC
POSITION (vert.)	centered	centered
	Time Base 'A'	Time Base 'B'
TIME/DIV.	.2 mSEC	.2 mSEC
VARIABLE	CALIBRATED	CALIBRATED
LINE-INT.-EXT.	LINE	LINE
LEVEL	AUTO.	AUTO.
STABILITY (screw-driver adjustment)	clockwise	clockwise
'B' MODE	NORMAL TRIGGER	
AMPLITUDE CALIBRATOR	.1	

Controls not mentioned may be left in any position.

3. Connect the power cord to the proper voltage source and turn on instrument power.

4. Allow several minutes for the instrument to warm-up. Then, slowly advance the INTENSITY controls to obtain traces of moderate brightness. It may be necessary to readjust the vertical POSITION controls.

5. Slowly turn the Time Base 'A' STABILITY control counter-clockwise. The Upper Beam trace should dim and then disappear. Set the STABILITY control in the middle of the "dim" range. Adjust the Time Base 'B' STABILITY control in the same manner.

6. Connect the CAL. OUT signal to the INPUT connector of both vertical plug-in units. Set the LINE-INT.-EXT. switch in both time-base blocks to INT. Adjust the INTENSITY controls so the vertical lines in the square wave display are just visible.

7. Adjust the FOCUS controls so the vertical lines near the center of the square wave display are as narrow and sharply defined as possible. Adjust the ASTIG. controls to reduce the width of the horizontal lines near the center of the display by slightly less than one-half. Then, readjust the FOCUS controls as previously described. Repeat the process, if necessary, so that both the vertical and horizontal lines in the display are very narrow and sharply defined.

NOTE

> The FOCUS and ASTIG. controls may require slight adjustment whenever the INTENSITY control setting is changed. The method of adjustment described in step 7 should provide satisfactory results regardless of the type of signal being displayed.

8. Set the gain adjustment on the plug-in units so that each of the square wave displays is exactly 2 major divisions in amplitude. If you require additional information about this adjustment, see the manual for your particular plug-in unit.

9. Remove the signal input leads. Turn both trigger LEVEL controls fully clockwise. The traces should be parallel to the horizontal graticule lines. If not, adjust the TRACE ALIGNMENT control to remove any tilt. (The TRACE ALIGNMENT control is a screwdriver adjustment located on the front panel, just below the crt.)

When the preceding steps have been completed, the Type 565 Oscilloscope is ready for use.

NOTE

It is important that steps 7 and 8 be rechecked each time plug-in units are exchanged in the Type 565.

Using the Type 565

Signal Input Connections

Signals to be displayed on the oscilloscope are connected to the input connectors of the vertical plug-in units. The signals are then changed to the proper amplitude and used to produce vertical deflection of the electron beams. Frequently it is possible to make the input connections with unshielded test leads. This is particularly true when you are observing a high-level, low-frequency signal from a low impedance source. When test leads are used, place a ground connection between the oscilloscope chassis and the chassis of the signal source.

In many applications, however, unshielded leads are unsatisfactory for making input connections due to the pickup resulting from stray magnetic fields. In such cases, shielded cables should be used. Care must be taken that the ground conductors of the cables are connected to the chassis of both the oscilloscope and the signal source.

In high-frequency applications, it is usually necessary to terminate the signal source and connecting cable in their characteristic impedance. Unterminated connections may result in reflections in the cables and cause distortion of the displayed waveforms.

In general, a termination resistor connected at the input connector of the plug-in unit will produce satisfactory results. In some cases, however, it may be necessary to terminate cables at both ends. The need for proper terminations increases as the length of the connecting cables is increased.

In analyzing the displayed waveforms, you must consider the loading effect of the oscilloscope on the signal source. The input resistance of the vertical plug-in unit is usually adequate to limit low-frequency loading to a negligible value. At high frequencies, however, the input capacitance of the plug-in unit and the distributed capacitance of input cables becomes important. Capacitive loading at high frequencies may be sufficient to adversely affect both the displayed waveform and operation of the signal source. Both capacitive and resistive loading can usually be limited to negligible values through use of attenuator probes.

Use of Probes

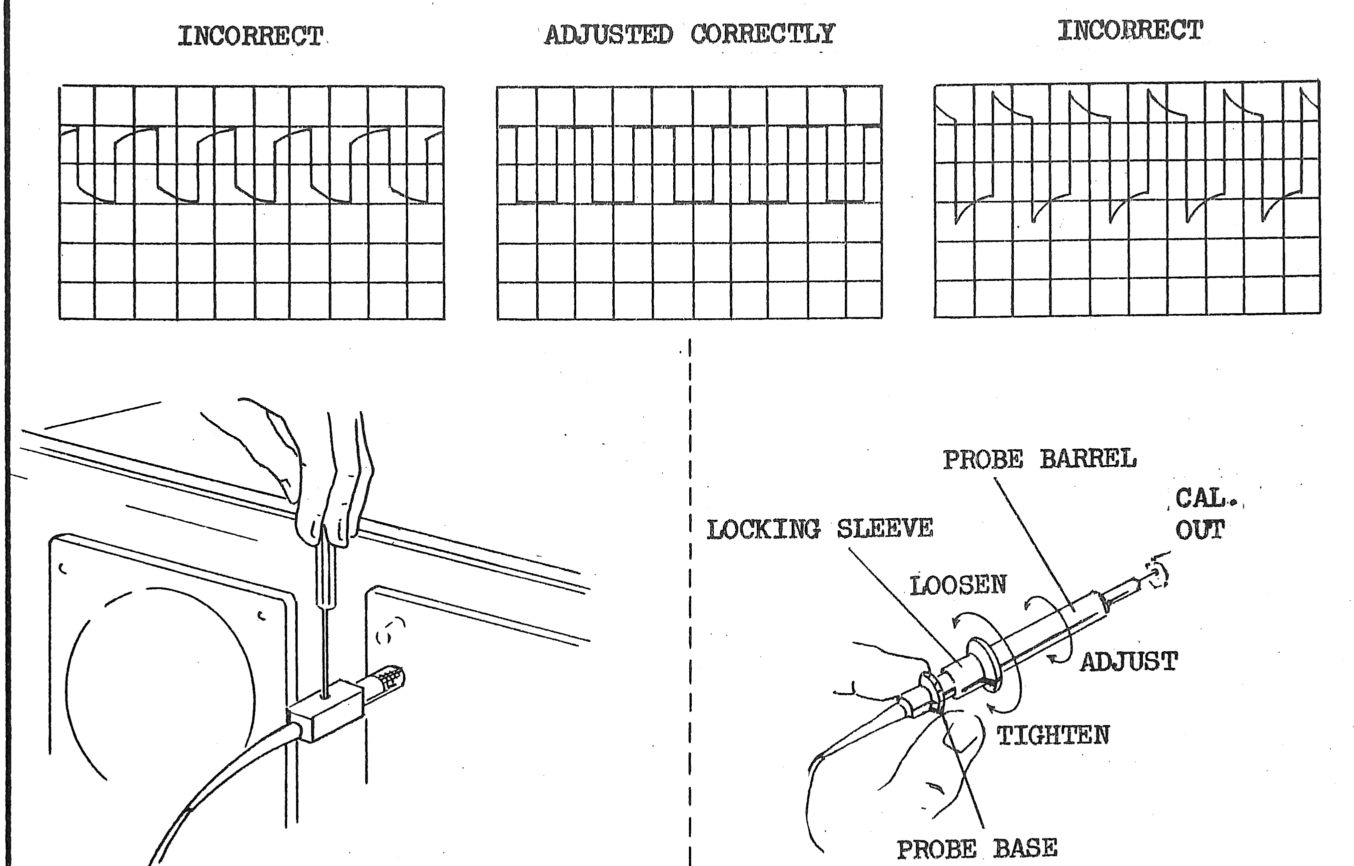
Occasionally, connecting the input of an oscilloscope to a signal source will load the source sufficiently to adversely affect both the operation of the source and the signal display on the oscilloscope. In many cases, an attenuator probe may be used to decrease both the capacitive and resistive loading, caused by the oscilloscope, to a negligible value.

In addition to providing isolation of the oscilloscope from the signal source, an attenuator probe also decreases the amplitude of the displayed waveform by the attenuation factor of the probe. Use of a probe allows you to increase the vertical-deflection factors of the oscilloscope to observe large-amplitude signals which are beyond the normal limits of the oscilloscope and plug-in combination. Signal amplitudes, however, must be limited to the maximum allowable value for the probe used.

Before using a probe you must check (and adjust if necessary) the compensation of the probe to prevent distortion of the observed waveform. Connect the probe tip to the CAL. OUT connector, and obtain a display of about 2 major divisions. Adjust the probe compensation as shown in Fig. 2-1.

Horizontal Sweeps

Horizontal sweeps for the Type 565 Oscilloscope are usually produced by the two time-base generators. Either beam can be deflected by either time base. Or, if desired, both beams may be swept simultaneously by the same time base. The selection of time base is made with the UPPER and LOWER BEAM HORIZ. DISPLAY switches.



P6017 Probe - Use small screwdriver to adjust capacitor for flat-top square waves.

P6000 Probe - Hold probe barrel and loosen locking sleeve several turns. Hold probe base while adjusting probe barrel for flat-top square waves. Hold probe barrel and carefully tighten locking sleeve.

Fig. 2-1. Probe compensation.

The sweep rates of the two beams are determined by the settings of the appropriate TIME/DIV. switch. The sweep characteristics of the two time bases are identical. Each time base provides 21 calibrated sweep rates ranging from 1 microsecond to 5 seconds per division. Uncalibrated VARIABLE TIME/DIV. controls permit sweep rates to be varied continuously between 1 microsecond and approximately 12 seconds per division.

Sweep Magnifiers

Signals displayed with either of the two beams can be expanded horizontally by a factor of 10 using the appropriate 10X MAG. switch. This magnification is obtained when the 10X MAG. switch is pulled outward. The magnifiers increase the actual sweep rates above those indicated by the TIME/DIV. controls. The true sweep time per division is found by multiplying the settings of the TIME/DIV. controls by .1.

The 1-division portion at the exact horizontal center of the crt screen in the unmagnified display is expanded to the full 10-division width of the graticule when the magnifier is turned on. Any other 1-division portion of the original display can then be observed by using the HORIZONTAL POSITION control to position that portion on the screen.

Sweep Triggering

In most cases, it is desirable for a repetitive signal to appear stationary on the oscilloscope screen so that the characteristics of the waveform can be examined in detail. As a necessary condition for this type of display, the start of the sweep must bear a definite, fixed-time relationship to the appearance of the input signal. In the Type 565 Oscilloscope, this is accomplished by using the displayed signal or another related signal to start (trigger) the sweep.

The four TRIGGER slide switches and the LEVEL control provide complete control over the means of triggering the sweep. Triggering controls for Time Base 'A' and Time Base 'B' are identical so that the following information is applicable to both.

Selecting The Triggering Signal Source

The triggering signal for either time base can be obtained from any one of four sources; the Upper Beam vertical amplifier, the Lower Beam vertical amplifier, the power line (via the power transformer), or from an external source.

It is usually convenient to trigger the sweeps internally from either the upper or lower beam signals. This is done by placing the EXT.-INT.-LINE switch to the INT. position and then setting the UPPER BEAM - LOWER BEAM switch to the appropriate position.

If the displayed signal frequency is related to the power line frequency, the LINE source can be used. This source is particularly useful when the displayed signal will not allow stable internal triggering.

External (EXT.) triggering is often used when signal tracing in amplifiers, phase shift networks, and wave-shaping circuits. The signal from a single point in the circuit can be used to trigger the sweep. It is then possible to observe the shaping and amplification of the signal at various points in the circuit without resetting the triggering controls.

Selecting The Triggering Slope

The sweeps can be triggered on either the rising (+ slope) or falling (- slope) portion of the triggering signal. When the display consists of several cycles of the input signal, either setting of the SLOPE switch may be used. However, if you wish to display less than one full cycle of the input signal, the SLOPE switch will permit you to start the sweep on the desired slopes either rising or falling.

Trigger Input Coupling

The trigger COUPLING switch permits you to accept or reject certain properties of triggering signals. Three means of coupling are provided; DC, AC, and AC FAST.

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

AC coupling rejects the dc component of trigger signals and attenuates ac signals below about 20 cycles.

