Errata

Title & Document Type: 3440A Digital Voltmeter Operating and Service Manual

Manual Part Number: 03440-90005

Revision Date: July 1970

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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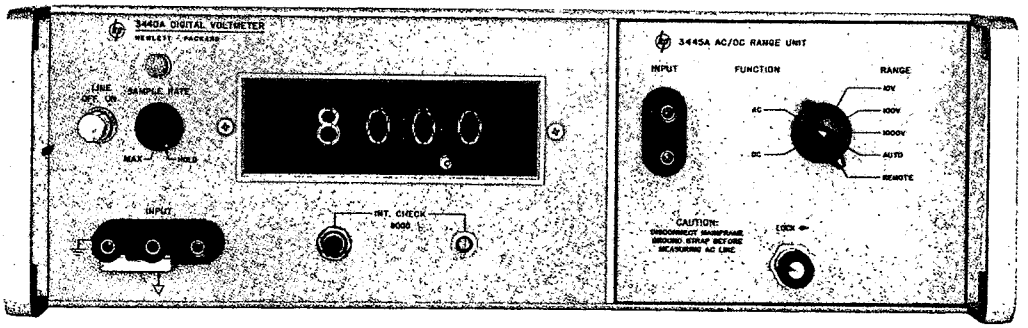
OPERATING AND SERVICE MANUAL

DIGITAL VOLTMETER

3440A



HEWLETT hp PACKARD

OPERATING AND SERVICE MANUAL

-hp- Part No. 03440-90005

MODEL 3440A
DIGITAL VOLTMETER

Serials Prefixed: 981-

Appendix C, Manual Backdating Changes, adapts manual to lower serial prefix numbers.

P. O. Box 301, Loveland, Colorado, 80537 U.S.A

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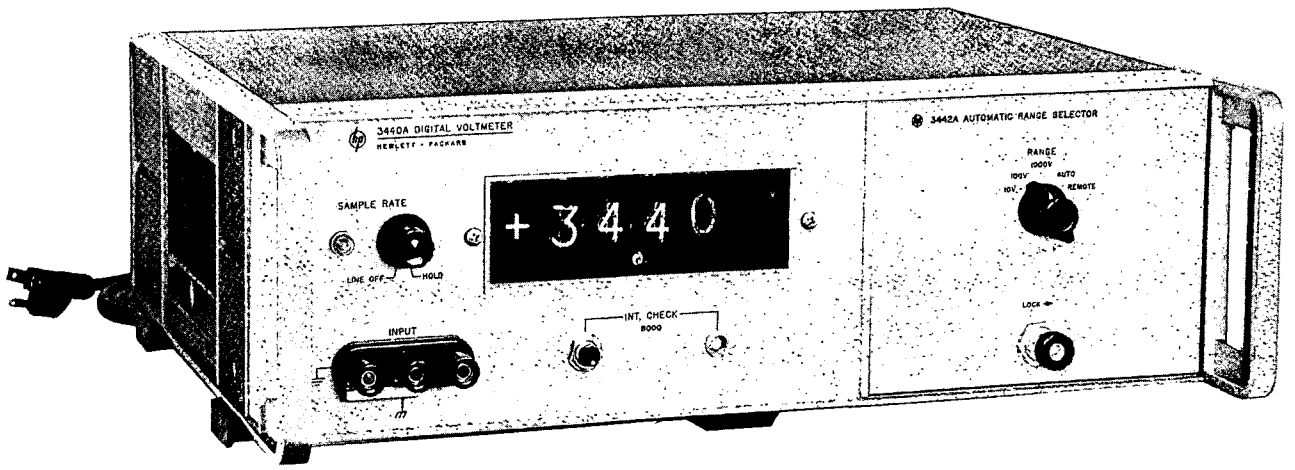


Figure 1-1. Model 3440A Digital Voltmeter

Table 1-1a. Specifications (Basic Unit)

*Available Plug-in Units:
Model 3441A Range Selector
Model 3442A Automatic Range Selector
Model 3443A High Gain/Auto Range
Model 3444A DC Multi-Function Unit
Model 3445A AC/DC Range Unit
Model 3446A AC/DC Remote Unit
*3440A requires a plug-in to operate.

Sample Rate: 5 samples per second to 1 per 5 seconds with storage during samples and "Hold." In "Hold," a sample may be initiated by applying a +10-volt pulse 20 μs wide or greater (ac coupled), or by contact closure.

DC Isolation: Signal common may be floated up to 500 volts dc from chassis ground.

BCD Output:
Output: 4-line BCD* (1-2-2-4) 6 columns consisting of 4 digits of data, polarity/function and decimal.
*4-line BCD (1-2-4-8) available on special order.

Impedance: 120K maximum, each line.
"0" state level: -24 volts.
"1" state level: -1 volt.

Reference Levels:
Positive: approximately -2.5 volts, 330 ohms source impedance.
Negative: approximately -27 volts, 920 ohms source impedance.

Print Command: Generated internally, hold-off level 12 vdc. Print level -2 vdc from 100 ohm source.

Hold-off Requirements: Anywhere from +6 volts to +15 volts max. from source impedance less than 2000 ohms. (Provided by -hp- 562A Digital Recorder.)

Power: 115 or 230 volts ±10%, 50 to 1000 Hz 20-30 watts depending on plug-in used.

Weight: Net, 18 lbs. (8 kg.); Shipping, 29 lbs. (13 kg.).

Dimensions: 16-3/4" wide, 5-7/32" high, 13-1/4" deep (426 x 133 x 337 mm).

Accessories Available:
K01-3440A Plug-in Extender.
J74-562A/AR Digital Recorder for use with -hp- 3440A accepting 1-2-2-4 BCD code. (Floating Operation) Includes special printwheel, 6 BCD column boards, input connector assembly with cable.
J75-562A/AR, same as J74-562A/AR except for single character function symbol.

Table 1-1b. Specifications (with -hp- Model 3441A Plug-in Unit)

Voltage Range: 4-digit presentation of 9.999, 99.99, and 999.9 volts full scale with 5% overrange capability and overrange indication.

Voltage Accuracy: ±0.05% of reading ±1 digit, including line voltage variations of ±10% from nominal. A front panel adjustment on the 3440A insures accuracy over the temperature range between +15°C and +40°C and ±0.1% ±1 digit over the temperature range of 0° to 15°C and 40° to 50°C.

Voltmeter Input Impedance: Constant 10.2 megohms (to dc) all ranges.

Input Filter AC Rejection: 10, 100, and 1000 volt ranges: 30 db at 60 Hz, increasing at 12 db/octave.

Input Filter Characteristics:
Response Time: Less than 450 msec to a step function to 99.95% of final value.

Common Mode Rejection:

	10V Range	100V Range	1000V Range
DC	90 db	70 db	50 db
60~	70 db	50 db	30 db

Range Selection: Manual.

Polarity: Automatic indication.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The -hp- Model 3440A Digital Voltmeter displays positive or negative dc voltages to four significant figures from 0.001 volt to 1050.0 volts. A Plug-in unit must be installed in the front panel compartment of the Model 3440A for measurements. Six Plug-in units are presently available for use with the Model 3440A.

1-3. INSTRUMENT DESCRIPTION.

1-4. The Model 3440A Digital Voltmeter is designed to measure dc voltages from 1 millivolt to 1000 volts with an accuracy of ±0.05% ±1 count for operating temperatures between +15°C and +40°C. Accuracy is maintained for overrange voltages of 5% on all ranges, and polarity is automatically indicated. The last completed measurement is displayed until a new measurement cycle is completed. This display storage feature prevents flickering of the readout during the measurement cycle. Measurement sampling time is controlled by the front panel SAMPLE RATE control. Selection of range is controlled by the RANGE switch on the Plug-in unit (see Paragraph 1-6). Mode of operation is also controlled by Plug-in controls.

1-5. Solid state components in the Model 3440A reduce the power consumption and internal heat dissipation, and increase instrument ruggedness. Nearly all circuit components are mounted on plug-in etched circuit boards, allowing easier access for maintenance.

1-6. PLUG-IN UNITS.

1-7. A Plug-in unit is necessary for operation and is an integral part of the voltmeter circuit. Available Plug-ins are listed below. Table 1-2 is a comparison chart of the various Plug-ins.

a. -hp- Model 3441A Range Selector provides manual selection of 10, 100 and 1000 volt range.

b. -hp- Model 3442A Automatic Range Selector provides manual, automatic and remote selection of 10, 100 and 1000 volt range.

c. -hp- Model 3443A High Gain/Auto Range Unit provides manual, automatic and remote selection of 100 and 1000 millivolt; 10, 100 and 1000 volt ranges.

d. -hp- Model 3444A DC Multi-Function Unit provides a manual ranging dc voltmeter, dc milliammeter and ohmmeter. Five ranges are provided for each function. (Full scale voltage ranges from 100 millivolts to 1000 volts; full scale current ranges from 100 microamperes to 1000 milliamperes; and full scale resistance ranges from 1000 ohms to 10 megohms.

e. -hp- Model 3445A AC/DC Range Unit provides manual, automatic, and remote selection of 10, 100, and 1000 volt ranges for both ac and dc voltages.

f. -hp- Model 3446A AC/DC Remote Unit provides ac and dc measurements of 10 v, 100 v, and 1000 v full scale. Both range and function may be selected either manually or remotely.

1-9. INSTRUMENT AND MANUAL IDENTIFICATION.

1-10. Hewlett-Packard uses a two-section eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 3440A described in this manual.

1-11. If the first three digits of the serial number are prefixed with an E or a G, your instrument was produced in Europe. An E000-00000 serial number indicates that the instrument was manufactured in England; a G000-00000 serial number indicates that the instrument was manufactured in Germany.

Table 1-2. Plug-in Function Chart

ⓗPLUG IN	AC VOLTS 10V TO 1000V	DC VOLTS 10V TO 1000V	DC VOLTS 100 MV TO 1000V	DC AMPS	OHMS	REMOTE FUNCTION	AUTO RANGING	FLOATING INPUT	PRINTER OUTPUT	REMOTE RANGING	REMOTE TRIGGERING
3441A	*	✓						✓	✓		✓
3442A	*	✓					✓	✓	✓	✓	✓
3443A	*		✓				✓	✓	✓	✓	✓
3444A	*		✓	✓	✓			✓	✓		✓
3445A	✓	✓					✓	✓	✓	✓	✓
3446A	✓	✓				✓		✓	✓	✓	✓

* TRUE RMS VOLTAGE MEASUREMENTS: 1MV TO 300VOLTS (10CPS TO 10MC) USING THE ⓗ3400A.

SECTION II
INSTALLATION

2-1. INCOMING INSPECTION.

2-2. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Paragraph 5-3. If there is damage or a deficiency, see the warranty on the inside front cover of this manual.

2-3. INSTALLATION.

2-4. Once the Plug-in unit has been installed in the Model 3440A, the instrument is ready for operation. Connect the power cable supplied with the instrument and check for proper power source and power cable requirements.

NOTE

If the Model 3443A High Gain/ Auto Range Unit or the Model 3445A AC/DC Range Unit is used as a Plug-in and your Model 3440A has a serial number below 415-00726, make the modification given in Paragraph 5-67. If your Model 3440A has a serial number below 347-00301, make the modification shown in Paragraph 5-70.

2-5. POWER SOURCE REQUIREMENTS.

2-6. The Model 3440A can be operated from a 115 or 230 volt, 50 to 1000 Hz ac source. Primary power requirements are set by the rear panel LINE VOLTAGE switch. Before plugging the Model 3440A into the power source, check that the designation on the two position LINE VOLTAGE switch matches the line voltage of your power source. The ac line fuse should be a 0.6 ampere, slow-blow type for both 115 and 230 volt modes of operation.

2-7. THREE-CONDUCTOR POWER CABLE.

2-8. To protect operating personnel, National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. The -hp- Model 3440A is equipped with a detachable three-conductor power cable, which, when plugged into the proper receptacle, grounds the instrument. The round, offset pin on the power cable connector is the ground connection. To retain the protection feature when operating the instrument from a two-contact outlet, use a three-conductor to two-conductor adapter and connect the adapter wire to a suitable ground.

2-9. RACK AND BENCH CONSIDERATIONS.

2-10. The Model 3440A Digital Voltmeter is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument. However, the Hewlett-Packard modular instrument enclosure system enables easy conversion from bench to rack model and vice versa. Instructions for the conversion are included with a kit shipped with the instrument and which includes the conversion hardware. The rack mount for the voltmeter is an EIA standard width of 19 inches. When rack mounted in a rack using mounting flanges, additional support at the rear of the instrument should be provided if vibration or similar stress is likely.

2-11. REPACKAGING FOR SHIPMENT.

2-12. The following is a general rule for repackaging an instrument for shipment. If you have any questions, contact your local -hp- Sales and Service Office (see lists in Appendix B for locations).

NOTE

If instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and serial number prefix.

a. Place instrument in original container if available. If original container is not available, a suitable container can be purchased from your nearest -hp- Sales and Service Office.

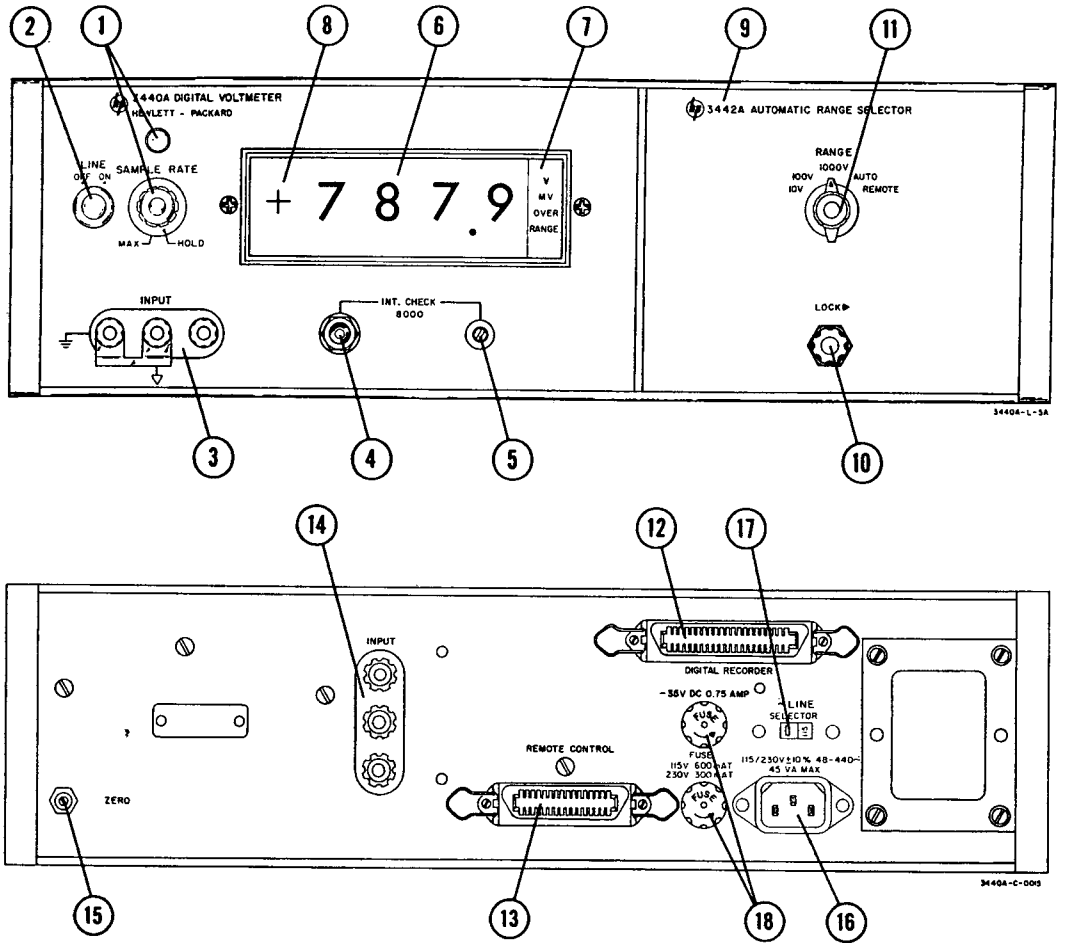
If original container is not used,

b. Wrap instrument in heavy paper or plastic before placing in an inner container.

c. Use plenty of packing material around all sides of instrument and protect panel faces with cardboard strips.

d. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

e. Mark shipping container with "Delicate Instrument," "Fragile" etc.



(1) SAMPLE RATE Control and Indicator : Control varies the voltmeter sampling rate from 5 samples per second to 1 sample every 5 seconds. Stops sampling when placed in HOLD position. Indicator flashes once for each sample.

(2) LINE Switch: Applies primary power to the instrument.

(3) INPUT: Input voltage is applied between the High (red) and Common (▽) terminals. A shorting bar provided with the instrument allows the input signal to be referenced to chassis ground when connected between the instrument Common (▽) and chassis ground (⏚) terminals.

(4) INT CHECK 8000 Pushbutton: Applies -8.000 volts to the input circuits for calibration.

(5) INT CHECK 8000 Screwdriver Adjust: Adjusts Model 3440A for -8.000 display when INT CHECK 8000 is depressed.

(6) Illuminated Readout Display: Indicates voltage magnitude.

(7) Mode Indicator: Indicates instrument measurement units (V or MV) and OVERRANGE.

(8) Polarity Indicator: Indicates input voltage polarity.

(9) Plug-in Unit: Completes Model 3440A circuits and provides range and mode of operation selection.

(10) Plug-in Unit Locking Screw: Locks Plug-in unit in place.

(11) Plug-in Unit RANGE Switch: Selects full scale input. Controls decimal point and mode indicator.

(12) DIGITAL RECORDER: Supplies displayed voltage in binary coded decimal form to a Digital Recorder providing a printed record.

(13) REMOTE CONTROL Connector: Connects remote commands to instrument when a remotely operated plug-in is used. Also connects remote triggers. See Paragraph 3-9.

(14) INPUT: Connected electrically in parallel with the front panel INPUT connector.

(15) ZERO: Sets the digital readout on the front panel for a zero indication.

(16) AC POWER: Connects to the primary power cable supplied with the instrument.

(17) AC VOLTAGE: Sets the Model 3440A for either 115 or 230 volt operation.

(18) -35 VDC and 115/230 Volt Fuse: The -35 vdc fuse is a 0.75 ampere fuse; the 115/230 volt fuse is a 0.6 ampere slow-blow fuse.

Figure 3-1. Front and Rear Panel Description

SECTION III
OPERATING INSTRUCTIONS

3-1. GENERAL.

3-2. The Model 3440A Digital Voltmeter will measure dc voltages to four significant figures. Inputs can be sampled at rates ranging from 5 samples per second to 1 sample per 5 seconds. When used with the appropriate plug-in unit, range selection can be remotely controlled. The Model 3440A is designed to provide output information to a Digital Recorder. (Refer to plug-in manual for measurements other than dc voltages.)

3-3. FRONT AND REAR PANEL DESCRIPTION.

3-4. A description of front and rear panel controls and indicators is given in Figure 3-1.

3-5. OPERATING INSTRUCTIONS.

3-6. Figure 3-2 shows turn-on procedure. After initial turn-on instructions have been performed, refer to the Plug-in manual for operating instructions.

3-7. OVERRANGE OPERATION.

3-8. The Model 3440A can be operated with input signals 5% overrange with no loss in accuracy giving five-digit resolution at these points. The first significant figure will not be seen under these circumstances. For example, if the 10-volt range is selected and the input voltage is 10.500 volts, the front panel reading would be 0.500 volts and the OVERRANGE light will be lighted.

3-9. REMOTE CONTROL OF SAMPLE RATE AND RANGE SELECTION.

3-10. Sampling can be remotely controlled by placing SAMPLE RATE control in HOLD position: (1) Apply a +10 volt pulse at least 20 microseconds wide to pin 18 of the REMOTE CONTROL connector (J4) on rear panel; or (2) Close a switch between pins 17 and 18 of the REMOTE CONTROL connector (J4). Mating connector for J4 is -hp- Part No. 1251-0084. Figure 6-10 shows the remote connections.

3-11. Refer to the Plug-in manual for remote ranging procedure.

3-12. DIGITAL RECORDER OUTPUT.

3-13. The digital recorder output (J2) on the rear panel supplies measurement data, function, polarity and range in a 6 column, 4 line, 1224 weight BCD output. -hp- Specification H02-3440A provides the same information in a 1248 weight BCD output. The first column of the printout indicates measurement function and polarity, columns two through five contain the measurement data, and column six indicates the range. Table 3-1 shows the printouts for each function and range.

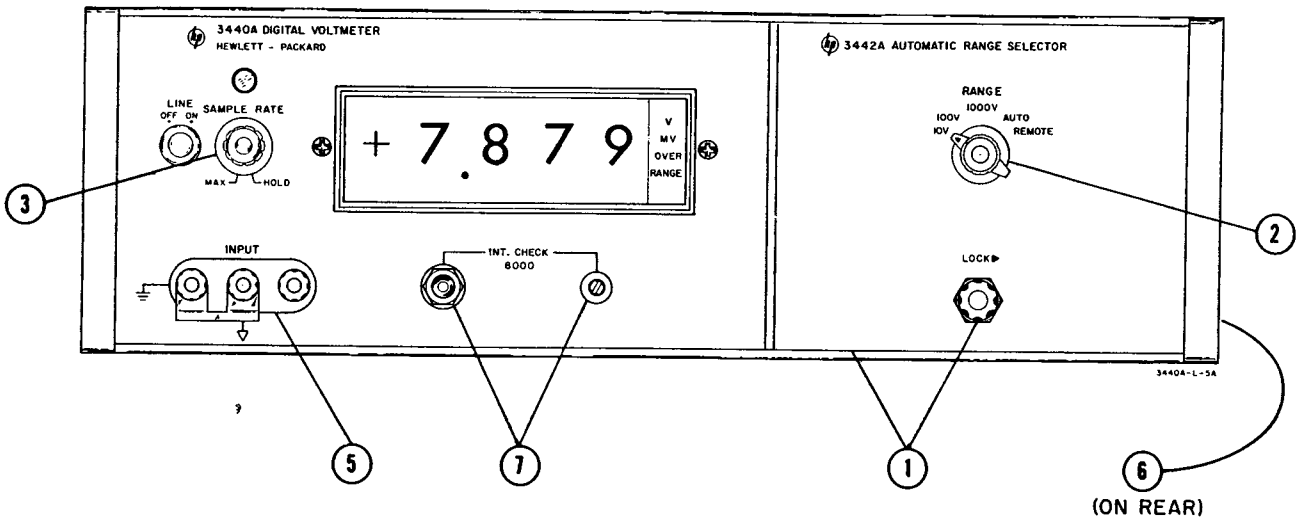
Table 3-1. Function and Range Printouts

FUNCTION (Col. 1)	PRINTOUT		RANGE (Col. 6)	PRINTOUT (Both Codes)
	1224 CODE	1248 CODE		
+ VOLTS	0	0	100 μA 100 mV	5
- VOLTS	1	1	1000 μA 1000 mV 1000 Ω	4
+ AMPS - AMPS	2 3	2 3	 10 mA 10 V 10 kΩ	3
AC VOLTS	4	6	100 mA 100 V 100 kΩ	2
OHMS	5	5	1000 mA 1000 V 1000 kΩ	1
OVER-RANGE	9	7	10 MΩ	0

3-14. The -hp- Model 562A Digital Printer is compatible with the Model 3440A, and the 562A-16C Cable Assembly included with the Model 562A mates with the J2 connector. The mating connector for J2 has -hp- Part No. 1251-0086. Figure 6-10 shows the J2 connections.

NOTE

The DIGITAL RECORDER OUTPUT is referenced to the front panel input connector and may be either floating or chassis grounded, depending on shorting bar position.



(1) Insert Plug-in unit in the Model 3440A and rotate locking screw fully clockwise.

(2) Set Plug-in unit RANGE switch to 10 V.

(3) Turn instrument on and adjust SAMPLE RATE control to desired rate.

(4) Allow instrument to warm up for approximately 30 minutes.

(5) Short INPUT terminals.

(6) Set the ZERO adjust on rear panel to obtain zero on all four digital readouts. Optimum adjustment occurs when all digits read zero and polarity is switching between (+) and (-). Remove input short.

(7) Depress the INT CHECK 8000 pushbutton and adjust the INT CHECK 8000 Adjust (front panel) for a -8000 indication on the Model 3440A display. Decimal point position depends on Plug-in RANGE switch, and does not affect this check.

(8) Repeat step (7) two hours after turn on and then once every eight hours if instrument is left on continuously. If instrument is turned off after use, repeat entire turn-on procedure each time it is turned on. For optimum accuracy, perform step (7) before making a measurement.

Figure 3-2. Turn On Procedure

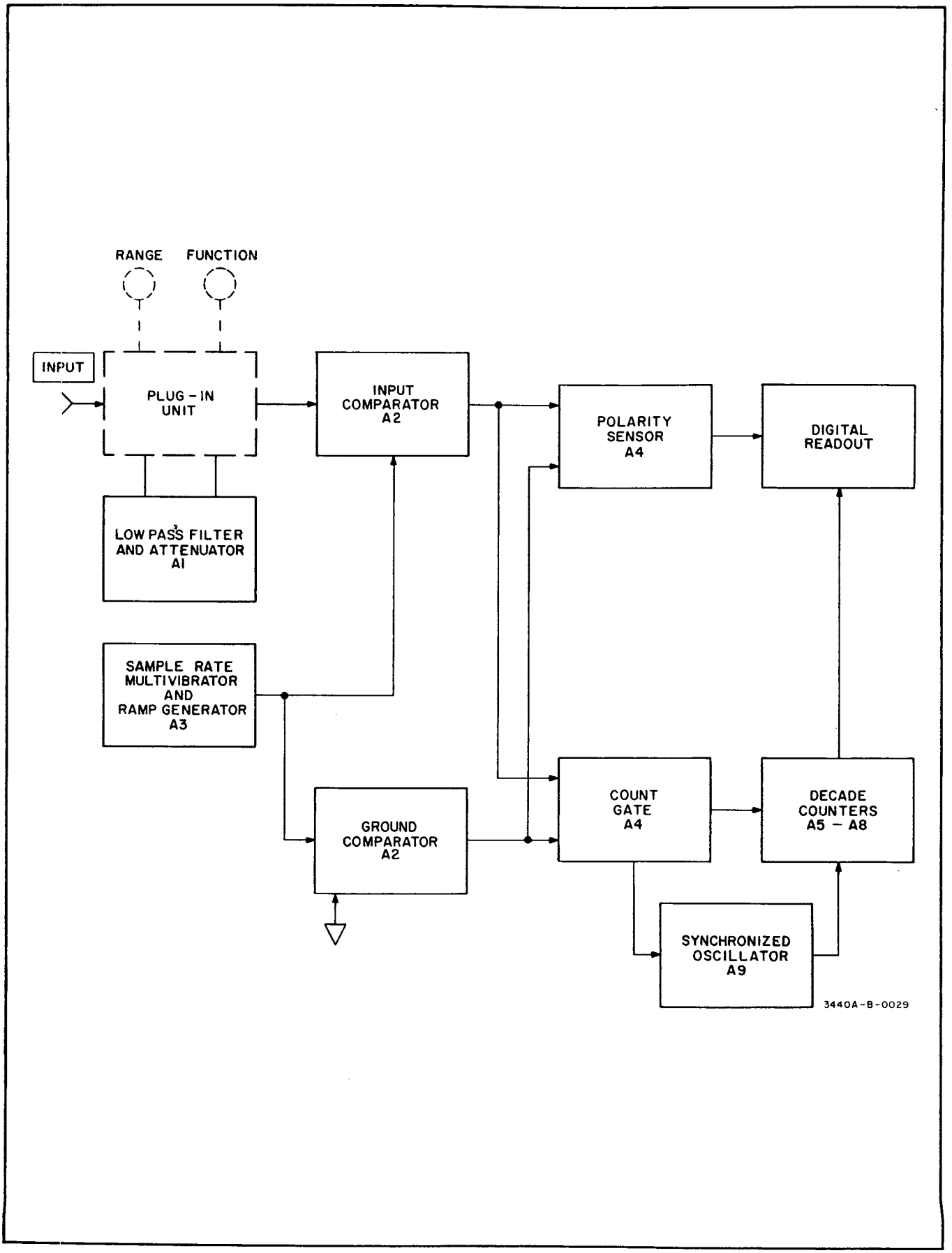


Figure 4-1. Simplified Block Diagram

SECTION IV
THEORY OF OPERATION

4-1. GENERAL.

4-2. The measurement technique used in the Model 3440A is a sampling process. During each sample, the input voltage is compared with a very linear internally generated ramp voltage, producing a pulse upon coincidence. The reference (ground) is also compared with the ramp voltage producing another pulse. The time interval between these two pulses is measured and displayed on the front panel readout. Polarity is automatically indicated by the order in which these pulses are generated.

4-3. Refer to Figure 4-1, Simplified Block Diagram, and Figure 4-3, Detailed Block Diagram, for a description of the Model 3440A operation.

4-4. The input signal is applied to the Plug-in unit. Depending on the position of the Plug-in unit function and range switches, this signal is either modified by the Plug-in unit or applied to the Low Pass Filter and Attenuator A1. From the Low Pass Filter and Attenuator, the signal is returned to the Plug-in unit RANGE switch which selects the proper range and applies the signal to the Input Comparator A2. (Refer to Plug-in manual for discussion of the plug-in unit function.)

4-5. The Input Comparator A2 compares the input dc voltage from the plug-in unit with an internally generated ramp voltage. A pulse is produced when the ramp reaches the same level as the input voltage. Another pulse is produced when the ramp passes through zero (ground). These two pulses are applied to the Polarity Sensor and Count Gate A4. The Polarity Sensor lights the proper sign on the front panel display. The Count Gate controls the 400 Kc Synchronized Oscillator A9 and the Decade Counters (A5 - A8). During the time interval between the two comparator pulses, the decade counters count the oscillator pulses and display the total count on the front panel. The last completed count is stored in the display circuits until a new measurement is completed. This storage feature prevents the readout from flickering during the count.

4-6. LOGIC SYMBOLOGY.

4-7. Some of the circuits in the Model 3440A are explained in terms of logic symbology (AND Gates, OR Gates etc). All the basic information required to understand the logic symbology and circuits discussed in this section is given in Table 4-2.

4-8. The Model 3440A uses positive true logic unless otherwise noted. A zero or false state is approximately -15 to -35 volts (relatively negative). A one or true state is approximately 0 to -2 volts (relatively positive) unless otherwise noted.

4-9. TIMING.

4-10. During each sample, the Model 3440A follows a specific time sequence as shown in Table 4-1.

Table 4-1. Timing Sequence

TIME	DESCRIPTION	CIRCUIT ACTION
T_0 (0 msec)	Reset	Beginning of Sample Voltage Comparator Reset Ramp started Decade Counters Reset Transfer inhibited
T_I (4 to 56 msec)	Input Voltage Comparison	Ramp Voltage equal to Input Voltage Count Gate opened if Input Voltage positive Count Gate closed if Input Voltage negative
T_G (30 msec)	Reference Comparison	Ramp Voltage Zero Count Gate opened if Input Voltage negative Count Gate closed if Input Voltage positive
T_2 (60 msec)	End of Ramp	End of Ramp Sample Rate Multivibrator reset Transfer enabled Print Command generated
T_3 (85 msec)	Recovery	Ramp Capacitor recharged Ready for new sample
T_0 200 ms to 5 sec (depends on sample rate setting)	Reset	Beginning of next sample.

LOGIC SYMBOLS

+ within a symbol indicates positive true logic

- within a symbol indicates negative true logic

1 indicates true signal

0 indicates false signal


on symbol indicates dc coupling


on symbol indicates ac coupling


on symbol indicates logical inversion (not necessarily electrical)

indicates direction of signal flow

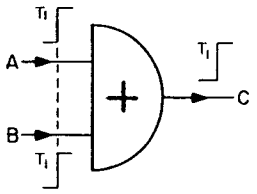
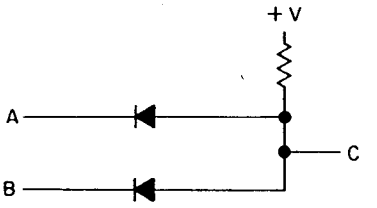
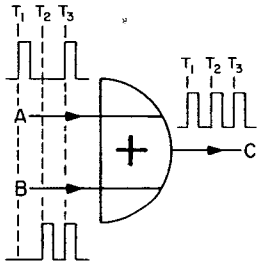
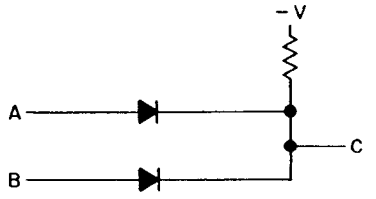
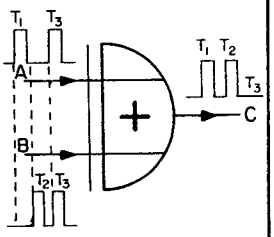
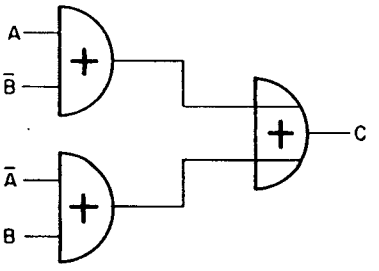
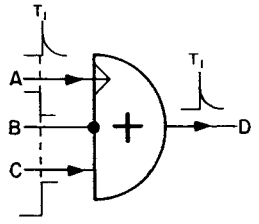
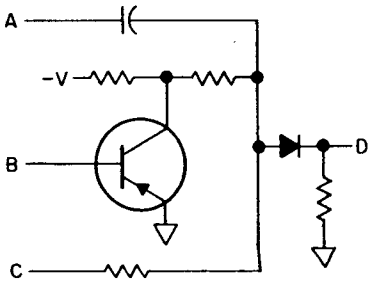
Desig.	Logic Symbol	Description	Truth Table	Equivalent Circuit
AND Gate		Both input signals (A and B) must be true simultaneously to produce a true output at C.	A B C 0 0 0 0 1 0 1 0 0 1 1 1	
OR Gate		If either input signal (A or B) or both is true, the output at C is true. (A positive OR Gate is electrically equivalent to a negative AND Gate only when dc coupling is used.	A B C 0 0 0 0 1 1 1 0 1 1 1 1	
Exclusive OR Gate		If either input signal (A or B), but not both, is true, the output at C is true.	A B C 0 0 0 0 1 1 1 0 1 1 1 0	
Multiple Input Gate		Any combinations of inputs may be used with an AND or OR Gate to obtain a desired output. In the AND Gate shown, input A is ac coupled, input B is dc coupled and inverted, and input C is dc coupled without inversion. Inputs A and C must both be true, and input B must be false simultaneously to produce a true output at D.	A B C D 0 0 0 0 0 0 1 0 0 1 0 0 0 1 1 0 1 0 0 0 1 0 1 1 1 1 0 0 1 1 1 0	

Table 4-2. Explanation of Logic Symbology

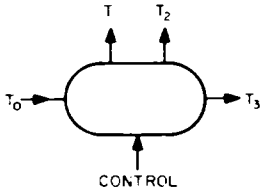
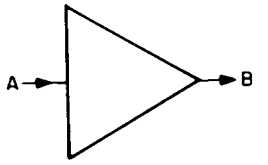
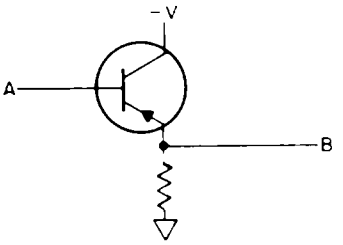
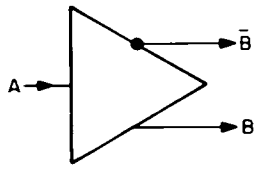
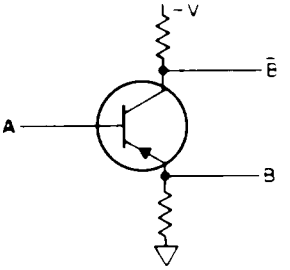
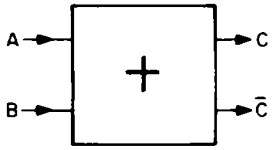
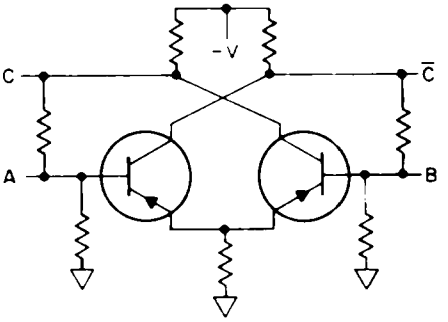
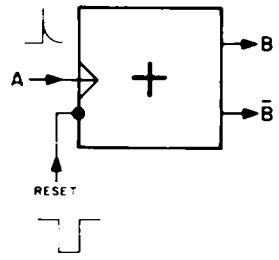
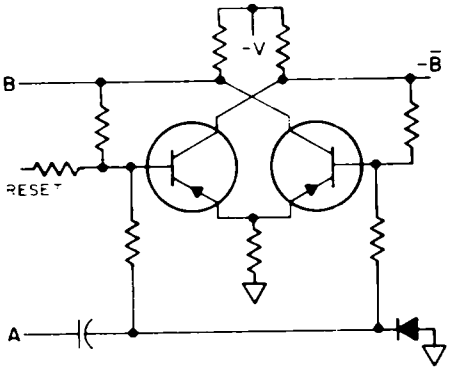
Desig.	Logic Symbol	LOGIC SYMBOLS Description	Equivalent Circuit
Passive Delay		Amount of delay depends on RC or RL time const.	RC or RL coupling
Amplifier		True input at A produces amplified true output at B. An amplifier will function with either positive true or negative true signals.	
Phase Splitter		True input at A produces true output at B and false output at $\overline{B}$ (read as "B bar" or "B not").	
Flip-Flop		Cutputs C and $\overline{C}$ are always in opposite states -- if C is true $\overline{C}$ is false. A true input will cause the output directly across to go true -- true input at A sets output C true. With no input the flip-flop remains in the state set by the last input signal. The flip-flop is considered to be in the zero state if output C is false.	
Binary		The binary is a flip-flop which changes state with every true input pulse at A. Since A is applied to the bases of both transistors,it is shown centered in the symbol. The negative pulse produces the same effect as a positive pulse applied to the opposite base. To preserve the positive logic, the reset pulse is shown inverted and applied to the opposite side.	

