INSTRUCTION MANUAL

Serial Number ______

TYPE 661 OSCILLOSCOPE

Tektronix, Inc.

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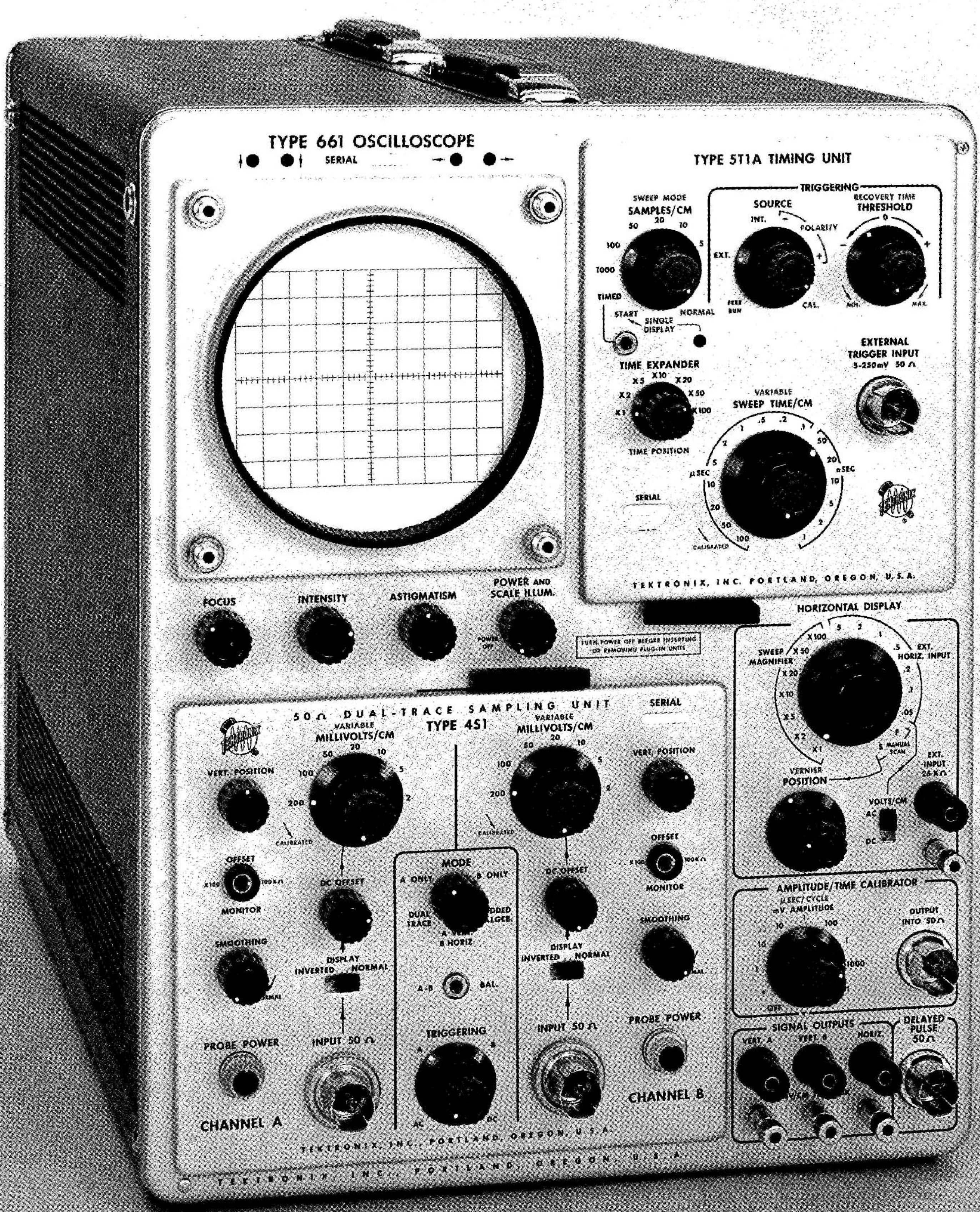

TYPE 661 OSCILLOSCOPE
SERIAL
TYPE 5T1A TIMING UNIT
TRIGGERING
SWEEP MODE
SAMPLES/CM
SOURCE
RECOVERY TIME
THRESHOLD
POLARITY
SINGLE DISPLAY
EXTERNAL TRIGGER INPUT
TIME EXPANDER
VARIABLE
SWEEP TIME/CM
TIME POSITION
TEKTRONIX, INC. PORTLAND, OREGON, U.S.A.
FOCUS
INTENSITY
ASTIGMATISM
POWER AND SCALE ILLUM.
HORIZONTAL DISPLAY
SWEEP MAGNIFIER
EXT. HORIZ. INPUT
VERNIER
POSITION
VOLTS/CM
50 Ω DUAL-TRACE SAMPLING UNIT
TYPE 4S1
VARIABLE
MILLIVOLTS/CM
VERT. POSITION
OFFSET
MONITOR
DC OFFSET
MODE
SMOOTHING
DISPLAY
INVERTED
NORMAL
TRIGGERING
PROBE POWER
INPUT 50 Ω
CHANNEL A
CHANNEL B
AMPLITUDE/TIME CALIBRATOR
SIGNAL OUTPUTS
DELAYED PULSE 50 Ω
TEKTRONIX, INC., PORTLAND, OREGON, U.S.A.

SECTION 1
CHARACTERISTICS

General Information

The Tektronix Type 661 Oscilloscope is intended for use with two associated plug-in units in a self-contained fractional nanosecond sampling system. An external connector allows use of a digital unit for readout of time and voltage information from the oscilloscope display.

The Type 661 is an indicator unit with power supplies for the vertical and horizontal plug-in units. It contains vertical and horizontal crt deflection-plate drivers, a sweep magnifier, and an external horizontal input. Auxiliary circuits offer front-panel amplitude and time references, output signals from both the vertical and horizontal systems, and a delayed fast-rise pulse occurring soon after the beginning of each sweep. The delayed pulse can be used to check the vertical sampling unit risetime.

Input Characteristics

The vertical system of the Type 661 can be driven by any of the Tektronix '4' Series sampling units. The equivalent bandpass, risetime, vertical deflection factor, and input impedance is a function of the individual plug-in unit in use.

The horizontal system of the Type 661 can be driven by any of the Tektronix '5' Series timing units or by an external input terminal at 25 k input resistance. Individual timing unit sweep rates determine the Type 661 equivalent sweep-time per centimeter.

External Horizontal Input—External horizontal input sensitivities of 0.05 to 5 volts/cm in seven calibrated steps, either ac or dc coupled. Sampling and timing plug-in units must be in place for the external signals to provide horizontal scanning. If the vertical unit is the Type 4S1 Dual-Trace Sampling Unit, external horizontal signals cannot be applied to the horizontal amplifier when the MODE switch is at A VERT. B HORIZ.

Front-Panel Characteristics

Sweep Magnifier—X1, X2, X5, X10, X20, X50, and X100 magnification, symmetrical about the crt center. When using the magnifier, the time per sampling dot remains the same as at X1.

Horizontal Position—Coarse and fine POSITION controls shift the display one crt diameter about its center (unmagnified), and the total trace can be shifted into view on all ranges of sweep magnification.

Manual Scan—Two positions of the HORIZONTAL DISPLAY switch permit the sampling display to be horizontally scanned by rotation of the POSITION controls. Choice of slow or fast rates of change. The slow rate of change may be required when the output waveforms drive a pen recorder.

Amplitude/Time Calibrator—A clipped sine-wave signal with the following tolerances:

Amplitude	at 10, 1 and 0.1 μSEC/CYCLE	at 0.01 μSEC/CYCLE
1000 mv	±2%	±8%
100 mv	±4%	±9%
10 mv	±5%	±10%
1 mv	±6%	±11%
Time per cycle	±0.2%	±2%

For instruments having serial numbers from 101 through 1999, the Calibrator sine-wave output is not clipped.

Delayed Pulse—A tunnel diode pulse generator that delivers a fast pulse of at least 350 mv offset by about 200 mv dc into 50 ohms. Risetime at the connector, 70 psec or less (for instruments with serial numbers 270 and up). The pulse occurs about 50 nsec after receipt of a trigger from the timing unit. Risetime appears as about 350 psec or less viewed by a Type 4S1 or Type 4S3, and about 115 psec or less viewed by a Type 4S2. For instruments with serial numbers 101 through 269, risetime at the Delayed Pulse connector is 190 psec or less, appearing as about 390 psec with a Type 4S1 or Type 4S3 and about 210 psec with a Type 4S2.

Signal Outputs—VERT. A, VERT. B, and HORIZ. system signals appear at front-panel terminals at 10 k output impedance. Output amplitude of each signal is 200 mv/cm ±3% referred to the crt display.

Cathode-Ray Tube

Type—T5030-2.

Phosphor—P2. Others available on special order.

Blanking—Deflection type, dc coupled.

Accelerating Potential—Approximately 3000 volts.

Useable Viewing Area—8 cm vertical by 10 cm horizontal.

Graticule

Illumination—Red or white variable edge lighting.

Markings—8 vertical and 10 horizontal 1-cm divisions with 2-mm divisions on the centerlines.

Beam Position Indicators

Indicate direction of off-crt spot or trace. All four lamps will be lighted when spot is near the crt center.

Power Supplies

Temperature isolated, electronically regulated for stable operation with varying line voltage, load, or temperature. Supplies all operating voltages. plus some dc heater current for added stability with line voltage change.

Ventilation

Forced filtered air. Thermal relay interrupts instrument power in the event of overheating and restores it after the inside temperature has dropped to a safe level.

Power Consumption

Approximately 445 watts with plug-ins installed.

Construction

Mechanical—Aluminum-alloy chassis and cabinet. Photo-etched anodized panel, blue vinyl paint over textured aluminum cabinet.

