INSTRUCTION MANUAL

Serial Number ____________

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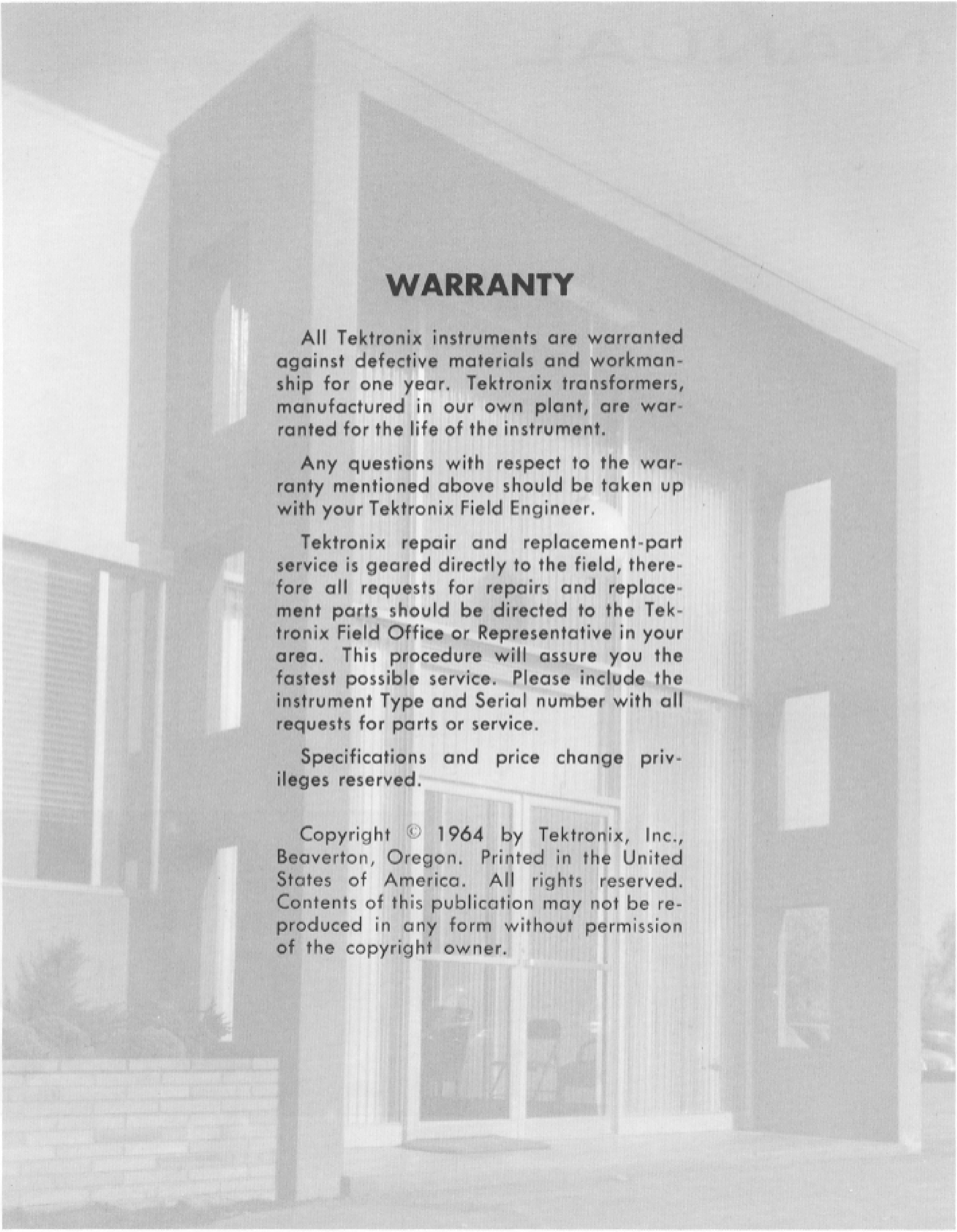
070-411 **264**



WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

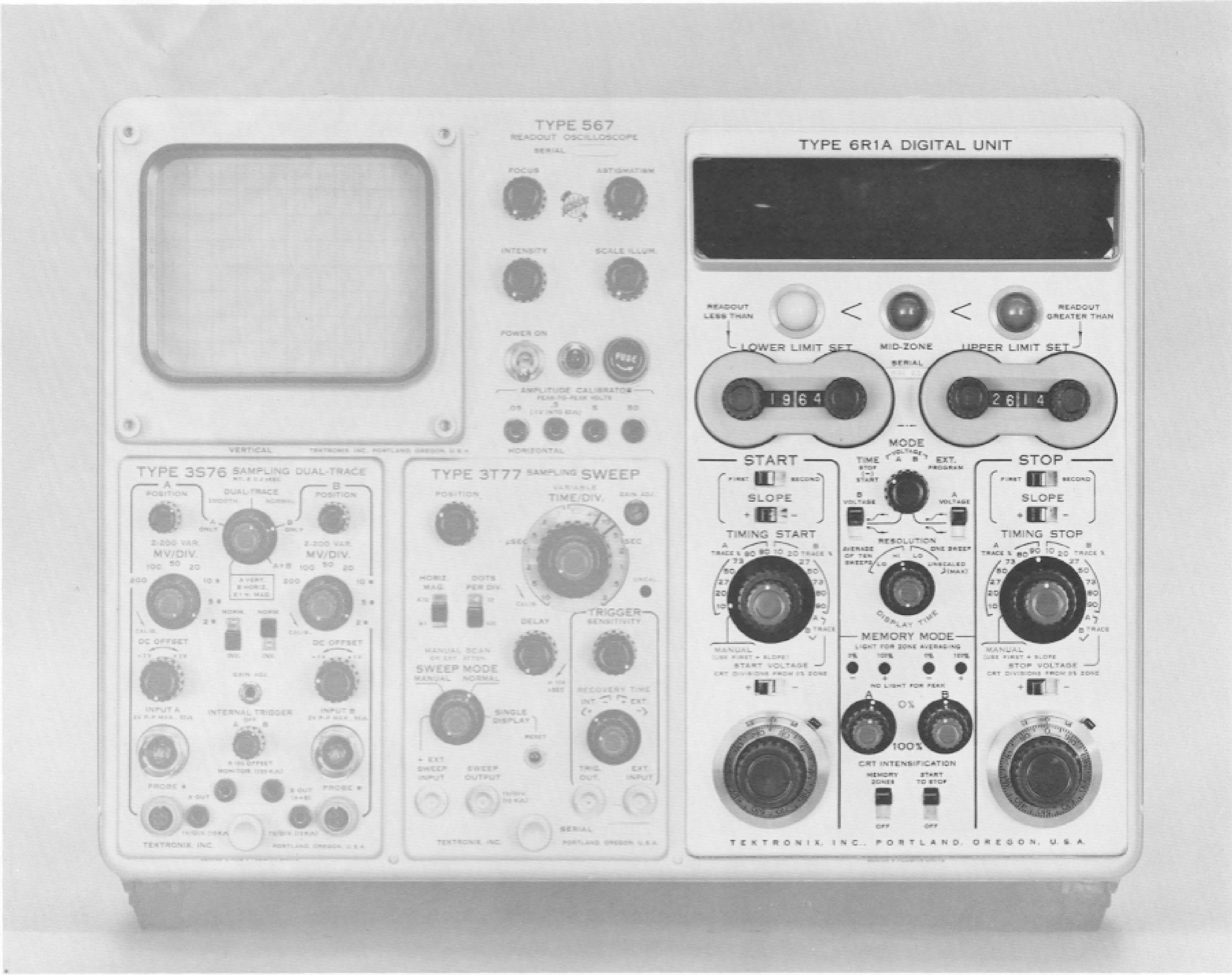
Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

Specifications and price change privileges reserved.

CONTENTS

A list of abbreviations and symbols used in this manual will be found on page 9-1. Change information, if any, is located at the rear of the manual.



Type 6R1A Digital Unit.

SECTION 1
CHARACTERISTICS

General Information

The Type 6R1A Digital Unit is designed to use in the Tektronix Type 567 Readout Oscilloscope in conjunction with certain 3-Series plug-in units for making automatic digital measurements of voltage, time between percentages of pulse amplitudes, and time difference between pulses. The Type 6R1A provides a 4-digit readout plus unit of measure.

OPERATING CHARACTERISTICS

Input

Internally from horizontal and vertical plug-in units.

Units of Measure

Volts: Readout in millivolts (MV) and volts (V).
Time: Readout in nanoseconds (NS), microseconds (μS), milliseconds (MS), and seconds (S).

Numerical Range

Readout from .0000 to 9999.

Accuracy of Readout

The accuracy of the number shown on the readout depends on the accuracy of the plug-in units, the difference in comparator delay, start and stop multivibrators, counters, and pickoff ability. Readout accuracy is always better than that of an operator reading from the crt.

Display Time

Variable from ≈0.1 second to ≈5 seconds.

Preset No-Go Limits

Front-panel controls set lower and upper limits. Front-panel indicator lights show whether the number on the readout is less than, between, or greater than the preset limits.

Start and Stop Timing

A or B Trace %: Seven fixed percentages (10% through 90%), accurate to within 0.25%.

Manual Control: Uncalibrated.

Start and Stop Voltages: Precision dials to measure crt divisions from the 0% Zone, accurate to within 1% at about 8 cm of deflection.

Maximum Sweep Rate

Non-Sampling Sweep: 20 μsec/div maximum useful rate.

Sampling Sweep: Not limited.

NOTE

When the memory RESPONSE switches are set to FAST and the memory MODE switches are set to PEAK (these switches are all on the Memory circuit cards), the memories will charge 4 volts in 2 μsec. With these switch settings, the leakdown rate is 300 mv/sec. If the RESPONSE switches are set to SLOW, the memories charge to 4 volts in 20 μsec, and the leakdown rate is 6 mv/sec. With the RESPONSE switches set to SLOW, the memories will charge with no more than 2 dots delay even at the fastest sampling sweep rate. Because of the previously listed leakdown rates, the switch combination of PEAK mode, FAST response, and AVERAGE OF TEN SWEEPS resolution should not be used with real-time sweep speeds of 0.1 cm/sec or slower, or with sampling rates less than 1000 samples/sec.

External Programming

The Type 6R1A can be programmed externally from remote or automatic equipment. Readout information is available for external readout.

MECHANICAL CHARACTERISTICS

Construction

Aluminum-alloy chassis. Anodized aluminum front panel.

CIRCUIT CARD IDENTIFICATION

The end plate of each circuit card contains the name or function of the card, such as Counter, Voltmeter, etc., and a letter to show its location in the Type 6R1A chassis. The Counter cards, for example, have the letter A as a location guide; the Voltmeter card has the letter E as a location guide.

Circuit cards now under development for other instruments may also operate in the Type 6R1A. These cards may be indentified by two location guide letters. For example, a new Counter card may be indentified as A/Z. This card will fit location A in the Type 6R1A, and location Z in another instrument.

Accessories

Information on accessories for use with this instrument is included at the rear of the mechanical parts list.

NOTES

SECTION 2

OPERATING INSTRUCTIONS

Introduction

To get the most from your instrument, it is important to understand the function of each front-panel control. This section of the manual describes each control and its use in the operation of the instrument.

For the purpose of this procedure, the terms "intensified zone" and "slope" should be clearly understood. The following explanations define these terms as they apply to Type 6R1A.

The Type 6R1A produces four intensified zones on the crt as shown in Fig. 2-1. Each zone appears as a brightened portion of the trace.

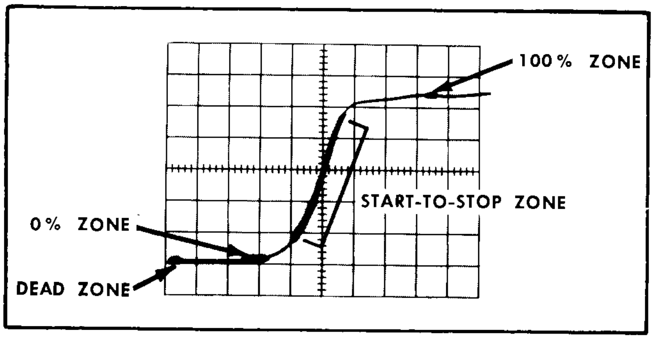


Fig. 2-1. Four types of intensified zones.

The first intensified zone is the dead zone. This zone appears at the start of the trace and has a fixed width and position.

The second intensified zone is the 0% zone. Its position is variable with the A or B 0% Zone Position control. The 0% memory circuit takes a voltage sample at this point.

The third intensified zone is the start-to-stop zone. Its position and width depend on the setting of the TIMING START and TIMING STOP switches. When the MODE switch is in the TIME position, this zone shows the portion of the waveform being measured. The start-to-stop zone is extinguished when the MODE switch is set to the A or B VOLTAGE position.

The fourth intensified zone is the 100% zone. Its position is variable with the A or B 100% Zone Position control. The 100% memory circuit takes a voltage sample at this zone.

All of the intensified zones can be turned off with the CRT INTENSIFICATION switches.

The term "slope" refers to the rising or falling portion of a pulse, as shown in Fig. 2-2. There are two kinds of slopes; a rising slope (positive-going) and a falling slope (negative-going). The SLOPE switches select the slope on which the measurement (time) starts and stops. The FIRST-SECOND SLOPE switch selects either the first or second positive-going slope, if the ±SLOPE switch is in the + position. If the ±SLOPE switch is in the — position, the FIRST-SECOND SLOPE switch will select either the first or second negative-going slope on the crt. To use the second slope you need at least two pulses or cycles on the crt, since the second slope refers to the slope on the second pulse or cycle. Any slope occuring during the dead zone will not be recognized.

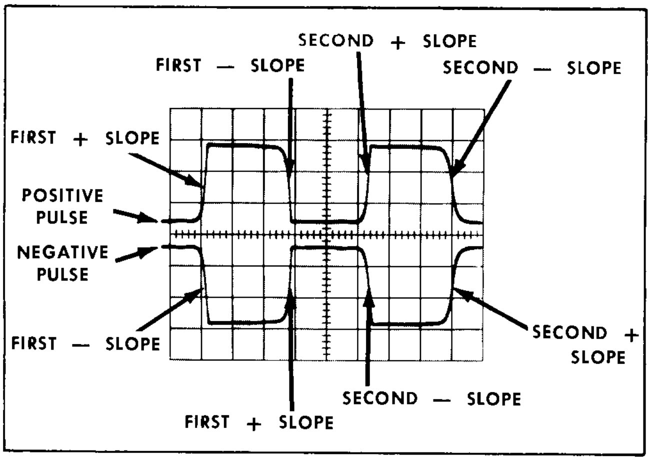


Fig. 2-2. Pulse slope definitions.

FUNCTION OF CONTROLS, SWITCHES, AND INDICATORS

START Block

The switches and controls in the START block are used only for time measurements.

SLOPE Switches

FIRST-SECOND	Selects the first or second slope on the display at which the measurement begins. To start on the second slope you need at least two cycles or pulses displayed on the crt. Always keep this switch in the FIRST position unless making a second-slope measurement.
±	Starts the measurement on the positive (+) or negative (—) slope of the pulse. To measure on a positive-going slope, use the + position. To measure on a negative-going slope, use the — position. This switch, in conjunction with a similar switch in the STOP block, gives a variety of combinations. Keep in mind that the START must be set to precede the STOP, otherwise the display will be meaningless. Detailed use of this switch is covered later in this section.

TIMING START Switch — MANUAL: In this position of the TIMING START switch, you can turn the red knob on the front of the switch to manually set the start point of the measurement. (Be sure the SLOPE switches are in the FIRST and + positions.) For example, if there were two pips on a waveform and you wanted to measure the time between them, first use this control to set the start of the intensified zone at the first pip, then use the MANUAL control on the TIMING STOP switch to set the end of the intensified zone at the second pip. The readout would give the time between pips.

A TRACE %: This precisely sets the percentage point at which the time measurement will start on the Channel A trace. For example, in a risetime measurement, set this switch to A TRACE 10% to start, and set the TIMING STOP switch to A TRACE 90%. The readout would give the risetime of the waveform.

B TRACE %: This starts the measurement on the Channel B trace when dual-trace plug-in units are used. Normally, when you start on B TRACE %, you also stop on B TRACE %. However, there are various combinations of A TRACE % and B TRACE % which will be described later in this section.

TRACE A-B — START VOLTAGE: In these positions of the TIMING START switch, use the precision dial just below the switch. The A-B refers to Channel A or B and is set to the channel in use.

± — To start a measurement above the 0% zone, use + (plus); to start below, use — (minus).

START VOLTAGE Control — A precision potentiometer and dial calibrated to move the start of the intensified zone 1 vertical graticule division for each major division (unit) on the dial. For example, with the dial set at 1, the time measurement will start 1 vertical division up from the 0% zone. The dial consists of ten unit numbers (shown in the window) with one unit per complete turn. Each unit is divided into 100 increments (numbers around the knob). For example, a 2 in the window and the number 43 opposite the index mark is a reading of 2.43.

If the 3-DOT DELAY switches on the Signal comparator circuit cards are at the IN position, the start of a measurement always has a 3 count or dot delay. Since the stop point has this same delay, the accuracy of a measurement is not affected. On fast-rising pulses the crt will show the start-to-stop zone 3 dots later than (or to the right of) the start point and 3 dots later than the stop point. Moving the 3-DOT DELAY switches to the OUT position eliminates the delay.

Center Controls

MODE Switch — TIME STOP (—) START: Position used for all time measurements.

VOLTAGE A-B: Position used for voltage measurements. The A and B refer to the channel of the vertical amplifier plug-in unit.

EXT PROGRAM: Used when the instrument is set up to operate on external commands.

B VOLTAGE Switch — Set the polarity to match the polarity of the 100% memory when the MODE switch is on Channel B.

A VOLTAGE Switch — Set the polarity to match the polarity of the 100% memory when the MODE switch is on Channel A.

RESOLUTION Switch — AVERAGE OF TEN SWEEPS — LO-HI: Counts ten continuous sweeps, and moves the decimal point to indicate average. Right-hand digit (units) blanked ir LO, visible in HI.

ONE SWEEP—LO: Measures one sweep of the displayed waveform.

UNSCALED (MAX): Turns off unit of measure (right-hand indicator tube) and decimals. Also, the count is direct (not divided down by the ÷ 1, 2, 5 circuit), and so gives maximum number resolution; but not necessarily in commonly accepted units, i.e., volts, seconds.

DISPLAY TIME Control — Varies the time from one readout display to the next. During this period the readout holds the last number counted. No further count will be made until the display periods ends ($\approx$0.1 to $\approx$6 sec).

MEMORY MODE Indicators A 0%, A 100%, B 0%, B 100% — These four neon lights indicate the mode of operation (peak or average) of the memory circuits. The mode of operation for each memory is selected by individual MODE switches on the memory cards.

ZONE POSITION Controls

- A 0% — Positions the 0% zone (intensified) on Channel A waveform.
- A 100% — Positions the 100% zone on Channel A waveform.
- B 0% — Positions the 0% zone on Channel B waveform.
- B 100% — Positions the 100% zone on Channel B waveform.

CRT INTENSIFICATION Switches

MEMORY ZONES — Turns off the intensified portion of the waveform at the 0% and 100% zones.

START TO STOP — Turns off the intensified part of the waveform between the start-to-stop zone.

STOP Block

The switches and controls in the STOP block are used only for time measurements.

SLOPE Switches

FIRST-SECOND — Selects the slope on the waveform at which the measurement stops. For example, the time of one cycle is found by setting the TIMING START and STOP switches to 50%, the START block SLOPE switch to FIRST, and the STOP block SLOPE switch to SECOND.

± — Stops the measurement on the positive (+) or negative (—) slope of the waveform.

TIMING STOP Switch — MANUAL: The red knob on the front of the switch sets the stop point on the displayed waveform. (Be sure the SLOPE switches are in FIRST and +.)

A TRACE %: Sets the percentage point on Channel A at which the measurement will stop.

B TRACE %: Sets the percentage point on Channel B at which the measurement will stop.

TRACE A-B — STOP VOLTAGE: In this position of the TIMING STOP switch, use the precision dial just below the switch.

± — To stop a measurement above the 0% zone, use + (plus); to stop below, use (—) (minus).

STOP VOLTAGE Control — A precision potentiometer and dial calibrated to move the stop point of the intensified zone one vertical graticule division for each major division (unit) on the dial. For example, with the dial set at 3, the measurement will stop 3 divisions up or down from the 0% zone. The dial consists of ten unit numbers (shown in the window) with one unit per complete turn. Each unit is divided into 100 increments (numbers around the knob). For example, a 2 in the window and the number 43 opposite the index mark is a reading of 2.43.

Upper Controls

LOWER LIMIT SET Dials and Lamp — In go no-go (accept or reject) type measurements, these dials set the lower acceptable limit. If the number on the readout (indicator tubes) is less than the number shown on these dials, the LOWER LIMIT lamp will light. This information is also present at the external program plug for automatic reject mechanisms.

MID-ZONE Lamp — This lamp lights when the number on the readout is within the limits (inclusive) set on the LOWER LIMIT SET and the UPPER LIMIT SET dials.

UPPER LIMIT SET Dials and Lamp — Sets the upper acceptable limit. If the number on the readout is greater than the number shown on these dials, the UPPER LIMIT lamp will light. This information is also present at the external program plug. The limit lamps also serve as a ready light to show that the instrument has completed a count. While the instrument is counting, these lamps are extinguished.

Digital Readout Indicators — The numbers (indicator tubes) are read direct.

Unit of Measure Indicator — The right-hand indicator tube gives the unit of measure in NS, μS, MS, MV, and V. This tube is dark when the RESOLUTION switch is in the UNSCALED (MAX) position or when either the VOLTS/DIV or TIME/DIV variable controls on the plug-in units are in the uncalibrated position.

Decimal Point Indicator — The decimal point is automatically placed in the proper position by the TIME/DIV switch of the horizontal timebase plug-in unit when you measure time, and by the VOLTS/DIV switch of the vertical amplifier plug-in unit when you measure voltage. No interpolation is necessary, since the reading is always direct.

MEASUREMENTS WITH THE TYPE 6R1A DIGITAL UNIT

The following paragraphs describe four basic measurements that can be made with the Type 6R1A.

In addition to the Type 567 Oscilloscope and two plug-in units (such as the Type 3S76 and 3T77), a signal source is required. A Tektronix Type 109, 110, or 111 Pulse Generator, or a similar type generator, will serve this purpose.

Preliminary Setup

Set the front-panel controls and switches as follows:

START Block	
SLOPE Switches	FIRST and +
TIMING START	A TRACE 10%
START VOLTAGE	+
Dial	0.00
STOP Block	
SLOPE Switches	FIRST and +
TIMING STOP	A TRACE 90%
STOP VOLTAGE	+

Dial	0.00
MODE	TIME STOP (—) START
B VOLTAGE	Up
A VOLTAGE	Up
RESOLUTION	ONE SWEEP LO
DISPLAY TIME	Fully clockwise
Zone Position Controls	
A 0%	Midrange
A 100%	Midrange
B 0%	Midrange
B 100%	Midrange
CRT INTENSIFICATION Switches	
MEMORY ZONES	Up
START TO STOP	Up
LOWER LIMIT SET	0000
UPPER LIMIT SET	0000

Risetime Measurement

Risetime is the time required for a pulse to rise from 10% to 90% of its amplitude. For example, assume that you have a 100 mv peak-to-peak pulse. The pulse begins at zero and starts to rise. When it reaches 10 mv (10% point) the count starts (μsec, msec, ect.). When the pulse amplitude reaches 90 mv (90% point), the count stops. The readout indicates the risetime of the pulse.

To make a risetime measurement proceed as follows (any control not mentioned should remain in the position called out in the preliminary setup):

1. Apply the signal to Channel A of the vertical amplifier plug-in unit and display a single pulse on the crt. (Adjust the delay or trigger on the horizontal plug-in unit so that the intensified dead zone is on a flat portion of the trace before the rise of the vertical signal.)
2. Adjust the A 0% control to place the 0% zone at the start of the waveform.
3. Adjust the A 100% control to place the 100% zone at the peak of the waveform. Be sure the TIMING START switch is set to A TRACE 10% and the TIMING STOP switch to A TRACE 90%.
4. Turn the DISPLAY TIME control to midrange. Each change of the readout represents a new count.
5. Read the risetime directly from the readout. This is the risetime of the pulse (see Fig. 2-3).

Notice the four intensified zones. First, on the left is the dead zone. Second, is the 0% zone. Next is the zone between 10% and 90% (start-to-stop zone) which was just measured. Last is the 100% zone. You can turn off the 0% and 100% zones by moving the MEMORY ZONES switch to OFF.

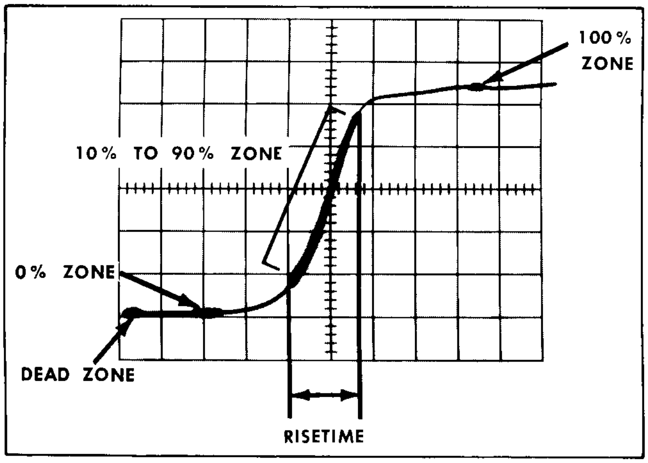


Fig. 2-3. Risetime measurement.

Falltime Measurement

This is similar to the risetime measurement except that this is the time it takes the pulse to fall from 90% of its amplitude to 10% of its amplitude. In the case of a positive pulse, the measurement is on the first negative slope of the pulse. Return all controls and switches to their preliminary positions.

1. Adjust the time-base plug-in controls to trigger on the negative slope of the pulse. Place the 0% zone on the waveform peak. Set the 100% zone to the lowest point on the waveform (see Fig. 2-4).
2. Set the SLOPE switches in the START block to FIRST and —.

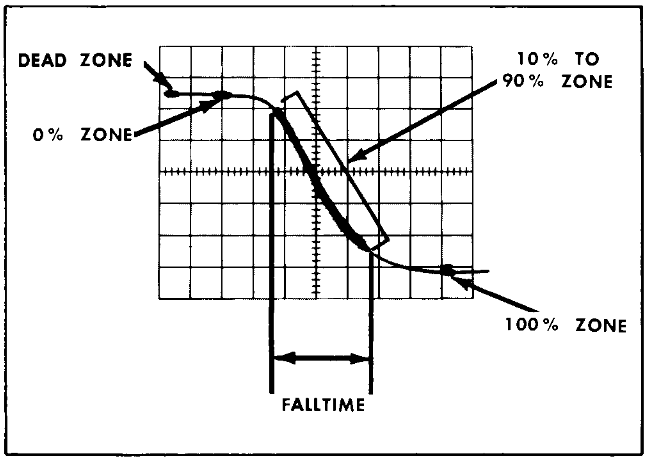


Fig. 2-4. Falltime measurement.

3. Set the TIMING START switch to A TRACE 10%.
4. Set the SLOPE switches in the STOP block to FIRST and —.
5. Set the TIMING STOP switch to A TRACE 90%.
6. Read the falltime on the readout.

Voltage Measurement

Using the same pulse as for the risetime measurement, the following steps describe how to measure the peak amplitude (voltage) of this pulse.

1. Set the MODE switch to VOLTAGE A.
2. Set the A VOLTAGE switch up.
3. Turn the A 0% control until the 0% zone is at the start of the pulse. Turn the A 100% control until the 100% zone is on the peak of the pulse. (In cases where the pulse has overshoot, set the 100% zone on the flattened part of the pulse beyond the overshoot.)
4. Read the voltage shown on the readout. This is the peak amplitude of the pulse.

This measurement shows that voltage readings are taken between the 0% and 100% zones. Since the zones can be moved to any point, the amplitude of any point on a waveform can be measured.

Frequency Measurement

This measurement counts the repetition rate in cycles per second (cps) or pulses per second (pps). The counter starts at the 50% point on one pulse and stops at the 50% point on the following pulse. This gives the time of one pulse or cycle. The reciprocal of the time, in seconds, equals the frequency in cps or pps (F = 1/T). Return all controls to their preliminary positions.

To measure frequency, proceed as follows:

1. Adjust the horizontal time-base plug-in unit to display 2 cycles or pulses (see Fig. 2-5).
2. Adjust the 0% control to place the 0% zone on the first negative peak.
3. Adjust the 100% control to place the 100% zone on the positive peak of the second pulse or cycle.
4. Set the MODE switch to TIME STOP (—) START.
5. Set the TIMING START switch to A TRACE 50%.
6. Set the SLOPE switch in the STOP block to SECOND.
7. Set the TIMING STOP switch to A TRACE 50%.
8. Read the time for one pulse or cycle on the readout. The reciprocal of the time is the frequency in cps or pps.

Phase or Time-Difference Measurement

The following steps describe how to measure the time difference between two similar pulses or cycles; one in Channel A and the other in Channel B (see Fig. 2-6). This procedure measures the time from the 50% point on the Channel A pulse to the 50% point on the Channel B pulse or the time difference between Channel B and A. Return the controls to their preliminary setting. To make a time-difference measurement proceed as follows:

1. Set both START and STOP SLOPE switches to FIRST and +.
2. Set the TIMING START switch to A TRACE 50%.
3. Set the TIMING STOP switch to B TRACE 50%.
4. Set the A 0% intensified zone to the negative peak of the pulse or cycle on A trace and set the B 0% intensified zone to the negative peak of the pulse or cycle on B trace.
5. Set the A 100% intensified zone to the positive peak of the pulse on A trace and set the B 100% intensified zone to the positive peak of the pulse or cycle on B trace.
6. The number shown on the readout is the delay of Channel B with respect to Channel A.

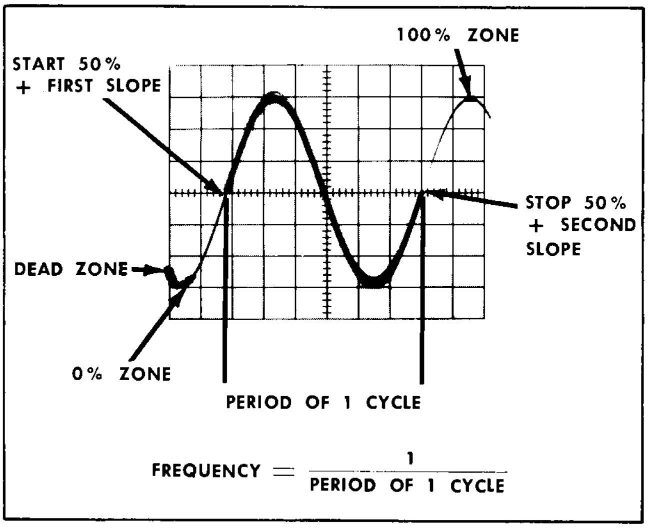


Fig. 2-5. Frequency measurement.

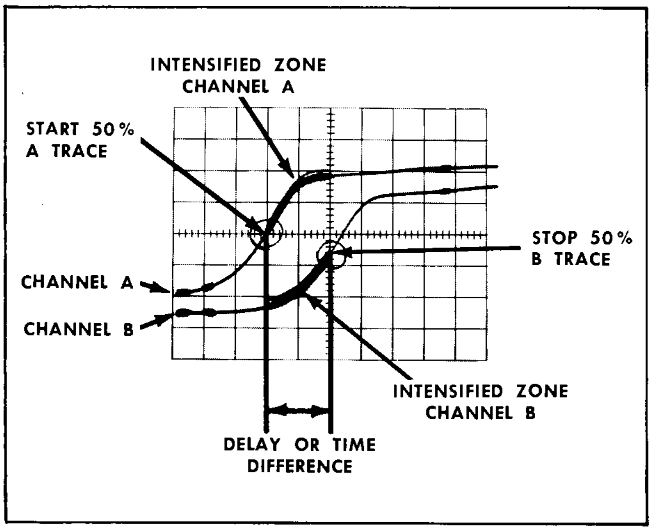


Fig. 2-6. Delay or time-difference measurement.

NOTES

SECTION 3
APPLICATIONS

Introduction

This section describes some typical applications of the Type 6R1A Digital Unit. Among these are transistor, diode, and delay-time measurements. In addition, other applications are illustrated to point out various features designed into the instrument. Since there are many applications for the Type 6R1A, this manual covers only a few of the more general ones.

Transistor Characteristics

This application is illustrated in Fig. 3-1. A pulse is fed to one channel of a dual-trace vertical amplifier plug-in unit (such as the Type 3S76). The pulse is also fed to the transistor under test and the output from the transistor is fed to the other channel of the vertical plug-in unit. With the proper program set into the Type 6R1A, a large variety of transistor characteristics can be measured. The equipment needed for this application is as follows:

1. Pulse generator, 0.5-nsec risetime (such as Tektronix Type 109, 110, or 111).
2. Transistor test fixture (such as Tektronix Type 290 Transistor Switching Time Tester).
3. Assorted 50 Ω cables.

Adjust the trigger stability of the time-base plug-in, and the pulse amplitude and polarity of the vertical amplifier plug-in, for a display similar to that shown in Fig. 3-2.

The following steps and Type 6R1A Program Chart outline a method for measuring eight different parameters of the transistor under test.

1. Set the MODE switch to TIME STOP (—) START.
2. Set the START and STOP SLOPE switch to FIRST.

PROGRAM CHART

MEASUREMENT	PROGRAM			
	START SLOPE	TIMING START	STOP SLOPE	TIMING STOP
Risetime B	—	10% B	—	90% B
Falltime B	+	90% B	+	10% B
Delay A to B	+	10% A	—	10% B
Storage A to B	—	90% A	+	90% B
Turn-on A to B	+	10% A	—	90% B
Turn-off A to B	—	90% A	+	10% B
Width A	+	50% A	—	50% A
Width B	—	50% B	+	50% B

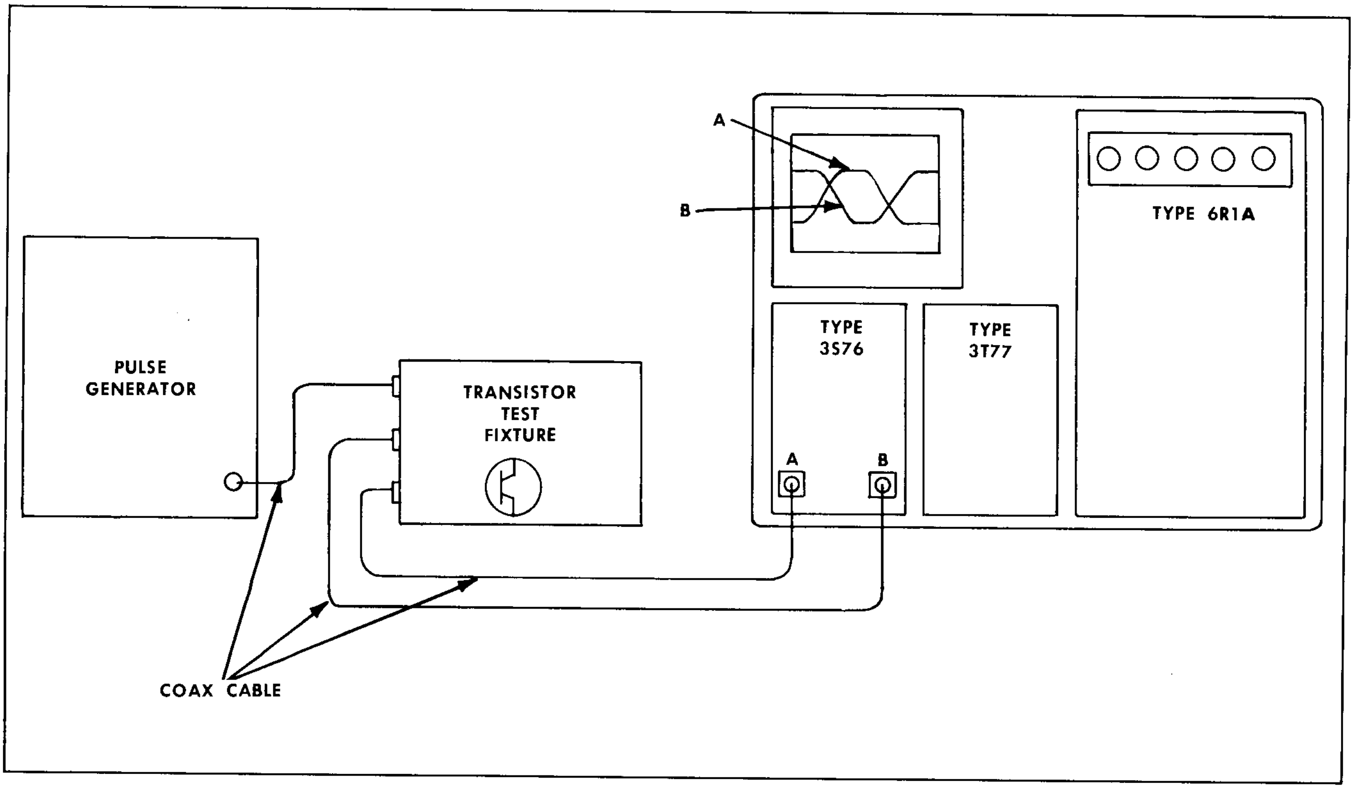


Fig. 3-1. Test setup for transistor measurements.

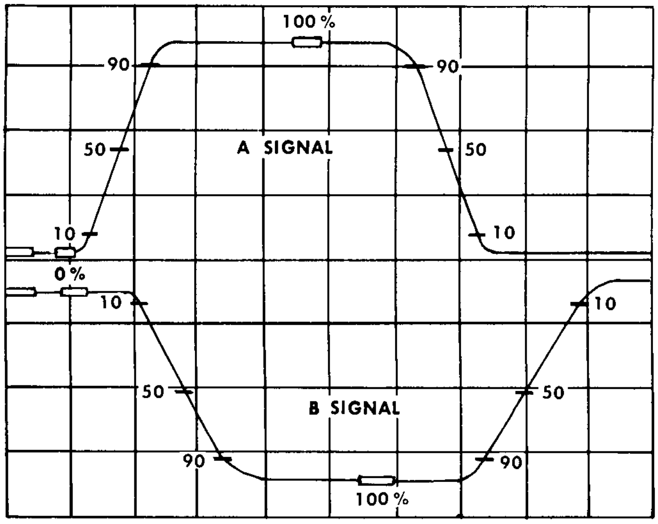


Fig. 3-2. Typical waveform display for NPN transistor measurements. The Channel A display is the pulse input to the transistor; the Channel B display is the output signal from the transistor.

3. The position of the ± SLOPE switches and the setting of the TIMING START and STOP switches for each measurement are listed in the chart.

4. Position the 0% and 100% zones. Each measurement is read directly from the readout indicator.

Delay-Line Measurements

The delay time of a coaxial cable can be measured using the Type 6R1A with sampling plug-in units (Tektronix Type 3S76 and 3T77). A pulse is fed directly to Channel A of a dual-trace vertical unit (Fig. 3-3). With a Tee connector (GR 874) at the input to Channel A, the cable under test couples the pulse to the Channel B input connector. The Type 6R1A measures the time between the 50% point on the rise of the Channel A pulse and the 50% point on the rise of the Channel B pulse. This time is the delay of the cable under test.

Set up the equipment as follows:

1. Adjust the pulse generator and sampling plug-in units to display a pulse through a Tee connector (GR 874) to Channel A of the Type 3S76.
2. Connect the cable under test from the Tee connector to the Channel B input connector. Turn the MODE switch on the Type 3S76 to DUAL-TRACE.
3. Adjust the 0% and 100% zones on the Type 6R1A to corresponding points on the Channel A and B pulses.
4. Set the Type 6R1A switches as follows:

   START Block: FIRST + SLOPE: A TRACE 50%
   STOP Block: FIRST + SLOPE: B TRACE 50%

5. The time shown on the readout is the delay time of the cable under test.

Another method for measuring cable delay uses the charge line connector on the pulse generator. This method requires only a single-channel vertical amplifier plug-in:

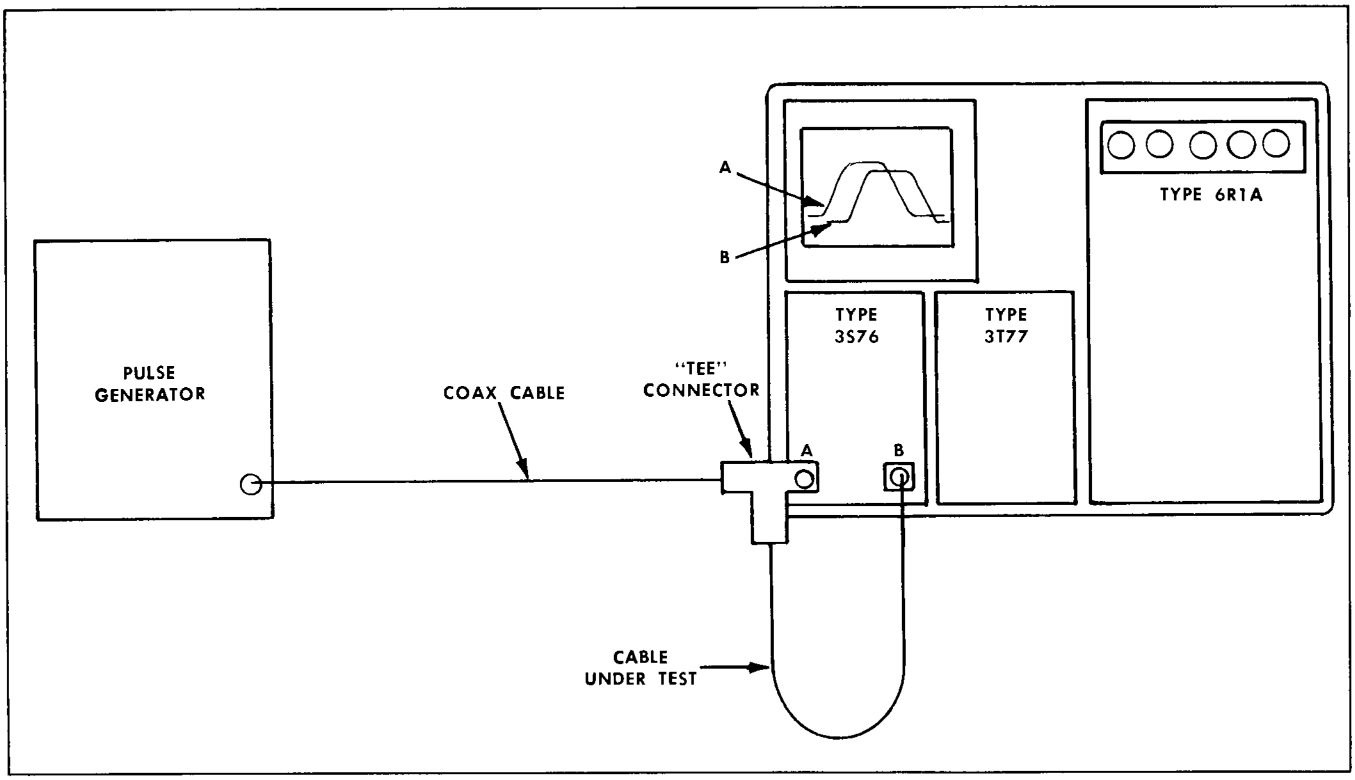


Fig. 3-3. Test setup for delay-line measurement.

1. Connect the pulse generator through a 50 Ω cable to Channel A of the vertical amplifier plug-in.
2. Connect a charge line (50 Ω) to the pulse generator and display a pulse.
3. Set the Type 6R1A switches as follows:

   STOP Block: FIRST — SLOPE: A TRACE 50%
   STOP Block: FIRST — SLOPE: A TRACE 50%
4. Record the time shown on the readout.
5. Add the cable to be measured to the charge line on the pulse generator. Record the readout.
6. Subtract the reading in step 4 from the reading of step 5. Divide the remainder by 2. The result is the delay time of the cable under test.

For example, assume the charge line produced a 50 nsec pulse width. When the cable to be measured is added, the pulse width increases to 70 nsec.

Subtract: 50 from 70 = 20
Divide by 2: 20 ÷ 2 = 10
Delay of Cable = 10 nsec.

Diode Meaurements

Switching and recovery time can be measured when the Type 6R1A is used with sampling plug-in units. Also, diodes can be compared and matched for particular response characteristics. Two basic diode test circuits are illustrated in Figs. 3-4 and 3-6.

To make these measurements, set the A and B 0% and 100% MODE switches on the Memory circuits cards to PEAK. Position the 0% zone on the zero-current level of the diode. The recovery-time measurement starts when the waveform rise crosses the zero-current level (0% zone) and stops when the waveform falls to the selected level (e.g. 1 to 3 ma).

A pulse generator is connected through a 50 Ω cable to a test jig which mounts the diode in series with the transmission line. A decoupling capacitor or dc current source are built into the jig as shown in Fig. 3-4.

A pulse generator (such as the Tektronix Type 109, 110 or 111) with a fast-rise pulse abruptly shuts off forward current through the diode. The leading edge of the pulse causes a reverse current peak followed by a drop to zero. The diode reverse recovery time is shown in Fig. 3-5.

The second diode test measures turn-on time. A pulse generator is connected through a 50 Ω cable to a diode test jig which mounts the diode in series with the transmission line and a dual-trace plug-in unit (sampling type).

If a Tektronix Type 291 Diode Switching Time Tester or Type 292 Semiconductor Tester is available, make the diode

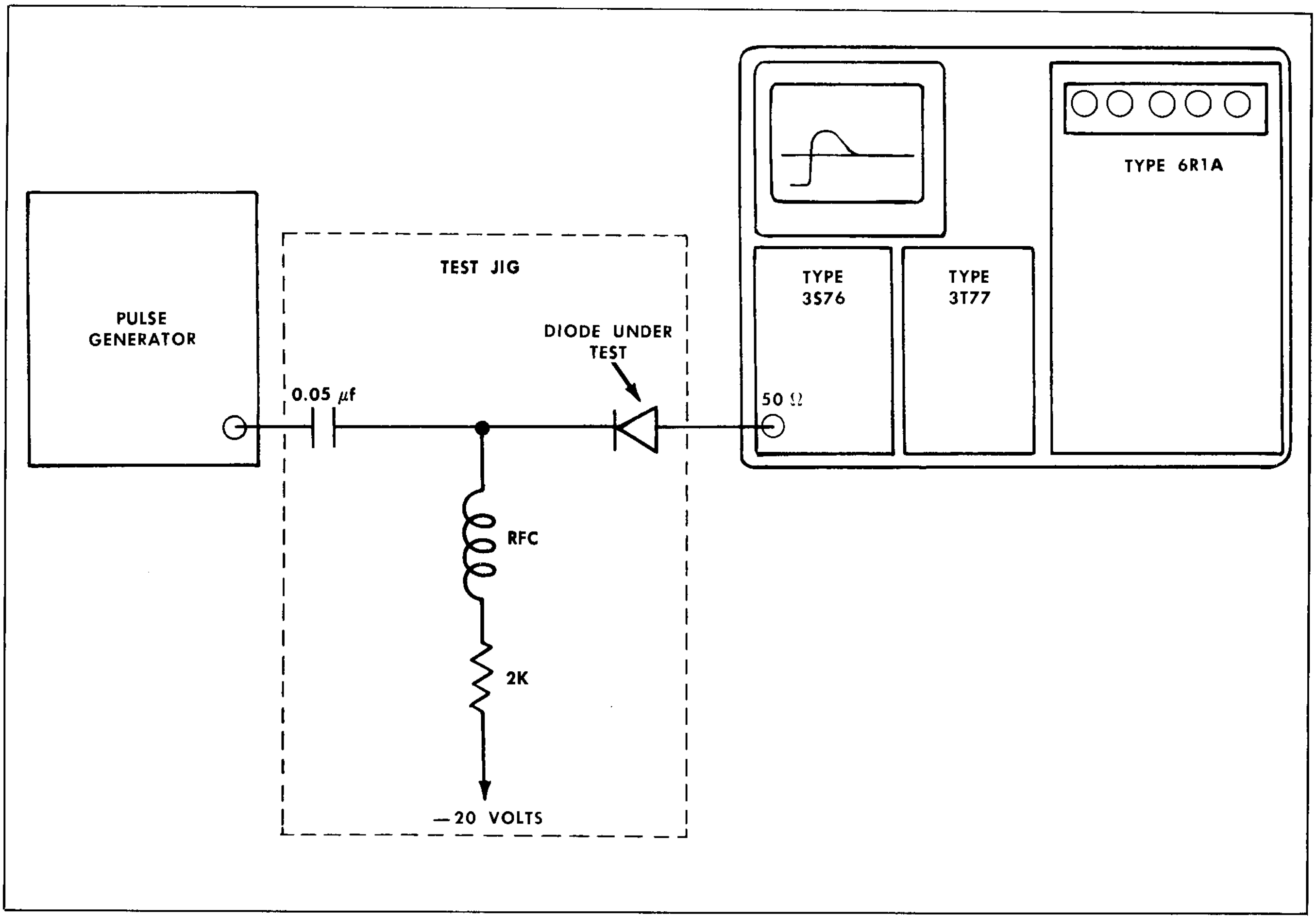


Fig. 3-4. Test setup for diode reverse-recovery measurements.

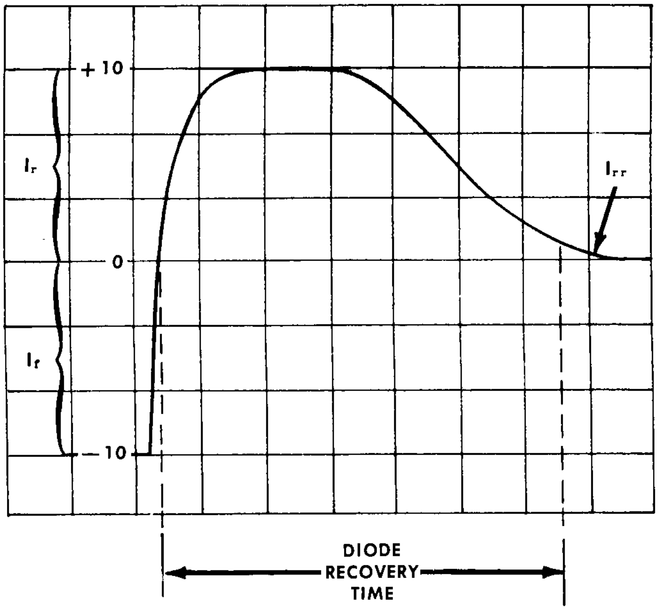


Fig. 3-5. Waveform measurement points for diode recovery time.

measurements as described in the Operating Instructions of the Type 291 or 292 instruction manuals.

Time Constants

The Type 6R1A with real-time plug-in units (Tektronix Type 3A2 and 3B2) can be used for production testing of capacitors and inductors.

The component under test becomes part of an RC or RL circuit and the time constant is measured. The TIMING START and STOP switches have been designed to measure one RC time between the 27% and 73% points of a waveform (see Fig. 3-7).

The acceptable tolerance limits of the component are calculated and these values are set on the UPPER and LOWER LIMIT SET dials. A component within the acceptable range will light a green indicator while component values

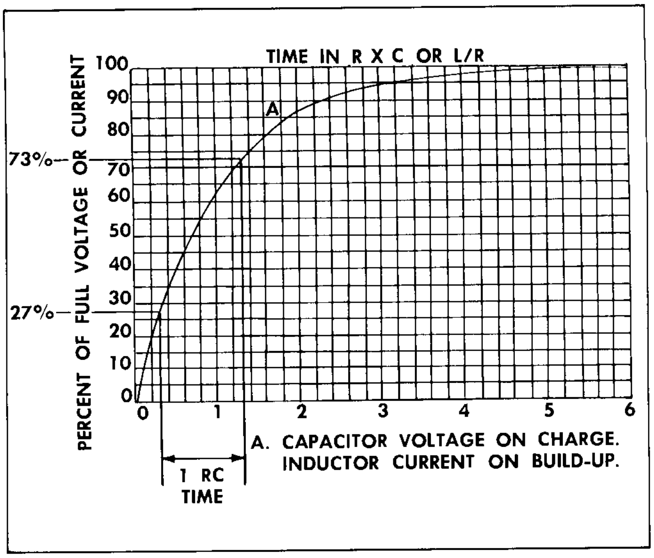


Fig. 3-7. Universal time constant chart.

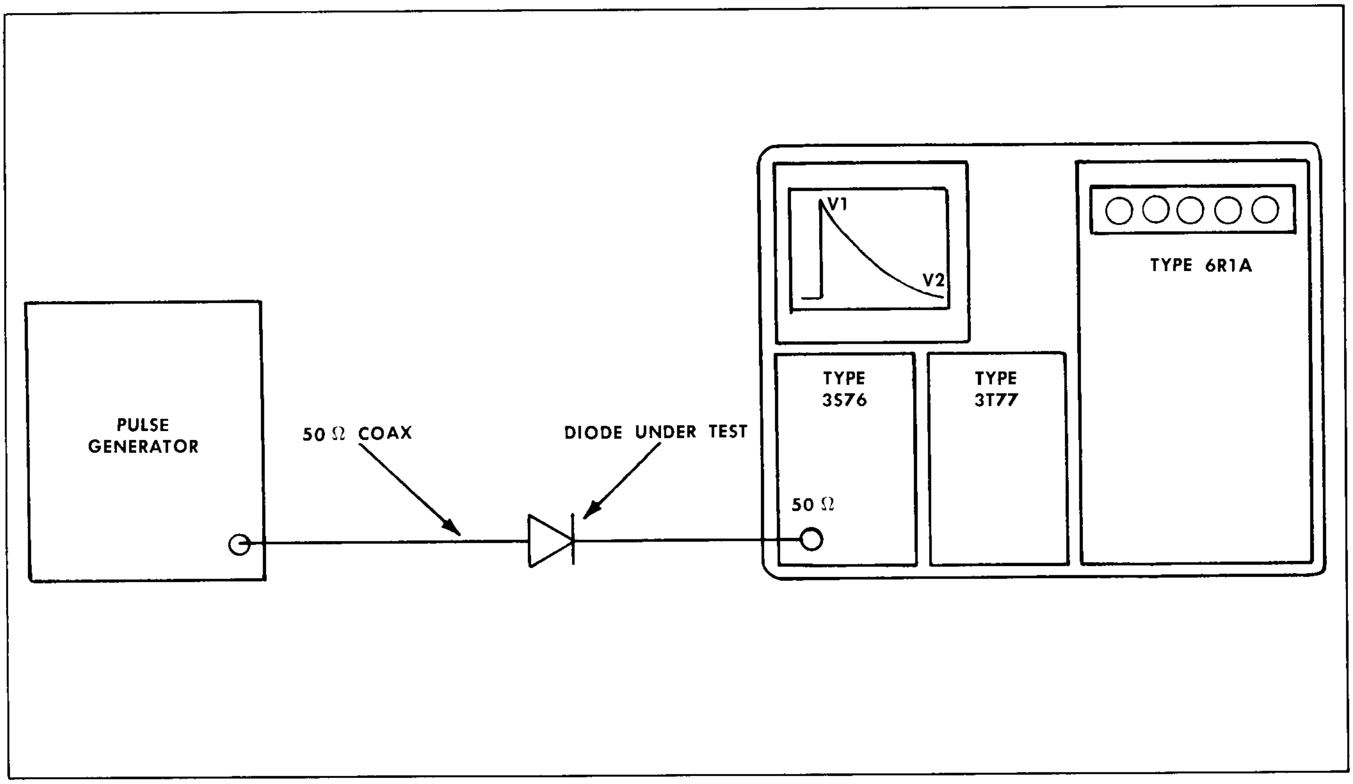


Fig. 3-6. Test setup to measure turn-on time.

outside the acceptable range will light either a yellow or red indicator.

Linearity Measurements

The rate-of-rise or linearity of a waveform such as a sawtooth can be checked with the calibrated START and STOP VOLTAGE dials as follows:

1. Display the waveform on the crt. Adjust the amplitude for between 6 and 8 divisions of vertical deflection.
2. Adjust triggering and delay controls to set the start of the waveform to the right of the dead zone.
3. Set the Type 6R1A controls and switches as follows:

   START Block } FIRST + SLOPE: A TRACE START VOLTAGE +

   STOP Block } FIRST + SLOPE: A TRACE STOP VOLTAGE +

   MODE Switch: TIME STOP (—) START
4. Set the START VOLTAGE dial to 0.00. Turn the STOP VOLTAGE dial to 1.00. Note the readout.
5. Set the START VOLTAGE dial to 1.00 and the STOP VOLTAGE dial to 2.00. Note the readout.
6. Continue to move each dial 1 division higher and note the readout.

An exact linear rise will give the same reading for each part of the waveform measured.

External Programming

The Type 6R1A is designed to operate with the Tektronix Type 262 Programmer or similar equipment when external programming is desired. A completely automatic system can be built that will make a series of tests, record the results of the tests, reject any component that fails to meet preset limits (go no-go), and signal the end of the test series.

Section 7 of this manual contains general information on external programming. Instructions for externally programming the Type 6R1A with the Type 262 are contained in the Type 262 instruction manual. For further information consult your Tektronix Field Engineer.

NOTES

SECTION 4

THEORY OF OPERATION

Introduction

The Type 6R1A Digital Unit consists of a plug-in type chassis with controls, switches, and a readout on the front panel. The circuits of the unit are contained on 17 plug-in etched circuit cards.

This discussion will first describe the theory of operation of the instrument with block diagrams, followed by an explanation of the makeup of the front-panel controls, and a detailed description of each etched circuit card.

THEORY OF OPERATION

The usual way to measure time periods with an oscilloscope is to count the horizontal divisions on the crt between the points to be measured. This distance multiplied by the sweep rate equals the elapsed time.

With the Type 6R1A, the elapesd time between two points on a waveform display is measured with a counter and presented as a digital readout. To do this, the instrument needs specific information from the vertical amplifier and time-base plug-in units.

The information required from the vertical plug-in unit includes:

1. The signal to be measured.
2. The unit of measure (mv, etc.).
3. The position of the decimal point for voltage measurements.

The information required from the time-base plug-in includes:

1. Horizontal sweep waveform.
2. Horizontal gate waveform.
3. Clock pulses (time measurements).
4. Unit of measure (nsec, etc.).
5. The position of decimal point for time measurements.

Fig. 4-1 shows the time relationship between a typical vertical signal and the horizontal waveform. In the description that follows, the 0% intensified zone of the crt is set for the minimum amplitude point of the input signal, and the 100% zone is set for the maximum amplitude. In addition, the output of the vertical amplifier plug-in unit has a quiescent dc level between +5 and +15 volts set by the amplifier position controls.

The horizontal sweep is applied to the 0% and 100% zone circuits as shown in Fig. 4-2. The horizontal sweep voltage is combined with the voltage from the zone position potentiometers to form gate pulses that are variable in time. These gate pulses are applied to the memory circuits. When the 0% gate pulse occurs, the 0% memory takes a sample of the vertical signal ('A' voltage, Fig. 4-1) at point A. This sample is stored in the 0% memory circuit. The output of the 0% memory circuit is applied to the bottom of a string of precision resistors (see Fig. 4-3).

When the horizontal sweep reaches point B (Fig. 4-1), the sweep voltage and the voltage from the 100% zone postion potentiometer combine to form a gate pulse that activates the 100% memory circuit. The 100% memory circuit takes a sample of the vertical signal at point B and stores it. The output of the 100% memory is applied to the top of the precision resistor string (Fig. 4-3).

The intensified zone at the start of the sweep is called the "dead zone" and its position is fixed in relation to the start of the sweep, and no memory gates can be generated during "dead" time. The position of the 0% and 100% zones can be moved to any point on the display by turning the 0% and 100% controls on the front panel.

The precision resistors mentioned previously and shown in Fig. 4-3 make up the TIMING START and TIMING STOP switches. The voltage from the 0% memory is applied to the bottom, and voltage from the 100% memory is applied to the top of both the TIMING START and TIMING STOP switches. Thus, the voltage across the switches represents 100% of the voltage between the 0% and 100% points on the display. These switches allow the operator to make measurements between preselected points from 10% to 90%.

Since the memory circuits take a sample of the vertical signal on each sweep, any change in signal voltage will cause a like change in the memory outputs. Thus, the memory circuits automatically adjust to the signal voltage with each sweep.

There are two memory circuit cards; one for Channel A and one for Channel B. The precision resistors that make up the TIMING START and TIMING STOP switches are switched from one channel to the other as the memories are switched.

The next part of the system contains the circuits that feed the start and stop signal comparators (see Fig. 4-4). Since the comparator inputs are different for each mode of operation, the modes will be described separately, starting with time measurements.

Time Measurements

Each comparator needs two input voltages:

1. A reference voltage that sets the point of comparison (start and stop of measurement).
2. The signal from the vertical amplifier plug-in. The START SLOPE and STOP SLOPE switches (Fig. 4-4) are front-panel switches set to the polarity of the waveform slope being measured (+ positive-going, — negative-going). The two inputs to each switch pass to the MODE switch (time measurements) and on to the comparators.

The operator has a choice of reference voltages:

1. A voltage from the floating power supply that allows the operator to start and stop a time measurement an exact amount of crt divisions from the 0% zone. The front-panel precision dial is used for this purpose.

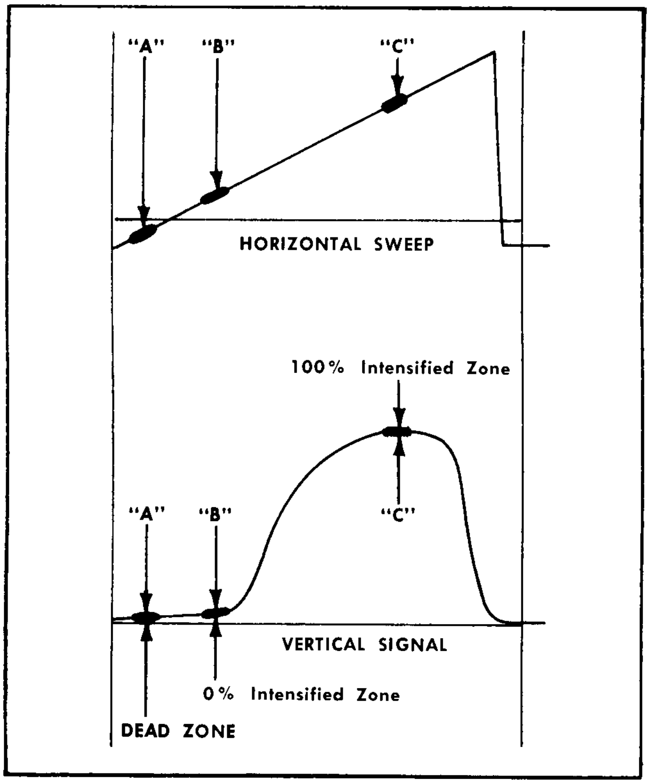


Fig. 4-1. Time relationship between the horizontal sweep and the vertical signal.

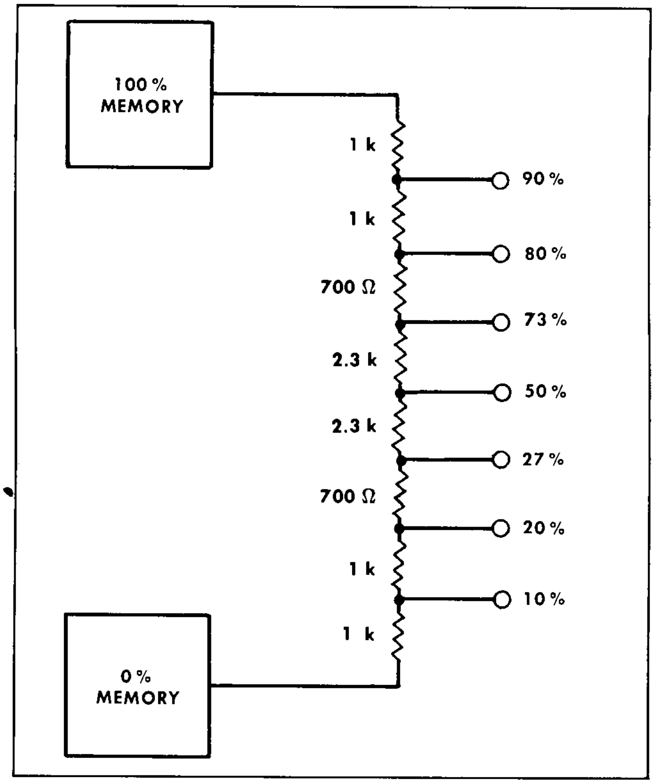


Fig. 4-3. Timing switch example.