Table 4-2. Explanation of Logic Symbology (Cont'd)

Section IV
Paragraphs 4-11 to 4-20 and Figure 4-2

4-11. CONTROL CIRCUITS.

4-12. RAMP GENERATOR.

4-13. The Ramp Generator (Figure 4-2) generates a very linear ramp voltage which decreases from +12 volts to -12 volts. The Ramp Generator is started and stopped by the Ramp Gate (A3Q10, 11). When the ramp decreases to -12 volts, the Ramp Sensor generates a pulse to reset the Sample Rate Multivibrator (refer to Paragraph 4-18) and end the sample.

4-14. At time T_0, the Sample Rate Multivibrator output S goes true. This is inverted by the Ramp Gate placing a reverse bias on the anode of A3CR11. The ramp capacitor begins to discharge. A3QCR1A, A3Q15, and A3Q16 form a current amplifier to increase the linearity of the ramp. Transistor A3Q17 acts as a current source to ensure proper bias for breakdown diode A3QCR1B.

4-15. At T_2, the ramp reaches -12 volts, and the Ramp Sensor (A3Q7, 8) applies a positive pulse to the Sample Rate Multivibrator causing S to go false, ending the sample.

4-16. When S is false, the Ramp Gate forward biases A3CR11 recharging the ramp capacitor toward +12 volts. At time T_3, the ramp capacitor is fully charged, and the Model 3440A is ready for another sample.

4-17. Breakdown diode A3QCR1B establishes a second ramp identical in slope, but at a level 6.6 volts more negative than the first ramp. The second ramp helps to provide a constant current to the Input Comparator (refer to Paragraph 4-41).

4-18. SAMPLE RATE MULTIVIBRATOR.

4-19. The Sample Rate Multivibrator (Figure 4-4) controls sampling rate, Ramp Gate, Reset Pulse and Print Command.

4-20. When the Model 3440A is not sampling, the Sample Rate Multivibrator output $\overline{S}$ (read as "S bar" or "S not") is true. A3C5 then begins to discharge through A3R18, R6, and A3R8. When A3C5 discharges sufficiently, output $\overline{S}$ goes false. This is time T_0 and a sample is started. At time T_2, the ramp voltage reaches -12 volts; and a positive pulse from the Ramp Sensor causes $\overline{S}$ to go true, ending the sample.

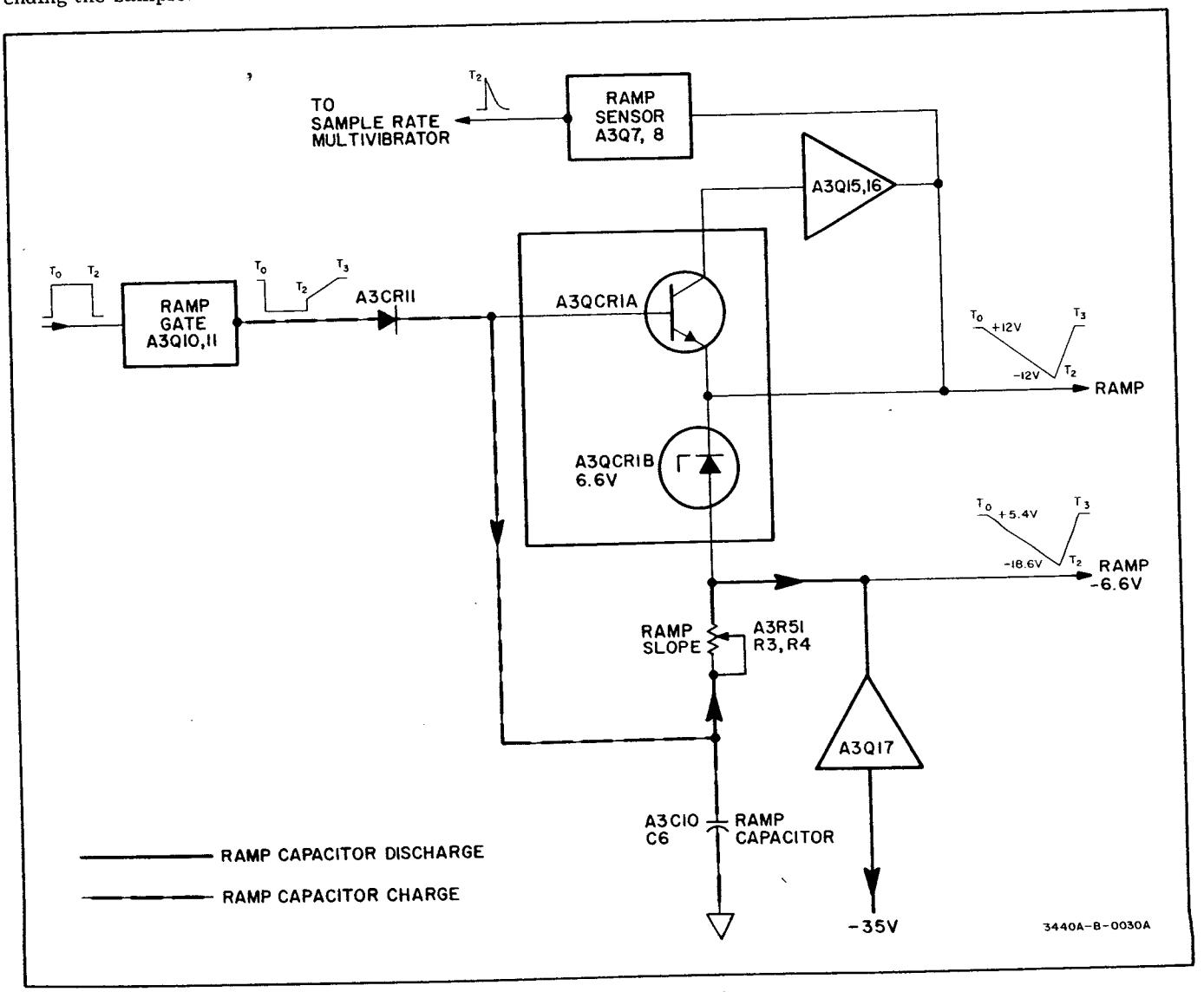


Figure 4-2. Ramp Generator

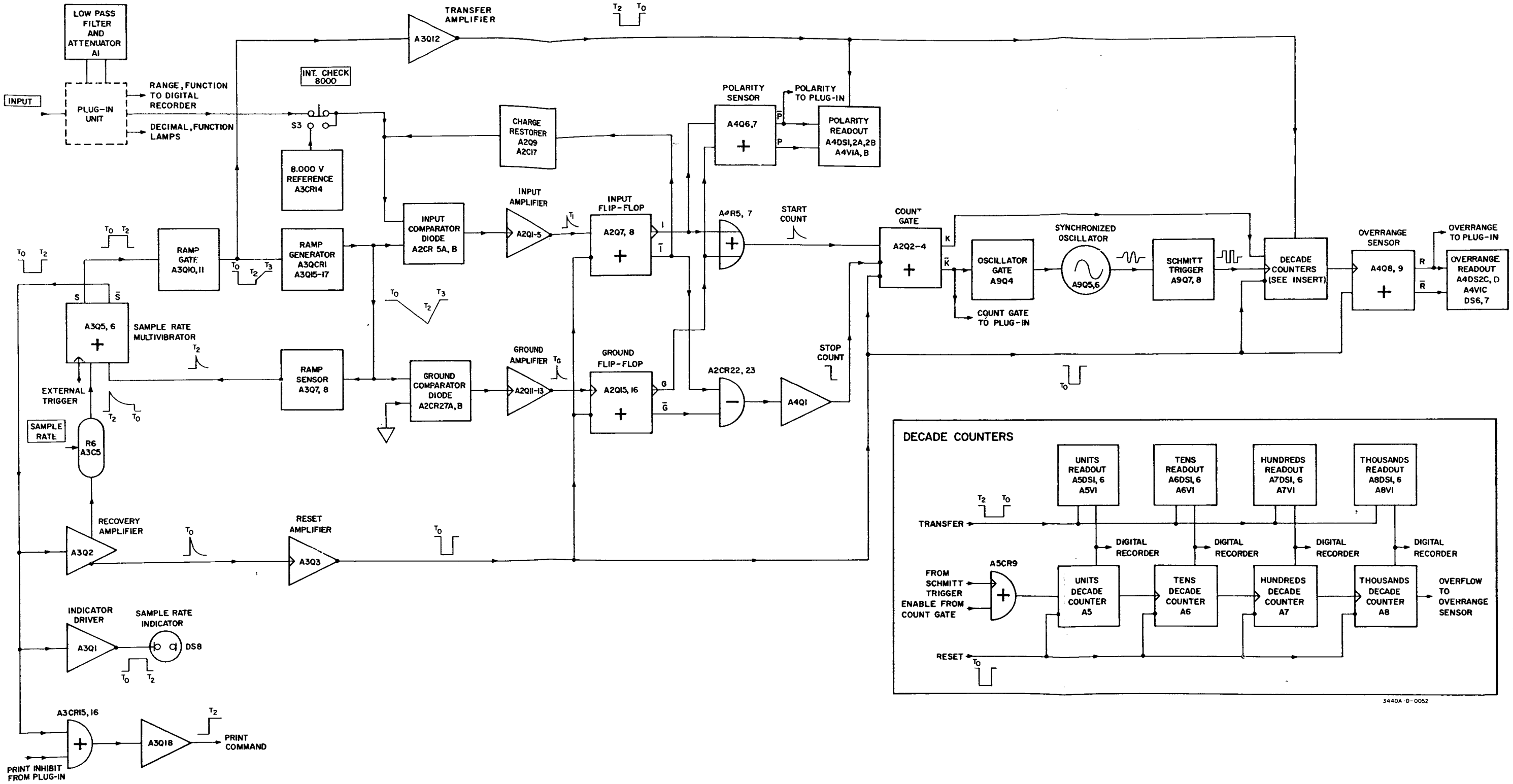


Figure 4-3. Detailed Block Diagram

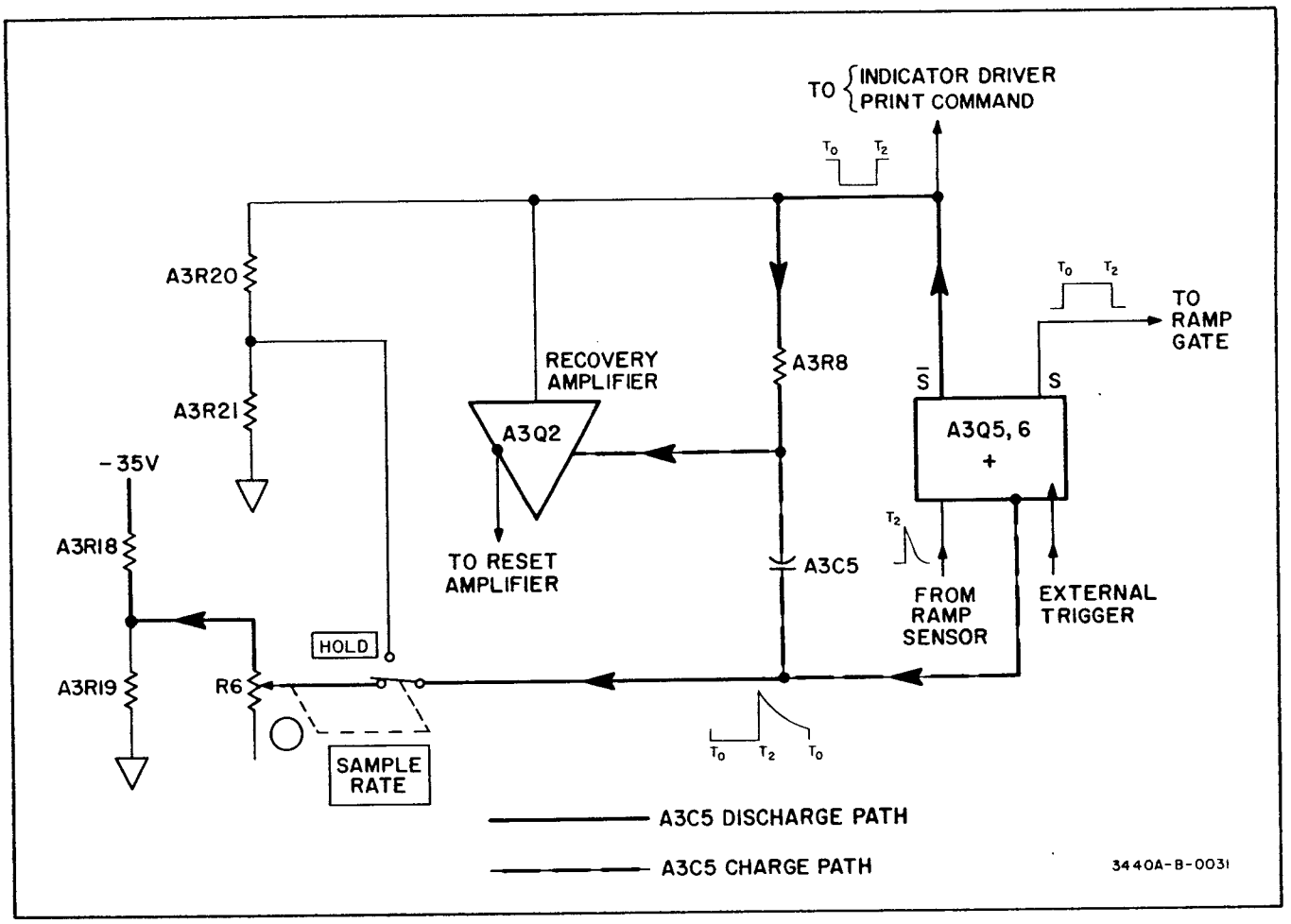


Figure 4-4. Sample Rate Multivibrator

SAMPLE RATE control R6 changes the discharge time of A3C5, allowing a variation in sample rate from 5 samples per second to 1 sample per 5 seconds.

4-21. When SAMPLE RATE control is in HOLD position (maximum clockwise), A3C5 is held at a slightly negative voltage by voltage divider A3R20 and A3R21, which keeps output $\overline{S}$ true, preventing a sample. Under these conditions, applying a positive going pulse to the External Trigger sets $\overline{S}$ false initiating one sample.

4-22. At time T_0, Recovery Amplifier A3Q2 is turned on by $\overline{S}$, quickly recharging A3C5.

4-23. During a sample, Indicator Driver A3Q1 is turned off by $\overline{S}$ causing SAMPLE RATE indicator DS8 to light.

4-24. RESET PULSE.

4-25. The negative reset pulse is generated at time T_0 by Reset Amplifier A3Q3. The reset pulse is applied to the Plug-in unit, Voltage Comparator A2, Count Gate A4, Decade Counter Assemblies A5 - A8, and Overrange Sensor A4. This negative reset pulse prepares these circuits for the start of the next sample by setting them to the zero state.

4-26. At time T_0, A3Q2 is switched to the one state. This positive going transition is differentiated and applied to the Reset Amplifier A3Q3. The differentiated pulse quickly drives A3Q3 into saturation, generating a short duration (20 microseconds) Reset Pulse.

4-27. TRANSFER PULSE.

4-28. The transfer pulse is used to transfer the count contained in the Decade Counters (A5 - A8) to the front panel display. This transfer is accomplished at time T_2 after the decade counters have completed the count. This prevents flickering of the front panel display.

4-29. At time T_2, Sample Rate Multivibrator output S goes false. This signal is inverted by Ramp Gate (A3Q10, 11) which sets the Transfer Amplifier A3Q12 output false. The date contained in the decade counters is then transferred to the front panel display. At time T_0, output S goes true, causing the Ramp Gate to set the Transfer Amplifier output true, preventing the further transfer of data to the front panel display. (Refer to Paragraphs 4-64 through 4-66 for discussion of count storage.)

4-30. PRINT COMMAND.

4-31. At the end of a sample, time T_2, the Print Command is generated to actuate a digital recorder. A signal from the Plug-in unit will inhibit this command preventing a printout during an automatic range change (refer to Plug-in manual for description).

4-32. At time T_2, Sample Rate Multivibrator output $\overline{S}$ goes true, and is direct coupled to the Print Command AND Gate. Normally, the Print Inhibit line from the Plug-in is in the one state allowing the level from $\overline{S}$ through AND Gate. This pulse is amplified by A3Q18 producing the Print Command. If the Plug-in is automatically changing range, the Print Inhibit line is in the zero state preventing the Print Command.

4-33. INPUT CIRCUITRY.

4-34. This section will discuss only the 10, 100 and 1000 volt dc ranges. For discussion of other ranges and functions, refer to the appropriate Plug-in manual.

4-35. LOW PASS FILTER AND ATTENUATOR.

4-36. The input signal is sent through the Plug-in unit to the Low Pass Filter and Input Attenuator A1. The Input Attenuator resistance and capacitance along with Input Comparator A2 capacitance form an rc filter which rejects ac voltages 30 db or more at 60 Hz. The three attenuator outputs (one for each of the three ranges -- 10, 100, and 1000 volts) are returned to the RANGE switch in the Plug-in unit, which selects the proper amount of attenuation and Model 3440A decimal point position. The attenuated voltage is applied to the voltage comparator A2.

4-37. INTERNAL CALIBRATION.

4-38. The reference 8000 circuit provides an accurate reference for internal calibration of the Model 3440A. This calibration voltage is supplied from breakdown diode A3CR14 through a precision voltage divider to the INT CHECK 8000 pushbutton switch S3. When this switch is depressed, -8.000 volts is applied to the Input Comparator A2, and the INT CHECK 8000 Adjust R3 (in Ramp Generator) is adjusted for a front panel display of -8000 to insure that the Model 3440A is within specifications.

NOTE

Plug-in controls do not affect this check.

4-39. VOLTAGE COMPARATORS.

4-40. INPUT COMPARATOR.

4-41. The Input Comparator (see Figure 4-5) compares the input dc voltage from the plug-in unit with the ramp voltage. Prior to coincidence of the ramp voltage and the input, the ramp voltage is more positive than the input voltage. Under this condition, A2CR7 is reverse biased and a constant current is flowing through A2CR5A. A2CR5B is reverse biased until the ramp voltage decreases enough to forward bias it. Current is then drawn from A2C4. This current pulse is amplified and used to trigger the input flip-flop to the I state. $\overline{I}$ becomes false and A2Q9 saturates and reverse biases both A2CR5A and A2CR5B so that no more current will be drawn from the input.

4-42. CHARGE RESTORER.

4-43. When the ramp voltage and the input voltage reach coincidence, some charge is removed from A2C4. The Charge Restorer circuit (see Figure 4-6) is designed to replace this removed charge. This keeps the comparator circuit from loading the attenuator network.

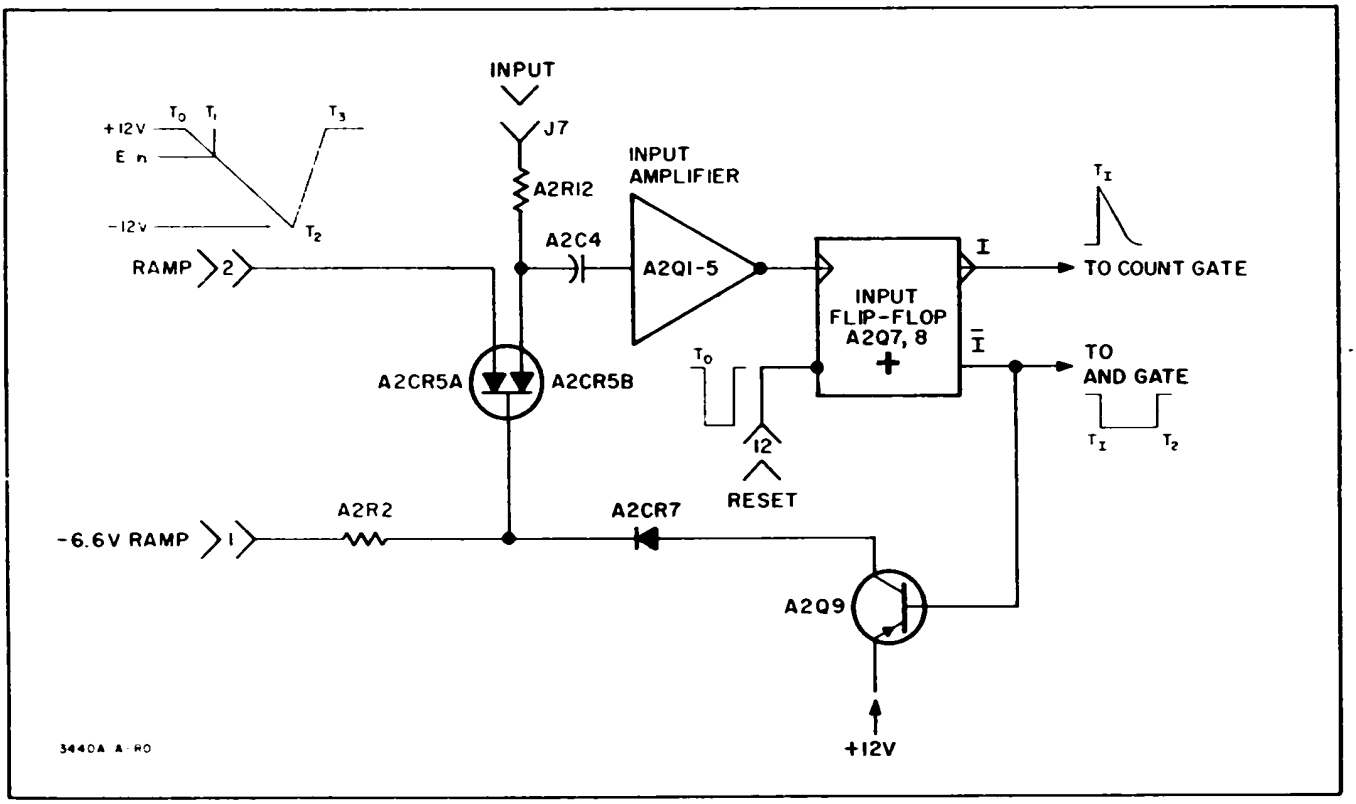


Figure 4-5. Input Comparator

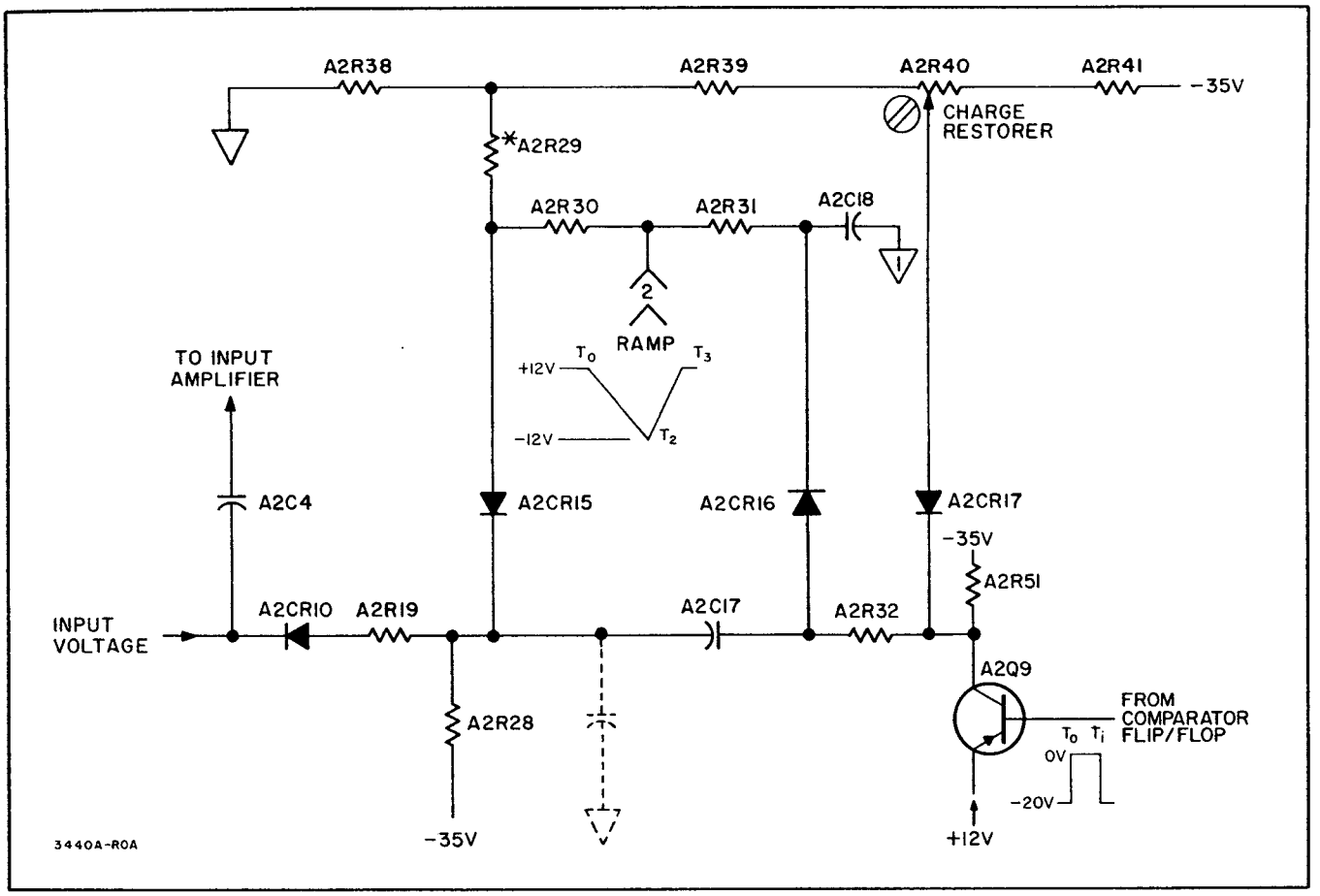


Figure 4-6. Charge Restorer

4-44. During the time interval between T_0 and T_1, A2Q9 is cut off; A2CR17 and A2CR15 are biased on. Diodes A2CR10 and A2CR16 are both reverse biased. A2C18 charges through resistor A2R31 so that its voltage decreases with the ramp voltage and is nearly equal to the ramp voltage. A2C17 charges to a voltage nearly equal to the voltage across A2R39 and that part of A2R40 which is to the left of the wiper.

4-45. At T_1, when coincidence occurs, A2Q9 saturates; A2CR17 and A2CR15 are reverse biased and A2CR16 is forward biased. The right side of A2C17 is clamped to the voltage across A2C18 which is nearly equal to the input voltage. The charge on A2C17 flows through A2CR10 to replace the charge which was removed from A2C4.

4-46. The amount of charge restored to the input is slightly dependent on the input level due to stray capacitance from the left side of A2C17 to ground. A2R30 compensates for the effects of this stray capacitance by reducing the charge on A2C17 as the ramp voltage becomes more negative.

4-47. GROUND COMPARATOR.

4-48. The ground comparator (Figure 4-7) compares the ramp voltage to the circuit ground potential and generates a pulse at coincidence. The ramp voltage forward biases A2CR27A, keeping A2CR27B reverse biased. As the ramp voltage goes more negative than ground level, A2CR7B starts to conduct. This current is mostly supplied by capacitor A2C26 and is amplified by the ground amplifier. The amplifier signal triggers the Ground Flip-Flop into the G state. The change to the G state forward biases A2CR28 preventing either A2CR27A or A2CR27B from conducting for the remainder of the measurement cycle.

4-49. COUNTING AND READOUT CIRCUITS.

4-50. GATING.

4-51. The gating circuits have three functions:

a. Control the Synchronized Oscillator by turning it on with the first comparator coincidence pulse, and turning it off with the second.

b. Control the count enable gate to operate the units decade counter.

c. Supply pulses used in the ranging logic of the automatic ranging plug-in units. (See Plug-in manual for a discussion of ranging.)

4-52. At time T_0, the reset pulse is applied to the count gate to insure it is in the zero state.

4-53. The first comparator pulse is applied to the OR Gate (Figure 4-8) and sets the count gate to the K state. The true K output enables the units decade counter, and the false $\overline{K}$ output starts the Synchronized Oscillator.

4-54. The second comparator pulse enables the AND Gate, and resets the count gate to the $\overline{K}$ state. The true $\overline{K}$ output turns off the Synchronized Oscillator, and the false K output disables the units decade counter.

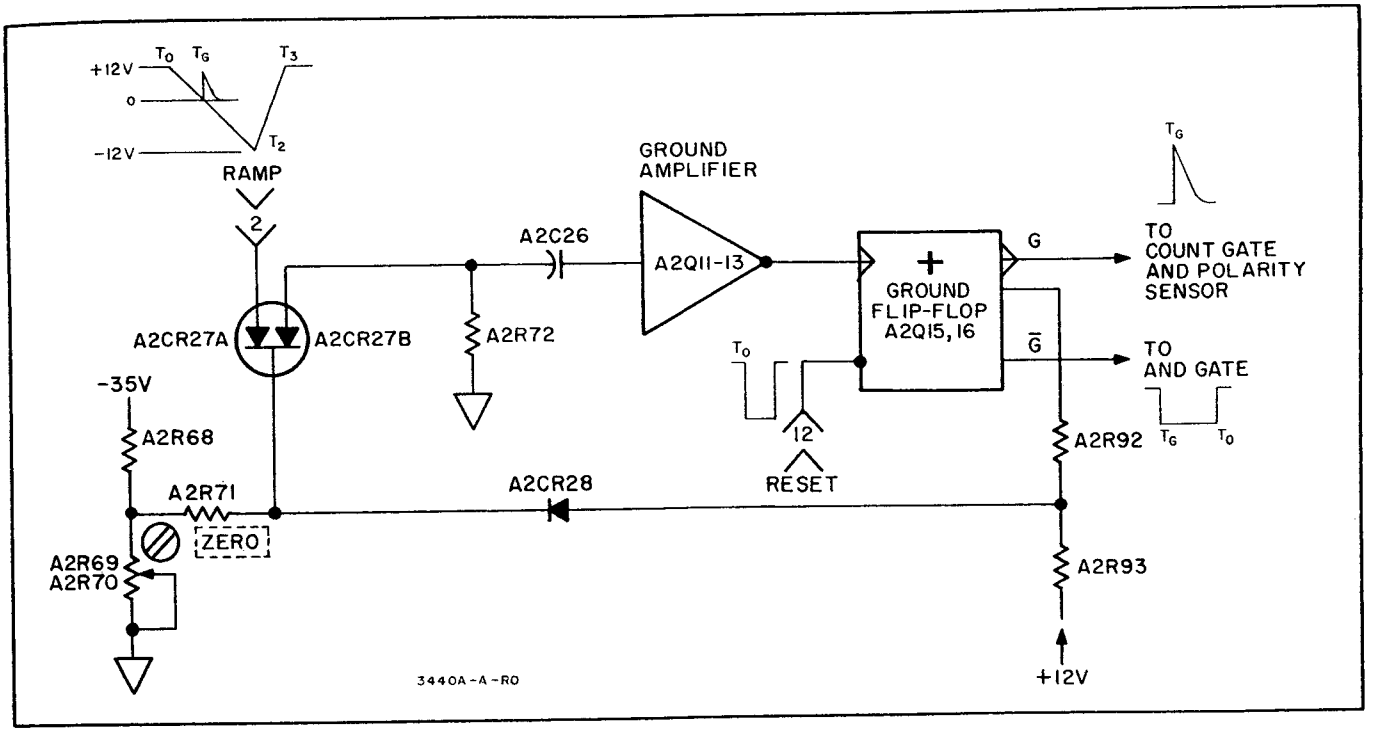


Figure 4-7. Ground Comparator

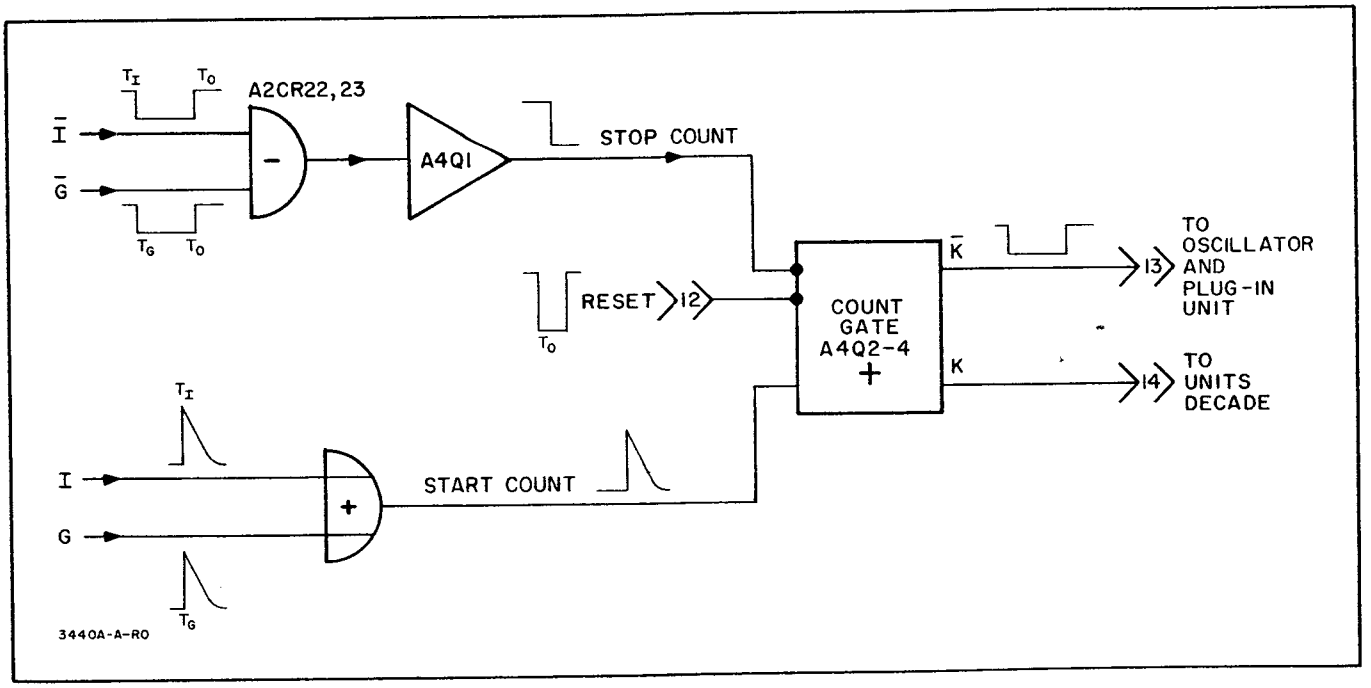


Figure 4-8. Gating

4-55. SYNCHRONIZED OSCILLATOR.