Dimensions—Height 17½ inches, width 13 inches, depth 22 inches.

Weight—Approximately 49 pounds.

Accessories Included

	Tektronix Part No.
1 — 3-conductor power cord	161-010
1 — 3- to 2-conductor power cord adapter	103-013
1 — Green crt filter	378-514
2 — Instruction Manuals	070-324

SECTION 3
CIRCUIT DESCRIPTION

General Information

The Type 661 Oscilloscope consists of five major parts: the low-voltage Power Supply, the CRT Circuits, the Horizontal Amplifier, the Vertical Amplifier, and the Amplitude/Time Calibrator. Auxiliary circuits are a 50-ohm Delayed Pulse Generator, and the Signal Output terminals.

The low-voltage Power Supply provides regulated outputs of —100, —25.2, —19, +19, +100, and +300 volts dc. —12.6 volts, obtained from the —25.2-volt supply, is used for heater current in cathode-follower probes. The +455-volt unregulated voltage is used by the crt high-voltage supply, and is available to the sampling and timing cells for possible plug-in use.

The Horizontal Amplifier and the Vertical Amplifier receive information from the appropriate plug-in unit. They are current-sensitive operational amplifiers, used to drive the crt deflection plates.

The CRT Circuits contain the high-voltage regulated power supply, the crt, and a blanking mixer. The high-voltage supply provides a nominal 3000-volt accelerating potential for the crt.

The Amplitude/Time calibrator is a self-excited, self-regulating, Colpitts oscillator controlled by the μSEC/CYCLE and mV AMPLITUDE switches.

The Delayed Pulse generator (Interconnecting Sockets schematic) is an internally triggered tunnel diode step generator, driven by the timing unit just before each sample is taken. Its output is a negative step of about 350 mv, offset by about 200 mv dc into 50 ohms. Risetime is 50 psec or less at the connector.

LOW VOLTAGE POWER SUPPLIES

General

The Type 661 Oscilloscope regulated power supplies are designed for exceptional short- and long-term stability. Sampling circuitry demands current pulses from the —100-, +100- and +300-volt supplies at irregular intervals. Thus, power supply leads and ground return current paths are carefully planned. All non-constant loads are supplied via individual leads from a common point at the output of the regulator circuits, and most grounds are returned to a common point at each regulator. The +300-volt supply reference tube V719 is temperature isolated for short-term stability. The crt display jitter is maintained at a very low level by use of high-gain feedback amplifiers within each regulator circuit.

Line voltage is applied through fuse F601 and the thermal cutout relay TK601 to the primary windings of the power transformer T601. When the oscilloscope is operated on 117 volts, the fan will remain on in the event the thermal cutout opens. When the oscilloscope is operated on 234 volts, the fan will be turned off in the event the thermal cutout opens. The thermal cutout automatically restores power to the primary of T601 when the oscilloscope inside temperature drops to a safe level.

Secondary terminals 20 and 21 of T601 energize the thermal time-delay relay K600 that controls the turn-on delay of the low-voltage power supplies when power is applied. As the contacts of K600 close (pins 4 and 9) K601 connects the unregulated supply leads of the —100-, +100-, and +300-volt supplies to the respective regulator circuits. The —25.2-, —19-, and +19-volt regulated supplies are not switched by K601. The —25.2-volt supply operates at about —25 to —27 volts before K601 is energized. The —19-volt supply operates at about —1 to —2 volts, and the +19-volt supply operates at about +15 volts before K601 is energized.

Voltage reference for the —100-, —19-, +19-, +100-, and +300-volt regulated supplies is V719, a gaseous voltage-regulator tube in the +300-volt supply. Voltage reference for the —25.2-volt regulated supply is a Zener diode, D643, in the —25.2-volt supply. The —12.6-volt supply is a shunt regulator utilizing Zener diode D649. This supply floats on the —25.2-volt supply.

+300-Volt Power Supply

The full-wave bridge rectifier circuit from terminals 9 and 16 of T601 is elevated upon the rectifier system of the +100-volt power supply. The total voltage of the two rectifier systems is about +455 volts at normal line voltage. It is used by both the crt high-voltage supply and by the +300-volt regulator system. The total load current of the +455-volt unregulated lead and the +300-volt regulated supply passes through the +100-volt rectifier system.

Voltage-regulator tube V719 maintains a fixed reference voltage of about +85 volts at the junction of R718 and R719. R718 is the +300 VOLTS adjustment. The voltage at the grid of V716B is obtained from a divider between ground and the +300-volt supply. A small ripple signal from the +455-volt supply is injected at the grid of V716B via a voltage divider and selected resistor R706. R718 (+300 VOLTS) is adjusted to set the voltage at the grid of V716A essentially equal to the voltage at the grid of V716B. Thus, V716, A and B, act as a voltage comparator; the A grid voltage (properly set by R718) is the reference for the +300-volt supply.

The voltage at the plate of V716A, about +200 volts, is divided by R720-R721 to place the grid of V724 just below ground. V724 amplifies and inverts the signals from V716 and establishes the correct grid voltage for series tube V737, A and B.

If the output voltage changes from +300 volts, a sample of the change is applied to the grid of V716B. The error signal is amplified, without phase reversal, by V716A and applied to the grid of V724. V724 amplifies and inverts the error signal, applying it to the grids of V737. V737 is a dual cathode follower; the cathodes follow the grid signal, restoring the +300-volt supply to its correct value.

Capacitors C707 and C720 increase the ac loop gain of the regulator circuit. Their function is to couple high-frequency error signals around the dividers to keep the feedback loop gain uniform with frequency. Thus, the supply will quickly compensate for rapid changes of output voltage. C696B, an electrolytic capacitor, aids in lowering the output impedance of the supply.

To assume minimum ripple and line voltage flutter in the output of the +300-volt supply, a small amount of ripple and line flutter voltage from the +455-volt supply is coupled to the grid of V716B. The value of R706 is selected to minimize the supply output ripple and null out any flutter when the ac line voltage is at its nominal value of 117 or 234 volts.

To assist in stabilizing the +300-volt supply against ripple and line flutter, Zener diode D726 provides a regulated supply voltage for V724. If the unregulated +455-volt bus were to be used as the plate supply voltage for V724, power line flutter would be coupled to the grids of V737 and the +300-volt supply leads.

Resistor R737, in parallel with V737, carries part of the current drawn from the +300-volt supply. R737 also provides for some voltage on the +300-volt supply leads (before the time delay relay closes) to turn on the —25.2-volt supply as soon as the ac power is turned on.

Resistors R731 and R733, located in the cathode circuit of V737, divide the load current between the two halves of the tube, avoiding the possibility of one side being overloaded while the other side does not carry its load share.

Due to careful reduction of ground currents, and by use of the special circuit design just discussed, the +300-volt supply output contains 120-cps ripple of less than 14 millivolts, peak-to-peak. Normal load variations can be as great as 200 ma, ranging from a minimum of 50 ma to a maximum of over 250 ma.

+100-Volt Power Supply

A full-wave bridge rectifier circuit from terminals 7 and 14 of T601 supplies power to the +100-volt regulator circuit and to the +300-volt power supply rectifier system.

A voltage divider, between the +100-volt regulator output and —100-volts, supplies a voltage near ground to the grid of error amplifier V694. If the supply voltage changes, a portion of this change is applied through the divider to the grid of V694. The error signal is then amplified and applied to the grid of series regulator tube V697. The change in voltage at the grid of V697 changes the voltage drop across V697, compensating for the change of the supply voltage.

A small amount of ripple and line flutter from the unregulated lead of the +100-volt rectifiers is coupled to the grid of V694 via selected resistor R694. The ripple and flutter is amplified and used to cancel almost all of the ripple at the output of the regulator. Normal load variations are from a minimum of about 30 ma to a maximum of about 130 ma.

For instruments with serial numbers 900 and above, the output voltage of the +100-volt supply is adjusted by R686.

—100-Volt Power Supply

The —100-volt regulated supply has a comparator-amplifier in the feedback circuit. The greater amount of feedback gain obtained by using both a comparator and a pentode amplifier keeps the output ripple to a value less than about 14 mv with a load of 200 ma or more.

To assure that V624 has an adequate plate supply voltage, neon glow tube B627 serves as a dc step-down to the grids of V637. The plate signal of V624 can then be at a higher dc level than required by the grids of V637, without attenuation of error correcting signals. Capacitor C627 assures that high-frequency correcting signals are not attenuated by the slow following action of B627.

The operation of the regulator circuit is similar to the operation of the +300-volt regulator circuit previously discussed.

—25.2-Volt Power Supply

A full-wave bridge rectifier circuit from terminals 20 and 21 of T601 supplies power to the —25.2-volt regulator circuit. The —25.2-volt regulator then supplies power to the —19-volt power supply and the —12.6-volt Zener diode regulator. The —25.2-volt power supply provides heater current for the vacuum tube feedback amplifiers of the other low voltage regulator circuits (this does not include the series tubes), and is available to the vertical and horizontal plug-in cells.

The output voltage of the —25.2-volt regulator is relatively independent of the other adjustable supplies. The reference voltage for the —25.2-volt supply is the drop across Zener diode D643 and the temperature compensating diode D644, compared to ground, at the emitter-base junction of Q644.

The operating current of D643 is set by R643. A small amount of additional current flows through R644, D644, and R645 to the +300-volt supply. R645 assures a forward bias for Q644, with D644 and D643 acting to limit Q644 current to the correct value.

Normally, the voltage at the base of Q644 rests at about +0.5-volt. If the voltage at the base changes because of a change in the supply voltage, the error signal will be amplified and applied to the base of power transistor Q647. The change in base voltage at Q647 changes the drop across Q647 in a direction to restore the output to normal.