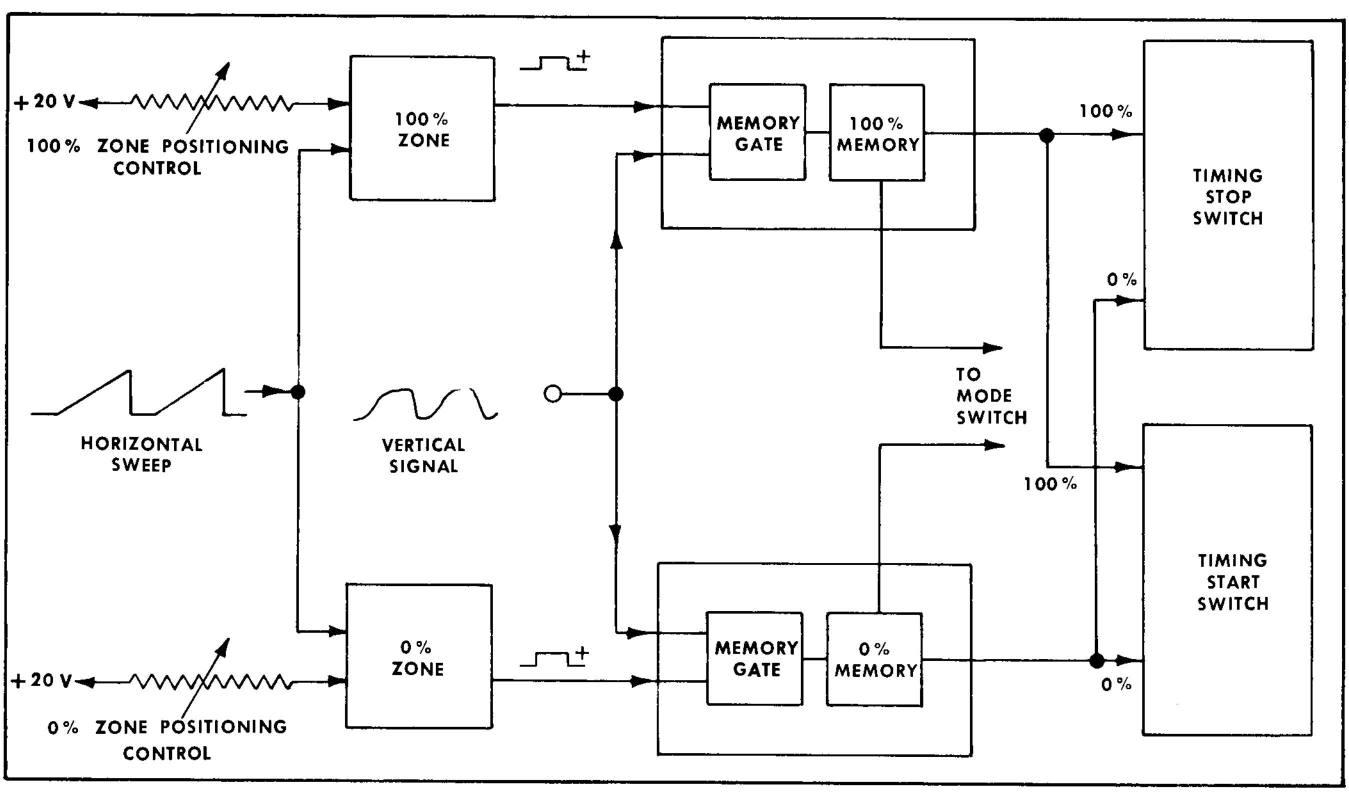


Fig. 4-2. Formation of 0% and 100% zones.

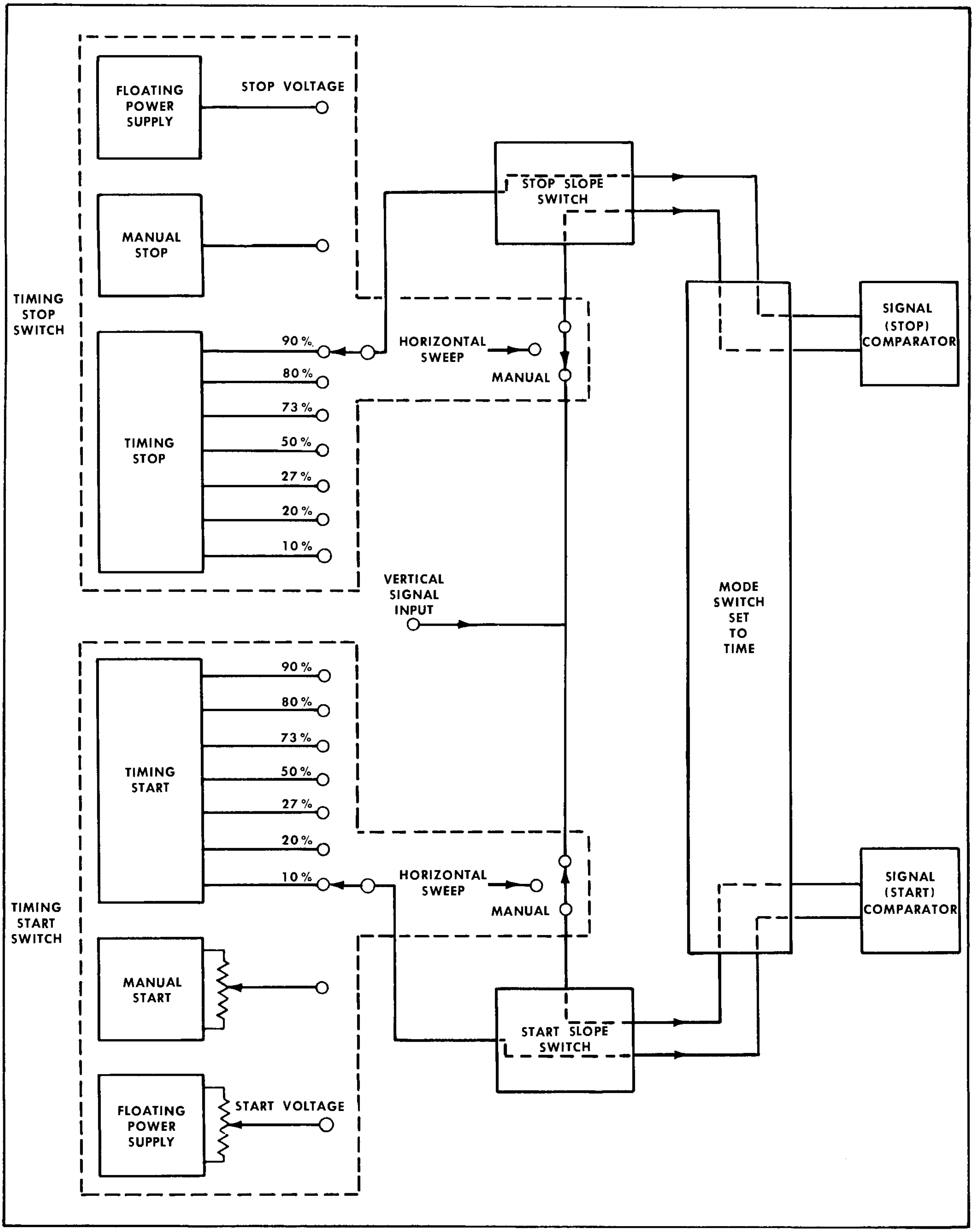


Fig. 4-4. Connection to comparators in time measurements.

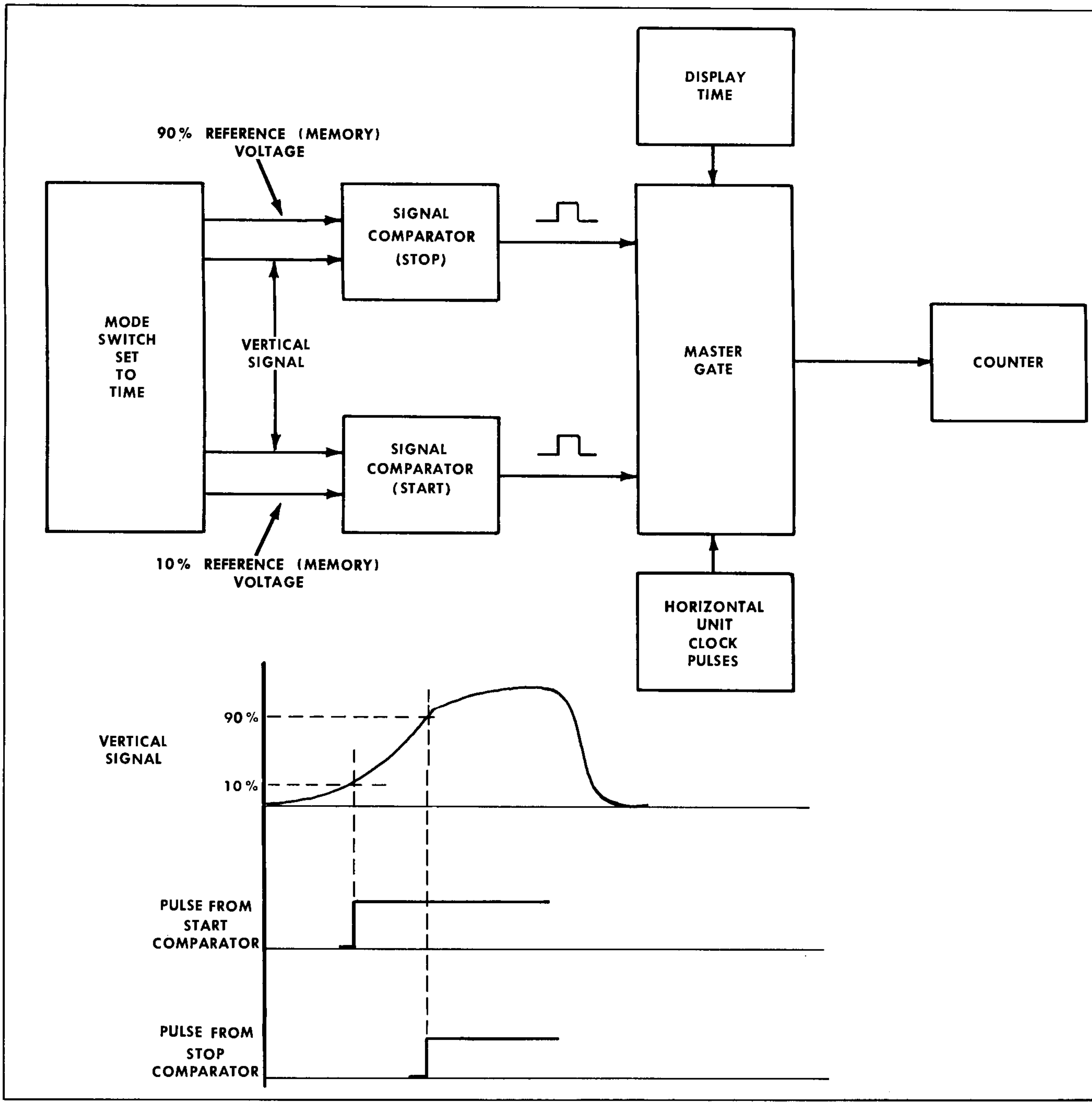


Fig. 4-5. Signal comparator start and stop pulses to master gate.

2. Precise percentage points, such as 10%, 20%, 27%, etc., between the 0% and 100% levels on the display.

3. A manually controlled voltage (uncalibrated) that allows the operator to set the start and stop points visually from the display. The second input to the comparators, in the MANUAL position of the TIMING switches, is the horizontal sweep voltage.

Fig. 4-5 shows the comparators and the time relationship between the reference and signal voltage. To illustrate the operation, a 10% to 90% time measurement is programmed into the instrument.

1. 10% of the memory difference voltage from the TIMING START switch is applied through the MODE switch to one input of the start comparator.

2. 90% of the memory difference voltage from the TIMING STOP switch is applied through the MODE switch to one input of the stop comparator.

The other input of each comparator receives the vertical signal from the MODE switch. When the vertical signal rises to 10% of its amplitude, the start comparator switches and sends a pulse to the master gate. The master gate opens and clock pulses pass to the counter.

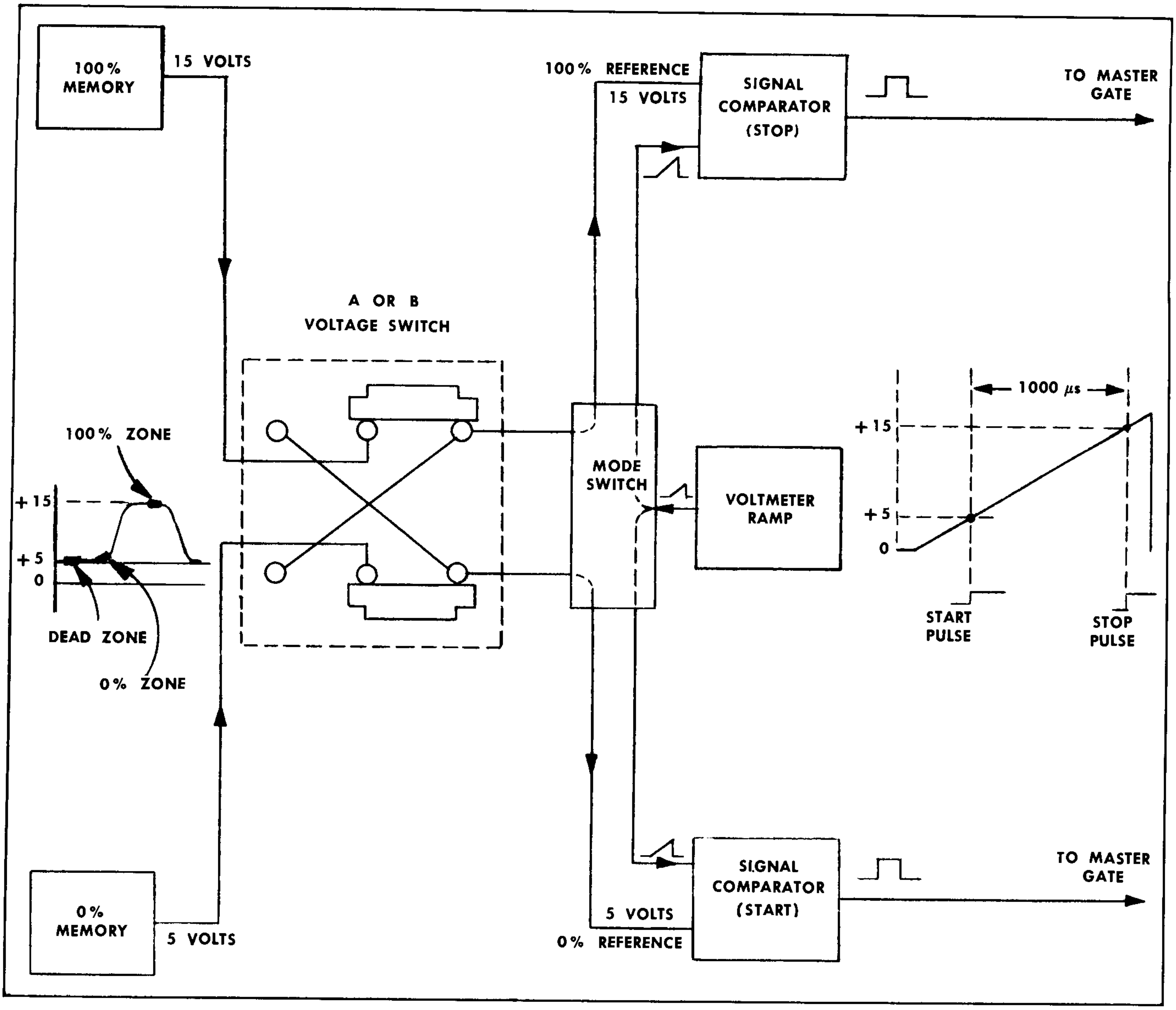


Fig. 4-6. Connections to signal comparators with MODE switch set to VOLTAGE. Voltages shown are used as examples in text.

When the vertical signal reaches 90% of its amplitude, the stop comparator switches and sends a pulse to the master gate. This pulse closes the gate and blocks the clock pulses to the counter.

As a result, the number shown on the readout is the time between the 10% and 90% voltage points of the vertical signal.

This illustration has been simplified to show the basic operation of the system to this point. The variety of programs such as negative-going signals, 2nd slope measurements, average of ten sweeps, start on Channel A, stop on Channel B, etc., can be understood by studying the individual circuits.

Voltage Measurements

Fig. 4-6 shows the connections to the comparators when making voltage measurements. Notice that the signal voltages are the outputs of the 0% and 100% memory circuits. The reference voltages for the comparators are the signal voltages from the memories while the variable voltage is the voltmeter ramp. The two voltages from the memory circuits pass through either the A VOLTAGE or B VOLTAGE switch and the MODE switch to the comparator inputs. The output voltages of the 0% and 100% memory circuits are always positive to ground.

The voltmeter ramp input to the comparators is linear, and the voltage rise is constant per unit of time. For example, with a ramp rise of 1 volt in 100 μsec, the 10 volts will take 1000 μsec. In the example of Fig. 4-6, the start comparator has a 5-volt reference (signal level at 0% zone). When the ramp rises to 5 volts, the start comparator switches and sends a pulse to the master gate and the counter starts. The stop comparator has a 15-volt reference (signal level at 100% zone). When the ramp reaches 15 volts, the stop compartor switches and sends a pulse to the master gate and the counter stops.

At a rate of rise of 1 volt per 100 μsec, the readout shows 10.00 V. The position of the decimal point and unit of measure is explained later in the text.

If the 100% zone is moved down the slope of the signal waveform to 12 volts, the difference between the two memory circuits is 7 volts. The counter counts 700 μsec and the readout shows 07.00 V. Since both the 0% and 100% zones can be manually adjusted from the front panel, the voltage between any two points on the display can be measured.

For a negative-going signal, the voltage from the 100% memory is less than that from the 0% memory. (Both voltages still positive to ground.) The A VOLTAGE or B VOLTAGE switch reverses the inputs to the comparators and the voltage from the 100% memory is used as the reference for the stop comparator.

Note that the START block and STOP block controls are not used during voltage measurements.

Master Gate

The master gate circuit is an "and" gate that controls the flow of clock pulses to the counter. Fig. 4-7 shows the four elements of the "and" gate and the conditions necessary to allow clock pulses to pass through the gate.

Elements 1, 2, and 3 must be turned on before clock pulses can pass through element 4. Element 1 is turned on by the delay gate from the time-base plug-in unit. Element 2 is turned on by a pulse from the start comparator. Element 3 is turned on at the start of a cycle and then turned off by a pulse from the stop comparator to close the gate.

When the "and" gate closes, a digital display-time circuit prevents the gate from being reopened until the display period is ended (see Fig. 4-8). This time period is set by the front-panel DISPLAY TIME control. When the display period ends, a reset pulse is sent to the counter circuit and the readout reverts to all zeros.

To improve the resolution, the end of measurement input to element 1 is switched through a ÷ 10 circuit. This allows the counter to accumulate the sum of 10 consecutive counts before the display time and counter reset. The RESOLUTION switch also causes the decimal point of the readout to move one place to the left and the resultant number is the average of 10 counts.

To summarize the operation of the master gate: Element 1 is turned on by the delay gate. While this element is on, the start and stop comparators can allow clock pulses to pass through to the counter. At the end of measurement, a — pulse turns off element 1 which closes the "and" gate and also starts the display-time period (viewing period).

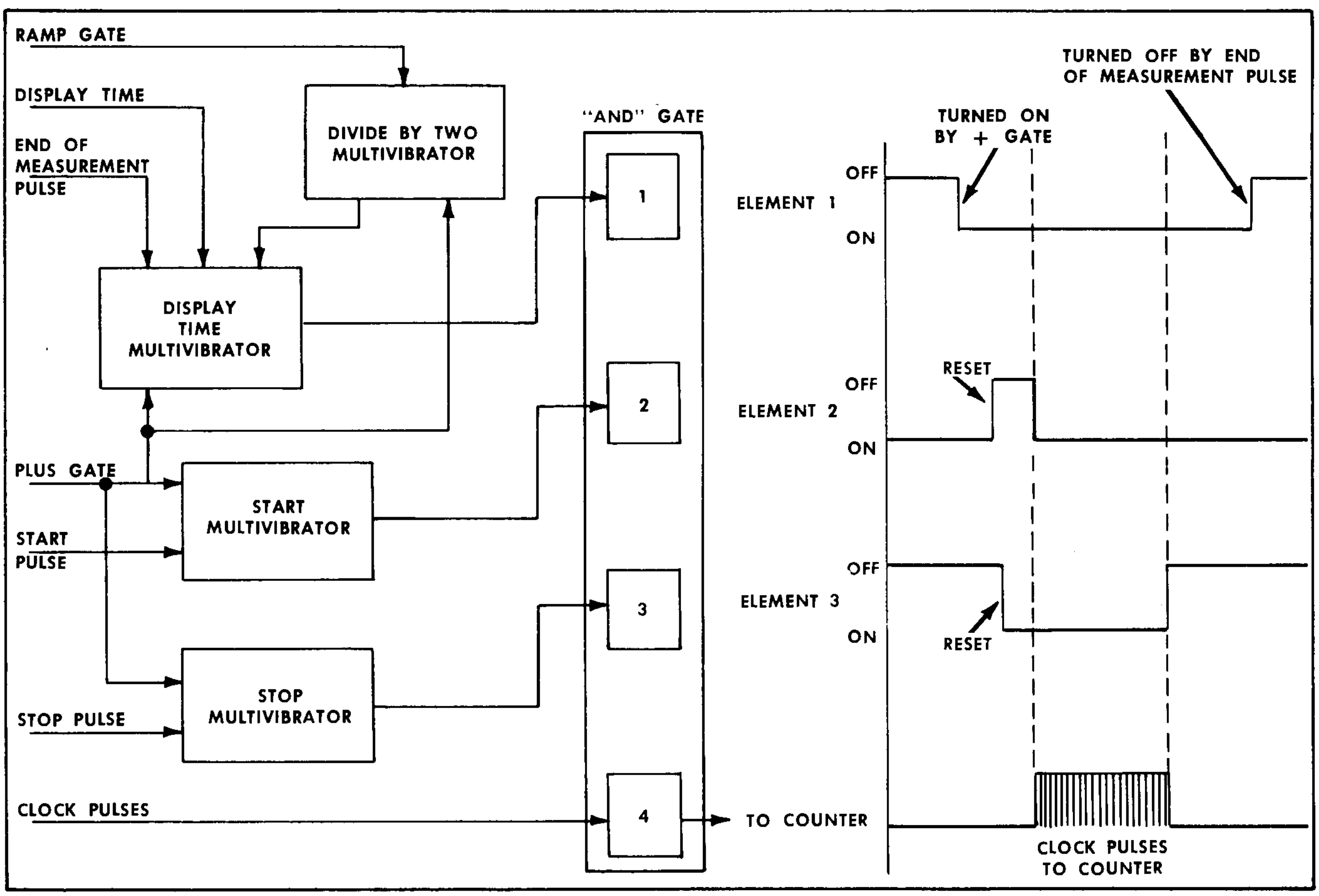


Fig. 4-7. Simplified illustration of the "AND" gate portion of the master gate.

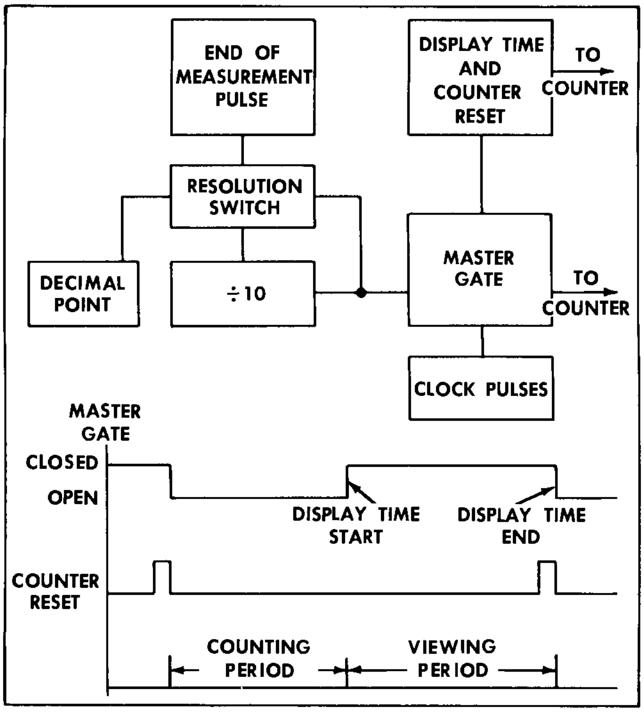


Fig. 4-8. Display time, reset, and ÷ 10 circuit relationship to the master gate.

At the end of this period, a reset pulse passes to the counter and it returns to zero. Since the end of measurement pulse turns off element 1 (closes "and" gate), this waveform can be passed through a ÷ 10 circuit and the counter will accumulate the total count of 10 consecutive sweeps before display time and reset. Fig. 4-9 shows the time relationship in the AVERAGE OF TEN SWEEPS position of the RESOLUTION switch.

The clock pulses from the master gate circuit pass to the ÷ 1, 2, 5 circuit before they are applied to the counter (see Fig. 4-10). When using sampling plug-in units, this circuit is necessary since the number of clock pulses that pass through the master gate is directly proportional to the number of crt divisions between the start and stop of a measurement. In time measurements, the correct division circuit is controlled by the TIME/DIV switch in the time-base plug-in unit.

In voltage measurements, the selection of the proper division circuit is controlled by the VOLTS/DIV switch in the vertical amplifier plug-in unit. Also, the clock pulses that pass through the master gate are directly proportional to the amount of vertical crt divisions between the 0% and 100% zones.

The clock pulses from the ÷ 1, 2, 5 circuit pass directly to the counter that, in turn, drives the readout.

Fig. 4-10 also shows the location of the no-go limit circuits.

Limit Circuits

The upper and lower limit circuits operate in conjunction with the counter. During the display-time period, each counter card has a staircase output voltage that is proportional to the number stored within the counter card Thus, there are four separate voltages from the four counter cards. These voltages are applied to both the Upper Limit and Lower Limit No-Go circuit cards. The front-panel

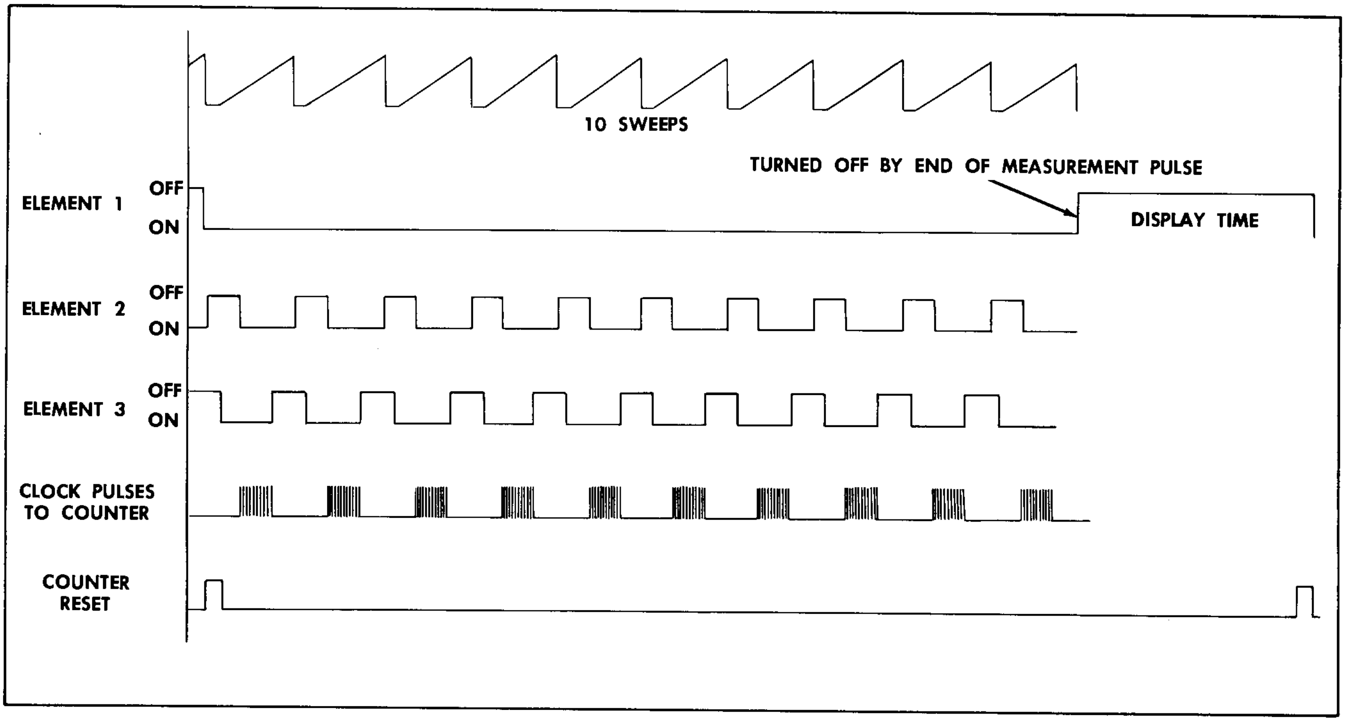


Fig. 4-9. Condition of the master gate with RESOLUTION switch in AVERAGE OF TEN SWEEPS.

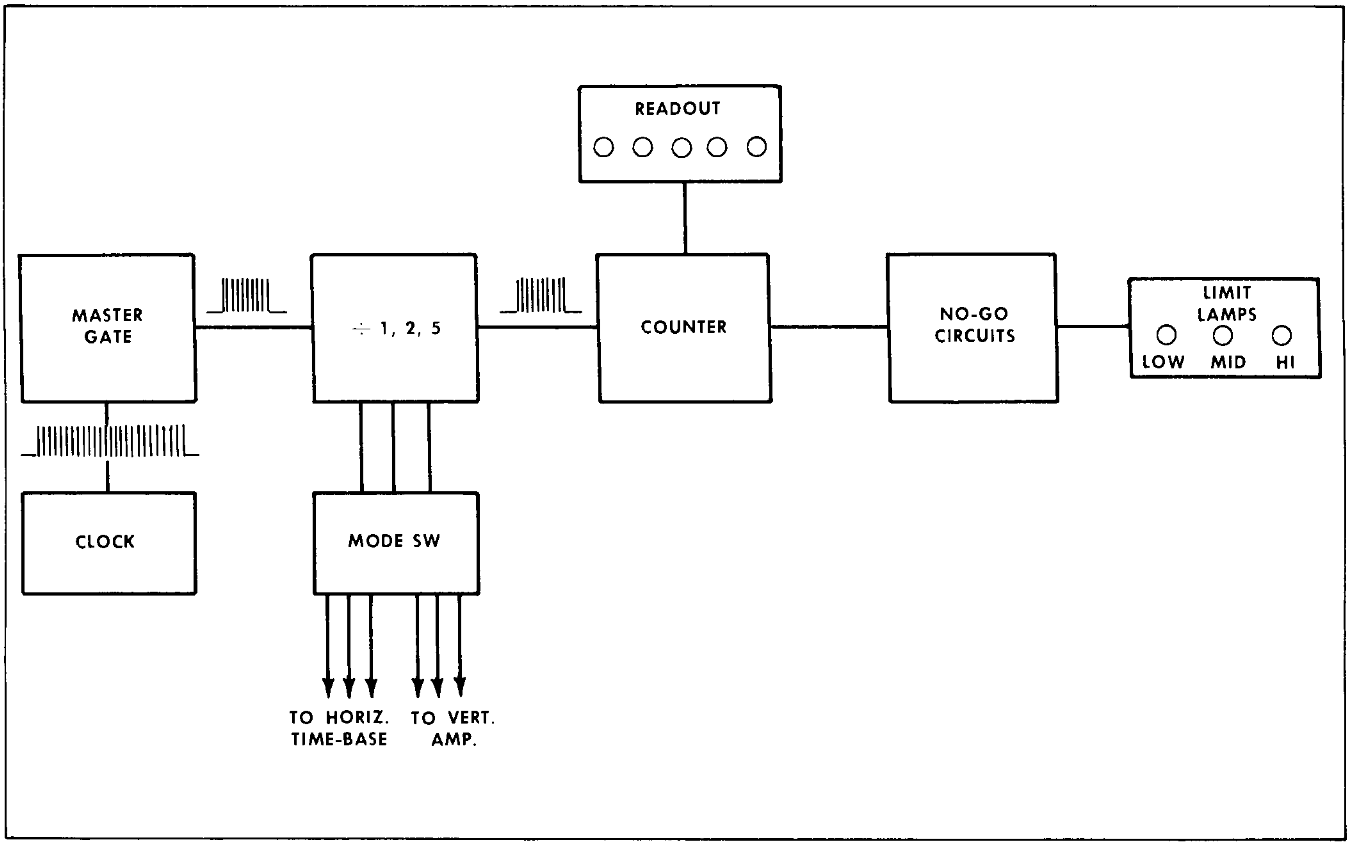


Fig. 4-10. Position of the ÷ 1, 2, 5 circuit in the overall system.

UPPER LIMIT SET and LOWER LIMIT SET dials also apply a voltage to the limit circuits that is proportional to the dial numbers.

With the voltage information described, the logic circuits on the Upper Limit and Lower Limit No-Go cards cause the front-panel lamps to indicate a high, low, or mid-zone readout. The switches are identical except that the start voltage from the TIMING START switch connects through the ± SLOPE switch to the start comparator circuit, while on the TIMING STOP switch, these points connect through the ± SLOPE switch to the stop comparator circuit.

In the MANUAL position of the TIMING START and TIMING STOP switches, a dc voltage set by the MANUAL controls on the front panel is connected to each signal comparator. The second input to the comparators is the sweep voltage from the 0% zone circuit card.

Note on the Timing Start Switching and the Timing Stop Switching schematics that the A 0% memory is applied to the bottom of a string of precision resistors and the A 100% memory is connected to the top of the string. While measurements are made on Channel A, the Channel B memory circuits are terminated by R429. This resistor is switched across Channel A when Channel B is in use. Since both TIMING switches have this resistor across the unused memory, the memories always have this resistance shunted across their output.

When the TIMING switches are turned to a percentage position (10%, 20%, 27%, etc.), the signal comparators receive a percentage of the total memory signal. The other input of each signal comparator is the signal from the vertical plug-in unit.

With the TIMING switches in the A or B position, the signal comparator inputs are connected to the wiper arm of a 10-turn precision potentiometer that is connected across the floating power supplies located on the Voltmeter circuit card. The other input of each signal comparator is the signal received from the vertical plug-in unit.

The analog display wafers of the TIMING switches ground either pin 5 or pin 10 of the Analog Display circuit card to intensify the proper channel.

CIRCUIT DESCRIPTION

0% Zone Circuit Card

Circuits on the 0% Zone circuit card (see schematic) generate the delayed plus gate pulse and the time-variable 0% zone memory-gate pulses. In addition, a phase splitter on the circuit card converts Channel A chopped-trace pulses from the vertical plug-in unit into both plus (+) and minus (—) gate signals. Signal inputs to the 0% Zone circuit card are the horizontal sweep voltage and the horizontal sweep gate from the horizontal-sweep plug-in unit, variable-level negative dc offset voltages from the A and B 0%

Zone Position controls, and the Channel A chop signal from the vertical plug-in unit. Outputs from the 0% Zone circuit card consist of the horizontal sweep ramp or staircase to the TIMING switches, the delayed plus gate pulse to the master gate, analog display and other circuits, the time-variable A and B 0% zone memory gate pulses to the A and B memories, and the plus (+) and minus (—) chop gates to the Analog Display circuit card.

Formation of the A and B 0% Zone Memory Gate Pulses. Except for part numbers, the two 0% zone memory gate pulse generators are alike, and a description of the operation of one generator serves for the operation of the other.

The A 0% zone memory gate pulse generator is composed of Schmitt circuit transistors Q35 and Q45, gating transistors Q23 and Q33, and associated circuit elements. In operation, the horizontal sweep voltage from emitter follower transistor Q3 is applied through R22 to the base of Q23. An adjustable negative voltage from the A 0% Zone Position potentiometer is also applied to the base of Q23 through R21. At the start of the sweep, the horizontal sweep voltage is zero volts and the negative voltage from the A 0% Zone Position potentiometer has Q23 biased to cutoff. D22 keeps the voltage on the base of Q23 from going more negative than approximately —0.3 volts. Q33 is biased to cutoff by a positive voltage at the junction of R31 and R33. With both Q23 and Q33 cut off, the base of Q35 in the Schmitt circuit has no current source and Q45 is the conducting transistor. When the sweep starts and the horizontal sweep voltage starts to rise, the current flowing through R21 and D23 is diverted through R22 to the positive-going emitter of Q3.

At a point determined by the setting of the A 0% Zone Position control, all of the current through R21 is diverted away from D23, and the voltage at the base of Q23 starts to go positive, forward biasing Q23. As the voltage on the base of Q23 goes positive, the emitter goes positive also, and starts to draw current from the base of Q35. The increasing current flow causes an increasing voltage drop across R23 and R25 (A Zone Width control) and the voltage at the collector of Q23 starts in a negative direction. A fraction of the negative-going voltage is coupled back to the base of Q23 through R27, and opposes the rising sweep voltage. The negative feedback to the base of Q23 slows down but does not stop the positive rise at that point, and finally the voltage on the emitter of Q23 is sufficient to bias Q35 into conduction, switching the Schmitt circuit on. With the Schmitt circuit switches and Q45 cut off, the collector voltage of Q45 rises to +18 volts, forming the leading edge of the positive 0% zone memory gate pulse. The voltage on the base of Q23 continues to rise, increasing current flow through Q23 and increasing the voltage drop across R23 and R25. At a point determined by the setting of the tap on R25, the increasing voltage drop permits Q33 to conduct. The conduction of Q33 effectively grounds the base of Q35 and resets the Schmitt circuit. Resetting the Schmitt circuit ends the 0% zone memory gate pulse. Q23 and Q33 remain in conduction until the end of the horizontal sweep staircase. When the sweep voltage falls to zero, the negative voltage from the A 0% Zone position potentiometer again cuts off Q23. The 0% zone memory gate pulse goes to the A and B Memory circuit cards.

Formation of the Plus Gate. The plus-gate pulse generator is a gated Schmitt circuit. The inputs are the horizontal sweep staircase voltage from emitter follower Q3 and the sweep-gate pulse from the horizontal-sweep plug-in unit.

In operation, the sweep-gate pulse drops to approximately —1.6-volts at the instant the sweep staircase voltage drops to zero. With —1.6 volts applied to its base, Q4 is cut off, opening the current paths of the base of Q15 and the collector of Q5. Neither Q5 nor Q15 can conduct, and the voltage across R14 falls to zero. At this point, Q13 is biased into heavy conduction, effectively grounding the plus-gate output terminal (terminal 13). With approximately zero volts on the emitter of Q13, Q14 is biased into conduction and applies a positive lock voltage to the Schmitt circuits in both 0%-zone pulse generators.

At the moment the sweep starts, the sweep gate pulse jumps to approximately +0.8 volts, turning on Q4 which in turn permits Q5 to conduct. Due to the biasing network consisting of R6 and R7, Q5 barely has conducting bias. When the sweep voltage rises approximately 2 volts, Q5 is biased into cutoff and the Schmitt circuit switches. The voltage on the collector of Q15 jumps to approximately 20 volts, and the positive pulse is coupled through D13 to terminal 13 on the circuit card. The circuit remains in this condition until the sweep ends and the sweep gate pulse again cuts off Q4.

Formation of the Plus and Minus Chop Gates. Q84 and Q94 and associated resistors form a conventional paraphase amplifier that is used as a phase splitter. Channel A chop signals, approximately 2 volts in amplitude, are applied to the paraphase amplifier. The output signals from the paraphase amplifier are opposite in phase and approximately 20 volts in amplitude.

Memory Circuit Cards

Two identical Memory circuit cards are used in the Type 6R1A; one for A trace and one for B trace. Each of the Memory cards contains two memory circuits, one for the 0% voltage and the other for the 100% voltage. Except for information processed, the operation of the circuits on the two Memory cards is the same.

Operation of the 100% Memory Circuit. The inputs to the 100% memory circuit (see 0% and 100% Memory Card schematic) are the plus gate on terminal 12, the print command pulse on pin 13, and a variable voltage on terminal 14. The plus gate is received from the 0% Zone circuit card. A time-variable positive pulse (100% zone) is synthesized from the horizontal sweep ramp voltage and a negative dc offset voltage from the 100% Zone Position potentiometer.

In operation, the start of the negative portion of the plus gate and the end of the horizontal sweep ramp voltage occur simultaneously. At the end of the horizontal sweep ramp, the ramp voltage and the plus gate both go in a negative direction. The negative going portion of the plus gate is applied to the base of Q4, placing it in conduction. With Q4 in conduction, the base of Q25 is effectively connected to +20 volts. This prevents the Schmitt circuit, composed of Q25 and Q35, from generating a memory gate pulse for the duration of the negative portion of the plus-gate signal. When the plus gate goes positive, the lockout voltage from Q4 is removed from the Schmitt circuit. The ramp voltage starts up, and at some point on the ramp, (determined by the setting of the 100% Zone Position potentiometer) the voltage on terminal 14 goes from —0.25 volt to +0.6 volt. The +0.6 volt biases Q14 into conduction.

Q14 draws current through R4 (100% Zone Width potentiometer) and R3. A fraction of the resulting voltage drop across R3 and R4 is applied as negative feedback through R12 to the base of Q14. The negative feedback causes the collector voltage of Q14 to fall at a fairly linear rate. As the collector voltage falls, a point is reached where Q25 in the Schmitt circuit is biased into conduction, and the Schmitt circuit switches. When the Schmitt circuit switches the votage on the collector of Q35 goes from approximately +20 volts to 0 volts and forms the leading edge of the negative memory gate pulse. As the voltage on the collector of Q14 continues to fall, Q4 is biased into conduction. When Q4 starts to conduct, it applies +20 volts to the base of Q25, resetting the Schmitt circuit and ending the negative memory-gate pulse. Q4 and Q14 remain in conduction until the end of the horizontal sweep ramp when the voltage on terminal 14 again goes to —0.25 volt, and the voltage on pin 12 goes to zero.

When the 100% MODE switch (SW46) on the circuit card is in the AVG position, the negative memory gate pulse is applied through R45 and SW46 to the memory capacitor in use. If there is no vertical signal input on terminal 5, the negative pulses discharge the capacitor after a few cycles. In operation, each time the memory gate pulse removes a portion of the charge on the memory capacitor, the voltage on the cathode of V63 decreases accordingly. The voltage at the junction of R65 and R67 goes in a negative direction. The voltage at this junction is applied to the base of Q54B, which is one half of a longtailed comparator. Q54A, the other half of this comparator, is connected to the vertical input signal from terminal 5. If the voltage at the junction of R65 and R67 drops below the level of the vertical input signal, Q54A starts to conduct. The current flow through Q54A in conjunction with the negative memory gate pulse through R46 can now turn on Q64 and charge the memory capacitor. (Note that Q64 cannot be turned on by either the negative memory gate pulse or the current flow through Q54A alone, but rather a combination of the two.) As the memory capacitor charges, the increasing positive voltage is applied to the grid of V63, and the cathode of V63 increases positive accordingly. The voltage at the junction of D64 and R65 goes positive as a result. When the charge on the memory capacitor is representative of the vertical signal input, the comparator increases or decreases current flow through Q54A during zone time as required to keep the charge on the memory capacitor representative of the vertical input signal. It generally requires several cycles for the memory circuit to adjust to large changes in the vertical input signal.

When the 100% MODE switch (SW46) is in the PEAK position, the memory capacitor in use is discharged during retrace time by transistor Q44. During retrace time, the negative going portion of the plus gate biases Q34 off. The collector voltage of Q34 goes positive, biasing Q44 into heavy conduction, which discharges the memory capacitor. Discharge is inhibited when print command is negative. The MODE switch also connects the emitter of Q64 directly to +20 volts, making large charging currents available when Q64 is turned on by the combination of the negative memory gate pulse and the conduction of Q54A. With large charging currents and a low-impedance discharge path available, any change in the vertical input signal is duplicated in the memory capacitor during the period of one horizontal sweep.

Operation of the 0% Memory Circuit. Operation of the 0% memory circuit is similar to the operation of the 100% memory circuit. The Schmitt circuit and gating transistors which generate the 0% memory gate pulse are located on the 0% zone circuit card and have been previously described. The time-variable 0% zone pulse from the 0% Zone circuit card is applied to terminal 2 of the 0% and 100% Memory circuit card. From terminal 2, the 0% zone pulse is applied through an OR gate composed of Q24 and D46 to terminal 10. In addition, the time-variable 0% zone memory gate pulse is applied to two points in the 0% memory circuit. One connection to the memory circuit is through R77 and the AVG contacts of the 0% MODE switch (SW76) to the memory capacitors. The other connection goes through R87 to the base of Q94.

When the circuit is first turned on, there is no charge in the memory capacitor, the cathode of V93 is consequently below ground, and Q84B is in conduction due to the vertical signal in, and the conduction of Q84A keeps Q94 cut off. When the first 0% zone memory gate pulse arrives, it is applied through R77 to the memory capacitor and to the base of Q94. The memory gate pulse by itself cannot overcome the negative bias on the base of Q94, so the only action that takes place is that the memory capacitor in use is partially charged. The charge on the memory capacitor is increased with each succeeding 0% zone memory gate pulse. The increasing positive voltage on the grid of V93 also increases the positive voltage on its cathode, which in turn causes Q84B to increase its conduction. As Q84B increases conduction, it robs current from Q84A. As the current through Q84A decreases, its collector voltage goes positive, and a point is finally reached where the combined collector voltage of Q84A and the 0% zone memory gate pulse can forward bias Q94. When Q94 starts to conduct, its collector voltage goes negative, providing a discharge path for the memory capacitor in use. From this point on, the circuit adjusts the charge on the memory capacitor to reflect the changes in the vertical input signal. If the vertical signal increases, Q84A increases its conduction and lowers the drive to Q94. If the vertical signal decreases, Q84B robs current from Q84A and permits Q94 to conduct heavier.

When the 0% MODE switch (SW76) is in the PEAK position, the charge path for the memory capacitor is through the collector circuit of Q34. Q34 operates an inverter with its base signal being the plus gate; thus the memory capacitor is charged during retrace time (except when inhibited by the print command signal through Q73). Discharge of the memory capacitor and operation of the remainder of the 0% zone memory circuit is the same as when the 0% MODE switch is in the AVG position, except that more discharge current is available as the Q94 emitter is tied to ground through the 0% MODE switch.

Signal Comparator Circuit Cards

The Type 6R1A contains two identical Signal Comparator circuit cards. The purpose of the cards is to form the start and stop pulses that control the master gate circuit when measurements are being made. In making time measurements, the TIMING START switch (front-panel control) sets the point at which the start Signal Comparator circuit card delivers a pulse, and the TIMING STOP switch (front-panel control) sets the point at which the stop Signal Comparator circuit card delivers a pulse. Except for the source of the input signals and the timing of the output pulse, the operations of the circuits on the two cards are the same.

When making time measurements, the inputs to the timing-start Signal Comparator card are the output of the TIMING START switch and the signal from the vertical plug-in unit on pins 8 and 9, the plus gate on pin 1, ground signals as required from the START FIRST-SECOND SLOPE switch on pins 4 and 5, and clock pulses on pin 16. The inputs on pins 8 and 9 may be reversed by the START + — SLOPE switch on the front panel to permit the time measurement to be started on either a positive-going or a negative-going portion of the vertical waveform. When making voltage measurements, the inputs are the same except for the inputs to pins 8 and 9. The inputs to pins 8 and 9 are a ramp voltage from the Voltmeter circuit card and a memory output from the appropriate Memory circuit card.

The inputs on pins 8 and 9 are applied to the two sides of a longtailed comparator which is arranged so that the side receiving the most positive input conducts and cuts the other side off. Assuming that time measurements are to be made, and that the START + — SLOPE switch is set to +, a positive reference voltage from the TIMING START switch is applied to pin 9 and the vertical signal from the vertical plug-in unit are applied to pin 8. Q13B and Q14B are conducting and have Q13A and Q14A cut off. The conduction of Q14B biases Q24 into conduction. The conduction of Q24 raises the emitter voltage of Q23 to approximately 20 volts, which cuts it off.

With conditions as explained in the preceding paragraph, the positive clock pulses on pin 16 are inverted by Q34 and applied through C34 and D39 to Q44 and C40. If the 4-DOT DELAY switch SW42 is closed, the negative pulses are also applied to C42. Each negative pulse removes some charge from C40 and C42 until the voltage drops to approximately —4.2 volts, biasing Q44 into conduction. The conduction of Q44 switches tunnel diode D55 to its low-voltage state, and Q54 is cut off. With the comparator circuit now quiescent and awaiting the proper vertical signal, it is now necessary to set the second slope flip-flop to the proper state.

When it is desired to start the time measurement on the second occurrence of a particular point on the vertical signal, the START FIRST-SECOND SLOPE switch is set to SECOND. Setting this switch to the SECOND position grounds pin 5, effectively grounding the junction of R71 and D72, D76, and D73. When the positive portion of the plus gate pulse arrives (immediately after the beginning of the horizontal sweep), it reverse biases D63 and forces the base voltage of Q85 to go more positive. Application of the positive portion of the plus gate waveform to Q85 ensures that it is cut off. These are the conditions at the start of the sweep.

As the sweep starts to run up, the comparator switches at the selected portion of the vertical signal and turns Q24 off. With Q24 turned off, the Clock Pulses pass through emitter follower Q23, C24 and D29 to C40 and C42. The capacitors are charged faster than Q34 and the associated circuit can discharge them, and finally the capacitors accumulate enough charge to switch tunnel diode D55 to its high-voltage state. When D55 switches to its high-voltage state, it turns on Q54. Q54 amplifies the output of D55 and applies the positive-going pulse to the base of Q85 or Q95 through C82 and C92 and steering diode D82 or D92. The multivibrator switches, and the output on pin 2 falls to zero. When the selected event occurs a second time on the same sweep, the switching of the Comparator and D55 causes a second pulse to be applied to Q85 and Q95, switching the flip-flop the other way and delivering a positive output on pin 2. This positive pulse is the start pulse and is sent to the Master Gate circuit card.

If it is desired to start the time measurement from the first occurrence of an event, the START FIRST-SECOND SLOPE switch is placed in the FIRST position. In this position, the switch grounds pin 4, effectively grounding the junction of D62 and R62. The positive portion of the plus gate which occurs immediately after the start of the sweep is applied through D73 and D76 to the base of Q95, ensuring that it is cut off. When the comparator switches at the first occurrence of the selected event, tunnel diode D55 switches to its high-voltage state, and through Q54 applies a switching pulse to Q85 and Q95. The multivibrator switches and Q95 becomes the conducting transistor. The conduction of Q95 applies a positive pulse to the output.

The purpose of the 3-DOT DELAY switch and capacitor is to prevent the tunnel diode from being switched to its high state if the comparator is momentarily switched by a noise transient. When 3-DOT DELAY switch SW42 is placed in the IN position, it takes three clock pulses to charge C40 and C42 to a voltage high enough to switch tunnel diode D55 to its high-voltage state. This three-pulse delay does not affect accuracy since the same delay exists in the stop comparator. The three-dot delay feature may be disabled by moving 3-DOT DELAY switch to the OUT position.

When the front-panel TIMING switches are set to the MANUAL position, the comparator reference is a dc voltage set by the MANUAL controls. The signal side of the comparators now receive the horizontal sweep voltages. As the sweep voltage rises, it reaches the voltage set by the TIMING START MANUAL control and the comparator delivers a pulse. As the sweep voltage continues to rise, it reaches the point set by the TIMING STOP MANUAL control in the stop comparator and that circuit delivers a pulse. Both pulses pass to the master gate circuit and determine the start and finish of the time measurement. The MANUAL positions of the TIMING START and TIMING STOP switches were included primarily for use in calibrating and troubleshooting the Type 6R1A.

Master Gate Circuit Card

The Master Gate circuit card (see Master Gate Schematic) performs six functions:

1. Gates clock pulses to the ÷ 1, 2, 5 circuit card.

2. Forms a start-to-stop pulse which is applied to the analog display (intensified zone).
3. Delivers a stop-pulse output to the RESOLUTION switch.
4. Forms a print-command pulse.
5. Controls the display time of the readout.
6. Forms a counter reset pulse.

The inputs to the Master Gate circuit card are the plus gate on pin 9; the start pulse from the start comparator on pin 2; the stop pulse from the stop comparator on pin 19; clock signals on pin 4; an adjustable dc current from the DISPLAY TIME control on pin 12; an end-of-measurement pulse derived from the stop pulse on pin 7; and a ramp-gate pulse on pin 17. The outputs are clock bursts to the ÷ 1, 2, 5 circuit card on pin 5; the start-to-stop zone intensification pulse to the Analog Display circuit card on pin 18; a stop pulse to the ÷ 10 circuit card on pin 16; the print command to the Limit Light Driver and Memory circuit cards on pin 13; and the reset pulse to the Counter circuit card on pin 8, (see Fig. 4-11).

Gating the Clock Bursts. When the MODE switch is set to VOLTAGE and the RESOLUTION switch is set to LO, the current from the DISPLAY TIME potentiometer starts to charge C42. As C42 charges, the voltage on the base of Q45 rises in the positive direction. During the time C42 is charging, the divide-by-two multivibrator is switching each time the plus gate goes negative. When the positive voltage on C42 and the base of Q45 rises high enough, the negative pulses from Q25 to Q55 cause the display-time multivibrator to switch, and both Q45 and Q55 conduct. The conduction of Q55 cuts off Q93 and pulls the base of Q83 to ground. Cutting off Q93 enables one input of AND gate Q93, Q153, Q163 and R163. With the base of Q83 at

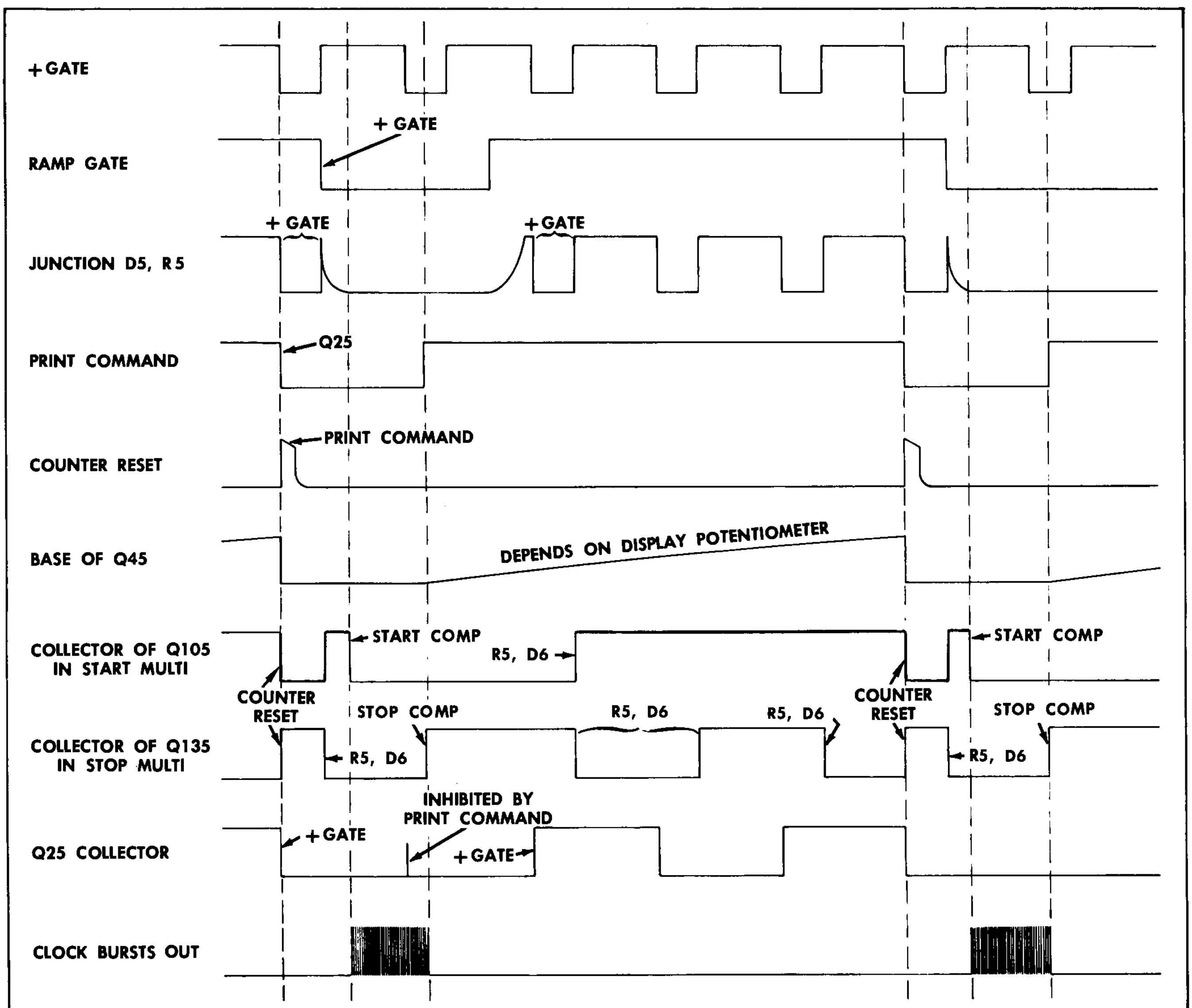


Fig. 4-11. Time relationships of waveforms in the master gate circuit.

ground, its emitter is low enough to bias Q84 into conduction. When Q84 conducts, its collector pulls up on the base of Q25 and holds it on, inhibiting divide-by-two multivibrator Q15 and Q25. The conduction of Q55 also terminates the positive portion of print command at the emitter of Q83. The negative level of print command is applied to the Voltmeter circuit card where, in conjunction with the plus gate, it ends the ramp gate and begins the voltmeter ramp runup.

The conduction of Q45 in the display-time multivibrator biases Q64 into conduction, in turn biasing Q73 into conduction. (Series M, Model 5-up) The positive-going emitter voltage of Q73 is applied through diodes D72 and D74 to the start and stop multivibrators, ensuring that Q105 and Q125 are turned off and that Q115 and Q135 are turned on at the end of display time. (For Series M, Models 1 through 4, the positive-going emitter voltage of Q73 is applied through R74 to the stop multivibrator, ensuring that Q125 is turned off and Q135 is turned on at the end of display time.) When Q135 starts to conduct, it sends a stop pulse through the RESOLUTION switch to the base of Q55, but the display-time multivibrator cannot be switched at this time since the capacitor in its base circuit (C42) has not yet had time to discharge. Also at the beginning of the negative portion of the plus gate, the voltmeter ramp gate is positive, enabling one input of an AND gate consisting of Q3, D5 and D6.

As the negative portion of the plus gate ends and the gate signal goes positive, the ramp gate goes negative, but the emitter of Q3 is connected to C3 which discharges at an exponential rate. For a time determined by C3, both inputs of the AND gate are enabled, and the gate passes a positive pulse to both the start and stop multivibrators. The positive spike from Q3, D5 and D6 makes Q105 the conducting transistor in the start multivibrator and Q125 the conducting transistor in the stop multivibrator. The conduction of Q105 biases Q143 into conduction and prevents clock pulses from passing through Q163. The conduction of Q125 cuts off Q135 which cuts off Q173 in turn. The master gate circuit card is now ready to receive the pulse from the start Signal Comparator circuit card.

When the positive pulse from the start comparator occurs, it switches the start multivibrator, cutting off Q105. Cutting off Q105 causes the voltage on the emitter of Q143 to go negative, which cuts off Q153. With Q93 and Q153 cut off, the clock pulses pass through Q163 and are amplified by Q164 during the time between the occurrence of the start pulse and the occurrence of the stop pulse. The burst of clock pulses out of the Master Gate circuit card pass to the ÷ 1, 2, 5 circuit card and from there to the counters. The burst of clock pulses is ended when the stop pulse from the stop comparator switches the stop multivibrator and makes Q135 the conducting transistor. The conduction of Q135 biases Q173 into conduction, which in turn biases Q153 into conduction and closes the AND gate.

The output of Q135 is applied through Q173 and the RESOLUTION switch back to the base of Q55 in the display-time multivibrator. The pulse, now called the end-of-measurement pulse, causes the display multivibrator (Q55 and Q45) to turn off. Q55 and Q45 stay cut off until C42 in the base circuit of Q45 charges through the DISPLAY TIME control. When Q55 turns off, it biases Q83 into conduction. The conduction of Q83 applies a positive pulse to the print-command output. The conduction of Q83 also turns off Q84 and removes the positive lock voltage from the base of Q25 in the divide-by-two multivibrator. The divide-by-two multivibrator is now free to switch each time a plus gate pulse is applied. During the charge time of C42, the divide-by-two multivibrator and the stop multivibrator switch with each plus gate pulse until finally the combination of signals shown on the schematic again opens the AND gates and allows the passage of clock pulses.

Formation of the Start-to-Stop Zone Pulse. With either Q173 or Q143 turned on, the voltage at pin 18 is approximately 20 volts. When both transistors are turned off during the time the clock bursts are being gated, the voltage on pin 18 falls to approximately +2 volts. The waveform at pin 18 is applied to the Analog Display circuit card where it is used to generate the start-to-stop zone trace brightening pulse.

Forming the Stop-Output Pulse. A stop-pulse output is formed each time Q135 in the stop multivibrator conducts. The conduction of Q135 turns on Q173. The conduction of Q173 raises the voltage on pin 16 to approximately +20 volts. The stop pulse on pin 16 is applied to the ÷ 10 circuit card and to one side of the RESOLUTION switch. When the RESOLUTION switch is placed in either of the ONE SWEEP positions, the stop pulse is routed directly back to pin 7 on the Master Gate circuit card. If the RESOLUTION switch is placed in either of the AVERAGE OF TEN SWEEPS positions, the ÷ 10 card counts the stop pulses and delivers one output pulse to the Master Gate circuit card for every ten input pulses. The pulse returned to pin 7 is now called the "end-of-measurement pulse".

Forming the Print-Command Pulse. The positive pulse on pin 7 is coupled through C30 and D31 to the base of Q55. The positive pulse turns off Q55, cutting off Q45 also. Q45 and Q55 form a bistable multivibrator which is stable whenever both transistors are on or both transistors are off. When Q45 is cut off, its collector voltage rises towards +125 volts. The positive-going voltage on the collector of Q45 is coupled through C46 and R46 back to the base of Q55, ensuring that Q55 will stay cut off when the end-of-measurement pulse terminates. When Q55 cuts off, the voltage at its emitter goes positive since it is connected to +20 volts through R80. The positive voltage turns on Q83. The positive-going output of Q83 is applied to pin 13 and to the base of Q84. Q84 cuts off as a result of the positive voltage on its base; its collector voltage goes to zero and unlocks the divide-by-two multivibrator. The positive output of Q83 applied to pin 13 is the positive print-command signal; if a negative print-command signal is required on pin 20, the moveable strap is changed to connect pin 20 with the collector of Q84.

The positive voltage at the emitter of Q55 and the base of Q83 (which results from the application of the end-of-measurement pulse) is also applied to the base of Q93. The positive voltage biases Q93 into conduction, closing the AND gate to the passage of clock pulses. The gate remains closed until Q45 and Q55 in the display time multivibrator are again turned on. C42 in the base circuit of Q45 has very little charge on it as long as Q45 and Q55 are conducting, but when the end-of-measurement pulse cuts the transistors off, C42 starts to charge to +20 volts through the 5-meg DISPLAY TIME potentiometer. The display-time multivibrator transistors Q45 and Q55 remain cut off until the voltage on C42 reaches approximately +18 volts. When the voltage reaches approximately +18 volts, the circuit waits until Q25 in the multivibrator has been switched into conduction by the plus gate pulse. When Q25 becomes the conducting transistor, a switching pulse from its collector is coupled through C35 and D36 to the base of Q55. Q55 starts to conduct, forcing Q45 into conduction. The negative-going voltage on the collector of Q45 is coupled back to the base of Q55 and holds Q55 in conduction until Q55 is again turned off by an end-of-measurement pulse. The time during which Q45 and Q55 are cut off is the display time. During display time, Q93 is conducting and keeps the clock pulse gate closed, and no measurements are made.

Formation of the Reset Pulse. When the combination of charge on C42 and a reset pulse from Q25 force Q45 and Q55 into conduction, the negative-going voltage on the collector of Q45 is coupled through C60 to the base of Q64. Q64 starts to conduct and biases Q73 into conduction. The output pulse from Q73 is differentiated by C76 and sent to the counter circuit cards as a reset pulse for the counters.

(Series M, Model 5-up) The output of Q73 is also applied to base of Q105 (start multivibrator) and to the base of Q125 (stop multivibrator). The reset pulse from Q73 switches both multivibrators, causing Q135 in the stop multivibrator to conduct and Q105 in the start multivibrator to cut off. The resulting conduction of Q135 causes Q173 and Q153 to conduct, inhibiting the passage of clock pulses.

(Series M, Models 1 through 4) The output of Q73 is applied to the base of Q125 in the stop multivibrator. The reset pulse from Q73 switches in the stop multivibrator, causing Q135 to conduct, and turning on Q173 and Q153 to inhibit the passage of clock pulses.

The next plus gate returns both multivibrators to their original state; Q135 cut off, Q105 turned on. Conduction through Q105, Q143 and Q153 continues to hold the clock gate in an inhibitated state until the next start pulse from the start comparator causes the start multivibrator to switch again. The ramp gate pulse in at pin 17 prevents a reset from being formed while the ramp circuit on the Voltmeter circuit card is running up.

÷1, 2, 5 Circuit Card

This circuit uses three binary sets (bistable multivibrators) to divide by 5, and 1 binary set to divide by 2. The divide-by-1 is a straight-through transistor amplifier. Refer to the Counter circuit description for details on binary set operation. A positive clock pulse enters the circuit at pin 7 and moves in three directions:

1. Through C2, to the ÷5 circuit.
2. Through C62, to the ÷2 circuit.
3. Through C80 and R80 to the base of Q84.

Selecting Division by 1, 2, or 5. Note that the base of Q44, Q74, and Q84 is connected through one side of a divider to a circuit card pin (Q44 to pin 2, Q74 to pin 10, Q84 to pin 1). These pins connect through the instrument wiring to the sampling horizontal time base and vertical plug-in units. When the Type 6R1A MODE switch is in the TIME position, a ground connection is made at the TIME/DIV switch in the horizontal plug-in unit. The ground is alternately connected to pins 1, 10, and 2 of the ÷1, 2, 5 circuit card. The transistors connected to the ungrounded pins are biased to cutoff.