AC FAST coupling rejects the dc component of trigger signals and attenuates ac signals below about 1000 cycles.

In general, the AC position of the COUPLING switch should be used. When the trigger signal is very low frequency, it will be necessary to use DC coupling. If line frequency hum is mixed with the desired high frequency trigger signal, best results may be obtained using AC FAST coupling. AC FAST coupling should be used when triggering internally from multi-trace plug-in units being operated in the alternate mode (unless the "Trigger From Channel One Only" feature of the plug-in is being used).

Use of the LEVEL-AUTO.-FREE RUN Control

The LEVEL-AUTO.-FREE RUN control permits operation of the trigger circuits and the time-base generator in one of three ways:

LEVEL -- This function of the control is in operation except at the clockwise and counterclockwise extremes. The LEVEL control determines the instantaneous voltage level (ac or dc, depending on 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.

AUTO. -- The automatic triggering mode is frequently used for ease of operation. It can be used to observe a large variety of signals without changes in settings of the triggering controls. Automatic triggering is useful for obtaining stable displays of signals in the range from approximately 60 cycles to one megacycle. In this mode, the triggering level and trigger coupling cannot be selected. Each sweep is triggered at the average voltage level of the ac-coupled trigger signal. In the absence of a triggering signal, the sweep continues to run to provide a convenient reference trace on the crt.

FREE RUN -- The FREE RUN mode produces a free-running sweep that is independent of any triggering signal. The repetition rate of the free-running sweep depends on the setting of the TIME/DIV. switch. This mode of operation is useful in applications in which the device under test requires a trigger or input signal. The rear panel + GATE OUT or HORIZ. SIG. OUT signal (from the appropriate time base or beam) may be fed to the device to cause its operation. The resulting signals from the device that are displayed on the crt will be synchronized with the sweep.

Using the 'B' MODE switch

The 'B' MODE switch permits operating Time Base 'B' in any of five different ways:

1. Normal Trigger
2. Single Sweep
3. Manual Trigger
4. Starts After Delay Interval
5. Triggerable After Delay Interval

The following paragraphs describe typical procedures used in operating Time Base 'B' in each mode.

Normal Trigger

When the 'B' MODE switch is in the NORMAL TRIGGER position, the operation of Time Base 'B' is independent of but identical to that of Time Base 'A'.

Single Sweep

Single Sweep is often used when photographing non-repetitive waveforms and in other applications where the signal varies in amplitude, shape, or time interval. A continuous display of such signals would appear as a jumbled mixture of many different waveforms and would yield little or no useful information.

The Type 565 Oscilloscope permits you to obtain a single-sweep presentation and to eliminate all subsequent sweeps so that information is clearly recorded without the confusion resulting from multiple traces.

The single sweep function of Time Base 'B' is selected by placing the 'B' MODE switch in the SINGLE SWEEP position. This renders Time Base 'B' inoperative. The Time Base can then be armed for operation by pressing the RESET button, located to the right of the 'B' MODE switch. At the instant that the Time Base 'B' becomes armed, its trigger circuits assume complete control and can cause the single sweep either to free-run or to be triggered. If there is sufficient delay between arming and triggering, the READY lamp will light to show the status (armed) of the time base. The completion of the single sweep turns off the READY lamp and returns the time base to the inoperative state. The RESET button must again be pressed before another sweep can occur.

Manual Trigger

The Manual Trigger mode operates in a manner similar to Single Sweep. The only difference is that in the Manual Trigger mode, Time Base 'B' is always armed and triggered at the same instant; that is, when the MANUAL TRIGGER button is pressed.

Starts After Delay Interval

There are essentially two ways in which the STARTS AFTER DELAY INTERVAL position of the 'B' MODE switch can be used to increase the versatility of the Type 565 Oscilloscope. It can be used (1) to obtain a magnified display of a selected event which is part of a series of events or (2) to cause a known amount of time delay between the application of a sweep trigger pulse and the actual starting time of the sweep. The following paragraphs describe both types of operation.

To demonstrate the magnified display type of operation, set the front-panel controls as follows:

	Upper Beam	Lower Beam
INTENSITY	to produce a normal display	counterclockwise
10X MAG.	off (pushed in)	off (pushed in)
HORIZ. DISPLAY	'A' TIME BASE	'B' TIME BASE
Plug-In Units		
VOLTS/DIV.	.05	.05
VARIABLE	CALIBRATED	CALIBRATED
	Time Base 'A'	Time Base 'B'
TIME/DIV.	1 mSEC	.1 mSEC
VARIABLE	CALIBRATED	CALIBRATED
TRIGGER controls		
UPPER BEAM-LOWER BEAM	UPPER BEAM	

	Time Base 'A'	Time Base 'B'
INT.-EXT.-LINE	INT.	
SLOPE	+	
LEVEL	AUTO.	
'B' MODE	STARTS AFTER DELAY INTERVAL	
AMPLITUDE CALIBRATOR	.1	
DELAY INTERVAL	5.00	

Controls not mentioned may be left in any position.

If necessary, readjust the Upper Beam INTENSITY control so that both brightness levels of the trace are easily seen. Set the Upper Beam horizontal POSITION control so the trace begins precisely at the left-hand graticule line. Connect the CAL. OUT signal to both the Upper and Lower Beam vertical input connectors.

Notice that the brightened portion of the display starts exactly five major divisions from the beginning of the sweep. The point at which the brightened segment begins is determined by the setting of the DELAY INTERVAL dial. The numbers on the dial correspond to the number of major graticule divisions. In this case, the dial setting of 5.00 corresponds to 5 major graticule divisions.

The length of the segment depends on the ratio between the sweep rates of the two time-base generators. In this case, the ratio is 10:1. Hence, the brightened segment is one tenth the length of the entire trace.

Advance the Lower Beam INTENSITY control. The Lower Beam display will be identical to the brightened segment in the Upper Beam display, but expanded to the full width of the crt screen.

Increase the Time Base 'B' sweep rate to 10 µSEC per division. Adjust the DELAY INTERVAL dial to position the brightened segment of the Upper Beam display throughout the rising portion of one of the square waves. This small segment of the Upper Beam display is now magnified 100 times in the Lower Beam display, permitting detailed examination of the waveform.

The second way of using the STARTS AFTER DELAY INTERVAL mode is nearly identical to the method just described. The only difference is in the interpretation of the display. The first method related the Upper and Lower Beam displays solely on a distance basis; that is, a certain number of major divisions of distance in the Upper Beam display to the starting point of the magnified Lower Beam display. This difference in distance also represents a difference in time. Hence, additional information can be obtained in the following manner.

The brightened segment in the Upper Beam display begins 5 major divisions after the main trace. The sweep rate of Time Base 'A' is 1 millisecond per major division. Hence, the brightened segment and the Lower Beam display begin 5 milliseconds after the Upper Beam display begins (5 major divisions times 1 millisecond per major division).

Although the number of divisions of delay between the main Upper Beam trace and the brightened segment can be measured on the crt, a much more accurate measurement is indicated by the DELAY INTERVAL dial setting.

Additional details about the use of this mode of operation are given in the Time Measurements portion of the Applications section of this manual.

Triggerable After Delay Interval

Complex signals often contain a number of individual events of dissimilar amplitude. Since Tektronix Oscilloscope trigger circuits are sensitive to signal amplitude, a stable display will normally be obtained only when the sweep is triggered by the event having the greatest amplitude.

The TRIGGERABLE AFTER DELAY INTERVAL feature of the Type 565 provides a means of triggering the sweep by events other than that having the greatest amplitude. The following instructions will permit you to demonstrate that Time Base 'B' can be triggered by virtually any event within a series of events.

Set the front-panel controls in the same manner as for the STARTS AFTER DELAY INTERVAL demonstration except as follows:

Lower Beam INTENSITY	for normal display
Time Base 'B' TRIGGER controls	same settings as Time Base 'A' TRIGGER controls.

Connect the CAL. OUT signal to both the Upper and Lower Beam vertical input connectors.

Turn the DELAY INTERVAL dial about 2 turns in either direction. Notice that both the Lower Beam display, and the brightened segment in the Upper Beam display, move smoothly across the crt.

Set the DELAY INTERVAL dial so the brightened segment in the Upper Beam display begins about in the middle of a pulse top. Notice that the Lower Beam display also begins in the middle of a pulse top. Then, set the 'B' MODE switch to the TRIGGERABLE AFTER DELAY INTERVAL position. Notice that the brightened segment in the Upper Beam display has shifted to the next pulse on the right. The Lower Beam display now begins within the rising portion of the pulse.

Now turn the DELAY INTERVAL dial several full turns. The brightened segment in the Upper Beam display should jump from one pulse to the next. The Lower Beam display appears unchanged because all pulses are identical.

The display is produced in the following manner:

Time Base 'B' normally cannot produce more than one sweep for each sweep produced by Time Base 'A'. 'B' sweep will occur after 'A' sweep has been in progress for a period determined by (1) the Time Base 'A' sweep rate (TIME/DIV.) multiplied by the DELAY INTERVAL dial setting, plus (2) the time between the end of the delay interval and the next event in the signal which will trigger Time Base 'B'.

External Horizontal Inputs

For special applications you can deflect either beam horizontally with an externally derived signal. This permits you to use the oscilloscope to plot one function versus another. The bandpass of the horizontal amplifier is dc to at least 350 kc when the EXT. HORIZ. GAIN control is set fully clockwise.

To use an external horizontal input, connect the external signal to the EXT. HORIZ. IN connector for either the Upper or Lower Beam. Place the appropriate HORIZ. DISPLAY switch in the EXT. position. The horizontal deflection produced by the external signal can be either increased or decreased through use of the EXT. HORIZ. GAIN control. The horizontal deflection factors are continuously variable from approximately .1 to 10 volts per major division with the use of this control.

Amplitude Calibrator

The amplitude calibrator provides a convenient source of square waves of known amplitude at a frequency of approximately 1 kc. The square waves are used primarily to adjust probe compensation and to verify the amplitude calibration of the oscilloscope vertical deflection systems.

Calibrator square waves are adjustable from 1 millivolt to 100 volts, peak-to-peak, in decade steps. The amplitude is controlled by the setting of the AMPLITUDE CALIBRATOR switch. The output voltage is accurate within 3% of the AMPLITUDE CALIBRATOR switch setting when the output is connected to a high-impedance load.

SECTION 3

APPLICATIONS

Introduction

Information in this section has been selected to show typical applications for the Type 565 Oscilloscope. Among these applications are measurements of voltage, time, and frequency. Several specific applications are described to point out the various features designed into the instrument. Since the number of applications for the Type 565 is large, it is beyond the scope of this manual to cover more than a few of the most general applications.

Voltage Measurements

The Type 565 Oscilloscope can be used to measure the voltage of an input signal by using the calibrated vertical-deflection factor of either plug-in unit. The method used for all voltage measurements is basically the same although the actual techniques vary somewhat depending on the type of measurements required. Essentially there are two types of voltage measurements: ac-component measurements and instantaneous voltage measurements with respect to some reference potential. Many signals contain both ac and dc voltage components. It is often necessary to measure one or both of these components.

When making voltage measurements, you should display the signal over as large a vertical portion of the screen as possible for maximum accuracy. Also, it is important that you do not include the width of the trace in your measurements. You should consistently make all measurements from one side of the trace. If the bottom side of the trace is used for one reading, it should be used for all succeeding readings. The VARIABLE VOLTS/DIV. control must be in the CALIBRATED position.

AC Component Voltage Measurements

To measure the ac component of a signal displayed by one of the beams, the plug-in unit input selector switch should usually be set to the AC position. In these positions only the ac components of the input signal are displayed on the oscilloscope screen. However, when the ac component of the input waveform is very low in frequency, it will be necessary to use the DC position to prevent errors.

To make a peak-to-peak voltage measurement on the ac component of a signal, perform the following steps:

1. With the aid of the graticule, measure the vertical distance in major divisions from the positive peak to the negative peak.
2. Multiply the vertical distance measured by the setting of the plug-in unit VOLTS/DIV. switch to obtain the indicated voltage.
3. Multiply the indicated voltage by the attenuation factor of the probe, if any, to obtain the actual peak-to-peak voltage.

As an example, assume that using a 10X probe and a deflection factor of 1 volt per division, you measure a vertical distance between peaks of 4 major divisions. In this case then, 4 major divisions multiplied by 1 volt per division gives you an indicated voltage of 4 volts, peak-to-peak. This voltage multiplied by the probe attenuation factor of 10 then gives you the true peak-to-peak amplitude of 40 volts.