For example, if the supply output starts to go less negative, Q644 will conduct more heavily. This produces a negative drop in the voltage at the collector of Q644 and at the base of Q647. The negative going signal at the base of Q647 causes it to conduct more heavily, reducing its collector-to-emitter voltage and pulling the whole supply in a negative direction to correct for the error.

Diode D644 protects Q644 from large low-impedance positive-going error signals, such as might occur if the supply output lead is accidentally grounded. If the output lead should be grounded, and D644 opens due to its normal inverse bias characteristics, the base current of Q644 is held to a safe limit by R645. As soon as the short is removed and the output voltage returns negative, D644 will again conduct, restoring normal regulator action. See the Maintenance section of this manual for probable damage and its correction for prolonged periods of short circuit of the —25.2-volt supply.

Electrolytic capacitor C644 assures that error signals are applied to the base of Q644 without delay, and that Zener diode D643 is not required to pass any high amplitude ac currents.

—19-Volt Power Supply

The —25.2-volt supply provides power to the —19-volt regulator circuit. A voltage divider between —19 volts and +19 volts provides a voltage near ground to the base of transistor Q654. This voltage is essentially compared to ground in the emitter-base junction of Q654. The emitter of Q654 is held about 0.4 volt above ground by the drop across diode D653. D653 is a first order temperature compensation, causing a small variation to Q654 emitter voltage with variations in temperature to correct for Q654 changes due to temperature.

R656, in the collector leads of Q653 and Q657, acts as a fuse in the event of a heavy overload.

The output voltage of the —19-volt power supply is adjusted by R651. The output is also sensitive to changes of both the +300- and +19-volt supplies.

Any changes of the output voltage are coupled to the base of Q654 via the divider R650-R651-R652, and by C652. Q654 amplifies the error and applies it as negative feedback to the base of emitter follower Q653. Q653 gives current gain to the correcting signal for the base of series regulator Q657. Q657 acts as an emitter follower for the —19-volt load, returning the output voltage to normal.

+19-Volt Power Supply

A full-wave bridge rectifier system from terminals 22 and 23 of T601 supplies power to the +19-volt regulator circuit.

Diode D672 gives the +19-volt power supply first order temperature compensation for added stability. R675, in the collector leads of Q673 and Q677, acts as a fuse in the event of a heavy overload.

Reference voltage for the +19-volt supply is adjusted by R666 as part of a voltage divider between the +300-volt supply and ground.

Any changes of the output voltage are coupled to the emitter of Q674 by D672, and compared to the base reference voltage. Q674 amplifies the error signal (in phase) and applies it to emitter follower Q673. Q673 gives current gain to the correcting signal for the base of series regulator Q677. As an example, if a negative error occurs, the correction signal will cause Q677 to decrease the voltage between its emitter and collector, raising the output voltage back to normal.

Probe Power Supply

The —12.6-volt supply is a shunt regulator floating on the —25.2-volt supply. Its purpose is to supply 180 ma to each of the sampling unit PROBE POWER jacks for heaters in cathode-follower signal probes.

CRT CIRCUITS

High-Voltage Power Supply

Unregulated +455 volts from the +300-volt power supply is applied to the high-voltage oscillator, V800. V800 and its associated circuitry is a modified Hartley oscillator. C809 and the primary of T801 form a tuned plate circuit for V800. The oscillator operates at approximately 40 kc. High-voltage transformer T801 provides the high voltage and heater voltage for the high-voltage rectifier V822.

The high-voltage secondary winding of T801, and rectifier V822, supplies the high voltage for the crt circuits. A voltage divider between the high voltage and the +300 volts supplies proper voltages to the crt cathode, grid, focusing element, and the HIGH VOLTAGE control R841. The voltage at the junction of R841 and R842 is the grid voltage of V814B, to control the output voltage and regulation of the supply. If the high-voltage supply changes from its set value, a portion of the change appears at the grid of V814B as an error signal. The error signal is amplified by V814B and V814A to change the voltage at the screen grid of V800 in the correct direction to compensate for the output error.

Capacitor C842 increases the ac loop gain of the high-voltage regulator circuit. This permits the regulator to compensate quickly for changes in the output voltage.

Crt Intensity Control

Neon glow tubes B847 and B848 provide a low-impedance path from the high-voltage lead to the crt cathode. The glow tubes also establish about 110 volts constant voltage across the INTENSITY control. Changing the setting of the INTENSITY control (R848) will change the crt bias and the display brightness.

Other Crt Voltages

Voltage for the focus element of the crt is obtained from potentiometer R845. Varying R845 adjusts the focus element voltage to permit proper spot focus.

Voltage for the astigmatism element is obtained from potentiometer R864. Varying R864 adjusts the astigmatism element voltage to permit best spot size and trace definition in conjunction with the FOCUS control.

A fixed voltage for the deflection plate isolation shield of about +160 volts is obtained from voltage divider R862-R863. This voltage divider is also connected to the crt internal dag coating and is the electron beam return path. The deflection plate isolation shield minimizes the electrostatic fields between the two sets of deflection plates and reduces interaction between the vertical and horizontal systems to insignificance.

Blanking

The oscilloscope uses deflection blanking during the interval that the spot is moved from one sampling dot position to the next, and during retrace. The deflection method of blanking uses a special set of deflection plates in the electron gun to divert the electron beam and turn off the display. The crt cathode experiences little or no change in current by the blanking action, because the positive deflection blanking plates accept the cathode current electrons when the display is turned off.

Blanking amplifier V874A rests at cutoff except when the blanking signal turns off the crt beam current. A voltage divider in the grid circuit of V874A sets its grid voltage at about −10 volts. The voltage divider at the plate of V874A holds the plate at about +170 volts when the tube is cutoff. Positive-going blanking signals can come from the vertical, the horizontal, or an external digital unit. The blanking signal at the plate of V874A takes the blanking deflection plate (pin 6 of the crt) from about +170 volts to about +50 volts. The other blanking deflection plate voltage is adjusted to its correct value by the BLANK BAL. potentiometer R866. During the time the spot is turned off, R866 and its associated divider accept the crt cathode current.

VERTICAL AMPLIFIER

The Vertical Amplifier receives input signals from the vertical sampling plug-in unit. The amplifier is a current sensitive operational amplifier with a very low input impedance. The amplifier output voltage drives the crt vertical deflection plates and the vertical position indicators. The amplifier sensitivity is calibrated to be about 25 μamps/cm.

The amplifier consists of two stages; an emitter-coupled paraphase input stage, and a plate-loaded push-pull output stage. The input current to an operational amplifier is always equal to the current in the feedback resistance. The plate voltage of V454A drives the feedback resistance (R472) sufficiently so that the feedback current is 25 μamps/cm. The vertical amplifier has essentially no series input resistance, therefore its input sensitivity is 25 μamps/cm. The push-pull output voltage of the amplifier is about 20 volts/cm as required by the crt.

The plate load resistor of V454A is divided for signal take-off to V874B, the vertical beam-position indicator cathode follower. Neon glow tubes B468 and B469 are ignited or extinguished according to the position of the crt spot when off screen. As an example, if the spot is off in a positive direction, the plate voltage of V454A will be somewhat lower than +130 volts. The cathode of V874B will be somewhat lower than +180 volts, B468 will be glowing and B469 will be dark.

HORIZONTAL AMPLIFIER

The Horizontal Amplifier consists of a three-transistor operational preamplifier, and a two-transistor, two-triode operational output amplifier. The preamplifier drives both the output amplifier and the front-panel horizontal signal output terminal. The preamplifier output signal is 200 mv/cm. The output amplifier drives the crt horizontal deflection plates, the horizontal takeoff, and horizontal neon position indicators.

All input signals to the Horizontal Amplifier pass either through terminals 6 and 19, or through terminal 8, of the vertical Interconnecting Socket, J1. Regardless of the type of horizontal presentation (sweep, external signal, X-Y operation), the vertical plug-in unit must be in place in its cell to complete the horizontal input signal path.

The horizontal preamplifier gain is varied from a minimum of 0.04 to a maximum of 4.0 by the HORIZONTAL DISPLAY switch. The input impedance at the base of Q313 is as low as 1 ohm when the magnifier gain is ×1 or the external horizontal deflection factor is 5 volts/cm. The Q313 input impedance rises to a maximum of 100 ohms when the magnifier gain is ×100 or the external horizontal deflection factor is 0.05 volt/cm. Since the input signal passes through R302 (except for X-Y operation), the input impedance then remains at essentially 25,000 ohms for all amplifier sensitivities. For X-Y operation, the input impedance is that of R303, 3,000 ohms, giving an increase in gain of 10 to the horizontal system.

Two silicon diodes are connected between the base of Q313 and ground to limit the input signal amplitudes to about ±0.6 volt. Higher input amplitudes could damage transistors or diodes in the rest of the horizontal amplifier system.

Q313 is an emitter-follower current amplifier, required for its low-impedance drive capabilities by the base of Q324. The collector circuit of Q313 is maintained at +6.3 volts by Zener diode D314, aiding in reducing the output impedance of Q313 to the required value. Amplifier Q324 has a first-order temperature compensating germanium diode in its emitter circuit.

Q333 is an output emitter follower required for its low output impedance to drive the feedback resistors, the output amplifier, and the horizontal signal output terminal. Since the emitter of Q333 rests at about −6 volts, and the output circuit of the operational preamplifier must rest near ground, Zener diode D334 alters the output dc level by 6.3 volts without signal attenuation.

The horizontal output amplifier is identical to the vertical output amplifier except its sensitivity is 20 μamps/cm. In some instruments, the crt *horizontal* deflection factor is adjusted to 16 volts/cm by adjusting the high voltage supply. In others, the horizontal output amplifier gain is adjusted by R359, and the high voltage supply is adjusted to establish the crt *vertical* deflection factor. Since both vertical and horizontal amplifiers are basically low-frequency systems, the horizontal system was given the deflection plates requiring less drive per centimeter but a longer required scan.