4-56. The Synchronized Oscillator (A9Q5) is a grounded base Colpitts Oscillator with an emitter follower output (A9Q6). The false output from the $\overline{K}$ side of the count gate saturates the oscillator gate (A9Q4) and enables the oscillator circuit. $\overline{K}$ goes true with the second comparator pulse, and the Synchronized Oscillator is disabled.

4-57. With A9Q4 shut off, initial charges are set up on the oscillator capacitors so that oscillations always start at the same point on the waveform and at approximately full amplitude. By controlling the starting point of the oscillator, a ±1 count ambiguity at the start of the count is eliminated.

4-58. The Schmitt Trigger (A9Q7 thru A9Q8) is a regenerative bistable circuit whose state is dependent on the input amplitude. It converts the oscillator output to pulses with a fast rise time. The output pulses are counted by the decade counters (A5 thru A8).

4-59. DECADE COUNTERS.

4-60. The decade counters (A5 thru A8) count the pulses from the Synchronized Oscillator, and the final count is displayed on the front panel.

4-61. Four binaries are connected as shown in Figure 4-9 to make a decade counter. Binary A will change state with each input pulse. Binaries B thru D will follow the switching sequence in Table 4-3. Each input pulse will produce a unique combination of outputs. There are ten possible combinations and each one represents a decimal digit.

4-62. A true binary represents a certain number (A = 1, B = 2, C = 2, D = 4), and a false binary represents zero. The decimal digit is the sum of the binary values. For Example: If D and A are true and B and C are false, the digit represented is 4 + 0 + 0 + 1 = 5. Binary coded decimals are usually written with the least significant digit on the right (DCBA). (For clarity in showing signal flow, the binaries are shown in ABDC order.)

4-63. Table 4-3 shows the counting sequence. The arrow in each block shows the direction the binary has switched. Initially each binary is set to the zero state by the reset pulse (DCBA = 0000). The following action takes place when a series of pulses is applied to the counter:

a. The first pulse switches A to the "1" state. (DCBA = 0001 = 1.)

b. The second pulse switches A to the "0" state, and the output from $\overline{A}$ switches B to the "1" state. (DCBA = 0010 = 2.)

c. The third pulse switches A to the "1" state. (DCBA = 0011 = 3.)

d. The fourth pulse switches A to the "0" state; the output from $\overline{A}$ changes B to the "0" state; the output from $\overline{B}$ changes D and C to the "1" state. The resulting signal from C is applied to $\overline{B}$ and D to return B to the "1" state and D to the "0" state. Although $\overline{D}$ is connected to C, no switching occurs at C because C has not recovered from its recent switching. (DCBA = 0110 = 4.)

e. The fifth pulse switches A to the "1" state. (DCBA = 0111 = 5.)

f. The sixth pulse switches A to the "0" state; the output from $\overline{A}$ switches B to the "0" state; the output from $\overline{B}$ switches D to the "1" state. (DCBA = 1100 = 6.)

g. The seventh pulse switches A to the "1" state. (DCBA = 1101 = 7.)

h. The eighth pulse switches A to the "0" state; the output from $\overline{A}$ switches B to the "1" state. (DCBA = 1110 = 8.)

i. The ninth pulse switches A to the "1" state. (DCBA = 1111 = 9.)

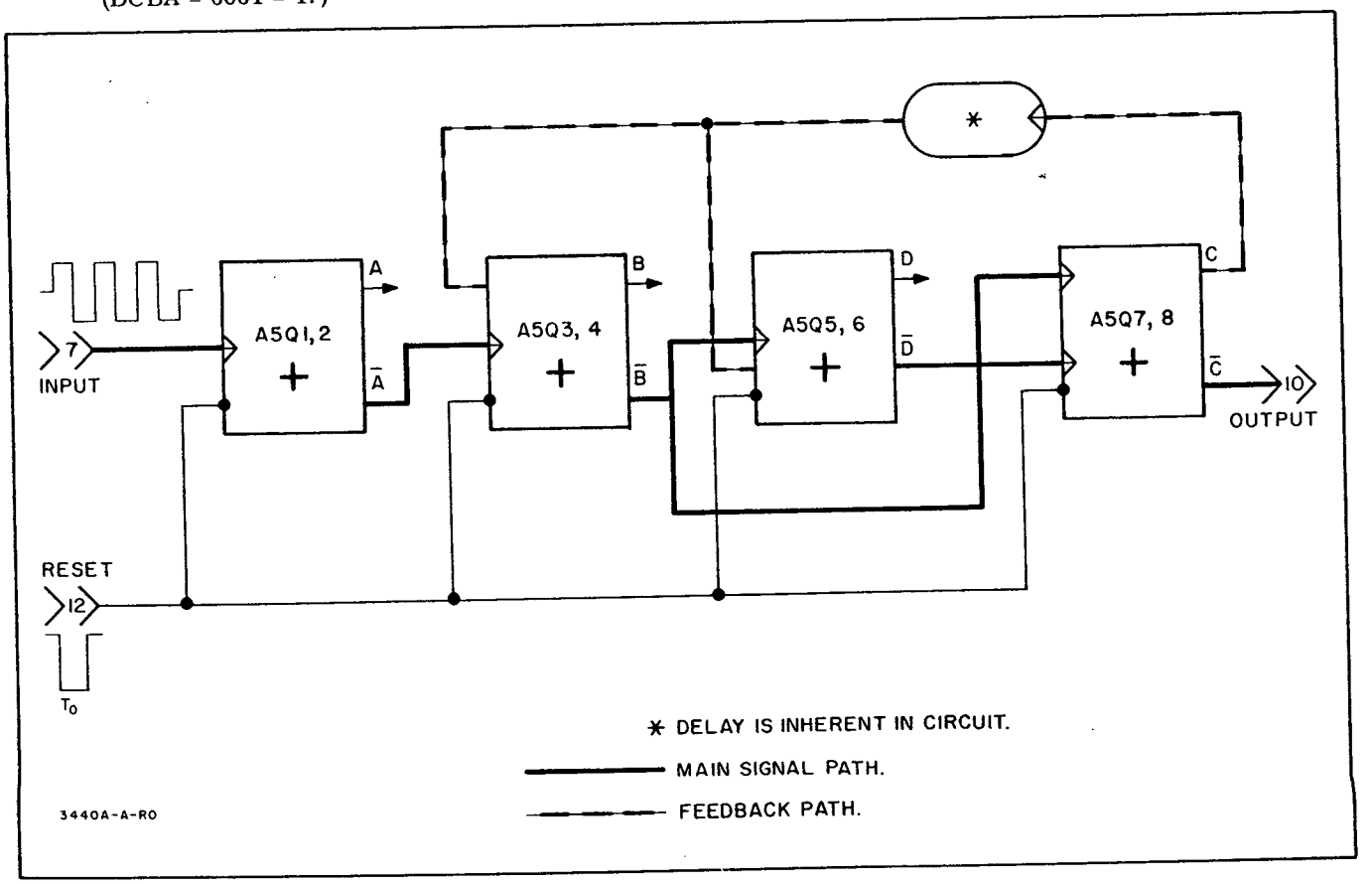
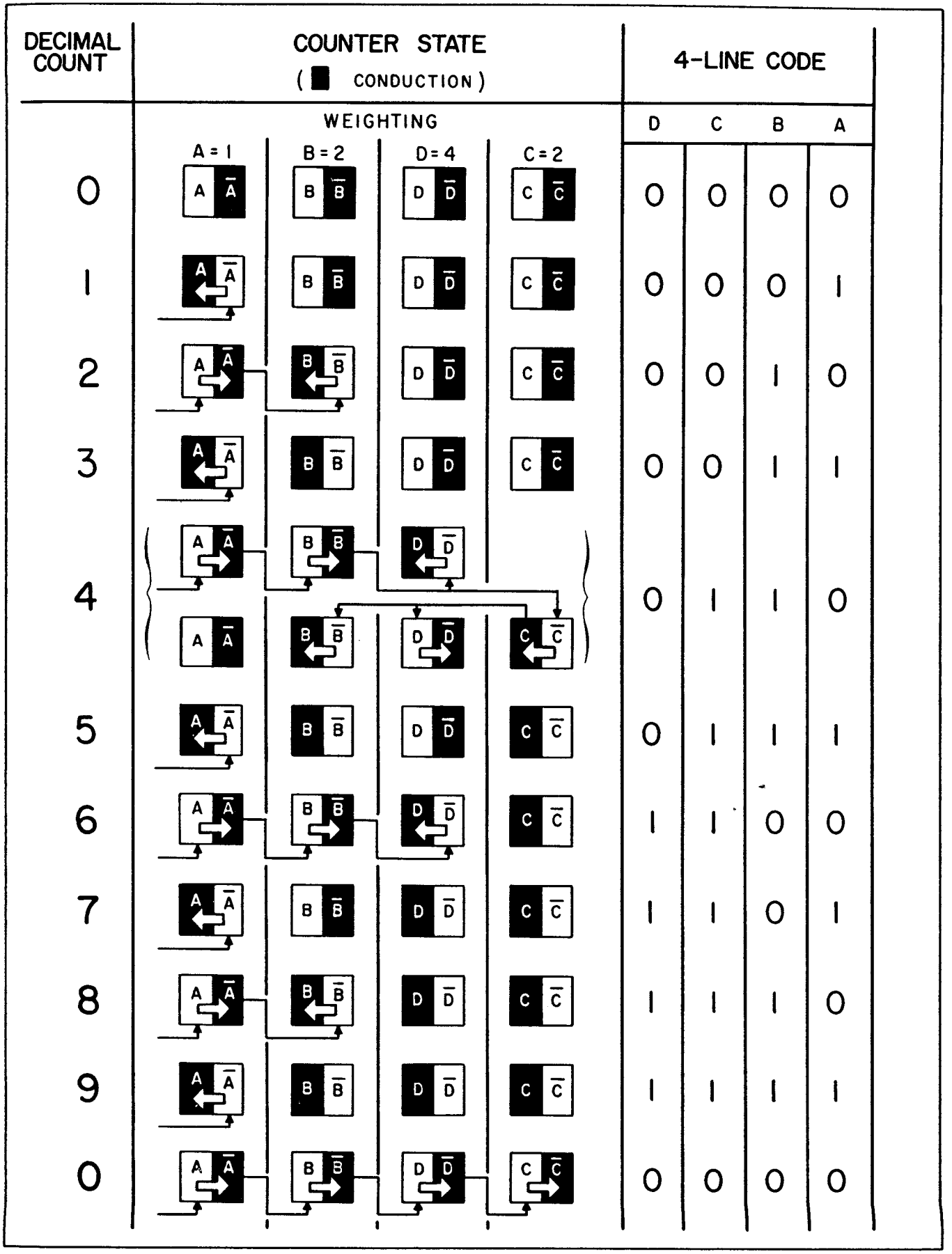


Figure 4-9. Decade Counter

Table 4-3. Counting Sequence of Decade Counter



j. The tenth pulse switches A to the "0" state; the output from $\overline{A}$ switches B to the "0" state; the output from $\overline{B}$ switches D to the "0" state; the output from $\overline{D}$ switches C to the "0" state. (DCBA = 0000.) When C becomes "0", $\overline{C}$ produces an output pulse which serves as a carry pulse to the next counter. The counter is now in its original state.

4-64. DIGITAL STORAGE AND DISPLAY.

4-65. The binary coded outputs of the counters control neon lamps. The lamps activate a photoconductor matrix which is connected to the display tube. A lighted photoconductor element has a resistance of about 20,000 ohms, and an unlighted element has a resistance of several megohms. Each binary coded decimal output yields a unique low resistance path through the matrix. There are ten such paths, and each is connected to a digit in the display tube.

4-66. Two lamps are connected to each binary, one to each collector. The lamp in the conducting collector is lit, and the one in the non-conducting collector is extinguished (see Figure 4-10A). Ordinarily, the lamps would reverse every time the binary switched, and the readout would flicker during the counting and resetting process. However, two diodes are connected between the lamps so that the lamps can only change state when the diodes are properly biased (see Figure 4-10B). This prevents flickering in the readout.

4-67. First consider the circuit without the diodes connected (Figure 4-10A-1). Lamp A is lighted, and lamp $\overline{A}$ is dark. Since transistor $\overline{A}$ is not conducting, the voltage across lamp $\overline{A}$ is established by both the circuit of conducting lamp A and the collector voltage of transistor $\overline{A}$. This voltage is typically 38 v, much lower than the lamp's firing potential of 70 v. So lamp $\overline{A}$ cannot fire.

4-68. When the binary changes state, the transistor $\overline{A}$ collector voltage drops to -1 volts, and the collector of transistor A rises to -30 volts. With transistor A cut off, the voltage at the junction of the two lamps increases to about 70 volts and lamp $\overline{A}$ fires. Lamp A has -30 volts on one side and -70 volts on the other, and is extinguished.

4-69. When the diodes are connected as shown in Figure 4-10B-1, the switching of the lamps can be stopped. With -1 volt applied, both diodes are forward biased, clamping the bottom side of both neons at -1 volt. The voltage across the extinguished neon is now held at the sustaining voltage of the lighted neon, and the lamps cannot change state.

4-70. At T_2, the -30 volt transfer pulse is applied to the diodes, reverse biasing them. The diodes are now effectively removed from the circuit and the lamps change to the state of the binary. At T_0, the transfer pulse is removed, and the lamps remain in that state until a new reading is transferred.

4-71. POLARITY SENSOR.

4-72. Both true Voltage Comparator pulses (I and G) are applied to the Polarity Sensor A4Q6, 7. This flip-flop remains in the state set by the last of these two pulses. At time T_2, the transfer pulse goes false allowing the proper sign to light on the front panel display. (Refer to Paragraphs 4-64 through 4-66 for discussion of storage.)

4-73. OVERRANGE SENSOR.

4-74. The Overrange Sensor (A4Q8, A4Q9) is a flip-flop whose true output lights the overrange indicator. If the voltage to the Input Comparator exceeds 9.999 volts, the thousands decade counter will generate an overflow pulse, setting the overrange flip-flop to the true state. At T_0, the overrange flip-flop is switched to the false state by the reset pulse.

4-75. DIGITAL RECORDER.

4-76. BCD information is supplied to the rear panel DIGITAL RECORDER jack from each binary. Range and function information is also supplied to this jack in BCD form by the Plug-in (refer to Plug-in manual for description). At time T_2, the Model 3440A generates a Print Command to actuate the Digital Recorder, printing the data obtained during the last sample (refer to Paragraphs 4-30 through 4-32 for discussion of the Print Command).

4-77. POWER SUPPLY.

4-78. PRIMARY POWER.

4-79. Either 115 or 230 volt ac power is connected through fuse F1 (0.6 amp slow-blow) and switch S2 (or SAMPLE RATE control) to the primary of power transformer T1. Switch S6 connects S1 primaries in parallel for 115 volt operation or in series for 230 volt operation.

4-80. UNREGULATED POWER SUPPLIES.

4-81. Full wave rectifier A9CR6 - 9 produces -150 volts and +150 volts for driving neon lamps and digit display tubes.

4-82. REGULATED POWER SUPPLIES.

4-83. Full wave rectifier A9CR1 - 4 produces +12 volts which is shunt regulated by breakdown diode A9CR12.

4-84. Full wave rectifier A9CR1 - 4 also provides -35 volts which is series regulated by transistor Q1. Breakdown diode A9CR11 provides a reference voltage to the control amplifier A9Q1, 2. The -35 volt supply is adjusted by A9R12. F2, the -35 volt fuse, provides protection for the supply.

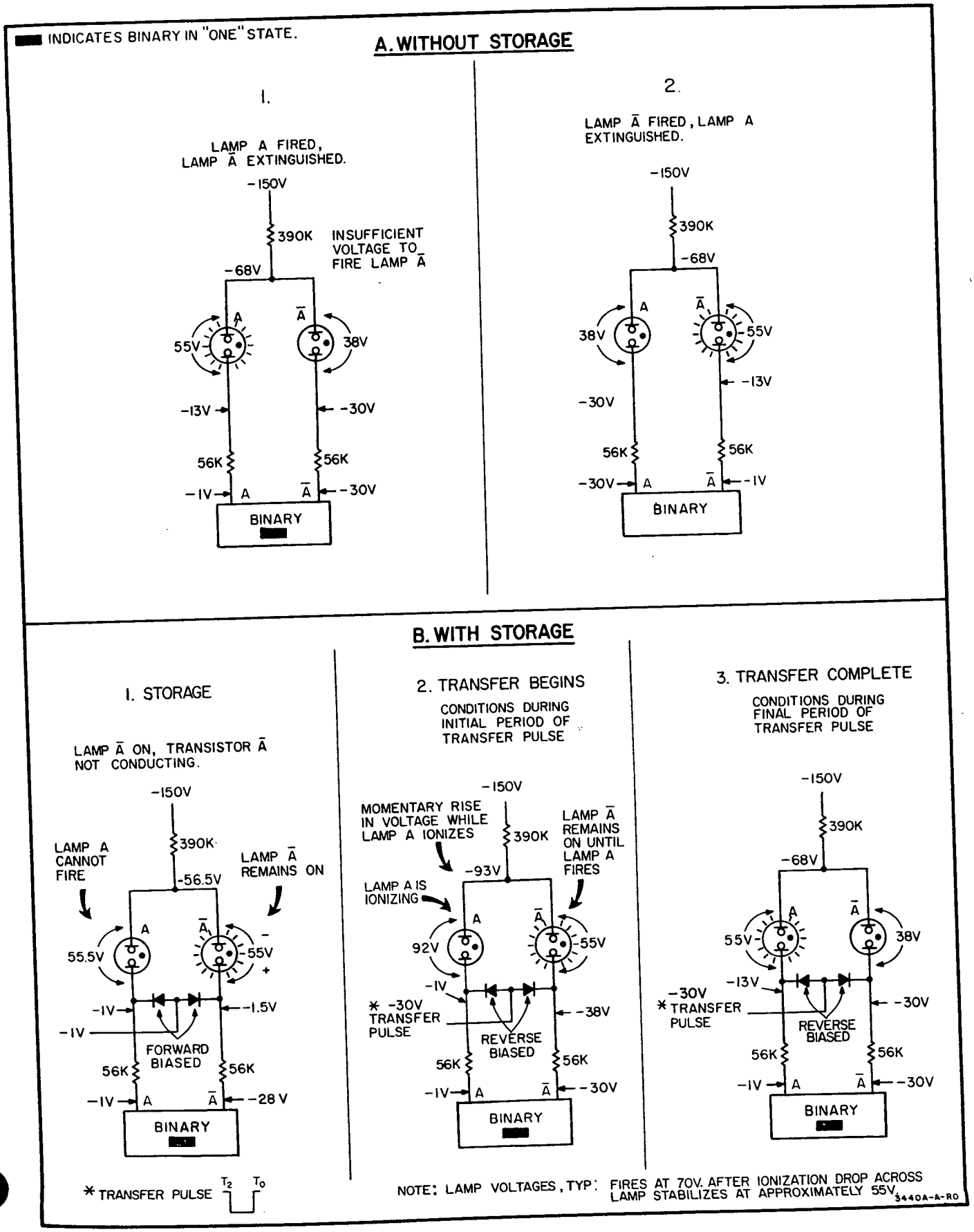


Figure 4-10. Lamp Control

Table 5-1. Recommended Test Equipment

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
DC Standard	Voltage Range: 0 - 1000 volts Accuracy: ±0.01% of reading	Performance Checks Adjustment	-hp- Model 740B
Digital Recorder	6-column print: 1-2-2-4 BCD Print Rate: 5 lines/second	Performance Checks	-hp- Model 562A
Pulse Generator	Pulse Width: 20 μsec Amplitude: +10 volts Repetition Rate: Manual	Performance Checks	-hp- Model 214A
Wide Range Oscillator	Frequency: 60 cps Amplitude: 1 volt p-p	Performance Checks	-hp- Model 200CD
AC Voltmeter	Voltage Range: 0 - 10 volts Accuracy: ±2%	Performance Checks	-hp- Model 427A
DC Voltmeter	Voltage Range: 0 - 100 volts Accuracy: ±1% Input Impedance: >10 Megohms	Adjustment	-hp- Model 412A
Electronic Counter	Range: to 400 Kc	Adjustment	-hp- Model 5532A
Transistor Power Supply	0 - 30 vdc; 0 - 15 ma	Troubleshooting	-hp- Model 721A
Oscilloscope	Bandwidth: Dc - 5 Mc Dual Channel Capability: Delayed Sweep Capability	Troubleshooting	-hp- Model 175A with -hp- Model 1781B Horizontal Plug-in -hp- Model 1750A Vertical Plug-in -hp- 10003A 10:1 Probe
Variable Transformer	Output Voltage: 103 to 127 vac (or 207 to 253 vac)	Performance Checks Adjustment	Superior Electric Co. Powerstat 3PF116 (for 115 v line) 3PF216 (for 230 v line)
Toggle Switch	Single pole - single throw	Performance Checks	-hp- Part No. 3101-0001
Resistor	1.0 Megohm, 1/2 watt ±1%	Performance Checks	-hp- Part No. 0727-0276
15-Pin Extender Board		Troubleshooting Adjustment	-hp- Part No. 5060-0049
22-Pin Extender Board		Troubleshooting Adjustment	-hp- Part No. 5060-0630

SECTION V
MAINTENANCE

5-1. REQUIRED TEST EQUIPMENT.

5-2. Recommended test equipment for maintaining and checking performance of the Model 3440A is listed in Table 5-1. Test instruments other than those listed may be used if their specifications equal or exceed the required characteristics.

5-3. PERFORMANCE CHECKS.

5-4. Use the following front and rear panel procedures to verify proper operation of the Model 3440A. The Model 3440A and test equipment should be operated at 115/230 vac unless otherwise specified. If the Model 3440A is found to be out of specifications at any point in this procedure, refer to Paragraph 5-15, Adjustment and Calibration Procedures.

5-5. CALIBRATION.

a. Connect the Model 3440A to a variable line transformer as shown in Figure 5-1.

b. Set line voltage switch to 115 or 230 vac, and turn the 3440A on.

c. Allow the 3440A to warm up for at least 1/2 hour.

d. Short the INPUT terminals, and set plug-in RANGE switch to 10 v.

e. Adjust the rear panel ZERO control for a front panel indication of 0.000. Optimum adjustment is indicated by alternate flashing of the (+) and (-) indicators.

f. Remove shorting connection from input.

g. Depress INT CHECK 8000 pushbutton and adjust the INT CHECK 8000 adjustment for an indication of -8.000.

h. Connect a dc standard as shown in Figure 5-1, and set the dc standard output to 1.000 volts. The 3440A indication should be between 0.998 and 1.002.

j. Repeat step h for the values shown in Table 5-2. Then repeat the entire test on the 100 volt and 1000 volt ranges. The values shown in Table 5-2 may be used on the 100 volt test by moving the decimal point 1 or 2 places to the right.

k. Repeat steps h and j with line voltages of 103 and 127 vac (207 and 253 vac).

Table 5-2. Calibration

DC STANDARD	MODEL 3440A	
	MINIMUM	MAXIMUM
0.000	-0.001	+0.001
1.000	0.998	1.002
2.000	1.998	2.002
3.000	2.997	3.003
4.000	3.997	4.003
5.000	4.996	5.004
6.000	5.996	6.004
7.000	6.995	7.005
8.000	7.995	8.005
9.000	8.994	9.006
10.000	9.994	0.006*
* Indicates OVERRANGE lamp should be lighted.		

5-6. INPUT IMPEDANCE CHECK.

a. Connect Model 3440A as shown in Figure 5-2.

b. Set RANGE switch on Plug-in to 10 v.

c. Set DC Standard to 10.00 volts.

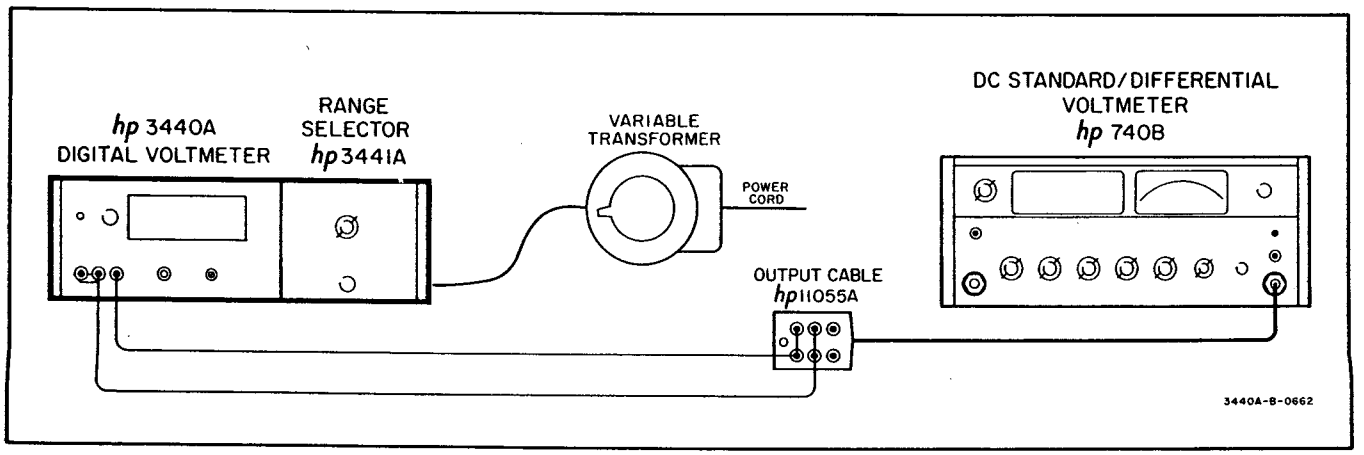


Figure 5-1. Calibration

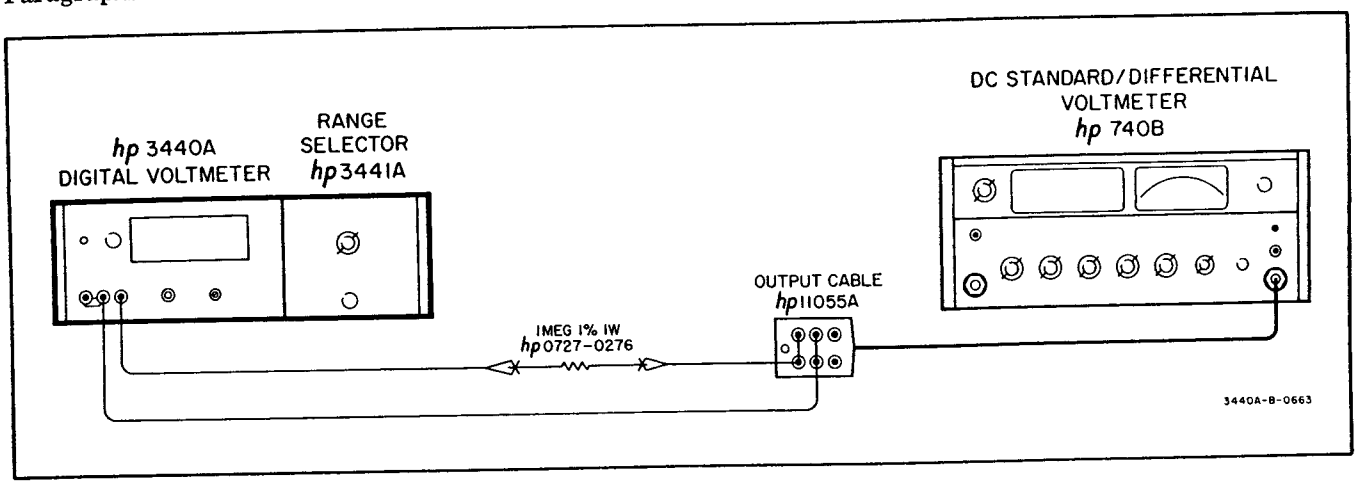


Figure 5-2. Input Impedance Check

d. The Model 3440A readout should indicate between 9.090 and 9.122. This corresponds to an input resistance of 10.0 to 10.4 megohms where:

$$R_{input} = \left(\frac{E_{displayed}}{E_{input} - E_{displayed}} \right) R_{series}$$

5-7. EXTERNAL TRIGGER CHECK.

a. Set SAMPLE RATE to HOLD.

b. Connect an SPST toggle switch between pins 17 and 18 of REMOTE CONTROL connector (J4) on rear panel.

c. Observe that SAMPLE RATE indicator flashes each time the switch is closed.

d. Connect Model 3440A as shown in Figure 5-3.

e. Set pulse generator controls for a manually initiated 20 μsec 10 volt pulse.

f. Observe that SAMPLE RATE indicator flashes each time a pulse is initiated from the pulse generator.

5-8. DIGITAL RECORDER CHECK.

a. Connect Model 3440A as shown in Figure 5-4.

NOTE

Ensure that both Model 3440A and DC Standard are isolated from power line ground. Disconnect ground link between (⏚) and (⏚) terminals.

b. Set SAMPLE RATE to maximum.

c. Set DC Standard for Model 3440A readouts as shown in Table 5-3. Digital Recorder second thru fifth column printouts should correspond.

Table 5-3. Digital Recorder Check

3440A DISPLAY	DIGITAL RECORDER PRINTOUT
+ 1.111	011113
- 2.222	122223
+ 3.333	033333
+ 4.444	044443
+ 5.555	055553
+ 6.666	066663
+ 7.777	077773
+ 8.888	088883
+ 9.999	099993
+ 1.000	010003
+ 10.00	010002
+100.0	010001
+ 00.50*	900502

* Indicates 100.50 volt input; OVERRANGE lighted.

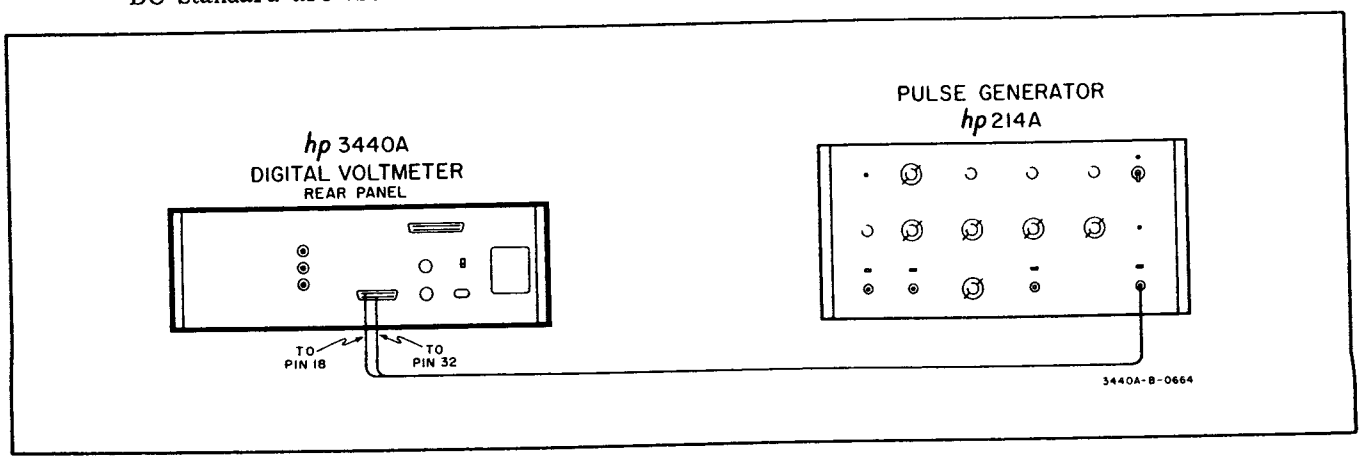


Figure 5-3. External Trigger Check

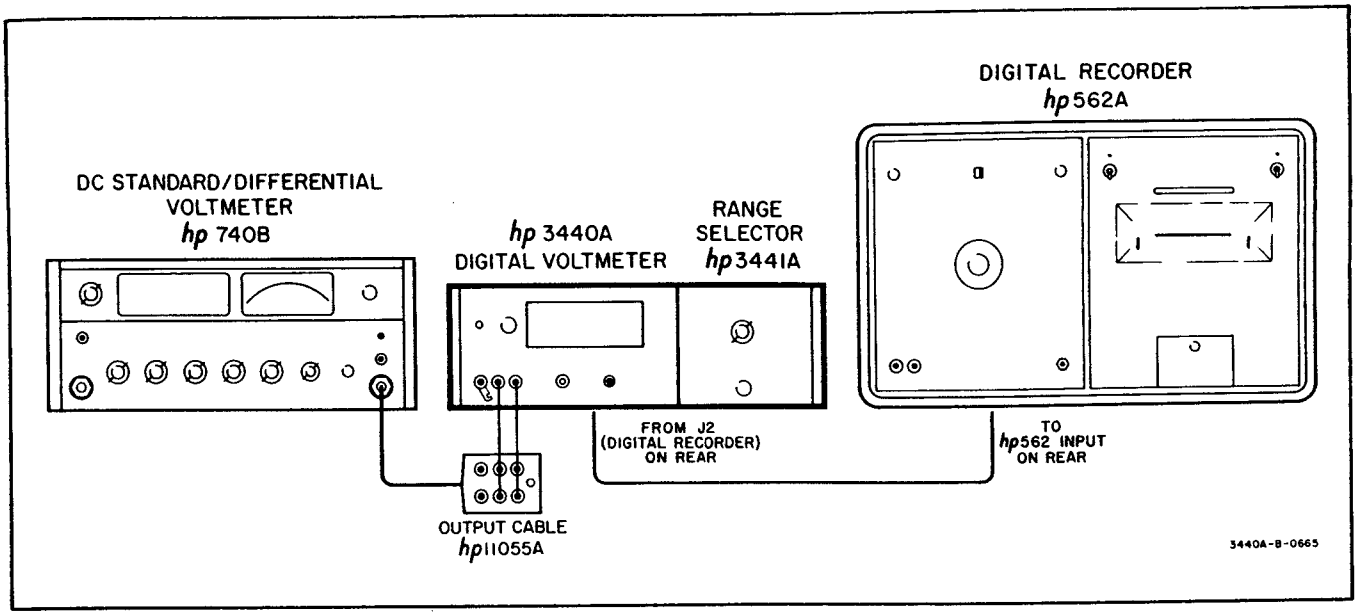


Figure 5-4. Digital Recorder Check

5-9. DC COMMON MODE REJECTION CHECK.

a. Connect Model 3440A and dc standard as shown in Figure 5-5.

b. Set RANGE to 10 V, and set dc standard output to 100 V.

c. Model 3440A should read less than ±0.003 V.

d. Set RANGE to 100 V.

e. Model 3440A should read less than ±00.03 V.

f. Set RANGE to 1000 V.

g. Model 3440A should read less than ±000.3 V.