For example, if the TIME/DIV switch on the horizontal plug-in unit is set at 10 μsec/div, pin 1 of the ÷ 1, 2, 5 circuit card is grounded and the number of positive clock pulses at pin 6 (output) is the same as the number at pin 7 (input). If the TIME/DIV switch is set at 5 μsec/div, pin 10 of the circuit card is grounded and the number of clock pulses at pin 6 (from Q74) is one-half the number at pin 7 (input). Finally, if the TIME/DIV switch is set to 2 μsec/div, pin 2 of the circuit card is grounded and the number of clock pulses at pin 6 (from Q44) is one-fifth the number at pin 7.

Each position of the TIME/DIV switch will ground either pin 1, 10, or 2, when the Type 6R1A MODE switch is in the TIME position.

When the Type 6R1A MODE switch is in a VOLTAGE position, a ground connection is made at the MV/DIV switch in the vertical plug-in unit. When the MV/DIV switch is set at 10, pin 1 of the ÷ 1, 2, 5 circuit card is grounded. The 5 mv/div position grounds pin 10, and the 2 mv/div position grounds pin 2.

Though the setting of the MV/DIV switch on the vertical plug-in unit may be changed, the readout will remain the same due to the ÷ 1, 2, 5 circuit. This is also true of time measurements, and changes in the setting of the TIME/DIV switch on the horizontal plug-in unit will not affect the readout.

All of the binary sets on the circuit card are reset at the beginning of a new count by a reset pulse at pin 8 from the master gate circuit.

Counter Circuit Card

Each Counter circuit card consists of four binary sets (bistable multivibrators), ten driver transistors, and a staircase emitter follower.

Since all binary sets are similar, only the first will be described in detail.

In a binary set, when one transistor is turned on, the other is off. Before a count is made, a positive reset pulse from the master gate is applied to the base of Q5 and this transistor turns off. Q15 turns on and its collector rises to +20 volts. D12, connected to the base of Q15, is forward biased. With Q5 turned off, its collector is at about 3 volts and D2 is back biased. A positive pulse coupled through C12 finds a path through D12 but is blocked by D2. The positive clock pulse passes through D12 to the base of Q15. Q15 turns off and its collector goes negative. This negative-going pulse couples through C16 to the base of Q5 and this transistor turns on. The binary set has changed states. D2 is now forward biased and D12 back biased. The next pulse coupled through C2 will pass through D2 to the base of Q5. The binary set will change again and a positive voltage will appear at the collector of Q15. This is coupled as a pulse through C32 to the next binary set.

It takes two positive pulses at the input to a binary set to get one positive pulse in the output. Thus, it divides by two.

By connecting a second binary set to the output of the first, the circuit divides by 4. A third divides by 8, and a fourth divides by 16.

To divide by 10, it is necessary to use feedback. C38 in the base circuit of Q35, and C58 in the base circuit of Q55, couple pulses back and change the states of the previous binary set to make the circuit divide by 10.

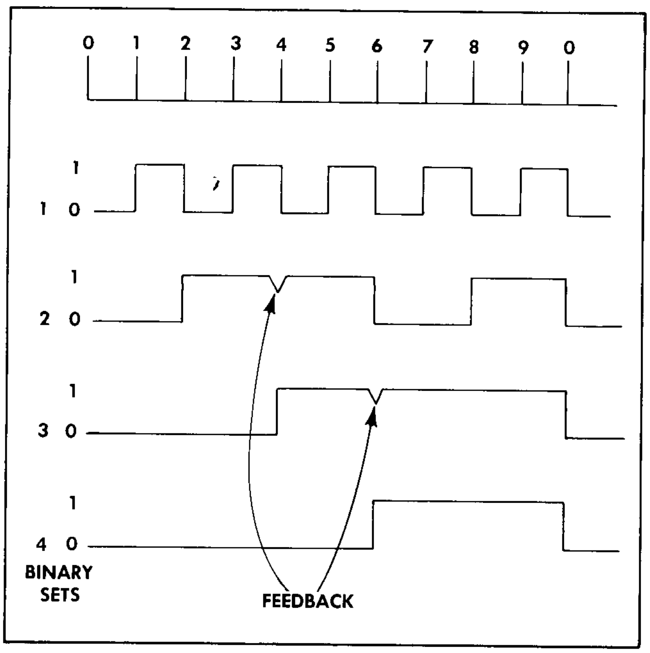
(a)

Pulse Number	Binary Set 1	2	3	4
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1
10	0	1	0	1
11	1	1	0	1
12	0	0	1	1
13	1	0	1	1
14	0	1	1	1
15	1	1	1	1
0	0	0	0	0

(b)

Pulse Number	Binary Set 1	2	3	4	
0	0	0	0	0	
1	1	0	0	0	
2	0	1	0	0	
3	1	1	0	0	Feedback
4	0	1	1	0	
5	1	1	1	0	Feedback
6	0	0	1	1	
7	1	0	1	1	
8	0	1	1	1	
9	1	1	1	1	
0	0	0	0	0	

Fig. 4-12. Comparison between scale of 16 (a) and scale of 10 (b) counter.



Fg. 4-13. Waveform relationship of binary sets showing feedback.

Fig. 4-12a shows the state of each binary set in a scale-of-16 circuit without feedback. A one (1) in the column means that the input transistor of a binary set is turned on; a zero is an off condition.

A count-by-ten counter must have 10 different arrangements of its binary sets caused by 10 consecutive pulse inputs, and must also return to its start point on the 10th input pulse.

Fig. 4-12b shows the change caused by feedback. On the 4th input pulse, the circuit "skips" ahead to a condition that represents the number "6" (although the readout shows a 4). Note that the only difference between four and six is the state of the 2nd binary set. The feedback pulse holds the 2nd binary set on, and the counter has instantaneously skipped ahead two counts, passing 4 and 5.

The 6th input pulse to the counter causes a feedback pulse from the last binary set to couple back to the 3rd binary set. This causes the counter to skip ahead four counts to the condition for number "12" (the readout shows a 7). The remaining pulses move the counter to the end of a cycle and it returns to zero on the 10th count. By skipping ahead a total of six counts, the circuit returns to zero on the 10th count (instead of the 16th count) and a count-of-ten is complete.

Fig. 4-13 shows the waveform condition of each binary set and includes the feedback points that convert the circuit to a scale -of-ten counter.

As each pulse passes through the counter circuit it should light a corresponding number on the readout tube. This is accomplished by readout driver transistors Q100 through Q109.

Notice that the emitters of the odd transistors are connected to R109 in the collector of Q15. With Q15 turned on, the positive voltage developed across R109 will back bias these odd transistors and prevent them from turning on. The even transistors are connected to R110 in the collector of Q5 and they become back biased when this transistor is turned on. Thus, the state of the first binary set determines whether the number on the readout is odd or even. Because of this, the bases of the pairs of transistors (Q108 and Q109, etc.) can be connected together since only one of the pair can turn on.

Q100 and Q101 drive the numbers 0 and 1. The voltage developed across R100 in the base circuit of this pair will determine whether they can be turned on. At the beginning of a count, a counter reset pulse from the master gate circuit enters the board at pin 8 and resets each binary set. After reset, the right-hand transistor in each binary set is turned on. Since Q5 in the first binary set is turned off, the number will be even. Notice that R100 in the base circuit of Q100 is connected through R75 to the collector of Q75, which is turned on. Also, R100 is connected through R35 to the collector of Q35, which is turned on. The combined current from these two transistors add across R100, and Q100 turns on. The number zero (0) will show on the readout. Each pair works in the same way with the current being derived from the transistors in the binary sets.

The staircase voltage required by the no-go circuits is formed by a voltage divider in the base circuit of Q83. The output level at the emitter of this transistor changes linearly with each count. For example, if the counter stops at the number 5, there will be a 12.4-volt dc level at pin 2 of the circuit card. R81, in the base circuit of Q83, together with R3, R23, R43, and R63, form a voltage divider that changes the value of voltage at the base of Q83 with each count. Each of these four resistors is connected in the collector circuit of the left-hand transistors of each binary set. The on or off condition of these transistors determines the value of voltage applied to the base of Q83.

Analog Display Circuit Card

The analog display circuit intensifies the crt display during the dead zone, 0% zone, 100% zone, and the area of the trace being measured (during time measurements).

The trace is intensified by an increased dc level coupled from the collector of Q94 to the crt grid.

Intensified Dead Zone. A negative pulse from the 0% Zone circuit card is received at pin 8. The pulse is applied to the base of Q43 which turns on. Its emitter follows the base and a negative pulse is applied to the base of Q53. This pulse appears in the emitter of Q53 and passes to the base of Q94 through R91 and C91. Q94 turns on and a positive pulse is coupled from its collector to the crt grid.

0% and 100% Intensified Zones. The 0% and 100% zone pulses from the Memory circuit card enter the circuit through pin 14 (Channel A) and pin 2 (Channel B). The Channel A pulse passes through Q3 and D12 to the base of Q53. The Channel B pulse passes through Q23 and D32 to the base of Q53.

Start-To-Stop Intensified Zone. A negative pulse from the Master Gate circuit card enters at pin 13 and is applied to the base of Q83 (emitter follower). The emitter of this transistor is coupled to the base of Q94. The positive pulse to the crt is taken from the collector of Q94.

CRT INTENSIFICATION Switches. Pin 15 of the Analog Display circuit card is connected to the CRT INTENSIFICATION - MEMORY ZONES switch on the front panel. When this switch is turned to OFF, +20 volts is applied to the junction of R52 and D52. D52 becomes forward biased and the +20 volts is applied to the base of Q53, which is held in cutoff. Pin 1 of the circuit card connects to the CRT INTENSIFICATION - START TO STOP switch on the front panel. When this switch is turned to OFF, +20 volts is applied to the junction of R82 and D82. D82 is forward biased and holds Q83 in cutoff.

Dual Trace. Due to the use of dual-trace, it is necessary to use a chopped signal in the analog display. Q13 and Q63 are controlled by the minus (—) chopped pulse from the 0% Zone circuit card. The plus (+) chopped signal controls Q33 and Q73. The action of the chopping pulses can be seen by examining Q3 and Q13. These two transistors are an AND gate that require a negative signal on both bases to get an output. With either transistor turned on, its emitter is near +20 volts and D12 is back biased. The junction of D12 and R42 is near +20 volts and Q53 (connected to this junction) is turned off. When both Q3 and Q13 receive a negative pulse, they both turn off, and D12 becomes forward biased through R13. Thus, the junction of D12 and R42 drops to about +3 volts and Q53 turns on.

Q63 and Q73 are used to gate the start-to-stop zone to the proper channel during dual-trace operation (for example, a risetime measurement on Channel A with both traces on the crt). Pin 5 is grounded by the TIMING START and STOP switches and Q73 is electrically removed from the circuit. Q63 receives the minus chop pulses from pin 12. During the time that the chopped trace on the crt is on Channel A, Q63 does not affect the start-to-stop pulse to the base of Q83. When the crt trace switches to Channel B, the minus chop pulse is at +20 volts and this voltage turns Q63 off. The emitter of Q63 rises to about +15 volts. This forward biases D63, which applies the positive voltage to the base of Q83. This transistor is cutoff for the duration of the chopped pulse and this period of time coincides with the time that the crt trace is on Channel B.

If both channels are intensified for a measurement made from one channel to the other, both pin 5 and pin 10 are grounded by the TIMING START and STOP switches and these two transistors (Q63 and Q73) are not used.

Voltmeter Circuit Card

The Voltmeter circuit card contains four separate circuits: the voltmeter ramp generator, clock crystal oscillator, and two floating power supplies. Each circuit is described separately in this section.

Functions. The Type 6R1A uses Counter circuit cards which count clock pulses to make voltage measurements. In making voltage measurements, the clock pulses counted are produced by a 1-mc crystal oscillator mounted on the Voltmeter circuit card. To maintain the correct reading when the MV/DIV switch is changed, the clock pulses pass through a ÷1, 2, 5 circuit card before being counted.

Voltage measurements are made between the 0% zone memory voltage and the 100% zone memory voltage. The voltage of the 0% memory circuit is applied to one side of the start comparator and the voltage of the 100% zone memory is applied to one side of the stop comparator. A ramp voltage (starting at zero) from the ramp generator on the Voltmeter circuit card is applied to the opposite

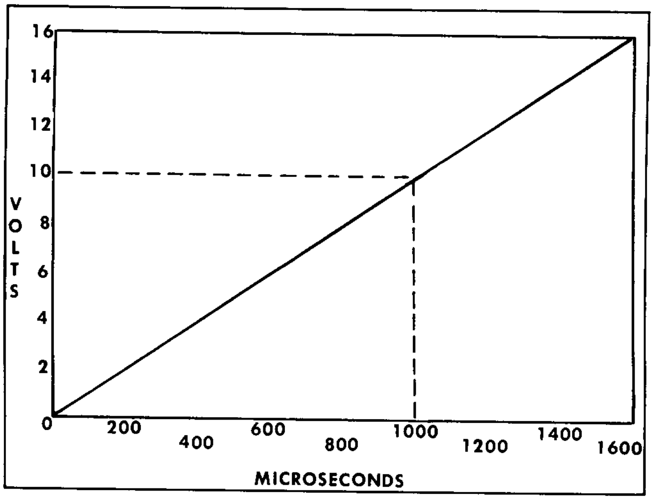


Fig. 4-14. Voltmeter ramp.

sides of both start and stop comparators. When the ramp voltage equals the 0% zone voltage level (at least 5 volts) the start comparator sends a pulse to the master gate circuit. The master gate opens and clock pulses pass to the counter. When the ramp reaches the voltage of the 100% zone (up to 15 volts) applied to the stop comparator, the stop comparator sends a pulse to the master gate circuit which closes the gate. When the master gate closes, the counter stops and the time shown on the readout is read as volts, mv, or μv. Consider a linear ramp (part of a sawtooth) such as shown in Fig. 4-14. It takes 1000 μsec for the ramp to rise 10 volts. Each volt takes exactly 100 μsec. This waveform is used to measure voltage as shown in Fig. 4-15. To measure a negative voltage, where the 100% zone is more negative than the 0% zone, the polarity switch (A VOLTAGE or B VOLTAGE) is pushed down. This reverses the inputs to the comparators and the measurement starts at the 100% zone and stops at the 0% zone.

Ramp Generator Circuit. The voltmeter ramp is formed by a self-restoring Miller sawtooth generator. The inputs to the ramp generator are the print command from the Master Gate card on pin 15 and the plus gate from the 0% Zone circuit card to pin 8. Q104 requires the print command and voltmeter ramp to be in the negative-going portion of the cycle before the plus gate signal can pass to Q115. When these conditions are met, the positive-going trailing edge of the plus gate cuts off Q115 in the voltmeter gating multivibrator. With Q115 cut off, its collector voltage, the ramp gate on pin 4, and the base voltage of Q141 start to go negative. As the base voltage on Q141 goes negative, its collector voltage starts positive, biasing Q153 into conduction. As Q153 starts to conduct, its emitter voltage goes positive, and the positive going waveform is coupled through C140 to the base of Q141. At the same time, C140 starts to charge due to the rising emitter voltage of Q153. The capacitor draws current through R140 and RAMP SLOPE resistor R141. The rising voltage on the emitter of Q153 continues to raise the voltage toward which C140 is charging. This "boot-strapping" keeps C140 charging at a constant rate. The linear decrease in the base current of Q141 results in a linear ramp voltage output from the emitter of Q153.

The ramp voltage output of Q153 is coupled through R158 to the base of Q104. When the ramp voltage reaches approximately +20 volts, Q104 cuts off. With Q104 cut off, the lockout voltage from the collector of Q104 to the base of Q115 is removed, and the ramp voltage biases Q125 into cutoff. Cutting off Q125 resets the voltmeter gating multivibrator. Q115 starts to conduct, ending the

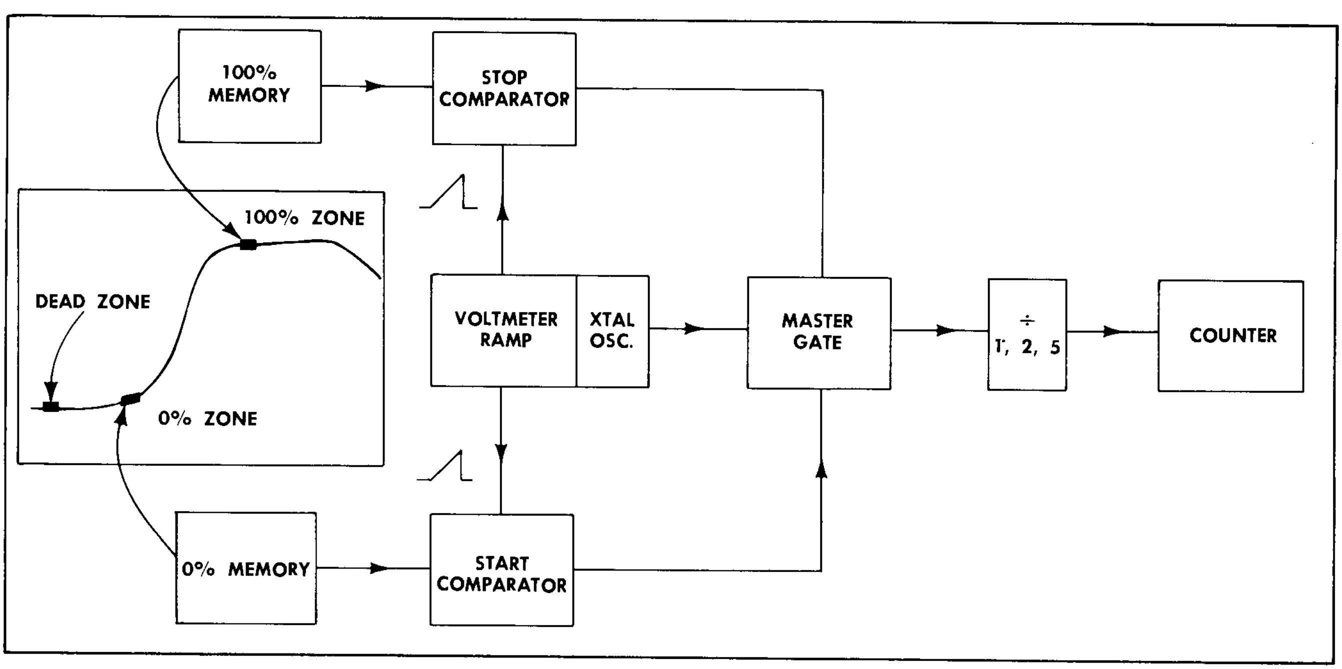


Fig. 4-15. Simplified diagram of circuits used for voltage measurements.

negative part of the ramp gate output to pin 4, and resets the ramp generator. C141 prevents noise from modulating the ramp

Clock Crystal Oscillator. The voltmeter clock oscillator is a conventional transistorized crystal oscillator with the crystal connected between the base and collector of Q10. The output of the clock oscillator is applied to shaping amplifier transistor Q14, which operates as an "overdriven" amplifier. The output of Q14 is applied to the base of Q24. When the MODE switch is in either of the VOLTAGE (A or B) positions, pin 12 is floating and pin 18 is grounded through the MODE switch. Grounding pin 18 biases Q24 into conduction and the clock pulses pass through Q24 to the clock output amplifier. The clock output amplifier is a conventional complementary emitter follower whose output is applied to pin 16.

If the MODE switch is in the TIME (STOP-START) position, pin 18 is floating and pin 12 is grounded through the MODE switch. With pin 18 floating, Q24 is biased to cutoff by the current flow through D24 and R21. The ground on pin 12 biases Q34 into conduction. With Q34 conducting, clock pulses from the horizontal plug-in unit are amplified by Q4 and pass through Q34 to the clock output amplifier.

Floating Power Supplies. The Voltmeter circuit card contains two identical power supplies, one for the START VOLTAGE control, and one for the STOP VOLTAGE control. Each supply consists of two transistors with an 11-volt Zener diode connected between their collectors. Q68 and Q78 supply the timing start voltage and Q88 and Q98 supply the timing stop voltage. The outputs are taken from across the Zener diodes and connected across the START VOLTAGE and STOP VOLTAGE controls located on the front panel. One side of the supply, depending on polarity switch (+ —), is connected to A or B 0% memory. One output lead of each supply contains a variable resistor (START VOLTAGE CAL and STOP VOLTAGE CAL). These controls adjust the current to place 10 volts across the START VOLTAGE and STOP VOLTAGE controls.

÷ 10 Circuit Card

The ÷10 circuit card is used when the RESOLUTION switch is in either of the AVERAGE OF TEN SWEEPS positions.

This circuit is almost the same as the binary set portion of the counter circuit and will not be described. For every ten pulses applied to pin 15 (input) of the circuit card, one pulse is present at pin 4 (output).

Lower Limit No-Go Circuit Card

The Lower Limit No-Go circuit card sends a signal to the limit lamp driver circuit when the number on the readout is below the number set on the LOWER LIMIT SET dials. If a number on the readout exceeds the numbers dialed on the LOWER LIMIT SET dials, the lockout portion of the circuit prevents the lower limit lamp from lighting.

The circuit consists of seven comparators; four of these compare the four digits of the readout and the other three are lockout comparators. Each digit comparator receives two voltages. The first is set by the LOWER LIMIT SET dials and corresponds to the number shown on the dials. The second is a staircase voltage that corresponds to the number on the readout and comes from the counter circuit. If the voltage from the counter circuit is below that supplied by the LOWER LIMIT SET dials, the lower limit lamp lights.

The voltages from the LOWER LIMIT SET dials are derived from a precision voltage divider. Two voltages are delivered to the tens, hundreds, and thousands comparator-lockout pairs of the Lower Limit No-Go circuit card. The lower value of the two voltages represents the number shown on the dial and the higher value represents one digit higher in value than the number shown on the dial. The voltage values are included on the Lower Limit Switches schematic.

To understand the circuit operation, consider only the thousands digit. Assume that the extreme left (thousands) digit shown on the LOWER LIMIT SET dials is 5. In the circuit, 11.4 volts is applied through pin 5 to the base of Q134. A count is made and the left-hand digit on the readout is 5. The counter circuit delivers 12.4 volts through pin 4 to the base of Q124. The base of Q134 has 11.4 volts and the base of Q124 has 12.4 volts; therefore Q134, being least positive, turns on. Due to current through Q134, its collector is positive and D141 is back biased. With this diode back biased, no signal is applied to the base of output transistor Q143 and this transistor cannot turn on.

If the number on the readout had been 4 instead of 5, then 10.7 volts would have been applied to the base of Q124, and this transistor, being least positive, would have turned on. In this case. Q134 would be turned off and D141 would be forward biased with —12 volts on its cathode. This —12 volts would turn on Q143 and the signal to the limit lamp driver circuit would light the lower limit lamp.

The other three comparators work the same way. Since each digit of the readout is compared with each digit on the LOWER LIMIT SET dials, it is possible for the total number to exceed the lower limit, yet one or more individual digits can be below the digits on the LOWER LIMIT SET dials. For example, assume the dials are set at 5678 and the readout shows 6000. The total number on the readout is higher than the lower limit, but the units, tens, and hundreds digits are lower.

Since each comparator compares the individual digits, either the units, tens, or hundreds digit would light the lower limit lamp. To prevent this, each comparator has a second comparator that will lock out all other comparators when the total readout exceeds the total number on the LOWER LIMIT SET dials.

From the simplified diagram in Fig. 4-16 the LOWER LIMIT SET dials (set at 5678) put 11.4 volts on the base of Q134. The staircase voltage from the thousands counter puts 14.1 volts (6000) on the bases of Q124 and Q104. The LOWER LIMIT SET dials also put 13.0 volts on the base of Q114.

The comparator traisistor with the least positive base turns on. The first comparator has 11.4 volts on Q134 and

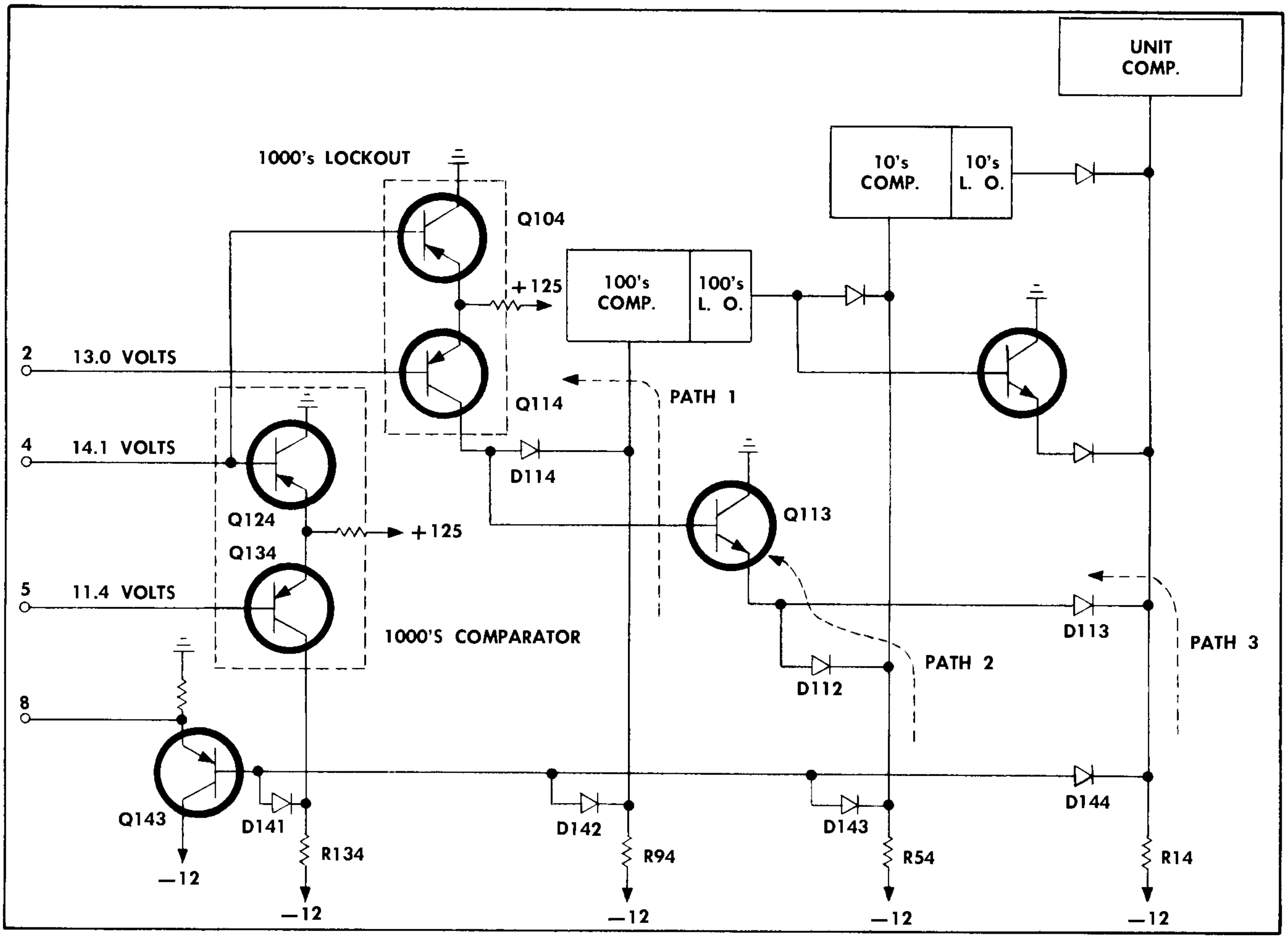


Fig. 4-16. Simplified diagram of lower limit no-go circuit.

14.1 volts on Q124, so Q134 turns on. Current flows through R134 and D141 is back biased. No negative signal reaches the base of Q143.

Since the number of the readout (6000) is larger than the number on the LOWER LIMIT SET dials (5678), the second comparator must lock out the remainder of the circuit. Q104 has 14.1 volts on its base while Q114 has 13.0 volts. Q114 is least positive and turns on. Three current paths are formed. Path 1 through D114 draws current through R94 and D142 is back biased. Path 2 turns Q113 on and draws current through D112 and R54, and D143 is back biased. Path 3 draws current through D113 and R14, and D144 is back biased.

With current through each of the four resistors, across the bottom of the diagram, the four diodes are back biased, and no negative voltage is applied to the base of Q143. In this condition, neither the hundreds, tens, nor units comparators can affect the circuit since they are locked out.

Each of the comparators except the units comparator has an associated lockout comparator. When the digits on the readout are read from the left, and each one is compared with the digit on the LOWER LIMIT SET dials, the first digit on the readout that exceeds its counterpart on the LOWER LIMIT SET dials will lock out all remaining digits to the right and their respective comparators will have no effect.

Upper Limit No-Go Circuit Card

This circuit is identical to the lower limit no-go circuit with the following exceptions:

1. The voltage applied to the base of the first comparator (Q124) by the UPPER LIMIT SET dials is higher than the voltage supplied by the counter staircase.

2. The voltage applied to the base of Q104 in the lockout comparator is approximately 1.8 volts lower than the voltage applied to the first comparator.

Limit Lamp Driver Circuit Card

The Limit Lamp Driver circuit card takes the outputs from the upper and lower limit no-go circuits and drives transistors that control the proper limit lamp on the front panel of the instrument.

The circuit is initially gated by a print-command pulse (a positive pulse from the master gate circuit). Without this pulse, none of the lamps can light. The pulse length of the gate is set by the DISPLAY TIME control on the front panel of the instrument. The positive print command is applied to the base of Q14 which is quiescently conducting. Q14 turns off and its collector goes to —12 volts. The base of Q13 is connected to the collector of Q14 and the —12 volts turns Q13 on. The emitter of Q13 then becomes the source voltage for Q43, Q23, and Q64.

Q64 may be considered as a switch to ground. When the transistor is turned on, R64 is almost grounded and the —12 volts cannot be applied to the base of Q63 (MID-ZONE lamp). If a —12-volt signal is received from the upper limit no-go circuit, Q23 turns on and applies —12 volts to the base of Q33 (the upper limit lamp). At the same time, the voltage across R60 is sufficient to turn Q64 on which switches the voltage across R64 almost to ground.

The signal from the lower limit no-go circuit works the same way. Without a signal from either the upper or lower limit no-go circuits, Q64 remains off and —12 volts turns on Q63 and lights the MID-ZONE lamp.

SECTION 5
MAINTENANCE

PREVENTIVE MAINTENANCE

Cleaning the Interior

Internal cleaning should precede calibration since the cleaning process could alter the setting of certain calibration controls.

One way to clean the interior is by vacuum and/or low-pressure compressed air (high-velocity air could damage certain components). Hardened dirt may be removed with a soft paint brush, cotton-tipped swab, or cloth dampened with a water and mild detergent solution. Pay special attention to high-voltage circuits where conductive dust can cause arcing.

The contacts on the plug-in interconnecting jacks and plugs should be lightly lubricated with an oil of the type used on rotary-switch contacts. To extend the life of the contacts, clean and relubricate if the oil becomes contaminated with abrasive dust.

The plug-in unit frame-rod contact springs (located just inside the upper corners of the plug-in unit compartments) should be lubricated with a grease of the type used on rotary-switch detents (e.g. Beacon No. 325).

Visual Inspection

The instrument should be inspected occasionally for such defects as poor connections, broken or damaged ceramic terminal strips, improperly seated tubes or transistors, and heat-damaged parts. The remedy for most visible defects is obvious. But overheating is usually a symptom of other unseen defects and unless the cause is determined before parts are replaced, the damage may be repeated.

Tube and Transistor Checks

Periodic preventive maintenance checks on the tubes and transistors used in the instrument are not recommended. The circuits within the instrument generally provide the most satisfactory means of checking tube or transistor performance. Performance of the circuits is throughly checked during recalibration so that substandard tubes and transistors will usually be detected at the time.

Recalibration

To insure accurate measurements, the instrument calibration should be checked after each 500 hours of operation or every six months if used intermittently. Complete calibration instructions are contained in Section 6 of this manual.

The calibration procedure can be helpful in isolating major troubles in the instrument. Moreover, minor troubles not apparent during regular operation may be revealed and corrected during calibration.

Cleaning the Exterior

Loose dust may be removed with a cloth and a dry paint brush. Water and mild detergents such as Kelite or Spray White may be used. Abrasive cleansers should not be used.

The graticule and crt face-plate may be cleaned with a soft, lint-free cloth dampened with denatured alcohol.

CORRECTIVE MAINTENANCE

General Information

Certain parts in the instrument are best replaced if definite procedures are followed as outlined in the following paragraphs.

Many electrical components are mounted in a particular way to reduce or control stray capacitance and inductance. When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance at high frequencies. After repair, portions of the instrument may require recalibration; see Section 6.

Standard Parts

Many components in the instrument are standard electronic parts available locally. However, all parts can be obtained through your Tektronix Field Engineer or Field Office. Before purchasing or ordering, consult the parts list to determine the value, tolerance, and rating required.

Special Parts

Some parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured for Tektronix to our specifications. These and most mechanical parts should be ordered directly from your Tektronix Field Engineer or Field Office. See "Parts Ordering Information" and "Special Notes and Symbols" on the first page of Section 9.

Soldering

Special silver-bearing solder is used to establish a bond to the ceramic terminal strips in Tektronix instruments. This bond may be broken by repeated use of ordinary tin-lead solder or by excessive heating. We recommend solder containing about 3% silver. Silver-bearing solder is usually available locally or may be purchased in one-pound rolls through your Tektronix Field Engineer or Field Office. Order by part number 251-514.

Soldering to Ceramic Strips:

1. Use a wedge-shaped soldering-iron tip about 1/8-inch wide. This will allow you to apply heat directly to the solder in the terminal without touching the ceramic, thereby reducing the amount of heat required.

2. Maintain a clean, properly tinned tip.

3. Use a hot iron for a short time. A 50- to 75-watt iron with good heat storage and transfer properties is adequate.

4. Avoid putting pressure on the strip with the soldering iron or other tools. Excessive pressure may cause the strip to crack or chip.

Ceramic Terminal Strips

Fig. 5-1 shows an assembled ceramic terminal strip. Replacement strips with studs attached are supplied under a single part number and spacers under another number. The original spacers may be reused if undamaged.

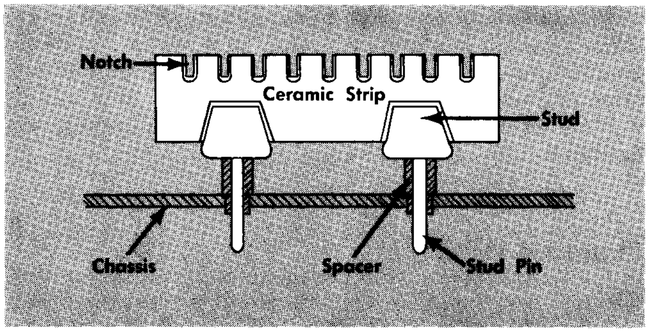


Fig. 5-1. Ceramic strip assembly.

Usually, a strip can be pried out of the chassis or pulled out with a pair of pliers. In some cases, you may choose to use a hammer and punch to drive out the studs from the opposite side of the chassis.

When the damaged strip has been removed, place new or used (but undamaged) spacers in the chassis holes. Then carefully force the studs of the new strip into the spacers until they are completely seated. If necessary, use a soft-faced mallet, tapping lightly directy over the stud area of the strip.

Switch Replacement

Individual wafers normally are not replaced in switch assemblies. Replacement switches may be ordered from Tektronix either unwired or with the associated wires and components attached. See Parts List, Section 9.

When soldering leads to a switch, do not let solder flow around and beyond the terminal rivet as this may destroy the contact spring tension.

Tubes and Transistors

Tubes and transistors should not be replaced unless actually defective. When a defect is suspected, it is suggested that circuit conditions be checked first to be certain that a replacement tube or transistor will not be immediately destroyed. In some cases, these checks will also show whether or not the tube or transistor is at fault.

When circuit conditions are known to be safe, install a tube or transistor of the same type that is known to be good and check for proper operation. If the original tube or transistor proves acceptable, return it to its original socket to avoid unnecessary recalibration.

TROUBLESHOOTING

General Information

This portion of the manual is intended as an aid for troubleshooting the Type 6R1A. Information in other parts of the manual, particularly the circuit description, may also prove helpful.

If trouble develops, first operate the front-panel controls to see what effect they may have. The operation of a control may help establish a symptom. (The location of trouble which occurs only in certain control positions can usually be found immediately from the symptom.) Once the trouble symptoms are established, look for obvious causes; check to see that the power is on, feel for irregularities in control operation, listen for unusual sounds, and visually check the instrument.

Transistor Checks

If you doubt that a transistor is good, substitute another in its place; but be sure the voltage and loads are normal before making the substitution. Be sure to return transistors to their original sockets unless they are defective.

If you have a Tektronix Type 575 Transistor Curve Tracer, the transistors in a suspected circuit can be quickly checked. If you do not have such an instrument, the transistors may be checked for opens or shorts with an ohmmeter. Check the resistance in both directions, between each of the transistor elements.

CAUTION

When checking transistors with an ohmmeter, the R×1 scale meter voltage may cause damage. Use only the R×10 or R×100 scale.

Switch Wafer Code

Switch wafers shown on the schematics are coded to show their position on a switch. The number in the code refers to the wafer number on the switch assembly. Wafers are numbered from front to rear. The letters F and R show whether the front or rear of the wafer is used. The number that follows the code letter indentifies the pin on the wafer.

Wire Code

All power-supply wiring in the Type 6R1A is color coded. The widest stripe indintifies the first color in the code.

White wire is used for plus (+) voltages (regulated).

Tan wire is used for minus (—) voltages (regulated).

Grey wire is used for unregulated voltages.

Voltage	Color Code
—12	Tan wire with brown and red stripes.
+20	White wire with red and black stripes.
—100	Tan wire with brown, black and brown stripes.
+75 (unreg.)	Grey wire with brown and violet stripes.
+125	White wire with brown, red, and brown stripes.
+225 (unreg.)	Grey wire with brown and yellow stripes.
+300	White wire with orange, black, and brown stripes.
+400 (unreg.)	Grey wire with orange and red stripes.

Test Equipment Required

The following test equipment or equivalent is required:

1. Wideband osicllloscope, such as Tektronix Type 541, 543, or 545, with Type K Plug-in Unit.
2. Ohmmeter, 20,000 ohms/volt, calibrated to 1% accuracy.
3. 20-pin etched circuit card extender, Tektronix part number 012-068.
4. 15-pin etched circuit card extender, Tektronix part number 012-067.

Power Supply Checks

The oscilloscope power supply should be checked before proceeding with the Type 6R1A. Remove the top panel of the oscilloscope and check the pins of J31 for the following voltages. (J31 is the connector at the top rear of the Type 6R1A compartment.)

J31 Pin No.	Voltage
13	+225 unregulated
14	+300
15	+125
16	+20
17	—12
18	—100
19	6.3 vac
20	ground
21	+75 unregulated
24	+400 unregulated

NOTE

The voltage at pin 18 should be exactly —100 volts. All other voltages should be within 1%. See oscilloscope instruction manual.

Circuit Substitution

Because several of the circuit cards are indentical, the defective circuit can often be verified by substitution. For example, if measurements cannot be made on Channel A and the Memory circuit card is suspected, reverse the positions of the Channel A and B Memory circuit cards. If Channel B is now inoperative, the Memory circuit card is defective.

Similar substitutions can be made with the Signal Comparator and Counter circuit cards.

Circuit Card Input and Output Checks

The schematics show waveforms and voltages normally present at the pins of each circuit card. They also indicate the circuit from which each signal is obtained or the circuit to which a signal is applied. Where trouble in a circuit card is not obivous, check each of the connector pins for the proper voltage or waveform.

NOTES

SECTION 6
CALIBRATION PROCEDURE

Introduction

This section contains a complete calibration procedure for the Type 6R1A Digital Unit. The step by step instructions that follow are in proper sequence to calibrate the instrument and avoid unnecessary repetition of checks and adjustments.

Troubles in the instrument are often caused by changes in component values. These troubles can usually be found by checking the calibration of the suspected circuit. When transistors, tubes and other components are changed, the calibration of the circuit under repair should be checked.

Equipment Required

1. Vertical amplifier plug-in unit, Tektronix Type 3S76.
2. Horizontal time base plug-in unit, Tektronix Type 3T77.
3. Differential voltmeter (to resolve ± 1 mv) such as John Fluke Model 801B or 825A, or Tektronix Type D High Gain Differential Plug-in Unit and a Tektronix Type 540-Series oscilloscope. Either of these instruments can be used as a dc voltmeter in the calibration procedure.
4. Square-wave generator with variable frequency (100 cycles to 1 mc) and variable output (0 to 20 volts); Tektronix Type 105 is recommended.
5. A 15-pin extender card (etched circuit) Tektronix part number 012-067.
6. A 20-pin extender card (etched circuit) Tektronix part number 012-068.

Adjustment Procedure

Connect the output of the square-wave generator through a 5X attenuator to the Channel A input of the vertical amplifier plug-in unit. Trigger the time base plug-in unit externally by connecting a coaxial lead from the sync output of the square-wave generator to the external input (trigger) of the time base plug-in unit. Let the equipment warm up for ½ hour before proceeding. After warmup, proceed as follows:

1. Comparators and Memories

a. On the Memory circuit cards (see Fig. 6-1) set the MEMORY MODE switch to AVG and the RESPONSE switch to SLOW. Set the square-wave generator for a 1-mc output. Display two complete waveforms on the crt. Set the Type 6R1A MODE switch to TIME, and the CRT INTENSIFICATION START TO STOP switch off. Position the 0% and 100% intensified zones to make a measurement with the 0% zone on the negative peak and the 100% zone on the positive peak.

b. Switch the START TO STOP switch on, then switch the TIMING STOP switch to manual operation and move the end of the intensified start-to-stop zone 1 cm in from the right side of the graticule. Set the TIMING START switch to the A TRACE 50% position. Set both SLOPE switches to + FIRST.

c. Slowly reduce the amplitude of the displayed pulse while adjusting the start DC BAL (upper Signal Comparator circuit card) so that the start comparator will switch on the positive- and negative-going edges of the pulse. It is necessary to switch the START ± SLOPE switch back and forth and watch the start-to-stop intensified zone while reducing the amplitude of the square-wave generator output. Note that as the START ± SLOPE switch is moved from the + to — and back, the start of the intensified zone changes from the positive-going slope of the pulse to the negative-going slope. Find a pulse amplitude where the comparator will not switch on either the plus or minus slope, and where the start-to-stop zone jitters due to noise pulses causing the start comparator to switch.

d. Adjust DC BAL control R19 so that the jitter is minimum but equal in both positions of the START ± SLOPE switch. A small increase in the amplitude of the pulse input from the square-wave generator will allow the start comparator to switch in both the plus and minus positions of the START ± SLOPE switch; this is balance.

e. Turn the TIMING START switch to MANUAL and position the beginning of the start-to-stop intensified zone to the left of the first pulse on the crt. Set the TIMING STOP switch to the A TRACE 50% position. Set both START and STOP SLOPE switches to FIRST and +. Increase the pulse amplitude until the stop (right-hand end) of the intensified start-to-stop zone switches on either edge of the pulse as the ± SLOPE switch is moved back and forth from + to —. Slowly reduce the amplitude of the pulse while adjusting the DC BAL control (R19) on the stop Signal Comparator circuit card (lower of the two cards). Find the balance point as in step (d).

f. Set the TIMING STOP switch at A TRACE 10% and increase pulse amplitude until the stop comparator switches on the normal and the inverted pulse as the normal-invert switch on the vertical amplifier plug-in unit is switched from normal to invert. Slowly reduce the amplitude of the input from the square-wave generator while adjusting the Channel A 0% BAL control (R96) on the A Memory circuit card (lower of the two Memory cards). Adjust the 0% BAL control so that the stop comparator continues to switch as the vertical plug-in unit normal-invert switch is moved from normal to invert. Find an amplitude where the comparator will not switch with either polarity pulse, and where a slight increase in pulse amplitude will let it switch on either the pulse or noise as the normal-invert switch is thrown; this is balance.

g. Set the TIMING STOP switch to A TRACE 90% and adjust the Channel A Memory 100% BAL (R66) for balance as in step (f).

h. Repeat steps (e) and (f) until no further change is noted.

i. Apply the output of the square-wave generator to Channel B of the vertical plug-in unit. Repeat steps (e), (f), and (g), substituting the Channel B signal and memory.

When balance is achieved, a 2 mm display of a 1-mc square-wave signal should cause the comparators to switch when the TIMING START and TIMING STOP switches are set to 10% or 90%, the SLOPE switches set to + or −, or the vertical plug-in unit normal-invert switch set to either position. In balancing the memories, be careful not to readjust a previously set control.

If a mating plug for J34 is available, the memories can be given a preliminary adjustment with the aid of a 50- or a 100-μamp meter. On the mating plug, solder leads to M, K, a, b, g, and h. Set up the equipment as in the preceding steps but with no signal applied. Connect the meter as follows for the individual adjustments:

M to g for A Memory 0% BAL

M to a for A Memory 100% BAL

K to h for B Memory 0% BAL

K to b for B Memory 100% BAL

In each case, turn the BAL control for a zero reading on the meter. The BAL control settings are now close to being correct.

2. 3-Dot Delay

a. Free-run the sweep and set the MODE switch to TIME.

b. Set the MANUAL adjustments for 6 cm of sweep intensification from start to stop (make sure the Crt Intensification START TO STOP switch is in the up position).

c. With the horizontal POSITION control on the horizontal plug-in unit, position the trace so that the start of the intensified zone is at the center of the graticule. Set the vertical plug-in unit for 10 dots per division. With the POSITION control, locate the beginning of the dots representing the intensified zone (it helps to turn the 0% Zone Position control fully counterclockwise and the 100% Zone Position control fully clockwise).

d. Switch the 3-DOT DELAY switch on the Signal Comparator circuit card in and out. As the switch is moved to the IN position, three dots should disappear from the start of the string of dots representing the intensified zone. If the number of dots that disappear is more or less than 3, turn off the oscilloscope, remove the start Signal Comparator circuit card and place it in an extender (see Fig. 6-2). Plug the start Signal Comparator card and extender back into the Type 6R1A. Turn on the oscilloscope. Adjust

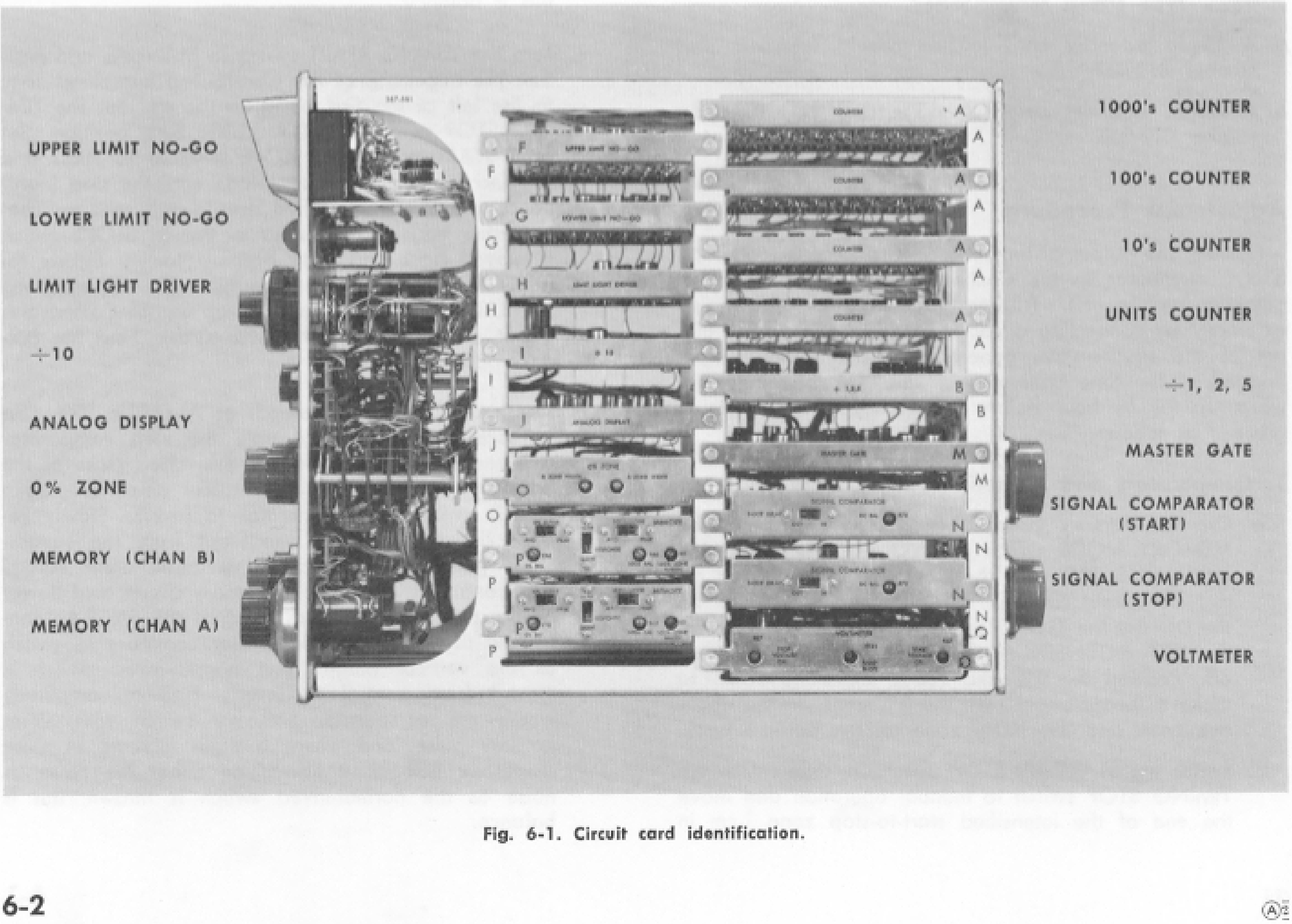


Fig. 6-1. Circuit card identification.

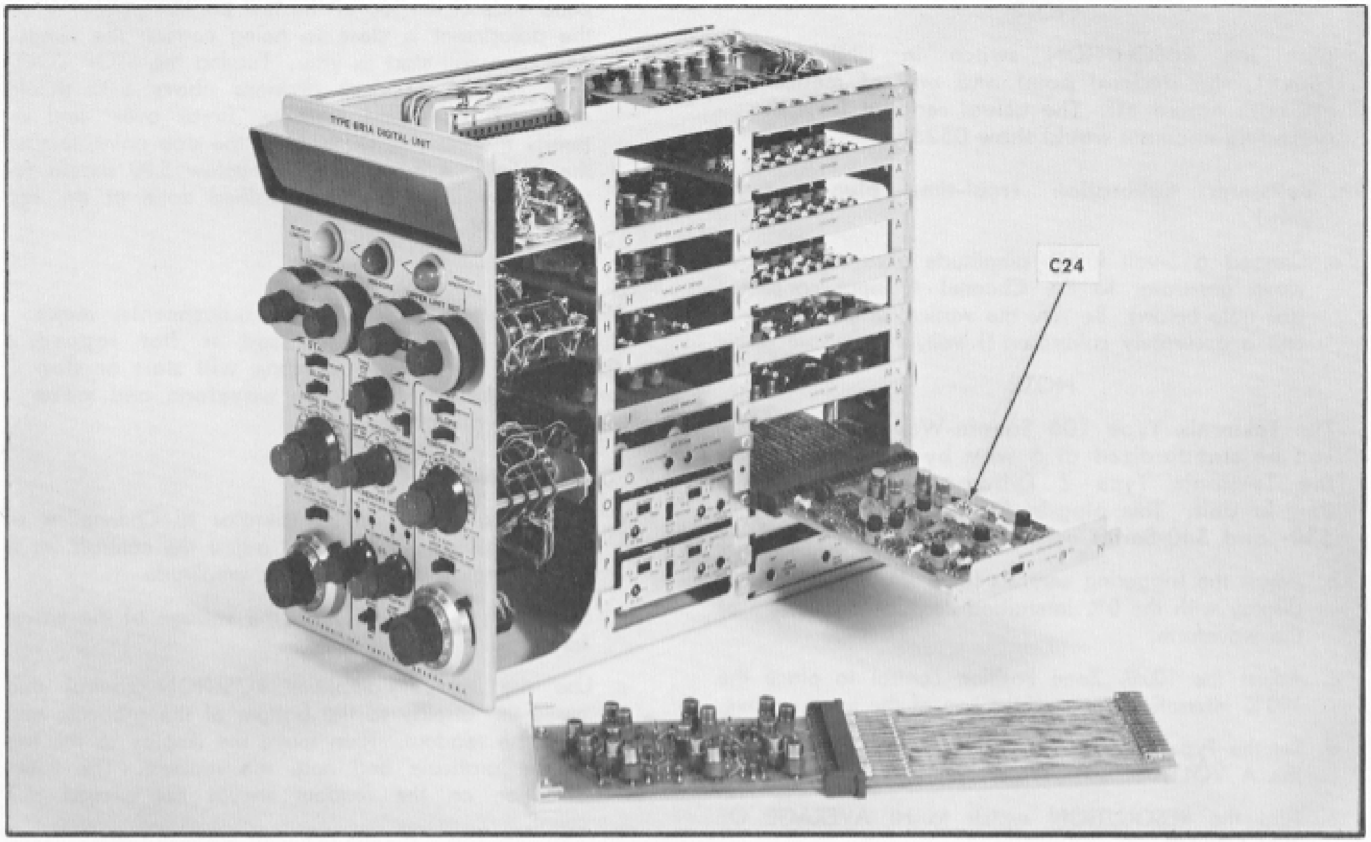


Fig. 6-2. Extender cards used for circuit calibration.

C24 on the start Signal Comparator circuit card for 3 dots.

e. Repeat steps (a) through (d) for the stop comparator, except in this case, the stop end of the intensified start-to-stop zone is positioned at the center of the graticule. Leave the 3-DOT DELAY switches on both the start and stop Signal Comparator circuit cards at the IN position.

3. 0% Zone Width

a. Turn the vertical plug-in unit to Channel A and display a free-running trace on the crt.

b. Adjust R25A (0% ZONE WIDTH control on 0% zone card) to make the 0% intensified zone on the trace 3 mm in width.

c. Change the vertical plug-in unit to Channel B and adjust R55 (B 0% ZONE WIDTH) to make the B 0% zone 3 mm in width.

4. 100% Zone Width

a. Use the same trace as in step 3.

b. Adjust R4 (100% ZONE WIDTH control on Channel B Memory card) to make the 100% intensified zone on the trace 3 mm in width.

c. Turn the vertical plug-in unit to Channel A and display a free-running trace on the crt.

d. Adjust R4 (100% ZONE WIDTH control on Channel A Memory card), to make the 100% intensified zone on the trace 3 mm in width.

5A. Voltmeter Calibration (sampling plug-in units only)

a. Connect the square-wave generator to Channel A of the vertical plug-in unit and display a single pulse of approximately 7 divisions in amplitude. Set the 100% intensified zone to the peak of the pulse.

b. Connect a 10-meg dc voltmeter (1%) to the Channel A output of the vertical amplifier plug-in unit.

c. Set the time-base plug-in unit for manual sweep mode and position the dot on the display at the 0% zone. Record the voltmeter reading.

d. Use the time-base plug-in manual scan control to position the dot at the 100% zone. Record the voltmeter reading.

e. Set the time base plug-in for the normal sweep mode and Type 6R1A MODE switch to A VOLTAGE. Set RESOLUTION switch to UNSCALED (MAX).

f. Subtract the voltmeter reading in step (c) from the reading in step (d). The result should be the same as the number shown on the readout. If it is not, adjust R141 (RAMP SLOPE on the Voltmeter card) to make the reading the same. For example, assume the voltmeter reading in step (c) is 7.25 volts and the reading in step (d) is 12.50 volts. 12.50 — 7.25 = 5.25 (number on readout).

NOTE

With the RESOLUTION switch in UNSCALED (MAX), the decimal point and unit of measure are both turned off. The actual readout from the preceding example would show 0525.

5B. Voltmeter Calibration (real-time plug-in units only)

a. Connect a 5-volt (0.5% amplitude accuracy) square-wave generator to the Channel A input connector (see note below). Be sure the vertical amplfier plug-in unit is accurately calibrated (1 volt/cm).

NOTE

The Tektronix Type 105 Square-Wave Generator can be standardized at 5 volts by comparison in the Tektronix Type Z Differential Comparator Plug-In Unit. This plug-in fits all Tektronix Type 530- and 540-Series oscilloscopes.

b. Adjust the triggering controls for a single pulse stable display with the 0% intensified zone at the bottom of the waveform.

c. Adjust the 100% Zone Position control to place the 100% intensified zone on the top of the square wave.

d. Set the Type 6R1A MODE switch to VOLTAGE A with the A VOLTAGE switch pushed up.

e. Turn the RESOLUTION switch to HI AVERAGE OF TEN SWEEPS.

f. Adjust R112 (RAMP SLOPE on Voltmeter card) until the readout shows exactly 5.000 V.

6. Start and Stop Voltage Calibration

a. With the equipment set up as in step 5B, adjust the signal input for a readout of 500 with the Type 6R1A set to measure voltage, unscaled.

b. Turn the Type 6R1A MODE switch to TIME. Turn the TIMING STOP switch to MANUAL, and position the right (stop) end of the start-to-stop intensified zone on the 9th graticule mark. Turn the TIMING START switch to A TRACE (START VOLTAGE). Set the START VOLTAGE - CRT DIVISIONS FROM 0% ZONE switch to +. Adjust the triggering so that the first waveform on the trace goes positive. Set the START VOLTAGE helidial to read 5.00.

c. Adjust START VOLTAGE CAL control R67 on the Voltmeter circuit card so that the start-to-stop intensified zone just starts to jitter at the top of the first waveform. The intensified start-to-stop zone should completely disappear if the START VOLTAGE helidial is now turned 4 minor divisions past 5.00.

d. Swith the TIMING START switch to Manual, turn the TIMING STOP switch to A TRACE (STOP VOLTAGE). Manually position the start of the start-to-stop intensified zone between the dead zone and the start of the first positive pulse. Turn the STOP VOLTAGE helidial to read 5.00.

e. Adjust STOP VOLTAGE CAL control R87 on the Voltmeter circuit card until the intensified start-to-stop zone ends at the top of the first positive pulse. When the adjustment is close to being correct, the intensified zone will start to jitter. Turning the STOP VOLTAGE helidial 4 minor divisions above 5.00 should cause the intensified zone to "break over" and intensify the trace to the right of the stop point; turning the helidial 4 minor divisions below 5.00 should remove any jitter in the intensified zone at the top of the first pulse.

NOTE

When making the preceding adjustments, make sure that the waveform used is flat topped. Otherwise, the intensified zone will start or stop on the highest point of the waveform and make adjustment difficult.

7. System Linearity Check

a. Connect a square-wave generator to Channel A of the vertical plug-in unit and adjust the controls for a stable display of 1 division in amplitude.

b. Set the Type 6R1A to read the voltage of the waveform.

c. Use the vertical amplifier POSITION control and move the display to the bottom of the graticule and note the readout. Then move the display to the top of the graticule and note the readout. The count deviation on the readout should not exceed ±1 count.

8. 0% And 100% Zone Position Range

a. Set the vertical plug-in for dual-trace operation, free-run the sweep, and display two traces. Set the Type 6R1A MODE switch to TIME.

b. Turn both Type 6R1A A and B 0% Zone Position controls from fully counterclockwise to fully clockwise. It should be possible to position the 0% zones into the first and tenth centimeters of graticule area.

c. Turn both the Type 6R1A A and B 100% Zone Position controls from fully counterclockwise to fully clockwise. It should be possible to position the 100% zones into the first and tenth centimeters of graticule area.

9. Start-to-Stop FIRST ± and SECOND ± SLOPE

a. Connect the square-wave generator to Channel A of the vertical amplifier plug-in unit (Calibrator waveform with real-time plug-in units) and adjust for two cycles of display.

b. Set the TIMING START switch to A TRACE 10%, TIMING STOP switch to A TRACE 90%, both START and STOP block SLOPE switches to FIRST +, and MODE switch to TIME. The start-to-stop zone should be on the rising portion of the first cycle between the 10% and 90% points on the waveform.

c. Change both START and STOP block SLOPE switches to SECOND +. The start-to-stop intensified zone should now be on the rising portion of the second cycle between the 10% and 90% points on the waveform.

d. Set both START and STOP block SLOPE switches to SECOND —. Set TIMING START to A TRACE 90% and TIMING STOP to A TRACE 10%. The start-to-stop intensified zone should be on the falling portion of the second cycle between the 10% and 90% points on the waveform.

e. Set both START and STOP block SLOPE switches to FIRST —. The start-to-stop intensified zone should now be on the falling portion of the first cycle between the 10% and 90% points on the waveform.

10. Readout Counting, Sampling Sweep

a. Set the square-wave generator to its lowest frequency. Set the Type 6R1A MODE switch to TIME. Set the TIMING START and TIMING STOP switches to MANUAL. Set the RESOLUTION switch to AVERAGE OF TEN SWEEPS HI. The units indicator tube should count from 0 through 9.

b. Increase the square-wave generator frequency and check each successive indicator tube for a correct count of 0 through 9. At the same time check that when an indicator tube count reaches 9, the next count transfers to the next tube on the left.

11A. ÷ 1, 2, 5 Circuit Check (sampling plug-in units only)

a. Set the MODE switch to TIME. Set both TIMING START and STOP switches to MANUAL, and the RESOLUTION switch to ONE SWEEP LO.

b. Free-run a trace (no input signal needed) on the crt and adjust the TIMING START and STOP MANUAL controls for an 8-division start-to-stop intensified zone.

c. Set the time base plug-in for a 1 μsec/div sweep rate; the readout should show 08.00 μS.

d. Set the time base plug-in for a .5 μsec/div sweep-rate; the readout should show 04.00 μS.

e. Set the time base plug-in for a .2 μsec/div sweep rate; the readout should show 01.60 μS.

11B. ÷ 1, 2, 5 Circuit Check (real-time plug-in units only)

a. Connect a jumper from the 5-volt jack of the Type 567 SQUARE-WAVE CALIBRATOR to the Channel A input of the vertical amplifier.

b. Set the vertical plug-in for a 5 volt/cm sensitivity.

c. Set the Type 6R1A MODE switch to A VOLTAGE. The readout should show 005.0 V.

d. Set the vertical plug-in for a 2 volt/cm sensitivity. The readout should still show 005.0 V. Finally set sensitivity for 1 volt/cm; the readout should still show 005.0 V.

12A. Time Readout Check (real-time plug-in units only)

a. Use the same connections as described in step 11B. Adjust the time base plug-in to display two pulses on the crt.

b. Set the Type 6R1A MODE switch to TIME.

c. Set the TIMING START and STOP switches to A TRACE 10%, START block SLOPE switches to FIRST +, and STOP block SLOPE switches to SECOND +.

d. The readout should show 16.66 MS ±2 counts.

e. Set the TIMING START and STOP switches to A TRACE 20%; the readout should remain the same. Make this same check for all numbered percentages on the A TRACE % side of the TIMING START and STOP switches.

f. Connect the signal to Channel B and repeat steps (c) through (e), substituting B TRACE % for A TRACE %. The readout should remain at 16.66 MS ±2 counts.

12B. Time Readout Check (sampling plug-in units only)

a. Connect the sine-wave generator of known frequency (between 10 and 50 megacycles with an accuracy of 0.5%) to the Channel A input of the vertical plug-in. Adjust the time base plug-in to display two cycles.

b. Calculate the period of one cycle by taking the reciprocal of the frequency. For example, the period of one cycle at 50 megacycles is 1/50 mc = 20 nsec.

c. Set the TIMING START and STOP switches to A TRACE 10%, START block SLOPE switches to FIRST +, STOP block SLOPE switches to SECOND +, and MODE switch to TIME.

d. The time shown on the readout should be the period of one cycle.

e. Check each percentage position of the TIMING START and STOP switches by setting both switches to the same percentage. The period should remain the same.

f. Connect the generator to Channel B and repeat steps (c) through (e), substituting B TRACE % for A TRACE %. The period should remain the same.

13. UPPER and LOWER LIMIT SET Dials Check

a. Set the MODE switch to TIME. Set both TIMING START and STOP switches to MANUAL, and the RESOLUTION switch to AVERAGE OF TEN SWEEPS HI.

b. Free-run a trace on the crt (either channel) and adjust the TIMING START and STOP MANUAL switches for a four-digit count (any count). Stop the sweep; the count will remain. Do this several times until the readout shows a count with no zeros or nines, such as 3258.

c. Set both UPPER and LOWER LIMIT SET dials to the count left in step (b). The MID-ZONE lamp (green) should turn on.

d. Turn the UPPER LIMIT SET units dials one number counterclockwise (lower); the UPPER LIMIT lamp (red) should turn on. Return the dial to the original number. Turn the tens dial one number counterclockwise; the UPPER LIMIT lamp should turn on. Continue this procedure with the UPPER LIMIT SET hundreds and thousands dials. When this check is finished, return the dials to the original number.

e. Turn the LOWER LIMIT SET units dial one number clockwise (higher); the LOWER LIMIT SET lamp (yellow) should turn on. Continue this procedure with the LOWER LIMIT SET tens, hundreds, and thousands dials.