Horizontal Takeoff Amplifier

The horizontal system of the Type 661 permits manual or external scanning of the sampling display. (In the MANUAL SCAN positions of the HORIZONTAL DISPLAY switch, the horizontal POSITION control acts as a scan control.) When either manually or externally scanning the display, the horizontal amplifier output voltage is used by the timing unit to control the delay time between triggering and sampling. Voltage from the plate of V364A is fed to the horizontal takeoff amplifier V384, which inverts, attenuates, and adjusts the dc level. The voltage from the takeoff amplifier is used by the timing unit as a fixed fast ramp voltage. Thus, each triggered sample no longer slews along the fast ramp (and the display), but is held at a fixed point by the level of the takeoff voltage. Rotating the POSITION control changes the takeoff voltage to the timing unit, much the same as if the timing unit fast ramp voltage were functioning in a normal manner. (See the instruction manual for the timing unit in use.) The position of the manually or externally scanned displays is made to agree with the normal timing unit scanned display by means of R378, the HORIZ. TAKEOFF DC LEVEL control. The takeoff amplifier voltage gain is calibrated to be about 0.6.

The horizontal beam position indicators are controlled by the voltage at the plate of V384A.

AMPLITUDE/TIME CALIBRATOR, S/N 101-1999

The Amplitude/Time Calibrator is a modified Colpitts oscillator with four amplitude and frequency settings. V930 forms a parallel triode oscillator. Adjustment of feedback voltage from the cathode of V930 aids in establishing the correct output amplitude. For the 10, 1, and .1 positions of the μSEC/CYCLE switch, the grid voltage of V930 is limited in amplitude by the emitter voltage of Q953. The voltage at the emitter of Q953 does not materially affect the output amplitude when the μSEC/CYCLE switch is in the .01 position.

V930 grid voltage limiting centers about ground potential. The emitter voltage of Q953 is adjusted during calibration to a value near +14 volts. Thus, diodes D942 and D952 conduct alternately when the voltage at their junction reaches ground and +14 volts. C941 thus maintains a nominal charge of 7 volts, permitting the grid of V930 to swing freely from about —7 to +7 volts each cycle. The oscillator feedback is high enough to drive the grid of V930 more than ±7 volts, thus diodes D942 and D952 limit the grid swing and the output amplitude.

The output circuit of the oscillator is capacitively coupled to a load of about 230 ohms made up of R976 in series with the two terminating resistors (R977-R978) and a 50-ohm four-position attenuator. The mV AMPLITUDE control switches in appropriate 50-ohm attenuators so that the oscillator amplitude can remain constant while the output connector receives the correct amplitude at the correct impedance.

A second oscillator output is taken through isolation resistor R966 to the timing unit for internally triggering the sampling display. This feature is particularly important when the vertical plug-in unit does not have triggering circuitry, or when the calibrator signal is less than that required by the vertical plug-in unit for proper internal trigger pickoff. Because of this signal, the calibrator should be turned off when not in use. If the calibrator is left on, there may be triggering interference due to stray coupling in the timing unit.

Selection of the output frequency is provided by resonant circuits that can be switched into the base-emitter circuit of Q930 by SW910, the front-panel μSEC/CYCLE switch. Each resonant circuit consists of fixed capacitors and an inductor that is variable for frequency adjustment. At the .01 μsec position (100 mc), the resonant circuit consists of the capacitance of C934 and C935 and the inductance of L916 and its associated leads.

Excursion of the oscillator sine-wave output is from about —5 volts to +5 volts, set primarily by clamp diodes D930. Feedback current to the oscillator is adjusted by R942 (OSC. FEEDBACK), and at the high frequencies C942 assists in providing oscillator feedback. For the 100 mc output (.01 μSEC/CYCLE), L955, R955 and C956 form a critically damped LRC circuit to insure a sinusoidal drive for the current-switching diode stage.

Current-switching diodes D958 and D959 receive approximately 40 ma of current from the —100-volt supply through R967, R965 and R964. At the .01 position of the μSEC/CYCLE switch, current is increased by shorting out R967. With the oscillator turned off, current is divided equally between the two diodes, with R962 (SYMMETRY) correctly adjusted. When the oscillator is operating, its sine-wave output is applied to the anode of D958. On the positive swing, current increases through D958 until the diode is conducting all of the 40 ma and D959 is cut off. The output level is at zero volts at that time. On the negative oscillator swing, current decreases through D958 until it cuts off and the 40 ma is conducted through D959 and the 25 Ω load. The output level is then at —1 volt. Thus the clipped sine-wave output has a peak-to-peak amplitude of one volt. Corrective networks provide compensation for circuit and diode capacitance in the current-switching stage. R970, L970 and C971 provide compensation for the 10 mc signal. R968 and C968 compensate the 100 mc waveform. L958 and L970 are self resonant at 100 mc to reduce losses caused by L960 and the 10-mc compensation network. Adjustments in these circuits are set to produce the best possible wave-shape of the clipped sine-wave output.

The output from the diode stage is applied to a network of three 50-ohm 10× attenuators that can be connected in series with the load to produce the desired output amplitude. Attenuation of the 1-volt calibrator signal is selected by SW980, the front-panel mV AMPLITUDE switch.

A second output from the oscillator circuit is taken through isolation resistor R954 to the timing unit for internally triggering the sampling display. This feature is particularly useful for observing the calibrator signal when the vertical plug-in unit does not have a trigger takeoff or when the calibrator signal is of low amplitude. The internal calibrator trigger has the same amplitude (about 100 mv) regardless of the position of the mV AMPLITUDE switch. Because of this signal, the calibrator should be turned off when not in use to avoid triggering interference through stray coupling in the timing unit.

AMPLITUDE/TIME CALIBRATOR, S/N 2000-UP

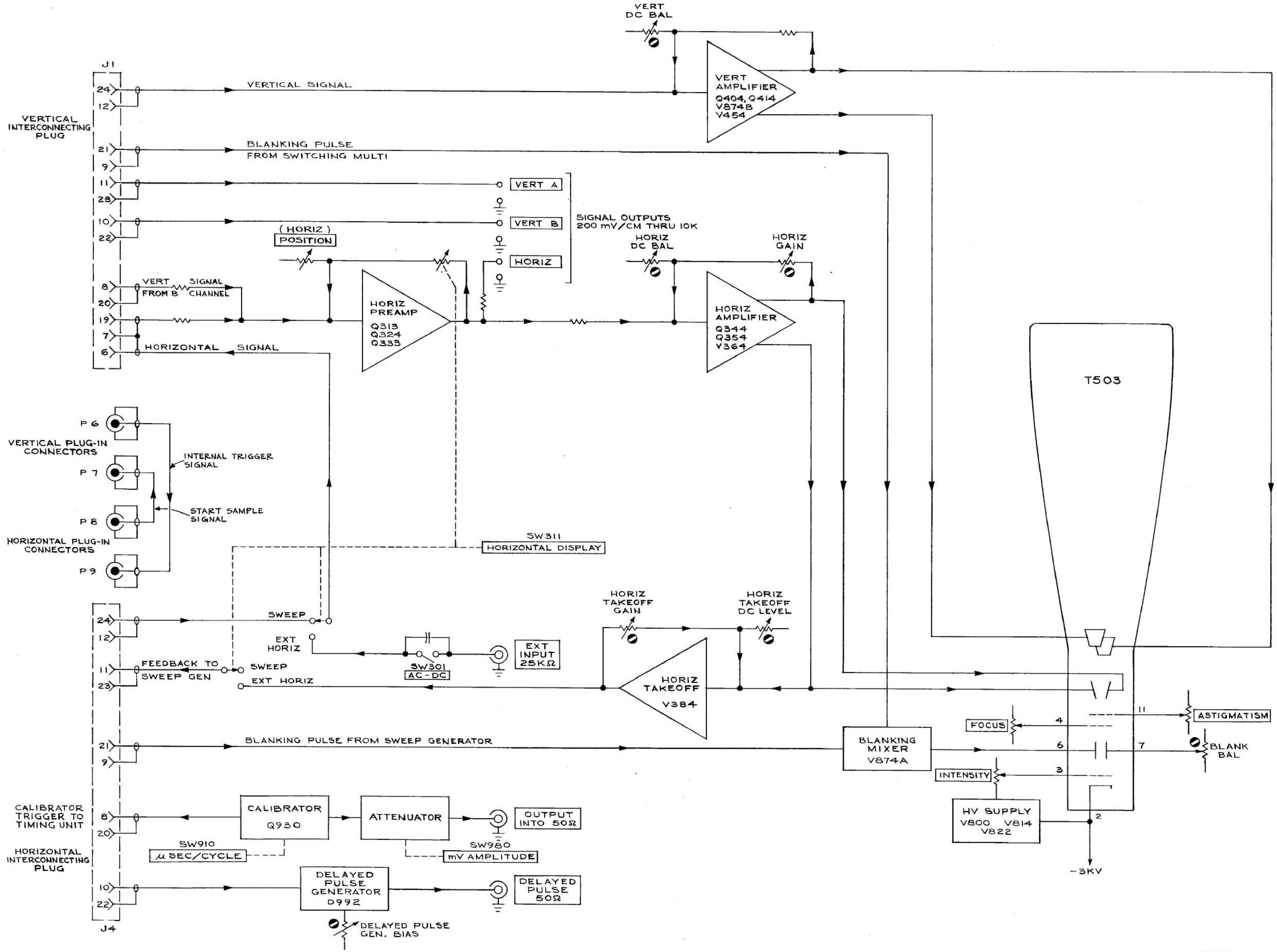
The Amplitude/Time Calibrator is a transistorized Colpitts oscillator with four output amplitudes from 1 mv to 1 volt and four output frequencies from 100 kc to 100 mc. The calibrated amplitudes and frequencies are in decade steps.