When sinusoidal signals are measured, the peak-to-peak voltage obtained can be converted to peak, rms, or average voltage through use of standard conversion factors.

Instantaneous Voltage Measurements

The method used to measure instantaneous voltages is virtually identical to the method described previously for the measurement of the ac components of a signal. However for instantaneous voltage measurements the plug-in unit input selector switch must be placed in the DC position. Also, since instantaneous voltages are measured with respect to some potential (usually ground), a reference line must be established on the oscilloscope screen which corresponds to that potential. For example, if voltage measurements are to be made with respect to +100 volts, the reference line would correspond to +100 volts. In the following procedure, a method is described for establishing this reference line at ground, since measurements with respect to ground are the most common. The same general method may be used to measure voltage with respect to any other potential, however, so long as that potential is used to establish the reference line.

To obtain an instantaneous voltage measurement with respect to ground, perform the following steps:

1. To establish the voltage reference line, touch the probe tip to an oscilloscope ground terminal (or if the reference line is to represent a voltage other than ground, to a source of that voltage) and adjust the oscilloscope controls to obtain a free-running sweep. Vertically position the trace to a convenient point on the oscilloscope screen. This point will depend on the polarity and amplitude of the input signal, but should be chosen so that the trace lies along one of the major divisions of the graticule. The graticule division corresponding to the position of the trace is the voltage reference line and all voltage measurements must be made with respect to this line. (Do not adjust the vertical positioning control after the reference line has been established.)

2. Remove the probe tip from ground and connect it to the signal source. Adjust the triggering controls for a stable display.

3. Using the graticule, measure the vertical distance in major divisions from the desired point on the waveform to the voltage reference line.

4. Multiply the setting of the VOLTS/DIV. switch by the distance measured to obtain the indicated voltage.

5. Multiply the indicated voltage by the attenuation factor of the probe you are using to obtain the actual voltage with respect to ground (or other reference voltage).

As an example of this method, assume that you are using a 10X probe and deflection factor of 0.2 volt per major division. After setting the voltage reference line at the bottom division of the graticule, using the lower beam, you measure a distance of 3 major divisions from the reference line to the point you wish to check. In this case, 3 divisions multiplied by 0.2 volt per division gives you an indicated 0.6 volt. Since the voltage point is above the voltage reference line, the polarity is indicated to be positive (except with plug-ins which permit you to invert the input signal). The indicated voltage multiplied by the probe attenuation factor of 10 then gives you the actual voltage of 6 volts.

Time Measurements

The calibrated sweep rates of the Type 565 Oscilloscope cause any horizontal distance on the crt to represent a definite known interval of time. This feature can be used to accurately measure the time lapse between two events displayed by either trace. Three methods of measurement are described here.

Method 1

1. Use the graticule divisions to measure the horizontal distance between the two displayed events on one trace whose time interval you wish to find.

2. Multiply the distance measured by the setting of the appropriate TIME/DIV. switch to obtain the apparent time interval. (The VARIABLE TIME/DIV. control must be in the

CALIBRATED position.)

3. If the 10X MAG. is turned on, multiply by 0.1 to obtain the actual time interval. If the 10X MAG. is not turned on, the actual time interval is the same as the apparent time interval.

For example, assume that the TIME/DIV. switch setting is 1 mSEC per division, the 10X MAG. is turned on, and the distance measured between events on the trace is 5 major divisions. In this example, then, 5 divisions multiplied by 1 millisecond per division gives an apparent time interval of 5 milliseconds. The apparent time interval multiplied by 0.1 gives an actual time interval of 0.5 millisecond.

Method 2

This method makes use of both Time-Base Generators and the Delay Interval feature of the Type 565 Oscilloscope. Time Base 'B' is used to produce a brightened time-reference marker on the upper beam display. The marker can be moved throughout the display by adjusting the DELAY INTERVAL control. The difference between two settings of the DELAY INTERVAL dial, multiplied by the sweep rate selected with the 'A' TIME/DIV. switch, gives the actual time interval between the two positions of the marker. This method is summarized as follows:

1. Connect the signal source to the Upper Beam vertical input connector.

2. Set the 'B' MODE switch to STARTS AFTER DELAY INTERVAL.

3. Set the UPPER HORIZ. DISPLAY switch to 'A' TIME BASE.

4. Set 'A' TRIGGER controls to UPPER BEAM and INT. and obtain a triggered display of the two events whose time difference you wish to measure. (If the sweep is being triggered by one of the events, set 'A' TIME/DIV. so that the two events occur twice during each sweep. The measurement can then be made at the second cycle of events in the display.)

5. Set 'B' TIME/DIV. switch for a sweep rate that is one hundred times faster than that of Time Base 'A' (or as near one hundred times as the range of the 'B' TIME/DIV. switch will permit).

6. Set the Upper Beam INTENSITY control low enough so the brightened segment of the Upper Beam trace is easily seen.

7. Set the DELAY INTERVAL dial so the brightened segment of the trace begins at the desired reference point in the first event. Note the exact setting of the DELAY INTERVAL dial.

8. Set the DELAY INTERVAL dial so the brightened segment of the trace begins at the desired reference point in the second event. Note the exact setting of the DELAY INTERVAL dial.

9. Subtract the first dial indication from the second indication.

10. Multiply the difference by the sweep rate indicated on the 'A' TIME/DIV. switch. This gives you the actual time interval.

Method 3

This method is similar to the second method. Both beams as well as both Time Bases are used. The main advantage of this method over the first or second method is improved resolution.

1. Connect the signal source to both the Upper Beam and Lower Beam vertical inputs.

2. Set the oscilloscope controls as described in steps 2, 3, and 4 of method 2.

3. Set the LOWER HORIZ. DISPLAY switch to 'B' TIME BASE. Set 'B' TIME/DIV. switch for a sweep rate that is ten times faster than that of Time Base 'A' (or as near ten times as the range of the 'B' TIME/DIV. switch will permit).

4. Set the DELAY INTERVAL dial so a suitable reference point in the first event is centered in the Lower Beam display. Note the exact horizontal position of the event reference point and the exact setting of the DELAY INTERVAL dial.

5. Adjust the DELAY INTERVAL dial to position the second event to the same point on the crt that was used for the first event. Note the exact setting of the DELAY INTERVAL dial.

6. Subtract the first dial indication from the second indication.

7. Multiply the difference by the 'A' TIME/DIV. switch indication. This gives you the actual time interval between the events.

Frequency Measurements

Using one of the three methods described in the previous section, you can measure the period (time required for one cycle) of a recurrent signal. The frequency of the signal will then be the reciprocal of the period. For example, if the period of a recurrent signal is accurately measured and found to be 0.2 millisecond, the frequency is 5 kc.

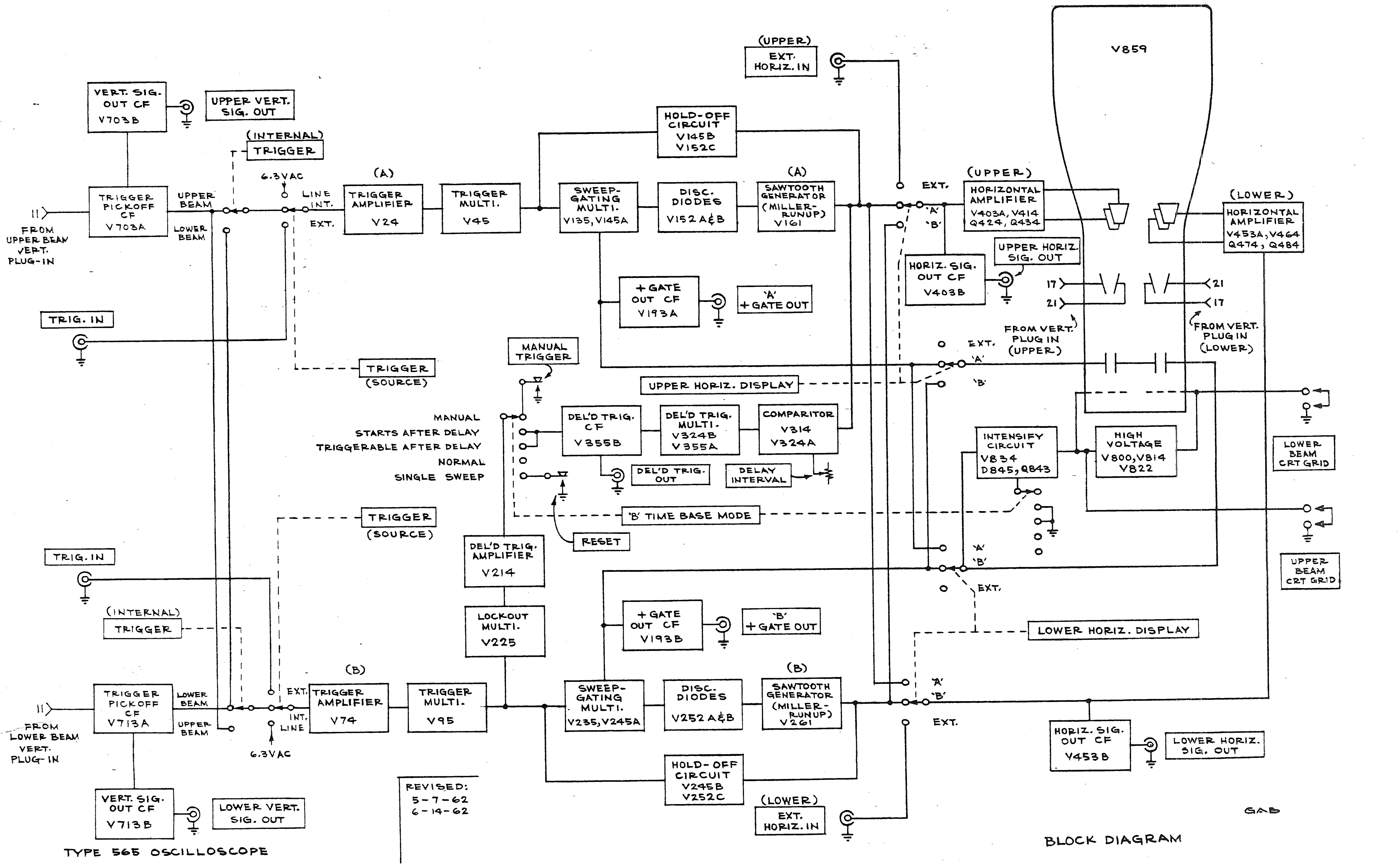
At any given sweep rate, the number of cycles of the input signal displayed on 10 major divisions of the crt is dependent on the frequency of the signal. At a sweep rate of 0.1 millisecond per major division, for example, 6 cycles are displayed with a 6-kc input signal, 5 cycles with a 5-kc signal, and 4 cycles with a 4-kc input signal. By utilizing the pattern of these observations you can measure frequencies by counting the number of cycles over 10 major divisions and multiplying this number by a factor which is dependent on the sweep rate. Since each sweep rate produces a definite fixed multiplication factor, frequencies can usually be measured by this method much faster than by the previous method. The method is summarized as follows:

1. Adjust the appropriate TIME/DIV. switch to display several cycles of the input signal. Be sure the VARIABLE TIME/DIV. control is in the CALIBRATED position.
2. Count the number of cycles that are displayed within the 10 major divisions of the graticule.
3. Multiply this number by the multiplication factor for the sweep rate you are using. The product is the frequency of the input signal.

NOTE

The multiplication factor for each sweep rate is equal to the reciprocal of the sweep period (10 times the sweep time per division).

For example, assume that you are using a sweep rate of 50 milliseconds per division, and you count 7.2 cycles in 10 divisions. The multiplication factor for a sweep rate of 50 milliseconds per division is the reciprocal of 500 milliseconds (10 times 50 milliseconds), or 2 per second. The frequency is 7.2 cycles multiplied by 2 per second, or 14.4 cycles per second.