5-10. AC COMMON MODE REJECTION CHECK.

a. Connect Model 3440A, ac voltmeter, and test oscillator as shown in Figure 5-6. Set 3440A RANGE to 10 V.

b. Using ac voltmeter as a monitor, set oscillator output to 7.07 V rms at 60 Hz.

c. Model 3440A should read less than ±0.003 V.

d. Set RANGE to 100 V.

e. Model 3440A should read less than ±00.03 V.

f. Set RANGE to 1000 V.

g. Model 3440A should read less than ±000.3 V.

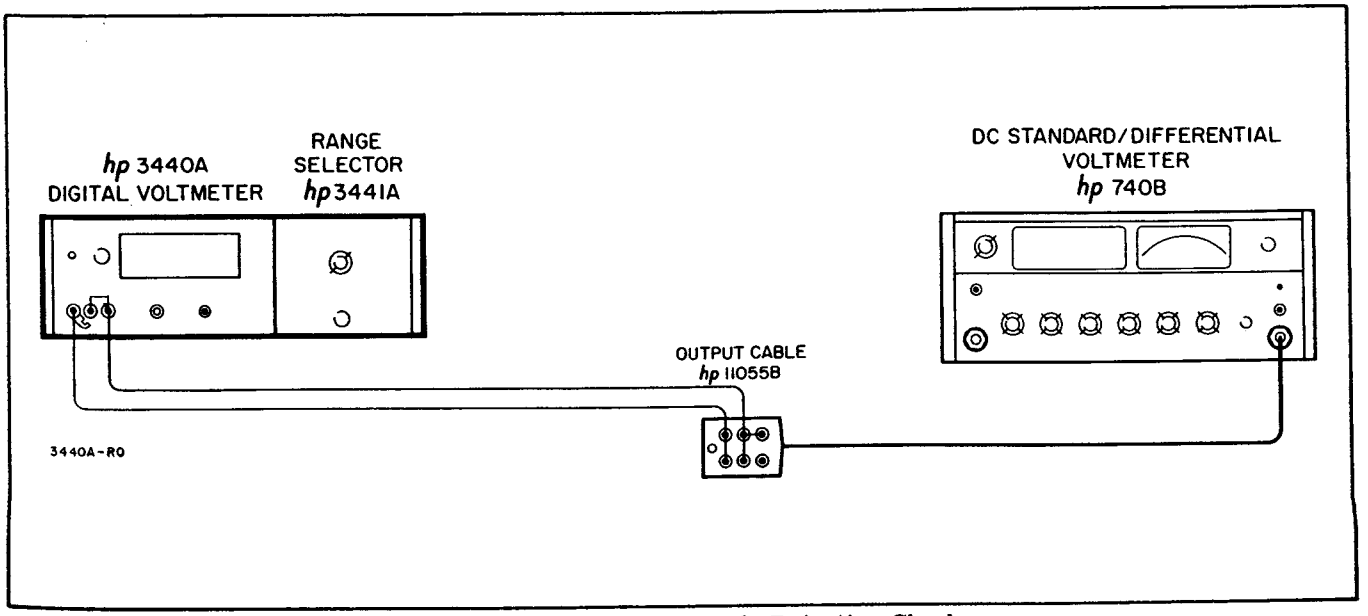


Figure 5-5. DC Common Mode Rejection Check

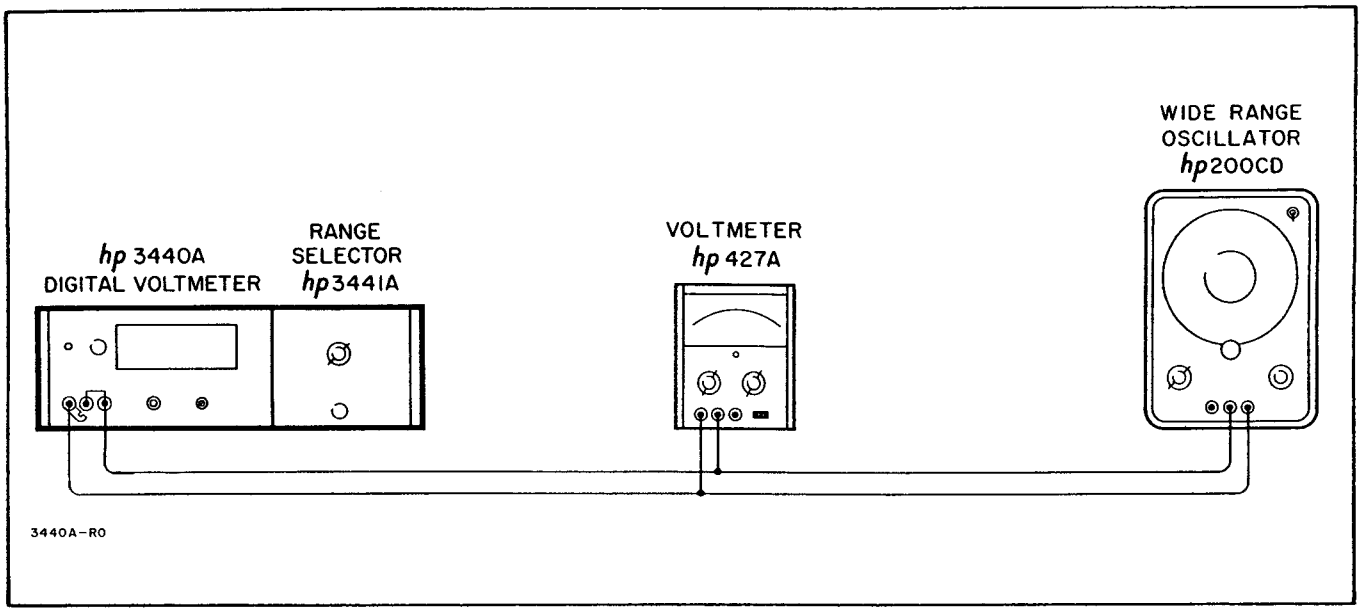


Figure 5-6. AC Common Mode Rejection Check

5-11. INPUT FILTER RESPONSE TIME CHECK.

a. Connect Model 3440A and a digital recorder as shown in Figure 5-4.

NOTE

Ensure that both Model 3440A and DC Standard are isolated from power line ground. Disconnect ground link between (⏚) and (⏚) terminals.

b. Set the SAMPLE RATE to maximum and set the plug-in RANGE to 1000 volts. Turn the digital recorder on.

c. The recorder should be printing zeros (000001 or 100001).

d. Connect a 500 volt input from the dc standard.

e. The printout should be within 0.05% of its final value within 450 msec. This should be read on the third printout.

5-12. INPUT FILTER AC REJECTION CHECK.

a. Connect the 3440A, a test oscillator, an rms voltmeter and the digital printer as shown in Figure 5-7.

b. Set the test oscillator frequency to 60 Hz (cps) and adjust its amplitude for an indication of 7.07 v rms on the rms voltmeter.

c. Set the 3440A SAMPLE RATE to 5 samples/sec, and set the plug-in RANGE switch to 10 v.

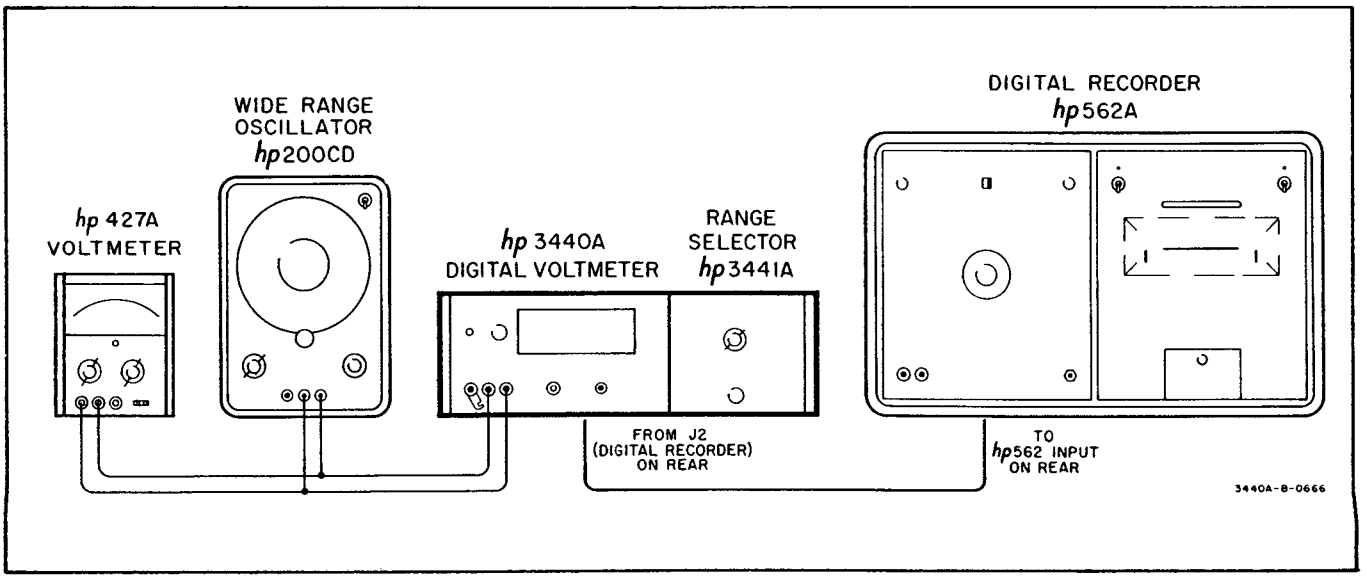


Figure 5-7. Input Filter AC Rejection Check

d. The 3440A display will be somewhat erratic, as the 3440A is sampling different points on the sine wave input. Monitor the digital recorder printout.

e. The digital recorder printout should be between + 03163 and - 03163. This corresponds to an ac rejection of 30 db where:

$$\text{Rejection in db} = 20 \log \left[\left(\frac{E_{in}(\text{rms})}{\Delta E_{\text{displayed}}(\text{peak})} \right) \times 2.82 \right]$$

5-13. INSTRUMENT COVER REMOVAL.

5-14. To remove either the top or bottom covers, remove the two Phillips-head screws which secure the cover to the instrument. Slide the cover approximately 1/2 inch to the rear of the instrument and lift free. To replace the cover, reverse the procedure.

5-15. ADJUSTMENT AND CALIBRATION PROCEDURES.

5-16. The following test and adjustment procedures should be performed only if it has been definitely determined by the Performance Checks given in Paragraphs 5-3 through 5-12 that the Model 3440A is out of specifications. Figure 5-8 shows the location of internal adjustments.

5-17. POWER SUPPLY A9 ADJUSTUMENT.

a. Supply Model 3440A primary power through a variable transformer.

b. Set line voltage to 115/230 vac.

c. Set SAMPLE RATE control to HOLD.

d. Connect DC Voltmeter and AC Voltmeter to A9 (15).

e. Adjust A9R12 (-35 v adj) for DC Voltmeter reading of -35.0 vdc.

f. Vary line voltage from 103 to 127 (207 to 253) vac.

g. DC Voltmeter reading should not change more than ±0.2 vdc. AC Voltmeter reading should remain below 4 mv.

h. Connect DC Voltmeter to A9 (4). (See Figure 6-7.)

j. Reading should read between +145 and +160 vdc.

k. Connect DC Voltmeter to A9 (1).

m. Reading should read between -145 and -160 vdc.

n. Connect DC Voltmeter and AC Voltmeter to A9 (10).

o. DC Voltmeter should read between +11.0 and +14.0 vdc.

p. Vary line voltage from 103 to 127 (207 to 253) vac.

q. DC Voltmeter reading should not change more than ±0.3 vdc. AC Voltmeter reading should remain below 2 mv.

5-18. OSCILLATOR A9 FREQUENCY ADJUST.

a. Set SAMPLE RATE control to HOLD.

b. Connect a clip lead from A4Q2 base (see Figure 6-4) to circuit common. This causes synchronized oscillator to free run.

c. Connect Electronic Counter to A9TP1. (See Figure 6-7.)

d. Adjust A9C14 for an Electronic Counter reading of 400.0 KHz ±400 Hz.

5-19. GROUND COMPARATOR BALANCE AND CHARGE RESTORER ADJUST.

a. Set SAMPLE RATE control to maximum counterclockwise (but not LINE OFF).

b. Set RANGE switch on Plug-in to 10 v.

c. Short Model 3440A INPUT terminals.

d. Adjust R2 (ZERO) until readout is 0.000. Optimum adjustment is indicated by alternate flashing of the (+) and (-) lights.

e. If R2 has insufficient range to obtain a zero reading, proceed as follows:

1) Set R2 to mechanical midpoint.

2) Adjust A2R70 (Comparator Balance) until readout display is 0.000 (see Figure 5-8).

3) Repeat step d for fine adjustment.

f. Remove short from INPUT terminals.

g. Adjust A2R40 (charge restorer) until readout display is 0.000. Optimum adjustment is indicated by alternate flashing of the (+) and (-) lights.

h. Set SAMPLE RATE to approximately one sample per second.

j. Reading should remain at zero. If not, repeat steps c thru g.

5-20. CALIBRATION.

a. Set RANGE switch on Plug-in to 10 v.

b. Apply +8.000 volts from DC Standard to INPUT terminals.

c. Set front panel INT CHECK 8000 adjust to approximately the mechanical midpoint (this is a ten turn potentiometer).

d. Adjust A3R51 (Ramp Slope) for front panel display of +8.000. (See Figure 5-8.) Front panel INT CHECK 8000 adjust may be used for fine adjustment.

e. Set RANGE switch on Plug-in to 100 v.

f. Apply +80.00 volts from DC Standard to INPUT terminals.

g. Adjust A1R7 (100 v adj) for front panel display of +80.00. (See Figure 5-8.)

h. Set RANGE switch on Plug-in to 1000 v.

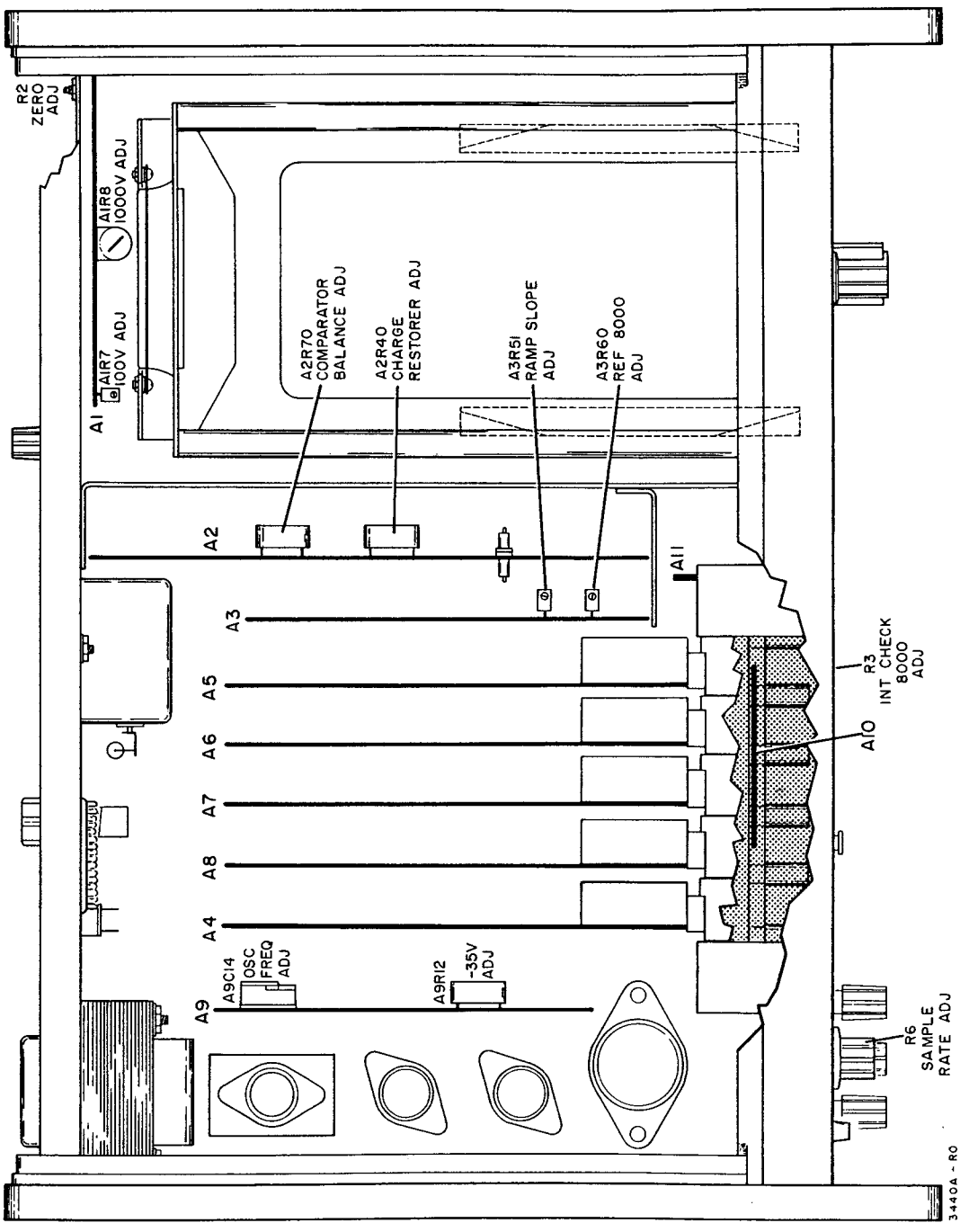


Figure 5-8. Location of Adjustments

j. Apply +800.0 volts from DC Standard to INPUT terminals.

k. Adjust A1R8 for front panel display of +800.0.

m. Apply -8.00 volts from DC Standard.

n. Set RANGE switch on Plug-in to 10 v.

p. Adjust INT CHECK 8000 for a reading of -8.000 if necessary.

q. Depress INT CHECK 8000 button.

r. Adjust A3R60 (Reference 8000) for front panel display of -8.000.

5-21. TROUBLESHOOTING.

5-22. Use the Troubleshooting Procedure only after determining that the difficulty cannot be removed by the Adjustment and Calibration Procedure, Paragraph 5-15.

5-23. Inspect the setup used when symptoms of malfunction were observed to be certain that the source of the trouble is not external to the Model 3440A.

5-24. Look for burned or loose components, loose connections, broken wires, or any other similar condition which suggests a source of trouble.

5-25. The following should be used to isolate the trouble to a particular circuit board:

a. Front panel symptoms;

b. Difficulties encountered during Adjustment and Calibration Procedure (Paragraphs 5-15 and 5-20);

c. Simplified Block Diagram (Figure 4-1);

d. Detailed Block Diagram (Figure 4-2);

e. Troubleshooting Aid (Table 5-4);

f. Waveform Time Sequence (Figure 5-10);

g. Typical Waveforms (Figure 5-11).

5-26. When malfunctioning assembly is found, the trouble may then be traced to the individual components by using the procedures outlined in Paragraphs 5-27 through 5-50. The order of testing shown

Table 5-4. Troubleshooting Aid

Symptom	Possible Cause
1. Display not lit	Fuse F1 (0.6 a slow-blow); 115/230 volt switch S6, LINE switch S2, Power Transformer T1 Power Supply A9
2. Display lit, no response to input SAMPLE RATE not lit	Power Supply A9, -35 volt fuse F2 (0.75a), Sample Rate Multivibrator (A3Q5, 6), Ramp Gate (A3Q10, 11), Ramp Generator (A3QCR1, A3Q15 - 17), Ramp Sensor (A3Q7, 8)
3. Display lit, no response to input Power Supply voltages normal, SAMPLE RATE lit continuously	Sample Rate Multivibrator (A3Q5, 6), Ramp Gate (A3Q10, 11), Ramp Generator (A3QCR1, A3Q15 - 17) Ramp Sensor (A3Q7, 8)
4. SAMPLE RATE normal, display counting continuously, Polarity normal	Reset Amplifier (A3Q2, 3) AND Gate (A2CR22, 23), AND Gate Amplifier (A4Q1), Count Gate (A4Q2 - 4), Synchronized Oscillator Gate (A9Q4)
5. SAMPLE RATE normal, display will not change	Reset Amplifier (A3Q2, 3), Transfer Amplifier (A3Q12), AND Gate (A2CR22, 23), AND Gate Amplifier (A4Q1), Count Gate (A4Q2 - 4), Synchronized Oscillator (A9Q4 - 8), Decade Counter (A5 - A8)
6. SAMPLE RATE normal, display continuously counting, polarity always indicates (+)	Input Comparator (A2Q1 - 5, A2Q6 - 9)
7. SAMPLE RATE normal, display continuously counting, polarity always indicates (-)	Ground Comparator (A2Q11 - 13, A2Q15, 16)
8. Particular digit(s) displayed erratically	Decade Counter Assemblies (A5 - A8)
9. Improper tracking	Ramp Generator A3QCR1, A3Q15 - 17
10. No response to input with normal indication on INT CHECK 8000	Attenuator (A1) Plug-in Unit

should be followed. If a particular circuit is known to be functioning properly, the tests for that circuit may be omitted.

5-27. POWER SUPPLY A9.

5-28. For power supply problems, check diodes (A9CR1 - 4, A9CR6 - 9, A9CR11, 12) and regulator transistors (Q1, A9Q1, A9Q2).

5-29. SAMPLE RATE AND RAMP GENERATOR TEST.

5-30. If SAMPLE RATE neon is either not lit or lit continuously, the problem is in the Ramp Generator circuits. The source of trouble is usually difficult to determine because of the feedback loop used to reset the Sample Rate Multivibrator. To locate the malfunction, use the following procedure:

a. Disconnect the emitter of A3Q8 (see Figure 6-3) from the circuit board. This breaks the feedback loop.

CAUTION

USE EXTREME CARE IN REMOVING THE LEAD AS IT IS VERY EASILY BROKEN.

b. Connect negative output of Transistor Power Supply to the emitter of A3Q8, using insulated miniature clip leads. Connect positive output to Model 3440A circuit common.

c. Set Transistor Power Supply to -11 and -13 vdc and observe the voltage levels at the points given in Table 5-5. The test voltages are approximate and a tolerance of ±20% is acceptable.

d. If the proper voltage is not present at any point, the malfunction is probably immediately before that point.

NOTE

Replacement of the A3QCR1A, B assembly or ramp capacitor C6 may require changing the value of R4*. See Paragraph 5-61.

Table 5-5. Sample Rate and Ramp Generator Test

TRANSISTOR POWER SUPPLY VOLTAGE	-11	-13
SAMPLE RATE Neon	ON	OFF
A3Q7 Base	+12.5	0
A3Q7 Collector	- 1.4	0
A3Q5 Collector	- 1.5	-14
A3Q6 Collector	-26	- 1.5
A3Q10 Base	0	- 6.6
A3Q10 Collector	0	13
A3Q11 Collector	-22	13
A3CR11 Cathode	-22.5	12
A3QCR1 Emitter	-18	12
A3QCR1 Anode	-24.5	5.5
A3Q17 Emitter	-24	-23
A3Q1 Base	- 4.0	0.5

5-31. RESET PULSE.

5-32. The reset pulse (see Figure 5-11B) is necessary for proper operation of most Model 3440A circuits. If the SAMPLE RATE neon is flashing and the reset pulse is not present, the trouble is probably A3Q2 or A3Q3 (see Figure 6-3).

5-33. COMPARATOR (A2).

5-34. INPUT COMPARATOR CHECK. (Refer to Figures 5-11 or 6-2.)

a. Check waveshape at A2TP2.

b. If waveshape at A2TP2 is incorrect, check waveshape at A2TP1. If the waveshape at A2TP1 is correct, the trouble is in A2Q7 or A2Q8.

c. If the waveshape at A2TP1 is incorrect, the trouble is in the input amplifier (A2Q1 thru A2Q5) or the input comparator (A2CR5A and B).

d. Check the input comparator by checking with an oscilloscope for a narrow positive pulse at the anode of A2CR5B.

e. Connect a clip lead from Pin 16 on the A3 board to signal common. This connection stops the instrument from sampling. With a DC Voltmeter, check the potentials listed in Table 5-6A. If the reading at any one collector is incorrect, either that transistor or its associated circuit is probably malfunctioning.

Table 5-6. Comparator Amplifier Voltages

NOTE

These voltages are typical. A tolerance of ±10% is acceptable.

A		B	
Measuring Point	Voltage	Measuring Point	Voltage
A2Q1 Collector	- 0.8 v	A2Q11 Collector	- 0.3 v
A2Q2 Collector	- 1.5 v	A2Q12 Collector	- 0.8 v
A2Q3 Collector	- 0.3 v	A2Q13 Collector	-20.5 v
A2Q4 Collector	- 0.8 v		
A2Q5 Collector	-18 v		

5-35. GROUND COMPARATOR CHECK. (Refer to Figures 5-11 or 6-2.)

a. The ground comparator check is essentially the same as the input comparator check.

b. Check the ground flip-flop output at A2TP4 with an oscilloscope. Then check the amplifier output at A2TP3. If the output at A2TP3 is correct, the trouble is probably in A2Q15 or A2Q16. If the output at A2TP3 is incorrect, check the ground amplifier and the ground comparator.

c. Check with an oscilloscope for a narrow positive pulse at the anode of A2CR27B. If no pulse is present, the ground comparator is malfunctioning.

d. Connect a clip lead from A3 Pin 16 to signal common and measure the dc voltages listed in Table 5-6B. If any one of the collector readings is wrong, either that transistor or its associated circuit is probably malfunctioning.

e. Remove lead from A3 Pin 16.

5-36. ZERO OFFSET.

5-37. If the Model 3440A cannot be zeroed by adjusting A2R70 (see Figure 6-3), use the following procedure:

a. Clean the plug-in connector J6 and P6 with Type TF Freon (-hp- Part No. 8500-0232).

b. If this does not help, short the INPUT terminals

c. If the instrument cannot be zeroed by adjusting A2R70, the trouble is probably in the charge restorer (A2Q9), A2CR10, 11 or A2CR15 - 17.

d. If the instrument still cannot be zeroed, the problem is probably A2CR27 - 28, A2CR5 - 7, or A2R68 - 71.

5-38. INPUT FILTER AC REJECTION.

5-39. Poor ac rejection can be caused by defective A1C1, A2C1, or Plug-in unit.

5-40. INPUT IMPEDANCE.

5-41. Excessive leakage current can be caused by a defective A2CR10, A2C1, A2C4, A2CR5B, Input Attenuator or Plug-in unit.

5-42. COUNT GATE AND POLARITY SENSOR.

a. If neither Polarity Sensor (A4Q6 - 7) or count gate (A4Q1 - 4) is functioning properly disconnect A4R29 and A4R41. (See Figure 6-4.)

b. If count gate now functions properly, the trouble is probably the polarity sensor (A4Q6, 7).

c. If count gate still does not function properly, the trouble is probably A4Q1 - 4.

5-43. SYNCHRONIZED OSCILLATOR.

a. Connect clip lead from A4Q2 base to circuit common.

b. Check waveform (Figure 5-11T) at A9TP1 (see Figure 6-4).

c. If proper waveform is not observed, ground the collector of A9Q4.

d. If this causes the proper waveform to appear at A9TP1, the trouble is probably A9Q4.

e. If there still is no output at A9TP1, check the waveform at the collector of A9Q5. (See Figure 5-11S.)

f. Proper waveform at this point indicates the trouble is in the Schmitt Trigger (A9Q6 - 8). Improper waveform indicates the problem is the oscillator A9Q5.

NOTE

If the oscillator is unstable, check that the value of A9R24 is 10 kΩ.

5-44. DECADE COUNTERS A5 - A8.

a. Place suspected Decade Counter in A5 position. This sets up worst case conditions.

b. Connect clip lead from A4Q2 base to circuit common causing oscillator to free run.

c. Observe waveform (see Figure 5-11X) at A5 (10)

d. If proper waveform is observed, the trouble is probably Photoconductor Assembly V1, Digit Display Tube DS6, or Transfer Amplifier A3Q12.

e. If improper waveform is observed at this point, observe waveforms of each binary. (See Figures 5-11U thru 5-11W.)

f. Improper waveform indicates defective binary.

5-45. OVERRANGE.

5-46. OVERRANGE indicator problems can be caused by defective A4Q8, A4Q9, A4CR10, or A4DS3.

5-47. CALIBRATION LINEARITY.

5-48. If Model 3440A fails to track properly, check the following:

a. Oscillator A9 stability.

b. Ramp generator A3QCR1, A3Q15 - 17.

5-49. DIGITAL RECORDER.

5-50. If digital recorder fails to print properly, check the following.

a. Digital recorder;

b. Interconnecting cable between Model 3440A and digital recorder;

c. Decade counter binary outputs;

d. Print command A3Q18 (see Figure 5-11);

e. Plug-in unit.

5-51. ADJUSTMENT OF FACTORY SELECTED COMPONENTS.

5-52. Certain components within the 3440A are individually selected to compensate for slightly varying circuit parameters. These components are denoted by an asterisk on the schematic, and the typical value is shown. The following paragraphs describe the function of the factory selected components and give instructions for their selection. Normally, these

components should not be changed unless an associated component has been changed. Replacement of a transistor or diode may require the changing of an associated factory selected component.

5-53. A2R2*.

5-54. A2R2 adjusts the current drawn by the Input Comparator. If A2R2 is too high, the 3440A will have a positive zero offset of several counts; and A2R2 should be lowered from 1.33 M Ω to 1.1 M Ω. Ordinarily A2R2 shouldn't be changed.

5-55. A2R29*.

5-56. A2R29 is selected so that a small amount of charge is added to A2C17 in the Charge Restorer. This compensates for a small amount of charge lost from capacitive loading from A2R28 to ground. Once A2R29 has been selected at the factory, there should be no reason to change its value.

5-57. A2C17*.

5-58. A2C17 controls the amount of charge fed back by the Charge Restorer. If there is a zero offset that cannot be removed by ordinary adjustments, A2C17 may be adjusted. If the offset is positive, decrease A2C17; and if the offset is negative, increase A2C17. The limits of A2C17 are from 100 pf to 130 pf.

5-59. A3R18* AND A3R19*.

5-60. A3R18 and A3R19 set up a negative bias on the Sample Rate Multivibrator in order to give the SAMPLE RATE control (R6) the proper range. To decrease the Sample Rate, increase A3R18; and to increase the Sample Rate, increase A3R19.

5-61. R4*.

5-62. R4 brings the ramp slope adjustment into the range of the Ramp Slope potentiometer (A3R51). R4 is temperature coefficient matched to the Ramp Capacitor C6. If the readings are consistently high, and the Ramp Slope adjustment cannot bring the readings down, R4 should be lowered to 7100 Ω. If the assembly containing A3QCR1A and A3QCR1B is changed, it may be necessary to change R4. R4 should either be 7700 Ω (-hp- Part No. 0811-0143) or 7100 Ω (-hp- Part No. 0811-0990).

5-63. SERVICE AND REPAIR.

5-64. DECIMAL ASSEMBLY A10 AND FUNCTION ASSEMBLY A11 REMOVAL.

a. Remove Assemblies A2 and A3.

b. Remove A2 and A3 support bracket.

c. Remove screw holding Function Assembly A11. Assembly A11 can now be slid back for repair.

d. Remove Assemblies A4 through A8.

e. Remove two front-panel screws holding readout assembly.

f. Remove two screws in molded decimal assembly holder. The decimal board is now accessible for repair.

g. To reassemble, reverse steps f thru a.

CAUTION

DO NOT REVERSE POLAROID WINDOW.

5-65. ETCHED CIRCUIT BOARD REPAIR.

5-66. The Model 3440A uses plated through double sided etched circuit boards. To prevent damage to the circuit board and components, observe the following rules when soldering:

a. Use a low-heat (25 to 50 watts) soldering iron with a small tip (1/16" to 3/32" dia.).

b. To remove a component, clip a heat sink (long nose pliers, commercial heat sink tweezers etc.) on the component lead as close to the component as possible. Place the soldering iron directly on the component lead and pull up on the lead. If a component is obviously damaged or faulty, clip the leads close to the component and then remove the leads from the board.

CAUTION

EXCESSIVE OR PROLONGED HEAT CAN LIFT THE CIRCUIT FOIL OR CAUSE DAMAGE TO COMPONENTS.

c. Clean the component lead holes by heating the solder in the hole, quickly removing the soldering iron, and inserting a pointed, non-metallic object such as a toothpick.

d. To mount a new component, shape the leads and insert them in the holes. Clip a heat sink on the component, heat with the soldering iron, and add solder as necessary to obtain a good electrical connection.

e. Clip excess leads off after soldering and clean excess flux from the connection and adjoining area, using type TF Freon (-hp- Part No. 8500-0232).