DELAYED PULSE GENERATOR

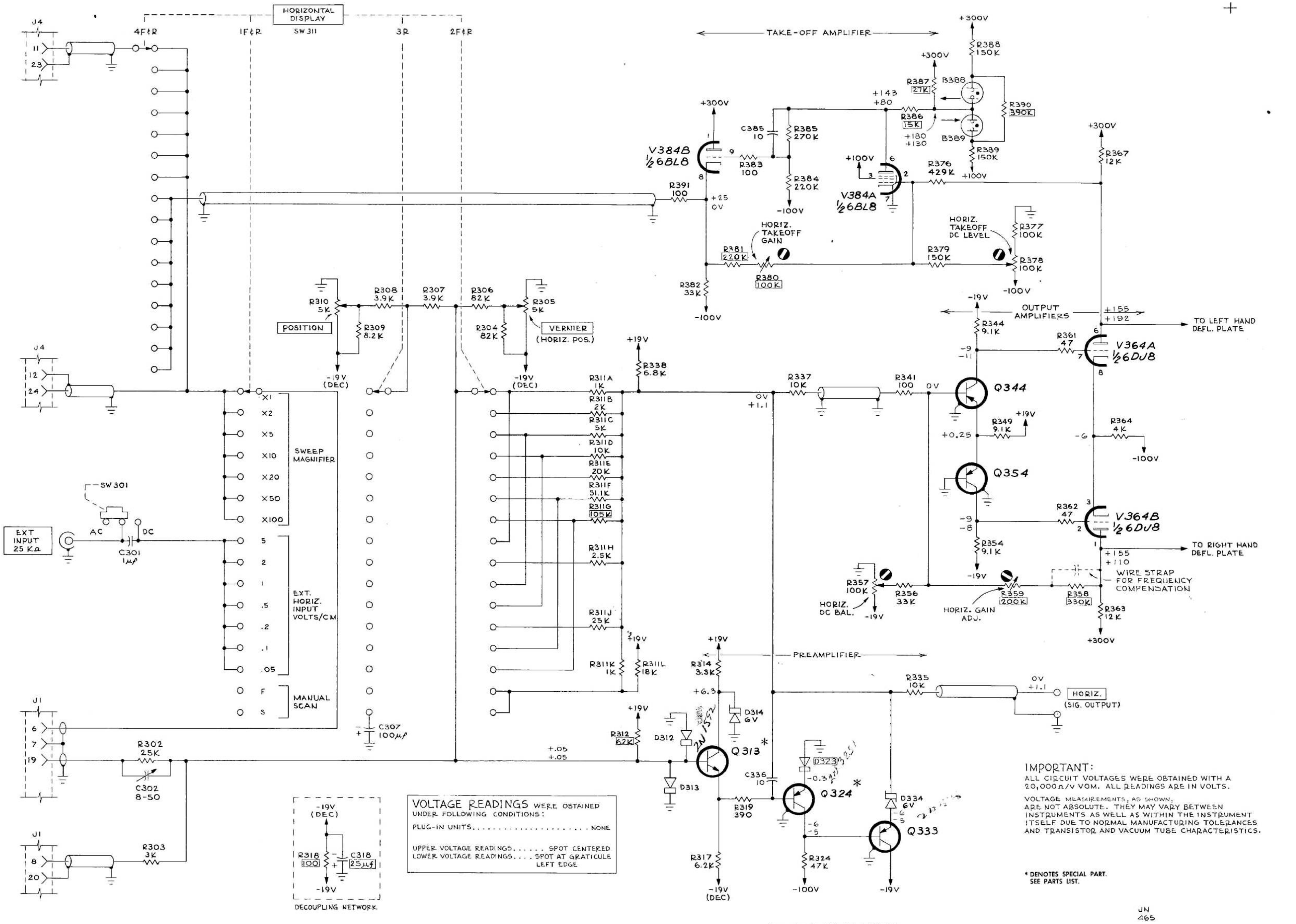
The Delayed Pulse Generator employs a strip-line 50-ma tunnel diode to deliver a fast negative-going pulse to a 50-ohm load (at the DELAYED PULSE 50 Ω connector). Tunnel diode switching voltage comes from the timing unit plug-in.

Static operating bias is obtained from the voltage drop across R990, the internal DELAYED PULSE GEN. BIAS control. Current for R990 comes from the —25.2-volt supply through the heaters of V694 and V814.

The tunnel diode is switched from its low-voltage state to its high-voltage state each time the timing unit is triggered. Thus, the negative step can be made to appear as a stable crt display regardless of the sweep rate. If the timing unit is triggered, the delay pulse repetition rate is the same as that of the signal (up to a maximum determined by the count-down rate of the timing unit). If the timing unit is free running, the delayed pulse will appear at the free-run rate.



BLOCK DIAGRAM

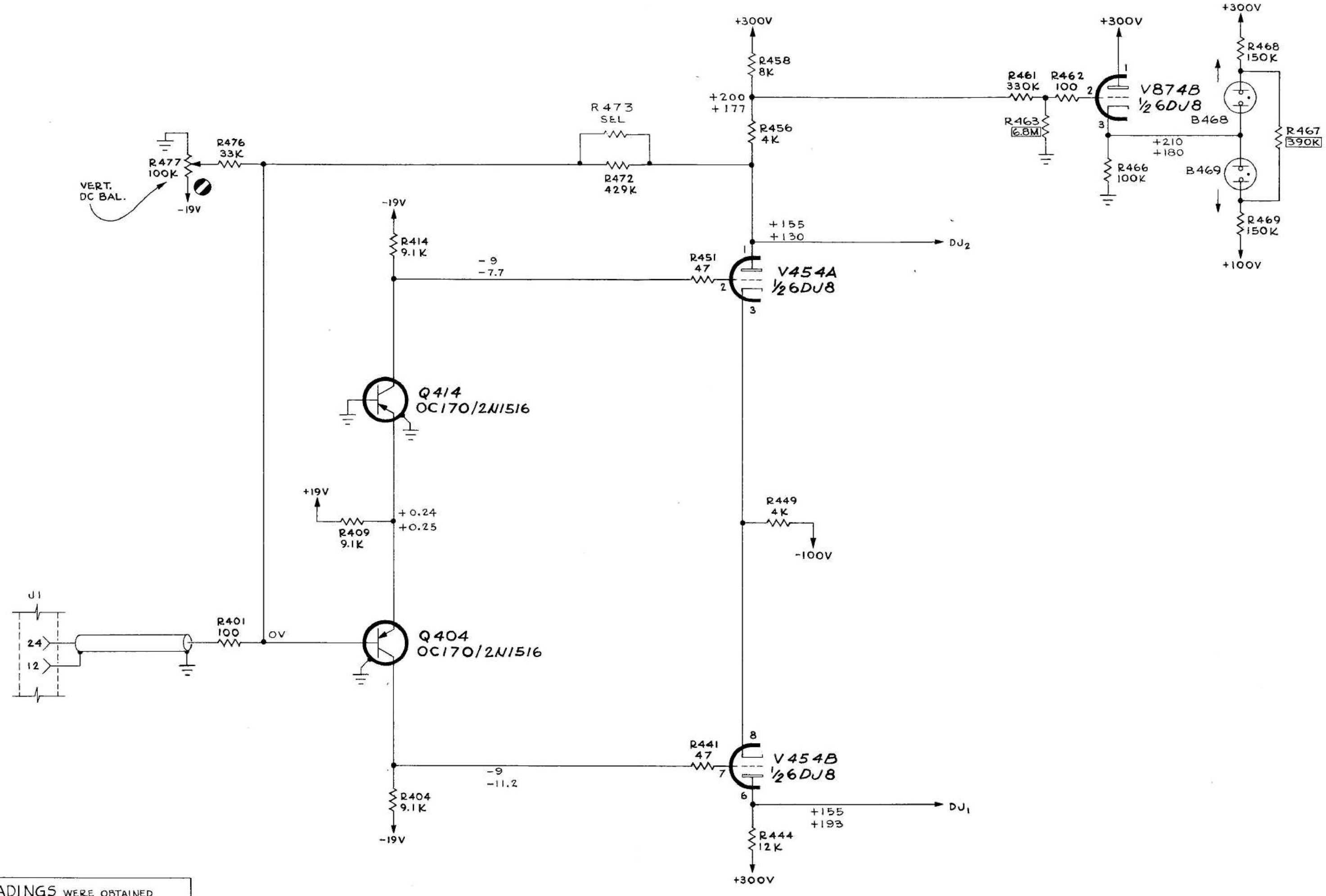


TYPE 661 OSCILLOSCOPE

E

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE

HORIZONTAL AMPLIFIER

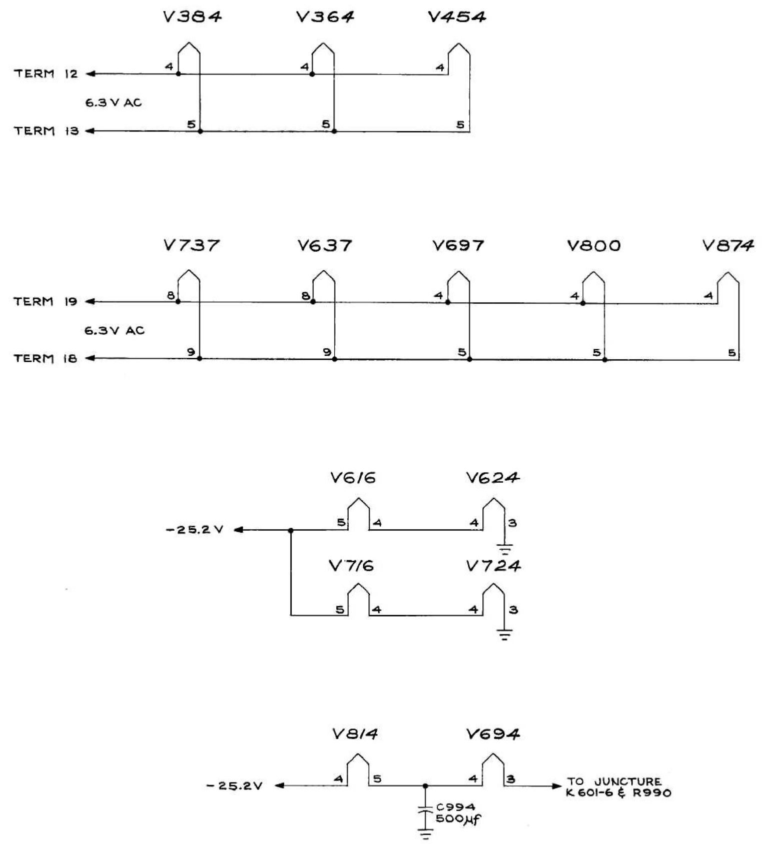


VOLTAGE READINGS WERE OBTAINED UNDER FOLLOWING CONDITIONS:
PLUG-IN UNIT . . . . NONE
UPPER VOLTAGE READINGS . . . . SPOT CENTERED LOWER VOLTAGE READINGS . . . . . . * SPOT AT +4 CM
ALSO SEE IMPORTANT NOTE ON HORIZ. AMP. DIAG.