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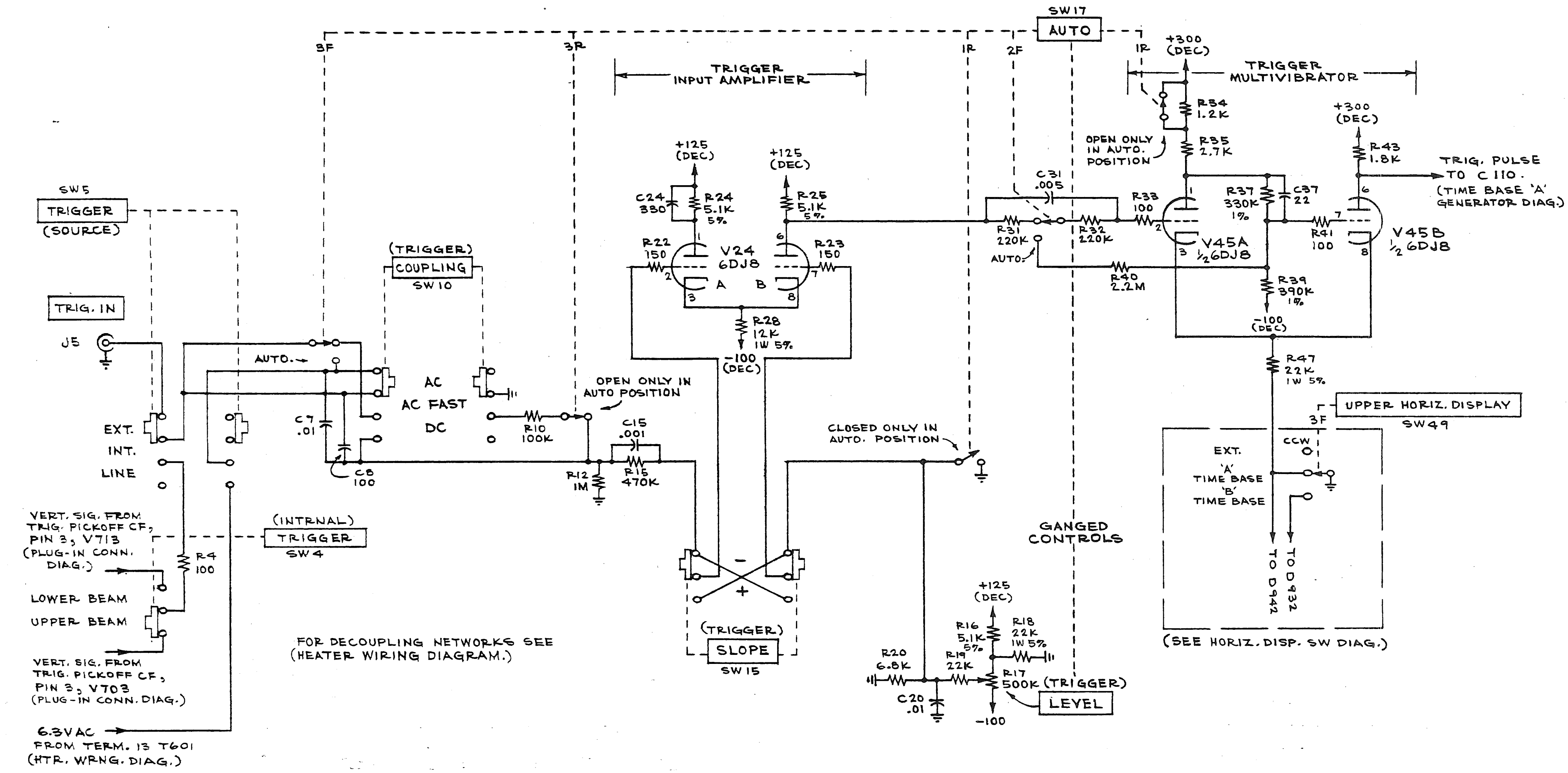
TYPE 565 OSCILLOSCOPE

BLOCK DIAGRAM



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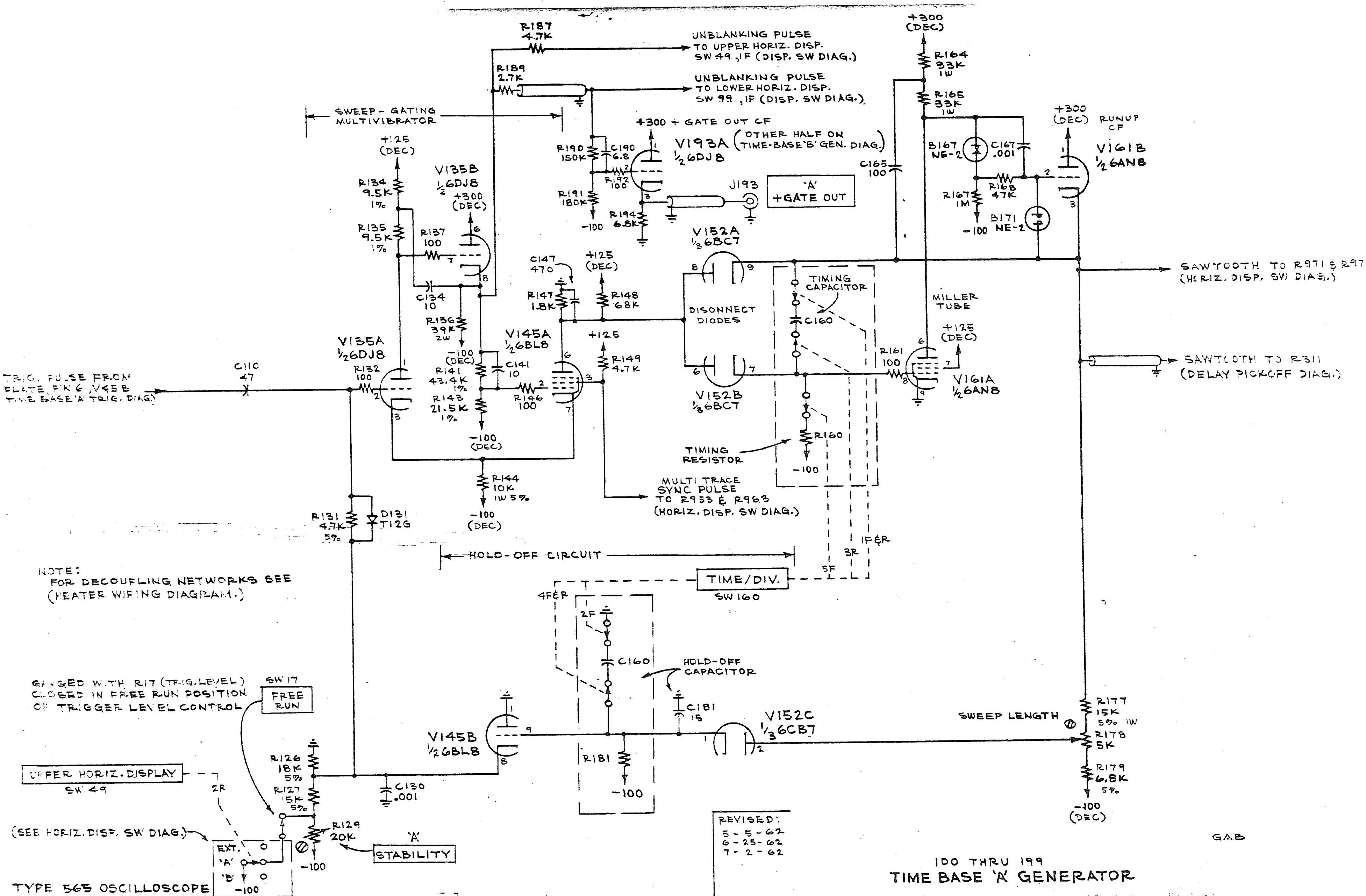
TYPE 565 OSCILLOSCOPE