5-67. POWER SUPPLY MODIFICATIONS.

5-68. POWER SUPPLY (Model 3440A Below Serial Number 415-00726).

5-69. When using the Model 3440A with -hp- Model 3443A High Gain/Auto Range Unit, the values of A9R15 and A9R16 should be 1.2 K ohms, fixed composition ±10%, 1/2 watt (-hp- Part No. 0687-1221) to prevent overloading of the power supply. Instruments with serial numbers 415-00726 and above have been modified during production. This modification does not require recalibration of the Model 3440A.

5-70. DC ISOLATION (Model 3440A Below Serial Number 347-00301).

5-71. This modification raises the dc isolation voltage of the above instruments from 400 volts to 500 volts above chassis ground. Change the heat sink insulator used with Q1 to a new heat sink, insulator -hp- Part No. 1200-0091. This can be purchased from your local -hp- Field Sales and Service Office.

5-72. MODIFICATION PROCEDURE.

a. Refer to Figure 5-9; remove Transistor Q1 and its insulator -- taking care not to lose the mounting stud insulators.

b. File the emitter and base holes 1/8" larger in a direction as shown in Figure 5-9. Be sure to deburr and smooth the filed portion of the hole to insure against any shorting of the new insulator to the chassis.

c. Install the new insulator block with the red side making contact with the 3440A chassis. Position the insulator so that it does not interfere with the grommet containing the transformer wires. (If the insulator overlaps the wiring grommet, it will not make good thermal contact with the -hp- 3440A chassis.)

d. Install Q1. Rotate it 180° from its original orientation so that the emitter is now in the hole nearest A9 receptacle. Be sure to use the stud insulators removed in step a.

e. Turn the instrument bottom side up and rotate Q1 socket 180°. It may be necessary to install longer wires from A9 receptacle to Q1 socket. Refer to Figure 5-9 for the proper wire colors and connections.

f. This modification does not require recalibration of the Model 3440A.

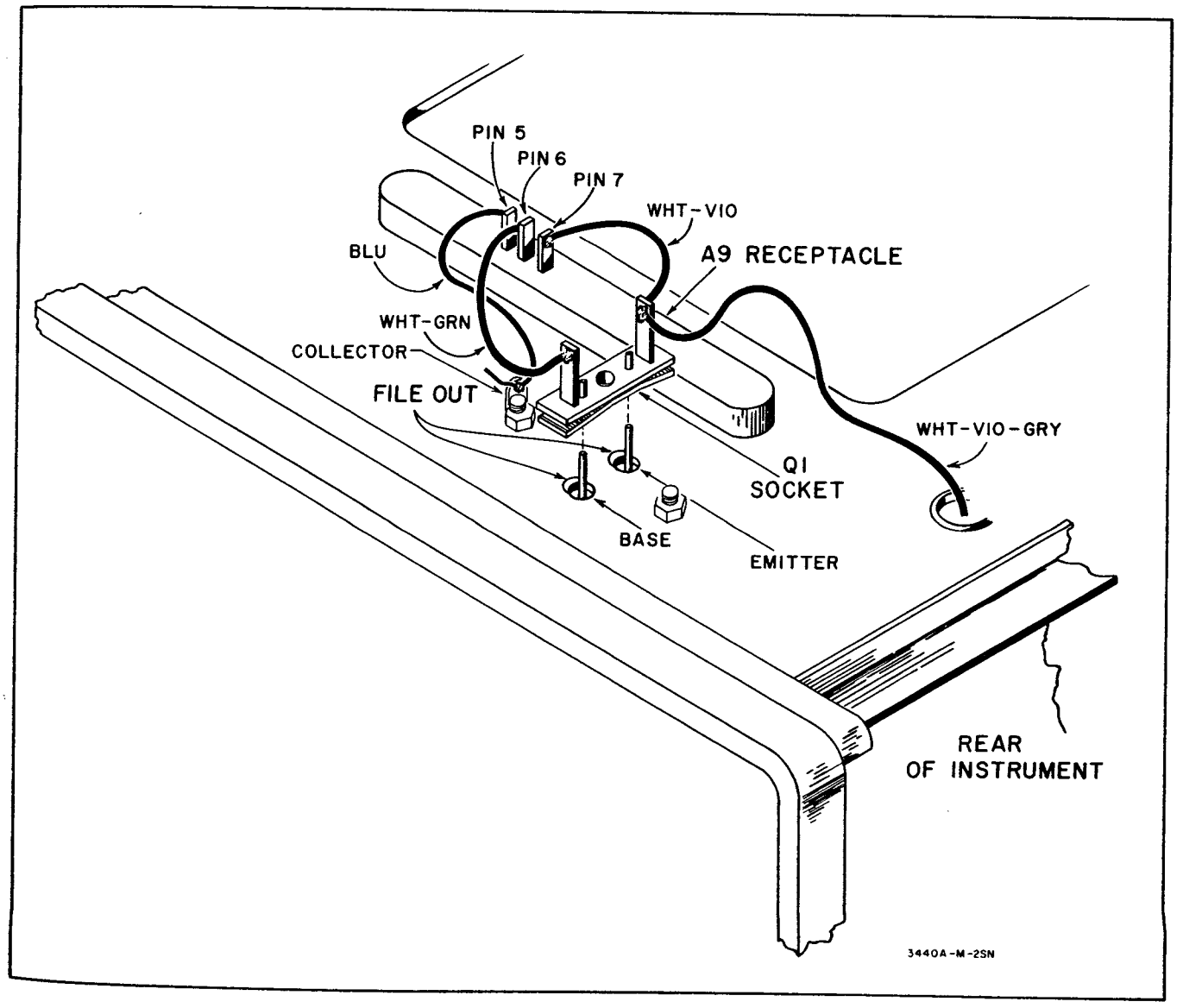
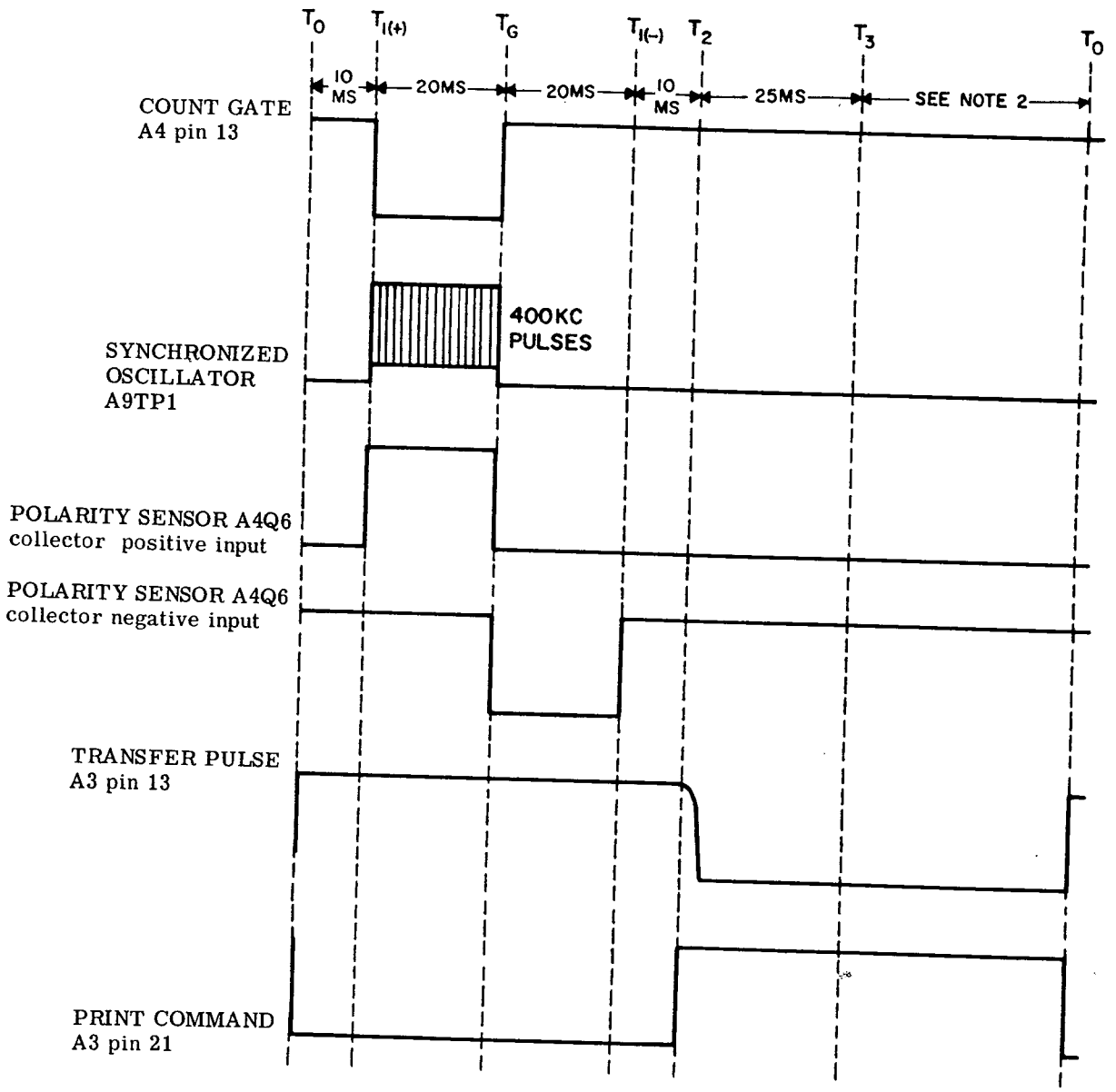


Figure 5-9. DC Isolation Increase Modification



NOTES

1. TIME INTERVAL BETWEEN TIMES T_1 and T_G IS DETERMINED BY INPUT VOLTAGE LEVEL (8.000 VOLTS SHOWN).
2. TIME INTERVAL GOING FROM TIME T_3 TO TIME T_0 IS DETERMINED BY SAMPLE RATE CONTROL SETTING.
3. REFER TO FIGURE 5-11 OR SCHEMATIC DIAGRAMS FOR VOLTAGE LEVELS OF WAVEFORMS.

3440A-8-0025

Figure 5-10. Waveform Time Sequence

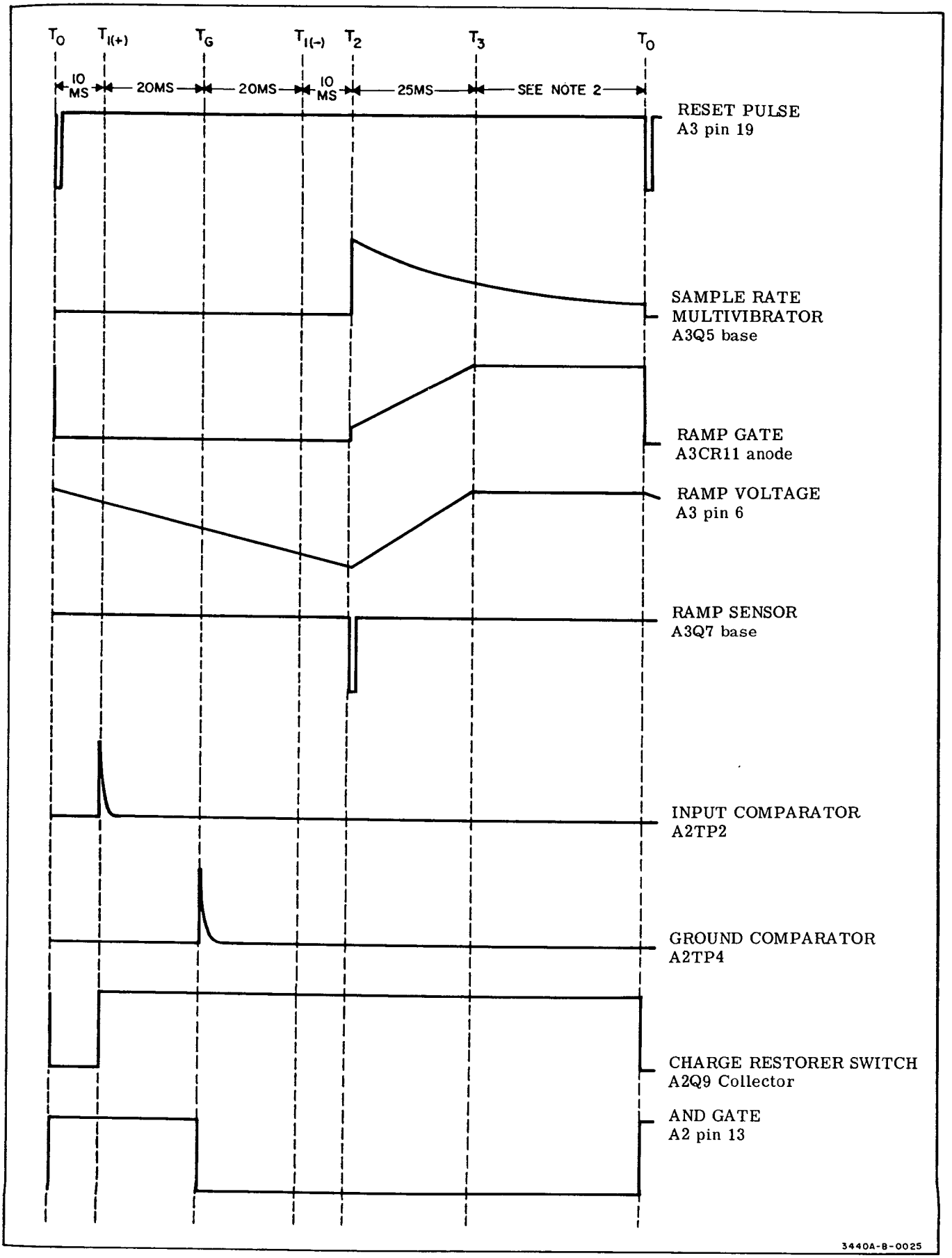
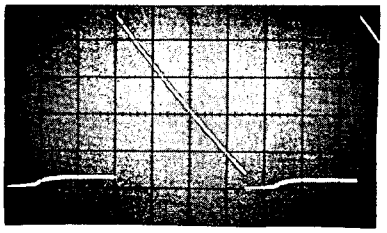
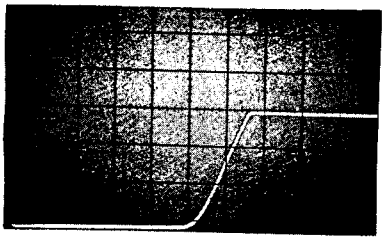


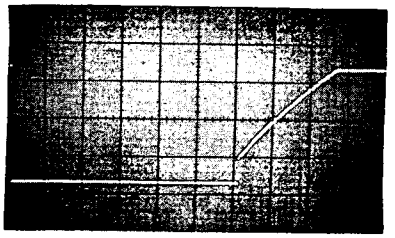
Figure 5-10. Waveform Time Sequence (Cont'd)



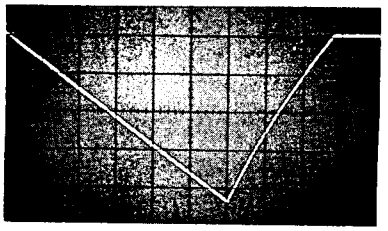
A - SAMPLE RATE MULTIVIBRATOR
A3Q5 base
1.0 volt/cm; 20 msec/cm



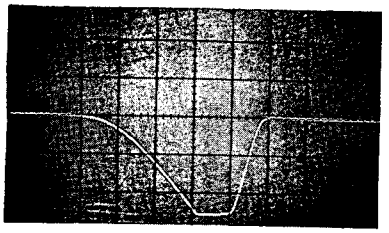
B - RESET PULSE
A3 (19)
10 volts/cm; 5 μsec/cm



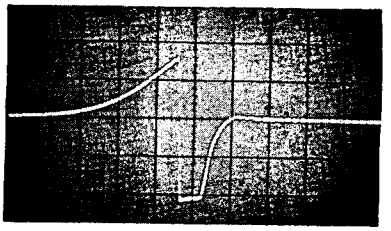
C - RAMP GATE
A3Q11 Collector
10 volts/cm; 10 msec/cm



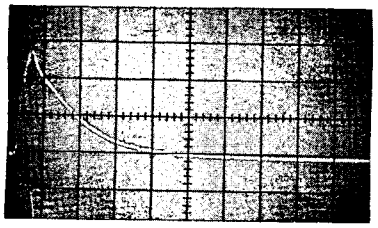
D - RAMP
A3 (6)
5.0 volts/cm; 10 msec/cm



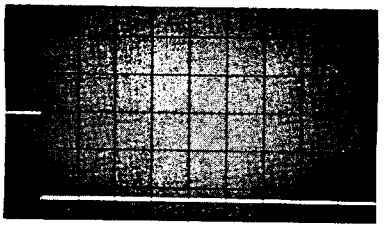
E - RAMP SENSOR
A3Q7 base
5.0 volts/cm; .1 msec/cm
time T_2



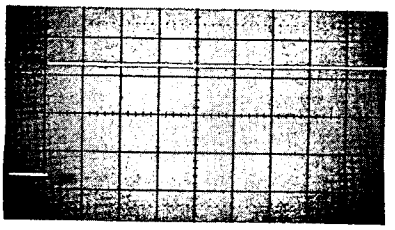
F - INPUT AMPLIFIER
A2TP1
5.0 volts/cm; 0.1 msec/cm
time T_i; AC coupled



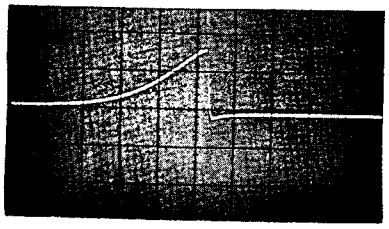
G - INPUT PULSE
A2TP2
5.0 volts/cm; 0.5 μsec/cm
time T_i; AC coupled



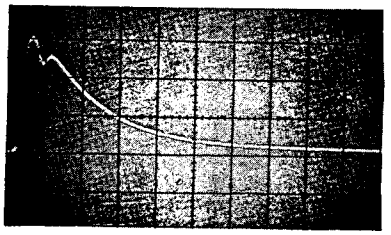
H - INPUT FLIP-FLOP
A2Q7 collector
10 volts/cm; 10 msec/cm



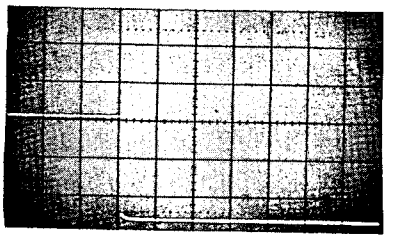
J - CHARGE RESTORER SWITCH
A2Q9 collector
10 volts/cm; 10 msec/cm



K - GROUND AMPLIFIER
A2TP3
5.0 volts/cm; 0.1 msec/cm
time T_g; AC coupled



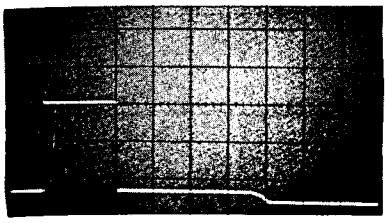
L - GROUND PULSE
A2TP4
5.0 volts/cm; 0.5 μsec/cm
time T_g, AC coupled



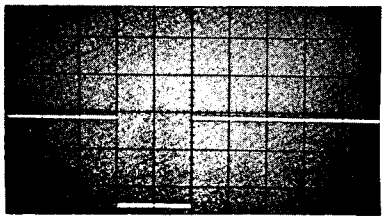
M - GROUND FLIP-FLOP
A2Q15 collector
10 volts/cm; 10 msec/cm

NOTE: Each waveform starts at T_0 unless otherwise stated.

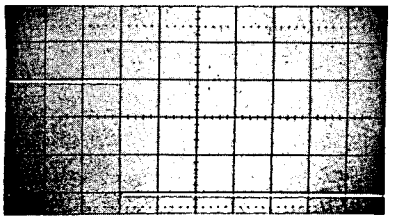
Figure 5-11. Typical Waveforms



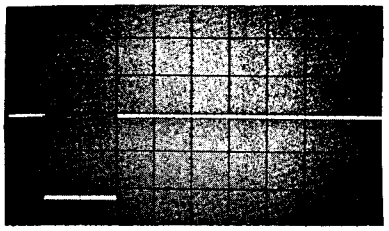
N - POLARITY SENSOR
A4Q6 collector
10 volts/cm; 10 msec/cm



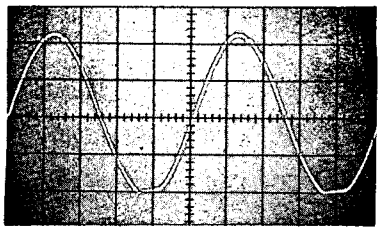
P - POLARITY SENSOR
A4Q6 collector
10 volts/cm; 20 msec/cm
-8.000 volt input



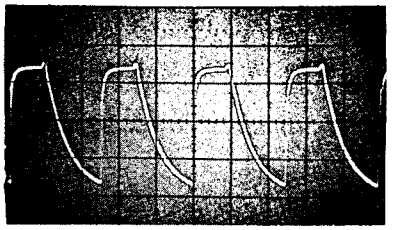
Q - AND GATE
A2 (13)
5.0 volts/cm; 10 msec/cm



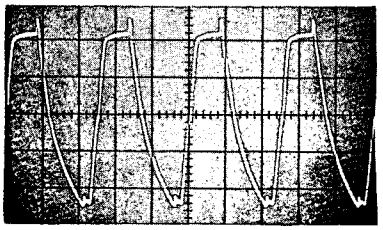
R - COUNT GATE
A4Q2 collector
10 volts/cm; 10 msec/cm



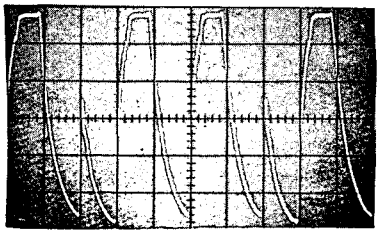
S - SYNCHRONIZED OSCILLATOR
A9Q5 collector
5.0 volts/cm; .5 μsec/cm
AC coupled



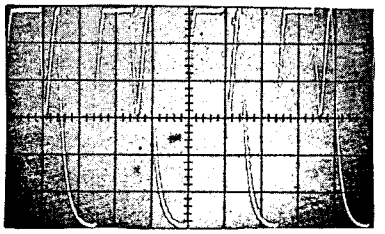
T - SYNCHRONIZED
OSCILLATOR
A9TP1
10 volts/cm; 1.0 μsec/cm
AC coupled



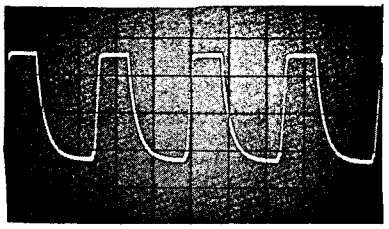
U - UNITS DECADE COUNTER
A5Q1 collector
5.0 volts/cm; 2.0 μsec/cm
AC coupled



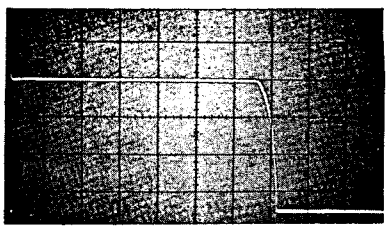
V - UNITS DECADE COUNTER
A5Q3 collector
5.0 volts/cm; 5.0 μsec/cm
AC coupled



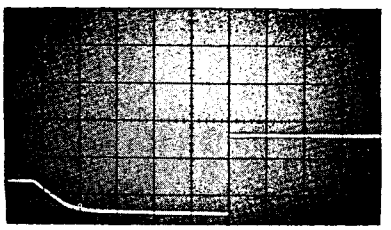
W - UNITS DECADE COUNTER
A5Q5 collector
5.0 volts/cm; 10 μsec/cm
AC coupled



X - UNITS DECADE COUNTER
A5 (10)
10 volts/cm; 10 μsec/cm
AC coupled



Y - TRANSFER PULSE
A3 (13)
10 volts/cm; 10 msec/cm



Z - PRINT COMMAND
A3 (21)
5.0 volts/cm; 10 msec/cm

Figure 5-11. Typical Waveforms (cont'd)

PERFORMANCE CHECK CARD

Hewlett-Packard Model 3440A
Digital Voltmeter
Serial No. _____ — _____

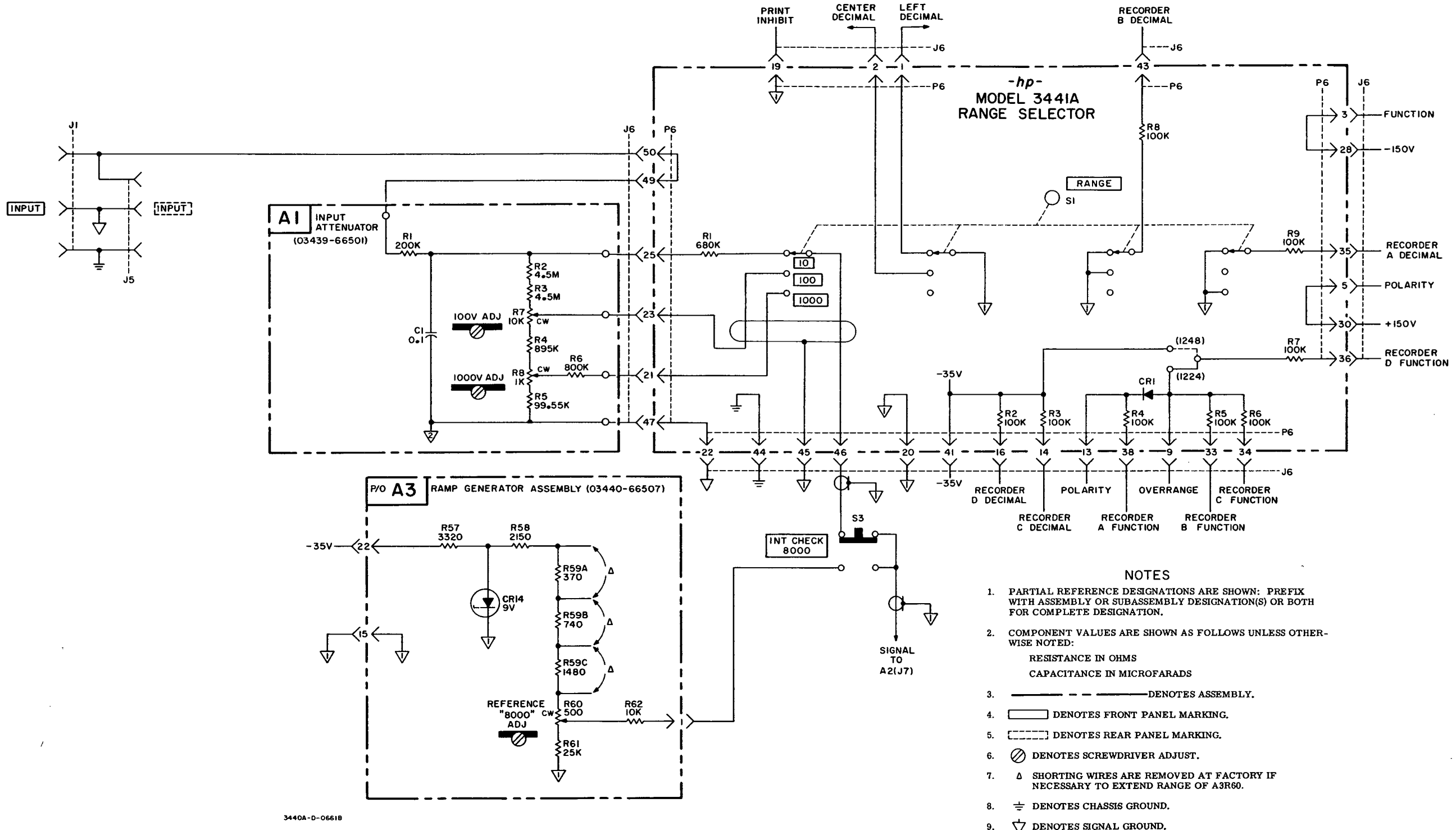
Tests performed by _____
Date _____

PARAGRAPH	DESCRIPTION	READING	TEST LIMITS
5-5	Calibration		
	Input: 0.000 V	_____	-0.001 to +0.001
	1.000 V	_____	0.998 to 1.002
	2.000 V	_____	1.998 to 2.002
	3.000 V	_____	2.997 to 3.003
	4.000 V	_____	3.997 to 4.003
	5.000 V	_____	4.996 to 5.004
	6.000 V	_____	5.996 to 6.004
	7.000 V	_____	6.995 to 7.005
	8.000 V	_____	7.995 to 8.005
	9.000 V	_____	8.994 to 9.006
	10.000 V	_____	9.994 to 0.006
5-6	Input Impedance Check	_____	9.090 to 9.112
5-7	External Trigger Check	_____	
5-8	Digital Recorder Check		
	Display: +1.111 V	_____	011113
	-2.222 V	_____	122223
	+3.333 V	_____	033333
	+4.444 V	_____	044443
	+5.555 V	_____	055553
	+6.666 V	_____	066663
	+7.777 V	_____	077773
	+8.888 V	_____	088883
	+9.999 V	_____	099993
	+1.000 V	_____	010003
	+10.00 V	_____	010002
	+100.00 V	_____	010001
	+00.50 V (Overrange)	_____	900502
5-9	DC Common Mode Rejection Check		
	Range: 10 V	_____	±0.003 V
	100 V	_____	±00.03 V
	1000 V	_____	±000.3 V
5-10	AC Common Mode Rejection Check		
	Range: 10 V	_____	±0.003 V
	100 V	_____	±00.03 V
	1000 V	_____	±000.3 V
5-11	Input Filter Response Time Check	_____	450 msec max.
5-12	Input Filter AC Rejection Check	_____	(+) 003163 to (-) 103163

SECTION VI
CIRCUIT DIAGRAMS

6-1. INTRODUCTION.

6-2. This section contains the circuit diagrams necessary for maintenance of the Model 3440A. Schematics, component location drawings, and a wiring diagram are included. The location drawings show the physical location of each component on each circuit board, and they accompany the appropriate schematic. The wiring diagram shows the connections between all the circuit boards and chassis components. Location grids are drawn on each diagram in this section, making the search for individual components easier. Figures 6-9 and 6-10 are wiring diagrams showing all the 3440A wiring.



NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
3. ——— - - - ——— DENOTES ASSEMBLY.
4. ▭ DENOTES FRONT PANEL MARKING.
5. ⬚ DENOTES REAR PANEL MARKING.
6. ⊘ DENOTES SCREWDRIVER ADJUST.
7. Δ SHORTING WIRES ARE REMOVED AT FACTORY IF NECESSARY TO EXTEND RANGE OF A3R60.
8. ⏚ DENOTES CHASSIS GROUND.
9. ▽ DENOTES SIGNAL GROUND.
10. ▽ DENOTES POWER SUPPLY GROUND.
11. ▽ DENOTES ATTENUATOR GROUND.
12. ▽ AND ▽ ARE COMMON ONLY WHEN THE PLUG-IN IS MATED WITH THE MAIN INSTRUMENT.

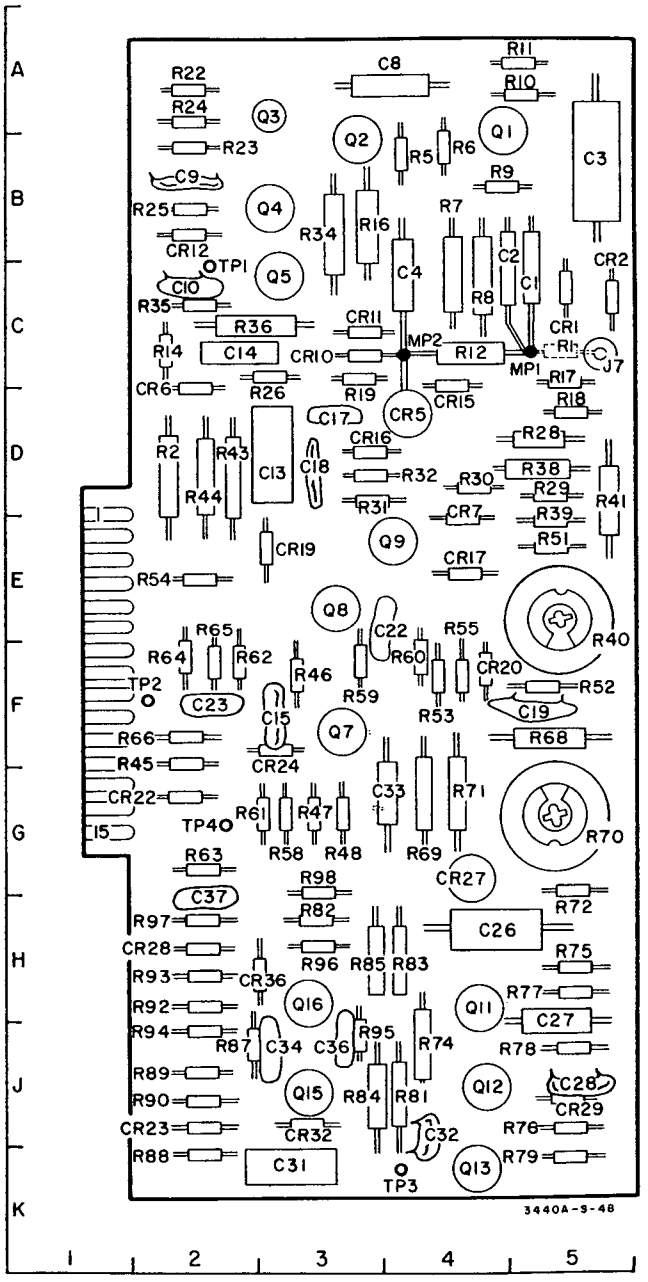
Figure 6-1. (A1) Input Attenuator

A2 ASSEMBLY COMPONENT LOCATIONS

	C	CR	Q	R	TP		R		R
1	C5	C5	A5	C5	C2	40	E5	79	K5
2	B5	B5	B3	D2	F2	41	D5	80	--
3	B5	--	A3	--	K4	42	--	81	J4
4	C4	--	B3	--	G2	43	D2	82	H3
5	--	D4	C3	B4		44	D2	83	H4
6	--	C2	--	B4		45	F2	84	J3
7	--	D4	F3	B4		46	F3	85	H3
8	A4	--	E3	C4		47	G3	86	--
9	B2	--	E4	B4		48	G3	87	J2
10	C2	C3	--	A5		49	--	88	K2
11	--	C3	H4	A5		50	--	89	J2
12	--	B2	J4	C4		51	E5	90	J2
13	D3	--	K4	--		52	F5	91	--
14	C2	--	--	C2		53	F4	92	H2
15	F3	D4	J3	--		54	E2	93	H2
16	--	D3	H3	B3		55	E4	94	J2
17	D3	E4		C5		56	--	95	J3
18	D3	--		D5		57	--	96	H3
19	F5	E3		D3		58	G3	97	H2
20	--	F4		--		59	F3	98	G3
21	--	--		--		60	F4	99	
22	E4	G2		A2		61	G3		
23	F2	J2		B2		62	F2		
24	--	F3		A2		63	G2		
25	--	--		B2		64	F2		
26	H4	--		D3		65	E2		
27	H5	G4		--		66	F2		
28	J5	H2		D5		67	--		
29	--	J5		D5		68	F5		
30	--	--		D4		69	G4		
31	K3	--		D3		70	G5		
32	J4	J3		D4		71	G4		
33	G4	--		--		72	H5		
34	J3	--		B3		73	--		
35	--	--		C2		74	J4		
36	J3	H3		C2		75	H5		
37	G2			--		76	J5		
38				D5		77	H5		
39				D5		78	J5		

A2

(hp Part No. 03440-66503)



NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
3. ———— — — ———— DENOTES ASSEMBLY.
4. [- - - - -] DENOTES REAR PANEL MARKING.
5. ⊘ DENOTES SCREWDRIVER ADJUST.
6. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY.
7. TEST VOLTAGES SHOWN OCCUR AT T_0.
8. WAVEFORMS SHOWN WITH +8.000 VOLTS INPUT.
9. ▽ DENOTES POWER SUPPLY GROUND.
10. ▽ AND ⫽ (SIGNAL GROUND) ARE COMMON ONLY WHEN THE PLUG-IN IS MATED WITH THE MAIN INSTRUMENT.
11. THE NUMBER BESIDE EACH ▽ DENOTES PIN CONNECTION FOR THAT GROUND.
12. IF INPUT IS NEGATIVE, TRAILING EDGE IS AT T_1 AND PERIOD IS PROPORTIONAL TO INPUT VOLTAGE.
13. TO OBSERVE THIS WAVEFORM, OSCILLOSCOPE SWEEP SPEED SHOULD BE 100 μSEC/CM OR GREATER.
14. TO OBSERVE THIS WAVEFORM, OSCILLOSCOPE SWEEP SPEED SHOULD BE 5 μSEC/CM OR GREATER.