NOTES

SECTION 7
EXTERNAL PROGRAMMING

Introduction

This section of the manual describes the principles of external programming and readout. Since each user may have different applications for the Type 6R1A, this section should serve only as a system design guide. Many external programming problems can be solved by using the Tektronix Type 262 Programmer. In special cases, consult your Tektronix Field Engineer.

External programming and readout is divided as follows:

1. Externally controlling the Type 6R1A circuits to make a measurement or series of measurements (measurement program).
2. Recording the test results with external equipment when the instrument has completed a measurement program (external readout).

Many combinations of measurement program and external readout can be used. For example, the controls on the instrument can be set by hand and the test results automatically recorded on a typewriter. Or, the measurement program can be set by an automatic programmer and the test results recorded by hand.

A completely automatic system can be built that will make a series of tests, record the results of each test, reject any component that fails to meet preset limits (go no-go), and signal the end of the test.

Measurement Program

External programming can:

1. Start and stop a time measurement:
   a. On first or second slope.
   b. On a (+) or (—) slope.
   c. On A trace or B trace.
   d. On either trace at any percentage.
   e. Start or stop at some preselected voltage level.
2. Measure the voltage between 0% and 100% on either trace.
3. Override the A and B 0% and 100% zone settings.
4. Control the display time.
5. Provide voltage for go no-go comparisons (counter staircase voltages).

When the Type 6R1A MODE switch is set to EXT PROGRAM, several circuit connections within the instrument are broken, and the inputs and outputs of these circuits are connected to J34 on the rear of the instrument chassis. The circuits affected are the TIMING START and TIMING STOP switches, both (+) and (—) SLOPE switches, both FIRST and SECOND SLOPE switches, and both precision dials. These switches and controls must be supplied externally if they are needed for a planned program.

Typical Program Plan

Consider a transistor program for measuring:

1. Risetime
2. Falltime
3. Storage
4. Delay
5. Saturation

Because each measurement involves a different set of connections between similar points, a mechanical switch can be used. A driven-type multiple-contact switch, such as a stepper, should suffice (relays can also be used).

The switch can be advanced through each measurement by pushbutton control, or by using the print command voltage present at pin GG of J133 at the completion of a measurement.

With this type of external program, the operator plugs the test transistor into a fixture, starts the programmer, and records the values shown on the readout as the programmer passes through its cycle.

This is one method of external programming. Many variations of this system are possible. Plug-in program cards, the Tektronix Type 262 Programmer, punched tape, punched cards, and pushbutton switches are just a few of the possible methods.

Go No-Go Programming

Because the acceptable limits of each measurement may be different, separate no-go comparisons are needed.

One method is to remove the Upper and Lower Limit circuit cards from the instrument and reinstall them in an external fixture. This fixture should supply the limit voltage in the same manner as the limit dials in the instrument. Thus, a second rotary switch can supply the correct limit voltages for each measurement in the program. The staircase voltages that represent the number shown on the readout are available at pins j, q, p, and y of J34.

The operator can be alerted to an out-of-limit measurement by limit lamps, bells, buzzers, or rejection relays. If a typewriter readout is used, the ribbon can be made to change automatically from black to red when the limit is exceeded.

No-go outputs (limit lamps) are shown in Fig. 7-1. 50 ma is available for external circuit operation. This can be increased to 200 ma by removing the Type 6R1A front-panel limit lamps.

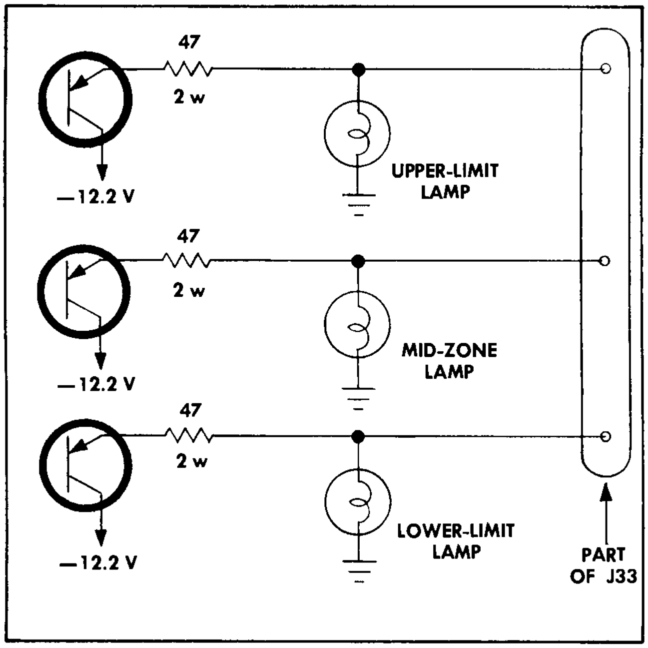


Fig. 7-1. External connections to limit lamps.

External Readout: Information From Connector J33

The number, decimal point, and unit of measure information shown on the Type 6R1A readout is present at J33 at the completion of a measurement. (The designer of a readout system can use either parallel or serial entry data recorders.)

Several commerically available printers are suitable for this purpose. Usually they consist of number wheels that are positioned to the correct number by data from the device to be read.

One type of printer uses the four 10-line output from the indicator tubes. When the command from the Type 6R1A is received, a clutch engages and turns number wheels. The number wheels turn until their individual armatures contact a negative voltage. The clutch disengages and the wheel stops at the correct number position. A print is made and the paper advances to display the count.

Some printers are designed to accept BCD code. With this type of instrument, a decimal-to-binary converter must be used between the output of the Type 6R1A and the printer.

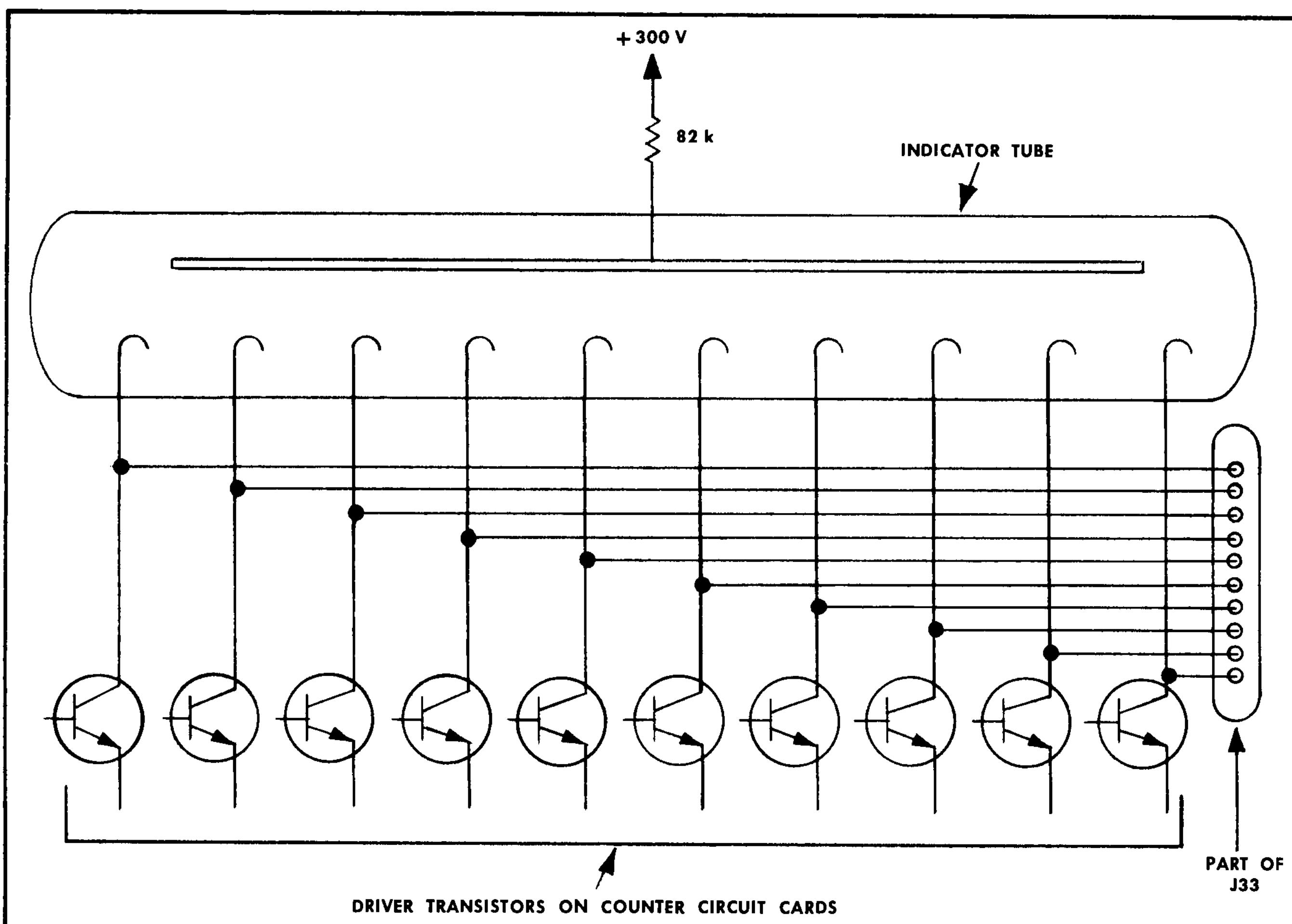


Fig. 7-2. Connection from indicator tube to external program jack.

Ⓐ

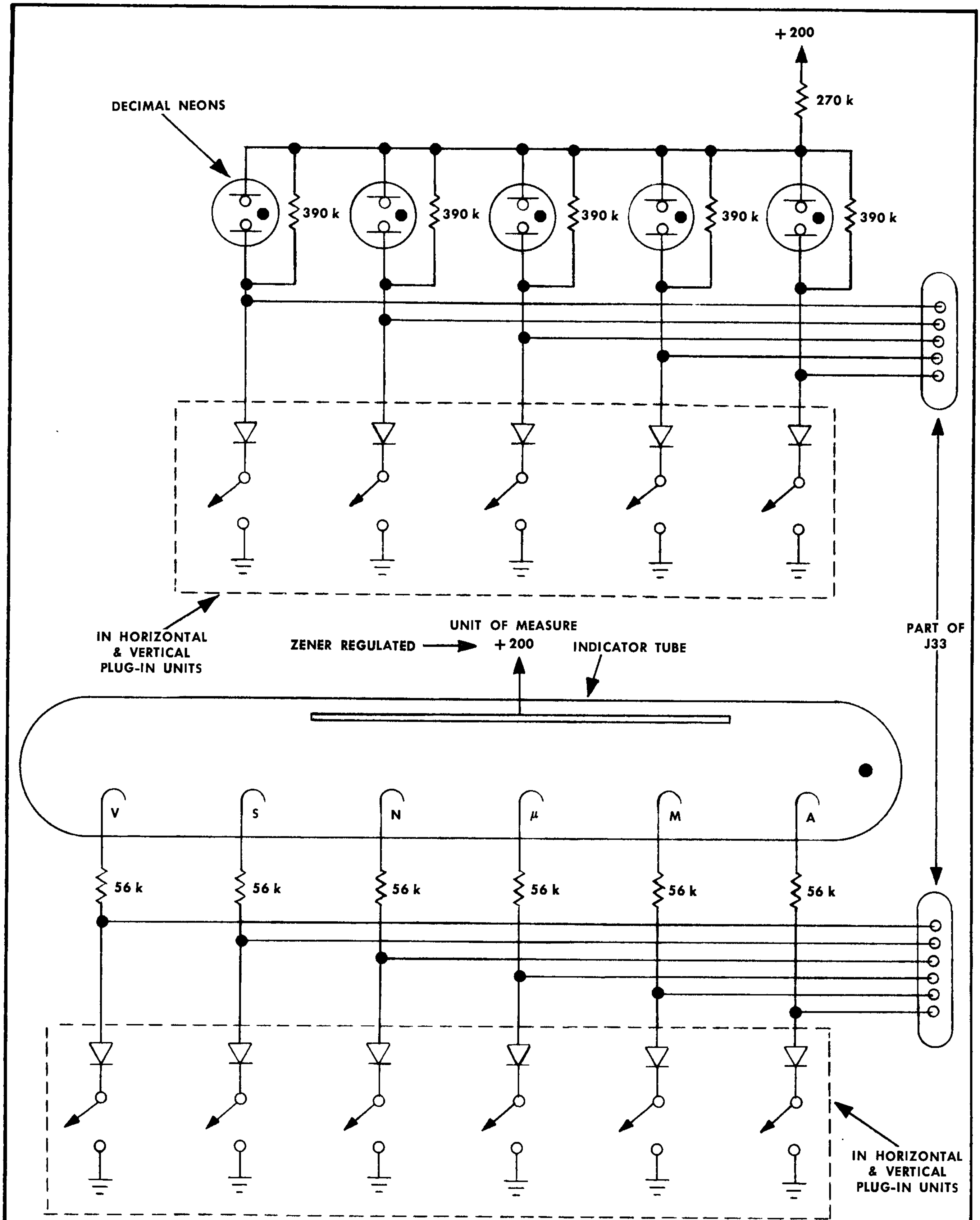


Fig. 7-3. Simplified decimals and unit of measure external outputs.

There are four 10-line outputs from the cathodes of each number indicator tube in the readout. Of the 10 cathodes from an indicator tube, one will be at about +0.5 volt (turned-on cathode), while all others will range from about +40 to +140 volts. The turned-on indicator tube driver transistor (on the counter card) will supply about 1.5 ma for external circuits. See Fig. 7-2.

Decimal location data is contained on five lines. Output on the "on" decimal line will be about +0.5 volt, while others are approximately +50 volts through 1.5 meg. See Fig. 7-3.

Outputs of the "on" units of measurement (M, N, or μ, and V or S) are about +0.5 volt, while others are approximately +150 volts.

A and B 0% and 100% Zone Override

Pins X and Z of J34 are used for 0% zone override, and pins R and J of J34 are used for 100% zone override. 100 k variable resistors should be connected between these points and ground. The A and B 0% and 100% Zone Position controls on the Type 6R1A front panel should be turned fully clockwise. The external variable resistors can be mounted on the external program fixture and used to control the A and B 0% and 100% zone positions.

A +20-volt print-command voltage is available at pin GG. The duration of this voltage is the same as the display time period. Whenever pin HH is grounded, the voltage at pin GG is +20 volts.

If a negative print command is desired, change the strap on the master gate card as described on page 4-13 in the paragraph "Forming The Print Command Pulse".

The display time waveform is present at pin HH. Grounding this point holds the Type 6R1A display and prevents it from making another measurement. When the ground is removed, the instrument waits through the display time set by the front-panel DISPLAY TIME control before making the next measurement.

SECTION 8
GLOSSARY

ALTERNATE TRACE — A method of dual-trace where a Channel A signal is displayed on the first sweep, a Channel B signal on the second sweep, Channel A again on the third sweep, etc.

ANALOG DISPLAY — A crt display.

"AND" GATE — A circuit with two or more inputs and common output that produces an output signal only when all inputs are activated (positive or negative depending on the circuit arrangement).

BINARY SET — A bistable multivibrator used in counting and dividing. A single binary set divides by 2.

CHOPPED TRACE — A method of dual-trace where the signals from two separate channels applied to the crt are switched.

CIRCUIT CARDS — The etched cards with mounted components that plug into the Type 6R1A chassis.

CLOCK — The time pulses used to drive the counter circuits. In voltage measurements, clock pulses are obtained from a crystal oscillator on the voltmeter circuit card. In time measurements, they are obtained from the horizontal plug-in unit.

CRT — The cathode-ray tube in the indicator unit.

DIFFERENTIAL AMPLIFIER — An amplifier that measures the difference between two voltages. The ability to resolve this difference is set by the common-mode rejection ratio of the amplifier.

DIGITAL — Quantities presented in regular rational numbers, such as 6.23 volts, 832.0 milliseconds, etc.

DISPLAY TIME — The time that the readout remains steady between counts. The DISPLAY TIME control (front panel) varies this time from approximately 0.1 second to approximately 6 seconds.

÷ 10 — A circuit consisting of 4 binary sets that extends the time between start and stop to allow 10 cumulative counts on the readout.

÷ 1, 2, 5 — A circuit that uses several binary sets to divide the count and show a correct readout as either the VOLTS/DIV or TIME/DIV switch is changed.

DOUBLE-EMITTER FOLLOWER — A two-transistor circuit (PNP and NPN) with good switching characteristics when used with a capacitive load.

DUAL-TRACE — A method where two signals from two separate channels are displayed on the crt at the same time.

EXTERNAL PROGRAM — A feature of the Type 6R1A where the instrument can be controlled by external equipment or use external readouts. Or, both control and readout can be done externally. Two connectors on the rear of the chassis provide inputs and outputs for this purpose.

FIRST SLOPE — The first rise (+ slope) or fall (— slope) of a waveform to the right of the intensified dead zone.

FLOATING POWER SUPPLIES — A Zener diode and two transistors between the +125-volt and —100-volt supplies make up this supply. It is used across precision potentiometers to establish calibrated start and stop voltages.

GO NO-GO — A clear-cut line of accept or reject. Refers to limits. Between limits, the item under test is "go". Outside the limits it is "no-go".

INTENSIFIED ZONES — Brightened portions of the crt display.

LOWER LIMIT — The number set on the LOWER LIMIT SET dials. When this number exceeds the number on the readout, the LOWER LIMIT lamp (yellow) lights.

MASTER GATE — An arrangement of 3 transistors where 2 must be turned off to allow the 3rd to pass a signal. Also called an "And" gate.

MEMORY — A circuit that receives a voltage sample and holds the voltage level until the arrival of the next sample.

MID-ZONE — Any number between and including the numbers set on the UPPER and LOWER LIMIT SET dials.

MODE — The type of operation taking place. For example, voltage mode or time mode.

ONE SWEEP — The total count between the start and stop points during one sweep of the display.

OR GATE — A circuit with two or more inputs and a common output. Produces an output when any one of the inputs is activated.

PERCENTAGE OF A PULSE — If the start of a pulse is termed 0% and the peak amplitude represents 100%, the in-between points represent percentages of the pulse. For example, risetime is the time required for a pulse to rise from 10% to 90% of its maximum amplitude.

PLUG-IN — Any type unit designed to plug into or be withdrawn from an indicator unit or other housing. For example, the Type 6R1A is a plug-in designed to plug into the Tektronix Type 567 Readout Oscilloscope.

PROGRAM — Refers to the setting of the controls on the instrument. For example, one setting or program will measure risetime and another falltime.

READOUT — The five indicator tubes mounted across the top of the Type 6R1A front panel.

RESET PULSE — A pulse used to set the counters and divider circuits to the proper condition for the start of a measurement (for example, returning all numbers to zero).

RESOLUTION — The number of significant figures in the readout. HI resolution is the total of ten cumulative counts with the decimal point moved one place to the left.

SAMPLING SYSTEM — A method that takes amplitude samples from a repetitive input signal with each sample at a progressively later time, then reconstructs these samples into a replica of the original waveform at a much lower frequency.

START COMPARATOR — A circuit with two inputs. A reference level is applied to one and a varying signal to the other. Each time the signal equals the reference, the comparator delivers a pulse. Used to start the counter.

STAIRCASE VOLTAGE — A voltage from each counter circuit that represents the number stored in the counter.

STOP COMPARATOR — A circuit with two inputs. A reference level is applied to one and a varying signal to the other. Each time the signal equals the reference, the comparator delivers a pulse. Used to stop the counter.

SECOND SLOPE — The second rise (+ slope) or fall (— slope) of a waveform to the right of the intensified dead zone.

START BLOCK — A group of controls that set the point on the display where a measurement starts.

STOP BLOCK — A group of controls that set the point on the display where a measurement stops.

UNSCALED (MAX) — The total count between the start and stop zones. Not divided by the ÷ 1, 2, 5 card. Decimal-point and unit-of-measure indicator tubes are turned off.

UPPER LIMIT — The number set on the UPPER LIMIT SET dials. When this number is exceeded by the number on the readout, the UPPER LIMIT lamp (red) turns on.

VOLTMETER RAMP — A linear, precise sawtooth waveform used in voltage measurements.

DEAD ZONE — Established by the sweep voltage and shown as an intensified zone at the extreme left side of the display.

0% ZONE — A point of measurement on a waveform; usually the lowest amplitude. Shows as an intensified zone that can be moved across the display by the 0% Zone Position control.

100% ZONE — A point of measurement on a waveform; usually set to the highest amplitude of the waveform. Shows as an intensified zone that can be moved across the display by the 100% Zone Position control.

SECTION 9
PARTS LIST AND SCHEMATICS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix Field Office.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix Field Office will contact you concerning any change in part number.

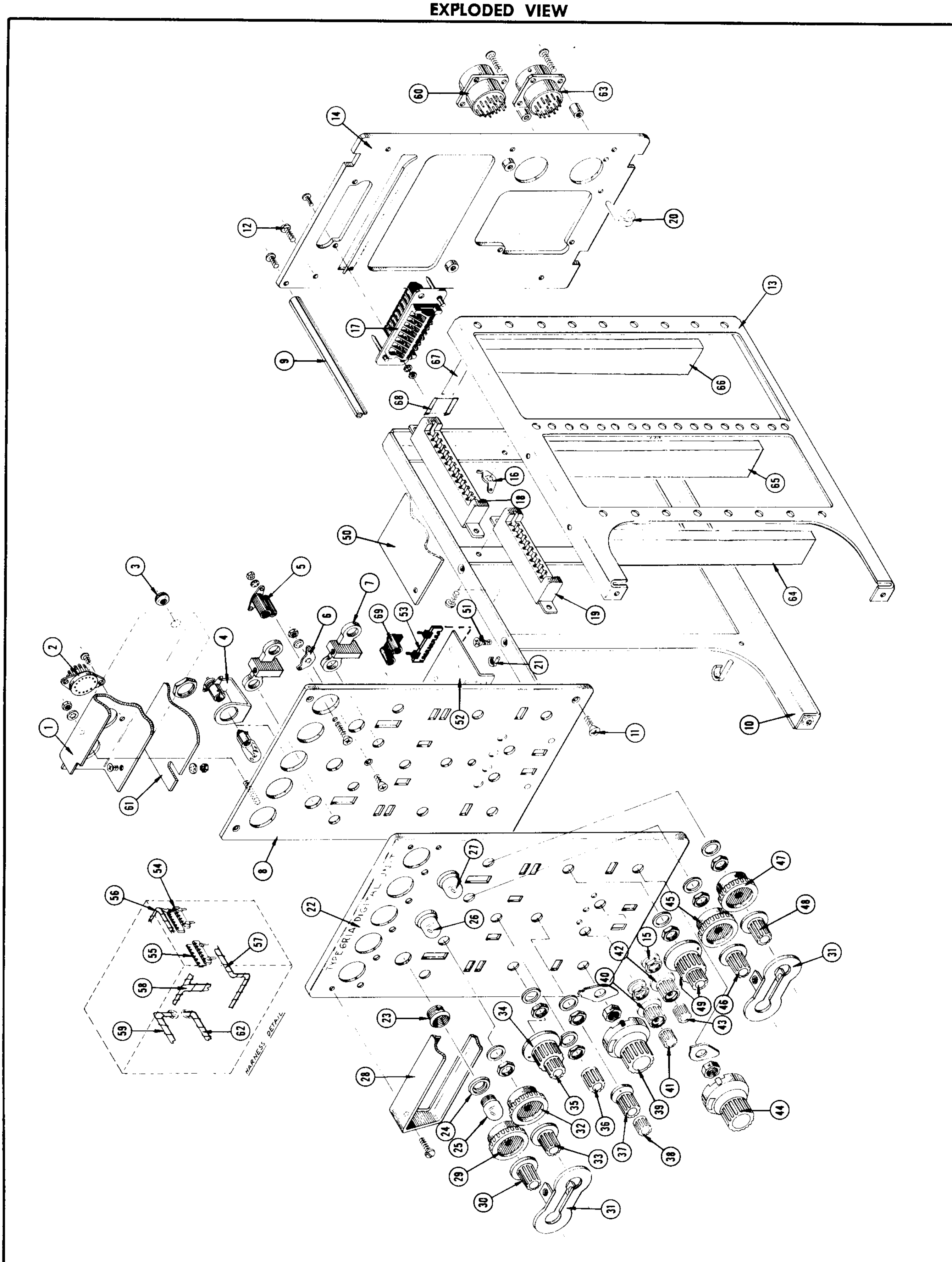
ABBREVIATIONS AND SYMBOLS

a or amp	amperes
BHS	binding head steel
C	carbon
cer	ceramic
cm	centimeter
comp	composition
cps	cycles per second
crt	cathode-ray tube
CSK	counter sunk
dia	diameter
div	division
EMC	electrolytic, metal cased
EMT	electroyltic, metal tubular
ext	external
f	farad
F & I	focus and intensity
FHS	flat head steel
Fil HS	fillister head steel
g or G	giga, or 10^9
Ge	germanium
GMV	guaranteed minimum value
h	henry
hex	hexagonal
HHS	hex head steel
HSS	hex socket steel
HV	high voltage
ID	inside diameter
incd	incandescent
int	internal
k or K	kilohms or kilo (10^3)
kc	kilocycle
m	milli, or 10^{-3}
mc	megacycle
mm	millimeter
meg or M	megohms or mega (10^6)
met.	metal
μ	micro, or 10^{-6}
n	nano, or 10^{-9}
Ω	ohm
OD	outside diameter
OHS	oval head steel
p	pico, or 10^{-12}
PHS	pan head steel
piv	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
Prec	precision
PT	paper tubular
PTM	paper or plastic, tubular, molded
RHS	round head steel
rms	root mean square
sec	second
Si	silicon
S/N	serial number
t or T	tera, or 10^{12}
TD	toroid
THS	truss head steel
tub.	tubular
v or V	volt
Var	variable
w	watt
w/	with
w/o	without
WW	wire-wound

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number.
000X	Part removed after this serial number.
*000-000	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, or reworked or checked components.
Use 000-000	Part number indicated is direct replacement.
	Internal screwdriver adjustment.
	Front-panel adjustment or connector.

EXPLODED VIEW



EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	406-0761-00			1	BRACKET, alum.
	- - - - - -			-	Mounting Hardware: (not included)
	210-0006-00			4	LOCKWASHER, internal, #6
	210-0407-00			4	NUT, hex, 6-32 x $1/4$ inch
2	136-0120-00			5	SOCKET, 13 pin
	- - - - - -			-	Mounting Hardware For Each: (not included)
	213-0044-00			2	SCREW, thread forming, 5-32 x $3/16$ inch PHS
3	348-0003-00			1	GROMMET, rubber, $5/16$ inch
4	136-0026-00			3	SOCKET, light
5	352-0038-00			5	HOLDER, single, neon
	- - - - - -			-	Mounting Hardware, internal, #4
	210-0004-00			1	LOCKWASHER, internal #4
	210-0406-00			1	NUT, hex, 4-40 x $3/16$ inch
	211-0086-00			1	SCREW, 4-40 x $3/4$ inch FHS 100° CSK
6	210-0207-00			1	LUG, solder
	- - - - - -			-	Mounting Hardware: (not included)
	210-0407-00			1	NUT, hex, 6-32 x $1/4$ inch
	211-0538-00			1	SCREW, 6-32 x $5/16$ inch FHS 100° CSK
7	406-0757-00			2	BRACKET, spacer switch
8	387-0894-00			1	PLATE, subpanel, front
9	384-0566-00			2	ROD, frame spacing
	- - - - - -			-	Mounting Hardware For Each: (not included)
	212-0043-00	995	1219X	2	SCREW, 8-32 x $1/2$ inch FHS 100° CSK
	212-0044-00			2	SCREW, 8-32 x $1/2$ inch RHS
10	387-0610-00			1	PLATE, left
	- - - - - -			-	Mounting Hardware: (not included)
11	211-0538-00			2	SCREW, 6-32 x $5/16$ inch FHS 100° CSK
12	211-0507-00	995	17849	3	SCREW, 6-32 x $5/16$ inch BHS
	211-0504-00	17850		3	SCREW, 6-32 x $1/4$ inch, BHS
13	387-0881-00	995	1529	1	PLATE, right
	387-0881-01	1530		1	PLATE, right
	- - - - - -			-	Mounting Hardware: (not included)
	211-0538-00	995	1529	2	SCREW, 6-32 x $5/16$ inch FHS 100° CSK
	210-0006-00	1530		2	LOCKWASHER, internal, #6
	210-0407-00	1530		2	NUT, hex, 6-32 x $1/4$ inch
	211-0507-00	995	17849	3	SCREW, 6-32 x $5/16$ inch BHS
	211-0504-00	17850		3	SCREW, 6-32 x $1/4$ inch, BHS
14	387-0607-00			1	PLATE, rear
15	- - - - - -			2	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0012-00			1	LOCKWASHER, internal, $3/8$ x $1/2$ inch
	210-0207-00			1	LUG, solder, $3/8$ inch
	210-0978-00			1	WASHER, $3/8$ ID x $1/2$ inch OD
	210-0590-00			1	NUT, hex, $3/8$-32 x $7/16$ inch
16	210-0201-00			3	LUG, solder, SE4
	210-0204-00			2	LUG, solder, DE6
17	131-0149-00			2	CONNECTOR, chassis mount
	- - - - - -			-	Mounting Hardware For Each: (not included)
	210-0004-00			1	LOCKWASHER, internal, #4
	210-0201-00			1	LUG, solder
	210-0406-00			2	NUT, hex, 4-40 x $3/16$ inch
	211-0011-00			2	SCREW, 4-40 x $5/16$ inch BHS

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
18	136-0122-00			9	SOCKET, 20 pin
	- - - - - -			-	Mounting Hardware For Each: (not included)
	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch PHS
19	136-0123-00			8	SOCKET, 15 pin
	- - - - - -			-	Mounting Hardware For Each: (not included)
	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch PHS
20	343-0089-00			2	CLAMP, cable, delrin
21	343-0088-00			1	CLAMP, cable, delrin
22	333-0803-00			1	PANEL, front
23	136-0026-00			3	BUSHING, (included with Ref. No. 4)
24	354-0164-00			3	RING, pilot light
25	378-0530-00			1	FILTER, light, pilot, yellow
26	378-0531-00			1	FILTER, light, pilot, green
27	378-0529-00			1	FILTER, light, pilot, red
28	337-0485-00			1	SHIELD, hood
	378-0532-00			1	FILTER, polarized, light
29	366-0168-00			1	KNOB, LOWER LIMIT SET, charcoal, large, left
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
30	366-0166-00			1	KNOB, LOWER LIMIT SET, charcoal, small, left
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
31	200-0374-00			2	COVER, dial
	- - - - - -			-	Mounting Hardware For Each: (not included)
	211-0538-00			2	SCREW, 6-32 x 5/16 inch FHS 100° CSK
32	366-0169-00			1	KNOB, LOWER LIMIT SET, charcoal, large, right
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
33	366-0165-00			1	KNOB, LOWER LIMIT SET, charcoal, small, right
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
34	366-0160-00			1	KNOB, TIMING START, charcoal
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
35	366-0031-00			1	KNOB, MANUAL START, red
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
36	366-0172-00			1	KNOB, MODE, charcoal
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
37	366-0250-00			1	KNOB, RESOLUTION, charcoal
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
38	366-0140-00			1	KNOB, DISPLAY TIME, red
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS

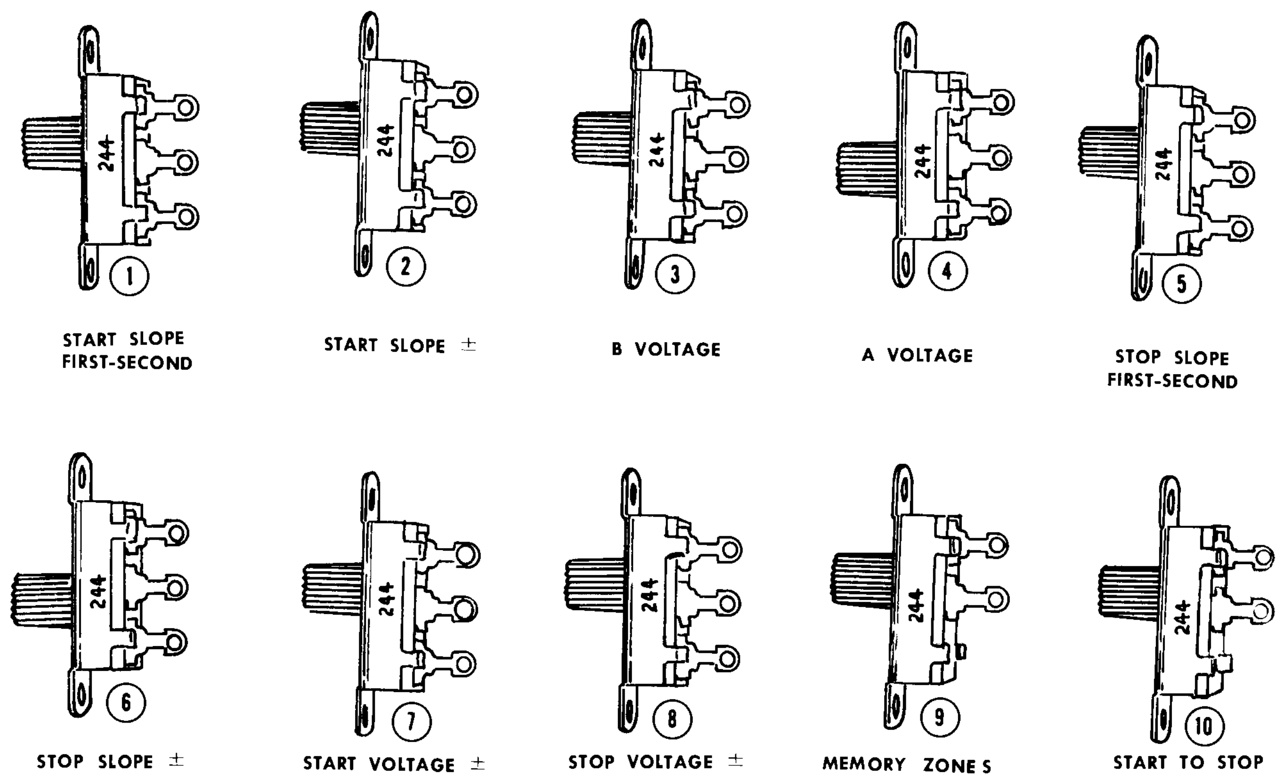
EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
39	331-0085-00			1	DIAL, START VOLTAGE with brake and charcoal knob
40	366-0249-00			1	KNOB, MEMORY MODE 100% "A", charcoal
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
41	366-0255-00			1	KNOB, MEMORY MODE 0% "A", red
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
42	366-0249-00			1	KNOB, MEMORY MODE 100% "B", charcoal
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
43	366-0255-00			1	KNOB, MEMORY MODE 0% "B", red
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
44	331-0085-00			1	DAIL, STOP VOLTAGE with brake and charcoal knob
45	366-0168-00			1	KNOB, UPPER LIMIT SET, charcoal, large, left
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
46	366-0165-00			1	KNOB, UPPER LIMIT SET, charcoal, small, left
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
47	366-0169-00			1	KNOB, UPPER LIMIT SET, charcoal, large, right
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
48	366-0166-00			1	KNOB, UPPER LIMIT SET, charcoal, small, right
	- - - - - -			-	Includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
49	366-0031-00			1	KNOB, MANUAL STOP, red
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
	366-0160-00			1	KNOB, TIMING STOP, charcoal
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
50	387-0730-00			1	PLATE, top brace, alum.
	- - - - - -			-	Mounting Hardware: (not included)
	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
51	211-0538-00			4	SCREW, 6-32 x 5/16 inch FHS 100° CSK
52	406-0976-00			1	BRACKET, transistor, alum.
	- - - - - -			-	Mounting Hardware: (not included)
	210-0006-00			1	LOCKWASHER, internal, #6
	210-0202-00			1	LUG, solder, SE6, with 2 wire holes
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
	211-0538-00			2	SCREW, 6-32 x 5/16 inch FHS 100° CSK

EXPLODED VIEW *(Cont'd)*

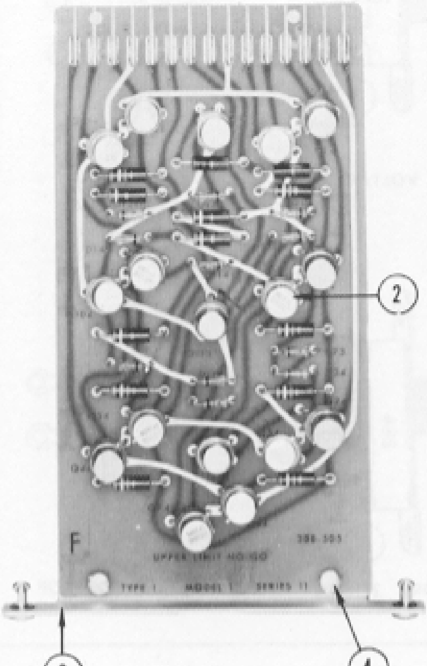
REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
53	124-0148-00			2	STRIP, ceramic, 9 notches x $1\frac{7}{16}$ x $\frac{7}{16}$ inch
	- - - - - - -			-	Mounting Hardware For Each (not included)
	361-0007-00			2	SPACER, nylon
54	124-0146-00			2	STRIP, ceramic, 16 notches x $2\frac{7}{16}$ x $\frac{7}{16}$ inch
	- - - - - - -			-	Mounting Hardware For Each: (not included)
	361-0007-00			2	SPACER, nylon
55	124-0145-00			2	STRIP, ceramic, 20 notches x 3 x $\frac{7}{16}$ inch
	- - - - - - -			-	Mounting Hardware For Each: (not included)
	361-0007-00			2	SPACER, nylon
56	179-0606-00			1	CABLE HARNESS, neon
57	179-0844-00			1	CABLE HARNESS, Stop-Start
58	179-0843-00			1	CABLE HARNESS, No-Go
59	179-0842-00			1	CABLE HARNESS, 55 pin
	- - - - - - -			-	cable harness includes:
60	131-0322-00			1	CONNECTOR, 55 pin
	- - - - - - -			-	mounting hardware: (not included)
	211-0016-00			4	SCREW, 4-40 x $\frac{5}{8}$ inch BHS
	166-0107-00			4	TUBE, spacing
	210-0004-00			4	LOCKWASHER, internal, #4
	210-0406-00			4	NUT, hex, 4-40 x $\frac{3}{16}$ inch
61	441-0417-00			1	CHASSIS, No-Go
	- - - - - - -			-	Mounting Hardware: (not included)
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x $\frac{1}{4}$ inch
62	179-0847-00			1	CABLE HARNESS, 41 pin
	- - - - - - -			-	cable harness includes:
63	131-0321-00			1	CONNECTOR, 41 pin
	- - - - - - -			-	mounting hardware: (not included)
	211-0016-00			4	SCREW, 4-40 x $\frac{5}{8}$ inch BHS
	166-0107-00			4	TUBE, spacing
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0201-00			2	LUG, solder, SE4
	210-0406-00			4	NUT, hex, 4-40 x $\frac{3}{16}$ inch
64	407-0152-00	X1530		1	BRACKET, front guide mount
	- - - - - - -			-	mounting hardware: (not included w/bracket)
	213-0107-00			3	SCREW, thread forming, 4-40 x $\frac{1}{4}$ inch FHS
65	407-0153-00	X1530		1	BRACKET, center guide mount
	- - - - - - -			-	mounting hardware: (not included w/bracket)
	213-0107-00			3	SCREW, thread forming, 4-40 x $\frac{1}{4}$ inch FHS
66	407-0154-00	X1530		1	BRACKET, rear guide mount
	- - - - - - -			-	mounting hardware: (not included w/bracket)
	213-0107-00			3	SCREW, thread forming, 4-40 x $\frac{1}{4}$ inch FHS
67	351-0087-00	X1530		34	GUIDE, circuit board, plastic
68	407-0072-00	X1530		34	BRACKET, circuit board guide
69	352-0006-00	995	1789	2	HOLDER, neon, double, black
	352-0064-00	1790		2	HOLDER, neon, double, gray
	- - - - - - -			-	mounting hardware for each: (not included w/holder)
	211-0031-00	995	1789	1	SCREW, 4-40 x 1 inch FHS
	211-0109-00	1790		1	SCREW, 4-40 x $\frac{7}{8}$ inch FHS
	210-0406-00			2	NUT, hex, 4-40 x $\frac{3}{16}$ inch
	378-0541-00	X1790		4	FILTER, lens, neon

SLIDE SWITCHES

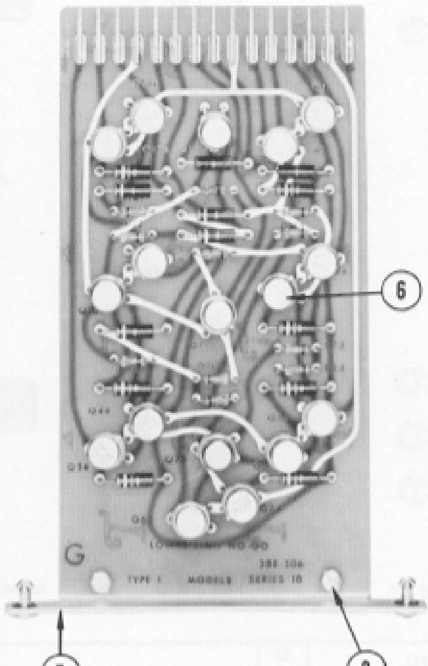


REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	260-0449-00			1	SWITCH, START SLOPE FIRST-SECOND, unwired
2	260-0447-00			1	SWITCH, START SLOPE ±, unwired
3	260-0447-00			1	SWITCH, B VOLTAGE, unwired
4	260-0447-00			1	SWITCH, A VOLTAGE, unwired
5	260-0449-00			1	SWITCH, STOP SLOPE FIRST-SECOND, unwired
6	260-0447-00			1	SWITCH, STOP SLOPE ±, unwired
7	260-0447-00			1	SWITCH, START VOLTAGE ±, unwired
8	260-0447-00			1	SWITCH, STOP VOLTAGE ±, unwired
9	260-0451-00			1	SWITCH, MEMORY ZONES, unwired
10	260-0451-00			1	SWITCH, START TO STOP, unwired
	- - - - - -			-	Mounting Hardware For Each Switch
	210-0406-00			2	NUT, hex, 4-40 x $^{3}/_{16}$ inch

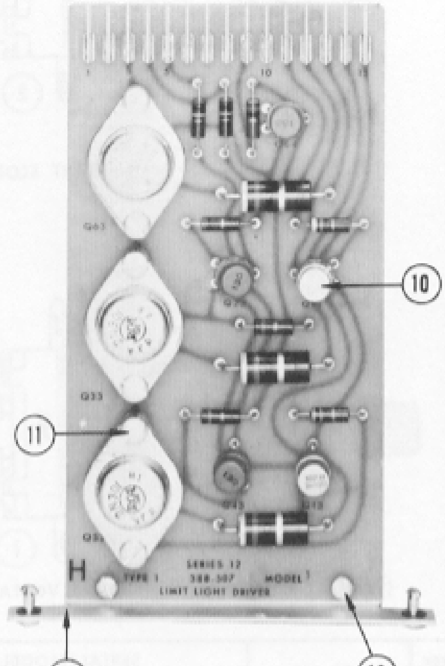
PRINTED CIRCUIT CARDS



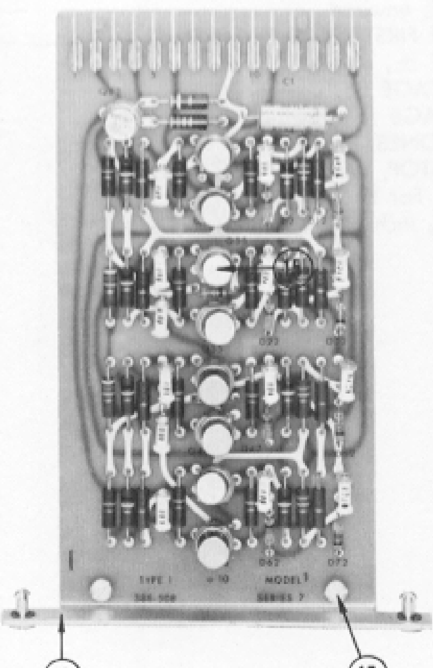
UPPER LIMIT NO-GO
(1)



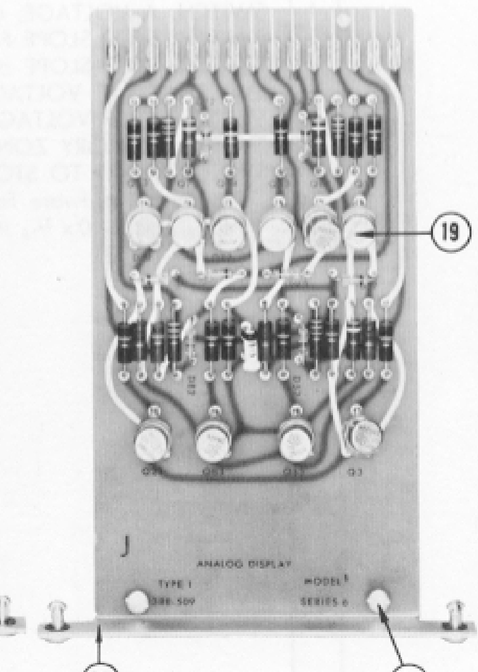
LOWER LIMIT NO-GO
(5)



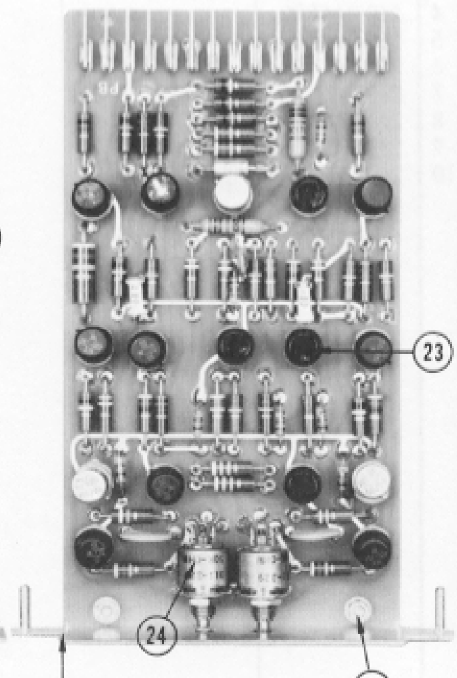
LIMIT LIGHT DRIVER
(9)



÷ 10
(14)



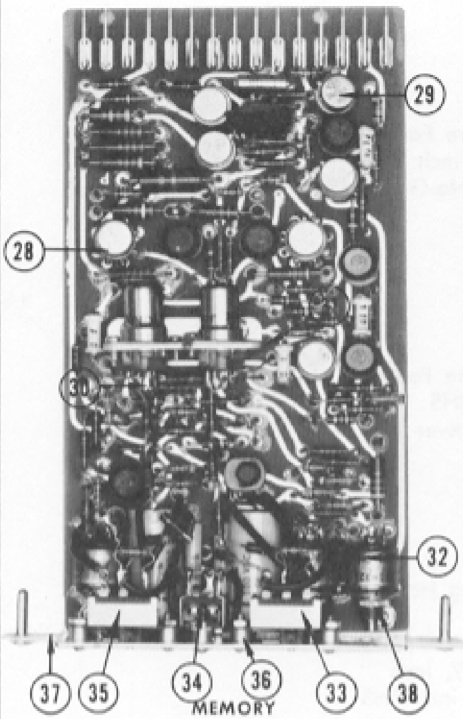
ANALOG DISPLAY
(18)



0% ZONE
(22)

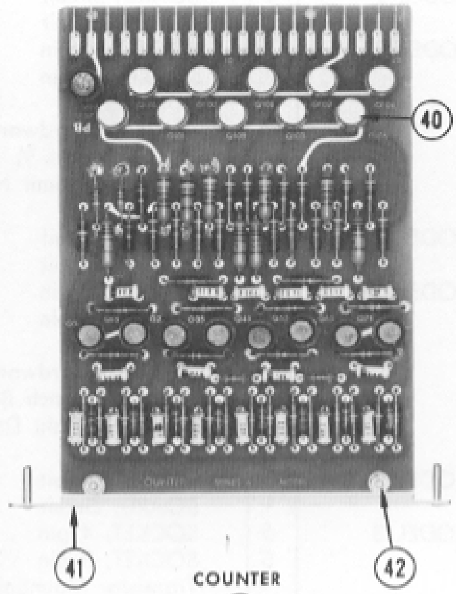
Ⓐ

PRINTED CIRCUIT CARDS



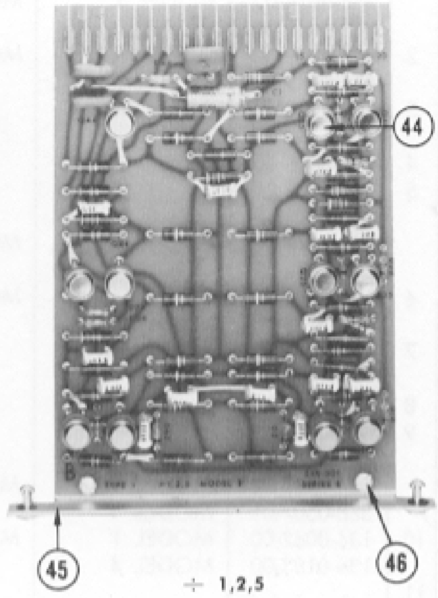
MEMORY

(27)



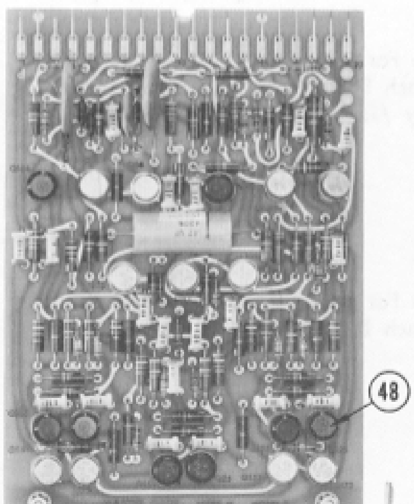
COUNTER

(39)



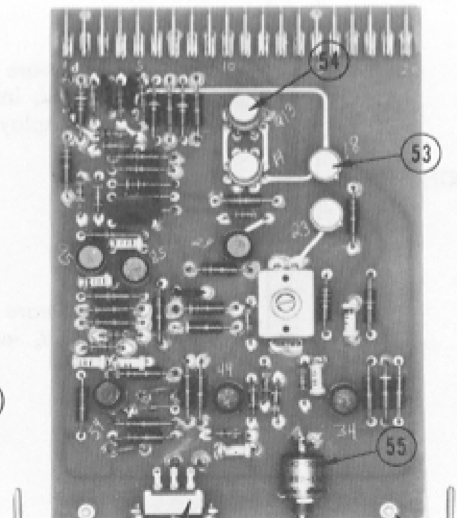
÷ 1,2,5

(43)



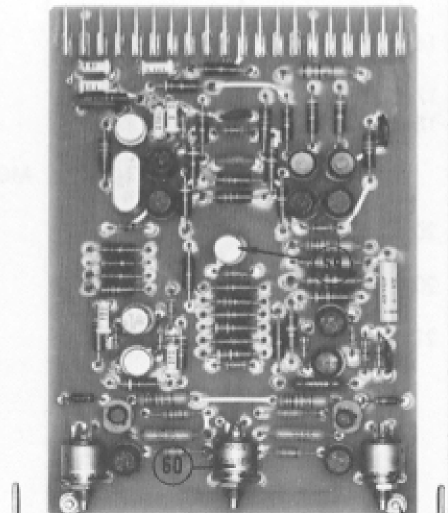
MASTER GATE

(47)



SIGNAL COMPARATOR

(51)



VOLTMETER

(58)

CIRCUIT CARDS

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	670-0047-00			1	CARD, Upper Limit No-Go /F/ (wired)
	- - - - - -			-	Includes:
	388-0576-00	MODEL 1	MODEL 2	1	BOARD, circuit
	388-0576-01	MODEL 3		1	BOARD, circuit
2	136-0062-00	MODEL 1	MODEL 2	17	SOCKET, 4 pin
	136-0183-00	MODEL 3		17	SOCKET, 3 pin
3	406-0970-00			1	BRACKET
	- - - - - -			-	Mounting Hardware For Brkt.
4	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS
5	670-0048-00			1	CARD, Lower Limit No-Go /G/ (wired)
	- - - - - -			-	Includes:
	388-0577-00	MODEL 1	MODEL 2	1	BOARD, circuit
	388-0577-01	MODEL 3		1	BOARD, circuit
6	136-0062-00	MODEL 1	MODEL 2	17	SOCKET, 4 pin
	136-0183-00	MODEL 3		17	SOCKET, 3 pin
7	406-0971-00			1	BRACKET
	- - - - - -			-	Mounting Hardware For Brkt.
8	211-0008-00			2	SCREW, 1/4 inch BHS
9	670-0049-00			1	CARD, Limit Light Driver /H/ (wired)
	- - - - - -			-	Includes:
	388-0507-00	MODEL 1	MODEL 3	1	BOARD, circuit
	388-0507-01	MODEL 4		1	BOARD, circuit
10	136-0062-00	MODEL 1	MODEL 3	5	SOCKET, 4 pin
	136-0183-00	MODEL 4		5	SOCKET, 3 pin
11	- - - - - -			-	Transistor Mounting Hardware For Each:
	166-0031-00			2	TUBE, spacer
	210-0006-00			2	LOCKWASHER, int. #6
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
	211-0511-00			2	SCREW, 6-32 x 1/2 inch BHS
12	406-0972-00			1	BRACKET
	- - - - - -			-	Mounting Hardware For Brkt.
13	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS
14	670-0050-00			1	CARD, ÷ 10 /1/ (wired)
	- - - - - -			-	Includes:
	388-0508-00	MODEL 1	MODEL 3	1	BOARD, circuit
	388-0508-01	MODEL 4		1	BOARD, circuit
15	136-0062-00	MODEL 1	MODEL 3	9	SOCKET, 4 pin
	136-0183-00	MODEL 4		9	SOCKET, 3 pin
16	406-0973-00			1	BRACKET
	- - - - - -			-	Mounting Hardware For Brkt.
17	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS
18	670-0051-00			1	CARD, Analog Display /J/ (wired)
	- - - - - -			-	Includes:
	388-0509-00	MODEL 1	MODEL 2	1	BOARD, circuit
	388-0509-01	MODEL 3		1	BOARD, circuit
20	406-0974-00			1	SOCKET, 4 pin
	136-0183-00	MODEL 3		10	SOCKET, 3 pin
20	406-0974-00			1	BRACKET
	- - - - - -			-	Mounting Hardware For Brkt.
21	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS

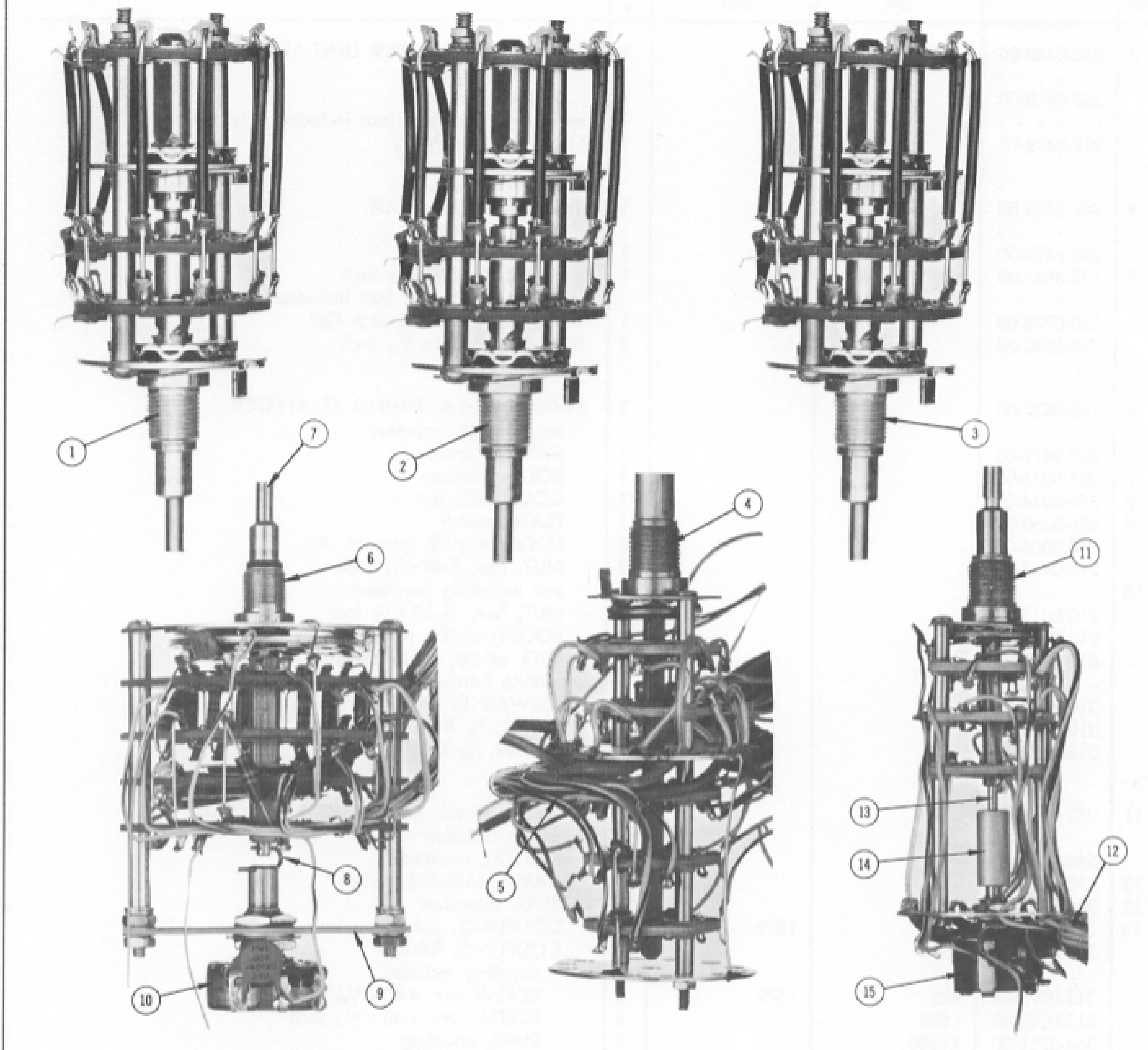
CIRCUIT CARDS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
22	670-0055-00			1	CARD, 0% Zone /O/ (wired)
	- - - - - -			-	Includes:
	388-0585-00			1	BOARD, etched circuit
23	136-0183-00			16	SOCKET, 3 pin
24	- - - - - -			-	Pot Mounting Hardware For Each:
	210-0046-00			1	LOCKWASHER, int.
	210-0583-00			1	NUT, hex, $^5/_{16}$ x $^1/_4$-32 inch double chamfer
	387-0794-00			1	PLATE, mounting $^1/_2$ x $^{41}/_{64}$ inch
25	406-0980-00			1	BRACKET
	- - - - - -			-	Mounting Hardware For Brkt.
26	211-0008-00			2	SCREW, 4-40 x $^1/_4$ inch BHS
27	670-0058-00	995	1543	2	CARD, memory /P/ (wired) (MODEL 1-3)
	670-0083-00	1544		2	CARD, memory /P/ (wired) (MODEL 4-up)
	- - - - - -			-	each card includes:
	388-0586-00	MODEL 1	MODEL 3	1	BOARD, circuit
	388-0586-01	MODEL 4		1	BOARD, circuit
28	136-0186-00			2	SOCKET, 8 pin
29	136-0183-00	MODEL 1	MODEL 3	10	SOCKET, 3 pin transistor
	136-0220-00	MODEL 4		9	SOCKET, 3 pin transistor
30	136-0101-00	MODEL 1	MODEL 3	2	SOCKET, 5 pin
	136-0125-00	MODEL 4		2	SOCKET, 5 pin
	387-0603-00	MODEL 4		2	PLATE, insulator
	- - - - - -			-	Mounting Hardware For Each Socket To Bracket
	213-0055-00	MODEL 1	MODEL 3X	2	SCREW, 2-32 x $^3/_{16}$ inch PHS
	210-0215-00	MODEL 1	MODEL 3X	1	LUG, banana, pee wee
31	406-0975-00	MODEL 1	MODEL 3X	1	BRACKET, transistor
	- - - - - -			-	Mounting Hardware, Bracket To Card
	210-0004-00			2	LOCKWASHER, int. #4
	210-0406-00			2	NUT, hex, 4-40 x $^3/_{16}$ inch
	211-0008-00			2	SCREW, 4-40 x $^1/_4$ inch
32	- - - - - -			-	Pot Mounting Hardware For Each
	210-0046-00	MODEL 1	MODEL 3X	1	LOCKWASHER, int.
	210-0583-00	MODEL 1	MODEL 3X	1	NUT, hex, $^5/_{16}$ x $^1/_4$-32 x inch double chamfer
	387-0794-00	MODEL 1	MODEL 3X	1	PLATE, mounting, $^1/_2$ x $^{41}/_{64}$ inch
33	260-0583-00	MODEL 1	MODEL 3	1	SWITCH, 100% MODE, unwired
	260-0723-00	MODEL 4		1	SWITCH, 100% MODE, unwired
34	260-0583-00	MODEL 1	MODEL 3	1	SWITCH, SLOW-FAST, unwired
	260-0723-00	MODEL 4		1	SWITCH, SLOW-FAST, unwired
35	260-0583-00	MODEL 1	MODEL 3	1	SWITCH, 0% MODE, unwired
	260-0723-00	MODEL 4		1	SWITCH, 0% MODE, unwired
	- - - - - -			-	Mounting Hardware For Each Switch
36	166-0024-00	MODEL 1	MODEL 3X	2	SPACER, steel, $^3/_{16}$ OD x $^1/_8$ inch long
	210-0405-00	MODEL 1	MODEL 3X	2	NUT, hex, 2-56 x $^3/_{16}$ inch
	211-0062-00	MODEL 1	MODEL 3X	2	SCREW, 2-56 x $^5/_{16}$ inch RHS
37	406-0981-00	MODEL 1	MODEL 3	1	BRACKET
	406-0981-01	MODEL 4		1	BRACKET
	- - - - - -			-	Mounting Hardware For Bracket
38	211-0008-00			2	SCREW, 4-40 x $^1/_4$ inch BHS

CIRCUIT CARDS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	Q T Y.	DESCRIPTION
39	670-0053-00			4	CARD, Counter* /A/ (wired)
	- - - - - -			-	Each Includes:
	388-0580-00			1	BOARD, circuit
	136-0183-00			19	SOCKET, 3 pin
41	406-0978-00			1	BRACKET
	- - - - - -			-	Mounting Hardware For Bracket
42	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS
43	670-0052-00			1	CARD, ÷ 1, 2, 5 /B/ (wired)
	- - - - - -			-	Includes:
	388-0581-00	100	2319	1	BOARD, circuit
	388-0581-01	2320		1	BOARD, circuit
44	136-0062-00	100	2319	11	SOCKET, 4 pin
	136-0183-00	2320		11	SOCKET, 4 pin
45	406-0977-00			1	BRACKET
	- - - - - -			-	Mounting Hardware For Bracket
46	211-0008-00			2	SCREW, 4-40 x 1/4 inch
47	670-0054-00			1	CARD, Master Gate /M/ (wired)
	- - - - - -			-	Includes:
	388-0582-00			1	BOARD, circuit
48	136-0183-00			19	SOCKET, 3 pin
49	406-0979-00			1	BRACKET
	- - - - - -			-	Mounting Hardware For Bracket
50	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS
51	670-0057-00			2	CARD, Signal Comparator /N/ (wired)
	- - - - - -			-	Each Includes:
	388-0583-00			1	BOARD, circuit
52	260-0583-00			1	SWITCH, OUT-IN, unwired
	- - - - - -			-	Mounting Hardware For Switch
	166-0024-00			2	SPACER, steel, 3/16 OD x 1/6 inch long
	210-0405-00			2	NUT, hex, 2-56 x 3/16 inch
	211-0062-00			2	SCREW, 2-56 x 5/16 inch RHS
53	136-0183-00			8	SOCKET, 3 pin
54	136-0186-00			2	SOCKET, 8 pin
55	- - - - - -			-	Pot Mounting Hardware
	210-0046-00			1	LOCKWASHER, int.
	210-0583-00			1	NUT, hex, 5/16 x 1/4-32 inch double chamfer
	387-0794-00			1	PLATE, mounting, 1/2 x 41/64 inch
56	406-0982-00			1	BRACKET
	- - - - - -			-	Mounting Hardware For Bracket
57	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS
58	670-0056-00			1	CARD, Voltmeter, /Q/ (wired)
	- - - - - -			-	Includes:
	388-0584-00			1	BOARD, circuit
59	136-0183-00			16	SOCKET, 3 pin
60	- - - - - -			-	Pot Mounting Hardware For Each
	210-0046-00			1	LOCKWASHER, int.
	210-0583-00			1	NUT, hex, 5/16 x 1/4-32 inch double chamfer
	387-0794-00			1	PLATE, mounting 1/2 x 41/64 inch
61	406-0983-00			1	BRACKET
	- - - - - -			-	Mounting Hardware For Bracket
	210-0004-00			2	LOCKWASHER, int. #4
62	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
	211-0101-00			2	SCREW, 4-40 x 1/4 inch FHS

SWITCHES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	262-0458-00			2	SWITCH, wired—UPPER/LOWER LIMIT SET (LEFT)
	- - - - - - -			-	each switch includes:
	260-0417-00			1	SWITCH, unwired
	- - - - - - -			-	mounting hardware for each; (not included w/switch)
	210-0419-00			1	NUT, shoulder, 3/8-32
2	262-0461-00			1	SWITCH, wired—LOWER LIMET SET (RIGHT)
	- - - - - - -			-	switch includes:
	260-0418-00			1	SWITCH, unwired
	- - - - - - -			-	mounting hardware: (not included w/switch)
	210-0419-00			1	NUT, shoulder, 3/8-32

SWITCHES *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
3	262-0459-00			1	SWITCH, wired—UPPER LIMIT SET (RIGHT)
	- - - - - -			-	switch includes:
	260-0418-00			1	SWITCH, unwired
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0419-00			1	NUT, shoulder, 3/8-32
4	262-0632-00			1	SWITCH, wired—MODE
	- - - - - -			-	switch includes:
	260-0420-00			1	SWITCH, unwired
5	179-0845-00			1	CABLE HARNESS, switch
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0978-00			1	WASHER, 3/8 ID x 1/2 inch OD
	210-0590-00			1	NUT, hex, 3/8-32 x 7/16 inch
6	262-0630-00			2	SWITCH, wired—TIMING START/STOP
	- - - - - -			-	each switch includes:
	260-0419-00			1	SWITCH, unwired
7	384-0077-00			1	ROD, extension
8	376-0014-00			1	COUPLING, pot
9	386-0450-00			1	PLATE, switch
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0449-00			2	NUT, hex, 5-40 x 1/4 inch
10	- - - - - -			-	pot mounting hardware:
	210-0413-00			2	NUT, hex, 3/8-32 x 1/2 inch
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0207-00			1	LUG, solder, 3/8 inch
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0978-00			1	WASHER, 3/8 ID x 1/2 inch OD
	210-0590-00			1	NUT, hex, 3/8-32 x 7/16 inch
11	262-0631-00			1	SWITCH, wired—RESOLUTION
	- - - - - -			-	switch includes:
	260-0588-00			1	SWITCH, unwired
12	179-0846-00			1	CABLE HARNESS, switch
13	384-0302-00			1	ROD, extension
14	376-0033-00	995	1579	1	COUPLING, pot
	376-0050-00	1580		1	COUPLING, flexible
	- - - - - -			-	coupling includes:
	213-0075-00	995	1579	2	SCREW, set, 4-40 x 3/32 inch
	213-0022-00	1580		4	SCREW, set, 4-40 x 3/16 inch
	354-0251-00	X1580		2	RING, coupling
	376-0046-00	X1580		1	COUPLING, delrin
15	- - - - - -			-	pot mounting hardware:
	210-0583-00			2	NUT, hex, 1/4-32 x 5/16 inch
	210-0046-00			1	LOCKWASHER, internal, .400 OD x .261 inch ID
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0978-00			1	WASHER, 3/8 ID x 1/2 inch OD
	210-0590-00			1	NUT, hex, 3/8-32 x 7/16 inch
					STANDARD ACCESSORIES
	070-0411-00			2	MANUAL, instruction (not shown)

ELECTRICAL PARTS

Values are fixed unless marked Variable.