1 THRU 49

TIME BASE 'A' TRIGGER

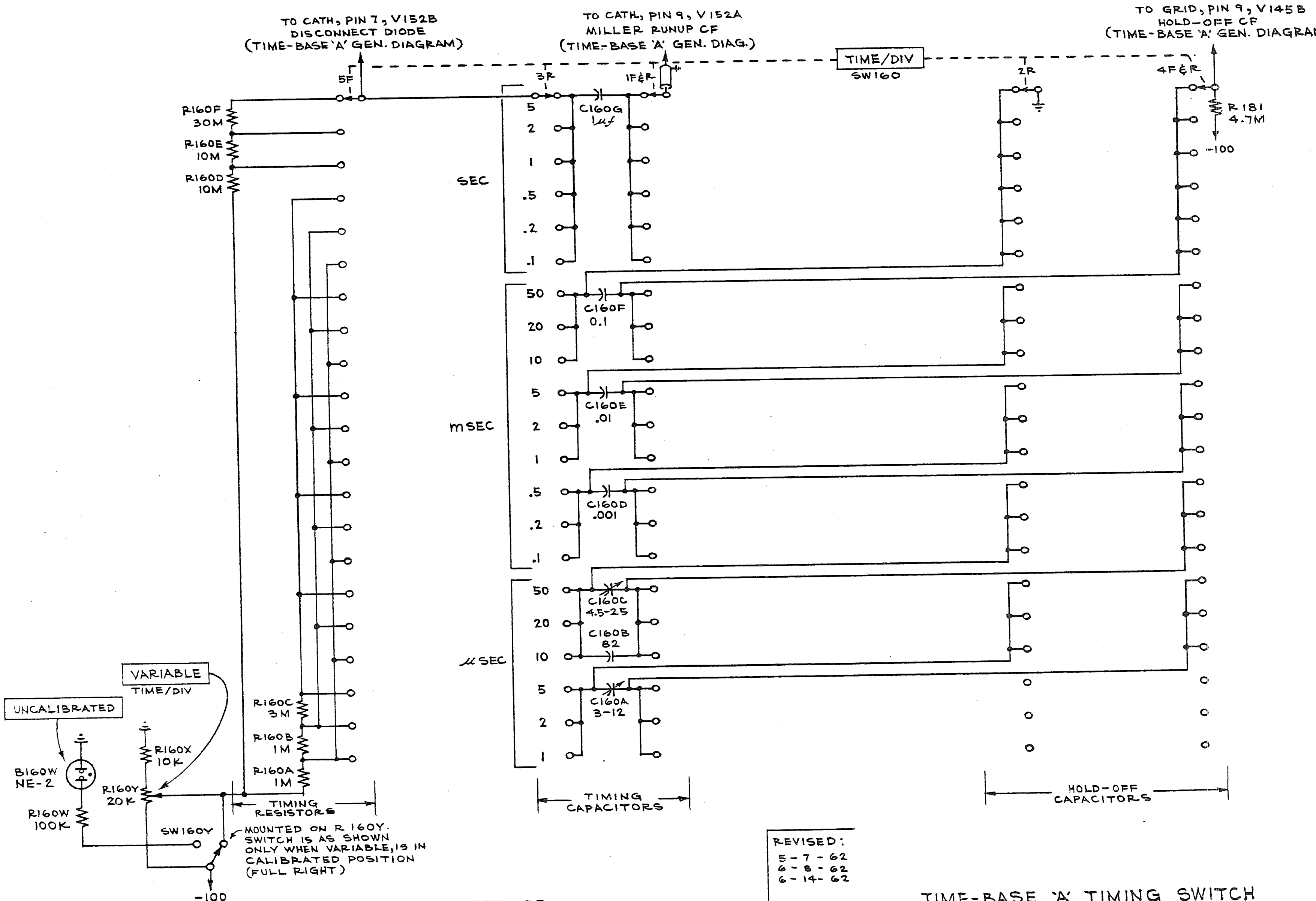
GAB



TYPE 565 OSCILLOSCOPE

100 THRU 199

TIME BASE 'A' GENERATOR



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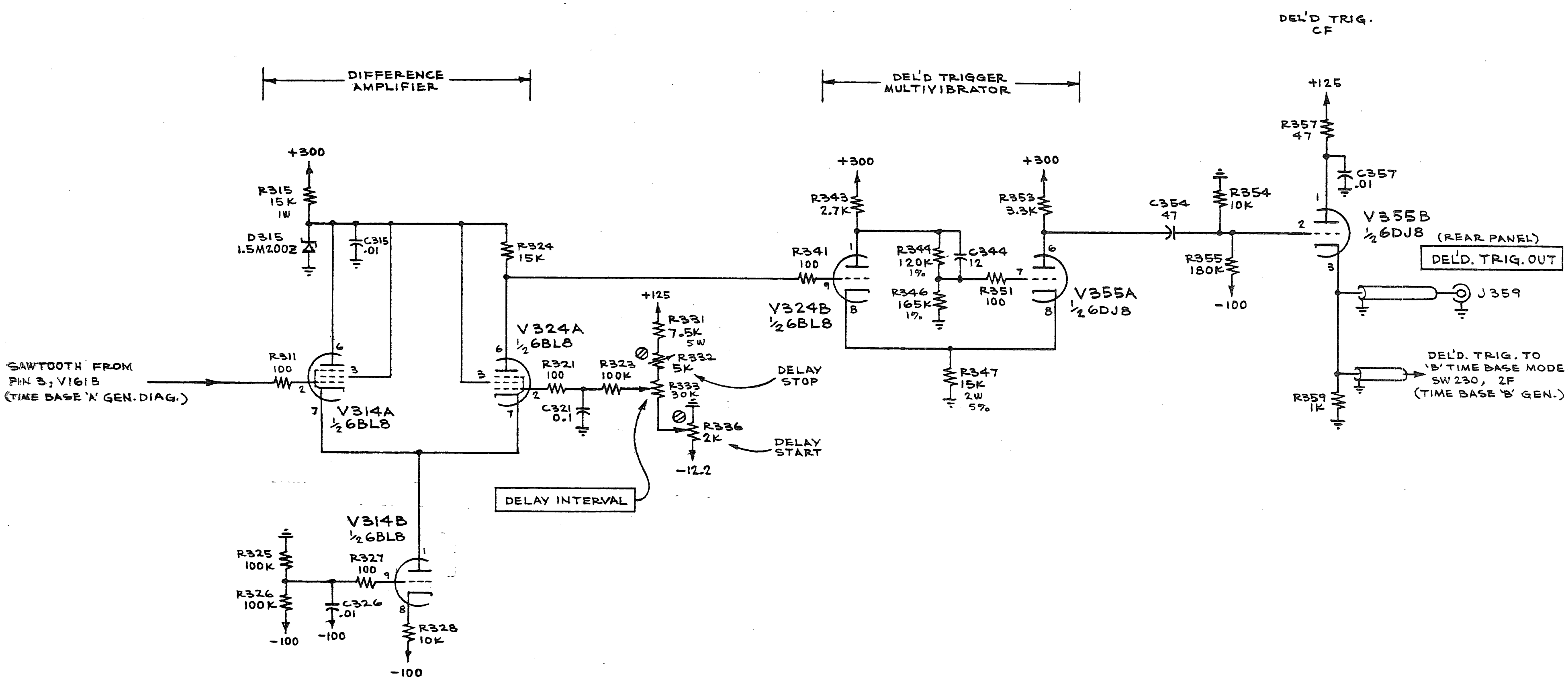
TYPE 565 OSCILLOSCOPE

TIME-BASE 'A' TIMING SWITCH

GAB



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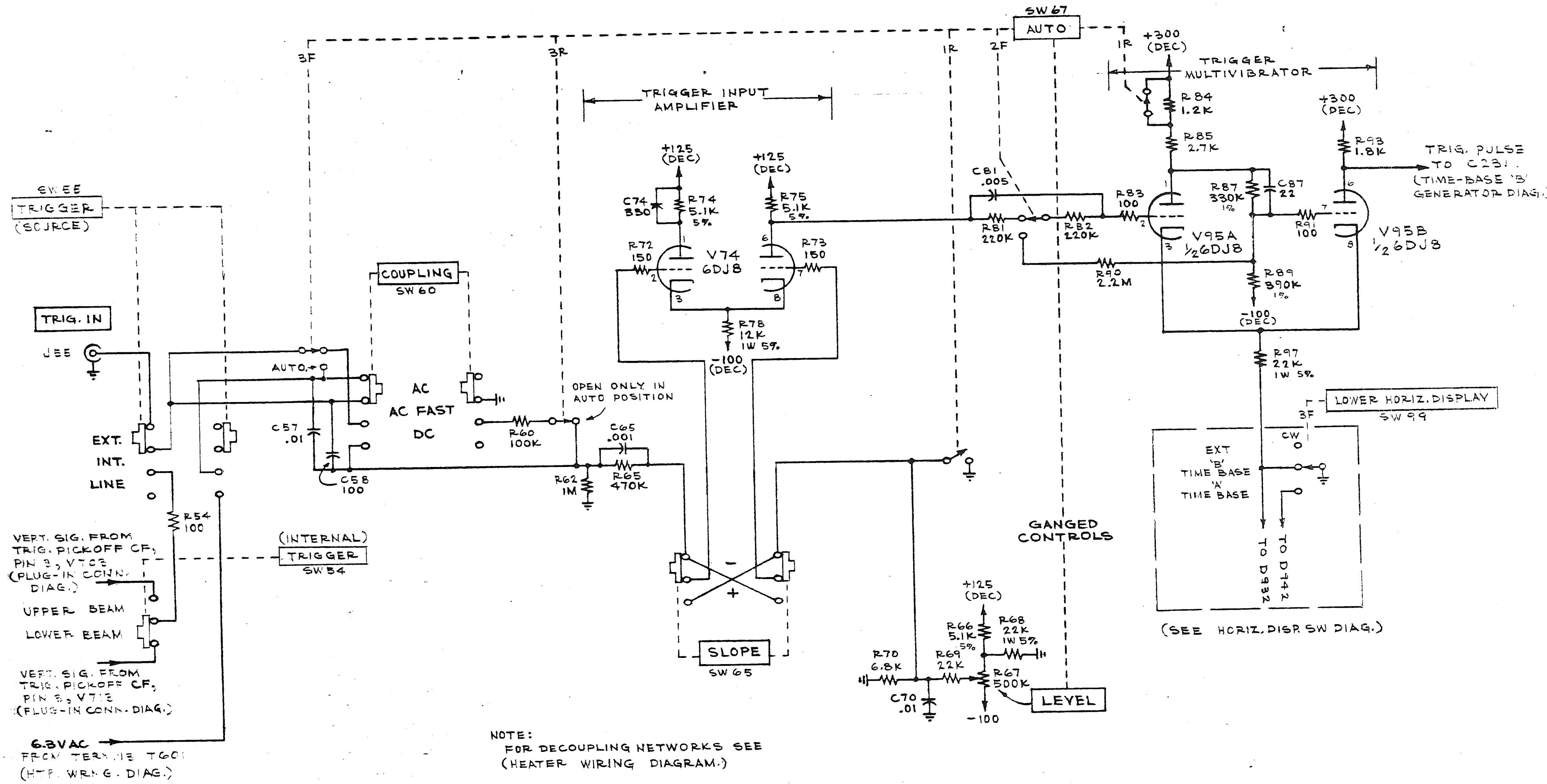
TYPE 565 OSCILLOSCOPE

300 THRU 399
DELAY PICKOFF

GAB



NOTE:
FOR DECOUPLING NETWORKS SEE
(HEATER WIRING DIAGRAM.)

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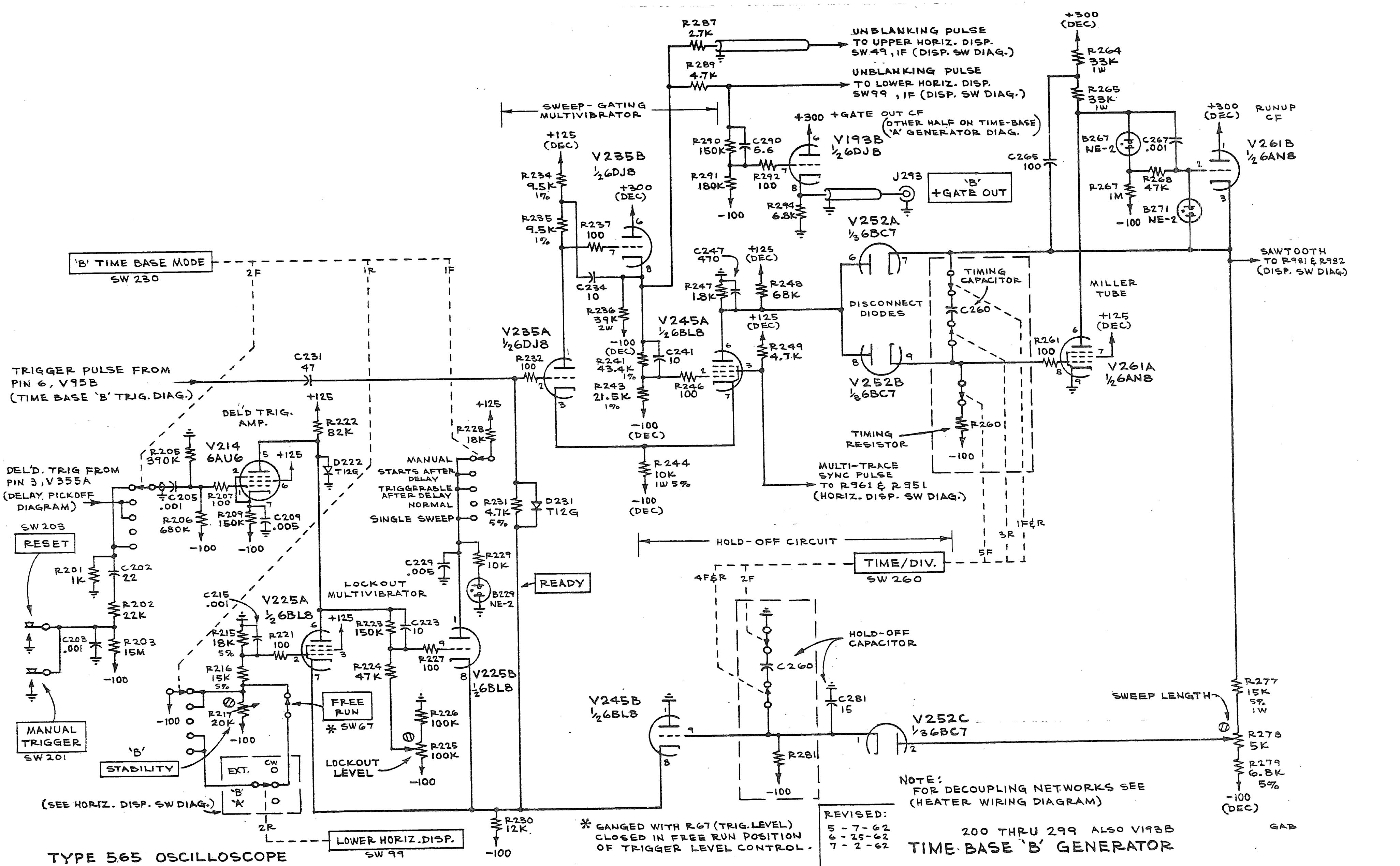
6 - 14 - 62
6 - 21 - 62