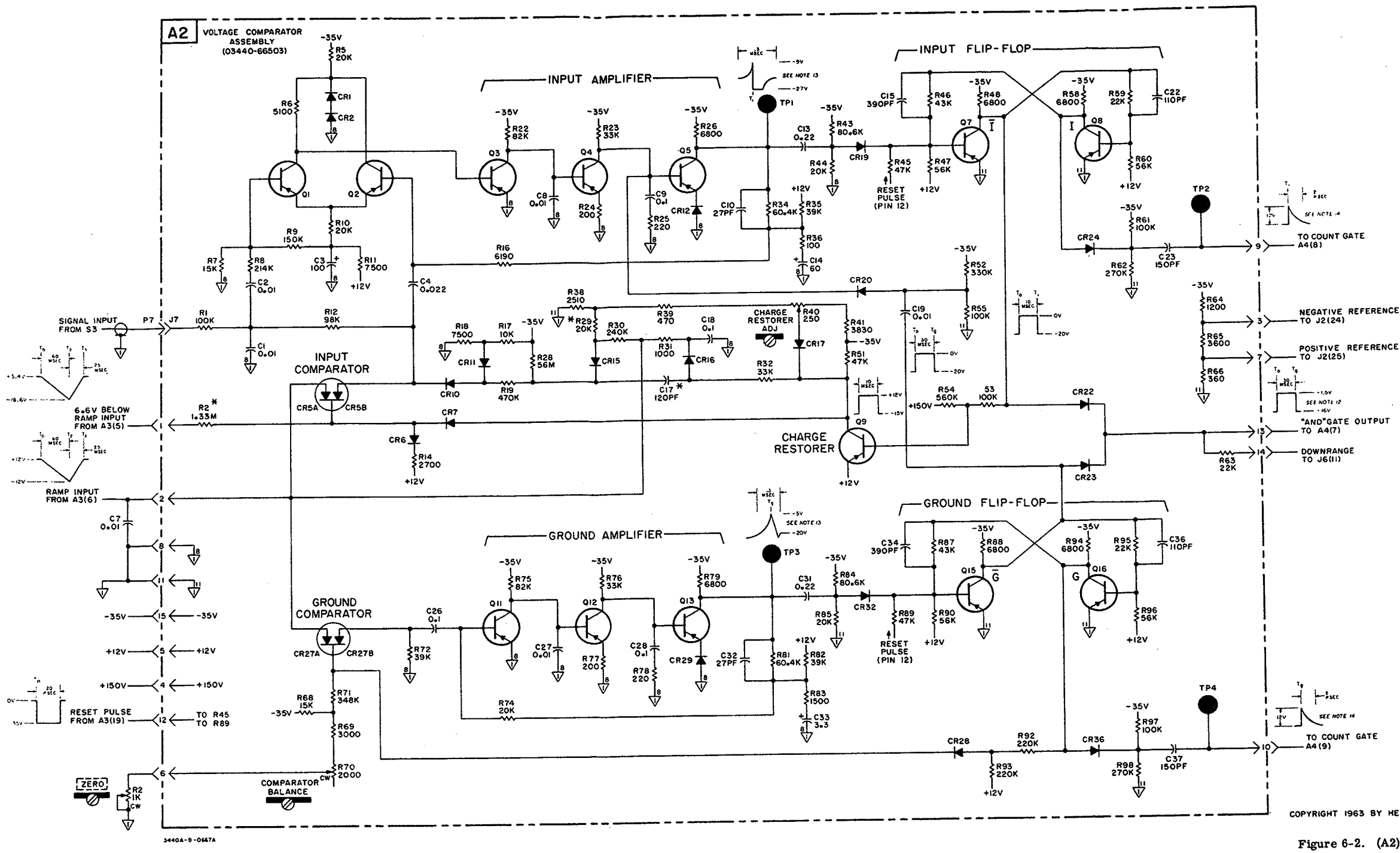


Figure 6-2. (A2) Voltage Comparator

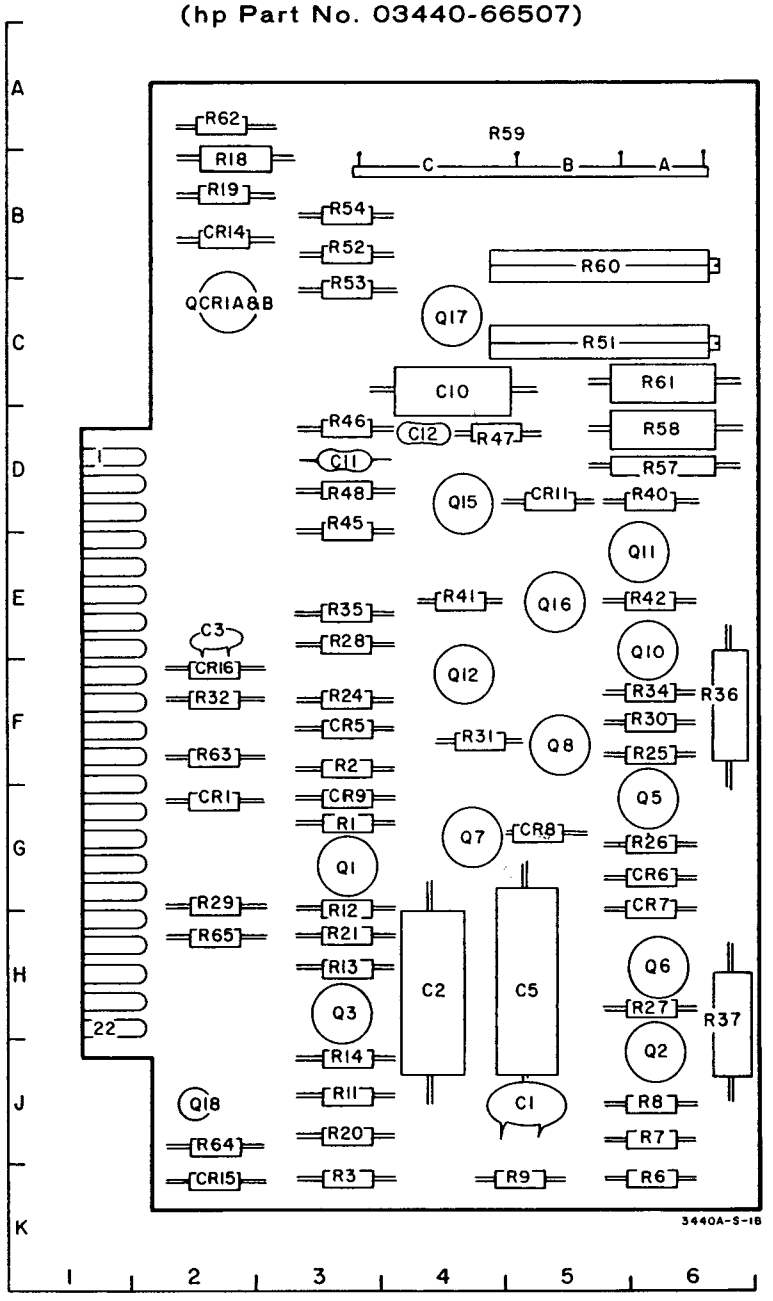
A3 ASSEMBLY COMPONENT LOCATIONS

	C	CR	Q	R		R
1	J5	G2	G3	G3	34	F6
2	H4	--	J6	F3	35	E3
3	E2	--	H3	K3	36	F6
4	--	--	--	--	37	H6
5	H5	F3	G6	--	38	--
6	--	G6	H6	K6	39	--
7	--	G6	G4	J6	40	D6
8	--	G5	F5	J6	41	E4
9	--	G3	--	K5	42	E6
10	C4	--	E6	--	43	--
11	D3	D5	E6	J3	44	--
12	D4	--	F4	G3	45	D3
13		--	--	H3	46	D3
14		B2	--	J3	47	D4
15		K2	D4	--	48	D3
16		F2	E5	--	49	--
17			C4	--	50	--
18			J2	B2	51	C5
19				B2	52	B3
20				J3	53	C3
21				H3	54	B3
22				--	55	--
23				--	56	--
24				F3	57	D6
25				F6	58	D6
26				G6	59	A5
27				H6	60	B5
28				E3	61	C6
29				G2	62	A2
30				F6	63	F2
31				F4	64	J2
32				F2	65	H2
33				--	66	

QCR1 LOCATED AT C2

A3

(hp Part No. 03440-66507)



NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
3. ——— – – ——— DENOTES ASSEMBLY.
4. – — – — – — – — DENOTES SUBASSEMBLY.
5. ▭ DENOTES FRONT PANEL MARKING.
6. ⊘ DENOTES SCREWDRIVER ADJUST.
7. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY.
8. DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.
9. ▽ DENOTES POWER SUPPLY GROUND.
10. ▽ AND ⫛ (SIGNAL GROUND) ARE COMMON ONLY WHEN THE PLUG-IN IS MATED WITH THE MAIN INSTRUMENT.
11. WAVEFORMS SHOWN WITH SAMPLE RATE SET AT MAXIMUM.
12. THE NUMBER BESIDE EACH ▽15 DENOTES PIN CONNECTION FOR THAT GROUND.
13. THE NUMBER BESIDE EACH -35 V ENTRY DENOTES PIN CONNECTION FOR THAT VOLTAGE.
14. REPLACING THE SAMPLE RATE CAPACITOR A3C5 MAY REQUIRE CHANGING THE VALUE OF A3R18* AND A3R19*. SEE PARAGRAPH 5-59.

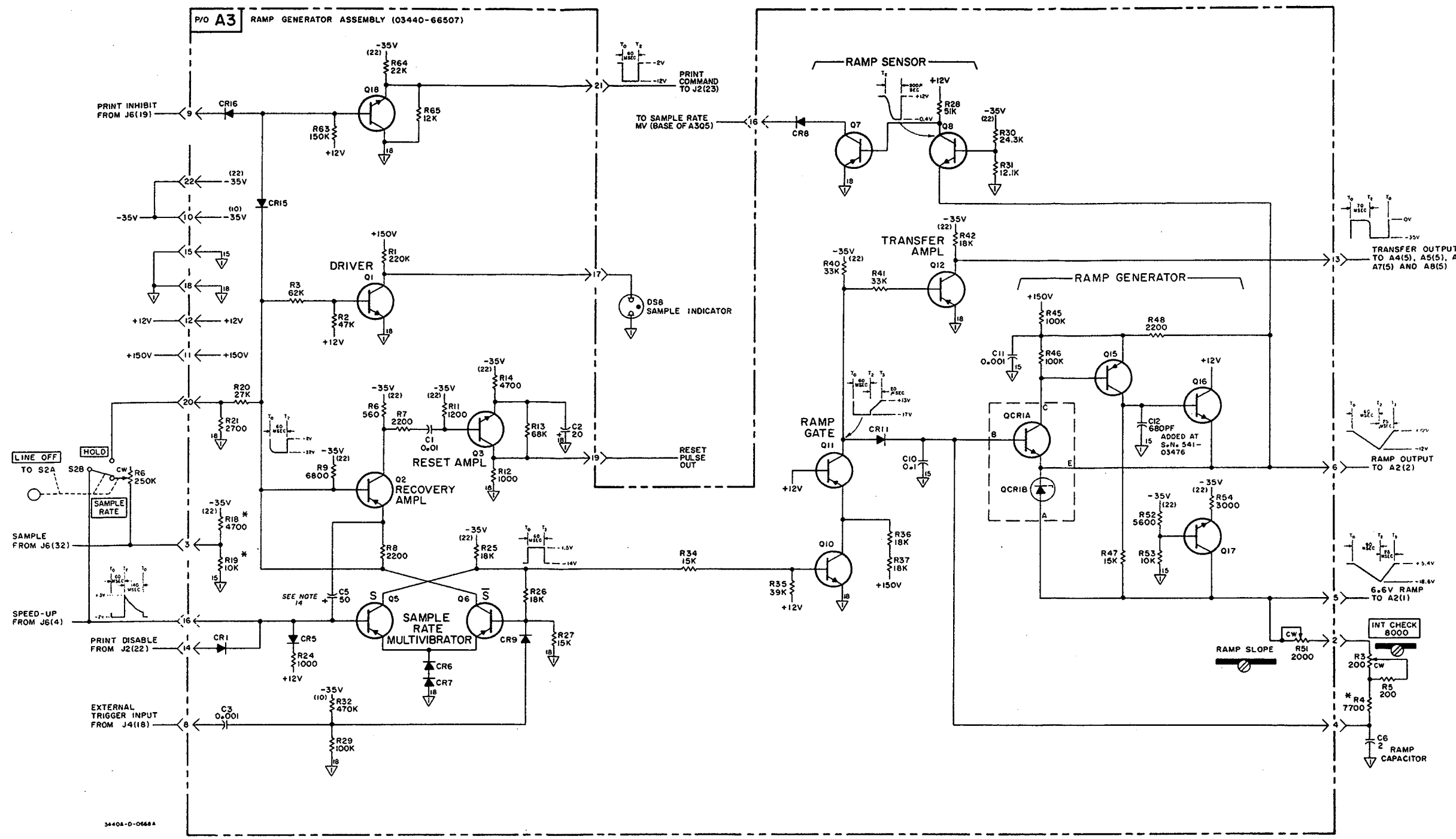


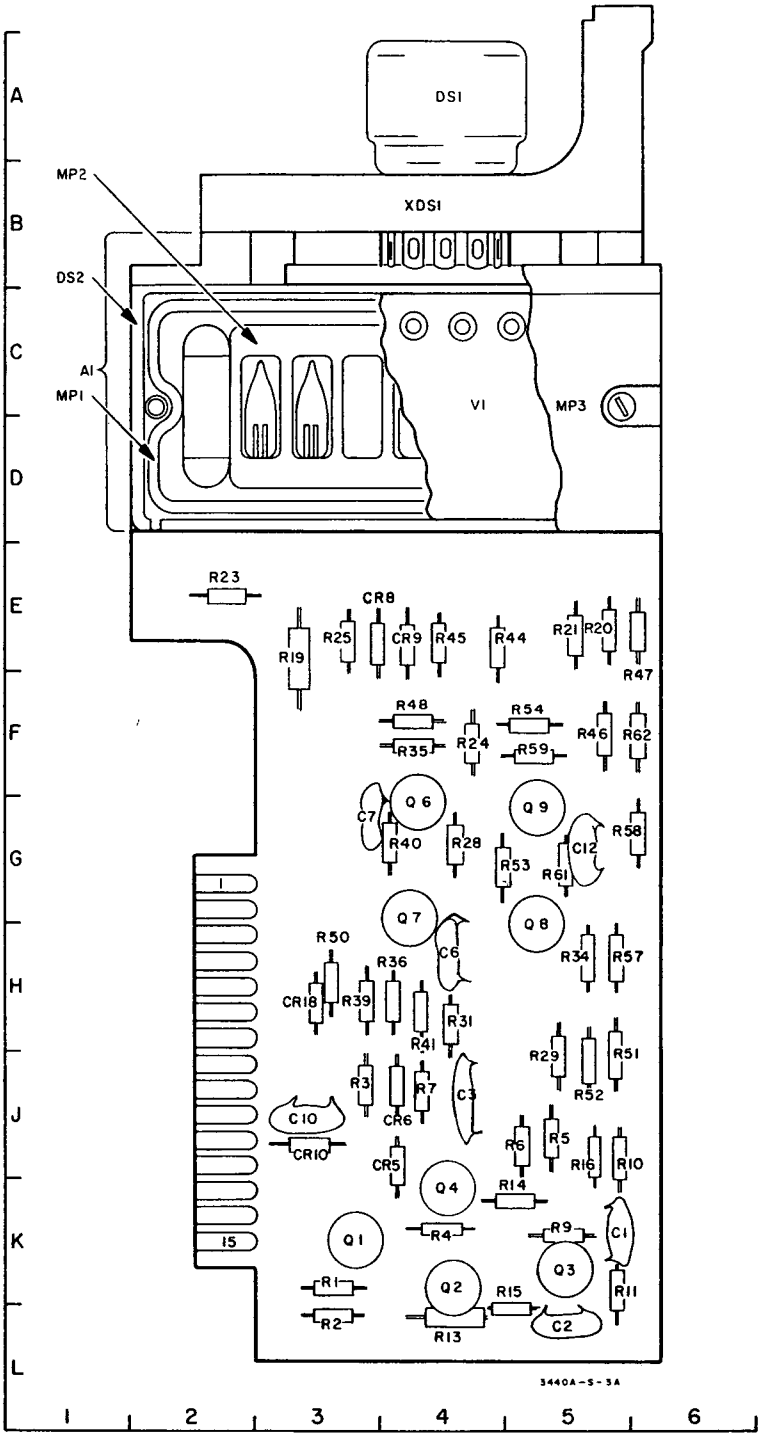
Figure 6-3. (A3) Ramp Generator

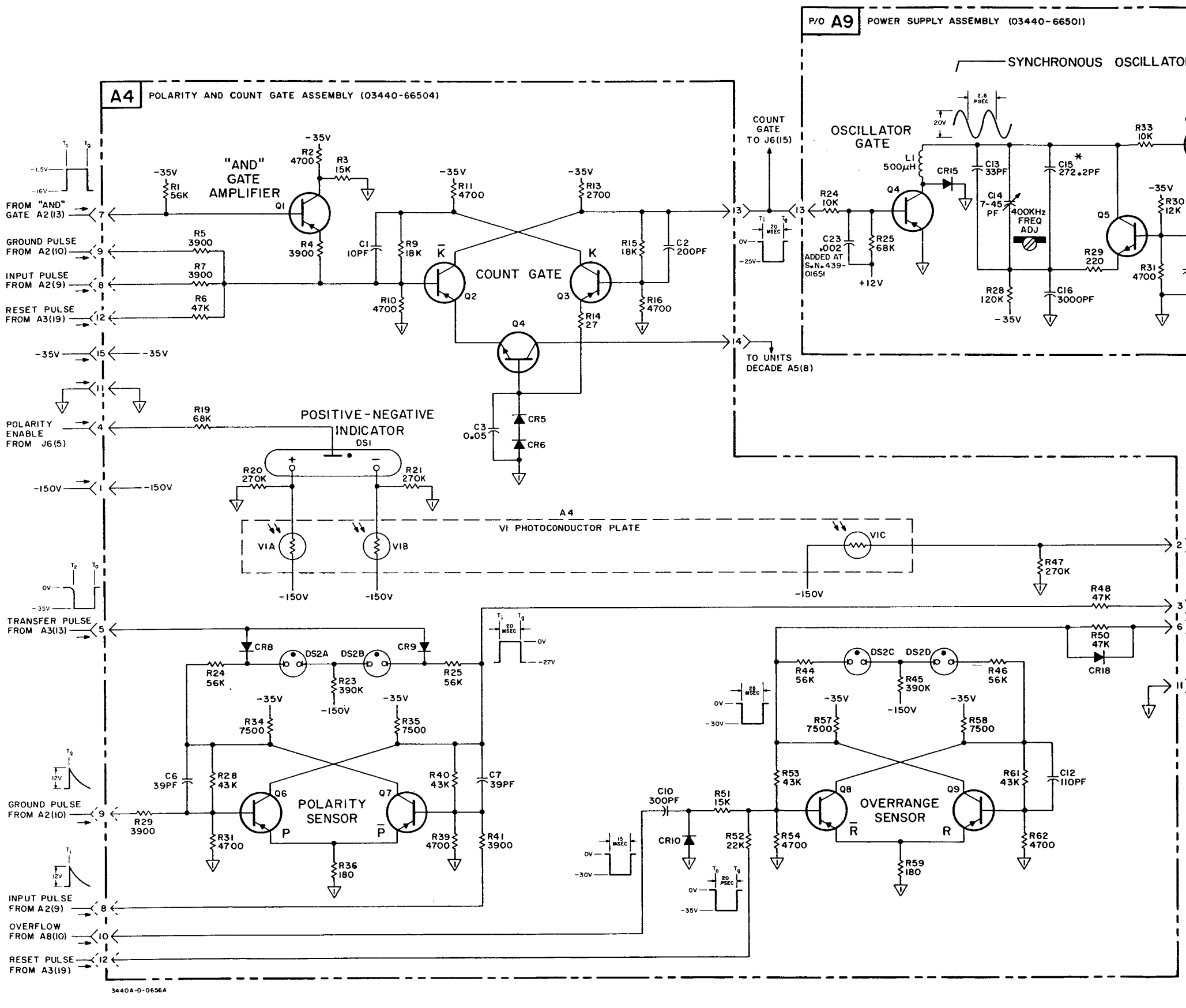
A4 ASSEMBLY COMPONENT LOCATIONS

	C	CR	Q	R		R
1	K5	--	K3	K3	34	H5
2	L5	--	K4	L3	35	F4
3	J4	--	K5	J3	36	H4
4	--	--	K4	K4	37	--
5	--	J4	--	J5	38	--
6	H4	J4	G4	J5	39	H3
7	G3	--	G4	J4	40	G4
8	--	E4	G5	--	41	H4
9	--	E4	G5	K5	42	--
10	J3	J3		J6	43	--
11	--	--		K6	44	E5
12	G5	--		--	45	E4
13		--		L4	46	F5
14		--		K5	47	F6
15		--		K5	48	F4
16		--		J5	49	--
17		--		--	50	H3
18		H3		--	51	J6
19				E3	52	J5
20				E5	53	G5
21				E5	54	F5
22				--	55	--
23				E2	56	--
24				F4	57	H6
25				E3	58	G6
26				--	59	F5
27				--	60	--
28				G4	61	G5
29				J5	62	F5
30				--	63	
31				H4	64	
32				--	65	
33				--	66	

A4

(hp Part No. 03440-66504)





NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
3. ——— — — ——— DENOTES ASSEMBLY.
4. — — — — — — — — DENOTES SUBASSEMBLY.
5. ⊘ DENOTES SCREWDRIVER ADJUST.
6. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY.
7. DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.
8. TEST VOLTAGES SHOWN OCCUR AT T_0.
9. WAVEFORMS SHOWN WITH +8.000 VOLTS INPUT.
10. ▽ DENOTES POWER SUPPLY GROUND.
11. ▽ AND ⏚ (SIGNAL GROUND) ARE COMMON ONLY WHEN THE PLUG-IN IS MATED WITH THE MAIN INSTRUMENT.
12. VERTICALLY ALIGNED PHOTOCONDUCTORS ARE ILLUMINATED BY THE LAMP DIRECTLY BELOW.

Figure 6-4. (A4) Count Gate, Polarity; (A9) Oscillator

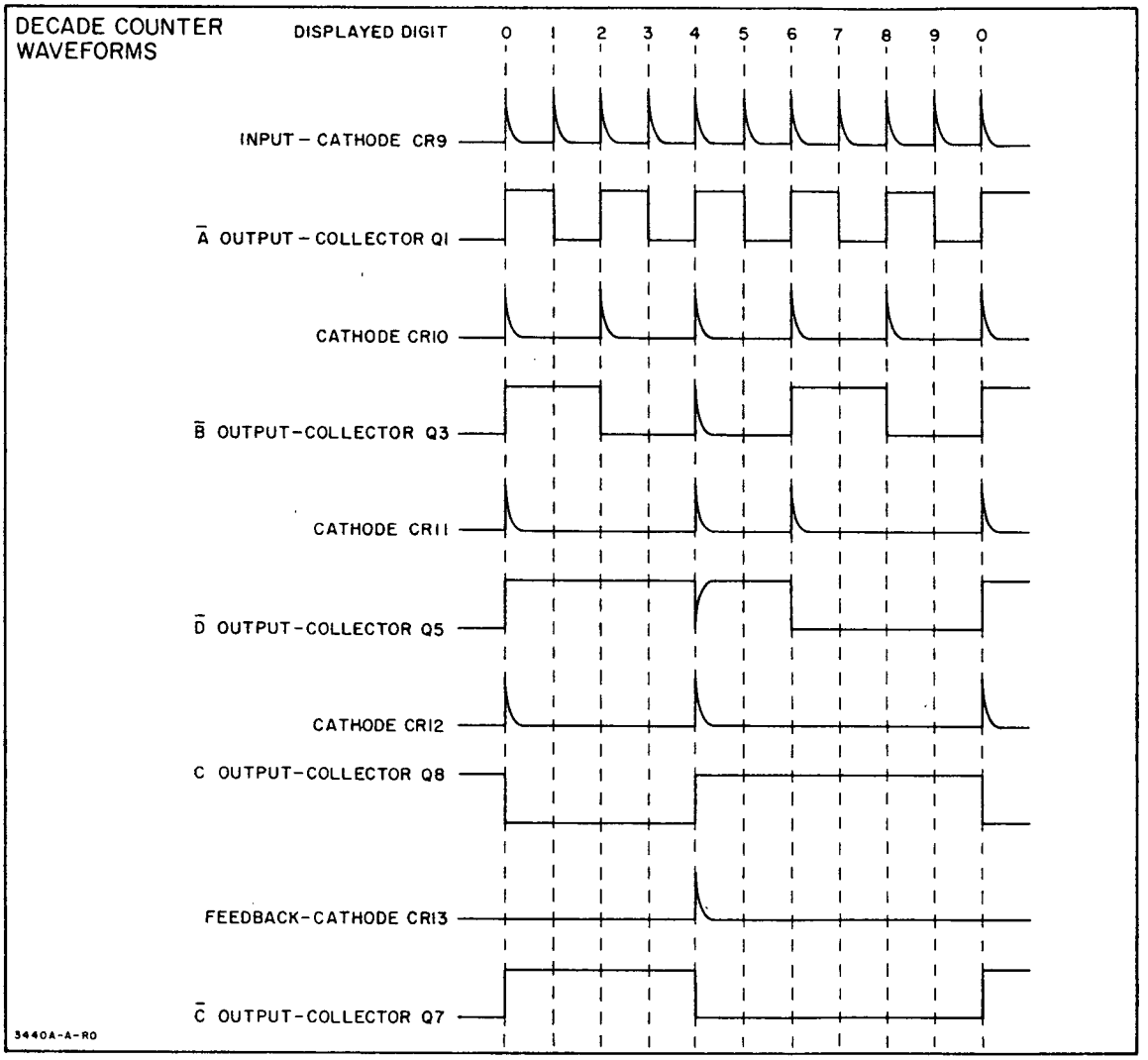
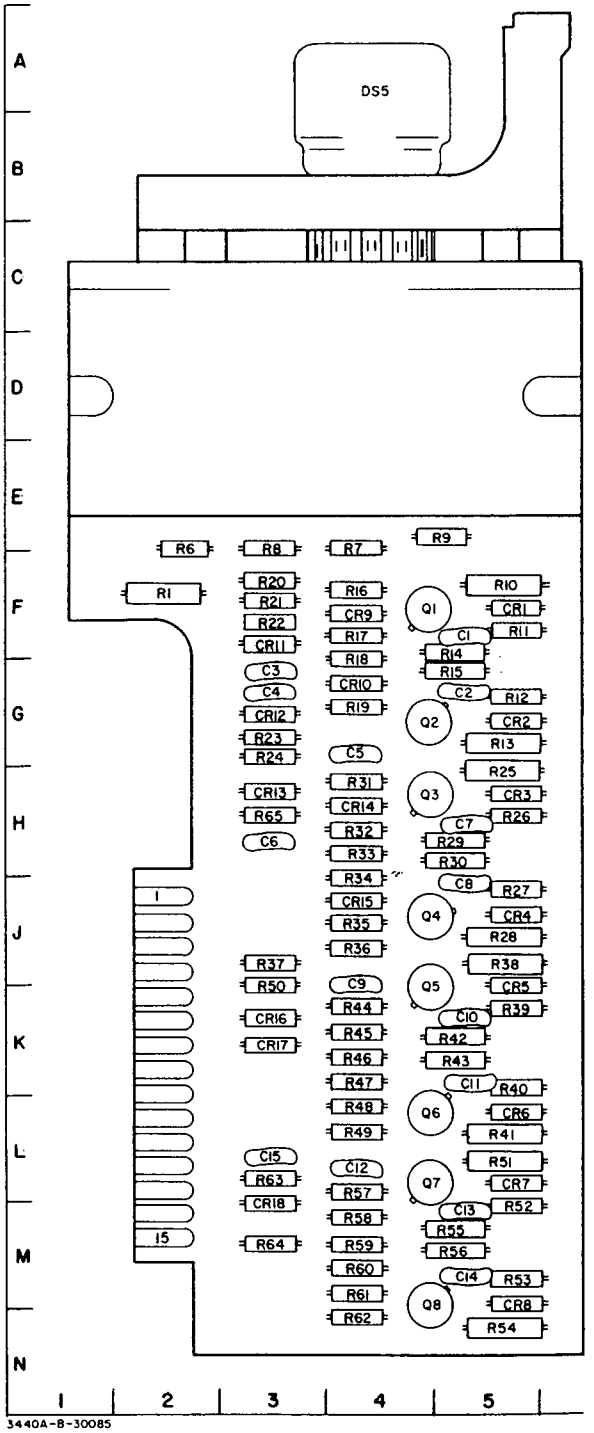


Figure 6-5. Decade Counter Waveforms

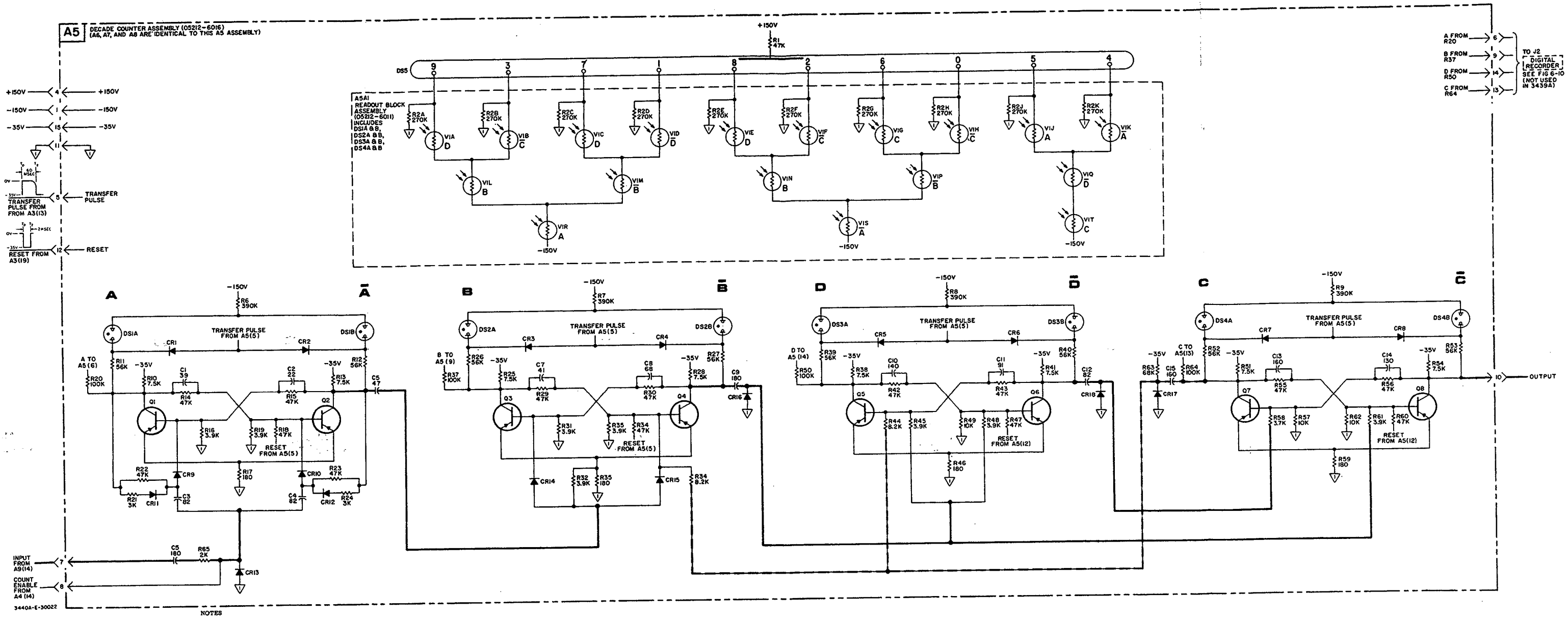
A5 thru A8 ASSEMBLY COMPONENT LOCATIONS

	C	CR	Q	R		R
1	F5	F5	F4	F2	34	H4
2	G5	G5	G4	--	35	J4
3	G3	H5	H5	--	36	J4
4	G3	J5	J4	--	37	J3
5	G4	J5	J4	--	38	J5
6	H3	L5	L4	E2	39	K5
7	H5	L5	L4	E4	40	K5
8	J5	M5	M4	E3	41	L5
9	J4	F4		E4	42	K4
10	K5	G4		F5	43	K4
11	K5	F3		F5	44	K4
12	L4	G3		G5	45	K4
13	M5	H3		G5	46	K4
14	M5	H4		F4	47	K4
15	L3	J4		G4	48	L4
16		K3		F4	49	L4
17		K3		F4	50	J3
18		L3		F4	51	L5
19				G4	52	L5
20				F3	53	M5
21				F3	54	N5
22				F3	55	M4
23				G3	56	M4
24				G3	57	L4
25				G5	58	M4
26				H5	59	M4
27				J5	60	M4
28				J5	61	M4
29				H4	62	N4
30				H4	63	L3
31				H4	64	M3
32				H4	65	H3
33				H4		

A5 thru A8
(hp Part No. 05212-6016)

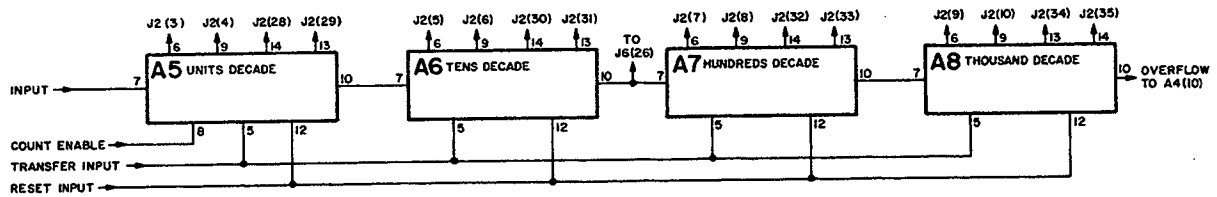


3440A-B-30085



NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
   RESISTANCE IN OHMS
   CAPACITANCE IN PICOFARADS
3. ——— DENOTES ASSEMBLY.
4. — — — — — DENOTES SUBASSEMBLY.
5. ——— DENOTES MAIN SIGNAL PATH.
6. ——— DENOTES FEEDBACK PATH.
7. WAVEFORMS SHOWN WITH COUNTER USED AS A UNITS COUNTER.
8. ⏚ DENOTES POWER SUPPLY GROUND.
9. ⏚ AND ⏚ (SIGNAL GROUND) ARE COMMON ONLY WHEN THE PLUG-IN IS MATED WITH THE MAIN INSTRUMENT.