* SPOT POSITION CONTROLLED BY VERT. DC BAL. CONTROL

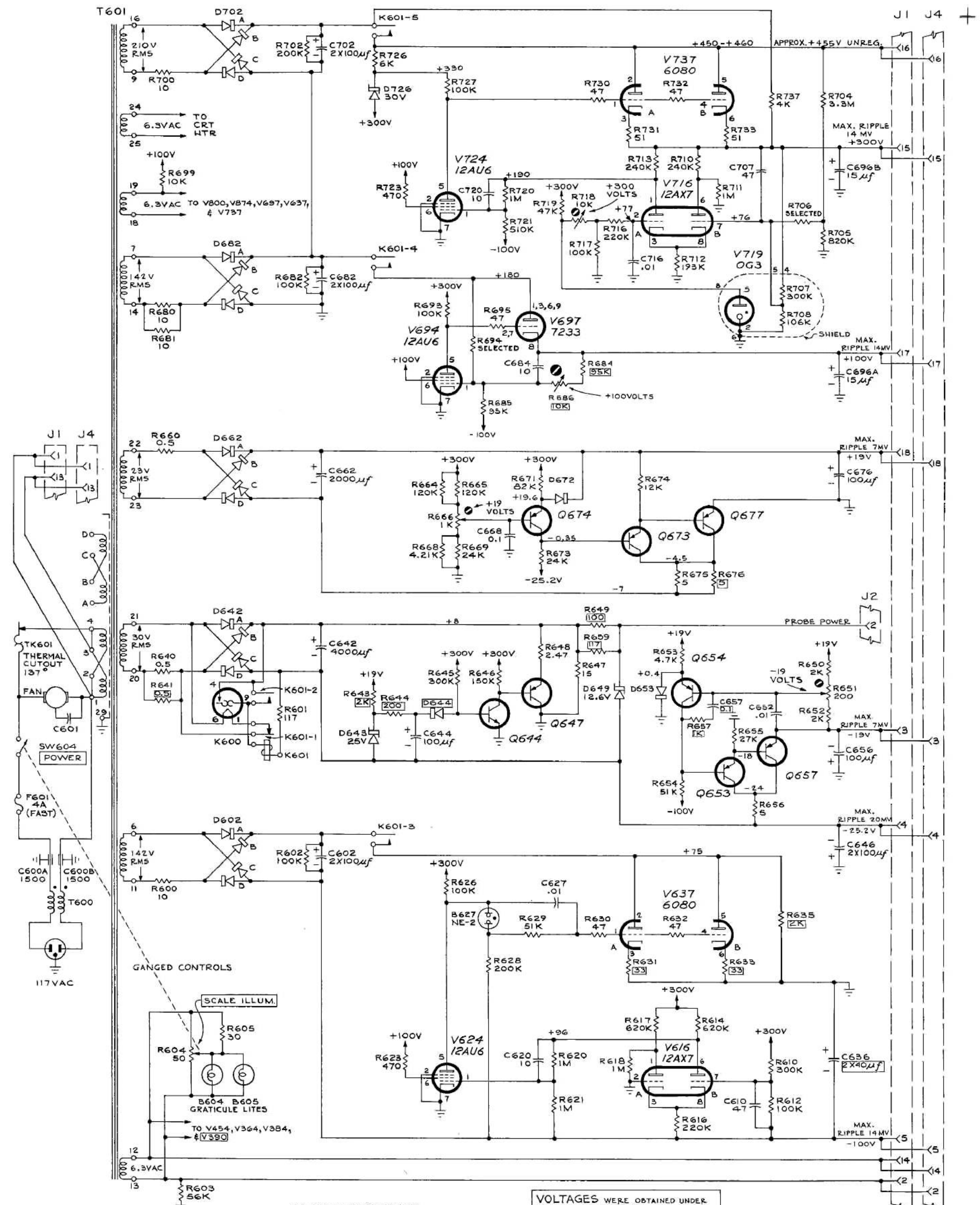
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE

JN
265



TYPE 661 OSCILLOSCOPE

1265
HEATER WIRING



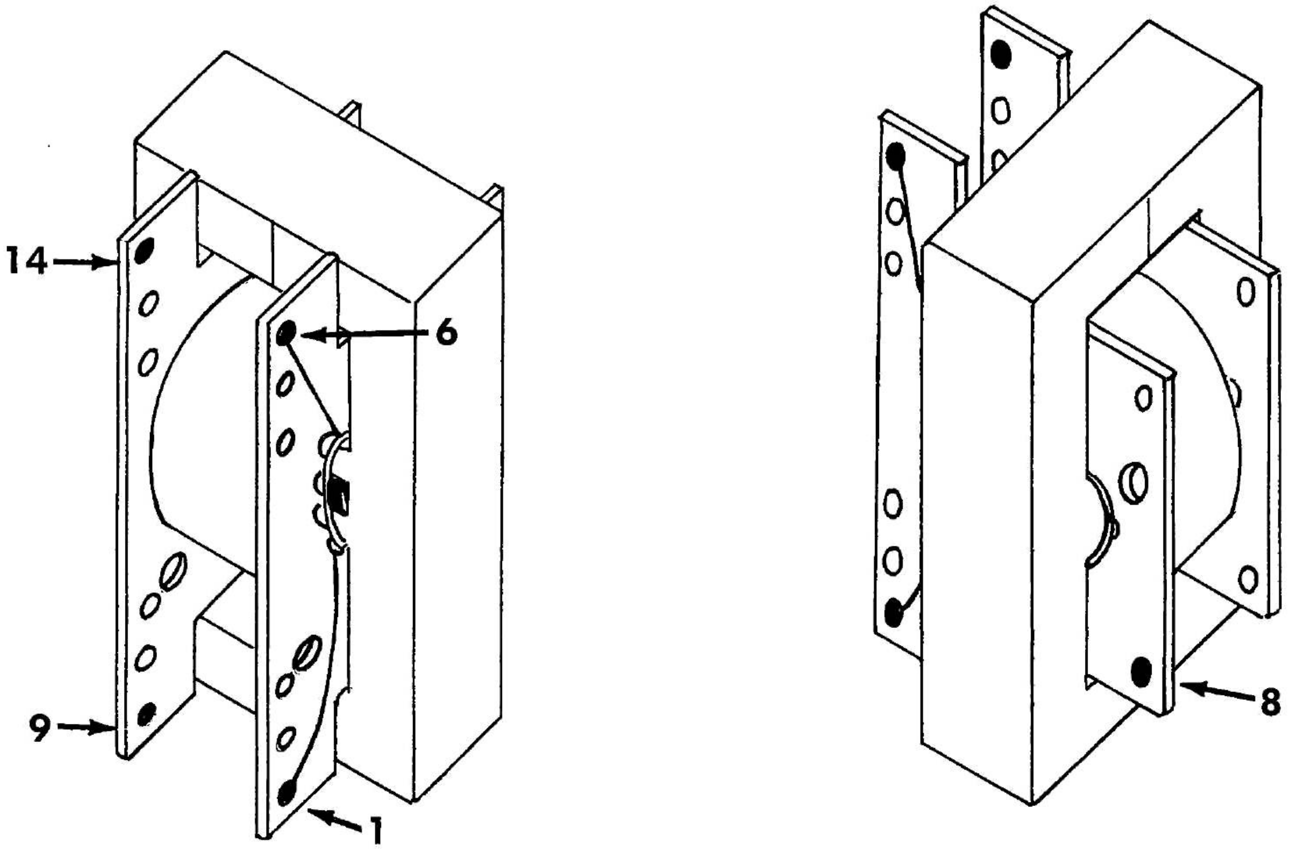
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