GAB

TYPE 565 OSCILLOSCOPE

50 THRU 99

TIME BASE 'B' TRIGGER


UNBLANKING PULSE TO UPPER HORIZ. DISP. SW49, 1F (DISP. SW DIAG.)
UNBLANKING PULSE TO LOWER HORIZ. DISP. SW99, 1F (DISP. SW DIAG.)
SWEEP-GATING MULTIVIBRATOR
+GATE OUT CF (OTHER HALF ON TIME-BASE 'A' GENERATOR DIAG.)
'B' +GATE OUT
J293
V193B ½ 6DJ8
V235B ½ 6DJ8
V235A ½ 6DJ8
V245A ½ 6BL8
V252A ⅓ 6BC7
V252B ⅓ 6BC7
V261A ½ 6AN8
V261B ½ 6AN8
RUNUP CF
MILLER TUBE
DISCONNECT DIODES
TIMING CAPACITOR
TIMING RESISTOR
SAWTOOTH TO R981 & R982 (DISP. SW DIAG.)
MULTI-TRACE SYNC PULSE TO R961 & R951 (HORIZ. DISP. SW DIAG.)
'B' TIME BASE MODE SW 230
TRIGGER PULSE FROM PIN 6, V95B (TIME BASE 'B' TRIG. DIAG.)
DEL'D TRIG. AMP.
V214 6AU6
DEL'D. TRIG FROM PIN 3, V355A (DELAY PICKOFF DIAGRAM)
SW203 RESET
MANUAL TRIGGER SW201
'B' STABILITY
(SEE HORIZ. DISP. SW DIAG.)
V225A ½ 6BL8
V225B ½ 6BL8
LOCKOUT MULTIVIBRATOR
LOCKOUT LEVEL
FREE RUN * SW67
MANUAL
STARTS AFTER DELAY
TRIGGERABLE AFTER DELAY
NORMAL
SINGLE SWEEP
READY
HOLD-OFF CIRCUIT
TIME/DIV. SW 260
HOLD-OFF CAPACITOR
V245B ½ 6BL8
V252C ⅓ 6BC7
SWEEP LENGTH
LOWER HORIZ. DISP. SW 99
* GANGED WITH R67 (TRIG. LEVEL) CLOSED IN FREE RUN POSITION OF TRIGGER LEVEL CONTROL.
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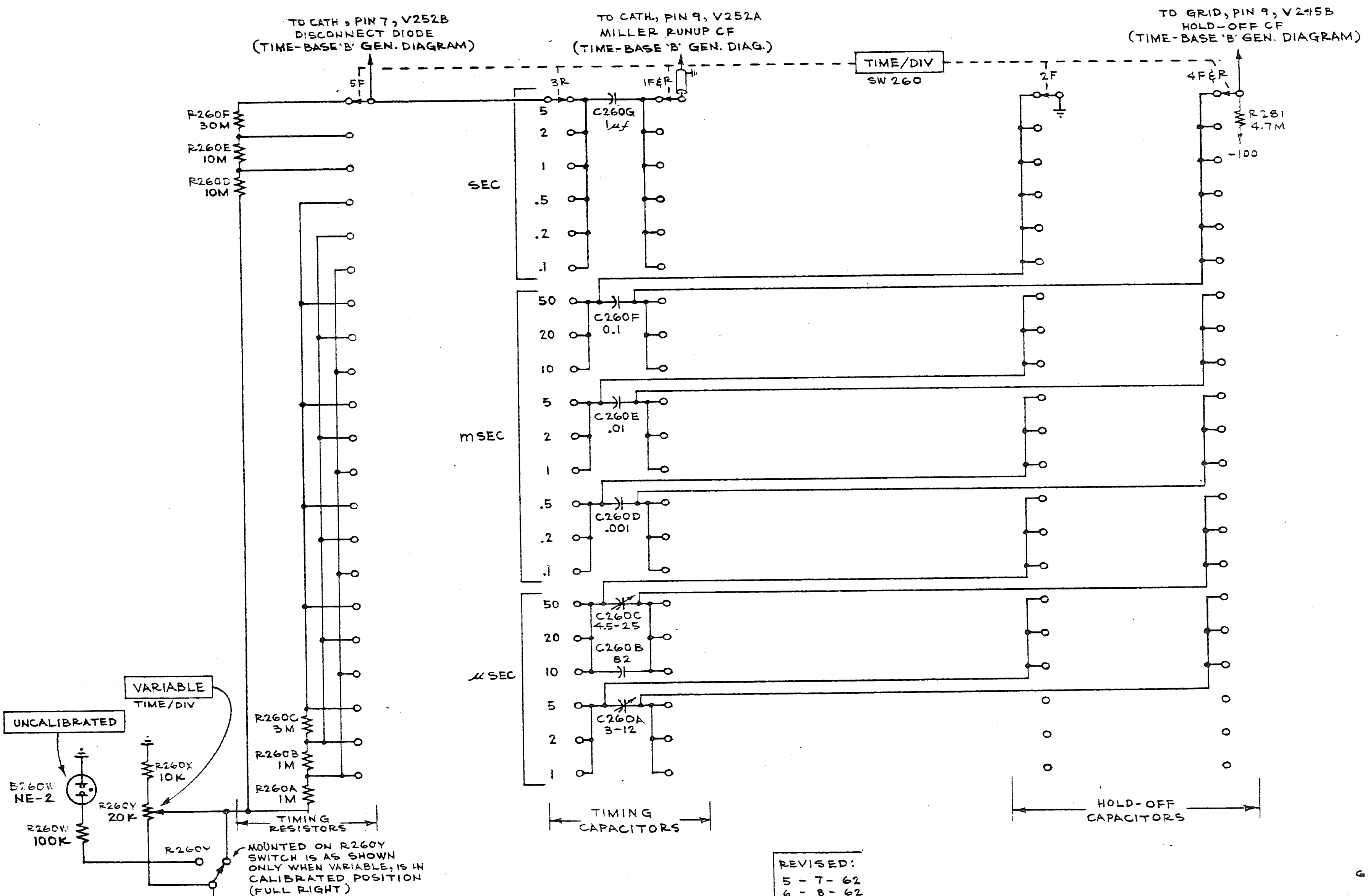
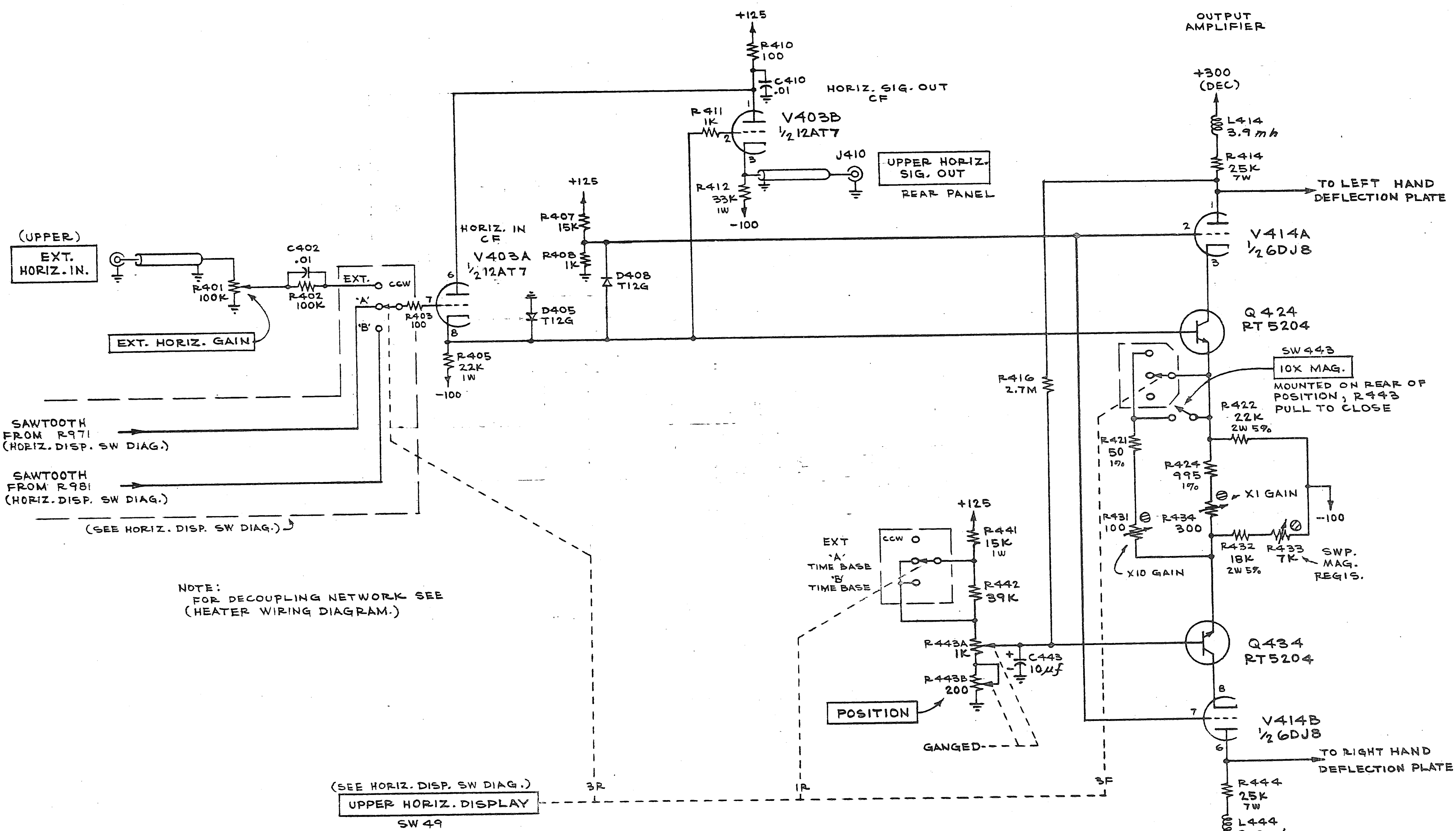
NOTE: FOR DECOUPLING NETWORKS SEE (HEATER WIRING DIAGRAM)
200 THRU 299 ALSO V193B
TIME BASE 'B' GENERATOR
TYPE 565 OSCILLOSCOPE
GAB



TYPE 565 OSCILLOSCOPE

TIME-BASE 'B' TIMING SWITCH



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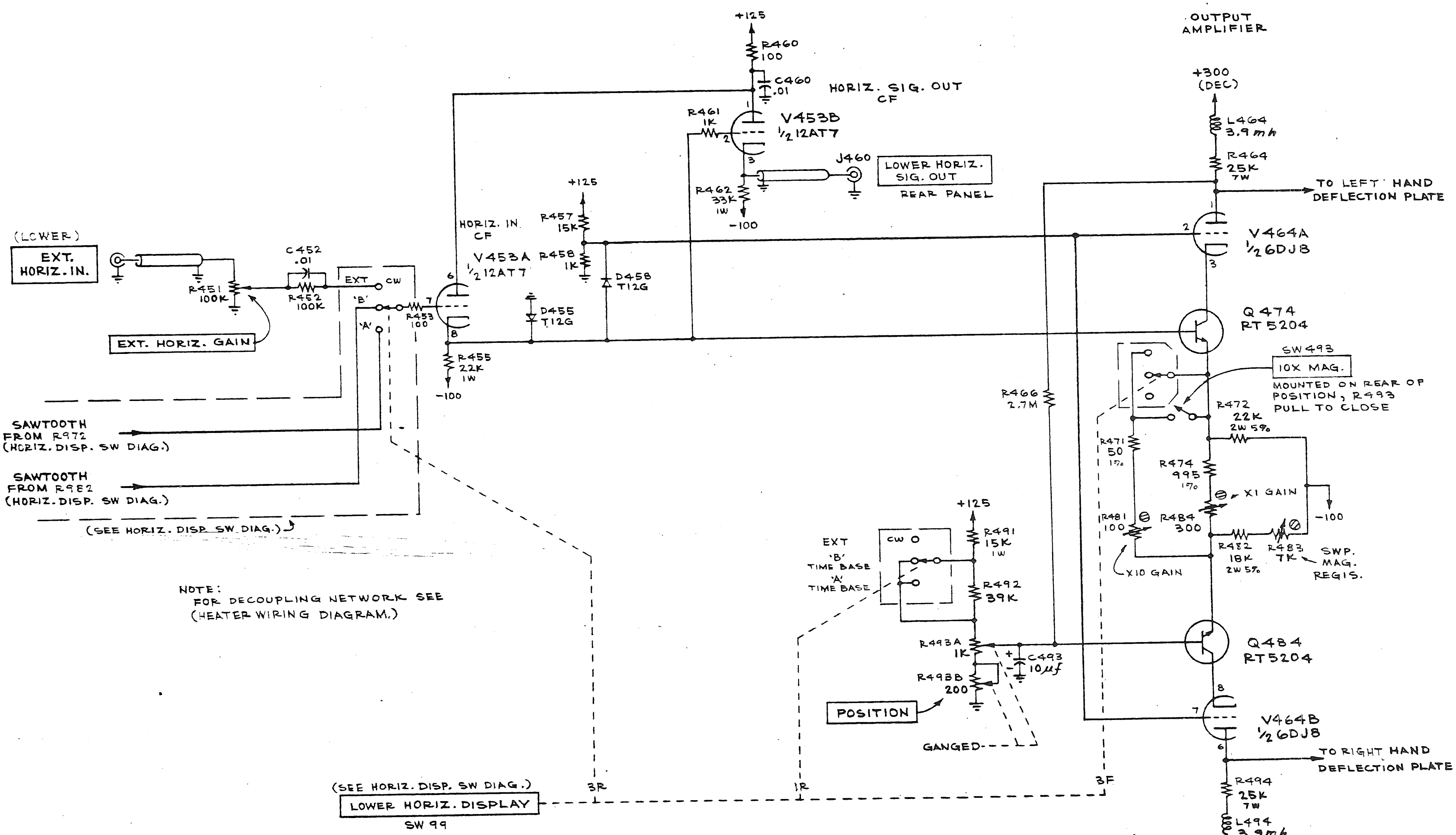
GAB