THIS SCHEMATIC APPLIES TO SERIAL NO. 637-08626 AND UP.

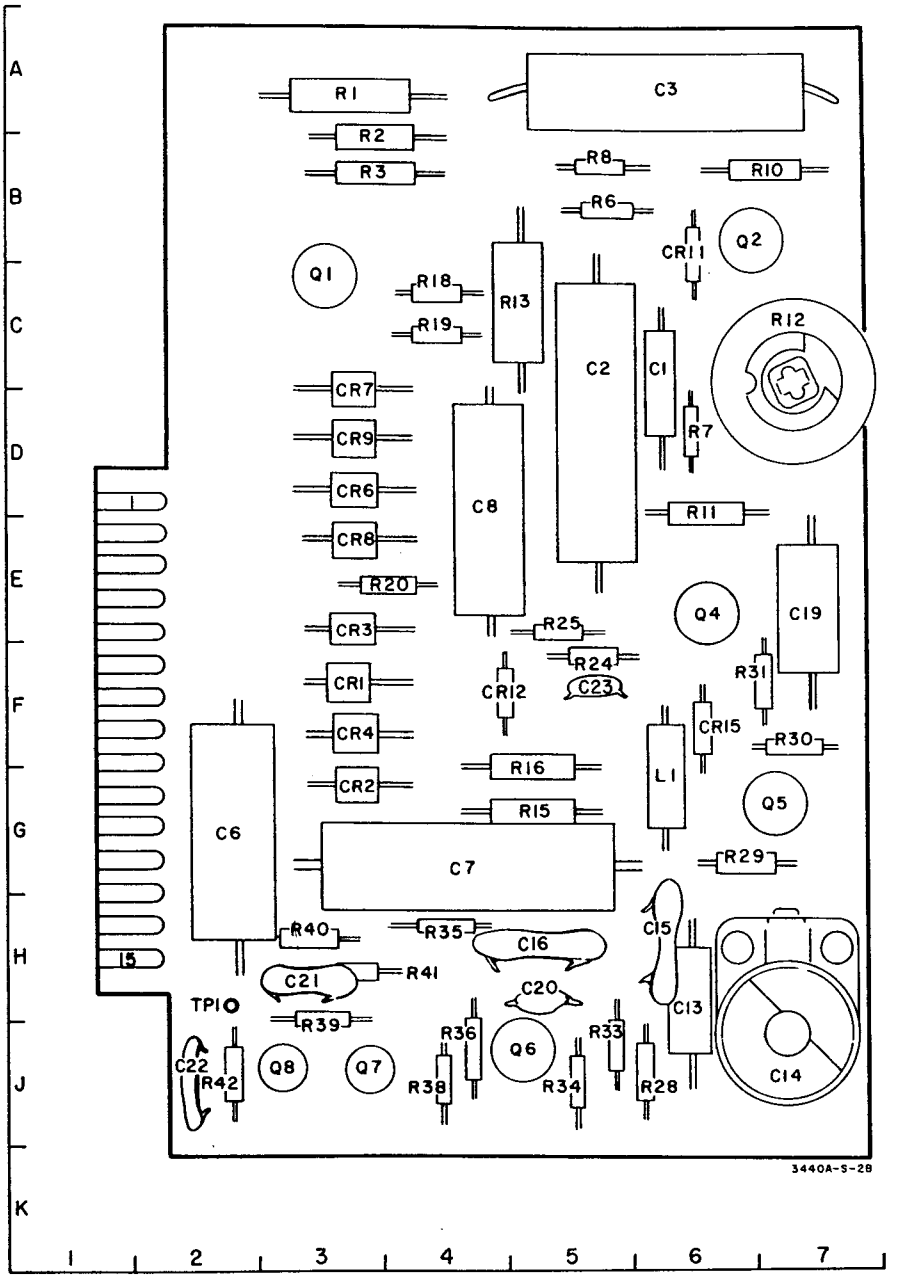
Figure 6-6. (A5 - A8) Decade Counters

A9 ASSEMBLY COMPONENT LOCATIONS

	C	CR	Q	R	L	TP
1	C6	F3	C3	A3	G6	H2
2	C5	G3	B6	B3		
3	A6	E3	--	B3		
4	--	F3	E6	--		
5	--	--	G7	--		
6	G2	D3	J5	B5		
7	G4	D3	J3	D6		
8	D4	E3	J3	B5		
9	--	D3		--		
10	--	--		B7		
11	--	B6		D6		
12	--	F5		C7		
13	H6	--		C5		
14	J7	--		--		
15	H6	F6		G5		
16	H5			G5		
17	--			--		
18	--			C4		
19	E7			C4		
20	H5			E4		
21	H3			--		
22	J2			--		
23	F5			--		
24				F5		
25				E5		
26				--		
27				--		
28				J6		
29				G6		
30				F7		
31				F7		
32				--		
33				J5		
34				J5		
35				H4		
36				J4		
37				--		
38				J4		
39				J3		
40				H3		
41				H4		
42				J2		

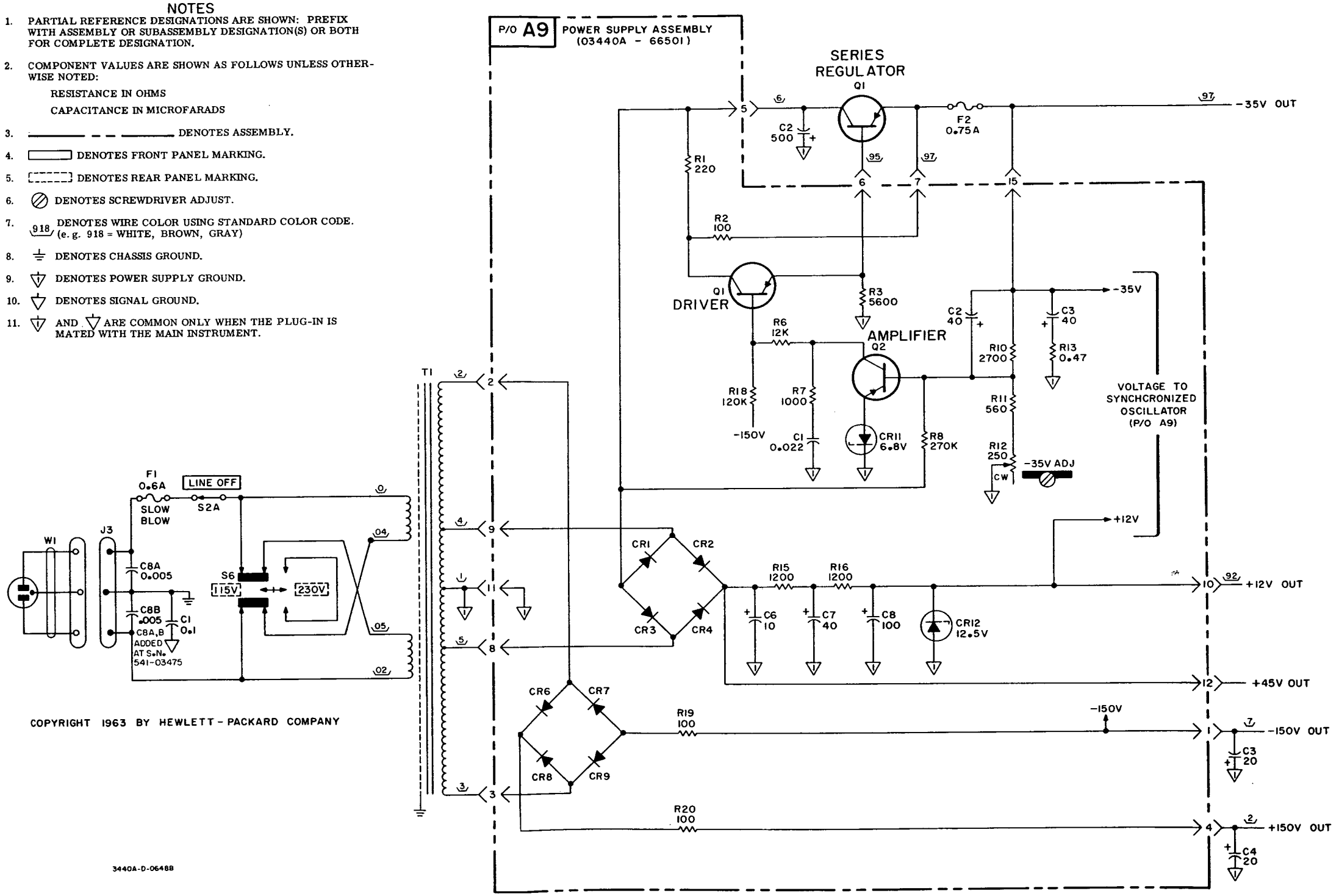
A9

(hp Part No. 03440-66501)



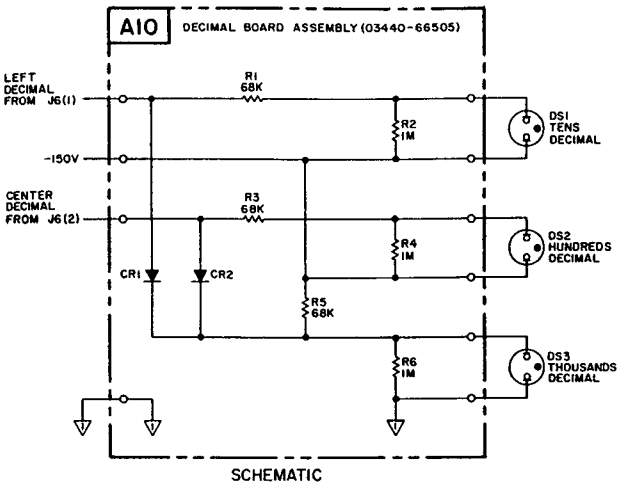
NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
3. ——— — — ——— DENOTES ASSEMBLY.
4. ▭ DENOTES FRONT PANEL MARKING.
5. ⬚ DENOTES REAR PANEL MARKING.
6. ⊘ DENOTES SCREWDRIVER ADJUST.
7. 918 DENOTES WIRE COLOR USING STANDARD COLOR CODE. (e.g. 918 = WHITE, BROWN, GRAY)
8. ⏚ DENOTES CHASSIS GROUND.
9. ▽ DENOTES POWER SUPPLY GROUND.
10. ▽ DENOTES SIGNAL GROUND.
11. ▽ AND ▽ ARE COMMON ONLY WHEN THE PLUG-IN IS MATED WITH THE MAIN INSTRUMENT.



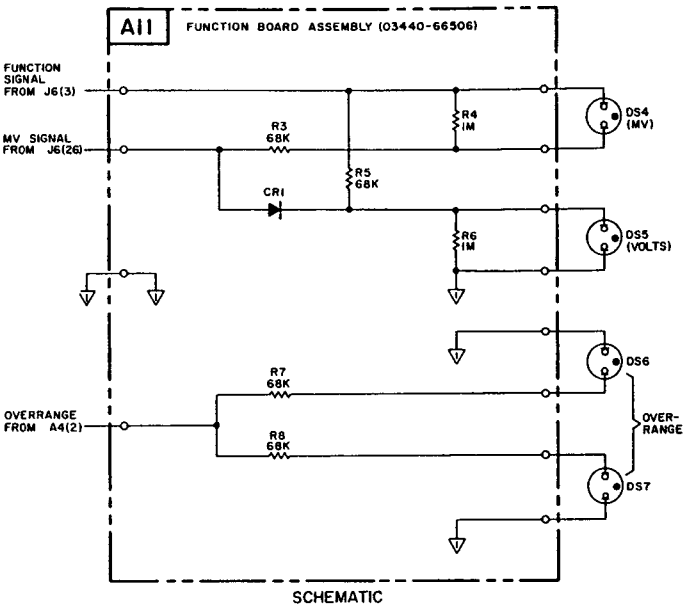
3440A-D-0648B

Figure 6-7. (A9) Power Supply



SCHEMATIC

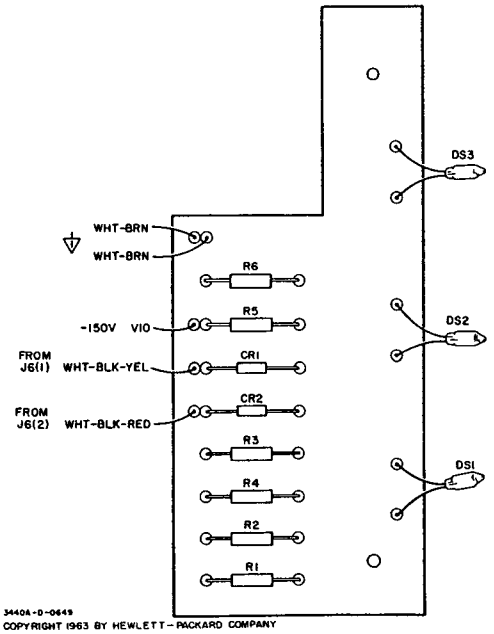
A10
DECIMAL BOARD ASSEMBLY



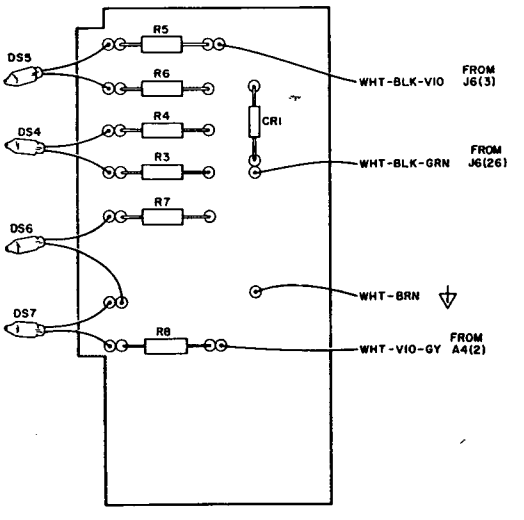
SCHEMATIC

A11
FUNCTION BOARD ASSEMBLY

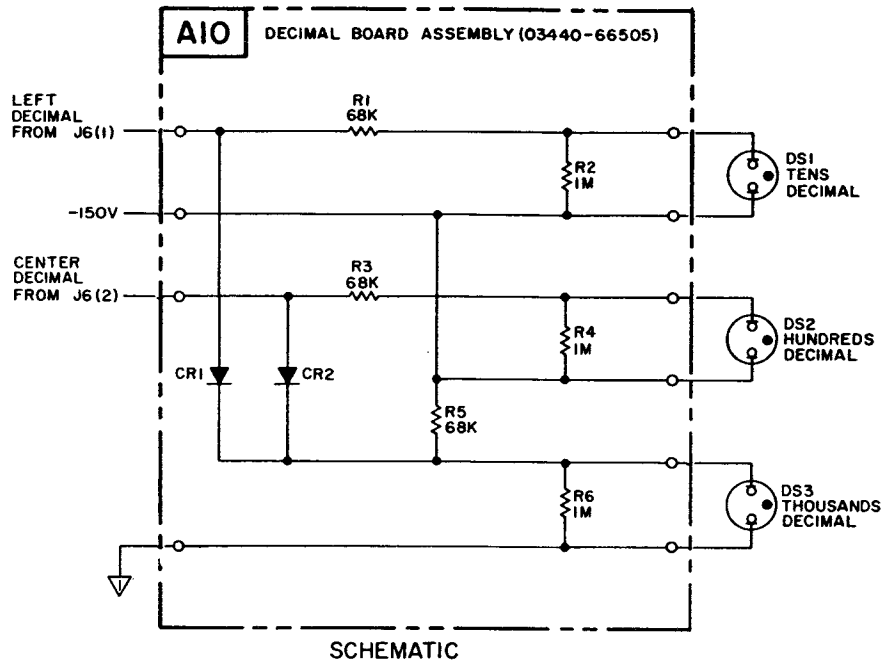
PICTORIAL



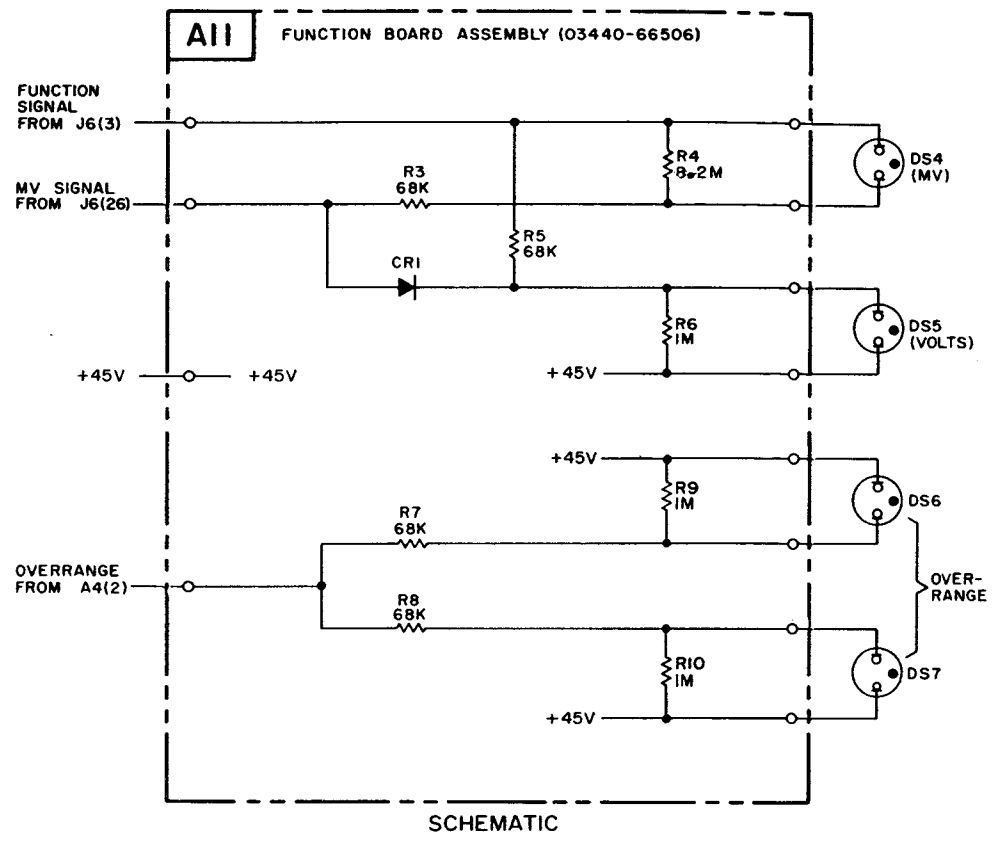
PICTORIAL



(SERIAL NO. 637-09525 AND BELOW)



A10
DECIMAL BOARD ASSEMBLY

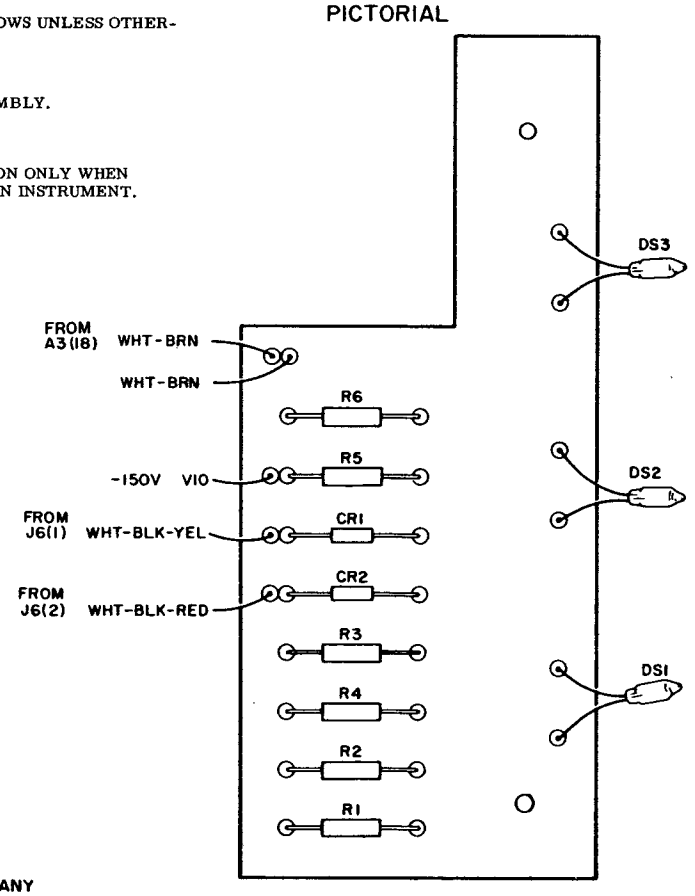


A11
FUNCTION BOARD ASSEMBLY
(SERIAL NO. 749-09526 AND UP)

NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
   RESISTANCE IN OHMS
3. ——— – – ——— DENOTES ASSEMBLY.
4. ⏚ DENOTES POWER SUPPLY GROUND.
5. ⏚ AND ▽ (SIGNAL GROUND) ARE COMMON ONLY WHEN THE PLUG-IN IS MATED WITH THE MAIN INSTRUMENT.

PICTORIAL



PICTORIAL

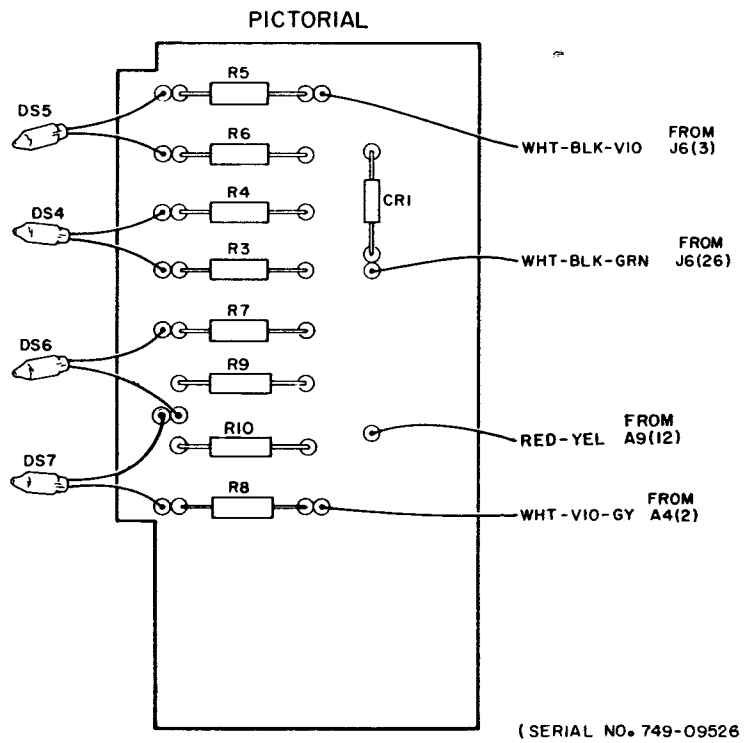


Figure 6-8. (A10 - A11) Decimal and Function Assemblies

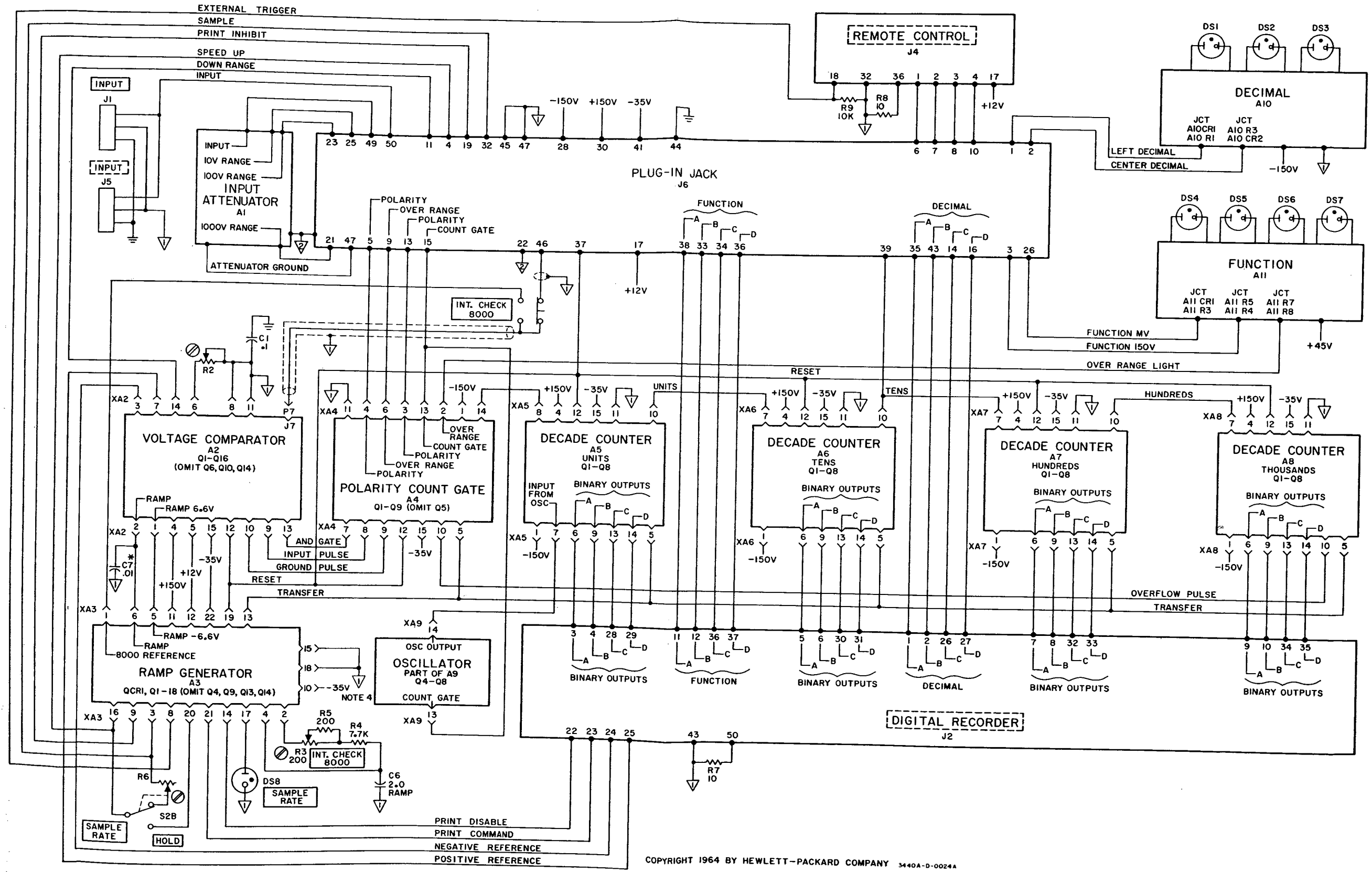


Figure 6-9. Wiring Block Diagram of 3440A

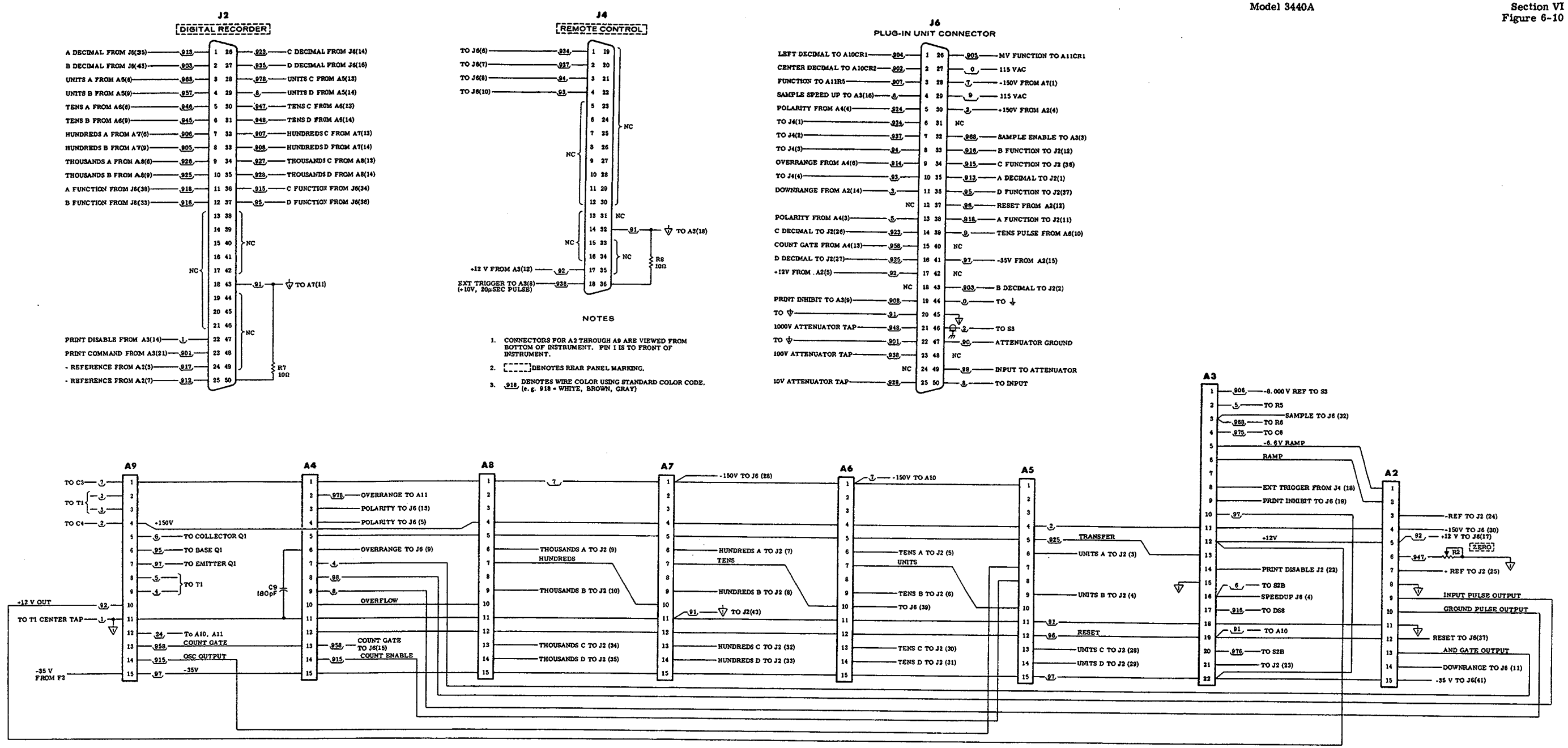


Figure 6-10. Wiring Diagram

SECTION VII
REPLACEABLE PARTS

7-1. INTRODUCTION.

7-2. This section contains information for ordering replacement parts. Table 7-1 lists parts in alphameric order of their reference designators and indicates the description and -hp- part number of each part, together with any applicable notes. Table 7-2 lists parts in alphameric order of their -hp- part number and provides the following information on each part:

a. Description of the part. (See list of abbreviations below.)

b. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.)

c. Manufacturer's part number.

d. Total quantity used in the instrument (TQ column).

7-3. Miscellaneous parts are listed at the end of Table 7-1.

7-4. ORDERING INFORMATION.

7-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix B for list of office locations.) Identify parts by their Hewlett-Packard part numbers.

7-6. NON-LISTED PARTS.