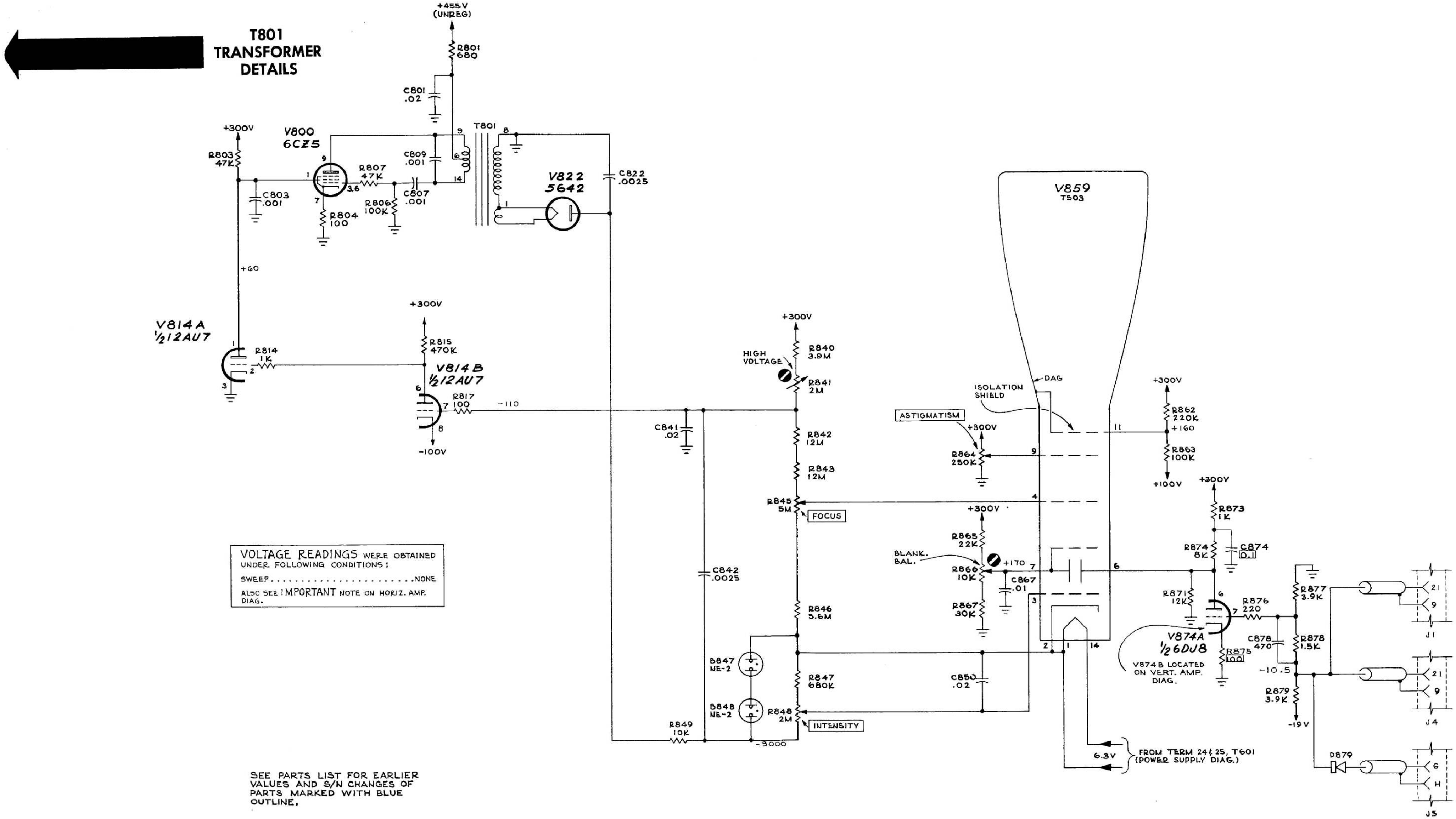
VOLTAGES WERE OBTAINED UNDER FOLLOWING CONDITIONS:
PLUG-IN UNITS .... TYPE 451 & TYPE 571
SWEEP .... NONE
CALIBRATOR .... OFF
ALSO SEE IMPORTANT NOTE ON HORIZ. AMP. DIAG.

MRH 865

POWER SUPPLY



T801 TRANSFORMER DETAILS



VOLTAGE READINGS WERE OBTAINED UNDER FOLLOWING CONDITIONS:

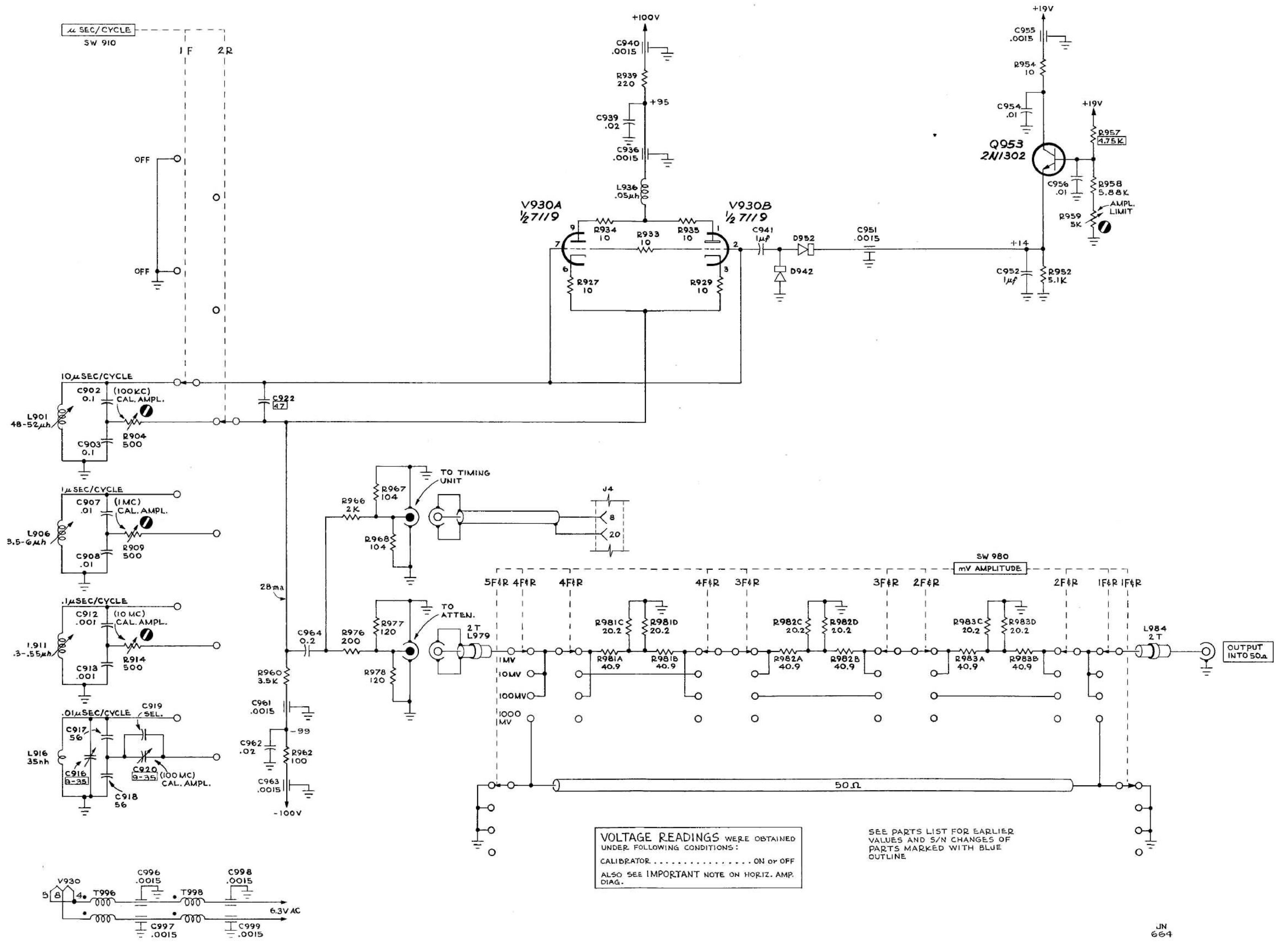
SWEEP......................NONE

ALSO SEE IMPORTANT NOTE ON HORIZ. AMP. DIAG.