Bulbs

Ckt. No.	Tektronix Part No.	Description		S/N Range
B361	150-025	Neon, NE-2E		995-2469
B361	150-0030-00	Neon, NE-2V		2470-up
B362	150-025	Neon, NE-2E		995-2469
B362	150-0030-00	Neon, NE-2V		2470-up
B363	150-025	Neon, NE-2E		995-2469
B363	150-0030-00	Neon, NE-2V		2470-up
B364	150-025	Neon, NE-2E		995-2469
B364	150-0030-00	Neon, NE-2V		2470-up
B365	150-025	Neon, NE-2E		995-2469
B365	150-0030-00	Neon, NE-2V		2470-up
B560	150-001	Incandescent, #47	UPPER LIMIT	
B561	150-001	Incandescent, #47	MID ZONE	
B562	150-001	Incandescent, #47	LOWER LIMIT	
B570	150-027	Neon, NE-23		995-1789
B570	150-0030-00	Neon, NE-2V		1790-up
B576	150-027	Neon, NE-23		995-1789
B576	150-0030-00	Neon, NE-2V		1790-up
B580	150-027	Neon, NE-23		995-1789
B580	150-0030-00	Neon, NE-2V		1790-up
B586	150-027	Neon, NE-23		995-1789
B586	150-0030-00	Neon, NE-2V		1790-up

Capacitors

Tolerance ±20% unless otherwise indicated.

Tolerance of all electrolytic capacitors as follows (with exceptions):
3V — 50V = −10%, +250%
51V — 350V = −10%, +100%
351V — 450V = −10%, +50%

Ckt. No.	Tektronix Part No.	Description		
C409	283-000	0.001 μf	Cer	500 v
C411	283-001	0.005 μf	Cer	500 v
C459	283-000	0.001 μf	Cer	500 v
C461	283-001	0.005 μf	Cer	500 v
C550	290-162	22 μf	EMT	35 v
C552	290-162	22 μf	EMT	35 v
C554	290-162	22 μf	EMT	35 v
C556	290-162	22 μf	EMT	35 v
C558	290-162	22 μf	EMT	35 v
C559	290-162	22 μf	EMT	35 v
C574	283-001	0.005 μf	Cer	500 v
C584	283-001	0.005 μf	Cer	500 v

Diode

Ckt. No.	Tektronix Part No.	Description				S/N Range
D387	152-091	Zener	1N982		75 v	995-2529
D387	152-0286-00	Zener	1N982B	0.4 w, 75 v, 5%		2530-up

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Description		
R360	301-274	270 k	½ w	5%
R361	301-394	390 k	½ w	5%
R362	301-394	390 k	½ w	5%
R363	301-394	390 k	½ w	5%
R364	301-394	390 k	½ w	5%

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R365	301-394	390 k	½ w			5%	
R370	301-823	82 k	½ w			5%	
R372	301-823	82 k	½ w			5%	
R374	301-823	82 k	½ w			5%	
R376	301-823	82 k	½ w			5%	
R381	301-563	56 k	½ w			5%	
R382	301-563	56 k	½ w			5%	
R383	301-563	56 k	½ w			5%	
R384	301-563	56 k	½ w			5%	
R385	301-563	56 k	½ w			5%	
R386	301-563	56 k	½ w			5%	
R387	303-303	30 k	1 w			5%	
R388	315-105	1 meg	¼ w			5%	
R389	315-105	1 meg	¼ w			5%	
R390	315-105	1 meg	¼ w			5%	
R407	321-347	40.2 k	⅛ w		Prec	1%	
R408	321-289	10 k	⅛ w		Prec	1%	
R410	Use 301-333	33 k	½ w			5%	
R411	311-224	50 k		Var		MANUAL START	
R420	322-632	1 k	¼ w		Prec	¼%	
R421	322-632	1 k	¼ w		Prec	¼%	
R422	322-631	696 Ω	¼ w		Prec	¼%	
R423	322-633	2.304 k	¼ w		Prec	¼%	
R424	322-633	2.304 k	¼ w		Prec	¼%	
R425	322-631	696 Ω	¼ w		Prec	¼%	
R426	322-632	1 k	¼ w		Prec	¼%	
R427	322-632	1 k	¼ w		Prec	¼%	
R429	301-103	10 k	½ w			5%	
R430	311-318	30 k		Var	WW	START VOLTAGE	
R460	Use 301-333	33 k	½ w			5%	
R461	311-224	50 k		Var		MANUAL STOP	
R470	322-632	1 k	¼ w		Prec	¼%	
R471	322-632	1 k	¼ w		Prec	¼%	
R472	322-631	696 Ω	¼ w		Prec	¼%	
R473	322-633	2.304 k	¼ w		Prec	¼%	
R474	322-633	2.304 k	¼ w			¼%	
R475	322-631	696 Ω	¼ w		Prec	¼%	
R476	322-632	1 k	¼ w		Prec	¼%	
R477	322-632	1 k	¼ w		Prec	¼%	
R479	301-103	10 k	½ w			5%	
R480	311-318	30 k		Var	WW	STOP VOLTAGE	
R500	321-097	100 Ω	⅛ w		Prec	1%	
R501	321-097	100 Ω	⅛ w		Prec	1%	
R502	321-097	100 Ω	⅛ w		Prec	1%	
R503	321-097	100 Ω	⅛ w		Prec	1%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R504	321-097	100 Ω	1/8 w		Prec	1%	
R505	321-097	100 Ω	1/8 w		Prec	1%	
R506	321-097	100 Ω	1/8 w		Prec	1%	
R507	321-097	100 Ω	1/8 w		Prec	1%	
R508	321-097	100 Ω	1/8 w		Prec	1%	
R509	321-097	100 Ω	1/8 w		Prec	1%	
R510	323-120	174 Ω	1/2 w		Prec	1%	
R550	307-060	6.8 Ω	1/2 w			5%	
R552	307-060	6.8 Ω	1/2 w			5%	
R554	307-060	6.8 Ω	1/2 w			5%	
R556	307-060	6.8 Ω	1/2 w			5%	
R559	307-015	3.3 Ω	1 w			5%	
R569	307-025	3.3 Ω	1/2 w			5%	
R570	301-393	39 k	1/2 w				
R571	301-203	20 k	1/2 w			5%	
R572	311-075	5 meg		Var		DISPLAY TIME	
R573	301-473	47 k	1/2 w			5%	
R574	301-203	20 k	1/2 w			5%	
R575	Use 301-433	43 k	1/2 w			5%	
R576A,B	311-414	2 x 100 k		Var		B 0% ZONE SET B 100% ZONE SET	
R577	Use 301-433	43 k	1/2 w			5%	
R578	316-470	47 Ω	1/4 w				X1160-up
R579	316-470	47 Ω	1/4 w				X1160-up
R580	316-470	47 Ω	1/4 w				X1160-up
R581	316-470	47 Ω	1/4 w				X1160-up
R583	301-473	47 k	1/2 w			5%	
R584	301-203	20 k	1/2 w			5%	
R585	Use 301-433	43 k	1/2 w			5%	
R586A,B	311-414	2 x 100 k		Var		A 0% ZONE SET A 100% ZONE SET	
R587	Use 301-433	43 k	1/2 w			5%	

Switches

	Unwired	Wired		
SW310	260-451		Slide	MEMORY ZONES
SW311	260-451		Slide	START TO STOP
SW320	260-420	*262-632	Rotary	MODE
SW330	260-447		Slide	START SLOPE (±)
SW331	260-449		Slide	START SLOPE (FIRST-SECOND)
SW340	260-447		Slide	STOP SLOPE (±)
SW341	260-449		Slide	STOP SLOPE (FIRST-SECOND)
SW350	260-447		Slide	A VOLTAGE
SW351	260-447		Slide	B VOLTAGE
SW360	260-588	*262-631	Rotary	RESOLUTION
SW430	260-447		Slide	START VOLTAGE
SW440	260-419	*262-630	Rotary	TIMING START
SW480	260-447		Slide	STOP VOLTAGE
SW490	260-419	*262-630	Rotary	TIMING STOP
SW500A,B	260-417	*262-458	Rotary	LOWER LIMIT SET (LEFT)

Switches *(Cont'd)*

Ckt. No.	Tektronix Part No. Unwired	Tektronix Part No. Wired	Description		S/N Range
SW502A,B	260-418	*262-461	Rotary	LOWER LIMIT SET (RIGHT)	
SW504A,B	260-417	*262-458	Rotary	UPPER LIMIT SET (LEFT)	
SW506A,B	260-418	*262-459	Rotary	UPPER LIMIT SET (RIGHT)	

Electron Tubes

V370	154-326	B5094
V371	154-327	B5092
V372	154-327	B5092
V373	154-327	B5092
V374	154-327	B5092

COUNTER CARD (4) SERIES A

Ckt. No.	Tektronix Part No.	Description	Model No.
	*670-053	Complete Card (Model 3-up)	

Capacitors

C2	281-518	47 pf	Cer	500 v	
C6	281-540	51 pf	Cer	500 v	5%
C12	281-518	47 pf	Cer	500 v	
C16	281-540	51 pf	Cer	500 v	5%
C22	281-518	47 pf	Cer	500 v	
C26	281-540	51 pf	Cer	500 v	5%
C32	281-518	47 pf	Cer	500 v	
C36	281-540	51 pf	Cer	500 v	5%
C38	281-524	150 pf	Cer	500 v	
C42	281-518	47 pf	Cer	500 v	
C46	281-540	51 pf	Cer	500 v	5%
C52	281-518	47 pf	Cer	500 v	
C56	281-540	51 pf	Cer	500 v	
C58	281-524	150 pf	Cer	500 v	5%
C62	281-518	47 pf	Cer	500 v	
C66	281-540	51 pf	Cer	500 v	5%
C72	281-518	47 pf	Cer	500 v	
C76	281-540	51 pf	Cer	500 v	5%

Diodes

D2	*152-075	Germanium	Tek Spec
D12	*152-075	Germanium	Tek Spec
D22	*152-075	Germanium	Tek Spec
D32	*152-075	Germanium	Tek Spec
D38	*152-075	Germanium	Tek Spec

COUNTER CARD (4) SERIES A *(Cont'd)*

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				Model No.
D42	*152-075	Germanium	Tek Spec			
D52	*152-075	Germanium	Tek Spec			
D58	*152-075	Germanium	Tek Spec			
D62	*152-075	Germanium	Tek Spec			
D72	*152-075	Germanium	Tek Spec			

Transistors

Ckt. No.	Tektronix Part No.	Description				Model No.
Q5	*151-054	Selected from 2N1754				
Q15	*151-054	Selected from 2N1754				
Q25	*151-054	Selected from 2N1754				
Q35	*151-054	Selected from 2N1754				
Q45	*151-054	Selected from 2N1754				
Q55	*151-054	Selected from 2N1754				
Q65	*151-054	Selected from 2N1754				
Q75	*151-054	Selected from 2N1754				
Q83	*153-520	2N404 Checked				
Q100	*151-059	Selected from 2N1893				
Q101	*151-059	Selected from 2N1893				
Q102	*151-059	Selected from 2N1893				
Q103	*151-059	Selected from 2N1893				
Q104	*151-059	Selected from 2N1893				
Q105	*151-059	Selected from 2N1893				
Q106	*151-059	Selected from 2N1893				
Q107	*151-059	Selected from 2N1893				
Q108	*151-059	Selected from 2N1893				
Q109	*151-059	Selected from 2N1893				

Resistors

Ckt. No.	Tektronix Part No.	Description				Model No.
R2	301-103	10 k	½ w		5%	
R3	323-414	200 k	½ w	Prec	1%	
R5	301-162	1.6 k	½ w		5%	
R6	301-123	12 k	½ w		5%	
R7	301-134	130 k	½ w		5%	
R12	301-103	10 k	½ w		5%	
R15	301-162	1.6 k	½ w		5%	
R16	301-123	12 k	½ w		5%	
R17	301-154	150 k	½ w		5%	
R22	301-103	10 k	½ w		5%	
R23	323-385	100 k	½ w	Prec	1%	
R24	301-432	4.3 k	½ w		5%	
R25	301-432	4.3 k	½ w		5%	
R26	301-123	12 k	½ w		5%	
R27	301-134	130 k	½ w		5%	

COUNTER CARD (4) SERIES A *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Part No. Tektronix	Description				Model No.
R32	301-103	10 k	½ w		5%	
R34	301-432	4.3 k	½ w		5%	
R35	301-432	4.3 k	½ w		5%	
R36	301-123	12 k	½ w		5%	
R37	301-154	150 k	½ w		5%	
R38	301-223	22 k	½ w		5%	
R39	301-473	47 k	½ w		5%	
R42	301-103	10 k	½ w		5%	
R43	323-385	100 k	½ w	Prec	1%	
R44	301-432	4.3 k	½ w		5%	
R45	301-432	4.3 k	½ w		5%	
R46	301-123	12 k	½ w		5%	
R47	301-134	130 k	½ w		5%	
R52	301-103	10 k	½ w		5%	
R54	301-432	4.3 k	½ w		5%	
R55	301-432	4.3 k	½ w		5%	
R56	301-123	12 k	½ w		5%	
R57	301-154	150 k	½ w		5%	
R58	301-223	22 k	½ w		5%	
R59	301-473	47 k	½ w		5%	
R62	301-103	10 k	½ w		5%	
R63	323-636	50 k	½ w	Prec	1%	
R64	301-432	4.3 k	½ w		5%	
R65	301-432	4.3 k	½ w		5%	
R66	301-123	12 k	½ w		5%	
R67	301-134	130 k	½ w		5%	
R72	301-103	10 k	½ w		5%	
R74	301-432	4.3 k	½ w		5%	
R75	301-432	4.3 k	½ w		5%	
R76	301-123	12 k	½ w		5%	
R77	301-154	150 k	½ w		5%	
R81	301-474	470 k	½ w		5%	
R83	301-104	100 k	½ w		5%	
R100	321-125	196 Ω	⅛ w	Prec	1%	
R102	321-125	196 Ω	⅛ w	Prec	1%	
R104	321-125	196 Ω	⅛ w	Prec	1%	
R106	321-125	196 Ω	⅛ w	Prec	1%	
R108	321-125	196 Ω	⅛ w	Prec	1%	
R109	321-105	121 Ω	⅛ w	Prec	1%	
R110	321-105	121 Ω	⅛ w	Prec	1%	

÷ 1, 2, 5 CARD (1) SERIES B

	*670-052	Complete Card

÷ 1, 2, 5 CARD (1) SERIES B *(Cont'd)*

Capacitors

Ckt. No.	Tektronix Part No.	Description				Model No.
C1	290-162	22 μf	EMT	35 v		
C2	281-549	68 pf	Cer	500 v	10%	
C6	281-523	100 pf	Cer	350 v		
C16	281-523	100 pf	Cer	350 v		
C22	281-518	47 pf	Cer	500 v		
C26	281-523	100 pf	Cer	350 v		
C36	281-523	100 pf	Cer	350 v		
C38	Use 281-0543-00	270 pf	Cer	500 v	10%	
C42	281-518	47 pf	Cer	500 v		
C46	281-523	100 pf	Cer	350 v		
C50	281-573	11 pf	Cer	500 v	10%	
C52	283-024	0.1 μf	Cer	30 v		
C56	281-523	100 pf	Cer	350 v		
C62	281-549	68 pf	Cer	500 v	10%	
C66	281-523	100 pf	Cer	350 v		
C70	281-501	4.7 pf	Cer	500 v	±1 pf	
C72	283-024	0.1 μf	Cer	30 v		
C76	281-523	100 pf	Cer	350 v		
C80	281-501	4.7 pf	Cer	500 v	±1 pf	
C82	283-024	0.1 pf	Cer	30 v		

Diodes

D2	*152-075	Germanium	Tek Spec
D12	*152-075	Germanium	Tek Spec
D18	*152-075	Germanium	Tek Spec
D22	*152-075	Germanium	Tek Spec
D32	*152-075	Germanium	Tek Spec
D38	*152-075	Germanium	Tek Spec
D42	*152-075	Germanium	Tek Spec
D44	*152-075	Germanium	Tek Spec
D52	*152-075	Germanium	Tek Spec
D62	*152-075	Germanium	Tek Spec
D72	*152-075	Germanium	Tek Spec
D74	*152-075	Germanium	Tek Spec
D84	*152-075	Germanium	Tek Spec

Transistors

Q5	*151-054	Selected from 2N1754
Q15	*151-054	Selected from 2N1754
Q25	*151-054	Selected from 2N1754
Q35	*151-054	Selected from 2N1754
Q44	*151-054	Selected from 2N1754

÷ 1, 2, 5 CARD (1) SERIES B *(Cont'd)*

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description			Model No.
Q45	*151-054	Selected from 2N1754			
Q55	*151-054	Selected from 2N1754			
Q65	*151-054	Selected from 2N1754			
Q74	*151-054	Selected from 2N1754			
Q75	*151-054	Selected from 2N1754			
Q84	*151-054	Selected from 2N1754			

Resistors

Ckt. No.	Tektronix Part No.	Description			Model No.
R1	307-060	6.8 Ω	½ w	5%	
R2	301-563	56 k	½ w	5%	
R5	301-222	2.2 k	½ w	5%	
R6	301-153	15 k	½ w	5%	
R7	301-154	150 k	½ w	5%	
R15	301-222	2.2 k	½ w	5%	
R16	301-153	15 k	½ w	5%	
R17	301-154	150 k	½ w	5%	
R22	301-563	56 k	½ w	5%	
R25	301-222	2.2 k	½ w	5%	
R26	301-153	15 k	½ w	5%	
R27	301-154	150 k	½ w	5%	
R35	301-222	2.2 k	½ w	5%	
R36	301-153	15 k	½ w	5%	
R37	301-154	150 k	½ w	5%	
R38	301-223	22 k	½ w	5%	
R39	301-473	47 k	½ w	5%	
R42	301-563	56 k	½ w	5%	
R44	301-222	2.2 k	½ w	5%	
R45	301-222	2.2 k	½ w	5%	
R46	301-153	15 k	½ w	5%	
R47	301-154	150 k	½ w	5%	
R50	301-273	27 k	½ w	5%	
R51	301-104	100 k	½ w	5%	
R52	301-243	24 k	½ w	5%	
R55	301-222	2.2 k	½ w	5%	
R56	301-153	15 k	½ w	5%	
R57	301-154	150 k	½ w	5%	
R62	301-563	56 k	½ w	5%	
R65	301-222	2.2 k	½ w	5%	
R66	301-153	15 k	½ w	5%	
R67	301-154	150 k	½ w	5%	
R70	301-273	27 k	½ w	5%	
R71	301-104	100 k	½ w	5%	
R72	301-243	24 k	½ w	5%	
R75	301-222	2.2 k	½ w	5%	

÷ 1, 2, 5 CARD (1) SERIES B *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description			Model No.
R76	301-153	15 k	½ w	5%	
R77	301-154	150 k	½ w	5%	
R80	301-273	27 k	½ w	5%	
R81	301-104	100 k	½ w	5%	
R82	301-243	24 k	½ w	5%	

UPPER LIMIT NO-GO CARD (1) SERIES F

	*670-047	Complete Card (Model 2-up)

Diodes

D14	*152-075	Germanium	Tek Spec
D34	*152-075	Germanium	Tek Spec
D73	*152-075	Germanium	Tek Spec
D74	*152-075	Germanium	Tek Spec
D112	*152-075	Germanium	Tek Spec
D113	*152-075	Germanium	Tek Spec
D114	*152-075	Germanium	Tek Spec
D141	*152-075	Germanium	Tek Spec
D142	*152-075	Germanium	Tek Spec
D144	*152-075	Germanium	Tek Spec
D153	*152-075	Germanium	Tek Spec

Transistors

Q4	151-071	2N1305
Q14	151-070	2N1377
Q24	151-071	2N1305
Q34	151-070	2N1377
Q44	151-071	2N1305
Q54	151-070	2N1377
Q64	151-071	2N1305
Q73	*151-059	Selected from 2N1893
Q74	151-070	2N1377
Q84	151-071	2N1305
Q94	151-070	2N1377
Q104	151-071	2N1305
Q113	*151-059	Selected from 2N1893
Q114	151-070	2N1377
Q124	151-071	2N1305
Q134	151-070	2N1377
Q143	151-071	2N1305

UPPER LIMIT NO-GO CARD (1) SERIES F *(Cont'd)*

Resistors

Ckt. No.	Tektronix Part No.	Description			Model No.
R3	301-393	39 k	½ w	5%	
R14	301-392	3.9 k	½ w	5%	
R23	301-393	39 k	½ w	5%	
R43	301-393	39 k	½ w	5%	
R54	301-392	3.9 k	½ w	5%	
R63	301-363	36 k	½ w	5%	
R72	301-473	47 k	½ w	5%	
R83	301-393	39 k	½ w	5%	
R94	301-392	3.9 k	½ w	5%	
R103	301-363	36 k	½ w	5%	
R112	301-473	47 k	½ w	5%	
R123	301-393	39 k	½ w	5%	
R134	301-392	3.9 k	½ w	5%	
R142	301-222	2.2 k	½ w	5%	

LOWER LIMIT NO-GO CARD (1) SERIES G

	*670-048	Complete Card (Model 2-up)

Diodes

D14	*152-075	Germanium	Tek Spec
D34	*152-075	Germanium	Tek Spec
D73	*152-075	Germanium	Tek Spec
D74	*152-075	Germanium	Tek Spec
D112	*152-075	Germanium	Tek Spec
D113	*152-075	Germanium	Tek Spec
D114	*152-075	Germanium	Tek Spec
D141	*152-075	Germanium	Tek Spec
D142	*152-075	Germanium	Tek Spec
D143	*152-075	Germanium	Tek Spec
D144	*152-075	Germanium	Tek Spec

Transistors

Q4	151-071	2N1305
Q14	151-070	2N1377
Q24	151-071	2N1305
Q34	151-070	2N1377
Q44	151-071	2N1305
Q54	151-070	2N1377
Q64	151-071	2N1305
Q73	*151-059	Selected from 2N1893
Q74	151-070	2N1377
Q84	151-071	2N1305

LOWER LIMIT NO-GO CARD (1) SERIES G *(Cont'd)*

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description			Model No.
Q94	151-070	2N1377			
Q104	151-071	2N1305			
Q113	*151-059	Selected from 2N1893			
Q114	151-070	2N1377			
Q124	151-071	2N1305			
Q134	151-070	2N1377			
Q143	151-071	2N1305			

Resistors

R3	301-393	39 k	½ w	5%	
R14	301-392	3.9 k	½ w	5%	
R23	301-393	39 k	½ w	5%	
R43	301-393	39 k	½ w	5%	
R54	301-392	3.9 k	½ w	5%	
R63	301-363	36 k	½ w	5%	
R72	301-473	47 k	½ w	5%	
R83	301-393	39 k	½ w	5%	
R94	301-392	3.9 k	½ w	5%	
R103	301-363	36 k	½ w	5%	
R112	301-473	47 k	½ w	5%	
R123	301-393	39 k	½ w	5%	
R134	301-392	3.9 k	½ w	5%	
R142	301-222	2.2 k	½ w	5%	

LIMIT LIGHT DRIVER CARD (1) SERIES H

	*670-049	Complete Card	

Transistors

Q13	151-070	2N1377	
Q14	151-070	2N1377	
Q23	151-071	2N1305	
Q33	Use 151-137	2N2148	
Q43	151-071	2N1305	
Q53	Use 151-137	2N2148	
Q63	Use 151-137	2N2148	
Q64	151-071	2N1305	

Resistors

R13	301-472	4.7 k	½ w	5%	
R14	301-332	3.3 k	½ w	5%	
R20	301-103	10 k	½ w	5%	
R23	301-272	2.7 k	½ w	5%	
R33	306-470	47 Ω	2 w		

LOWER LIMIT LIGHT DRIVER CARD (1) SERIES H *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description			Model No.
R40	301-103	10 k	½ w	5%	
R43	301-272	2.7 k	½ w	5%	
R53	306-470	47 Ω	2 w		
R60	301-680	68 Ω	½ w	5%	
R63	306-470	47 Ω	2 w		
R64	301-102	1 k	½ w	5%	

÷ 10 CARD (1) SERIES I

*670-050 Complete Card (Model 3-up)

Capacitors

C1	290-162	22 μf	EMT	35 v
C2	281-524	150 pf	Cer	500 v
C6	281-525	470 pf	Cer	500 v
C16	281-525	470 pf	Cer	500 v
C22	281-524	150 pf	Cer	500 v
C26	281-525	470 pf	Cer	500 v
C36	281-525	470 pf	Cer	500 v
C38	281-525	470 pf	Cer	500 v
C42	281-524	150 pf	Cer	500 v
C46	281-525	470 pf	Cer	500 v
C56	281-525	470 pf	Cer	500 v
C58	281-525	470 pf	Cer	500 v
C62	281-524	150 pf	Cer	500 v
C66	281-525	470 pf	Cer	500 v
C76	281-525	470 pf	Cer	500 v

Diodes

D2	*152-075	Germanium	Tek Spec
D12	*152-075	Germanium	Tek Spec
D22	*152-075	Germanium	Tek Spec
D32	*152-075	Germanium	Tek Spec
D38	*152-075	Germanium	Tek Spec
D42	*152-075	Germanium	Tek Spec
D52	*152-075	Germanium	Tek Spec
D58	*152-075	Germanium	Tek Spec
D62	*152-075	Germanium	Tek Spec
D72	*152-075	Germanium	Tek Spec

Transistors

Q5	151-071	2N1305
Q15	151-071	2N1305
Q25	151-071	2N1305
Q35	151-071	2N1305
Q45	151-071	2N1305

÷ 10 CARD (1) SERIES I *(Cont'd)*

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description			Model No.
Q55	151-071	2N1305			
Q65	151-071	2N1305			
Q75	151-071	2N1305			
Q83	151-069	2N1304			

Resistors

Ckt. No.	Tektronix Part No.	Description			Model No.
R1	307-060	6.8 Ω	½ w	5%	
R2	301-563	56 k	½ w	5%	
R5	301-332	3.3 k	½ w	5%	
R6	301-203	20 k	½ w	5%	
R7	301-204	200 k	½ w	5%	
R15	301-332	3.3 k	½ w	5%	
R16	301-203	20 k	½ w	5%	
R17	301-204	200 k	½ w	5%	
R22	301-563	56 k	½ w	5%	
R25	301-332	3.3 k	½ w	5%	
R26	301-203	20 k	½ w	5%	
R27	301-204	200 k	½ w	5%	
R35	301-332	3.3 k	½ w	5%	
R36	301-203	20 k	½ w	5%	
R37	301-204	200 k	½ w	5%	
R38	301-223	22 k	½ w	5%	
R39	301-473	47 k	½ w	5%	
R42	301-563	56 k	½ w	5%	
R45	301-332	3.3 k	½ w	5%	
R46	301-203	20 k	½ w	5%	
R47	301-204	200 k	½ w	5%	
R55	301-332	3.3 k	½ w	5%	
R56	301-203	20 k	½ w	5%	
R57	301-204	200 k	½ w	5%	
R58	301-223	22 k	½ w	5%	
R59	301-473	47 k	½ w	5%	
R62	301-563	56 k	½ w	5%	
R65	301-332	3.3 k	½ w	5%	
R66	301-203	20 k	½ w	5%	
R67	301-204	200 k	½ w	5%	
R75	301-332	3.3 k	½ w	5%	
R76	301-203	20 k	½ w	5%	
R77	301-204	200 k	½ w	5%	
R83	301-392	3.9 k	½ w	5%	

ANALOG DISPLAY CARD (1) SERIES J

Ckt. No.	Tektronix Part No.	Description	Model No.
	*670-051	Complete Card (Model 2-up)	

ANALOG DISPLAY CARD (1) SERIES J *(Cont'd)*

Capacitor

Ckt. No.	Tektronix Part No.	Description				Model No.
C91	281-511	22 pf	Cer	500 v	10%	

Diodes

Ckt. No.	Tektronix Part No.	Description	
D12	*152-075	Germanium	Tek Spec
D32	*152-075	Germanium	Tek Spec
D52	152-025	Germanium	1N634
D62	*152-075	Germanium	Tek Spec
D63	*152-075	Germanium	Tek Spec
D72	*152-075	Germanium	Tek Spec
D73	*152-075	Germanium	Tek Spec
D82	152-025	Germanium	1N634

Transistors

Ckt. No.	Tektronix Part No.	Description
Q3	151-069	2N1304
Q13	151-069	2N1304
Q23	151-069	2N1304
Q33	151-069	2N1304
Q43	151-071	2N1305
Q53	151-071	2N1305
Q63	151-071	2N1305
Q73	151-071	2N1305
Q83	151-071	2N1305
Q94	151-071	2N1305

Resistors

Ckt. No.	Tektronix Part No.	Description		
R2	301-103	10 k	½ w	5%
R10	301-103	10 k	½ w	5%
R13	301-222	2.2 k	½ w	5%
R20	301-103	10 k	½ w	5%
R30	301-103	10 k	½ w	5%
R33	301-222	2.2 k	½ w	5%
R40	301-103	10 k	½ w	5%
R42	301-123	12 k	½ w	5%
R43	301-222	2.2 k	½ w	5%
R50	301-103	10 k	½ w	5%
R52	301-333	33 k	½ w	5%
R53	301-392	3.9 k	½ w	5%
R60	301-103	10 k	½ w	5%
R62	301-333	33 k	½ w	5%
R63	301-392	3.9 k	½ w	5%

ANALOG DISPLAY CARD (1) SERIES J *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description			Model No.
R70	301-103	10 k	½ w	5%	
R72	301-333	33 k	½ w	5%	
R73	301-392	3.9 k	½ w	5%	
R74	301-123	12 k	½ w	5%	
R80	301-103	10 k	½ w	5%	
R82	301-333	33 k	½ w	5%	
R90	301-104	100 k	½ w	5%	
R91	301-103	10 k	½ w	5%	

MASTER GATE CARD (1) SERIES M

	*670-054	Complete Card (Model 1,2,3,4)
	*670-0054-01	Complete Card (Model 5-up)

Capacitors

C3	281-536	0.001 μf	Cer	500 v	10%
C12	281-523	100 pf	Cer	350 v	
C16	281-550	120 pf	Cer	500 v	
C22	281-523	100 pf	Cer	350 v	
C26	281-550	120 pf	Cer	500 v	
C30	281-524	150 pf	Cer	500 v	
C35	281-504	10 pf	Cer	500 v	10%
C42	285-623	0.47 μf	PTM	100 v	
C46	281-525	470 pf	Cer	500 v	
C60	281-536	0.001 μf	Cer	500 v	10%
C62	283-010	0.05 μf	Cer	50 v	
C63	285-572	0.1 μf	PTM	200 v	
C76	285-572	0.1 μf	PTM	200 v	
C102	Use 281-516	39 pf	Cer	500 v	10%
C106	281-550	120 pf	Cer	500 v	
C112	Use 281-524	150 pf	Cer	500 v	
C116	281-550	120 pf	Cer	500 v	
C121	281-523	100 pf	Cer	350 v	
C122	281-523	100 pf	Cer	350 v	
C126	281-550	120 pf	Cer	500 v	
C132	281-523	100 pf	Cer	350 v	
C136	281-550	120 pf	Cer	500 v	
C166	281-516	39 pf	Cer	500 v	10%

Diodes

D5	*152-075	Germanium	Tek Spec
D6	*152-075	Germanium	Tek Spec
D12	*152-075	Germanium	Tek Spec
D22	*152-075	Germanium	Tek Spec
D30	*152-075	Germanium	Tek Spec

MASTER GATE CARD (1) SERIES M *(Cont'd)*

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description		Model No.
D31	*152-075	Germanium	Tek Spec	
D35	*152-075	Germanium	Tek Spec	
D36	*152-075	Germanium	Tek Spec	
D41	152-141	Silicon	1N4152	1,2,3,4,5
D41	152-0141-02	Silicon	1N4152	6-up
D45	152-141	Silicon	1N4152	1,2,3,4,5
D45	152-0141-02	Silicon	1N4152	6-up
D71	*152-107	Silicon	Replaceable by 1N647	
D72	152-0141-00	Silicon	1N4152	X5
D72	152-0141-02	Silicon	1N4152	6-up
D74	152-0141-00	Silicon	1N4152	X5
D74	152-0141-02	Silicon	1N4152	6-up
D76	*152-107	Silicon	Replaceable by 1N647	
D81	*152-075	Germanium	Tek Spec	
D102	*152-075	Germanium	Tek Spec	
D112	*152-075	Germanium	Tek Spec	
D121	*152-075	Germanium	Tek Spec	
D122	*152-075	Germanium	Tek Spec	
D132	*152-075	Germanium	Tek Spec	
D140	*152-075	Germanium	Tek Spec	1,2,3,4X
D143	*152-075	Germanium	Tek Spec	
D164	*152-075	Germanium	Tek Spec	
D173	*152-075	Germanium	Tek Spec	

Transistors

Ckt. No.	Tektronix Part No.	Description
Q3	151-071	2N1305
Q15	*151-103	Replaceable by 2N2219
Q25	*151-103	Replaceable by 2N2219
Q45	*151-103	Replaceable by 2N2219
Q55	151-071	2N1305
Q64	151-093	2N2043
Q73	*151-059	Selected from 2N1893
Q83	151-069	2N1304
Q84	151-071	2N1305
Q93	151-069	2N1304
Q105	*151-054	Selected from 2N1754
Q115	*151-054	Selected from 2N1754
Q125	*151-054	Selected from 2N1754
Q135	*151-054	Selected from 2N1754
Q143	151-069	2N1304
Q153	151-069	2N1304
Q163	151-069	2N1304
Q164	*151-054	Selected from 2N1754
Q173	151-069	2N1304

Resistors

Ckt. No.	Tektronix Part No.	Description		
R3	301-393	39 k	½ w	5%
R5	303-273	27 k	1 w	5%
R12	301-393	39 k	½ w	5%
R14	301-222	2.2 k	½ w	5%
R16	301-153	15 k	½ w	5%

MASTER GATE CARD (1) SERIES M *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description			Model No.
R17	301-474	470 k	½ w	5%	
R22	301-393	39 k	½ w	5%	
R24	301-222	2.2 k	½ w	5%	
R26	301-153	15 k	½ w	5%	
R27	301-474	470 k	½ w	5%	
R30	301-103	10 k	½ w	5%	
R35	301-103	10 k	½ w	5%	
R40	301-183	18 k	½ w	5%	
R41	Use 301-0302-00	3 k	½ w	5%	
R42	301-363	36 k	½ w	5%	
R43	301-201	200 Ω	½ w	5%	
R44	301-433	43 k	½ w	5%	
R46	301-223	22 k	½ w	5%	
R47	301-823	82 k	½ w	5%	
R60	301-104	100 k	½ w	5%	
R61	301-822	8.2 k	½ w	5%	
R62	301-183	18 k	½ w	5%	
R63	301-124	120 k	½ w	5%	
R64	301-104	100 k	½ w	5%	
R72	301-0104-00	100 k	½ w	5%	X5-up
R73	301-223	22 k	½ w	5%	
R74	301-104	100 k	½ w	5%	
R80	301-332	3.3 k	½ w	5%	
R81	301-274	270 k	½ w	5%	
R82	301-103	10 k	½ w	5%	
R83	301-332	3.3 k	½ w	5%	
R84	301-682	6.8 k	½ w	5%	
R85	301-103	10 k	½ w	5%	
R102	301-393	39 k	½ w	5%	
R104	301-222	2.2 k	½ w	5%	
R106	301-153	15 k	½ w	5%	
R107	301-474	470 k	½ w	5%	
R112	301-393	39 k	½ w	5%	
R114	301-222	2.2 k	½ w	5%	
R116	301-153	15 k	½ w	5%	
R117	301-474	470 k	½ w	5%	
R121	301-393	39 k	½ w	5%	
R122	301-393	39 k	½ w	5%	
R124	301-222	2.2 k	½ w	5%	
R126	301-153	15 k	½ w	5%	
R127	301-274	270 k	½ w	5%	
R132	301-393	39 k	½ w	5%	
R134	301-222	2.2 k	½ w	5%	
R136	301-153	15 k	½ w	5%	
R137	301-474	470 k	½ w	5%	
R140	301-103	10 k	½ w	5%	

MASTER GATE CARD (1) SERIES M *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					Model No.
R143	301-362	3.6 k	½ w			5%	
R163	301-332	3.3 k	½ w			5%	
R164	301-362	3.6 k	½ w			5%	
R166	301-393	39 k	½ w			5%	
R167	301-394	390 k	½ w			5%	
R173	301-223	22 k	½ w			5%	

SIGNAL COMPARATOR CARD (2) SERIES N

	*670-057	Complete Card					

Capacitors

C24	281-044	80-480 pf	Mica	Var			
C26	283-003	0.01 μf	Cer		150 v		
C31	281-576	11 pf	Cer		500 v	5%	
C34	281-605	200 pf	Cer		500 v		
C40	281-551	390 pf	Cer		500 v	10%	
C42	283-000	0.001 μf	Cer		500 v		1, 2, 3, 4
C42	283-0594-00	0.001 μf	Mica		100 v	1%	5-up
C44	283-000	0.001 μf	Cer		500 v		
C62	283-003	0.01 μf	Cer		150 v		
C69	Use 281-543	270 pf	Cer		500 v	10%	
C72	283-003	0.01 μf	Cer		150 v		
C80	283-081	0.1 μf	Cer		25 v		
C82	281-528	82 pf	Cer		500 v	10%	
C86	281-524	150 pf	Cer		500 v		
C92	281-528	82 pf	Cer		500 v	10%	
C96	281-524	150 pf	Cer		500 v		

Diodes

D24	*152-075	Germanium	Tek Spec				
D27	*152-075	Germanium	Tek Spec				
D29	152-141	Silicon	1N4152				1,2,3,4,5
D29	152-0141-02	Silicon	1N4152				6-up
D37	*152-075	Germanium	Tek Spec				
D39	152-141	Silicon	1N4152				1,2,3,4,5
D39	152-0141-02	Silicon	1N4152				6-up
D44	152-141	Silicon	1N4152				1,2,3,4,5
D44	152-0141-02	Silicon	1N4152				6-up
D54	152-141	Silicon	1N4152				1,2,3,4,5
D54	152-0141-02	Silicon	1N4152				6-up
D55	152-093	Tunnel	1N3716	4.7 MA			
D62	*152-075	Germanium	Tek Spec				
D63	*152-075	Germanium	Tek Spec				
D66	*152-075	Germanium	Tek Spec				
D72	*152-075	Germanium	Tek Spec				
D73	*152-075	Germanium	Tek Spec				
D76	*152-075	Germanium	Tek Spec				
D82	*152-075	Germanium	Tek Spec				
D92	*152-075	Germanium	Tek Spec				
D99	*152-075	Germanium	Tek Spec				

SIGNAL COMPARATOR CARD (2) SERIES N *(Cont'd)*

Transistors

Ckt. No.	Tektronix Part No.	Description	Model No.
Q13A,B	*151-104	Replaceable by 2N2913	
Q14	*151-104	Replaceable by 2N2913	
Q18	*151-103	Replaceable by 2N2219	
Q23	151-069	2N1304	
Q24	*151-054	Selected from 2N1754	
Q34	*151-103	Replaceable by 2N2219	
Q44	*151-103	Replaceable by 2N2219	
Q54	*151-054	Selected from 2N1754	
Q85	*151-054	Selected from 2N1754	
Q95	*151-054	Selected from 2N1754	

Resistors

Ckt. No.	Tektronix Part No.	Value	Wattage	Type	Tolerance	Model No.
R14	301-513	51 k	½ w		5%	
R18	Use 301-0132-00	1.3 k	½ w		5%	
R19	311-086	2.5 k	.5 w	Var	DC BAL	
R24	Use 303-132	1.3 k	1 w		5%	
R26	301-471	470 Ω	½ w		5%	
R27	301-911	910 Ω	½ w		5%	
R31	301-223	22 k	½ w		5%	
R32	301-333	33 k	½ w		5%	
R34	301-102	1 k	½ w		5%	
R36	301-912	9.1 k	½ w		5%	
R37	301-102	1 k	½ w		5%	
R44	301-102	1 k	½ w		5%	
R45	301-302	3 k	½ w		5%	
R54	301-752	7.5 k	½ w		5%	1, 2
R54	301-562	5.6 k	½ w		5%	3-up
R55	301-680	68 Ω	½ w		5%	1, 2
R55	301-910	91 Ω	½ w		5%	3-up
R57	301-752	7.5 k	½ w		5%	
R60	301-105	1 meg	½ w		5%	
R61	301-104	100 k	½ w		5%	
R62	301-513	51 k	½ w		5%	
R69	301-362	3.6 k	½ w		5%	
R70	301-105	1 meg	½ w		5%	
R71	301-104	100 k	½ w		5%	
R72	301-513	51 k	½ w		5%	
R80	301-101	100 Ω	½ w		5%	
R82	301-822	8.2 k	½ w		5%	
R85	301-512	5.1 k	½ w		5%	
R86	301-223	22 k	½ w		5%	
R87	301-474	470 k	½ w		5%	
R92	301-822	8.2 k	½ w		5%	
R95	301-512	5.1 k	½ w		5%	
R96	301-223	22 k	½ w		5%	
R97	301-474	470 k	½ w		5%	
R99	301-393	39 k	½ w		5%	

SIGNAL COMPARATOR CARD (2) SERIES N *(Cont'd)*

Switch

Ckt. No.	Tektronix Part No. Unwired	Tektronix Part No. Wired	Description		Model No.
SW42	260-583		Slide	3 DOT DELAY	

0% ZONE CARD (1) SERIES O

Ckt. No.	Tektronix Part No.	Description				Model No.
	*670-055	Complete Card				

Capacitors

Ckt. No.	Tektronix Part No.	Description				Model No.
C11	281-536	0.001 μf	Cer	500 v	10%	
C23	283-001	0.005 μf	Cer	500 v		
C36	281-543	270 pf	Cer	500 v	10%	
C53	283-001	0.005 μf	Cer	500 v		
C66	281-543	270 pf	Cer	500 v	10%	

Diodes

Ckt. No.	Tektronix Part No.	Description			Model No.
D2	152-094	Zener	¾M50Z10	¾ w, 50 v, 10%	1
D2	152-0150-00	Zener	1N3037B	1 w, 51 v, 5%	2-up
D5	*152-075	Germanium	Tek Spec		
D13	*152-075	Germanium	Tek Spec		
D15	*152-075	Germanium	Tek Spec		
D23	*152-075	Germanium	Tek Spec		
D42	*152-075	Germanium	Tek Spec		
D53	*152-075	Germanium	Tek Spec		
D72	*152-075	Germanium	Tek Spec		

Transistors

Ckt. No.	Tektronix Part No.	Description	Model No.
Q3	*151-096	Selected from 2N1893	
Q4	*151-103	Replaceable by 2N2219	
Q5	*151-054	Selected from 2N1754	
Q13	*151-054	Selected from 2N1754	
Q14	*151-054	Selected from 2N1754	
Q15	*151-054	Selected from 2N1754	
Q23	*151-103	Replaceable by 2N2219	
Q33	151-071	2N1305	
Q35	*151-103	Replaceable by 2N2219	
Q45	*151-103	Replaceable by 2N2219	
Q53	*151-103	Replaceable by 2N2219	
Q63	151-071	2N1305	
Q65	*151-103	Replaceable by 2N2219	
Q75	*151-103	Replaceable by 2N2219	
Q84	*151-103	Replaceable by 2N2219	
Q94	*151-103	Replaceable by 2N2219	

0% ZONE CARD (1) SERIES O *(Cont'd)*

Resistors

Ckt. No.	Tektronix Part No.	Description					Model No.
R3	301-104	100 k	½ w			5%	
R4	301-102	1 k	½ w			5%	
R5	301-392	3.9 k	½ w			5%	
R6	323-318	20 k	½ w		Prec	1%	
R7	323-392	118 k	½ w		Prec	1%	
R10	301-224	220 k	½ w			5%	
R11	301-223	22 k	½ w			5%	
R12	301-470	47 Ω	½ w			5%	
R13	301-624	620 k	½ w			5%	
R14	301-222	2.2 k	½ w			5%	
R17	301-223	22 k	½ w			5%	
R18	301-474	470 k	½ w			5%	
R19	301-392	3.9 k	½ w			5%	
R21	301-203	20 k	½ w			5%	
R22	301-473	47 k	½ w			5%	
R23	301-433	43 k	½ w			5%	
R25	311-329	50 k		Var		A ZONE WIDTH	
R27	301-473	47 k	½ w			5%	
R31	301-243	24 k	½ w			5%	
R33	301-104	100 k	½ w			5%	
R35	301-392	3.9 k	½ w			5%	
R36	301-223	22 k	½ w			5%	
R37	301-224	220 k	½ w			5%	
R42	301-682	6.8 k	½ w			5%	
R45	301-122	1.2 k	½ w			5%	
R47	301-470	47 Ω	½ w			5%	
R51	301-203	20 k	½ w			5%	
R52	301-473	47 k	½ w			5%	
R53	301-433	43 k	½ w			5%	
R55	311-329	50 k		Var		B ZONE WIDTH	
R57	301-473	47 k	½ w			5%	
R61	301-243	24 k	½ w			5%	
R63	301-104	100 k	½ w			5%	
R65	301-392	3.9 k	½ w			5%	
R66	301-223	22 k	½ w			5%	
R67	301-224	220 k	½ w			5%	
R72	301-682	6.8 k	½ w			5%	
R75	301-122	1.2 k	½ w			5%	
R77	301-470	47 Ω	½ w			5%	
R82	301-102	1 k	½ w			5%	
R84	301-103	10 k	½ w			5%	
R89	303-473	47 k	1 w			5%	
R94	301-103	10 k	½ w			5%	

MEMORY CARD (2) SERIES P

Use *670-0083-00 Complete Card

MEMORY CARD (2) SERIES P *(Cont'd)*

Capacitors

Ckt. No.	Tektronix Part No.	Description				Model No.
C1	290-135	15 μf	EMT	20 v		1, 2, 3
C1	283-0059-00	1 μf	Cer	25 v	+80% —20%	4-up
C12	281-524	150 pf	Cer	500 v		
C23	281-525	470 pf	Cer	500 v		
C48	285-569	0.01 μf	PTM	200 v		1, 2, 3
C48	285-0596-00	0.01 μf	PTM	100 v	1%	4-up
C49	285-623	0.47 μf	PTM	100 v		1, 2, 3
C49	285-0701-00	0.47 μf	PTM	50 v		4-up
C63	281-0636-00	100 pf	Cer	500 v	+80% —20%	X4-up
C64	281-551	390 pf	Cer	500 v	10%	1, 2, 3X
C74	283-081	0.1 μf	Cer	25 v		1, 2, 3X
C78	285-569	0.01 μf	PTM	200 v		1, 2, 3
C78	285-0596-00	0.01 μf	PTM	100 v	1%	4-up
C79	285-623	0.47 μf	PTM	100 v		1, 2, 3
C79	285-0701-00	0.47 μf	PTM	50 v		4-up
C82	281-551	390 pf	Cer	500 v	10%	1, 2, 3X
C93	281-0636-00	100 pf	Cer	50 v	+80% —20%	X4-up
C94	281-551	390 pf	Cer	500 v	10%	1, 2, 3X

Diodes

Ckt. No.	Tektronix Part No.	Description		Model No.
D4	*152-075	Germanium	Tek Spec	1, 2, 3
D4	*152-0185-00	Silicon	Replaceable by 1N4152	4-up
D14	*152-075	Germanium	Tek Spec	1, 2, 3
D14	*152-0185-00	Silicon	Replaceable by 1N4152	4-up
D34	*152-075	Germanium	Tek Spec	1, 2, 3
D34	*152-0185-00	Silicon	Replaceable by 1N4152	4-up
D35	*152-075	Germanium	Tek Spec	1, 2, 3
D35	*152-0185-00	Silicon	Replaceable by 1N4152	4-up
D46	*152-075	Germanium	Tek Spec	1, 2, 3
D46	*152-0185-00	Silicon	Replaceable by 1N4152	4-up
D47	*152-0185-00	Silicon	Replaceable by 1N4152	X4-up
D48	Use *050-232	Replacement Kit		1
D48	*152-165	Silicon	Selected from 1N3579	2, 3, 4, 5
D48	*152-0323-00	Silicon	Tek Spec	6-up
D49	*152-185	Silicon	Replaceable by 1N4152	X2-3X
D52	*152-075	Germanium	Tek Spec	1, 2, 3X
D57	152-141	Silicon	1N4152	1, 2, 3
D57	*152-0185-00	Silicon	Replaceable by 1N4152	4-up
D58	152-141	Silicon	1N4152	1, 2, 3
D58	*152-0185-00	Silicon	Replaceable by 1N4152	4-up
D59	*152-075	Germanium	Tek Spec	1, 2, 3
D59	*152-0185-00	Silicon	Replaceable by 1N4152	4-up
D60	*152-185	Silicon	Replaceable by 1N4152	X2-up
D61	*152-075	Germanium	Tek Spec	1, 2, 3
D61	*152-0185-00	Silicon	Replaceable by 1N4152	4-up
D62	Use *050-232	Replacement Kit		1
D62	*152-165	Silicon	Selected from 1N3579	2, 3, 4, 5
D62	*152-0323-00	Silicon	Tek Spec	6-up

MEMORY CARD (2) SERIES P *(Cont'd)*

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	Model No.
D63	*152-075	Germanium Tek Spec	1, 2, 3
D63	*152-0185-00	Silicon Replaceable by 1N4152	4-up
D64	152-141	Silicon 1N4152	1, 2, 3X
D66	152-0246-00	Silicon Low Leakage 0.25 w, 40 v	X5-up
D65	*152-075	Germanium Tek Spec	1, 2, 3X
D74	*152-075	Germanium Tek Spec	1, 2, 3X
D75	*152-075	Germanium Tek Spec	1, 2, 3
D75	*152-0185-00	Silicon Replaceable by 1N4152	4-up
D77	*152-0185-00	Silicon Replaceable by 1N4152	X4-up
D78	Use *050-232	Replacement Kit	1
D78	*152-165	Silicon Selected from 1N3579	2, 3, 4, 5
D78	*152-0323-00	Silicon Tek Spec	6-up
D79	*152-185	Silicon Replaceable by 1N4152	2, 3X
D82	*152-075	Germanium Tek Spec	1, 2, 3X
D84	*152-0185-00	Silicon Replaceable by 1N4152	X4-up
D85	152-142	Zener 1N972A, 30 v	1, 2, 3, 4, 5, 6
D85	152-0282-00	Zener 1N972B 0.4 w, 30 v, 5%	7-up
D86	*152-075	Germanium Tek Spec	1, 2, 3
D86	*152-0185-00	Silicon Replaceable by 1N4152	4-up
D87	152-141	Silicon 1N4152	1, 2, 3
D87	*152-0185-00	Silicon Replaceable by 1N4152	4-up
D88	152-141	Silicon 1N4152	1, 2, 3
D88	*152-0185-00	Silicon Replaceable by 1N4152	4-up
D90	*152-185	Silicon Replaceable by 1N4152	X2-up
D91	*152-075	Germanium Tek Spec	1, 2, 3
D91	*152-0185-00	Silicon Replaceable by 1N4152	4-up
D92	Use *050-232	Replacement Kit	1
D92	*152-165	Silicon Selected from 1N3579	2, 3, 4, 5
D92	*152-0323-00	Silicon Tek Spec	6-up
D93	*152-075	Germanium Tek Spec	1, 2, 3
D93	*152-0185-00	Silicon Replaceable by 1N4152	4-up
D94	152-141	Silicon 1N4152	1, 2, 3X
D95	*152-075	Germanium Tek Spec	1, 2, 3X
D96	152-0246-00	Silicon Low Leakage 0.25 w, 40 v	X5-up

Transistors

Ckt. No.	Tektronix Part No.	Description	Model No.
Q4	Use 151-0164-00	2N3702	
Q14	Use 151-0166-00	2N2923	
Q24	Use 151-0166-00	2N2923	
Q25	Use 151-0164-00	2N3702	
Q34	Use 151-0166-00	2N2923	
Q35	Use 151-0164-00	2N3702	
Q44	Use 151-0166-00	2N2923	
Q54A,B	*151-104	Replaceable by 2N2913	
Q63	*151-103	Replaceable by 2N2219	
Q64	Use 151-0164-00	2N3702	
Q73	151-071	2N1305	1, 2, 3X
Q84A,B	*151-104	Replaceable by 2N2913	
Q93	*151-103	Replaceable by 2N2219	1, 2, 3
Q93	151-0164-00	2N3702	4-up
Q94	*151-103	Replaceable by 2N2219	

MEMORY CARD (2) SERIES P *(Cont'd)*

Resistors

Ckt. No.	Tektronix Part No.	Description					Model No.
R1	315-100	10 Ω	1/4 w		5%		
R2	301-100	10 Ω	1/2 w		5%		
R3	301-433	43 k	1/2 w		5%		
R4	311-326	10 k		Var	100%	ZONE WIDTH	1, 2, 3
R4	311-0267-00	10 k		Var	100%	ZONE WIDTH	4-up
R5	315-103	10 k	1/4 w		5%		
R6	315-133	13 k	1/4 w		5%		
R12	315-473	47 k	1/4 w		5%		
R14	315-103	10 k	1/4 w		5%		
R21	315-470	47 Ω	1/4 w		5%		
R22	315-394	390 k	1/4 w		5%		
R23	315-203	20 k	1/4 w		5%		
R25	315-392	3.9 k	1/4 w		5%		
R26	315-393	39 k	1/4 w		5%		
R27	315-754	750 k	1/4 w		5%		
R28	315-103	10 k	1/4 w		5%		1, 2, 3
R28	315-0203-00	20 k	1/4 w		5%		4-up
R35	301-202	2 k	1/2 w		5%		1, 2, 3
R35	301-0362-00	3.6 k	1/2 w		5%		4-up
R36	315-393	39 k	1/4 w		5%		
R37	315-754	750 k	1/4 w		5%		
R38	303-223	22 k	1 w		5%		
R41	315-223	22 k	1/4 w		5%		
R42	301-434	430 k	1/2 w		5%		1, 2, 3
R42	315-0474-00	470 k	1/4 w		5%		4-up
R43	315-102	1 k	1/4 w		5%		
R44	315-123	12 k	1/4 w		5%		
R45	315-303	30 k	1/4 w		5%		
R46	315-912	9.1 k	1/4 w		5%		
R48	315-100	10 Ω	1/4 w		5%		1, 2, 3
R48	315-0470-00	47 Ω	1/4 w		5%		4-up
R49	307-106	4.7 Ω	1/4 w		5%		1, 2, 3
R49	307-0104-00	3.3 Ω	1/4 w		5%		4-up
R52	315-0472-00	4.7 k	1/4 w		5%		X4-up
R53	311-0550-00	25 k		Var	100%	BAL	X4-up
R54	301-473	47 k	1/2 w		5%		1, 2, 3
R54	301-0333-00	33 k	1/2 w		5%		4-up
R55	301-333	33 k	1/2 w		5%		1, 2, 3
R55	303-0303-00	30 k	1 w		5%		4-up
R60	315-393	39 k	1/4 w		5%		
R61	315-823	82 k	1/4 w		5%		
R62	315-154	150 k	1/4 w		5%		
R63	315-102	1 k	1/4 w		5%		
R64	Use 315-390	39 Ω	1/4 w		5%		1, 2, 3
R64	315-0392-00	3.9 k	1/4 w		5%		4-up

MEMORY CARD (2) SERIES P *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description						
R65	301-363	36 k	½ w			5%		
R66	311-097	200 Ω	.5 w	Var		100%	BAL	1, 2, 3X
R67	315-471	470 Ω	¼ w			5%		1, 2, 3
R67	315-0472-00	4.7 k	¼ w			5%		4-up
R68	315-470	47 Ω	¼ w			5%		
R69	301-363	36 k	½ w			5%		1, 2, 3
R69	304-0222-00	2.2 k	1 w					4-up
R73	315-103	10 k	¼ w			5%		1, 2, 3X
R74	315-202	2 k	¼ w			5%		1, 2, 3X
R76	315-102	1 k	¼ w			5%		
R77	315-303	30 k	¼ w			5%		
R78	315-100	10 Ω	¼ w			5%		1, 2, 3
R78	315-0470-00	47 Ω	¼ w			5%		4-up
R79	307-106	4.7 Ω	¼ w			5%		1, 2, 3
R79	307-0104-00	3.3 Ω	¼ w			5%		4-up
R82	315-0472-00	4.7 k	¼ w			5%		X4-up
R83	311-0556-00	50 k		Var		0%	BAL	X4-up
R84	301-473	47 k	½ w			5%		1, 2, 3
R84	301-0433-00	43 k	½ w			5%		4-up
R85	301-393	39 k	½ w			5%		1, 2, 3
R85	322-0383-00	95.3 k	¼ w		Prec	1%		4-up
R86	315-392	3.9 k	¼ w			5%		1, 2, 3
R86	323-0380-00	88.7 k	½ w		Prec	1%		4-up
R87	315-103	10 k	¼ w			5%		1, 2, 3
R87	321-0312-00	17.4 k	⅛ w		Prec	1%		4-up
R90	315-393	39 k	¼ w			5%		
R91	315-113	11 k	¼ w			5%		
R92	315-156	150 k	¼ w			5%		
R93	315-102	1 k	¼ w			5%		
R94	Use 315-390	39 Ω	¼ w			5%		1, 2, 3
R94	315-0392-00	3.9 k	¼ w			5%		4-up
R95	301-363	36 k	½ w			5%		
R96	311-097	200 Ω	.5 w	Var		0%	BAL	1, 2, 3
R96	301-0363-00	36 k	½ w			5%		4-up
R97	315-471	470 Ω	¼ w			5%		1, 2, 3
R97	315-0472-00	4.7 k	¼ w			5%		4-up
R98	315-470	47 Ω	¼ w			5%		
R99	301-363	36 k	½ w			5%		1, 2, 3
R99	301-0152-00	1.5 k	½ w			5%		4-up

Switches

	Unwired	Wired			
SW46	260-583		Slide	100% MODE	1, 2, 3
SW46	260-0723-00		Slide	100% MODE	4-up
SW50	260-583		Slide	RESPONSE	1, 2, 3
SW50	260-0723-00		Slide	RESPONSE	4-up
SW76	260-583		Slide	0% MODE	1, 2, 3
SW76	260-0723-00		Slide	0% MODE	4-up

MEMORY CARD (2) SERIES P *(Cont'd)*

Electron Tubes

Ckt. No.	Tektronix Part No.	Description	Model No.
V63	154-323	6CW4	
V93	154-323	6CW4	

VOLTMETER CARD (1) SERIES Q

	*670-056	Complete Card				

Capacitors

C1	283-059	1 μf	Cer	25 v		
C2	281-605	200 pf	Cer	500 v		
C6	283-003	0.01 μf	Cer	150 v		
C10	283-000	0.001 μf	Cer	500 v		
C11	Use 281-550	120 pf	Cer	500 v		
C12	283-029	0.02 μf	Cer	25 v		
C14	281-516	39 pf	Cer	500 v		
C16	283-003	0.01 μf	Cer	150 v		
C102	281-523	100 pf	Cer	350 v		
C116	281-543	270 pf	Cer	500 v		
C126	281-543	270 pf	Cer	500 v		
C140	285-650	0.027 μf	PTM	100 v	5%	1, 2
C140	*285-663	0.1 μf	PTM	100 v	3.5%	3-up
C142	283-003	0.01 μf	Cer	150 v		

Diodes

D4	*152-075	Germanium	Tek Spec		
D14	*152-075	Germanium	Tek Spec		
D24	*152-075	Germanium	Tek Spec		
D34	*152-075	Germanium	Tek Spec		
D67	152-055	Zener	¼M11Z5	¼ w, 11 v, 5%	
D87	152-055	Zener	¼M11Z5	¼ w, 11 v, 5%	
D104	*152-075	Germanium	Tek Spec		
D105	*152-075	Germanium	Tek Spec		
D115	*152-075	Germanium	Tek Spec		
D125	*152-075	Germanium	Tek Spec		
D132	152-141	Silicon	1N4152		1,2,3,4
D132	152-0141-02	Silicon	1N4152		5-up
D140	152-141	Silicon	1N4152		1,2,3,4
D140	152-0141-02	Silicon	1N4152		5-up
D142	152-141	Silicon	1N4152		1,2,3,4
D142	152-0141-02	Silicon	1N4152		5-up
D153	*152-075	Germanium	Tek Spec		
D156	*152-075	Germanium	Tek Spec		

Transistors

Q4	*151-103	Replaceable by 2N2219
Q10	151-069	2N1304
Q14	*151-103	Replaceable by 2N2219
Q24	*151-054	Selected from 2N1754
Q33	*151-103	Replaceable by 2N2219

VOLTMETER CARD (1) SERIES Q *(Cont'd)*

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	Model No.
Q34	*151-054	Selected from 2N1754	
Q43	*151-054	Selected from 2N1754	
Q68	*151-133	Selected from 2N3251	
Q78	*151-103	Replaceable by 2N2219	
Q88	*151-133	Selected from 2N3251	
Q98	*151-103	Replaceable by 2N2219	
Q104	151-071	2N1305	
Q115	151-071	2N1305	
Q125	151-071	2N1305	
Q141	*151-103	Replaceable by 2N2219	
Q153	*151-103	Replaceable by 2N2219	

Resistors

Ckt. No.	Tektronix Part No.	Value	Wattage	Type		Tolerance
R1	301-100	10 Ω	½ w			5%
R2	301-470	47 Ω	½ w			5%
R4	301-392	3.9 k	½ w			5%
R5	301-273	27 k	½ w			5%
R6	301-273	27 k	½ w			5%
R10	301-563	56 k	½ w			5%
R11	Use 301-103	10 k	½ w			5%
R12	301-470	47 Ω	½ w			5%
R14	301-392	3.9 k	½ w			5%
R15	301-273	27 k	½ w			5%
R16	301-273	27 k	½ w			5%
R21	301-104	100 k	½ w			5%
R31	301-104	100 k	½ w			5%
R34	301-103	10 k	½ w			5%
R35	301-470	47 Ω	½ w			5%
R45	301-471	470 Ω	½ w			5%
R60	323-336	30.9 k	½ w		Prec	1%
R61	323-300	13 k	½ w		Prec	1%
R64	321-405	162 k	⅛ w		Prec	1%
R67	311-326	10 k		Var		START VOLTAGE CAL
R74	321-405	162 k	⅛ w		Prec	1%
R80	323-336	30.9 k	½ w		Prec	1%
R81	323-300	13 k	½ w		Prec	1%
R84	321-405	162 k	⅛ w		Prec	1%
R87	311-326	10 k		Var		STOP VOLTAGE CAL
R94	321-405	162 k	⅛ w		Prec	1%
R100	323-317	19.1 k	½ w		Prec	1%
R101	323-358	52.3 k	½ w		Prec	1%
R102	301-102	1 k	½ w			5%
R104	301-202	2 k	½ w			5%
R105	301-183	18 k	½ w			5%
R116	301-433	43 k	½ w			5%
R117	301-474	470 k	½ w			5%
R124	301-392	3.9 k	½ w			5%
R126	301-433	43 k	½ w			5%

VOLTMETER CARD (1) SERIES Q *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description						Model No.
R127	301-474	470 k	½ w			5%		
R130	301-113	11 k	½ w			5%		1, 2
R130	301-822	8.2 k	½ w			5%		3-up
R131	301-163	16 k	½ w			5%		
R140	323-438	357 k	½ w		Prec	1%		1, 2
R140	323-384	97.6 k	½ w		Prec	1%		3-up
R141	311-329	50 k		Var		RAMP SLOPE		1, 2
R141	311-326	10 k		Var		RAMP SLOPE		3-up
R144	301-474	470 k	½ w			5%		
R153	303-183	18 k	1 w			5%		
R154	301-202	2 k	½ w			5%		
R155	Use 301-333	33 k	½ w			5%		
R156	301-202	2 k	½ w			5%		
R157	301-104	100 k	½ w			5%		
R158	323-308	15.8 k	½ w		Prec	1%		
R114	301-622	6.2 k	½ w			5%		
R115	301-102	1 k	½ w			5%		

Crystal

Y10	158-014	1000 KC Type H17 ±0.01%

IMPORTANT

The waveform photographs shown on certain of the 6R1A schematics were taken from the crt face of a Tektronix Type 545A/CA oscilloscope system. The equipment was initially set up as listed below. After the initial setup was made, the controls were changed as necessary to obtain the individual photographs.