400 THRU 449

UPPER BEAM HORIZONTAL AMPLIFIER

TYPE 565 OSCILLOSCOPE



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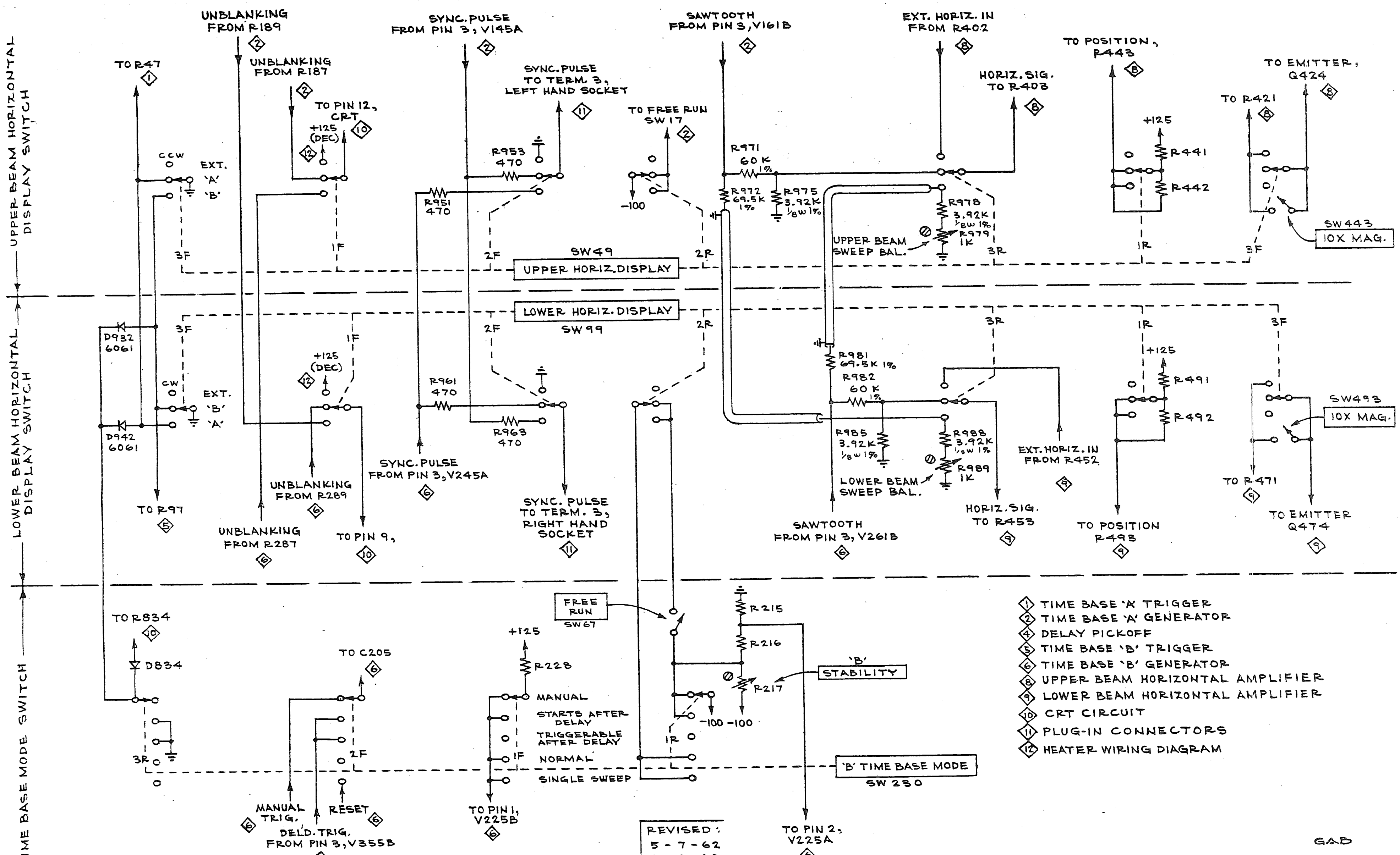
450 THRU 499
LOWER BEAM HORIZONTAL AMPLIFIER

TYPE 565 OSCILLOSCOPE



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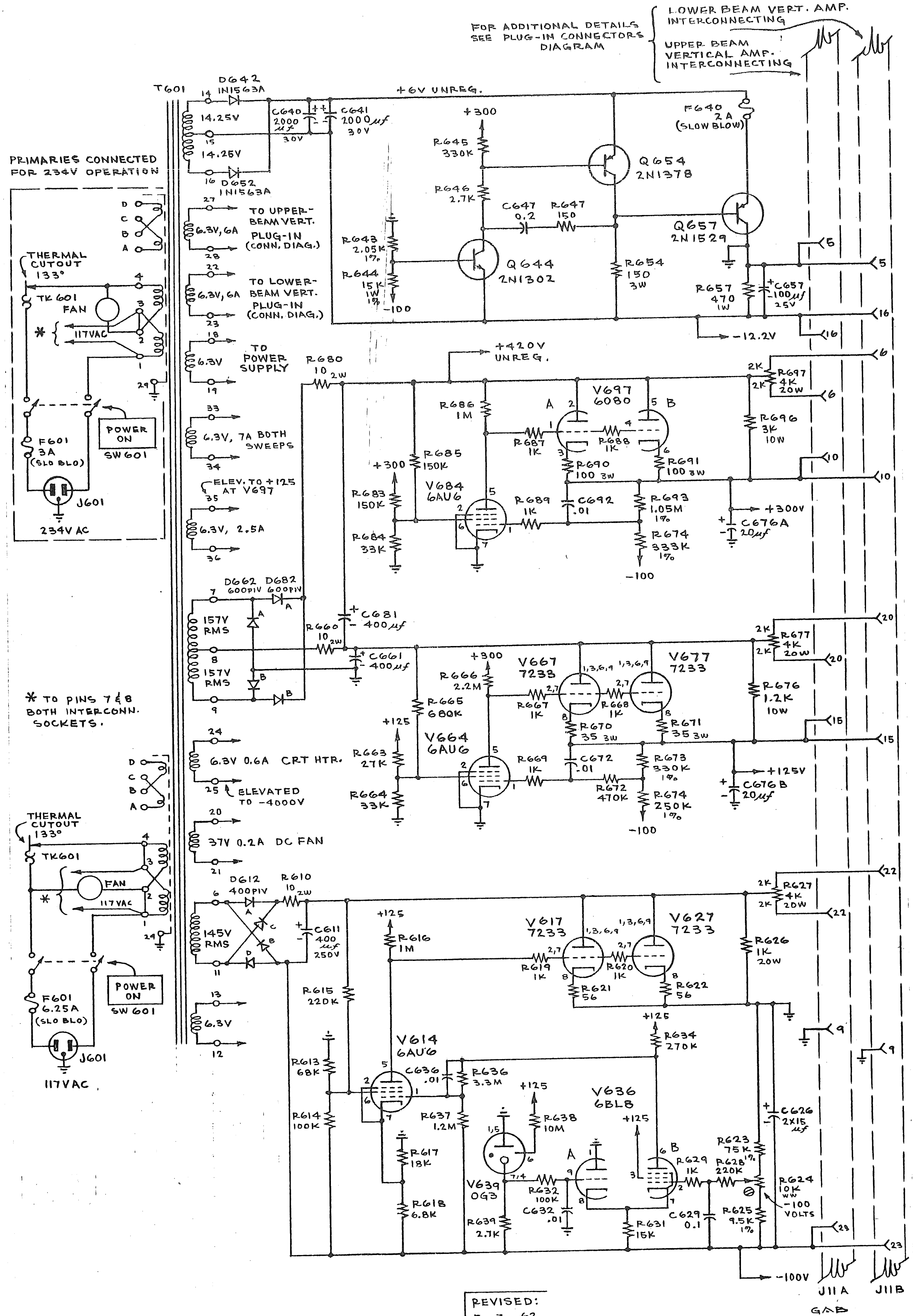
GAB

TYPE 565 OSCILLOSCOPE

930 THRU 999

HORIZONTAL DISPLAY SWITCHING



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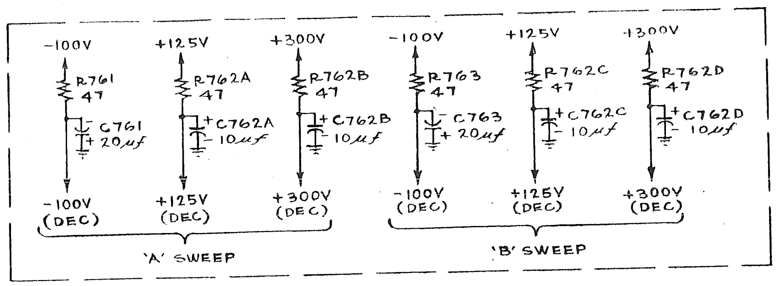
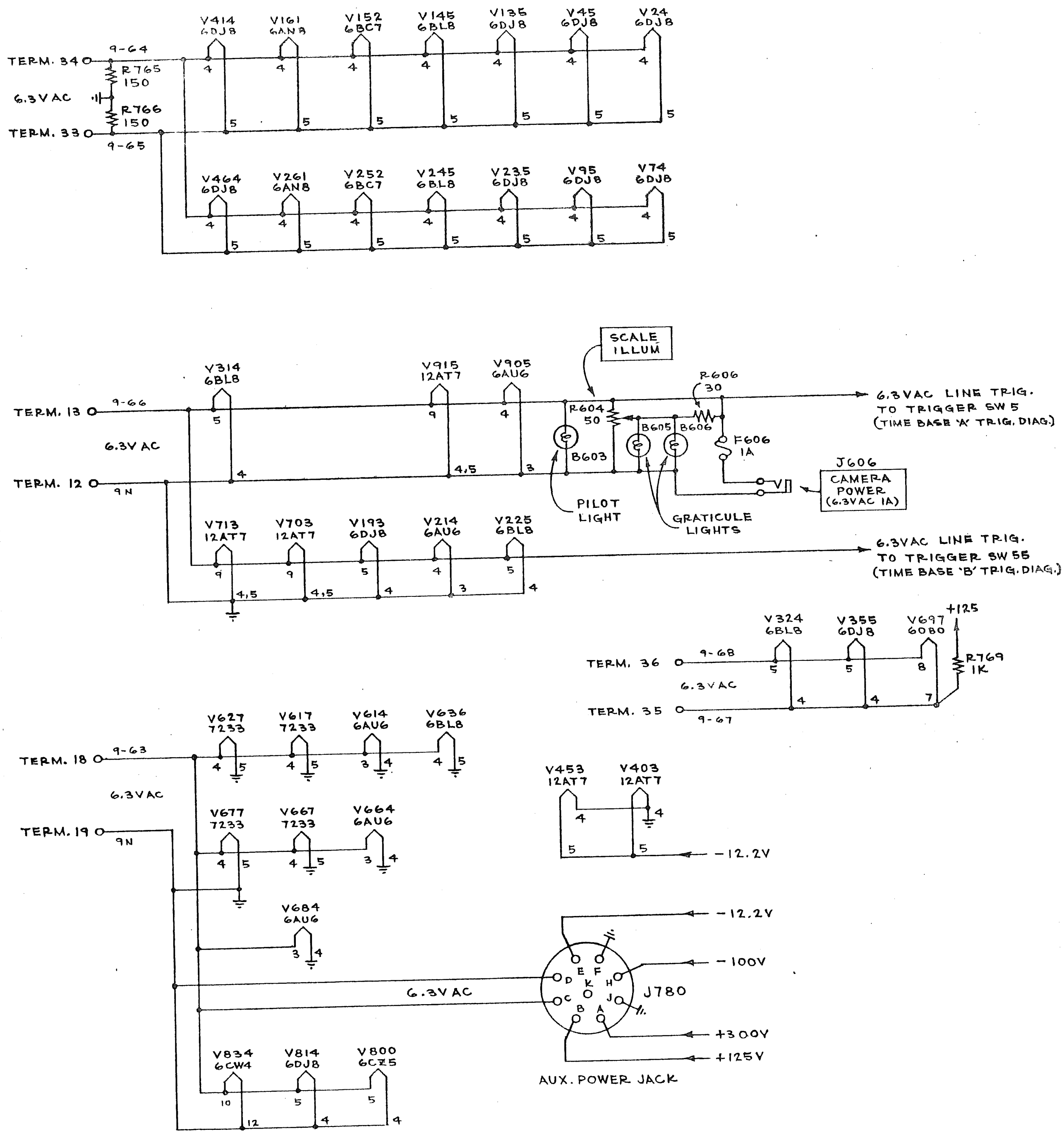
7-12-62