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

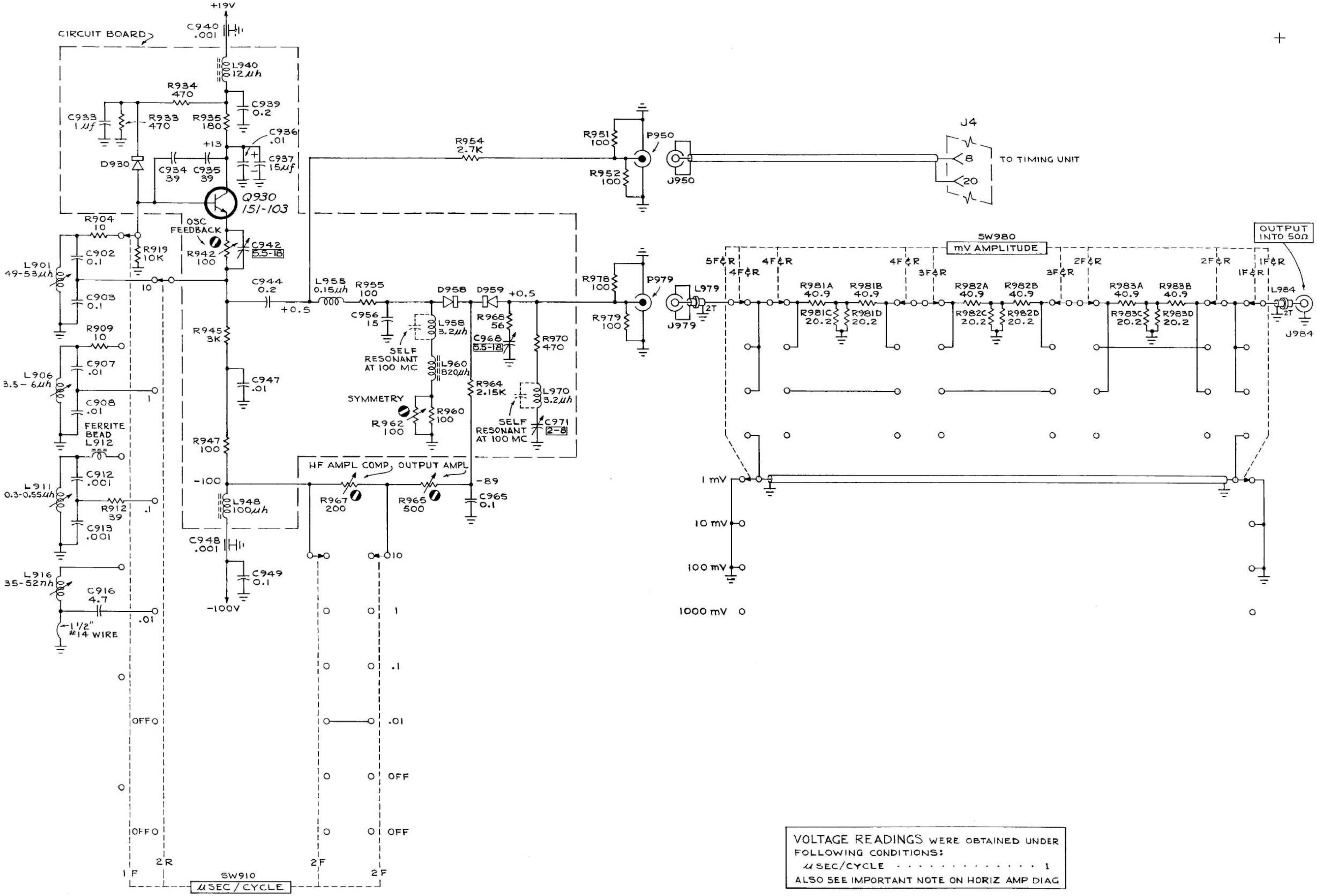
JN
763

CRT CIRCUIT



AMPLITUDE/TIME CALIBRATOR

S/N 101 - 1999

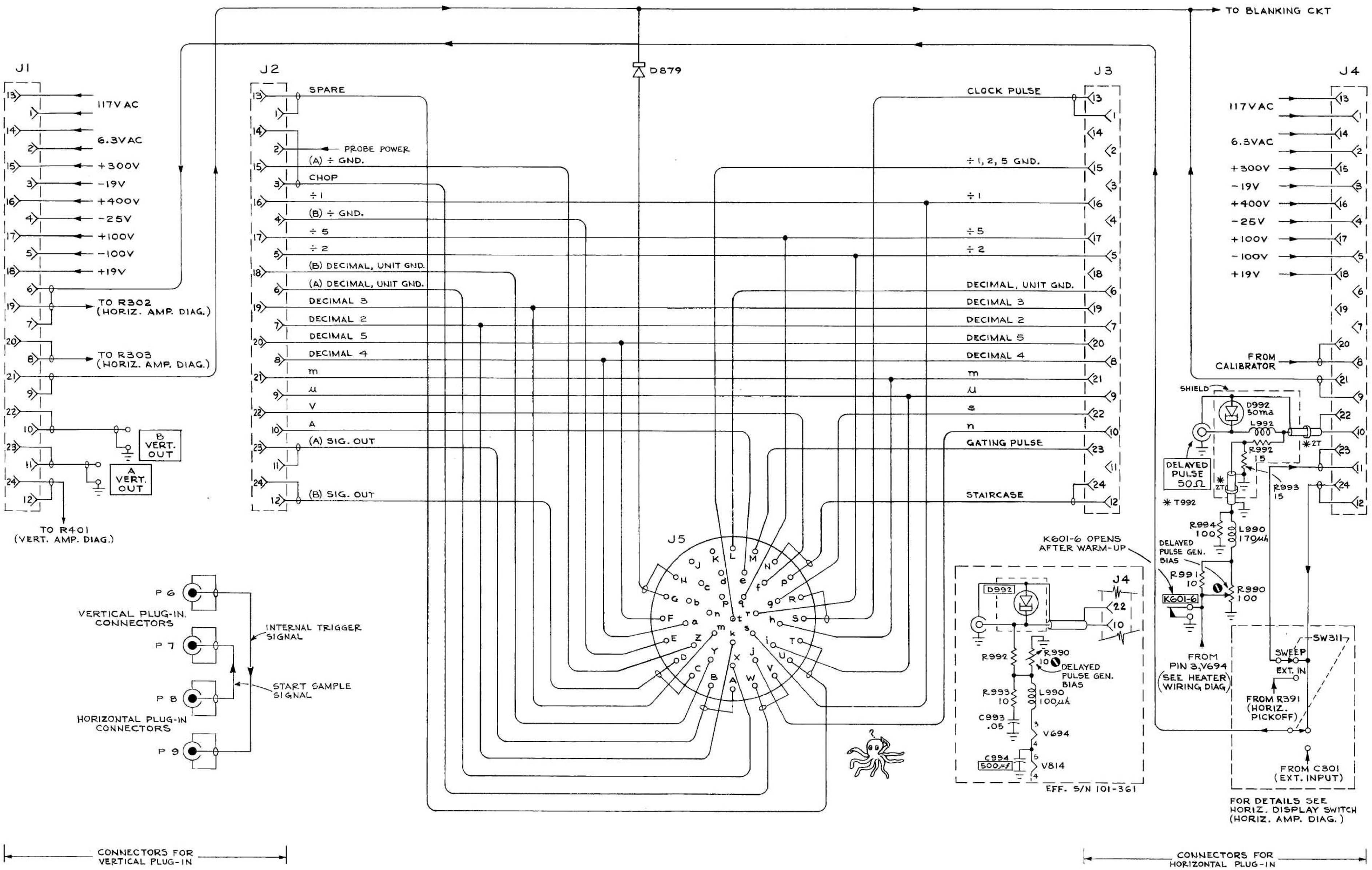


VOLTAGE READINGS WERE OBTAINED UNDER FOLLOWING CONDITIONS:
μSEC/CYCLE 1
ALSO SEE IMPORTANT NOTE ON HORIZ AMP DIAG

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

MRH
665

AMPLITUDE / TIME CALIBRATOR
S/N 2000-UP



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE

MRH
1064

TYPE 661 OSCILLOSCOPE

B1

INTERCONNECTING SOCKETS

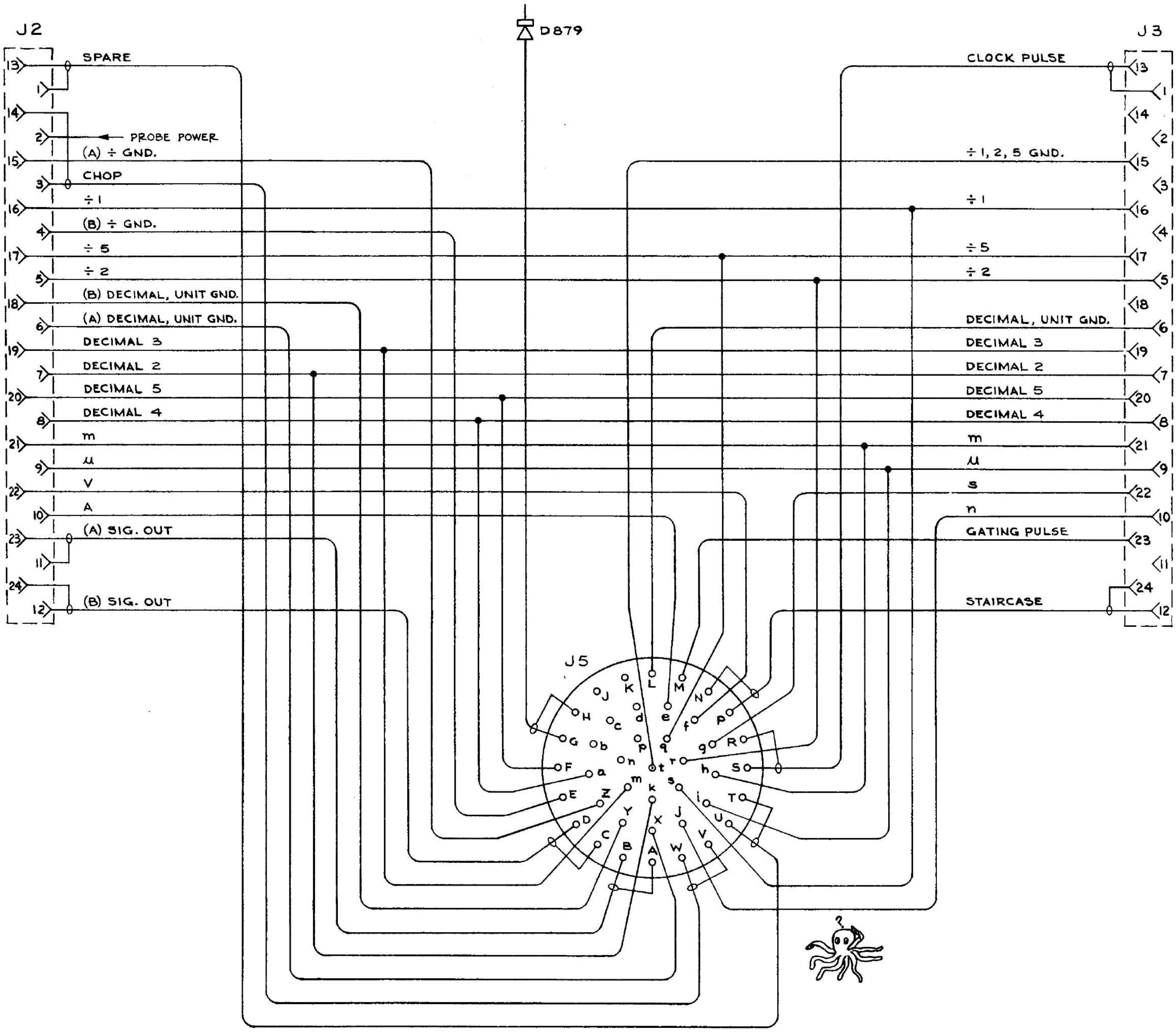
MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

SCHEMATIC CORRECTION

Remove all of below circuitry except J2 and Pin 2 (Probe power).



PART. INTERCONNECTING SOCKETS