545A

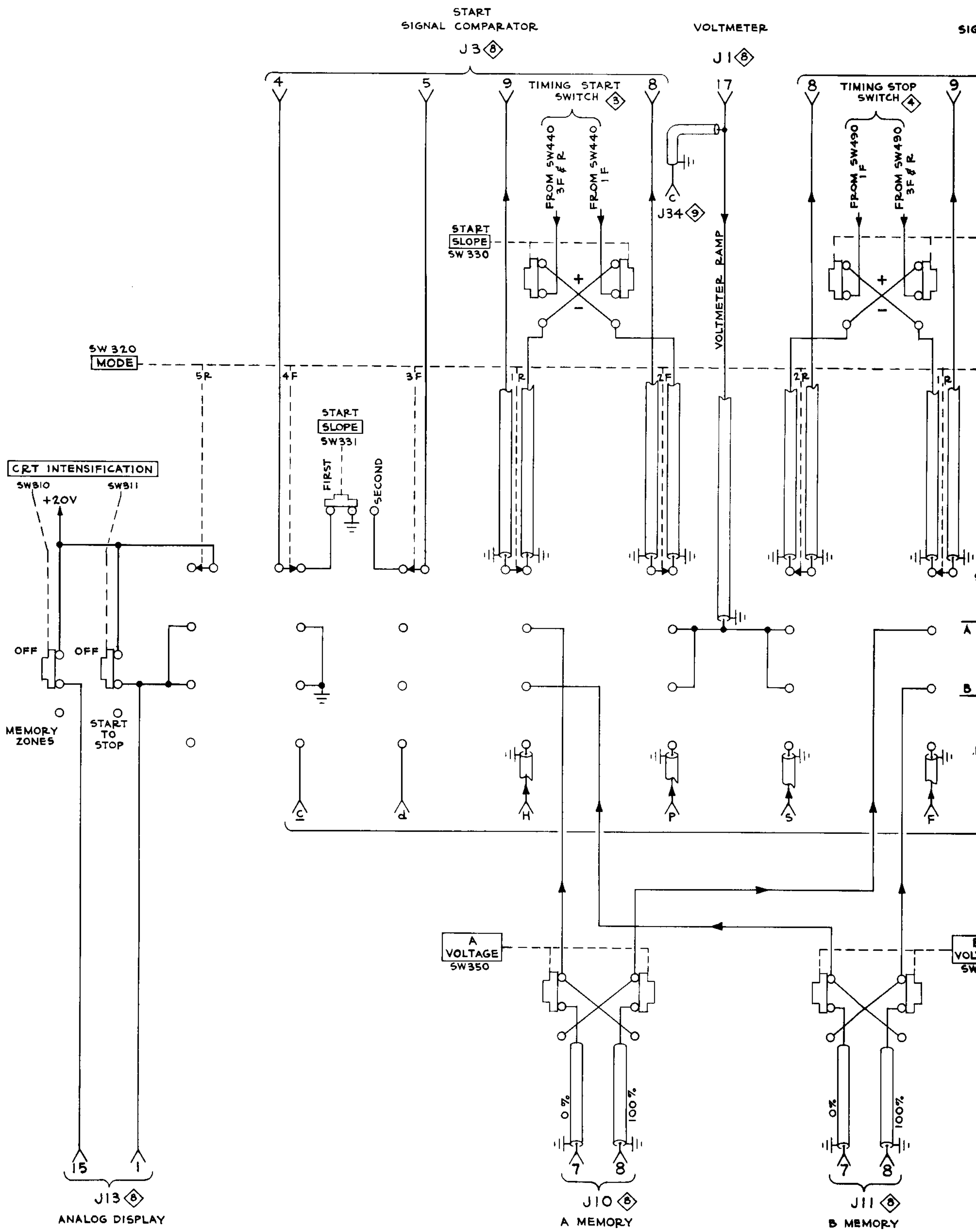
TIME/CM .... 2 mSEC/CM
MAGNIFIER .... OFF
Triggering controls .... To obtain stable display

CA Unit

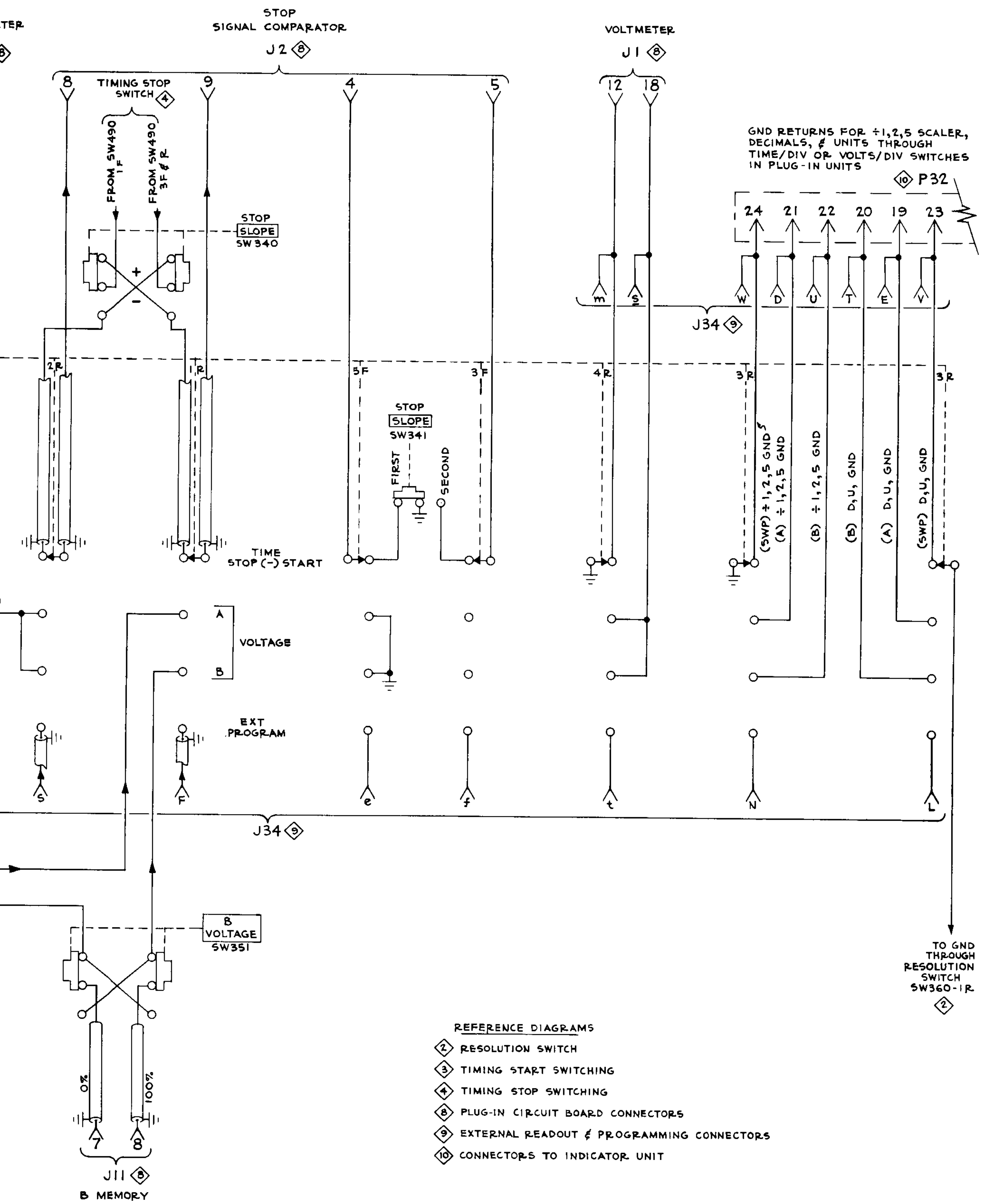
VOLTS/CM 1
Probe 10X
POLARITY .... NORMAL
Coupling .... DC
CHOPPED mode was used when photographing two time related signals.

3S76

MV/DIV 100
Mode .... A ONLY
Polarity .... NORM.
INTERNAL TRIGGER .... A
Signal input .... 2 cm of 1 mc squarewave


START
SIGNAL COMPARATOR
J3 8
VOLTMETER
J1 8
TIMING START SWITCH 3
FROM SW440 3F & R
FROM SW440 1F
TIMING STOP SWITCH 4
FROM SW490 1F
FROM SW490 3F & R
J34 9
START SLOPE SW330
VOLTMETER RAMP
SW 320 MODE
5R
4F
3F
1R
2F
2R
START SLOPE SW331
FIRST
SECOND
CRT INTENSIFICATION
SW810
SW811
+20V
OFF
OFF
MEMORY ZONES
START TO STOP
A VOLTAGE SW350
0%
100%
J13 8
ANALOG DISPLAY
J10 8
A MEMORY
J11 8
B MEMORY

TYPE 6R1A



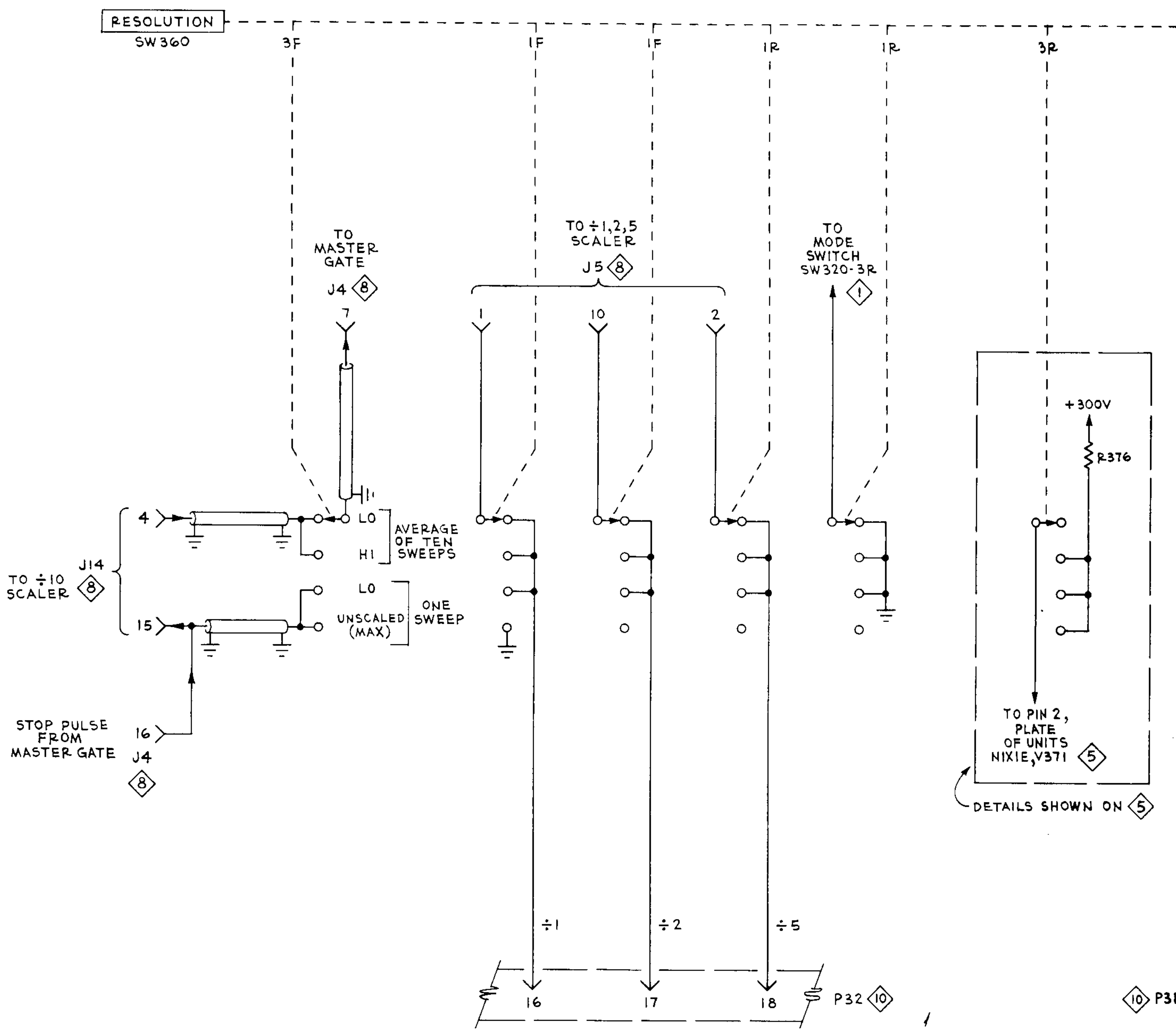
REFERENCE DIAGRAMS

② RESOLUTION SWITCH
③ TIMING START SWITCHING
④ TIMING STOP SWITCHING
⑧ PLUG-IN CIRCUIT BOARD CONNECTORS
⑨ EXTERNAL READOUT & PROGRAMMING CONNECTORS
⑩ CONNECTORS TO INDICATOR UNIT

MODE SWITCH ①

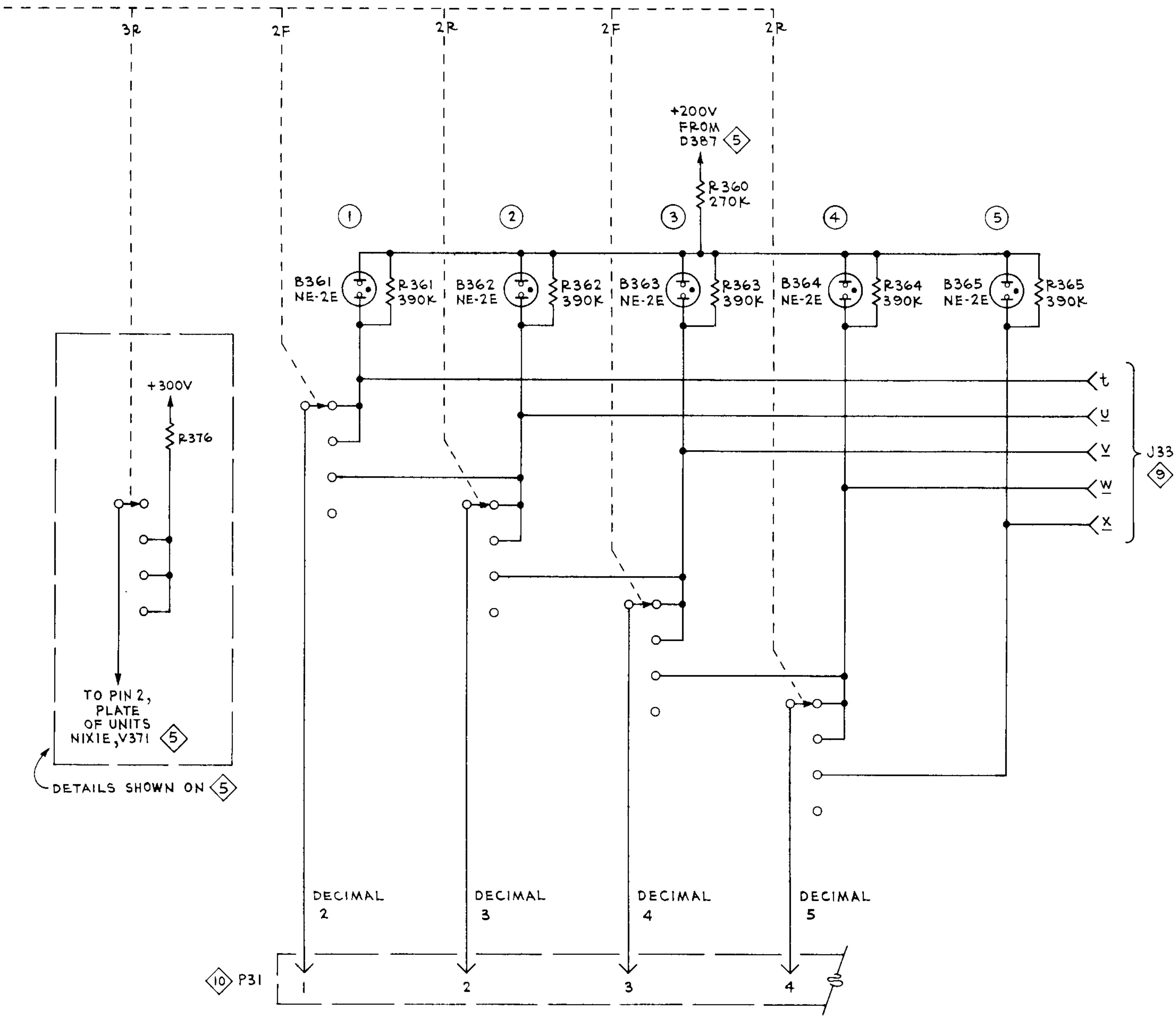
364

A₁

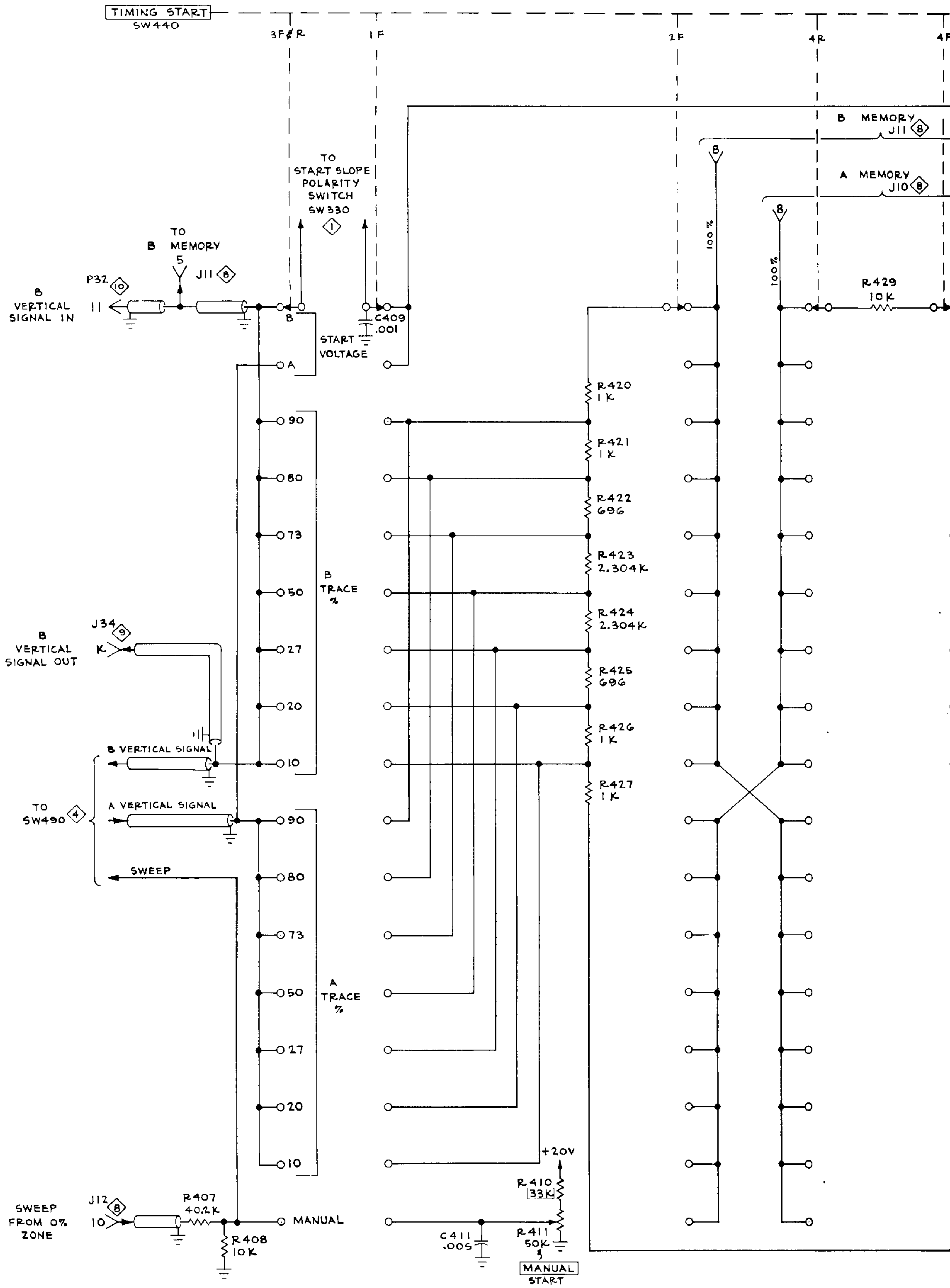


REFERENCE DIAGRAMS

- ⟨1⟩ MODE SWITCH
- ⟨5⟩ READOUT TUBES
- ⟨8⟩ PLUG-IN CIRCUIT BOARD CONNECTORS
- ⟨9⟩ EXTERNAL READOUT & PROGRAMMING CONNECTORS
- ⟨10⟩ CONNECTORS TO INDICATOR UNIT

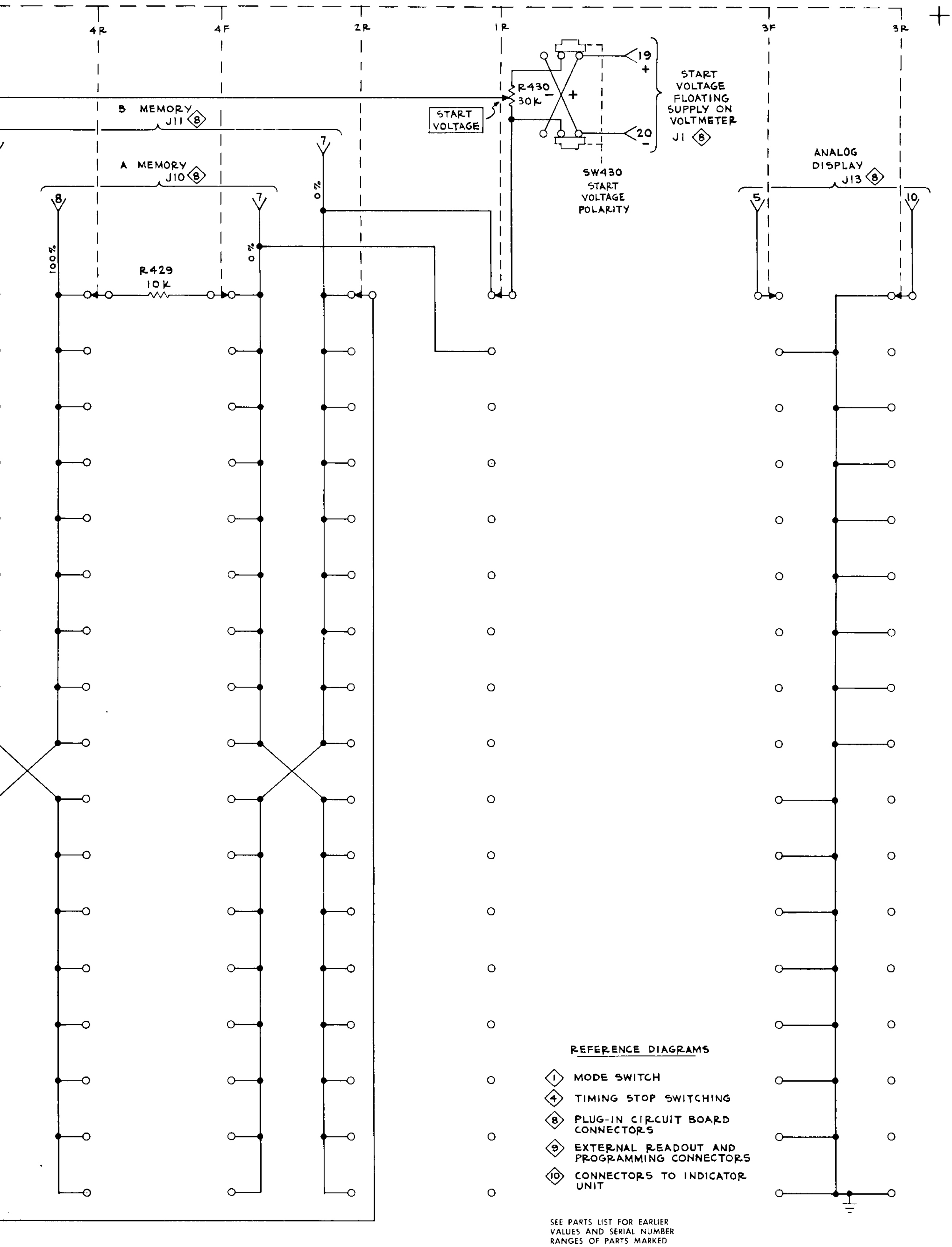


RESOLUTION SWITCH ② GAB 364


TIMING START
SW440
3F&R
1F
2F
4R
B MEMORY J11 8
A MEMORY J10 8
TO START SLOPE POLARITY SWITCH SW330 1
TO B MEMORY 5
J11 8
P32 10
B VERTICAL SIGNAL IN
C409 .001
START VOLTAGE
R429 10K
100%
R420 1K
R421 1K
R422 696
R423 2.304K
R424 2.304K
R425 696
R426 1K
R427 1K
90
80
73
50
27
20
10
B TRACE %
A TRACE %
J34 9
B VERTICAL SIGNAL OUT
B VERTICAL SIGNAL
A VERTICAL SIGNAL
SWEEP
TO SW490 4
+20V
R410 33K
R411 50K
MANUAL START
C411 .005
J12 8
SWEEP FROM 0% ZONE
R407 40.2K
R408 10K
MANUAL

TYPE 6R1A

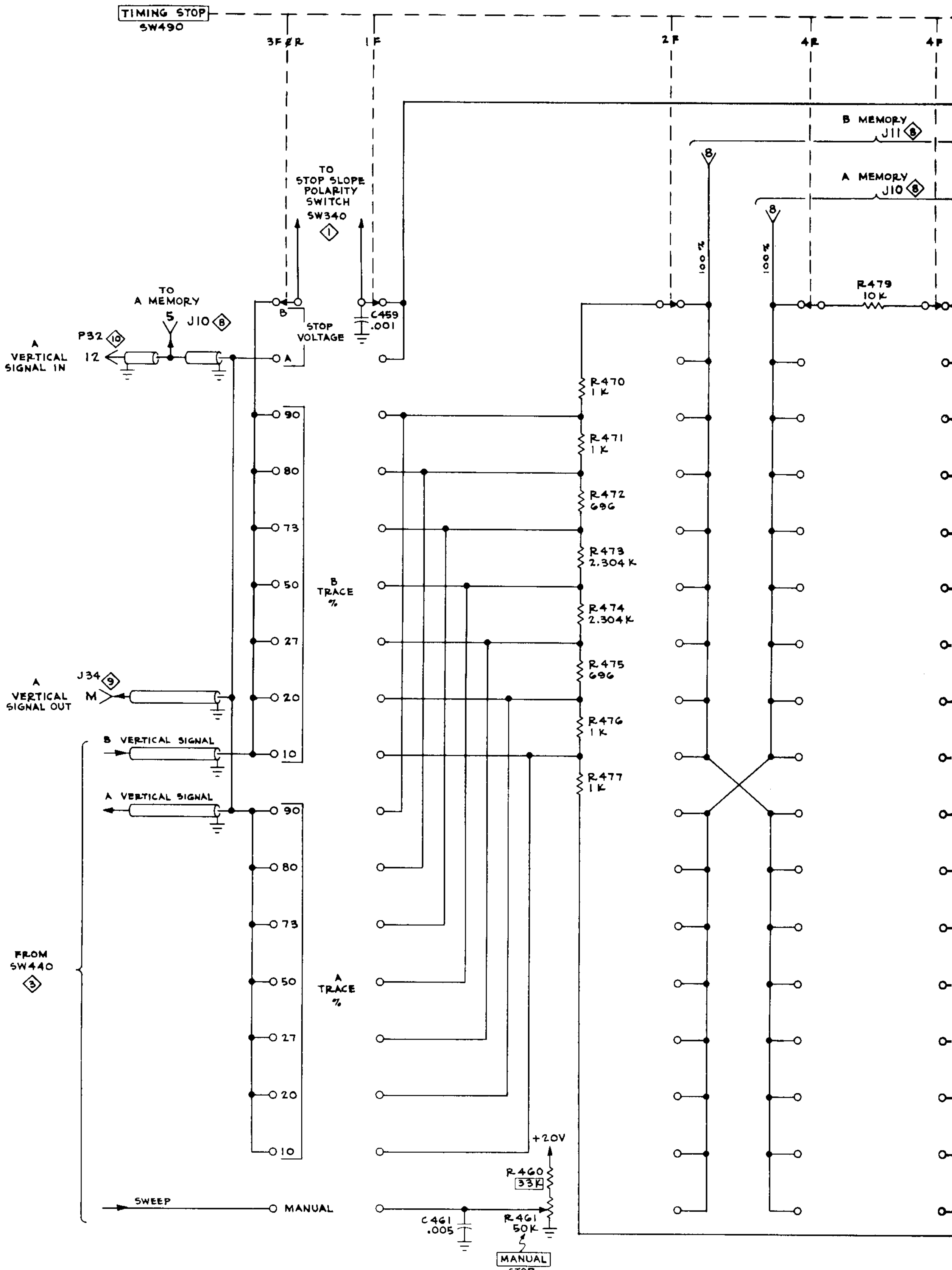
B



B

TIMING START SWITCHING ③

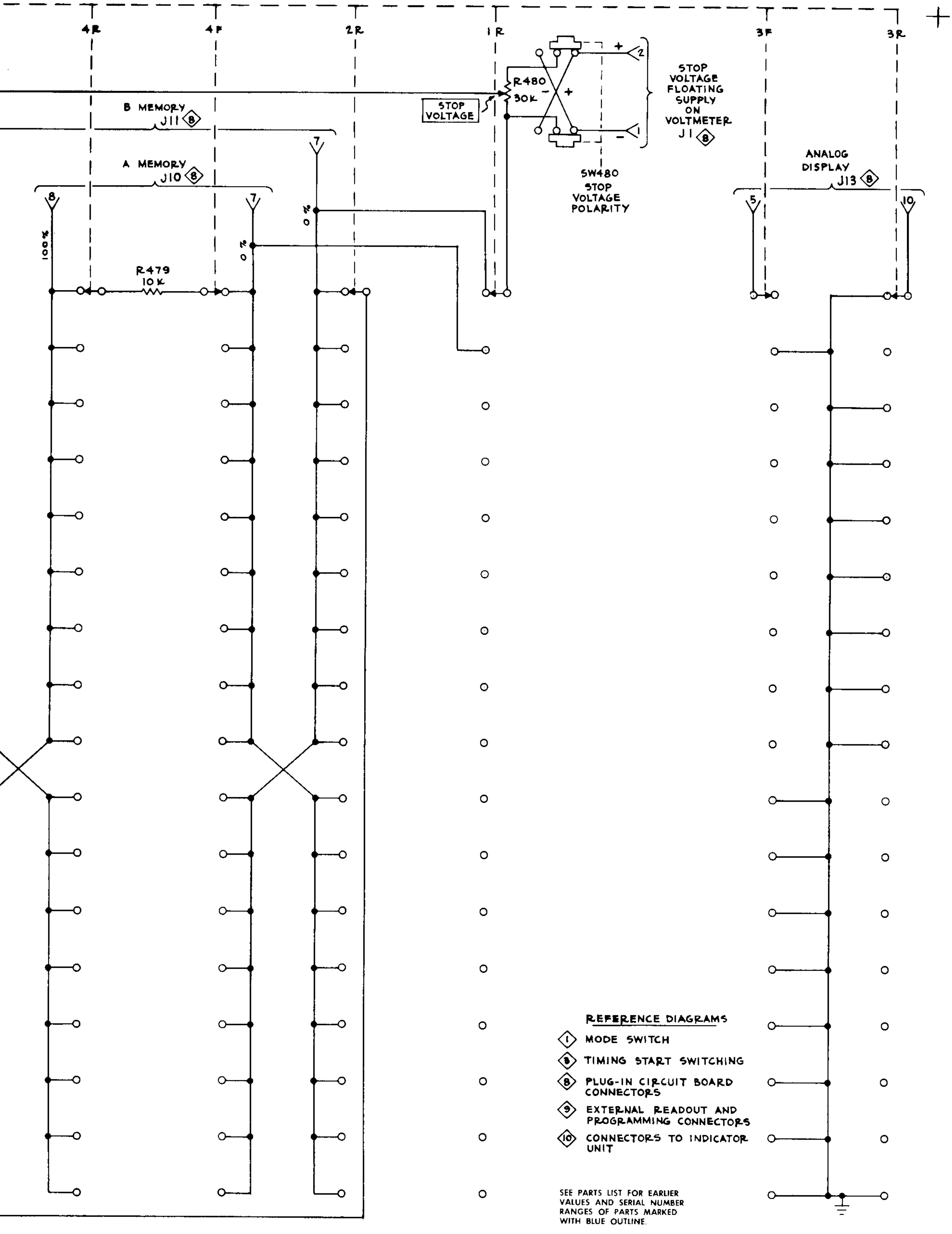
565 A



TIMING STOP
SW490
3F & R
1F
2F
4R
4F
B MEMORY
J11
A MEMORY
J10
TO STOP SLOPE POLARITY SWITCH SW340
TO A MEMORY
J10
P32
A VERTICAL SIGNAL IN
B
A
STOP VOLTAGE
C459 .001
100%
R479 10K
R470 1K
R471 1K
R472 696
R473 2.304K
R474 2.304K
R475 696
R476 1K
R477 1K
90
80
73
50
27
20
10
B TRACE %
A TRACE %
J34
A VERTICAL SIGNAL OUT
B VERTICAL SIGNAL
A VERTICAL SIGNAL
FROM SW440
SWEEP
MANUAL
+20V
R460 33K
R461 50K
C461 .005
MANUAL STOP

TYPE 6R1A

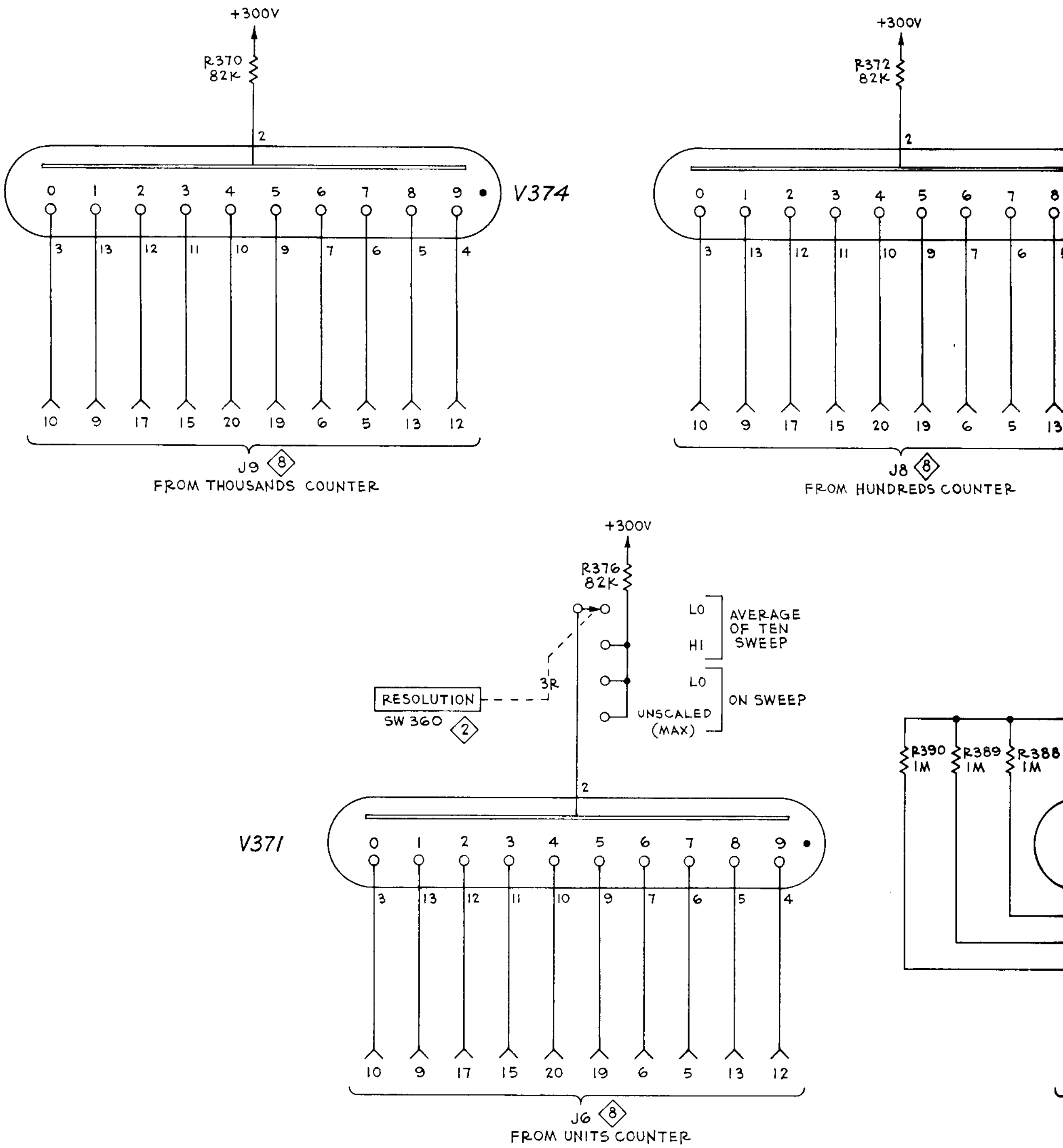
B1



TIMING STOP SWITCHING ⟨4⟩

565

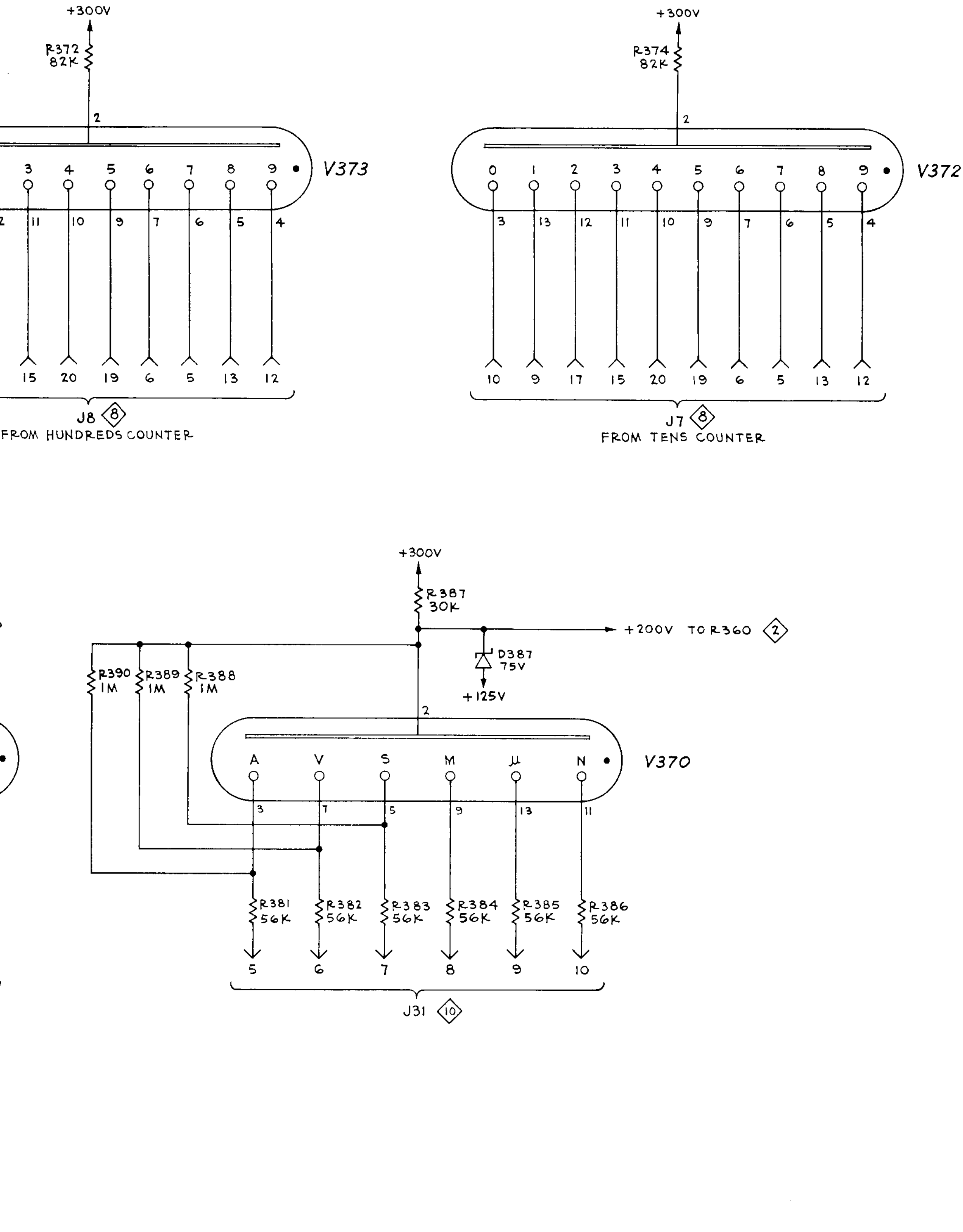
B1



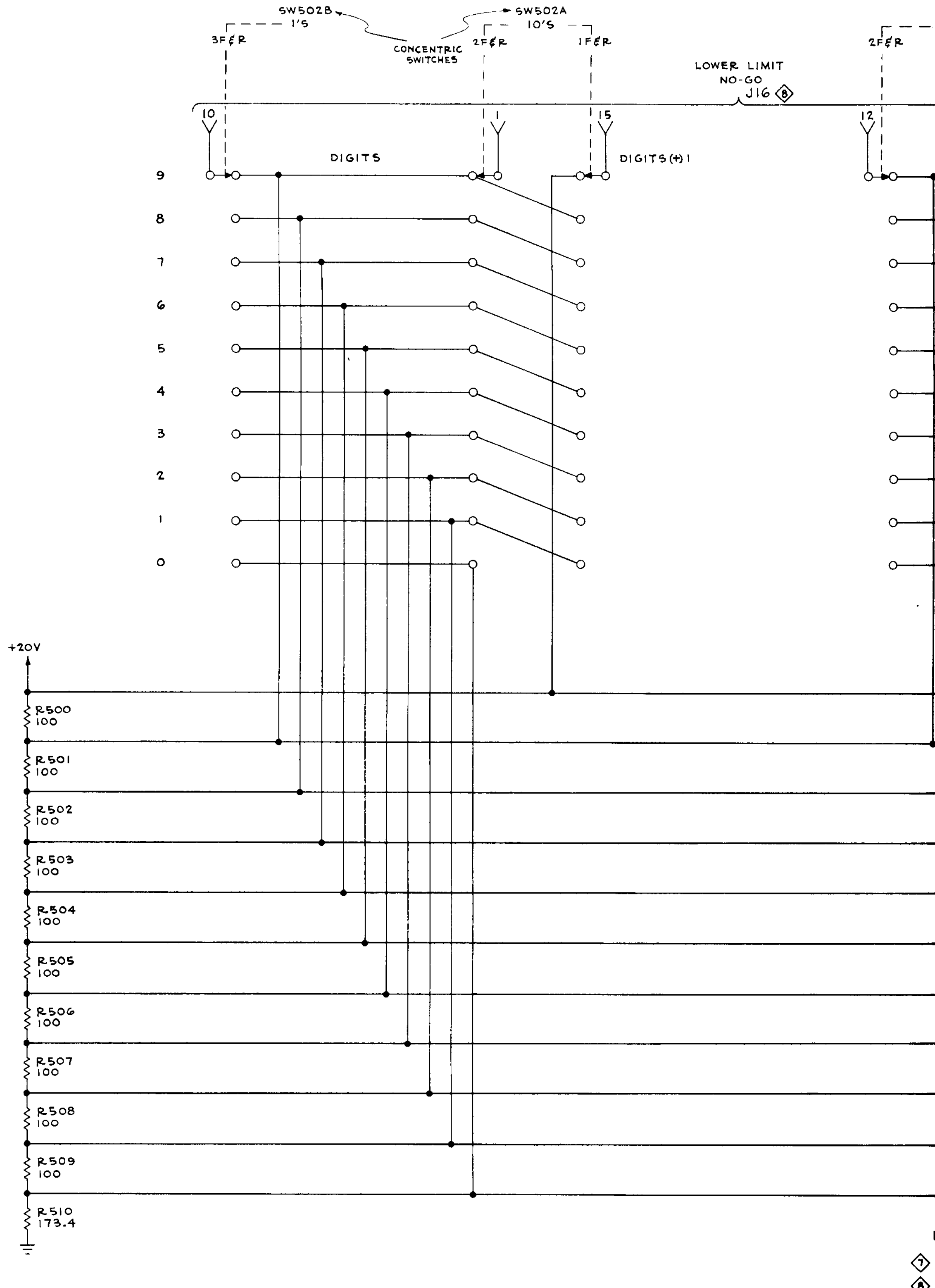
REFERENCE DIAGRAMS

- ⟨2⟩ RESOLUTION SWITCH
- ⟨8⟩ PLUG-IN CIRCUIT BOARD CONNECTORS
- ⟨10⟩ CONNECTORS TO INDICATOR UNIT

TYPE 6R1A

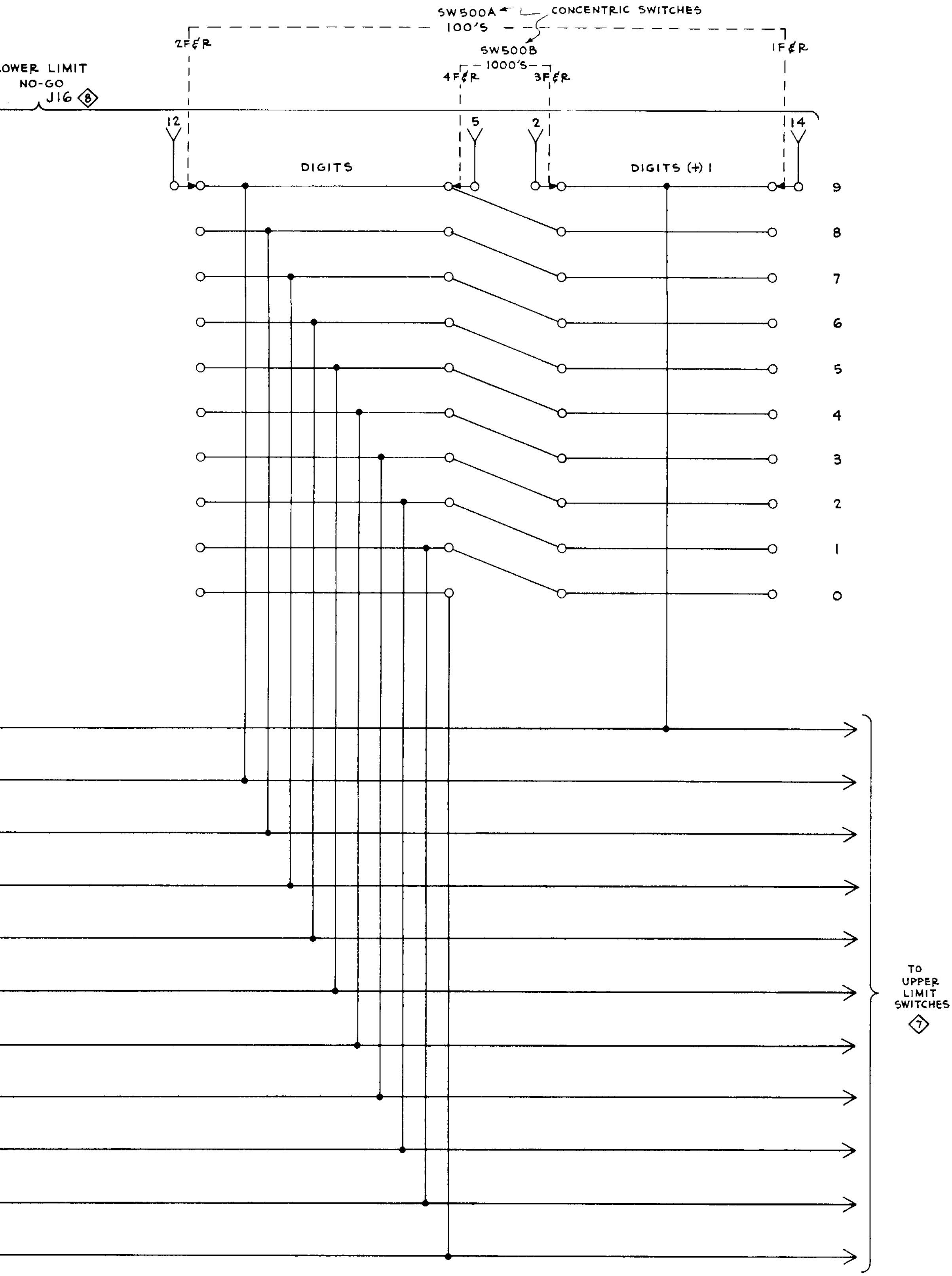


READOUT TUBES 5 GAB 364


SW502B 1'S
SW502A 10'S
CONCENTRIC SWITCHES
3F&R
2F&R
1F&R
LOWER LIMIT NO-GO J16 8
10
1
15
12
DIGITS
DIGITS(+)1
9
8
7
6
5
4
3
2
1
0
+20V
R500 100
R501 100
R502 100
R503 100
R504 100
R505 100
R506 100
R507 100
R508 100
R509 100
R510 173.4

TYPE 6R1A

A



REFERENCE DIAGRAMS

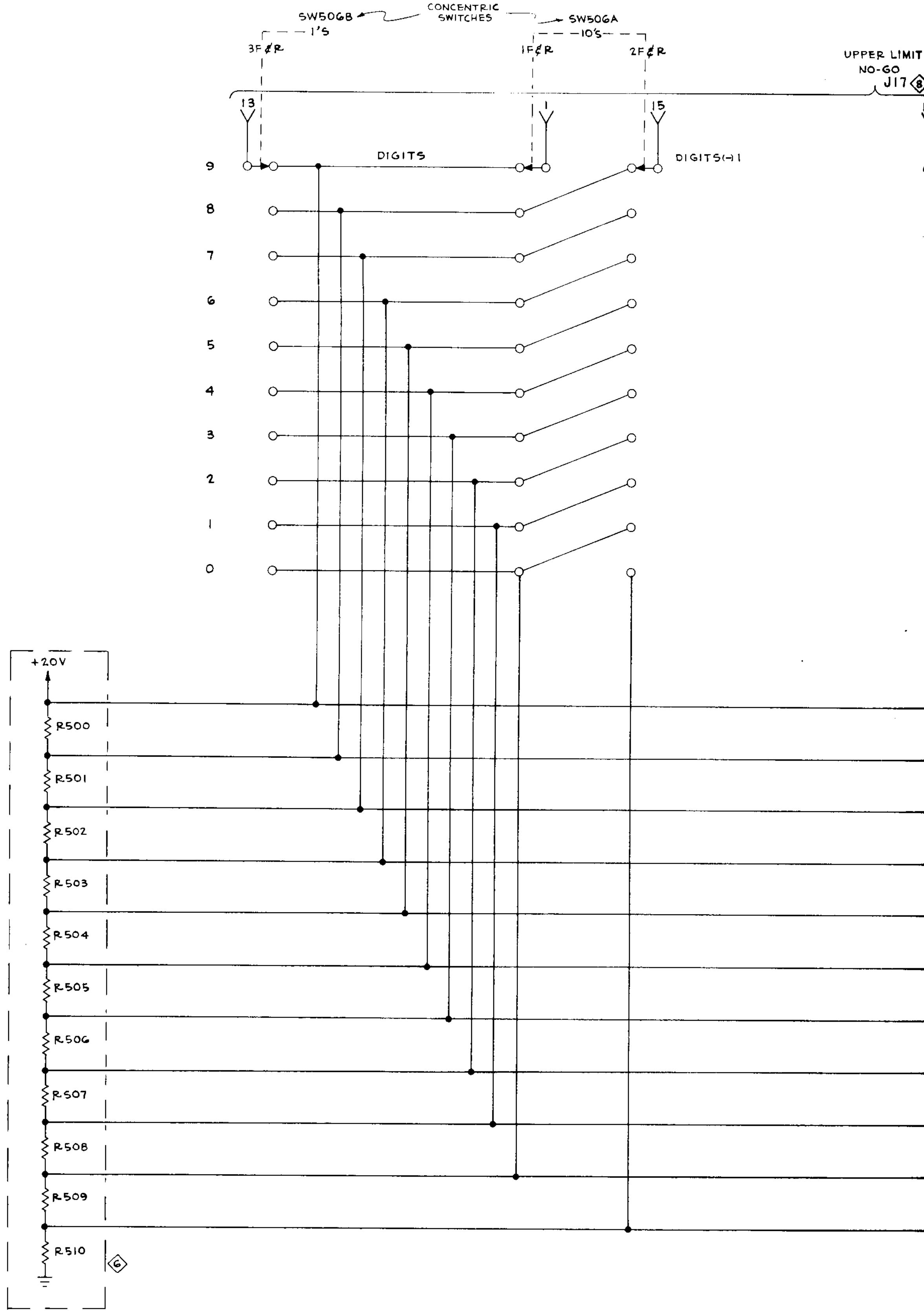
7 UPPER LIMIT SWITCHES

8 PLUG-IN CIRCUIT BOARD CONNECTORS

LOWER LIMIT SWITCHES 6

364

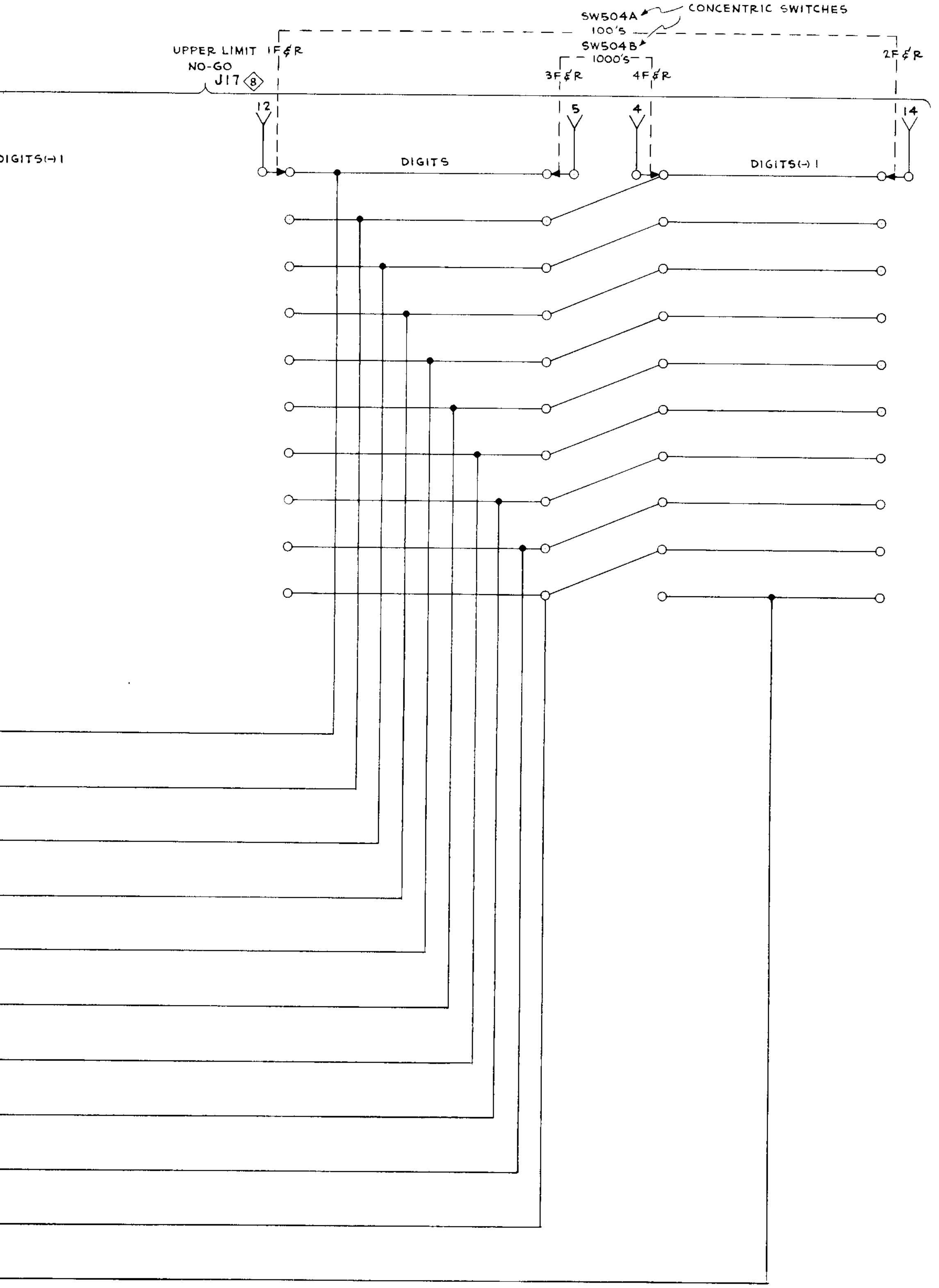
A



CONCENTRIC SWITCHES
SW506B
1'S
SW506A
10'S
3F&R
1F&R
2F&R
UPPER LIMIT
NO-GO
J17
13
1
15
DIGITS
DIGITS(-)1
9
8
7
6
5
4
3
2
1
0
+20V
R500
R501
R502
R503
R504
R505
R506
R507
R508
R509
R510

TYPE 6R1A

A



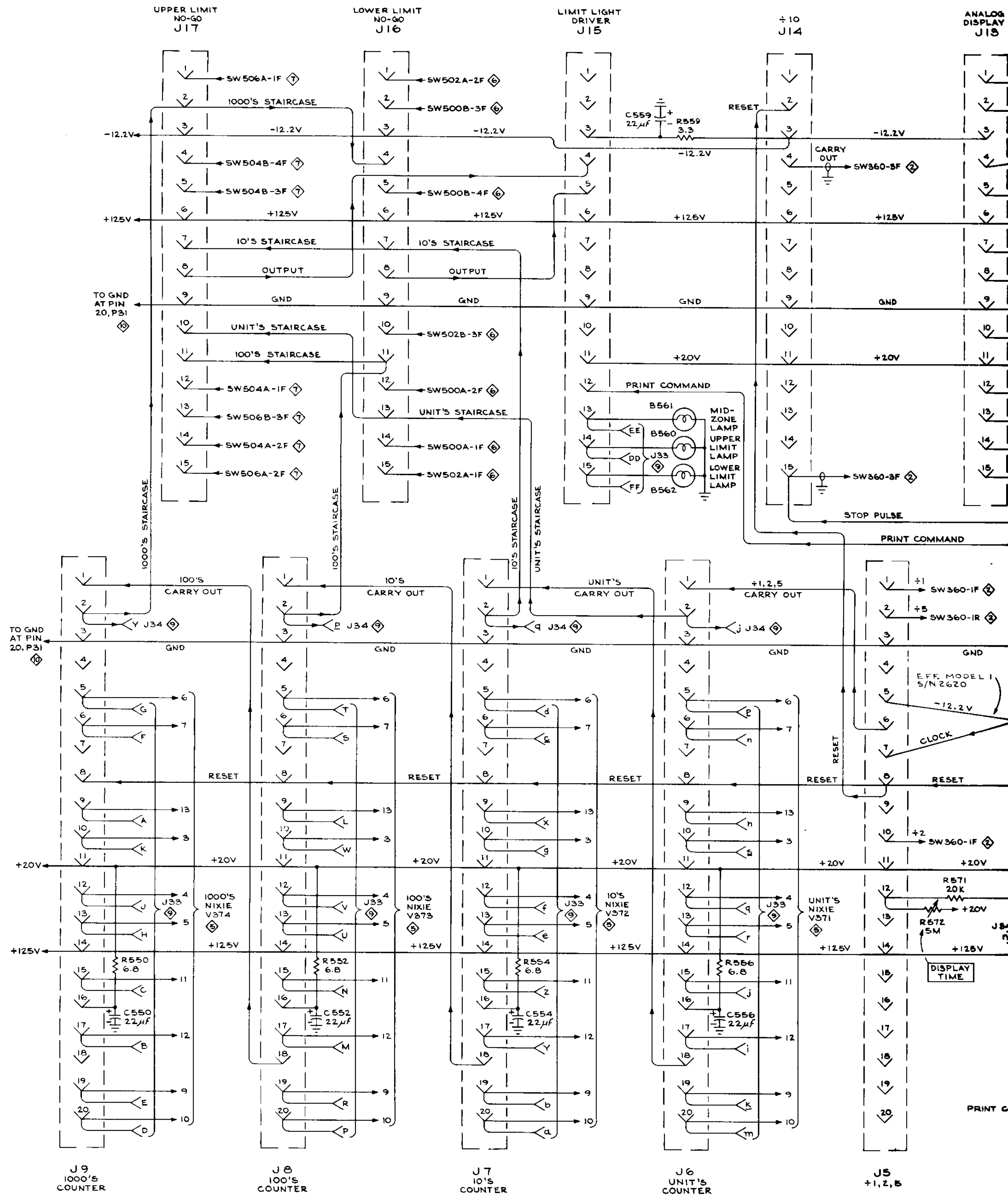
REFERENCE DIAGRAMS

6 LOWER LIMIT SWITCHES

8 PLUG-IN CIRCUIT BOARD CONNECTORS

A

UPPER LIMIT SWITCHES 7



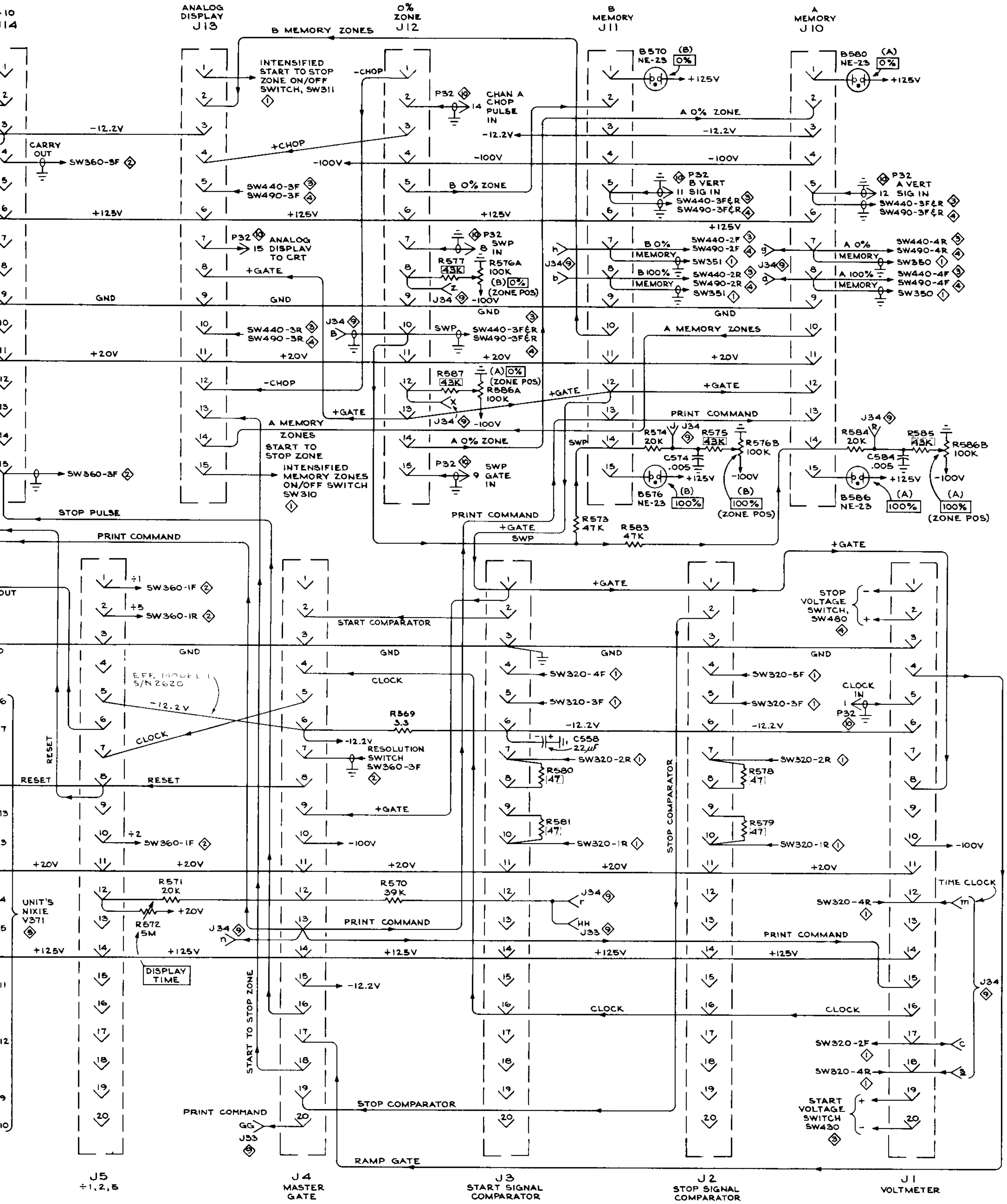
REFERENCE DRAWINGS

- ① MODE SWITCH
- ② RESOLUTION SWITCH
- ③ TIMING START SWITCHING
- ④ TIMING STOP SWITCHING
- ⑤ READOUT TUBES
- ⑥ LOWER LIMIT SWITCHES
- ⑦ UPPER LIMIT SWITCHES
- ⑨ EXTERNAL READOUT & PROGRAMMING CONNECTORS
- ⑩ CONNECTORS TO INDICATOR UNIT