600 THRU 699
POWER SUPPLY

TYPE 565 OSCILLOSCOPE



DECOUPLING NETWORKS



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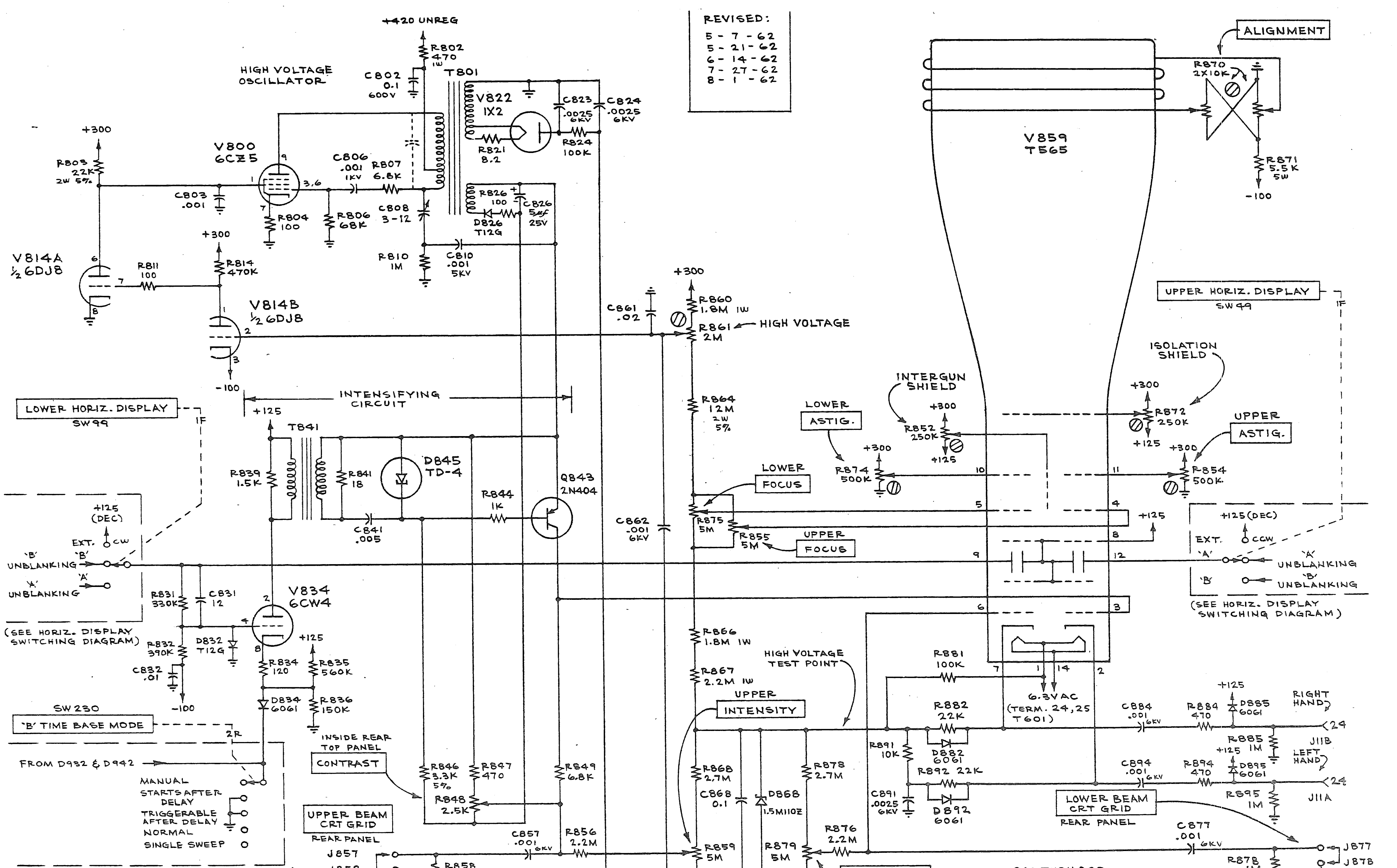
GAB

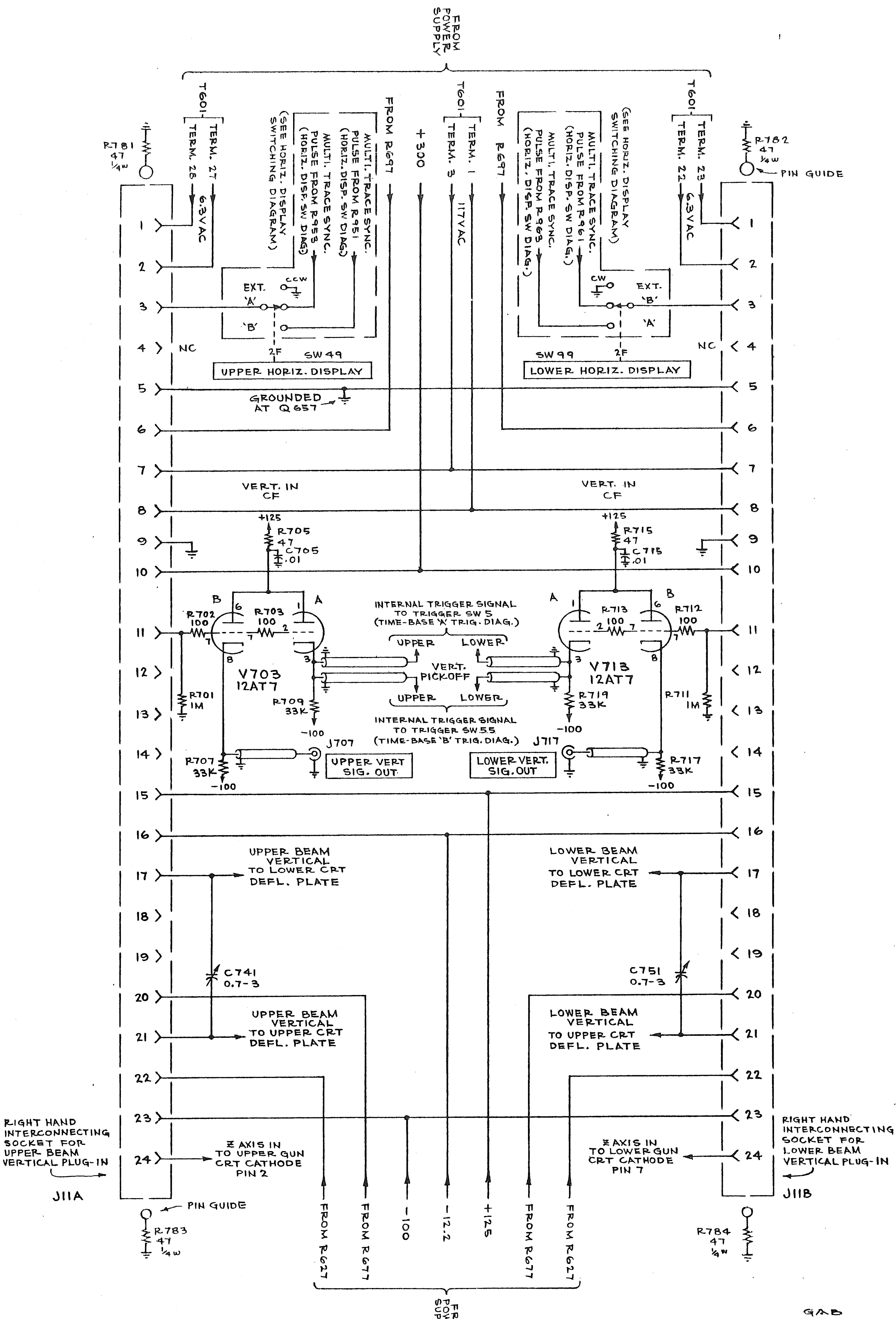
TYPE 565 OSCILLOSCOPE

HEATER WIRING DIAGRAM



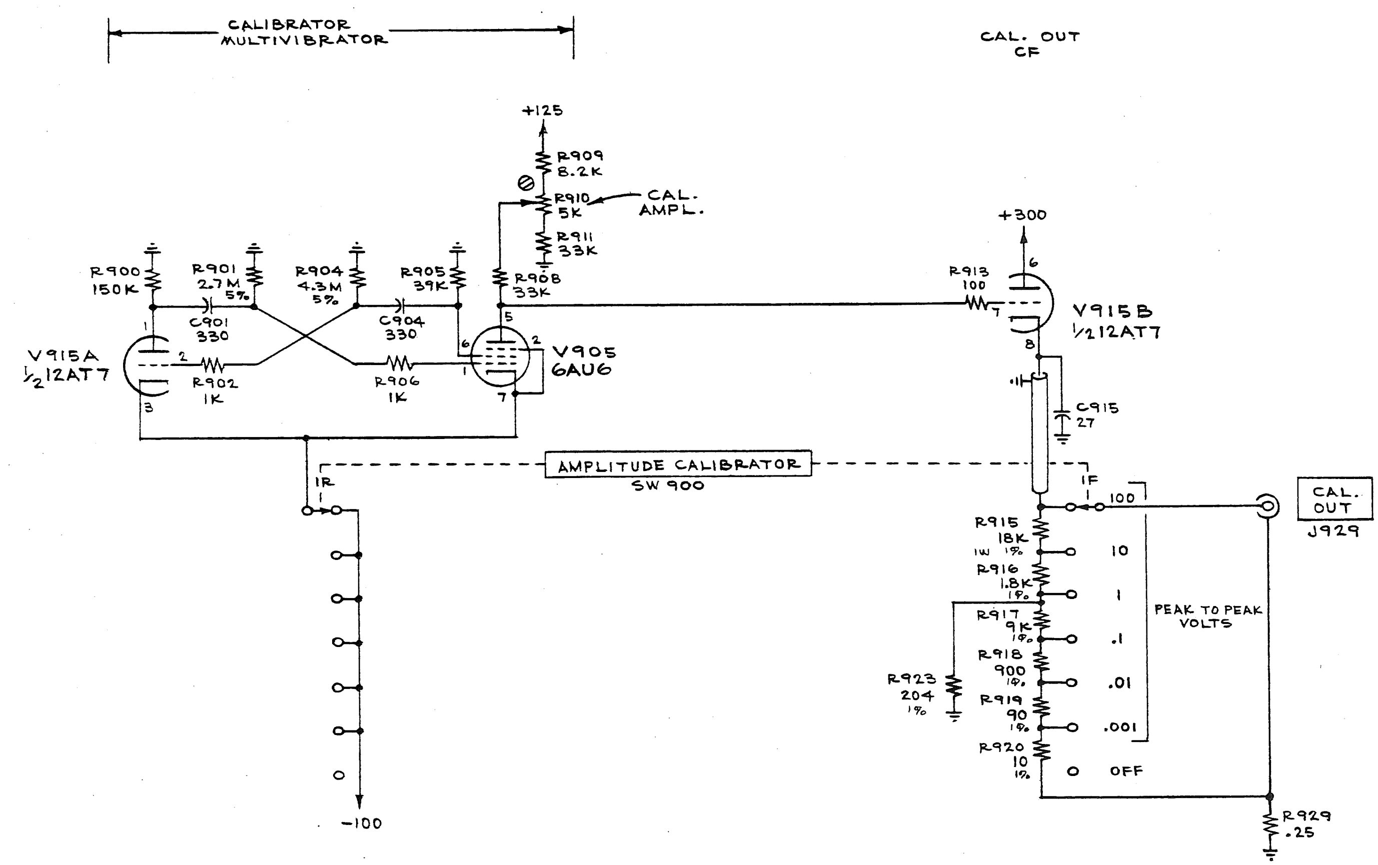
TYPE 565 OSCILLOSCOPE

CRT CIRCUIT



TYPE 565 OSCILLOSCOPE

PLUG-IN CONNECTORS



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TYPE 565 OSCILLOSCOPE

900 THRU 929
AMPLITUDE CALIBRATOR