SEE PARTS LIST FOR VALUES AND SERIAL RANGES OF PARTS WITH BLUE OUTLINE

TYPE 6R1A

D



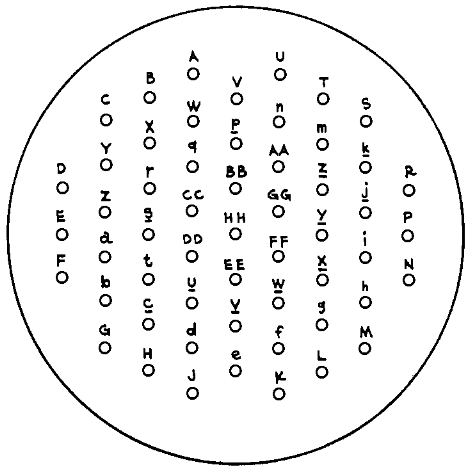
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

D

PLUG-IN CIRCUIT CARD CONNECTORS ⑧

DON 769

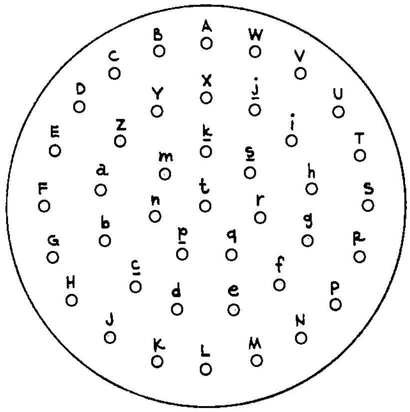
EXTERNAL READOUT J33



A	1000S'-1	J9-9	⟨8⟩
B	1000S'-2	J9-17	⟨8⟩
C	1000S'-3	J9-15	⟨8⟩
D	1000S'-4	J9-20	⟨8⟩
E	1000S'-5	J9-19	⟨8⟩
F	1000S'-6	J9-6	⟨8⟩
G	1000S'-7	J9-5	⟨8⟩
H	1000S'-8	J9-13	⟨8⟩
J	1000S'-9	J9-12	⟨8⟩
K	1000S'-0	J9-10	⟨8⟩
L	100S'-1	J8-9	⟨8⟩
M	100S'-2	J8-17	⟨8⟩
N	100S'-3	J8-15	⟨8⟩
P	100S'-4	J8-20	⟨8⟩
R	100S'-5	J8-19	⟨8⟩
S	100S'-6	J8-6	⟨8⟩
T	100S'-7	J8-5	⟨8⟩
U	100S'-8	J8-13	⟨8⟩
V	100S'-9	J8-12	⟨8⟩
W	100S'-0	J8-10	⟨8⟩
X	10S'-1	J7-9	⟨8⟩
Y	10S'-2	J7-17	⟨8⟩
Z	10S'-3	J7-15	⟨8⟩
a	10S'-4	J7-20	⟨8⟩
b	10S'-5	J7-19	⟨8⟩
c	10S'-6	J7-6	⟨8⟩
d	10S'-7	J7-5	⟨8⟩
e	10S'-8	J7-13	⟨8⟩

f	10S'-9 J7-12	⟨8⟩
g	10S'-0 J7-10	⟨8⟩
h	1S'-1 J6-9	⟨8⟩
i	1S'-2 J6-17	⟨8⟩
j	1S'-3 J6-15	⟨8⟩
k	1S'-4 J6-20	⟨8⟩
m	1S'-5 J6-19	⟨8⟩
n	1S'-6 J6-6	⟨8⟩
p	1S'-7 J6-5	⟨8⟩
q	1S'-8 J6-13	⟨8⟩
r	1S'-9 J6-12	⟨8⟩
s	1S'-0 J6-10	⟨8⟩
t	DECIMAL 1 FROM SW360-2F	⟨2⟩
u	DECIMAL 2 FROM SW360-2F&R	⟨2⟩
v	DECIMAL 3 FROM SW360-2F&R	⟨2⟩
w	DECIMAL 4 FROM SW360-2F&R	⟨2⟩
x	DECIMAL 5 FROM SW360-2R	⟨2⟩
y	m FROM P31-8	⟨10⟩
z	n FROM P31-10	⟨10⟩
AA	μ FROM P31-9	⟨10⟩
BB	V FROM P31-6	⟨10⟩
CC	S FROM P31-7	⟨10⟩
DD	NO-GO UPPER LIMIT FROM J17-14	⟨8⟩
EE	NO-GO MID-ZONE FROM J17-13	⟨8⟩
FF	NO-GO LOWER LIMIT FROM J17-15	⟨8⟩
GG	PRINT COMMAND FROM J4-20	⟨8⟩
HH	DISPLAY HOLD FROM J3-12	⟨8⟩

A	GROUND
B	SWEEP (
C	VOLTME
D	A VERT
E	A VERT
F	-STOP (
G	+20V
H	-START
J	B 100%
K	B VER
L	DEC, U
M	A VERT
N	+ 1,2,
P	+STAR
R	A 100%
S	+STOP
T	B VERT
U	B VERT
V	HORIZ
W	HORIZ
X	A 0%
Y	1000S'
Z	B 0%



EXTERNAL
PROGRAMMING
J34

- A GROUND
- B SWEEP OUT FROM J12-10 ◇8
- C VOLTMETER RAMP FROM J1-17 ◇8
- D A VERT ÷1,2,5 GND TO P32-21 ◇10
- E A VERT DEC, UNITS GND TO P32-19 ◇10
- F -STOP COMPARATOR TO SW320-1R ◇1
- G +20V
- H -START COMPARATOR TO SW320-1R ◇1
- J B 100% OVERRIDE TO J11-14 THRU R574 ◇8
- K B VERT SIGNAL OUT, SW440-3F&R ◇3
- L DEC, UNITS RETURN FROM SW320-3R ◇1
- M A VERT SIGNAL OUT, SW490-3F&R ◇4
- N ÷1,2,5 RETURN FROM SW320-3R ◇1
- P +START COMPARATOR TO SW320-2F ◇1
- R A 100% OVERRIDE TO J10-14 THRU R584 ◇8
- S +STOP COMPARATOR TO SW320-2R ◇1
- T B VERT DEC, UNITS GND TO P32-20 ◇10
- U B VERT ÷1,2,5 GND TO P32-22 ◇10
- V HORIZ DEC, UNITS GND TO P32-23 ◇10
- W HORIZ ÷1,2,5 GND TO P32-24 ◇10
- X A 0% OVERRIDE FROM J12-12 ◇8
- Y 1000S' STAIRCASE FROM J9-2 ◇8
- Z B 0% OVERRIDE FROM J12-8 ◇8

- a 100% A MEMORY FROM J10-8 ◇8
- b 100% B MEMORY FROM J11-8 ◇8
- c 1ST START SLOPE TO SW320-4F ◇1
- d 2ND START SLOPE TO SW320-3F ◇1
- e 1ST STOP SLOPE TO SW320-5F ◇1
- f 2ND STOP SLOPE TO SW320-3F ◇1
- g 0% A MEMORY FROM J10-7 ◇8
- h 0% B MEMORY FROM J11-7 ◇8
- i SPARE
- j 1S' STAIRCASE FROM J6-2 ◇8
- k -12.2V
- m TIME CLOCK TO J1-12 ◇8
- n PRINT COMMAND, FROM J4-13 ◇8
- p 100S' STAIRCASE FROM J8-2 ◇8
- q 10S' STAIRCASE FROM J7-2 ◇8
- r DISPLAY HOLD TO J3-12 ◇8
- s VOLTMETER OSC TO J1-18 ◇8
- t VOLTMETER OSC, TIME CLOCK RETURN FROM SW320-4R ◇1

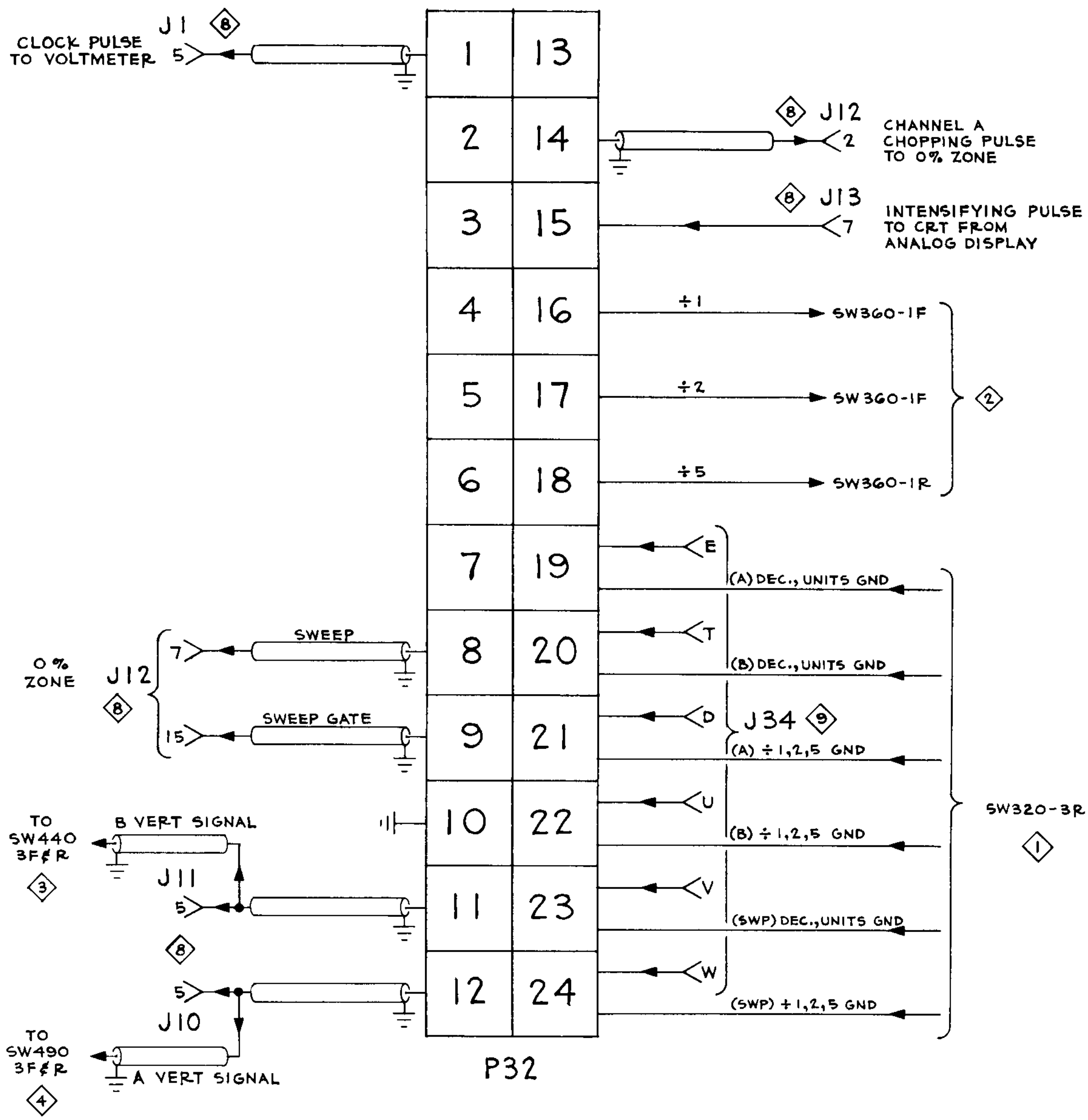
REFERENCE DIAGRAMS

- ◇1 MODE SWITCH
- ◇2 RESOLUTION SWITCH
- ◇3 TIMING START SWITCHING
- ◇4 TIMING STOP SWITCHING
- ◇8 PLUG-IN CIRCUIT BOARD CONNECTORS
- ◇10 CONNECTOR TO INDICATOR UNIT

GAB
364

A1

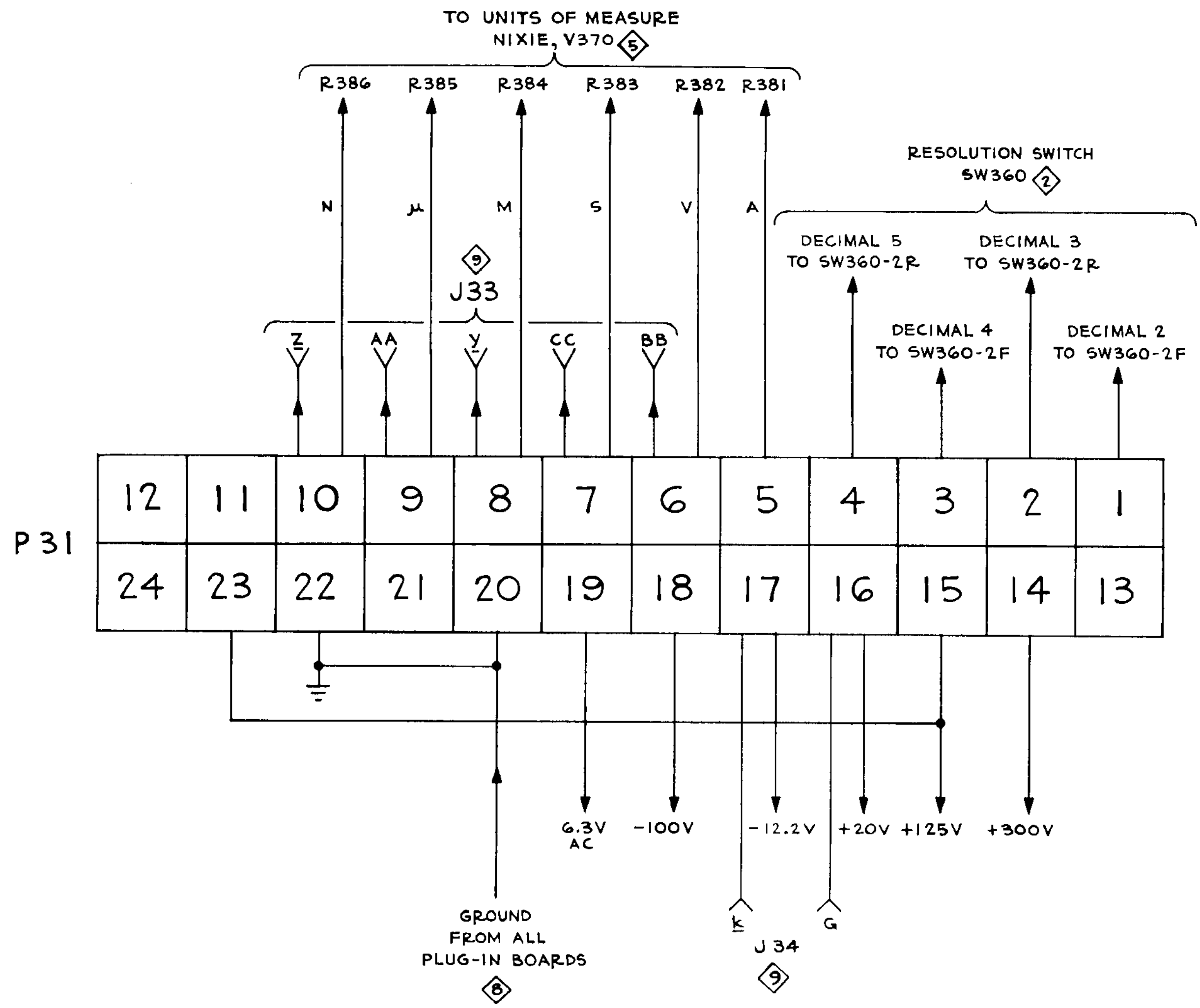
EXTERNAL READOUT & PROGRAMMING CONNECTORS ◇9



REFERENCE DIAGRAMS

1. MODE SWITCH
2. RESOLUTION SWITCH
3. TIMING START SWITCHING
4. TIMING STOP SWITCHING
5. READOUT TUBES
8. PLUG-IN CIRCUIT BOARD CONNE
9. EXTERNAL READOUT & PROGRAM

TYPE 6R1A



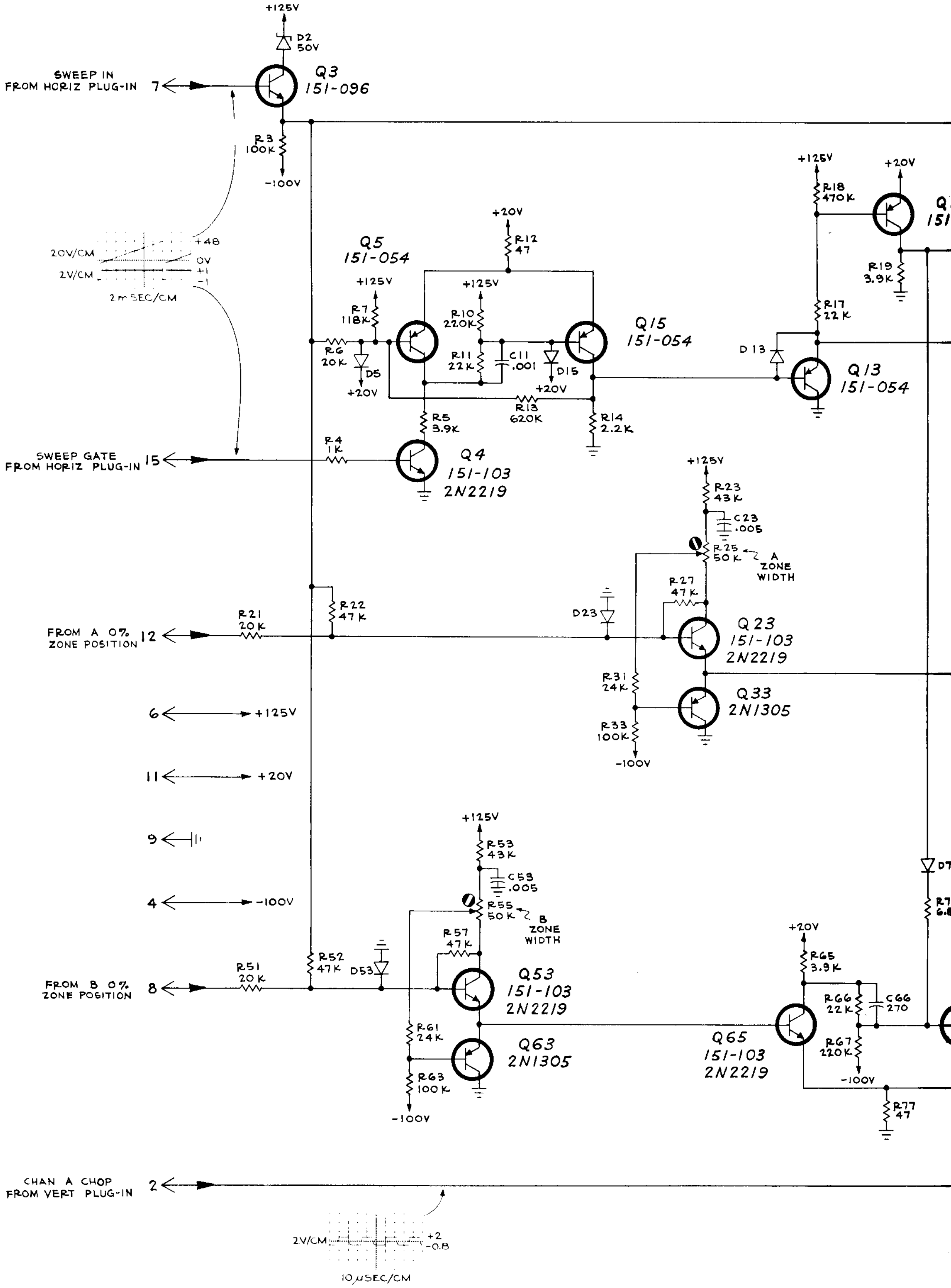
ERENCE DIAGRAMS

ODE SWITCH
ESOLUTION SWITCH
IMING START SWITCHING
IMING STOP SWITCHING
EADOUT TUBES
LUG-IN CIRCUIT BOARD CONNECTORS
XTERNAL READOUT & PROGRAMMING CONNECTORS

CONNECTORS TO INDICATOR UNIT 10

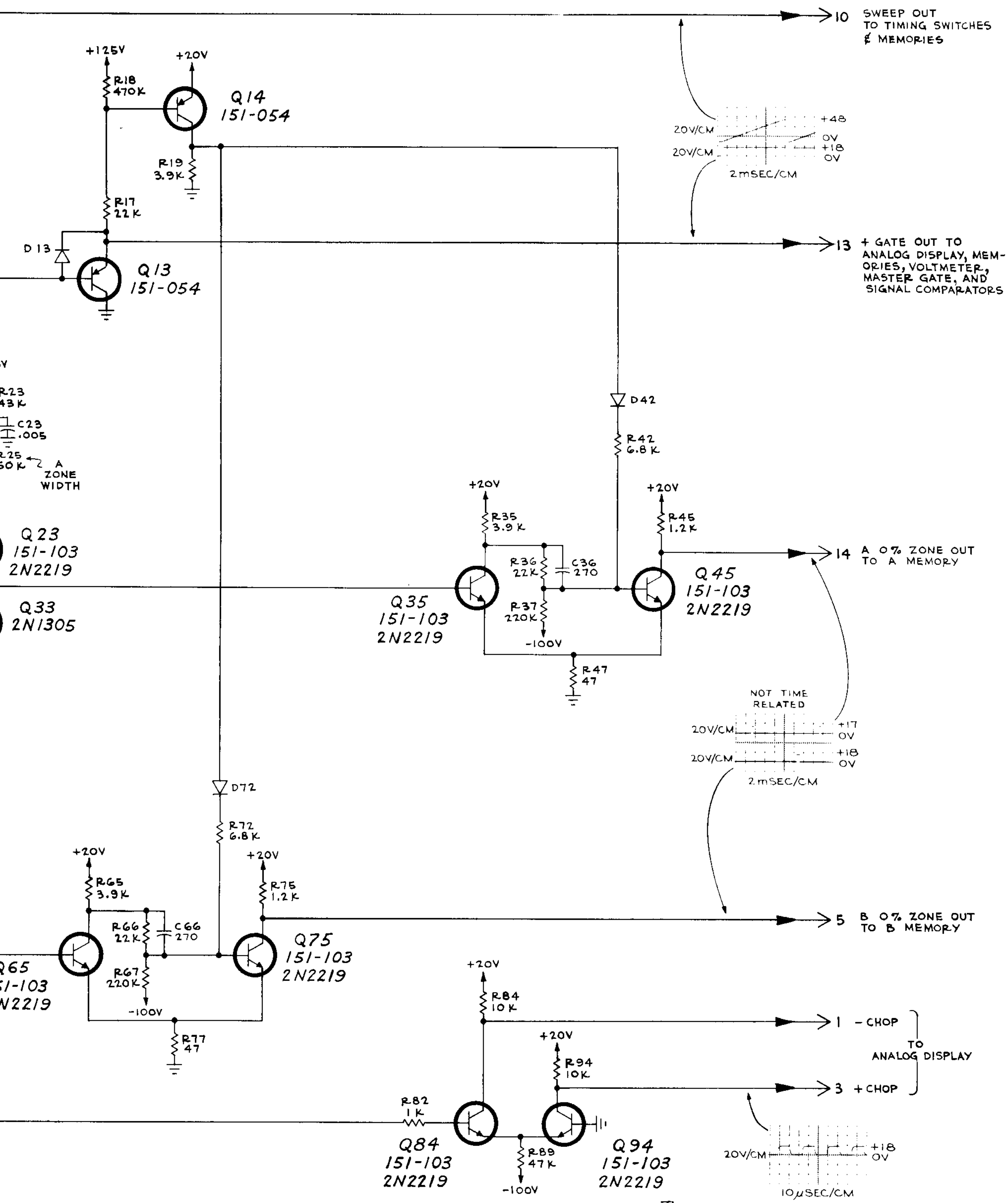
765

A2


+125V
D2 50V
Q3 151-096
SWEEP IN FROM HORIZ PLUG-IN 7
R3 100K
-100V
20V/CM
2V/CM
+48
0V
+1
-1
2mSEC/CM
Q5 151-054
+20V
R12 47
+125V
R7 118K
R6 20K
D5
+20V
R10 220K
R11 22K
C11 .001
D15
+20V
R13 620K
Q15 151-054
R14 2.2K
R5 3.9K
SWEEP GATE FROM HORIZ PLUG-IN 15
R4 1K
Q4 151-103 2N2219
R18 470K
R19 3.9K
R17 22K
D13
Q13 151-054
R23 43K
C23 .005
R25 50K
A ZONE WIDTH
R27 47K
D23
R22 47K
FROM A 0% ZONE POSITION 12
R21 20K
Q23 151-103 2N2219
R31 24K
Q33 2N1305
R33 100K
6 +125V
11 +20V
9
4 -100V
R53 43K
C53 .005
R55 50K
B ZONE WIDTH
R57 47K
R52 47K
D53
FROM B 0% ZONE POSITION 8
R51 20K
Q53 151-103 2N2219
R61 24K
Q63 2N1305
R63 100K
R65 3.9K
R66 22K
C66 270
R67 220K
Q65 151-103 2N2219
R77 47
CHAN A CHOP FROM VERT PLUG-IN 2
+2
-0.8
10µSEC/CM

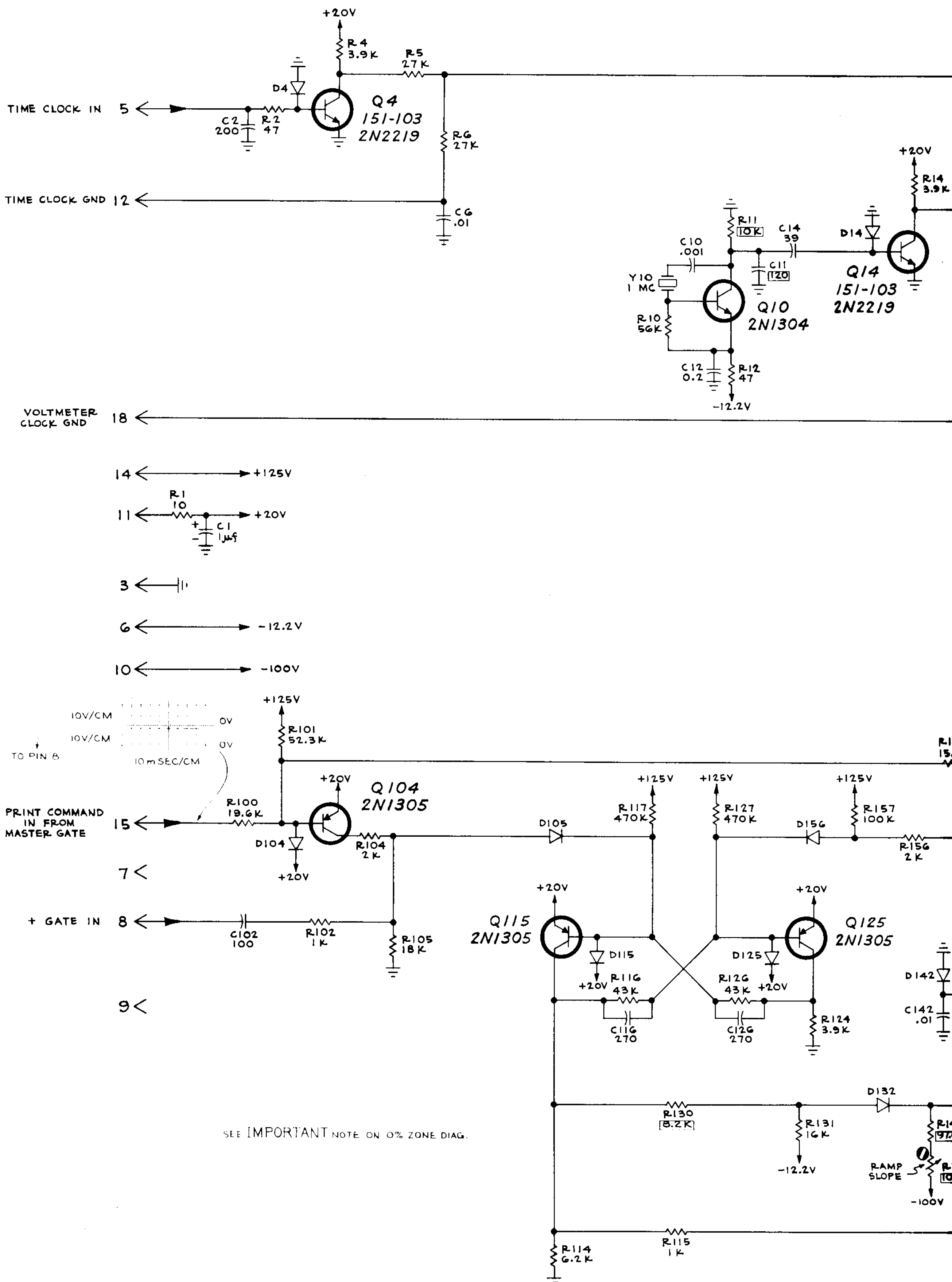
TYPE 6R1A

A2



TR 467
SERIES 0 MODEL 1
0% ZONE

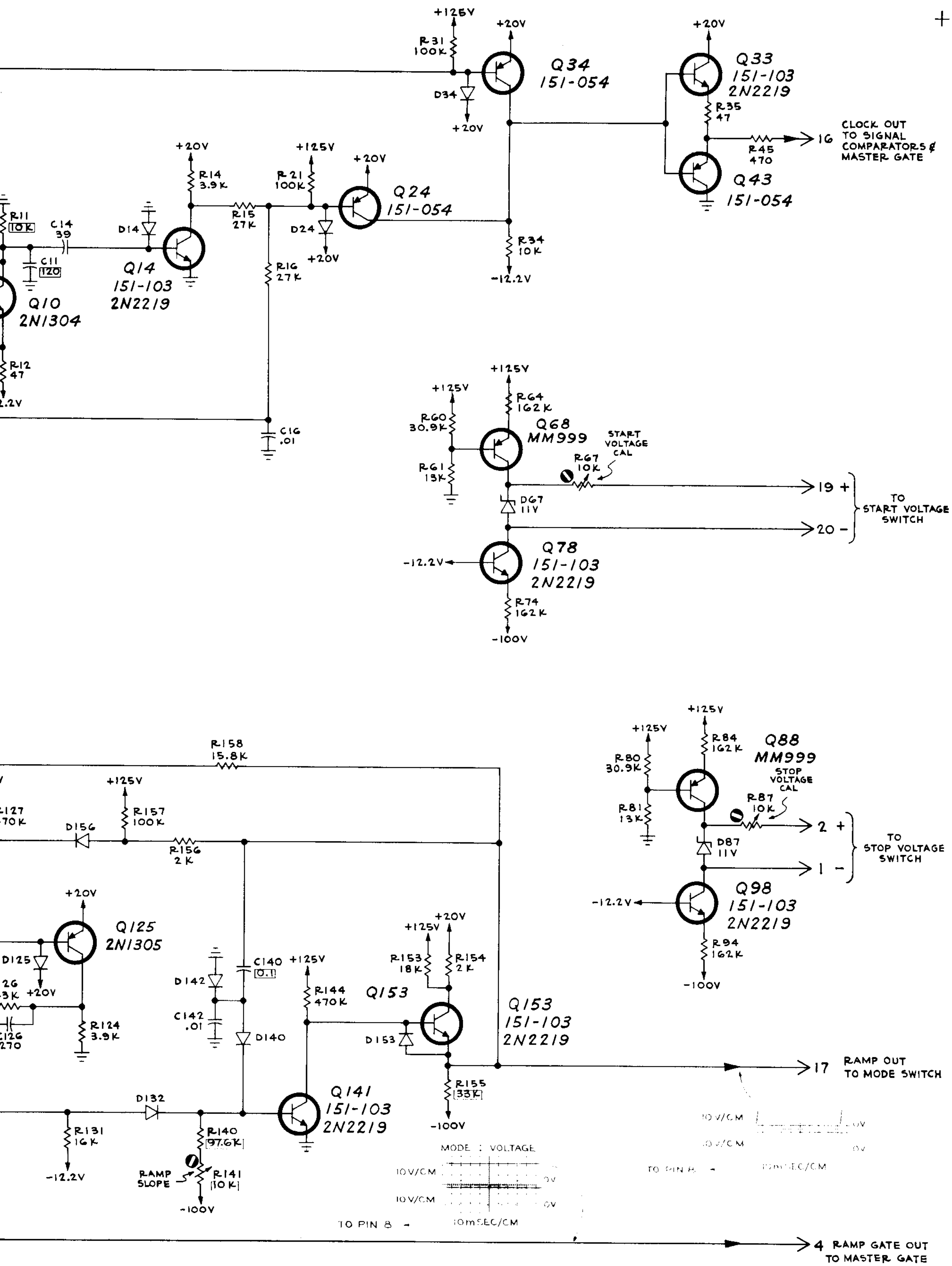
A2



+20V
R4
3.9K
R5
27K
D4
Q4
151-103
2N2219
TIME CLOCK IN 5
C2
200
R2
47
R6
27K
TIME CLOCK GND 12
C6
.01
+20V
R14
3.9K
R11
10K
C14
39
D14
C10
.001
C11
120
Y10
1 MC
Q14
151-103
2N2219
R10
56K
Q10
2N1304
C12
0.2
R12
47
-12.2V
VOLTMETER CLOCK GND 18
14
+125V
R1
10
11
+20V
C1
1µf
3
6
-12.2V
10
-100V
10V/CM
10V/CM
0V
0V
TO PIN 8
10 mSEC/CM
+125V
R101
52.3K
+20V
Q104
2N1305
PRINT COMMAND IN FROM MASTER GATE
15
R100
19.6K
D104
+20V
R104
2K
D105
+125V
R117
470K
+125V
R127
470K
D156
+125V
R157
100K
R156
2K
7
+ GATE IN 8
C102
100
R102
1K
R105
18K
+20V
Q115
2N1305
D115
+20V
R116
43K
C116
270
+20V
Q125
2N1305
D125
R126
43K
+20V
C126
270
R124
3.9K
D142
C142
.01
9
D132
R130
8.2K
R131
16K
-12.2V
RAMP SLOPE
-100V
SEE IMPORTANT NOTE ON 0% ZONE DIAG.
R114
6.2K
R115
1K

TYPE 6R1A

D1



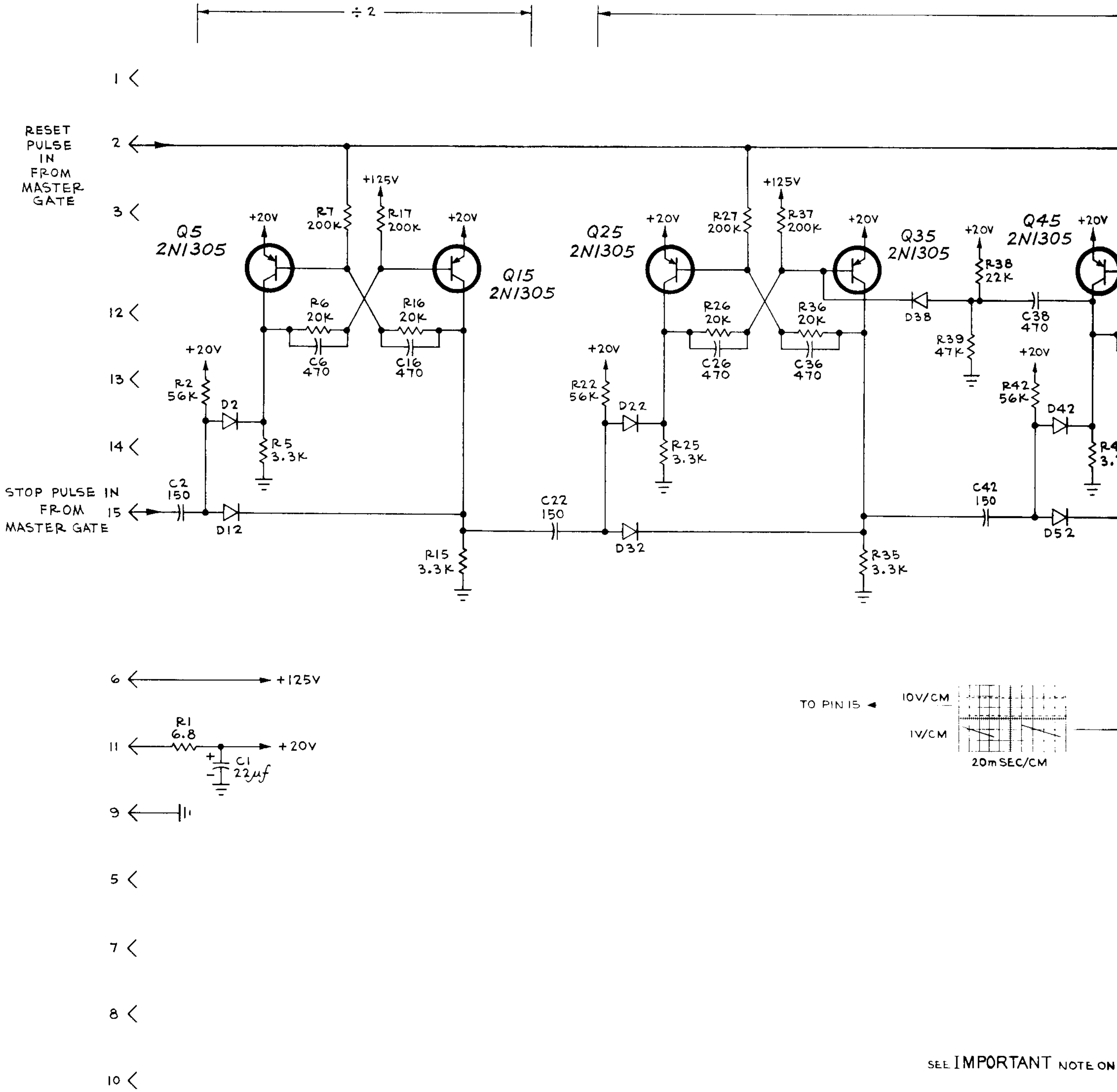
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

D1

SERIES Q MODEL 1, 2, 3, 4

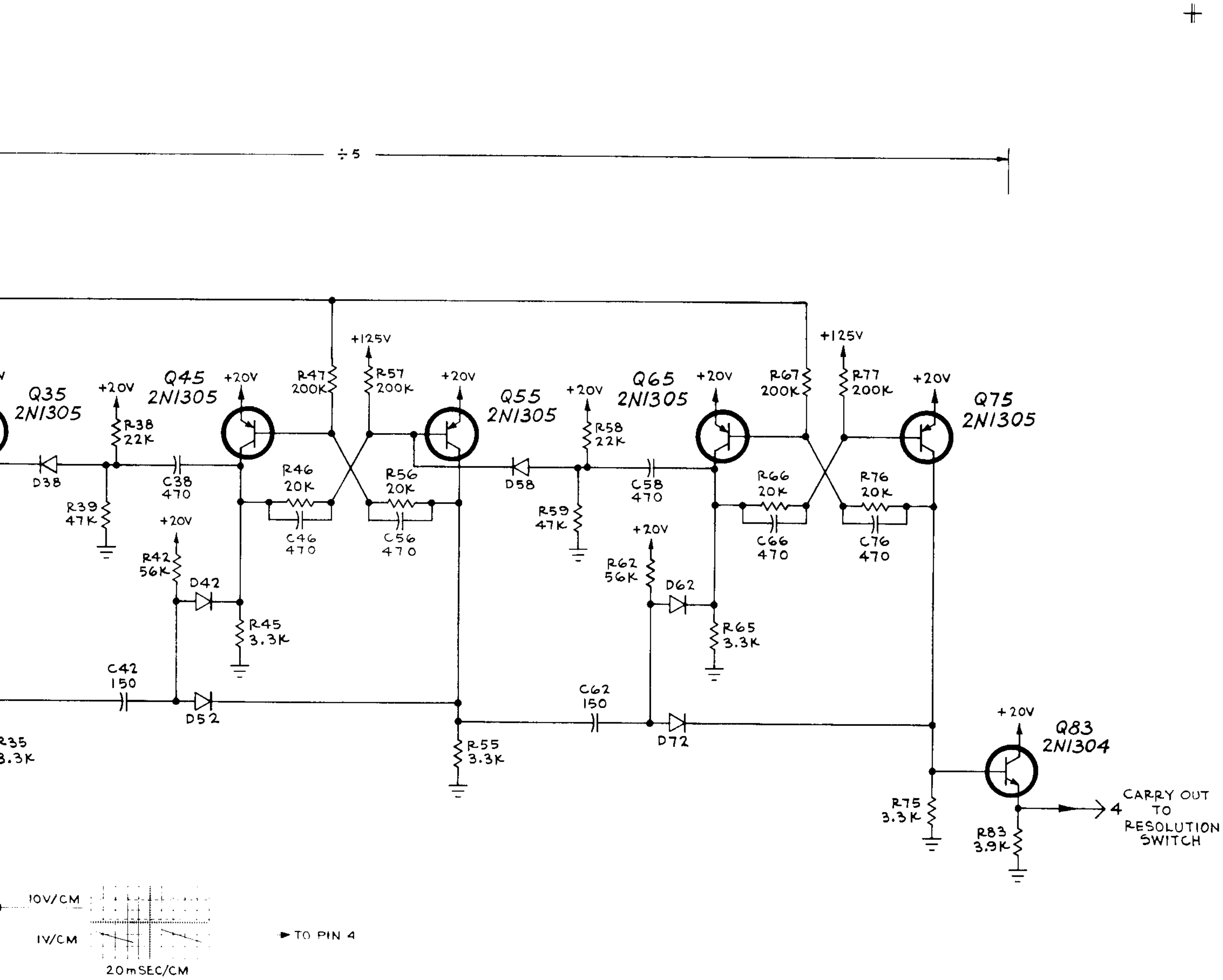
VOLTMETER

465


÷ 2
RESET PULSE IN FROM MASTER GATE
STOP PULSE IN FROM MASTER GATE
1
2
3
12
13
14
15
6
11
9
5
7
8
10
+125V
+20V
Q5 2N1305
Q15 2N1305
Q25 2N1305
Q35 2N1305
Q45 2N1305
R7 200K
R17 200K
R6 20K
R16 20K
C6 470
C16 470
R2 56K
D2
R5 3.3K
C2 150
D12
R15 3.3K
C22 150
R27 200K
R37 200K
R26 20K
R36 20K
C26 470
C36 470
R22 56K
D22
R25 3.3K
D32
R35 3.3K
D38
R38 22K
R39 47K
C38 470
R42 56K
D42
C42 150
D52
R1 6.8
C1 22μf
TO PIN 15
10V/CM
1V/CM
20m SEC/CM
SEE IMPORTANT NOTE ON

TYPE 6R1A

A



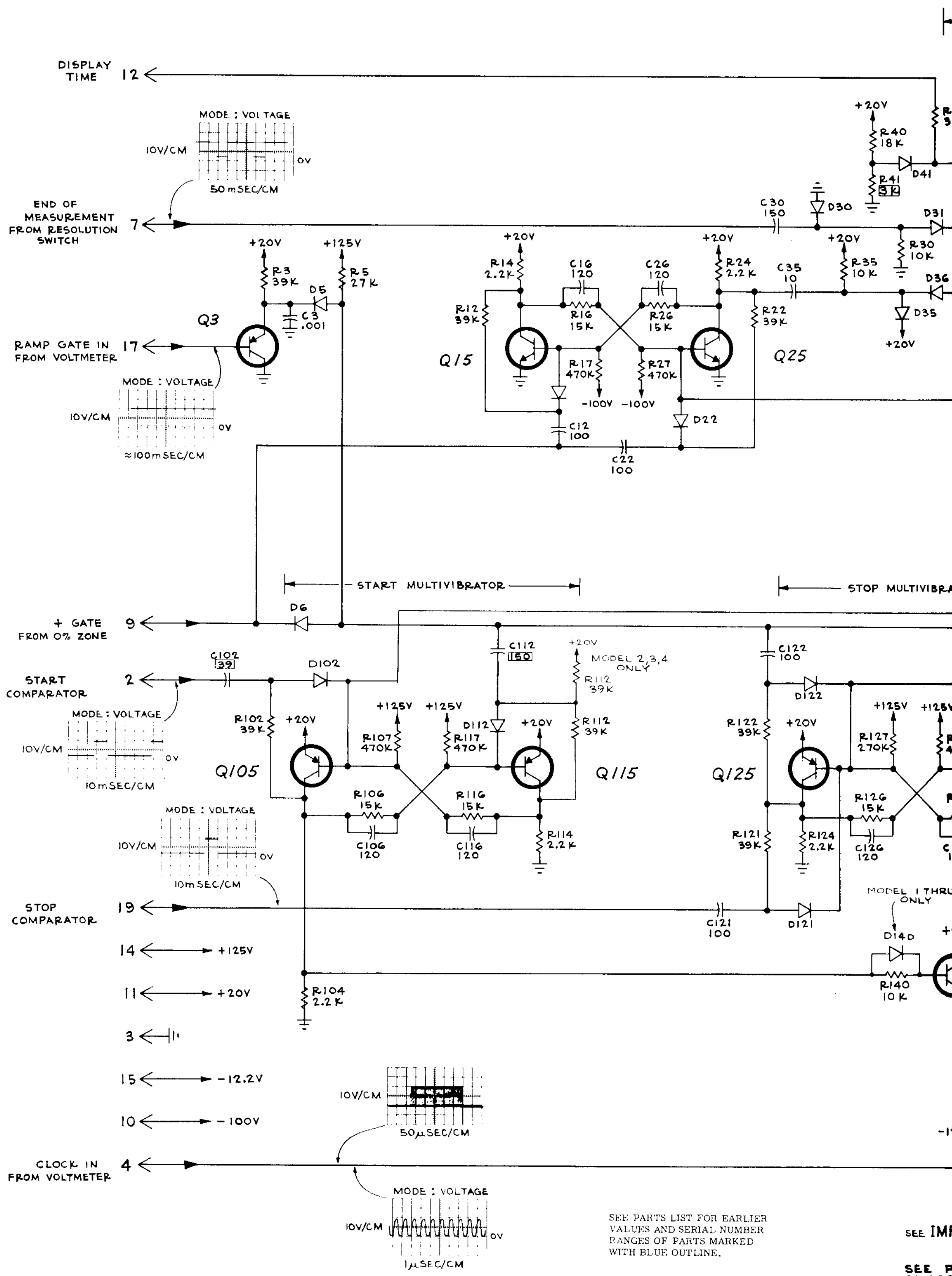
SEE IMPORTANT NOTE ON 0% ZONE DIAG.

SERIES I MODEL 3

÷ 10

GAB 3?1

A



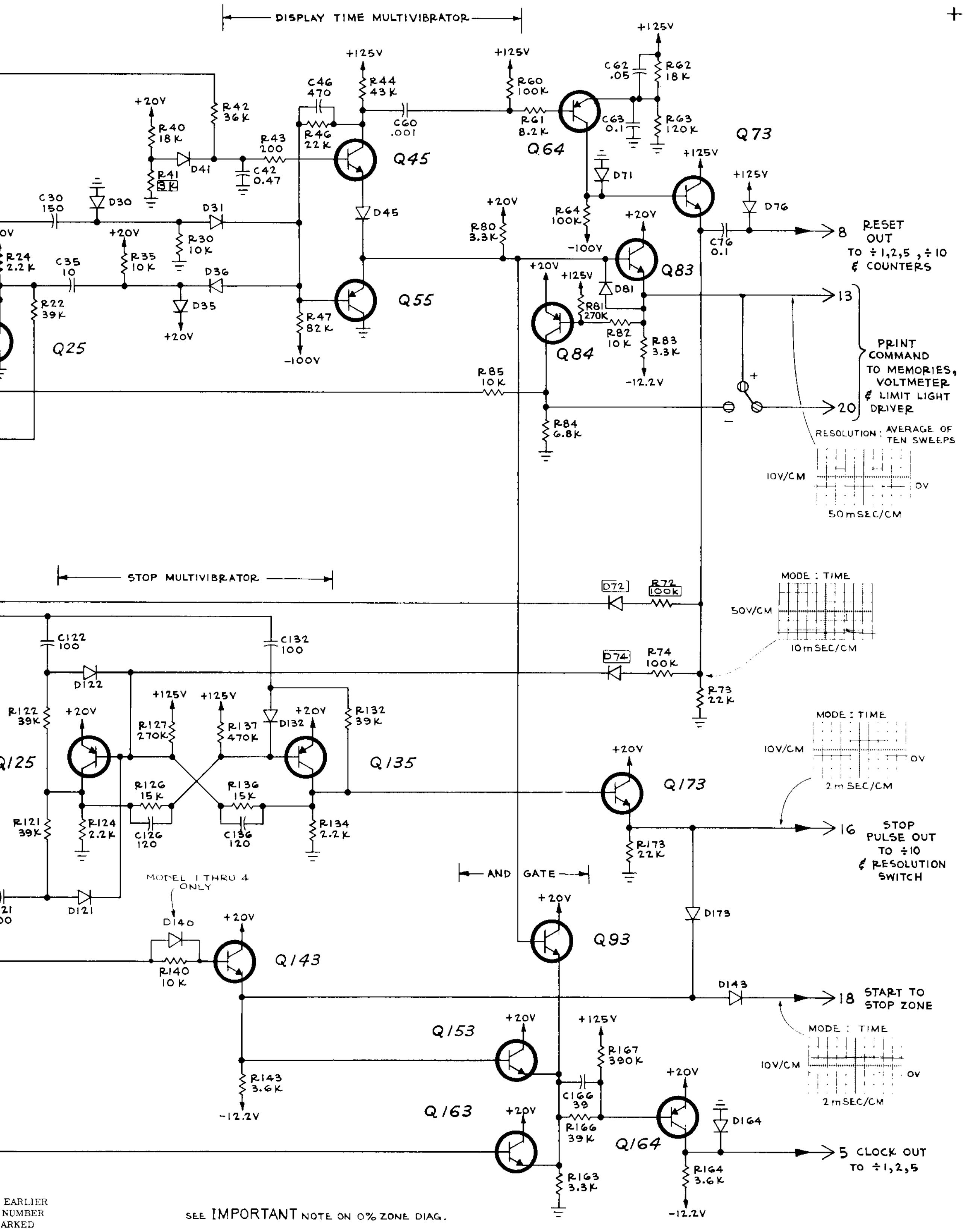
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

SEE IMF

SEE F SEMICO

TYPE 6R1A

E1



EARLIER
NUMBER
ARKED

SEE IMPORTANT NOTE ON 0% ZONE DIAG.

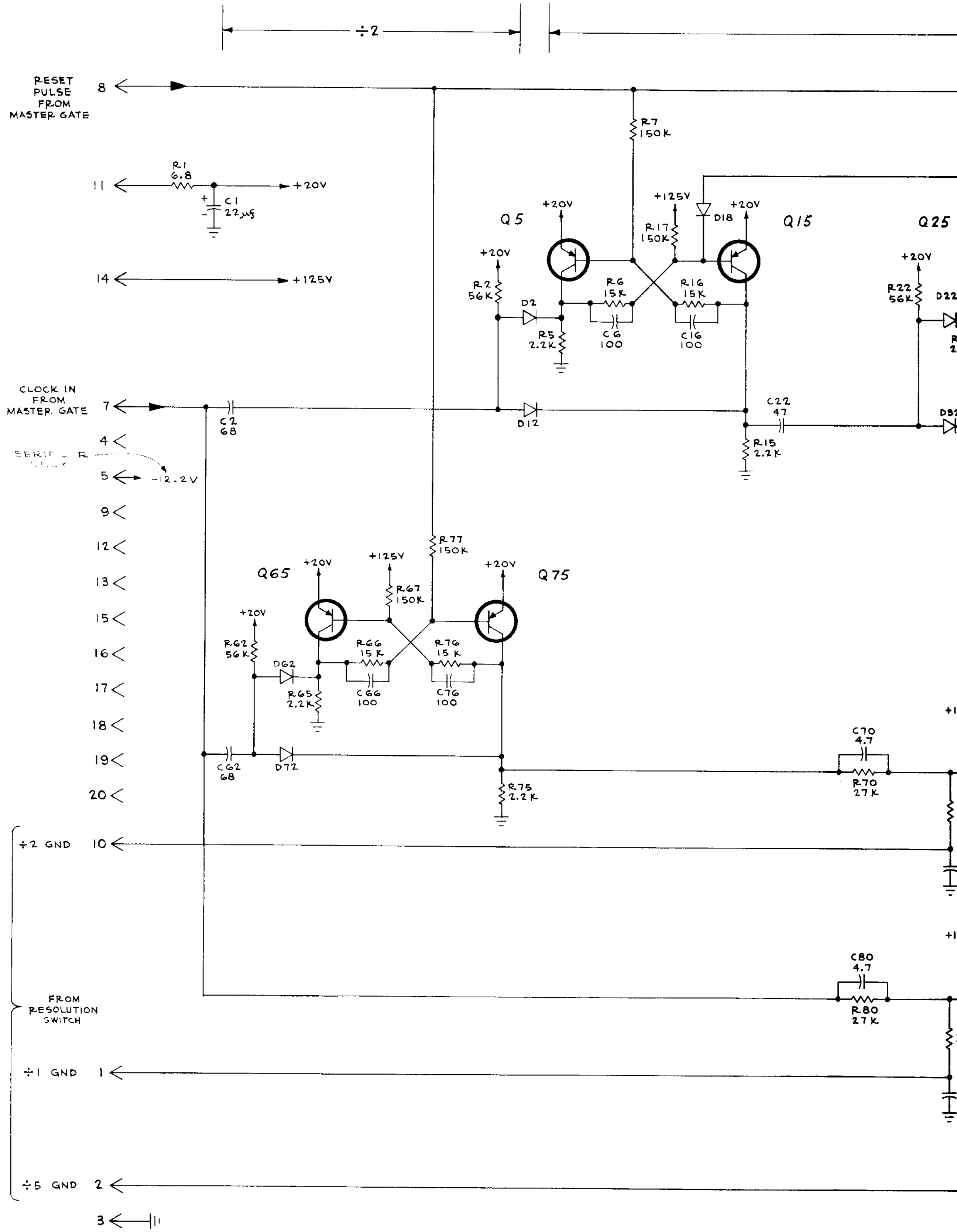
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

SERIES M MODEL 1,2,3,5

MASTER GATE

1067

E1

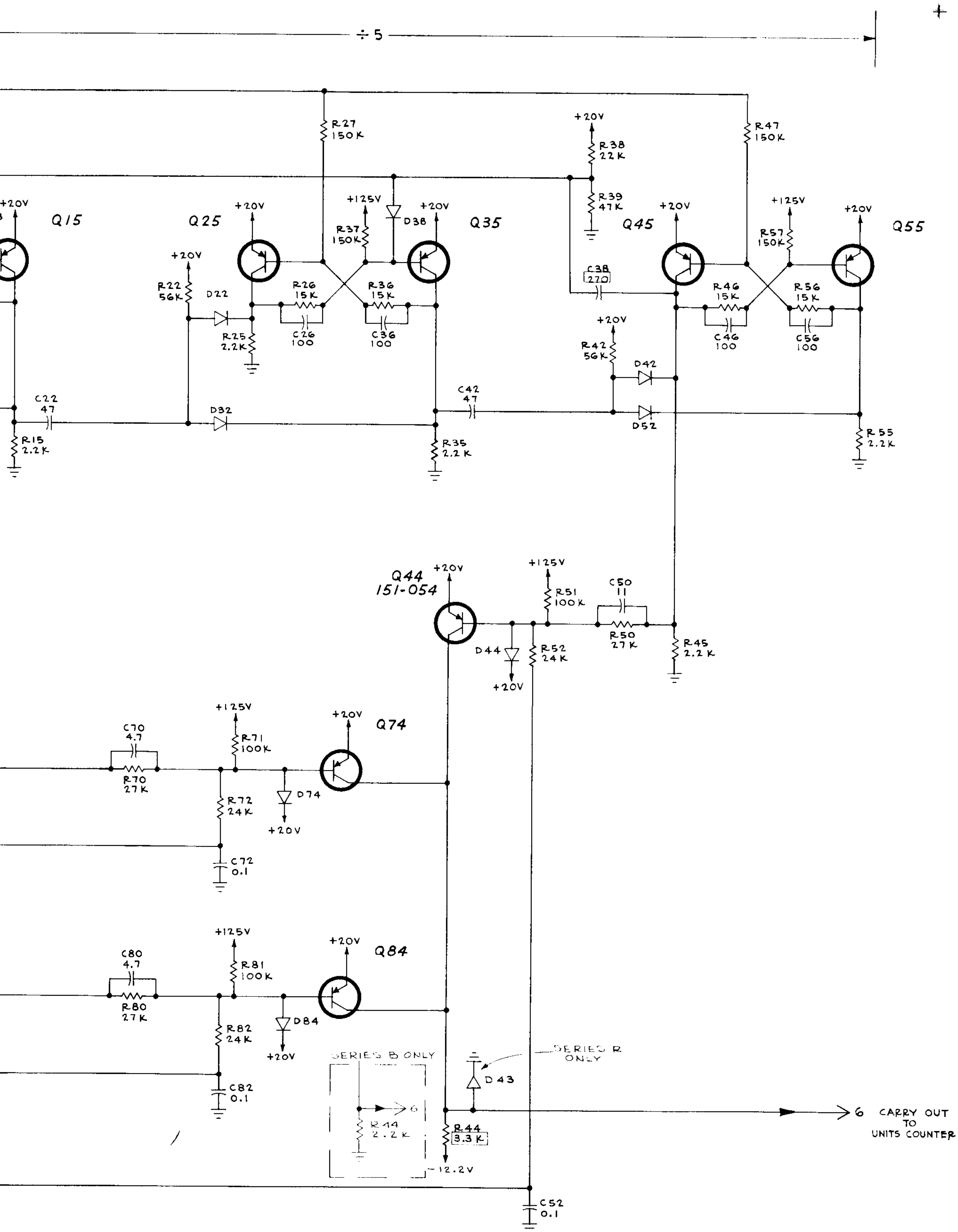


SEE PARTS LIST FOR SEMICONDUCTOR TYPES

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

C

TYPE 6R1A

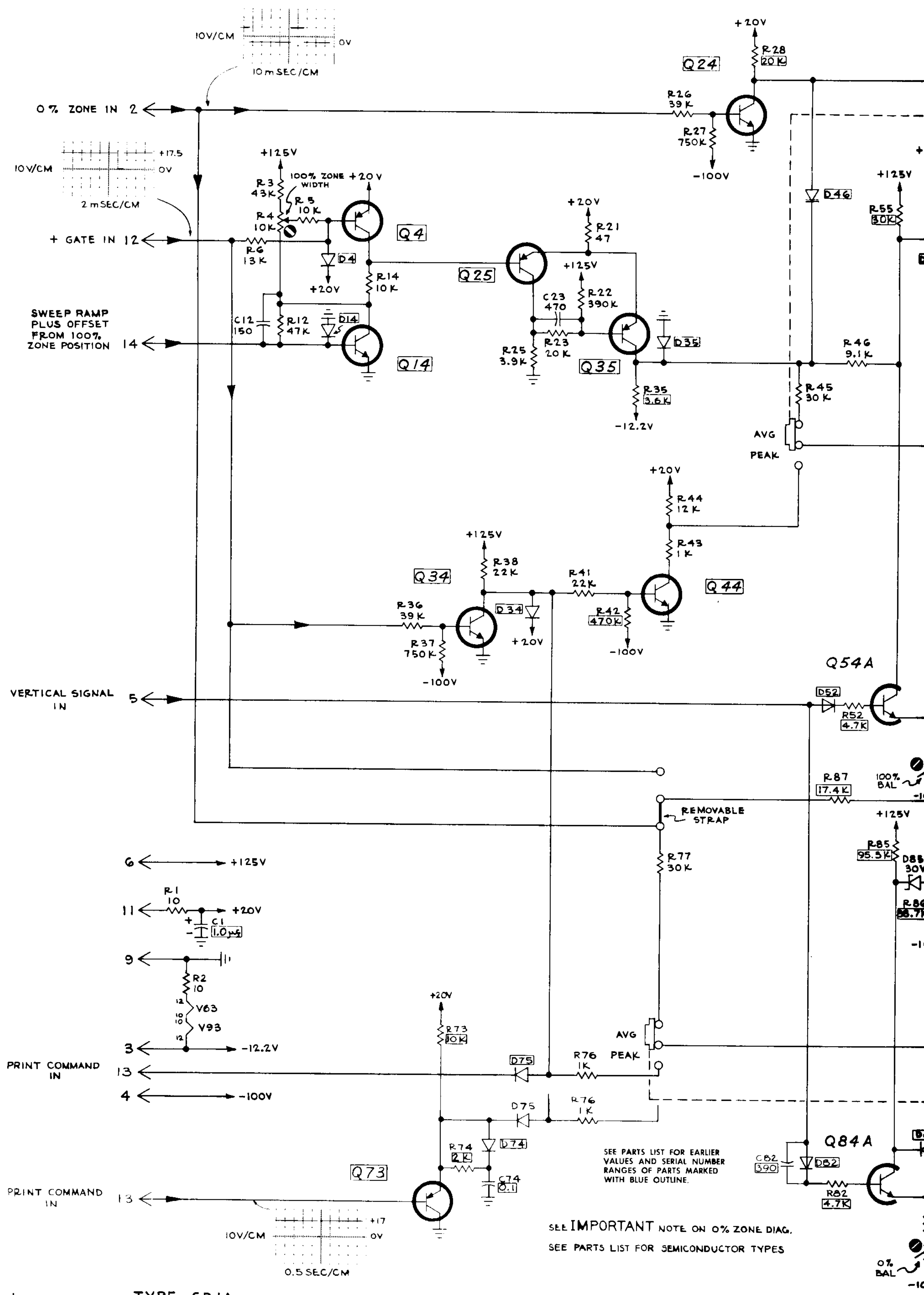


SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

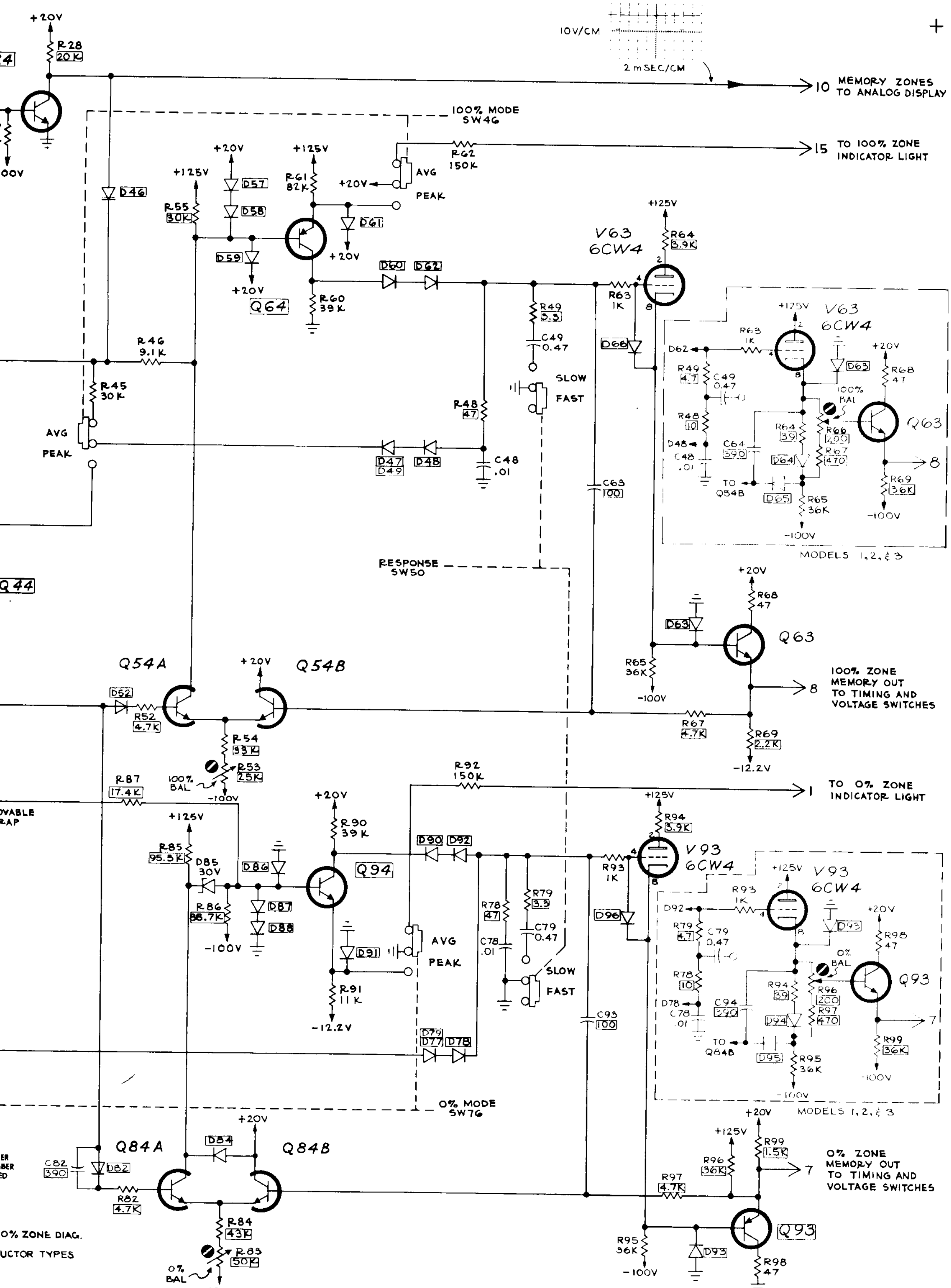
c

SERIES B & R MODELS 1-UP

÷ 1, 2, 5 769


0% ZONE IN 2
+ GATE IN 12
SWEEP RAMP PLUS OFFSET FROM 100% ZONE POSITION 14
VERTICAL SIGNAL IN 5
PRINT COMMAND IN 13
10V/CM
10 mSEC/CM
2 mSEC/CM
0.5 SEC/CM
100% ZONE WIDTH
Q4
Q14
Q24
Q25
Q34
Q35
Q44
Q54A
Q73
Q84A
AVG
PEAK
REMOVABLE STRAP
100% BAL
0% BAL
6 +125V
11 +20V
9
3 -12.2V
4 -100V
V63
V93
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.
SEE IMPORTANT NOTE ON 0% ZONE DIAG.
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

TYPE GR1A

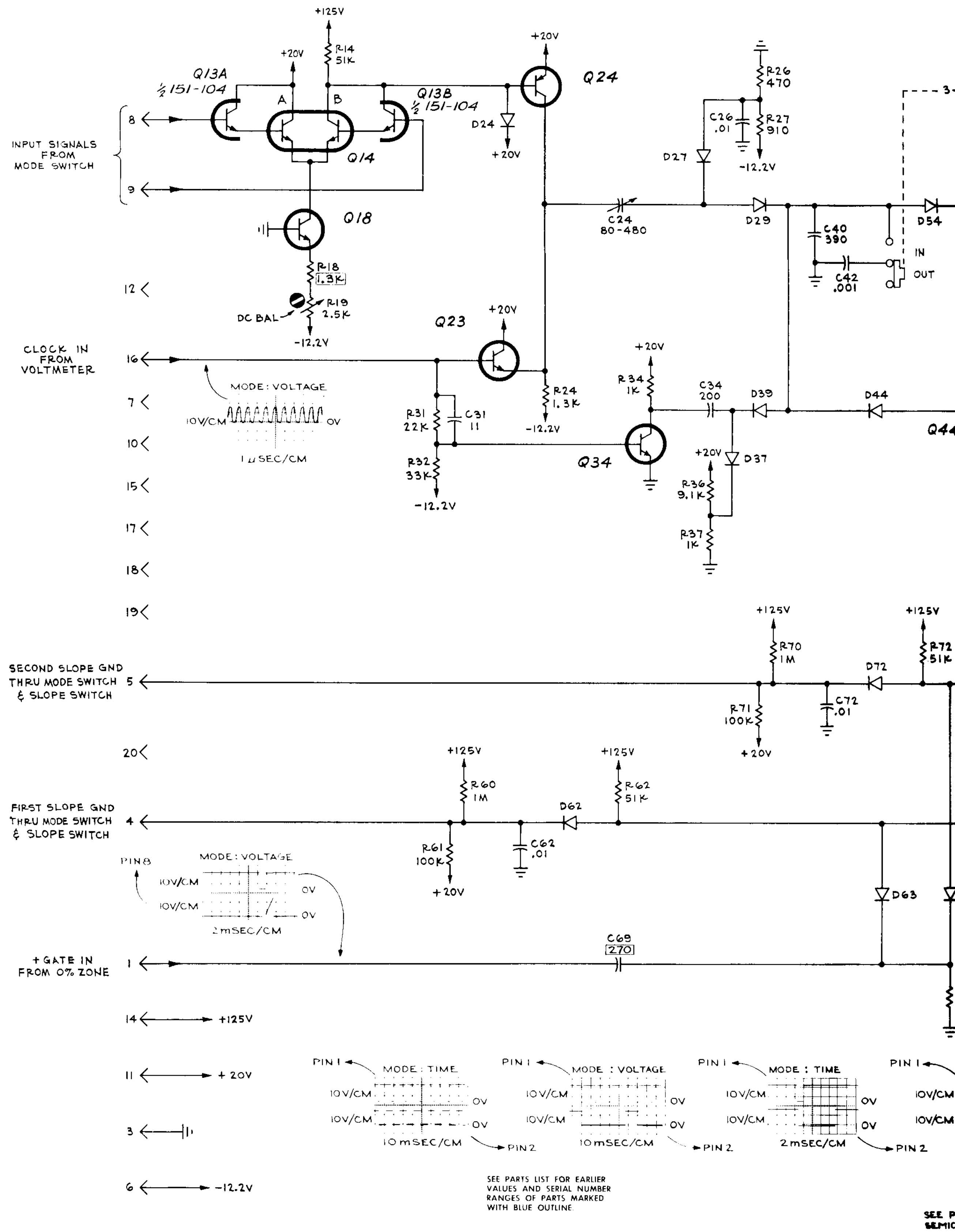


SERIES P MODELS 1, 2, 3 & 4

0% & 100% MEMORIES

366

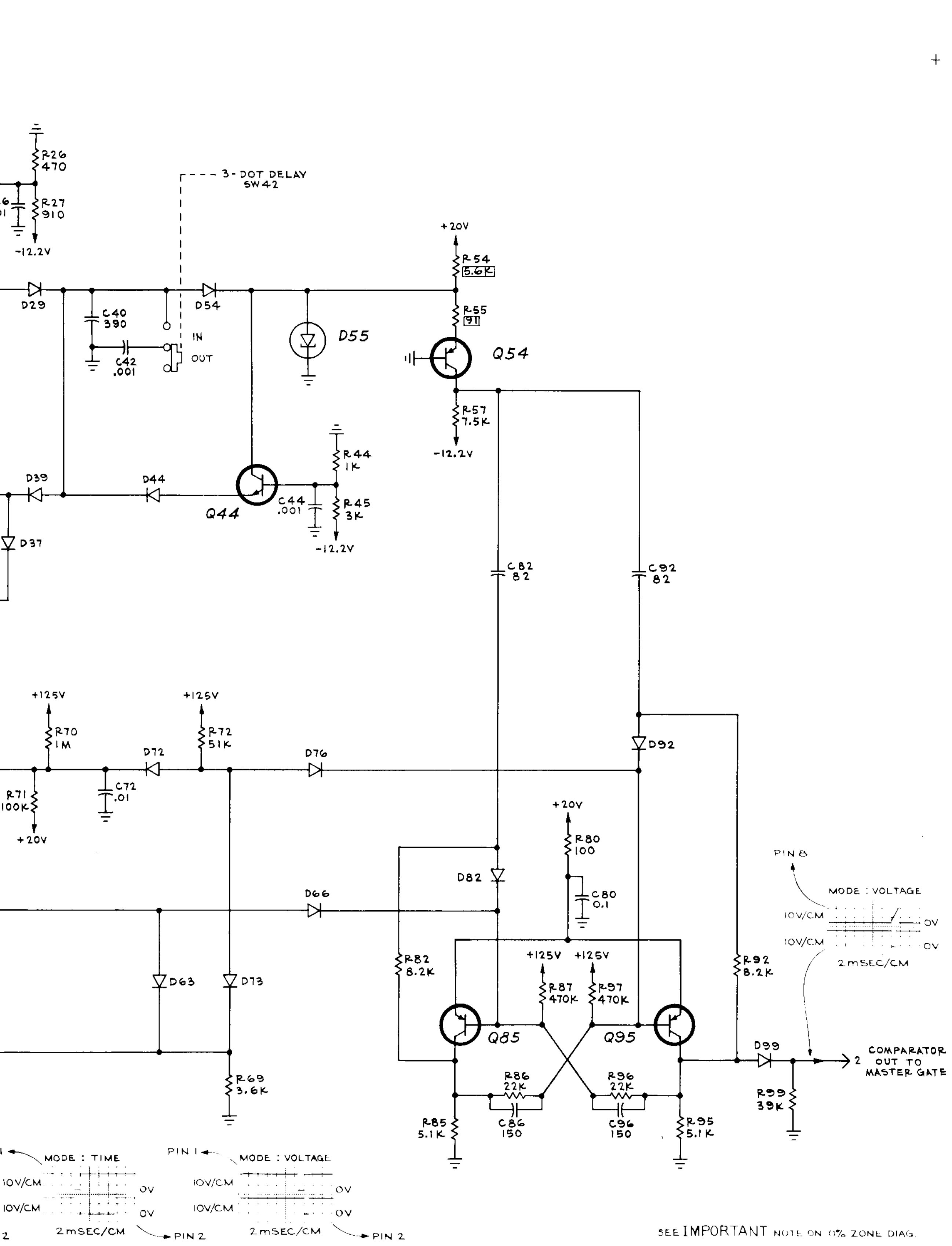
E



+125V
R14 51K
+20V
Q13A ½ 151-104
A
B
Q13B ½ 151-104
Q14
+20V
Q24
D24
+20V
INPUT SIGNALS FROM MODE SWITCH
8
9
Q18
R18 1.3K
R19 2.5K
DC BAL
-12.2V
12
R26 470
C26 .01
R27 910
D27
-12.2V
C24 80-480
D29
C40 390
D54
IN
OUT
C42 .001
Q23
+20V
CLOCK IN FROM VOLTMETER
16
MODE: VOLTAGE
10V/CM
0V
1 μSEC/CM
7
10
15
17
18
19
R24 1.3K
-12.2V
R31 22K
C31 11
R32 33K
-12.2V
Q34
R34 1K
C34 200
D39
D44
Q44
+20V
D37
R36 9.1K
R37 1K
+125V
R70 1M
+125V
R72 51K
D72
SECOND SLOPE GND THRU MODE SWITCH & SLOPE SWITCH
5
R71 100K
C72 .01
+20V
20
+125V
R60 1M
+125V
R62 51K
D62
FIRST SLOPE GND THRU MODE SWITCH & SLOPE SWITCH
4
R61 100K
C62 .01
+20V
D63
PIN 8
MODE: VOLTAGE
10V/CM
10V/CM
0V
0V
2 mSEC/CM
C69 270
+ GATE IN FROM 0% ZONE
1
14 +125V
11 +20V
3
6 -12.2V
PIN 1
MODE: TIME
10V/CM
10V/CM
0V
0V
10 mSEC/CM
PIN 2
PIN 1
MODE: VOLTAGE
10V/CM
10V/CM
0V
0V
10 mSEC/CM
PIN 2
PIN 1
MODE: TIME
10V/CM
10V/CM
0V
0V
2 mSEC/CM
PIN 2
PIN 1
10V/CM
10V/CM
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

TYPE 6R1A

D



SEE IMPORTANT NOTE ON 0% ZONE DIAG.

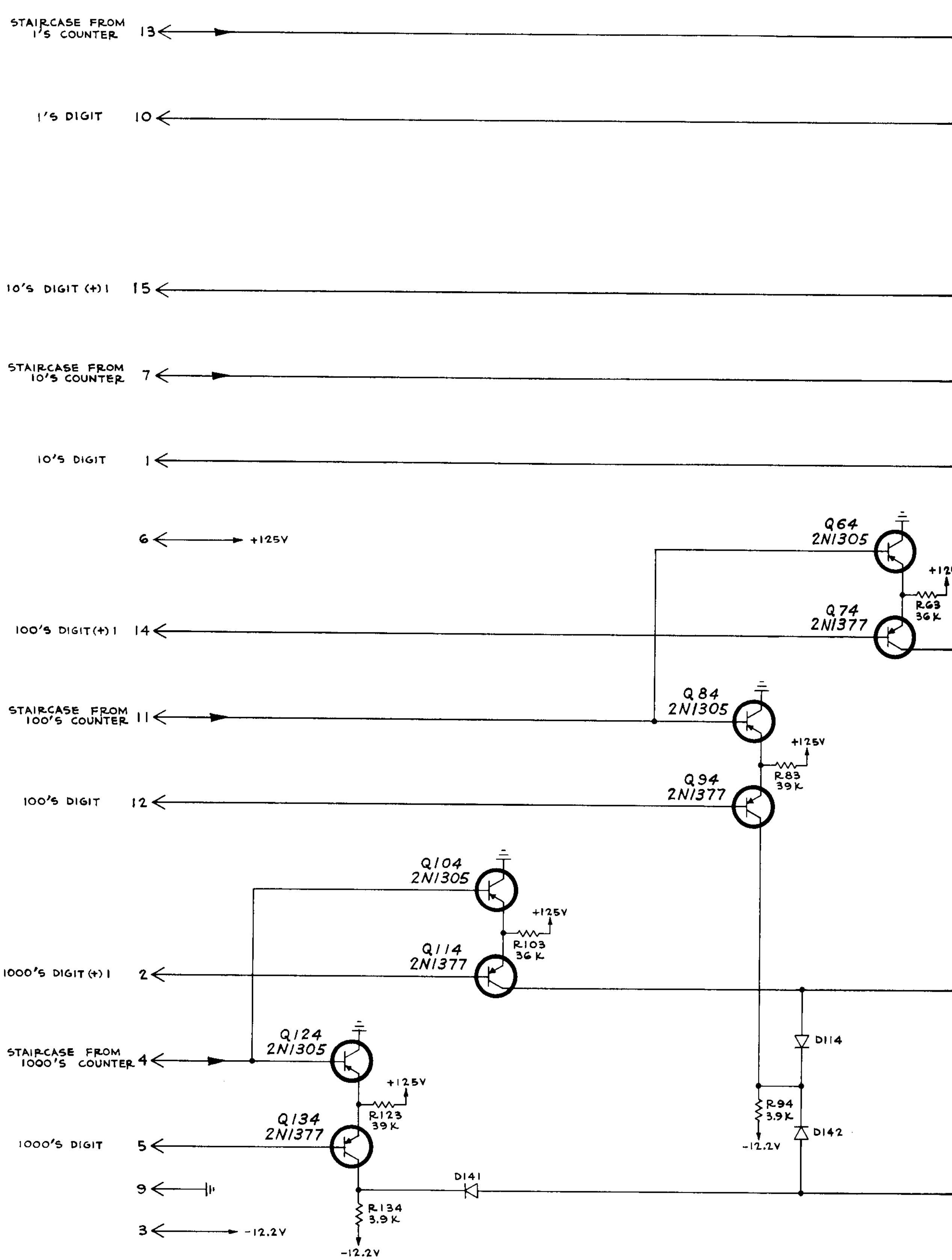
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

D

SERIES N MODEL 1,2,3

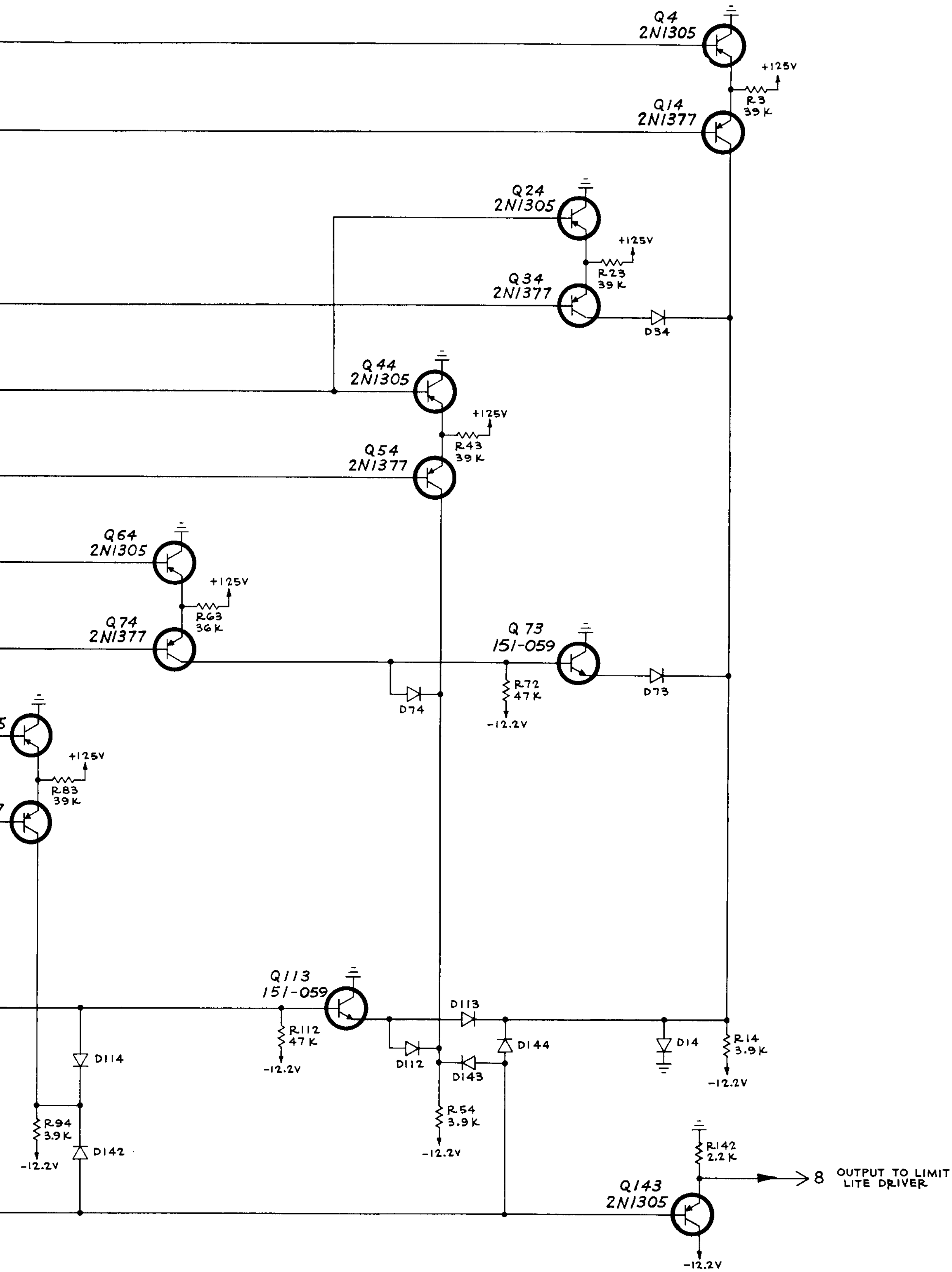
SIGNAL COMPARATOR

GAB 965


STAIRCASE FROM 1'S COUNTER 13
1'S DIGIT 10
10'S DIGIT (+) 1 15
STAIRCASE FROM 10'S COUNTER 7
10'S DIGIT 1
6 +125V
Q64 2N1305
R63 36K
Q74 2N1377
100'S DIGIT (+) 1 14
STAIRCASE FROM 100'S COUNTER 11
Q84 2N1305
+125V
R83 39K
Q94 2N1377
100'S DIGIT 12
Q104 2N1305
+125V
R103 36K
Q114 2N1377
1000'S DIGIT (+) 1 2
Q124 2N1305
STAIRCASE FROM 1000'S COUNTER 4
+125V
R123 39K
Q134 2N1377
1000'S DIGIT 5
9
3 -12.2V
D141
R134 3.9K
-12.2V
D114
R94 3.9K
-12.2V
D142

TYPE 6R1A

A₁

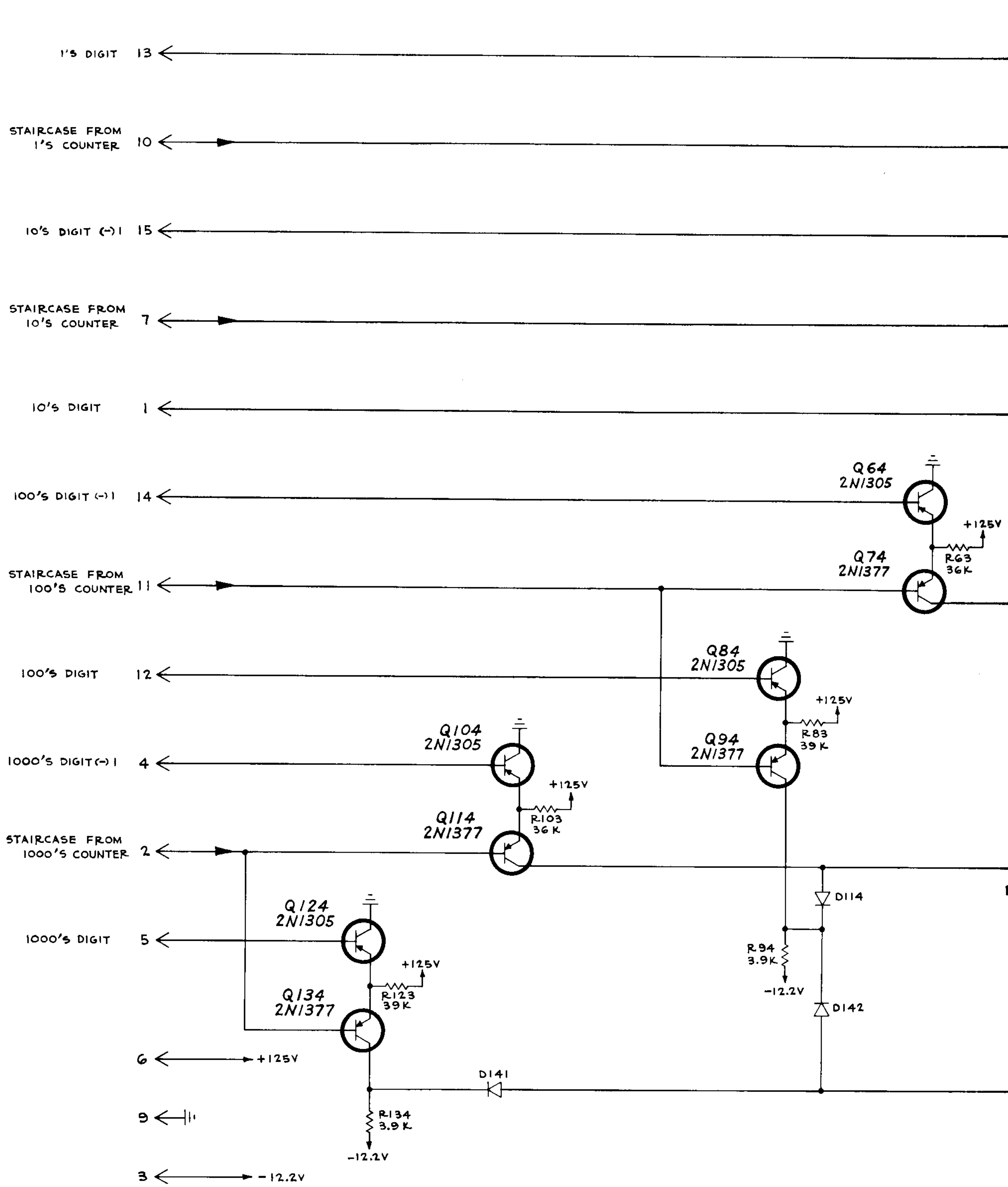


SERIES G MODEL 1A

LOWER LIMIT NO-GO

964

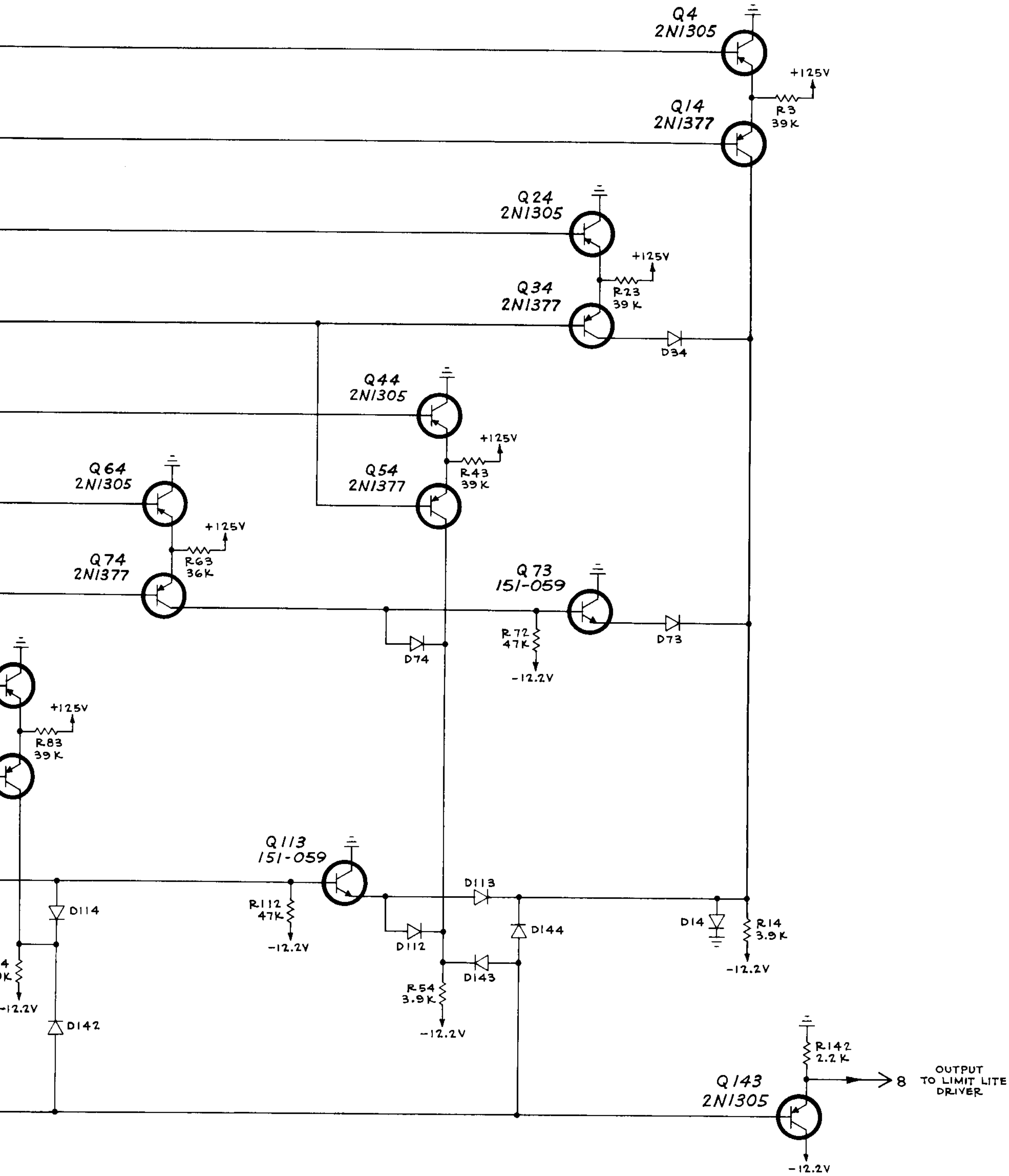
A1



1'S DIGIT 13
STAIRCASE FROM 1'S COUNTER 10
10'S DIGIT (-) 1 15
STAIRCASE FROM 10'S COUNTER 7
10'S DIGIT 1
100'S DIGIT (-) 1 14
STAIRCASE FROM 100'S COUNTER 11
100'S DIGIT 12
1000'S DIGIT (-) 1 4
STAIRCASE FROM 1000'S COUNTER 2
1000'S DIGIT 5
6 +125V
9
3 -12.2V
Q64 2N1305
Q74 2N1377
R63 36K
+125V
Q84 2N1305
Q94 2N1377
R83 39K
Q104 2N1305
Q114 2N1377
R103 36K
Q124 2N1305
Q134 2N1377
R123 39K
R134 3.9K
-12.2V
R94 3.9K
D114
D142
D141

TYPE 6R1A

A1

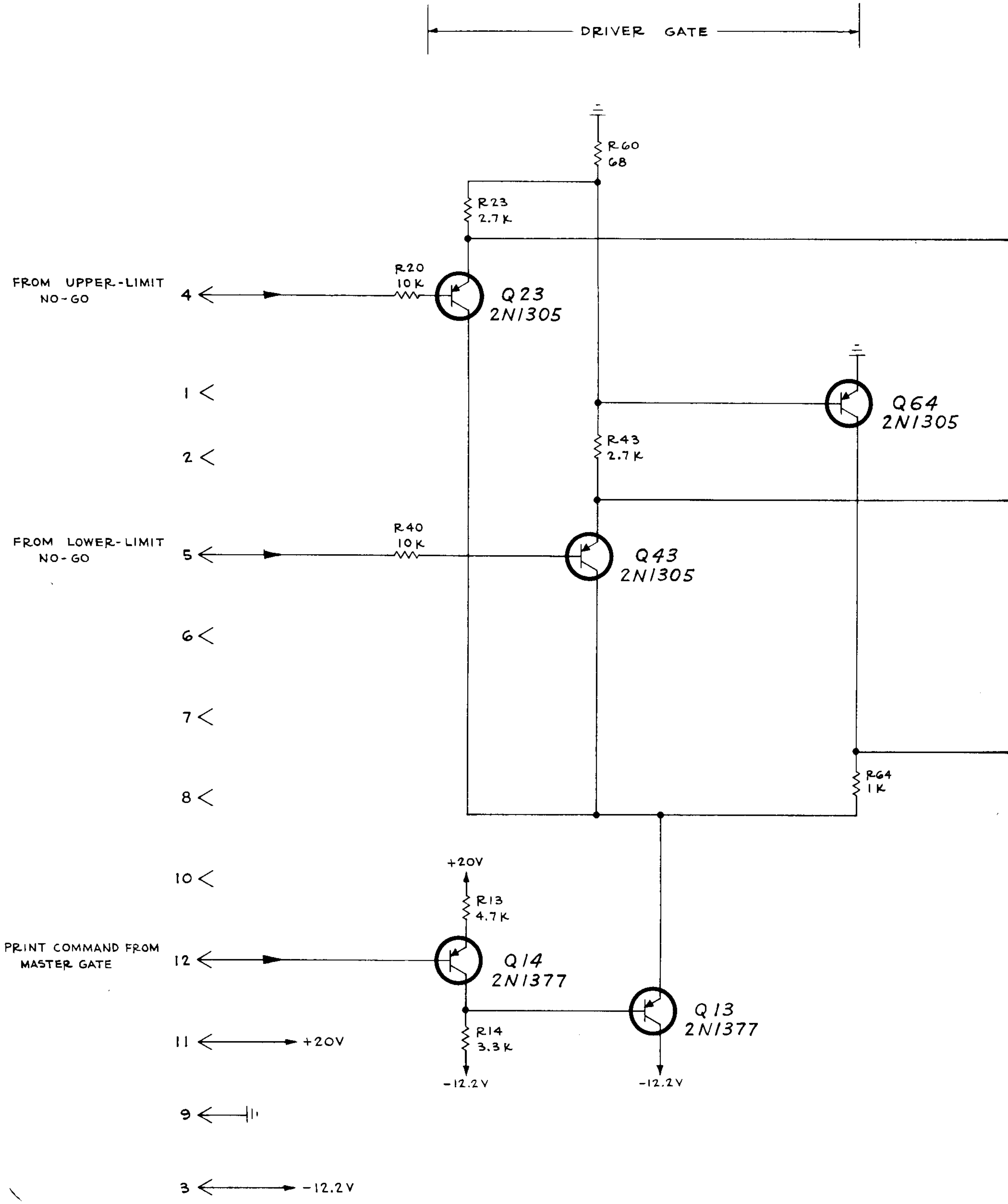


SERIES F MODEL 1A

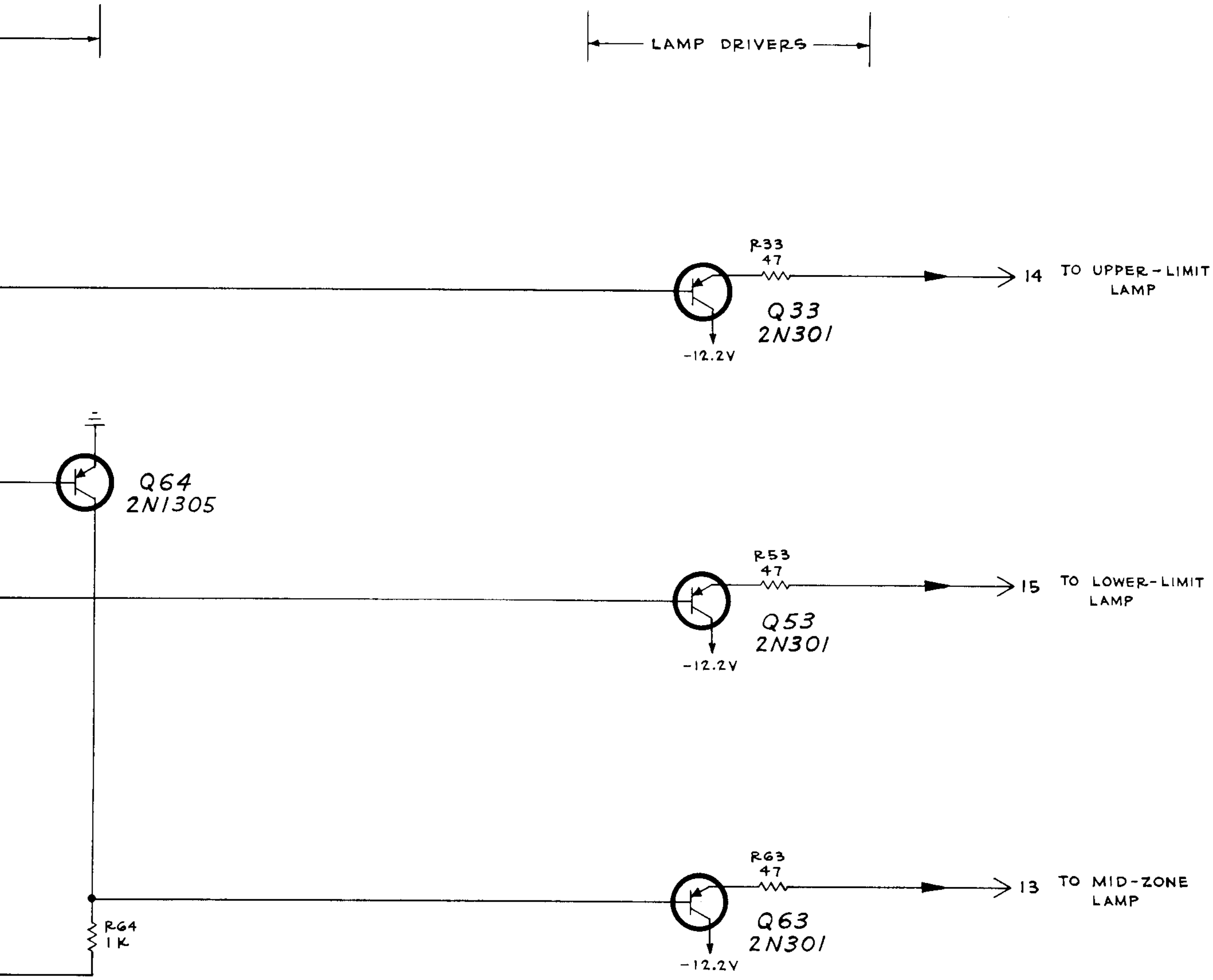
UPPER LIMIT NO-GO

964

A1


DRIVER GATE
R60
68
R23
2.7K
FROM UPPER-LIMIT
NO-GO
4
R20
10K
Q23
2N1305
1
Q64
2N1305
R43
2.7K
2
FROM LOWER-LIMIT
NO-GO
5
R40
10K
Q43
2N1305
6
7
8
R64
1K
10
+20V
R13
4.7K
PRINT COMMAND FROM
MASTER GATE
12
Q14
2N1377
Q13
2N1377
11
+20V
R14
3.3K
-12.2V
-12.2V
9
3
-12.2V

TYPE 6R1A

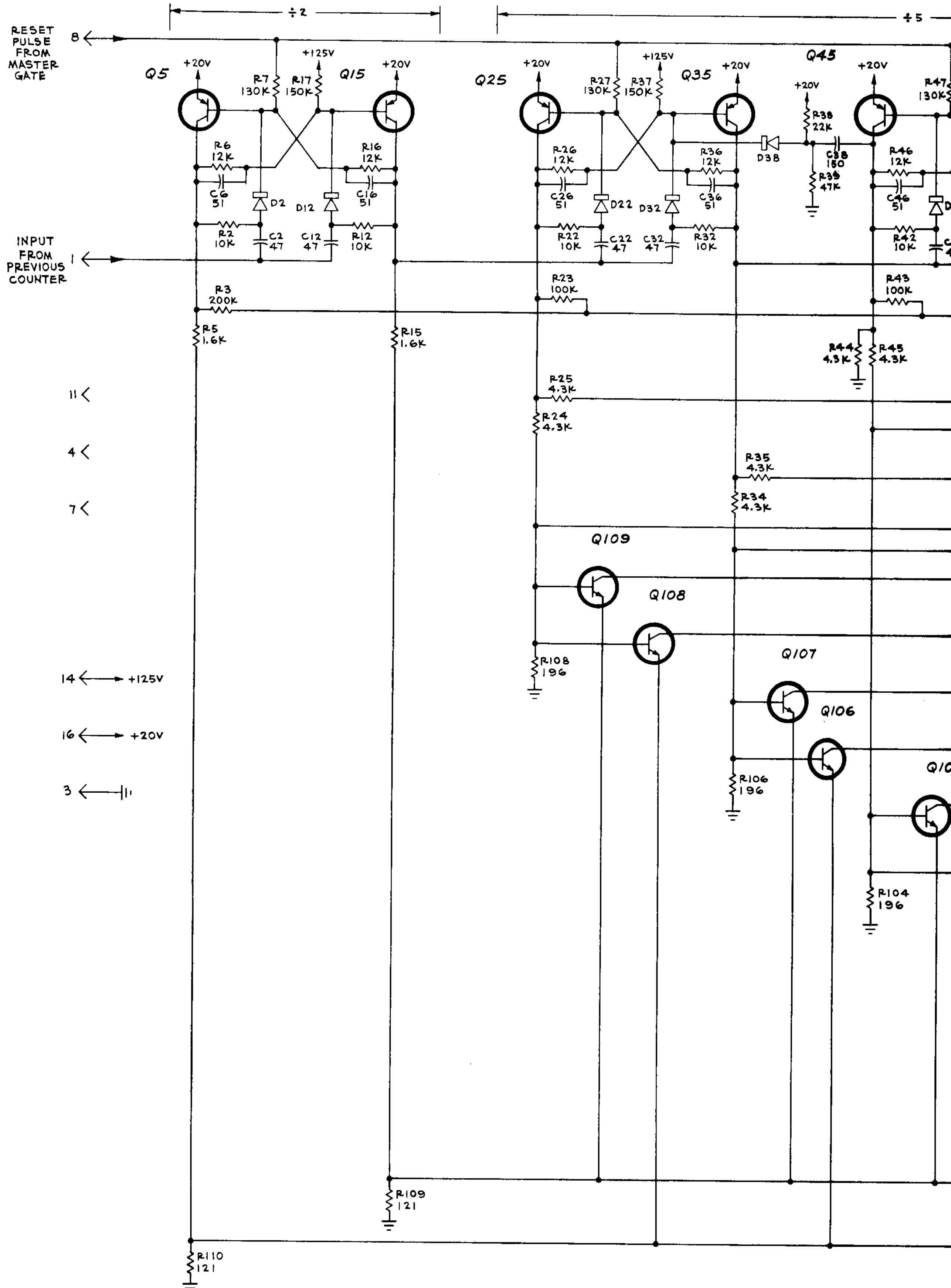


SERIES H MODEL I

LIMIT LIGHT DRIVER

A

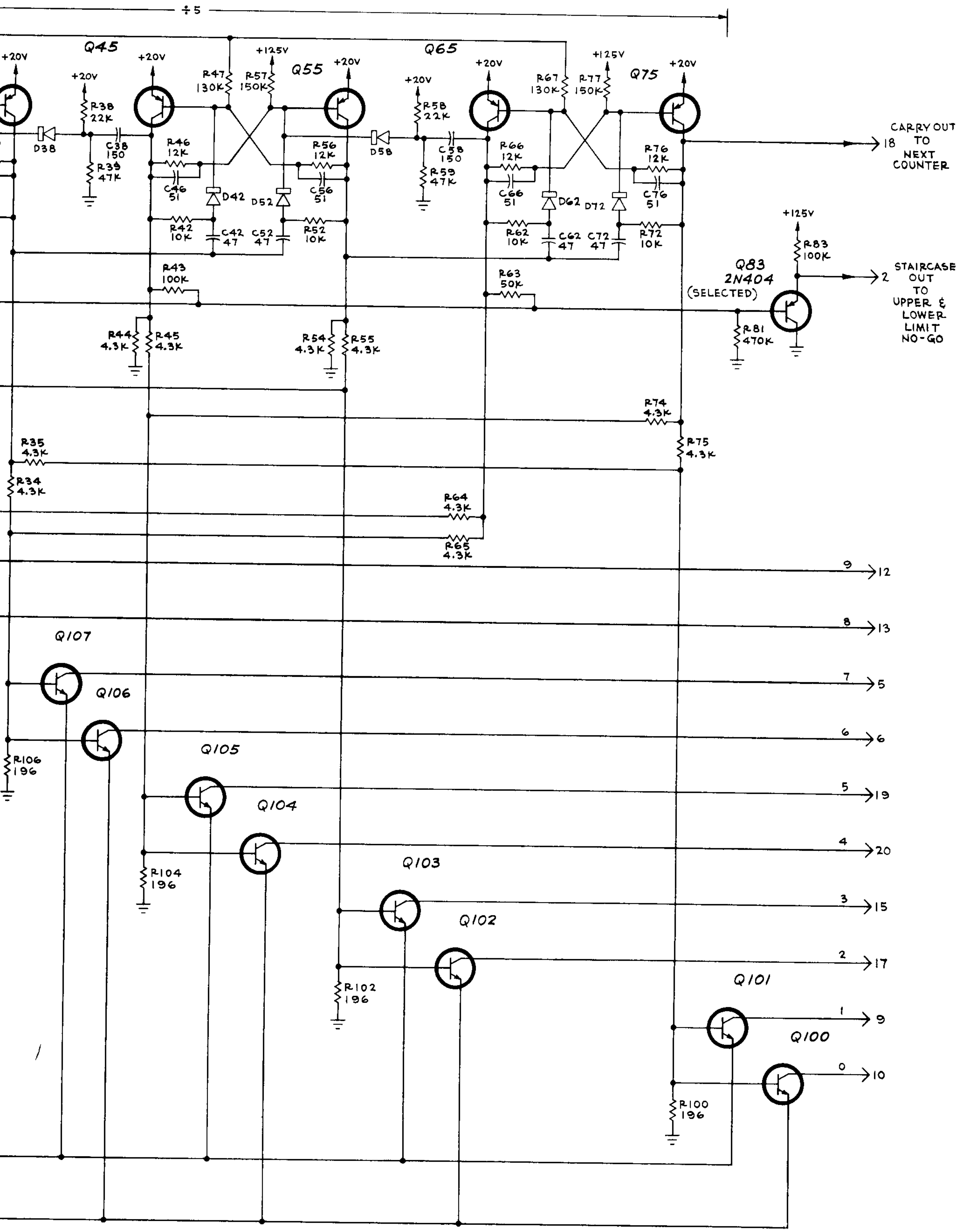
364



÷2
÷5
RESET PULSE FROM MASTER GATE
INPUT FROM PREVIOUS COUNTER
Q5
Q15
Q25
Q35
Q45
Q109
Q108
Q107
Q106
+20V
+125V
R7 130K
R17 150K
R6 12K
C6 51
R16 12K
C16 51
D2
D12
R2 10K
C2 47
C12 47
R12 10K
R3 200K
R5 1.6K
R15 1.6K
R27 130K
R37 150K
R26 12K
C26 51
D22
D32
R36 12K
C36 51
R22 10K
C22 47
C32 47
R32 10K
R23 100K
R25 4.3K
R24 4.3K
R35 4.3K
R34 4.3K
R38 22K
C38 150
R39 47K
D38
R46 12K
C46 51
R42 10K
R43 100K
R44 4.3K
R45 4.3K
R108 196
R106 196
R104 196
R109 121
R110 121
14 +125V
16 +20V
3
11
4
7
8
1

TYPE 6R1A

A1



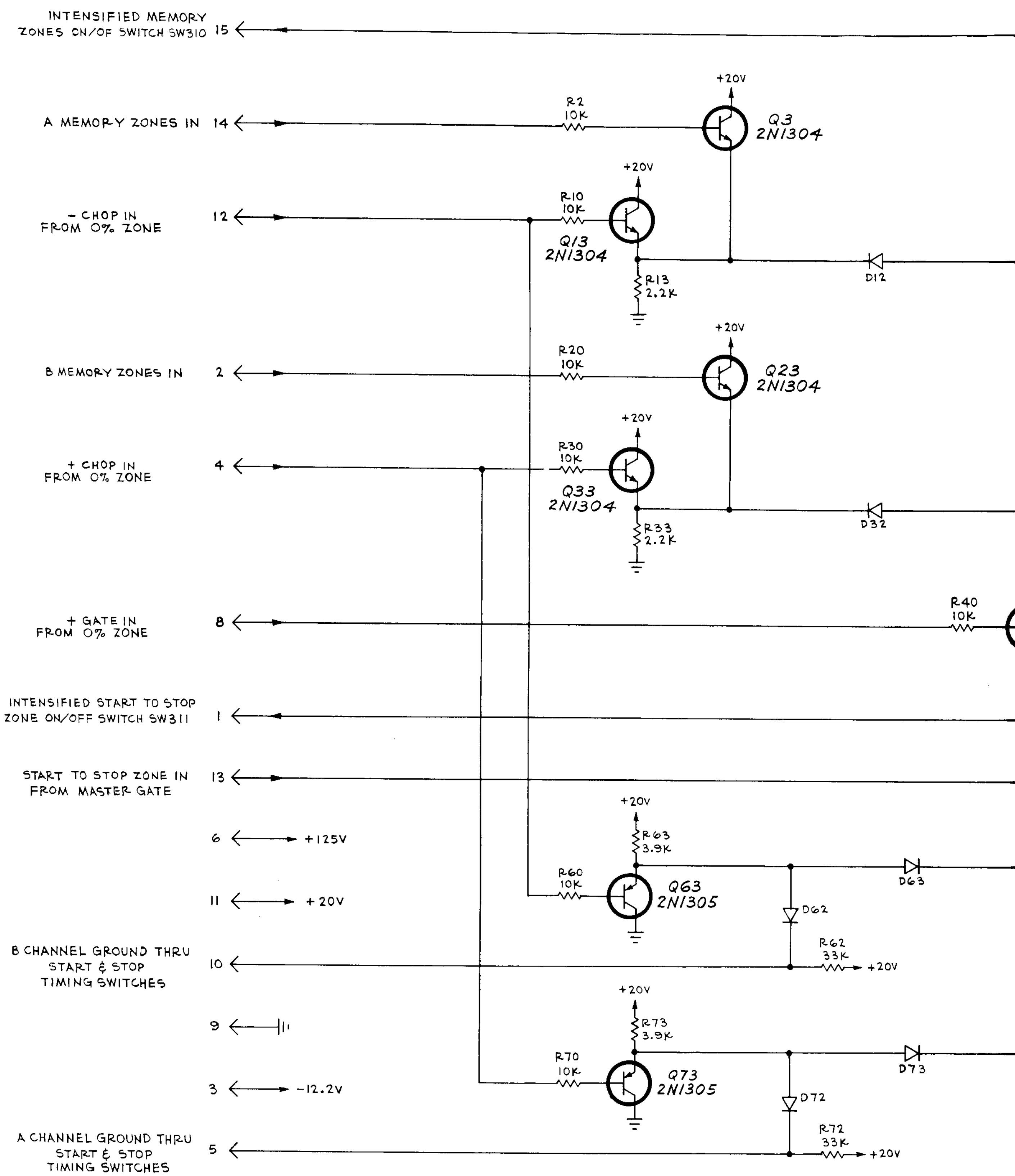
SEE PARTS LIST FOR
SEMICONDUCTOR TYPES

SERIES A MODEL 3

COUNTER

GAB
364

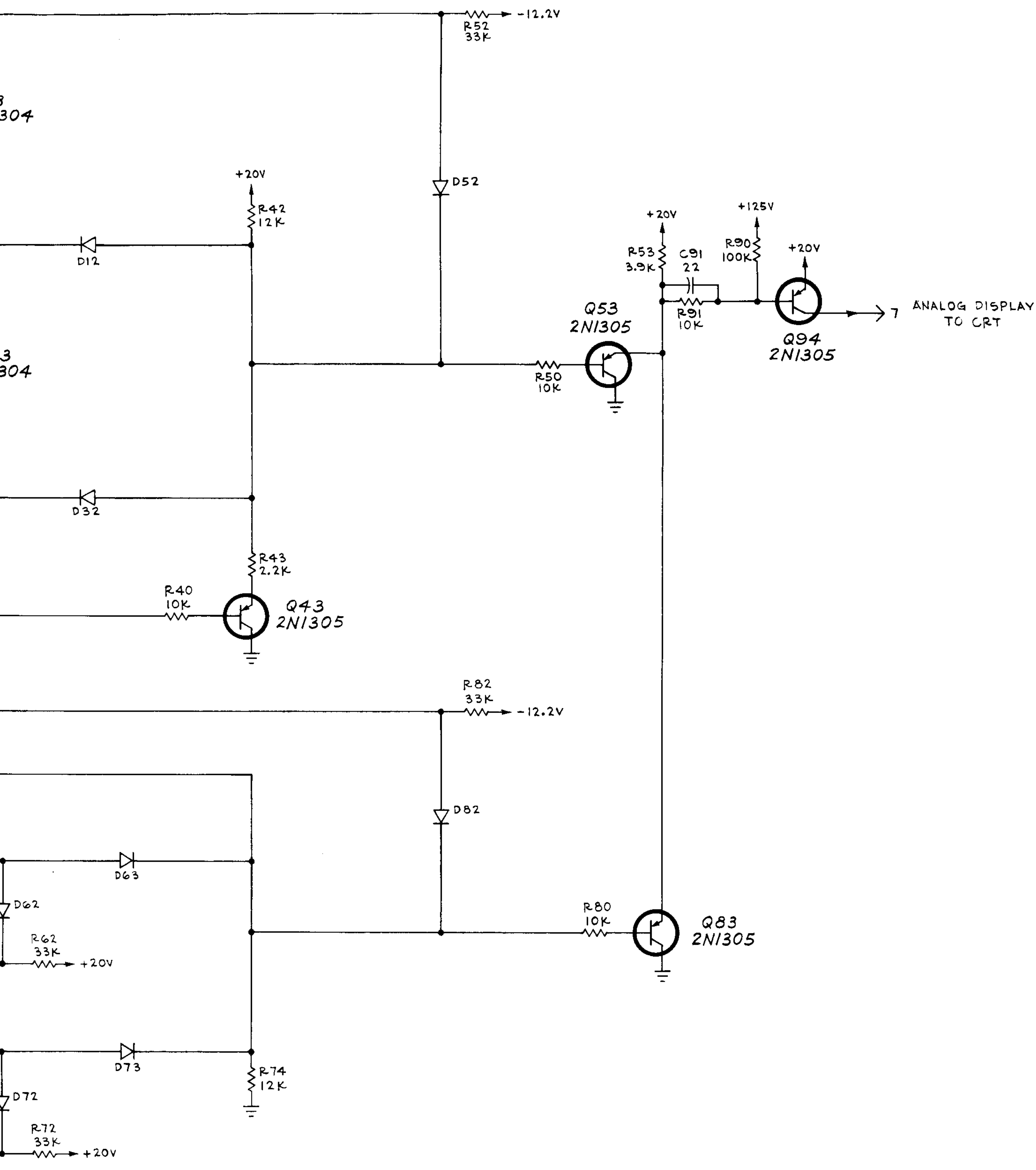
A1



INTENSIFIED MEMORY ZONES ON/OF SWITCH SW310 15
A MEMORY ZONES IN 14
R2 10K
+20V
Q3 2N1304
- CHOP IN FROM 0% ZONE 12
R10 10K
Q13 2N1304
R13 2.2K
D12
B MEMORY ZONES IN 2
R20 10K
Q23 2N1304
+ CHOP IN FROM 0% ZONE 4
R30 10K
Q33 2N1304
R33 2.2K
D32
+ GATE IN FROM 0% ZONE 8
R40 10K
INTENSIFIED START TO STOP ZONE ON/OFF SWITCH SW311 1
START TO STOP ZONE IN FROM MASTER GATE 13
6 +125V
11 +20V
R63 3.9K
R60 10K
Q63 2N1305
D62
D63
B CHANNEL GROUND THRU START & STOP TIMING SWITCHES 10
R62 33K
9
3 -12.2V
R73 3.9K
R70 10K
Q73 2N1305
D72
D73
A CHANNEL GROUND THRU START & STOP TIMING SWITCHES 5
R72 33K

TYPE 6R1A

A



SERIES J MODEL I

A

ANALOG DISPLAY

GAB
364

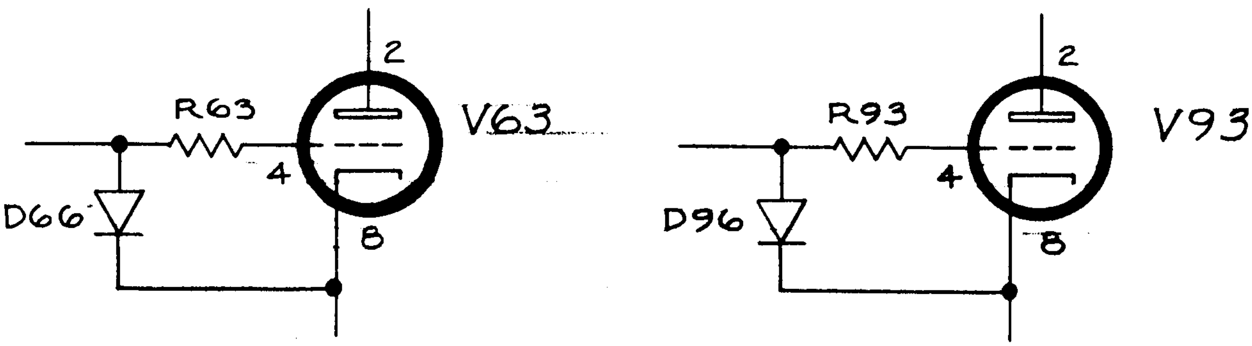
MANUAL CHANGE INFORMATION

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.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

SCHEMATIC CORRECTION



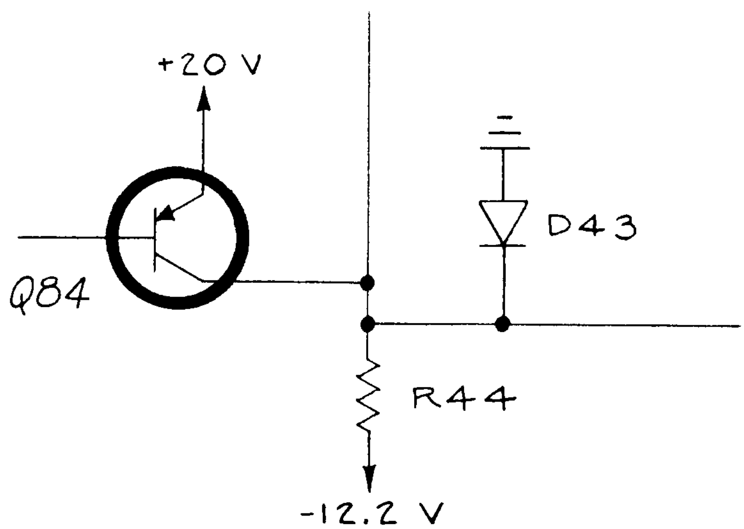
PARTIAL- 0% & 100% MEMORIES

SCHEMATIC CORRECTION

÷ 1, 2, 5 ◇15

Series B Model 3-5

CHANGE: the position of D43 as shown below:



TEXT CORRECTION

Section 6 Calibration

Page 6-2 Column 2, Step 2(c)

CHANGE: Line 4 to read:

the horizontal plug-in unit for 10 dots per division.

TEXT CORRECTION

Section 6 Calibration

Page 6-1 Column 1

ADD:

NOTE

If done in sequence, the following procedure returns the instrument to original performance standards. Limits, tolerances and waveforms in this procedure are given as calibration guides and are not instrument specifications.

ELECTRICAL PARTS LIST CORRECTIONS

÷ 1, 2, 5 CARD (1) Series R

CHANGE:

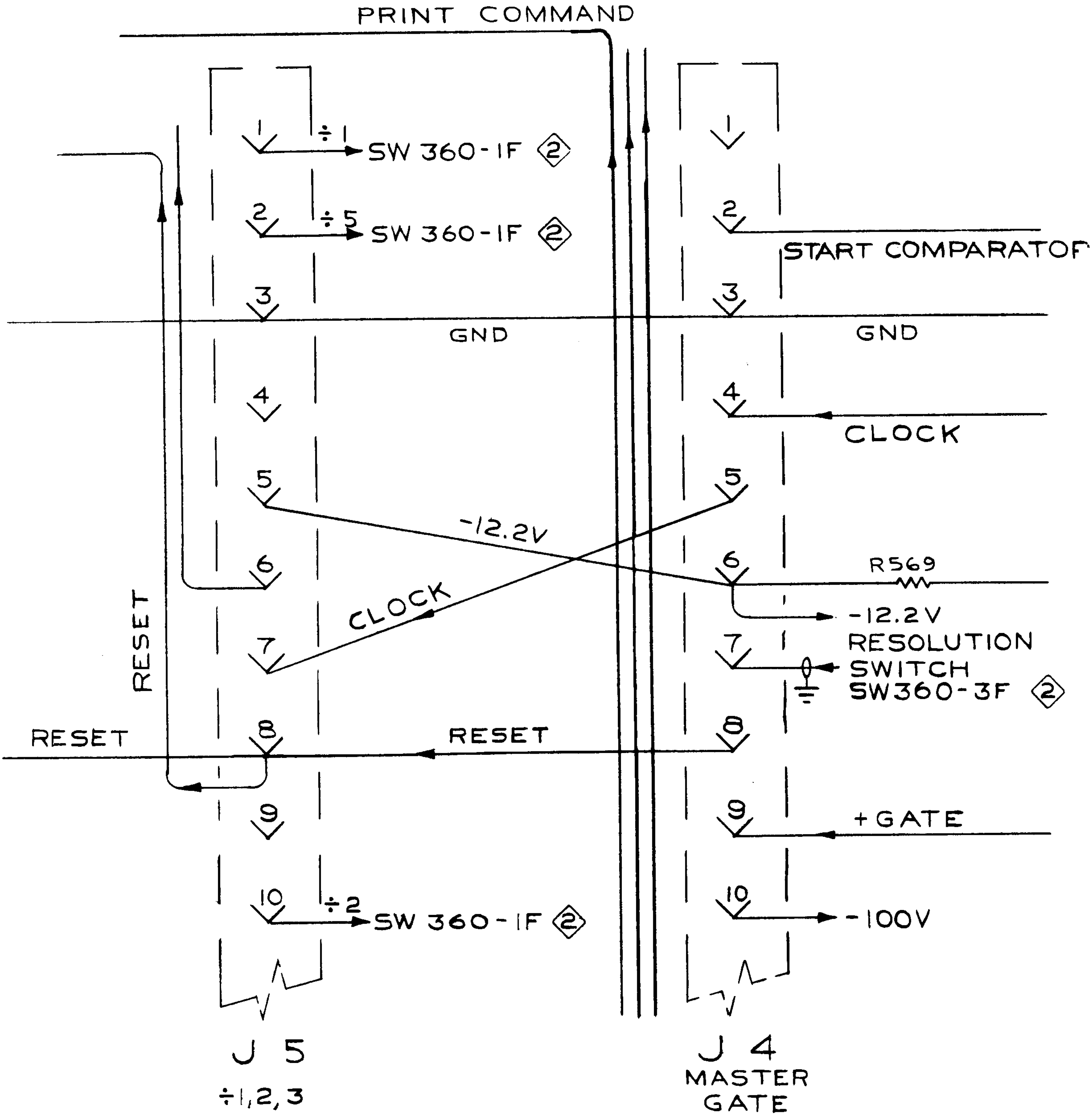
R44	301-0332-00	3.3 kΩ	1/2 W	5%	Model 1-up

ADD:

D43	152-0141-02	Silicon	1N3605		Model 1-up

M11,465/669

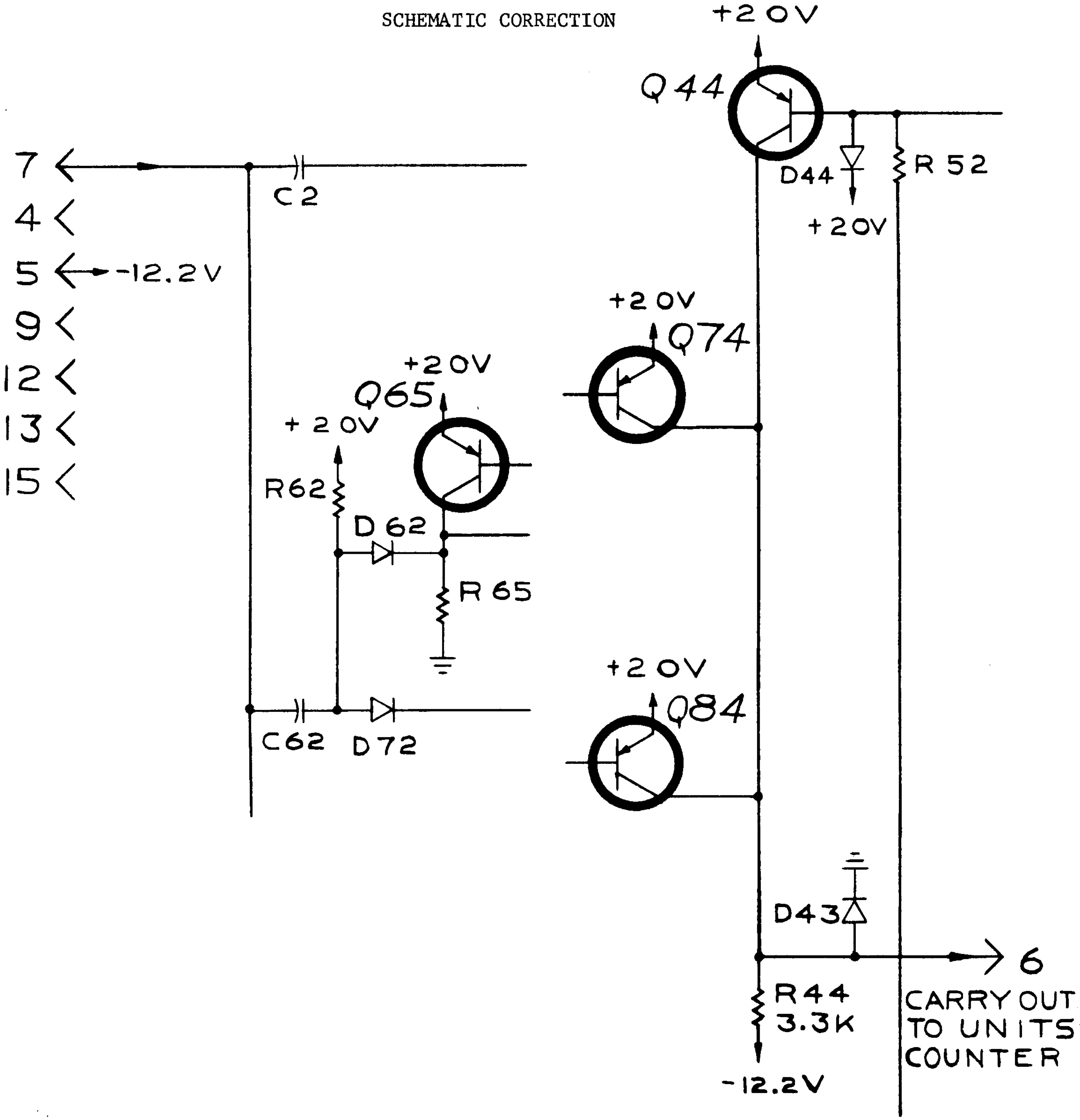
SCHEMATIC CORRECTION



PARTIAL

PLUG-IN CIRCUIT CARD CONNECTORS ⑧

SCHEMATIC CORRECTION



PARTIAL
÷1,2,5
SERIES R, MODEL 1-UP