7-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

ABBREVIATIONS

Ag ..... silver
Al ..... aluminum
A ..... ampere(s)
Au ..... gold

C ..... capacitor
cer ..... ceramic
coef ..... coefficient
com ..... common
comp ..... composition
conn ..... connection

dep ..... deposited
DPDT ..... double-pole double-throw
DPST ..... double-pole single-throw

elect ..... electrolytic
encap ..... encapsulated

F ..... farad(s)
FET ..... field effect transistor
fxd ..... fixed

GaAs ..... gallium arsenide
GHz ..... gigahertz = 10^{+9} hertz
gd ..... guard(ed)
Ge ..... germanium
grd ..... ground(ed)

H ..... henry(ies)
Hz ..... mercury
Hz ..... hertz (cycle(s) per second)

ID ..... inside diameter
impg ..... impregnated
incd ..... incandescent
ins ..... insulation(ed)

kΩ ..... kilohm(s) = 10^{+3} ohms
kHz ..... kilohertz = 10^{+3} hertz

L ..... inductor
lin ..... linear taper
log ..... logarithmic taper

mA ..... milliampere(s) = 10^{-3} amperes
MHz ..... megahertz = 10^{+6} hertz
MΩ ..... megohm(s) = 10^{+6} ohms
met flm ..... metal film
mfr ..... manufacturer
ms ..... millisecond
mtg ..... mounting
mV ..... millivolt(s) = 10^{-3} volts
μF ..... microfarad(s)
μs ..... microsecond(s)
μV ..... microvolt(s) = 10^{-6} volts
my ..... Mylar (R)

nA ..... nanoampere(s) = 10^{-9} amperes
NC ..... normally closed
Ne ..... neon
NO ..... normally open
NPO ..... negative positive zero (zero temperature coefficient)
ns ..... nanosecond(s) = 10^{-9} seconds
nsr ..... not separately replaceable

Ω ..... ohm(s)
obd ..... order by description
OD ..... outside diameter

p ..... peak
pA ..... picoampere(s)
pc ..... printed circuit
pF ..... picofarad(s) 10^{-12} farads
piv ..... peak inverse voltage
p/o ..... part of
pos ..... position(s)
poly ..... polystyrene
pot ..... potiometer
p-p ..... peak-to-peak
ppm ..... parts per million
prec ..... precision (temperature coefficient, long term stability, and/or tolerance)

R ..... resistor
Rh ..... rhodium
rms ..... root-mean-square
rot ..... rotary

Se ..... selenium
sect ..... section(s)
Si ..... silicon
sl ..... slide
SPDT ..... single-pole double-throw
SPST ..... single-pole single-throw

Ta ..... tantalum
TC ..... temperature coefficient
TiO_2 ..... titanium dioxide
tog ..... toggle
tol ..... tolerance
trim ..... trimmer
TSTR ..... transistor

V ..... volt(s)
vacw ..... alternating current working voltage
var ..... variable
vdcw ..... direct current working voltage

W ..... watt(s)
w/ ..... with
wiv ..... working inverse voltage
w/o ..... without
ww ..... wirewound

* ..... optimum value selected at factory, average value shown (part may be omitted)
** ..... no standard type number assigned (selected or special type

(R) Dupont de Nemours

DECIMAL MULTIPLIERS

Prefix	Symbols	Multiplier	Prefix	Symbols	Multiplier
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^{9}	milli	m	10^{-3}
mega	M or Meg	10^{6}	micro	μ	10^{-6}
kilo	K or k	10^{3}	nano	n	10^{-9}
hecto	h	10^{2}	pico	p	10^{-12}
deka	da	10	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

DESIGNATORS

A ..... assembly
B ..... motor
BT ..... battery
C ..... capacitor
CR ..... diode
DL ..... delay line
DS ..... lamp
E ..... misc electronic part
F ..... fuse
FL ..... filter
HR ..... heater
IC ..... integrated circuit
J ..... jack
K ..... relay
L ..... inductor
M ..... meter
MP ..... mechanical part
P ..... plug
Q ..... transistor
QCR ..... transistor-diode
R ..... resistor
RT ..... thermistor
S ..... switch
T ..... transformer
TB ..... terminal board
TC ..... thermocouple
TP ..... test point
TS ..... terminal strip
V ..... vacuum tube, neon bulb, photocell, etc.
W ..... cable
X ..... socket
XDS ..... lampholder
XF ..... fuseholder
Y ..... crystal
Z ..... network

Rev H

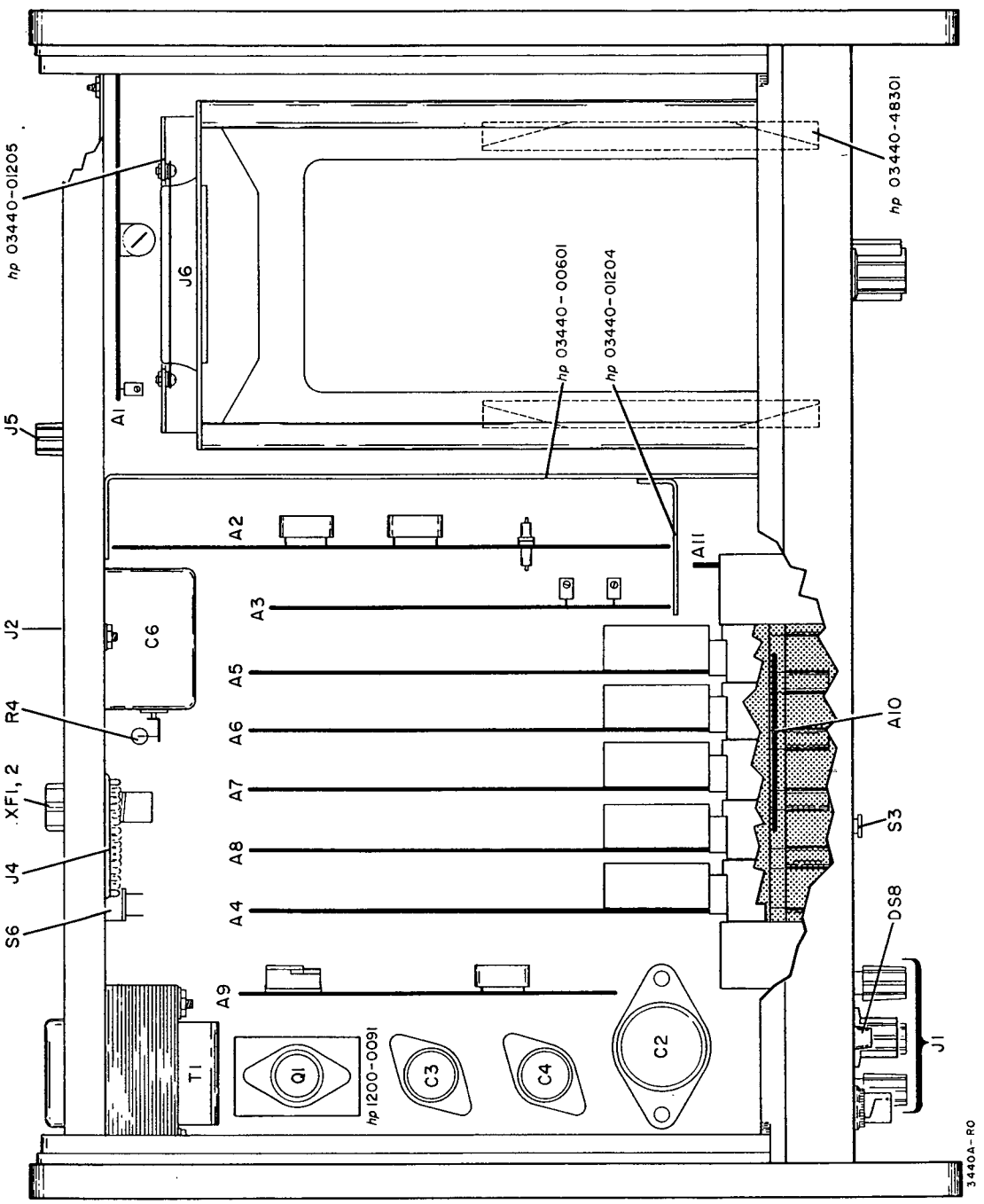
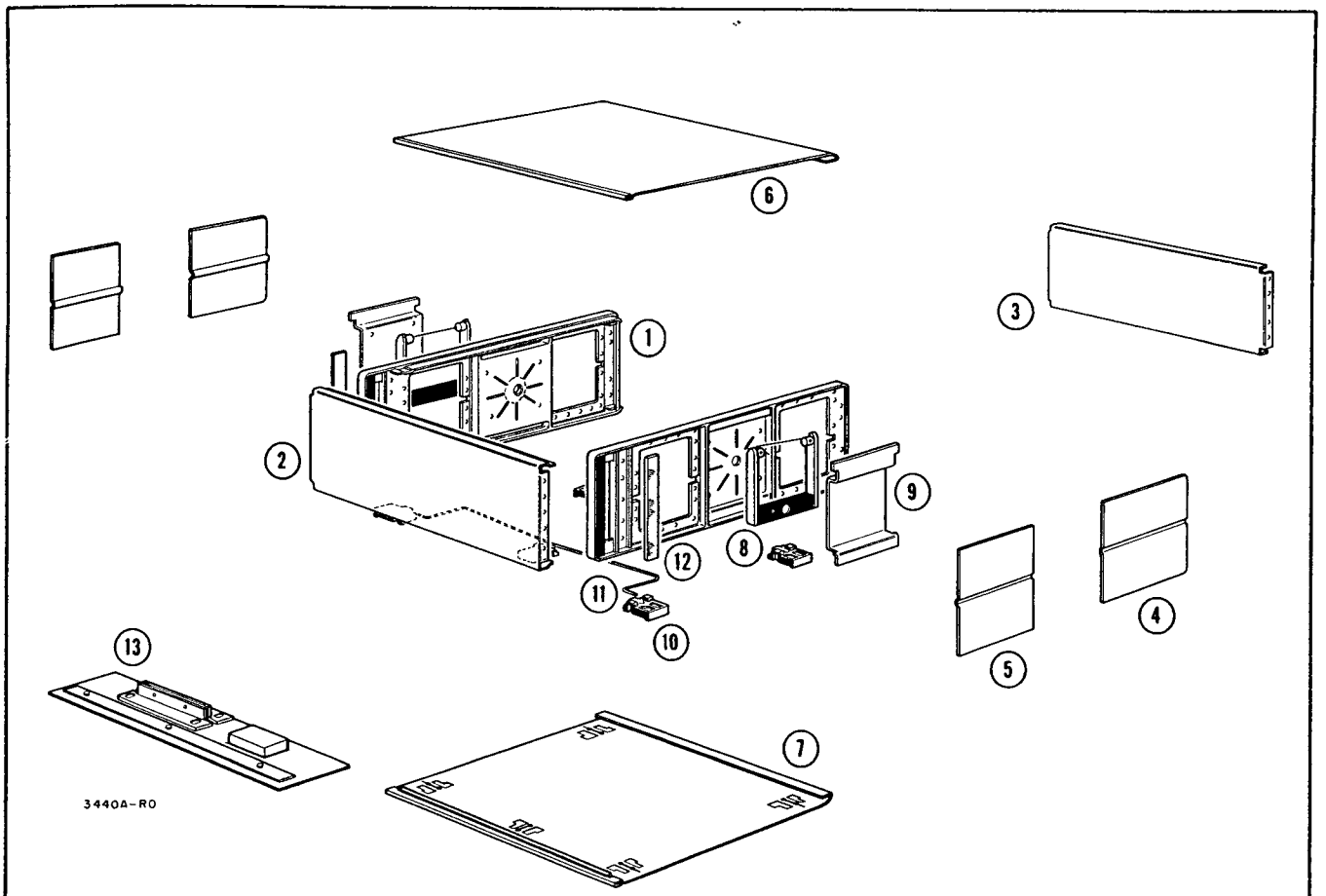


Figure 7-1. Location of Important Mechanical Parts



DESIGNATOR	DESCRIPTION	-hp- PART NUMBER
(1)	Side Frame Assembly	5060-0731
(2)	Panel: Front	03440-00201
(3)	Panel: Rear	03440-00202
(4)	Rear Side Cover: 5 x 11 FM	5000-0732
(5)	Front Side Cover: 5 x 11 FM	5000-0733
(6)	Cover Assembly: Top, 11 LM	5060-0739
(7)	Cover Assembly: bottom, 11 LM	5060-0751
(8)	Handle Assembly: Side	5060-0763
(9)	Retainer: Handle Assembly	5060-0766
(10)	Foot Assembly: Full Module	5060-0767
(11)	Stand: Tilt	1490-0030
(12)	Trim: Fluted Aluminum	5000-0051
(13)	Kit: Accessory	03440-84401

Figure 7-2. Chassis Part Location

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
C1	0170-0022		1	C: fxd my 0.1 μf 20% 600 vdcw	56289	148P175A
C2	0180-0047		1	C: fxd elect 500 μf 75 vdcw	56289	D32443
C3, C4	0180-0107		2	C: fxd elect 20 μf -10% +100% 200 vdcw	56289	90803
C5				Not assigned		
C6	0160-0221		1	C: fxd poly 2 μf 5% 50 vdcw	56289	obd
C7	0160-0161		5	C: fxd my 0.01 μf 10% 200 vdcw	56289	192P10392
C8	0160-3333		1	C: fxd dual 0.005μF 20% 1400V	08988	THD-8-502M-1.4KV
C9	0140-0147		1	C: fxd mica 180 pF ±5%	72136	obd
DS1 thru DS3	2140-0028		3	Lamp: Glow, neon frosted NE2E	24455	NE-2E
DS4, DS5	2140-0015		2	Lamp: Glow, neon NE-2H	24455	NE-2H
DS6, DS7	2140-0234		2	Lamp: Glow, neon	74276	A219
DS8	1450-0049		1	Indicator: Lamp, glow neon	08717	858-c/NE2E
F1	2110-0016		1	Fuse: cartridge 0.6 amp slo-blo	75915	313.600
F2	2110-0033		1	Fuse: 0.75 amp 250 V	75915	F02GH750A
J1				Includes:		
	0340-0087		2	Insulator: binding post, 3 hole in-line	-hp-	
	0340-0091		2	Insulator: binding post, 3 hole with pin	-hp-	
	5060-0625		1	Binding Post Assy: left hand link	-hp-	
	5060-0634		2	Binding Post Assy: red 3/4" stud	-hp-	
	5060-0635		3	Binding Post Assy: blk 3/4" stud	-hp-	
J2	1251-0087		1	Connector: female 50 pin miniature	02660	57-4057-40500 (375)
J3	1251-2357		1	Connector: power	82389	EAC-301
J4	1251-0085		1	Connector: female 36 pin miniature	02660	57-40360 (375)
J5				Includes:		
	0340-0087			Insulator: binding post, 3 hole in-line	-hp-	
	0340-0091			Insulator: binding post, 3 hole with pin	-hp-	
	5060-0634			Binding Post Assy: red 3/4" stud	-hp-	
	5060-0635			Binding Post Assy: blk 3/4" stud	-hp-	
J6	1251-1026		1	Connector: socket female 50 pin	75173	57-20500-25
P7	1251-0324		1	Connector: test jack male red	00373	69026-1064
Q1	1850-0098		1	TSTR: Ge PNP selected	04713	SP-776
R1				Not assigned		
R2	2100-1439		1	R: var comp 1 kΩ 20% lin 0.3 W	71450	series 70
R3	2100-0436		1	R: var comp 200 Ω 20% lin 1/2 W	71450	VA-45
R4*				See Paragraph 5-61		
R5	0683-2015		3	R: fxd comp 200 Ω 5% 1/4 W	01121	CB2015
R6	2100-2993		1	R: var 250 kΩ ±20% 1/4 W	71450	series 45
R7, R8	0684-1001		2	R: fxd comp 10 Ω ±10% 1/4 W	01121	CB1001
R9	0683-1035		19	R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB1035
R10	0683-3335			R: fxd comp 33 kΩ ± 5% 1/4W	01121	CB3335
S1	3101-1244			Switch: pushbutton	87034	53-55480-120/A1H
S2				N.S.R. Part of R6		
S3	3101-0053		1	Switch: push-button SPDT	82389	NF4003
S4, S5				Not assigned		
S6	3101-1234		1	Switch: slide 115/230 V	82389	11A-1242
T1	9100-0182		1	Transformer: power	-hp-	
W1	8120-1348		1	Cable: power, SVT-18-3 7.5 ft	70903	KH7041
XA2	1251-0135		8	Connector: 15 pin	02660	143-015-08 (109)
XA3	1251-0208		1	Connector: 22 pin	95354	91-6922-1500-00
XA4 thru XA9	1251-0135			Connector: 15 pin	02660	143-015-08 (109)
XF1, XF2	1400-0084		2	Fuseholder: extractor post type	75915	342014
XQ1	1200-0044		1	Socket: transistor	97464	M7 (PB)

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	03439-66501		1	Attenuator Board Assembly	-hp-	
C1	0160-0222		1	C: fxd poly 0.1 μf 20% 1000 vdcw	56289	obd
MP1 thru MP12	0340-0060		14	Insulator: feed-thru	98291	FT-E-15
R1	0811-0142		1	R: fxd ww 200 kΩ 0.2% 1/4 W	05347	510A obd
R2, R3	0811-0139		2	R: fxd ww 4.5 MΩ 0.2% 1/2 W	05347	510A obd
R4	0811-0140		1	R: fxd ww 895 kΩ 0.01% 1/4 W	05347	510A obd
R5	0811-0141		1	R: fxd 99.55 kΩ 0.01% 1/4 W	05347	510A obd
R6	0727-0255		1	R: fxd depc 800 kΩ 1% 1/2 W	19701	DC1/2AR5
R7	2100-0451		1	R: var ww 10 kΩ 10% lin 2 W	09145	114/06
R8	2100-0941		1	R: var ww 1000 Ω 10% lin 2 W	75042	CT106-2
A2	03440-66503		1	Comparator Board Assembly	-hp-	
C1, C2	0160-0161			C: fxd 0.01 μf 10% 200 vdcw	56289	192P10392
C3	0180-0039		1	C: fxd elect 100 μf 12 vdcw	56289	D32697
C4	0160-0162		1	C: fxd 0.022 μf 10%	56289	192P22392
C5 thru C7				Not assigned		
C8	0160-0161			C: fxd 0.01 μf 10% 200 vdcw	56289	192P10392
C9	0150-0121		4	C: fxd cer 0.1 μf 50 vdcw	56289	obd
C10	0160-0178		2	C: fxd mica 27 pf 5% 300 vdcw	14655	CD15E270J
C11, C12				Not assigned		
C13	0170-0070		2	C: fxd my 0.22 μf 20% 50 vdcw	84411	obd
C14	0180-0106		1	C: fxd Ta 60 μf 20% 6 vdcw	56289	150D606X0006B2
C15	0140-0200		1	C: fxd mica 390 pf 5% 300 vdcw	14655	RDM15F391J3C
C16				Not assigned		
C17*				See Paragraph 5-57		
C18	0150-0121			C: fxd cer 0.1 μf 50 vdcw	56289	obd
C19	0150-0098		1	C: fxd cer 0.01 μf 1000 vdcw	91418	obd
C20, C21				Not assigned		
C22	0140-0194		4	C: fxd mica 110 pf 5% 300 vdcw	14655	CD15F111J
C23	0140-0196		2	C: fxd mica 150 pf 5% 300 vdcw	14655	CD15F151J
C24, C25				Not assigned		
C26	0170-0019		2	C: fxd my 0.1 μf 5% 200 vdcw	56289	192P10452
C27	0160-0161			C: fxd 0.01 μf 10% 200 vdcw	56289	192P10392
C28	0150-0121			C: fxd cer 0.1 μf 50 vdcw	56289	obd
C29, C30				Not assigned		
C31	0170-0070			C: fxd my 0.22 μf 20% 50 vdcw	84411	obd
C32	0160-0178			C: fxd mica 27 pf 5% 300 vdcw	14655	CD15E270J
C33	0180-0161		1	C: fxd Ta 3.3 μf 20% 35 vdcw	56289	150D335X0035B2
C34	0140-0200			C: fxd mica 390 pf 5% 300 vdcw		
C35				Not assigned		
C36	0140-0194			C: fxd mica 110 pf 5% 300 vdcw	14655	CD15F111J
C37	0140-0196			C: fxd mica 150 pf 5% 300 vdcw	14655	CD15F151J
CR1, CR2	1901-0025		55	Semicon Device: diode, junction	93332	D3072
CR3, CR4				Not assigned		
CR5A, B	1901-0509		1	Semicon Device: diode pair selected	17856	FD101
CR6, CR7	1901-0053		2	Semicon Device: diode junction	07263	FD3444
CR8, CR9				Not assigned		
CR10	1901-0054		1	Semicon Device: diode silicon	17856	FD102
CR11	1901-0033		9	Semicon Device: diode 1N485B	07910	1N485B
CR12	1901-0025			Semicon Device: diode junction	93332	D3072
CR13, CR14				Not assigned		
CR15, CR16	1901-0033			Semicon Device: diode 1N485B	07910	1N485B

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A2 (Cont'd)							
CR17	1901-0025			Semicon Device: diode, junction	93332	D3072	
CR18				Not assigned			
CR19	1901-0033			Semicon Device: diode, 1N485B	07910	1N485B	
CR20	1901-0040		1	Semicon Device: diode, junction	07263	FDG1088	
CR21				Not assigned			
CR22, CR23	1901-0025			Semicon Device: diode, junction	93332	D3072	
CR24	1901-0033			Semicon Device: diode, 1N485B	07910	1N485B	
CR25, CR26				Not assigned			
CR27A, B	1901-0576		1	Semicon Device: diode, pair, selected	17856	FD100	
CR28	1901-0033			Semicon Device: diode 1N485B	07910	1N485B	
CR29	1901-0025			Semicon Device: diode junction	93332	D3072	
CR30, CR31				Not assigned			
CR32	1901-0033			Semicon Device: diode 1N485B	07910	1N485B	
CR33 thru CR35				Not assigned			
CR36	1901-0033			Semicon Device: diode 1N485B	07910	1N485B	
J7	1251-0131		1	Connector: socket female 1 pin	00373	69026-1164 (red)	
MP1 and MP2	0340-0060			Insulator: feed-thru	98291	FT-E-15	
Q1, Q2	1850-0062		50	TSTR: GE PNP selected	-hp-		
Q3	1850-0074		1	TSTR: GE 2N1396 PNP	02735	2N1396	
Q4, Q5	1850-0062			TSTR: GE PNP selected	-hp-		
Q6				Not assigned			
Q7, Q8	1850-0062			TSTR: GE PNP selected	-hp-		
Q9	1850-0040		2	TSTR: GE 2N383 PNP	94154	2N383	
Q10				Not assigned			
Q11 thru Q13	1850-0062			TSTR: GE PNP selected	-hp-		
Q14				Not assigned			
Q15, Q16	1850-0062			TSTR: GE PNP selected	-hp-		
R1	0683-1045		24	R: fxd comp 100 kΩ 5% 1/4 W	01121	CB1045	
R2*				See Paragraph 5-53			
R3, R4				Not assigned			
R5	0683-2035		2	R: fxd comp 20 kΩ 5% 1/4 W	01121	CB2035	
R6	0683-5125		1	R: fxd comp 5100 Ω 5% 1/4 W	01121	CB5125	
R7	0727-0168		2	R: fxd depc 15 kΩ 1% 1/2 W	19701	DC1/2CR5	obd
R8	0727-0222		1	R: fxd depc 214 kΩ 1% 1/2 W	19701	DC1/2CR5	
R9	0683-1545		2	R: fxd comp 150 kΩ 5% 1/4 W	01121	CB1545	
R10	0683-2035			R: fxd comp 20 kΩ 5% 1/4 W	01121	CB2035	
R11	0683-7525		6	R: fxd comp 7500 Ω 5% 1/4 W	01121	CB7525	
R12	0727-0206		1	R: fxd depc 98 kΩ 1% 1/2 W	19701	DC1/2CR5	obd
R13				Not assigned			
R14	0683-2725		2	R: fxd comp 2700 Ω 5% 1/4 W	01121	CB2725	
R15				Not assigned			
R16	0757-0196		1	R: fxd met flm 6.19 kΩ 1% 1/2 W	75042	CEC	
R17	0683-1035			R: fxd comp 10 kΩ 5% 1/4 W	01121	CB1035	
R18	0683-7525			R: fxd comp 7500 Ω 5% 1/4 W	01121	CB7525	
R19	0683-4745		2	R: fxd comp 470 kΩ 1/4 W	01121	CB4745	
R20, R21				Not assigned			
R22	0683-8235		2	R: fxd comp 82 kΩ 5% 1/4 W	01121	CB8235	
R23	0683-3335		5	R: fxd comp 33 kΩ 5% 1/4 W	01121	CB3335	
R24	0683-2015			R: fxd comp 200 Ω 5% 1/4 W	01121	CB2015	
R25	0683-2215		3	R: fxd comp 220 Ω 5% 1/4 W	01121	CB2215	
R26	0683-6825		7	R: fxd comp 6800 Ω 5% 1/4 W	01121	CB6825	
R27				Not assigned			

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2 (Cont'd)						
R28	0687-5661		1	R: fxd comp 56 MΩ 10% 1/2 W	01121	EB5661
R29*				See Paragraph 5-55		
R30	0683-2445		1	R: fxd comp 240 kΩ 5% 1/4 W	01121	CB2445
R31	0683-1025		4	R: fxd comp 1000 Ω 5% 1/4 W	01121	CB1025
R32	0683-3335			R: fxd comp 33 kΩ 5% 1/4 W	01121	CB3335
R33				Not assigned		
R34	0757-0192		2	R: fxd met flm 60.4 kΩ 1% 1/2 W	75042	CEC
R35	0683-3935		4	R: fxd comp 39 kΩ 5% 1/4 W	01121	CB3935
R36	0757-0198		1	R: fxd met flm 100 Ω 1% 1/2 W	75042	CEC
R37				Not assigned		
R38	0727-0122		1	R: fxd depc 2.51 kΩ 1% 1/2 W	19701	DC1/2CR5
R39	0683-4715		2	R: fxd 470 Ω 5% 1/4 W	01121	CB4715
R40	2100-0439		1	R: var ww 250 Ω lin 20% 1/4 W	71450	110
R41	0698-3123		1	R: fxd depc 3830 Ω 1% 1/2 W	01121	EB3121
R42				Not assigned		
R43	0757-0191		2	R: fxd met flm 80.6 kΩ 1% 1/2 W	75042	CEC
R44	0757-0190		3	R: fxd met flm 20 kΩ 1% 1/2 W	75042	CEC
R45	0683-4735		66	R: fxd comp 47 kΩ 5% 1/4 W	01121	CB4735
R46	0683-4335		6	R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R47	0683-5635		17	R: fxd comp 56 kΩ 5% 1/4 W	01121	CB5635
R48	0683-6825			R: fxd comp 6800 Ω 5% 1/4 W	01121	CB6825
R49, R50				Not assigned		
R51	0683-4735			R: fxd comp 47 kΩ 5% 1/4 W	01121	CB4735
R52	0683-3345		1	R: fxd comp 330 kΩ 5% 1/4 W	01121	CB3345
R53	0683-1045			R: fxd comp 100 kΩ 5% 1/4 W	01121	CB1045
R54	0683-5645		1	R: fxd comp 560 kΩ 5% 1/4 W	01121	CB5645
R55	0683-1045			R: fxd comp 100 kΩ 5% 1/4 W	01121	CB1045
R56, R57				Not assigned		
R58	0683-6825			R: fxd comp 6800 Ω 5% 1/4 W	01121	CB6825
R59	0683-2235		5	R: fxd comp 22 kΩ 5% 1/4 W	01121	CB2235
R60	0683-5635			R: fxd comp 56 kΩ 5% 1/4 W	01121	CB5635
R61	0683-1045			R: fxd comp 100 kΩ 5% 1/4 W	01121	CB1045
R62	0683-2745		6	R: fxd comp 270 kΩ 5% 1/4 W	01121	CB2745
R63	0683-2235			R: fxd comp 22 kΩ 5% 1/4 W	01121	CB2235
R64	0683-1225		2	R: fxd comp 1200 Ω 5% 1/4 W	01121	CB1225
R65	0683-3625		1	R: fxd comp 3600 Ω 5% 1/4 W	01121	CB3625
R66	0683-3615		1	R: fxd comp 360 Ω 5% 1/4 W	01121	CB3615
R67				Not assigned		
R68	0727-0168			R: fxd carbon flm 15 kΩ 1% 1/2 W	19701	DC1/2CR5
R69	0727-0124		1	R: fxd carbon flm 3000 Ω 1% 1/2 W	19701	DC1/2CR5
R70	2100-0239		1	R: var ww 2000 Ω 20% lin 1-1/4 W	71450	110
R71	0757-0195		1	R: fxd met flm 348 kΩ 1% 1/2 W	75042	CEC
R72	0683-3935			R: fxd comp 39 kΩ 1/4 W	01121	CB3935
R73				Not assigned		
R74	0757-0190			R: fxd met flm 20 kΩ 1% 1/2 W	75042	CEC
R75	0683-8235			R: fxd comp 82 kΩ 5% 1/4 W	01121	CB8235
R76	0683-3335			R: fxd comp 33 kΩ 5% 1/4 W	01121	CB3335
R77	0683-2015			R: fxd comp 200 Ω 5% 1/4 W	01121	CB2015
R78	0683-2215			R: fxd comp 220 Ω 5% 1/4 W	01121	CB2215
R79	0683-6825			R: fxd comp 6800 Ω 5% 1/4 W	01121	CB6825
R80				Not assigned		
R81	0757-0192			R: fxd met flm 60.4 kΩ 1% 1/2 W	75042	CEC
R82	0683-3935			R: fxd comp 39 kΩ 1/4 W	01121	CB3935
R83	0757-0197		1	R: fxd met flm 1500 Ω 1% 1/2 W	75042	CEC
R84	0757-0191			R: fxd met flm 80.6 kΩ 1% 1/2 W	75042	CEC
R85	0757-0190			R: fxd met flm 20 kΩ 1% 1/2 W	75042	CEC

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2 (Cont'd)						
R86				Not assigned		
R87	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R88	0683-6825			R: fxd comp 6800 Ω 5% 1/4 W	01121	CB6825
R89	0683-4735			R: fxd comp 47 kΩ 5% 1/4 W	01121	CB4735
R90	0683-5635			R: fxd comp 56 kΩ 5% 1/4 W	01121	CB5635
R91				Not assigned		
R92, R93	0683-2245		3	R: fxd comp 220 kΩ 5% 1/4 W	01121	CB2245
R94	0683-6825			R: fxd comp 6800 Ω 5% 1/4 W	01121	CB6825
R95	0683-2235			R: fxd comp 22 kΩ 5% 1/4 W	01121	CB2235
R96	0683-5635			R: fxd comp 56 kΩ 5% 1/4 W	01121	CB5635
R97	0683-1045			R: fxd comp 100 kΩ 5% 1/4 W	01121	CB1045
R98	0683-2745			R: fxd comp 270 kΩ 5% 1/4 W	01121	CB2745
A3	03440-66507		1	Assembly: Display and Ramp Board Used in instruments Serial No. 421-00926 and up. Previous instruments used Part No. 03440-66502 (See Appendix C). If necessary to replace entire circuit board assembly, use Part No. 03440-66507.	-hp-	
C1	0150-0012		1	C: fxd cer 0.01 μF 20% 1000 vdcw	71590	obd
C2	0180-0049		1	C: fxd elect 20 μF 50 vdcw	56289	30D198A1
C3	0150-0050		1	C: fxd cer 1000 pF 600 vdcw	77630	obd
C4				Not assigned		
C5	0180-0105		1	C: fxd elect 50 μF 25 vdcw	56289	S97441
C6 thru C9				Not assigned		
C10	0170-0019			C: fxd my 0.1 μF 5% 200 vdcw	56289	192P10452
C11	0160-0153		1	C: fxd 0.001 μF 10%	56289	192P10292
C12	0140-0208		2	C: fxd 680 pF 5% 500 vdcw	14655	RDM15F681J3C
CR1	1901-0025			Semicon Device: diode junction	93332	D3072
CR2 thru CR4				Not assigned		
CR5 thru CR9	1901-0025			Semicon Device: diode junction	93332	D3072
CR10				Not assigned		
CR11	1901-0033			Semicon Device: diode 1N485B	07910	1N485B
CR12, CR13				Not assigned		
CR14	1902-0071		1	Semicon Device: diode silicon breakdown	04713	DT30306B
CR15, CR16	1901-0025			Semicon Device: diode junction	93332	D3072
Q1	1854-0022		2	TSTR: NPN silicon selected	-hp-	
Q2	1850-0040			TSTR: GE 2N383 PNP	94154	2N383
Q3	1851-0024		1	TSTR: GE 2N388A NPN	01295	2N388A
Q4				Not assigned		
Q5 thru Q7	1850-0062			TSTR: GE selected PNP	-hp-	
Q8	1851-0017		5	TSTR: 2N1304	01295	2N1304
Q9				Not assigned		
Q10	1851-0017			TSTR: 2N1304	01295	2N1304
Q11	1850-0111		3	TSTR: GE PNP selected	01295	2N404A
Q12	1850-0128		1	TSTR: GE 2N383 PNP	02735	34600
Q13, Q14				Not assigned		
Q15	1853-0001		1	TSTR: PNP silicon selected	01295	SM1016B
Q16	1854-0003		1	TSTR: NPN silicon selected	01295	SM0843
Q17	1854-0022			TSTR: NPN silicon selected	-hp-	
Q18	1851-0017			TSTR: 2N1304 GE	01295	2N1304

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR	MFR. PART NO.
A3 (Cont'd)						
QCR1	1820-0001		1	Semicon Device: Transistor--diode, silicon	03508	4JX19A519
R1	0683-2245			R: fxd comp 220 kΩ 5% 1/4 W	01121	CB2245
R2	0683-4735			R: fxd comp 47 kΩ 5% 1/4 W	01121	CB4735
R3	0683-6235		1	R: fxd comp 62 kΩ 5% 1/4 W	01121	CB6235
R4, R5				Not assigned		
R6	0683-5615			R: fxd comp 560 Ω 5% 1/4 W	01121	CB5615
R7, R8	0683-2225		4	R: fxd 2.2 kΩ 5% 1/4 W	01121	CB2225
R9	0683-6825			R: fxd comp 6800 Ω 5% 1/4 W	01121	CB6825
R10				Not assigned		
R11	0683-1225			R: fxd comp 1200 Ω 5% 1/4 W	01121	CB1225
R12	0683-1025			R: fxd comp 1000 Ω 5% 1/4 W	01121	CB1025
R13	0683-6835		12	R: fxd comp 68 kΩ 5% 1/4 W	01121	CB6835
R14	0683-4725			R: fxd comp 4700 Ω 5%	01121	CB4735
R15 thru R17				Not assigned		
R18*				See Paragraph 5-59		
R19*				See Paragraph 5-59		
R20	0683-2735		1	R: fxd comp 27 kΩ 5% 1/4 W	01121	CB2735
R21	0683-2725			R: fxd comp 2700 Ω 5% 1/4 W	01121	CB2725
R22, R23				Not assigned		
R24	0683-1025			R: fxd comp 1000 Ω 5% 1/4 W	01121	CB1025
R25, R26	0683-1835		6	R: fxd comp 18 kΩ 5% 1/4 W	01121	CB1835
R27	0683-1535		5	R: fxd comp 15 kΩ 5% 1/4 W	01121	CB1535
R28	0683-5135		2	R: fxd comp 51 kΩ 5% 1/4 W	01121	CB5135
R29	0683-1045			R: fxd comp 100 kΩ 5% 1/4 W	01121	CB1045
R30	0757-0451		1	R: fxd met flm 24.3 kΩ 1% 1/8 W	75042	CEA
R31	0757-0444		1	R: fxd met flm 12.1 kΩ 1% 1/8 W	75042	CEA
R32	0683-4745		1	R: fxd comp 470 kΩ 5% 1/4 W	01121	CB4745
R33				Not assigned		
R34	0683-1535			R: fxd comp 15 kΩ 5% 1/4 W	01121	CB1535
R35	0683-3935			R: fxd comp 39 kΩ 1/4 W	01121	CB3935
R36, R37	0689-1835			R: fxd comp 18 kΩ 5% 1 W	01121	CB1835
R38, R39				Not assigned		
R40, R41	0683-3335			R: fxd comp 33 kΩ 5% 1/4 W	01121	CB3335
R42	0683-1835			R: fxd comp 18 kΩ 5% 1/4 W	01121	CB1835
R43, R44				Not assigned		
R45, R46	0683-1045			R: fxd comp 100 kΩ 5% 1/4 W	01121	CB1045
R47	0683-1535			R: fxd comp 15 kΩ 5% 1/4 W	01121	CB1535
R48	0683-2225			R: fxd comp 2.2 kΩ 5% 1/4 W	01121	CB2225
R49, R50				Not assigned		
R51	2100-0392		1	R: var 2 kΩ lin 10% 1/4 W	09145	114 06
R52	0683-5625		5	R: fxd comp 5600 Ω 5% 1/4 W	01121	CB5625
R53	0683-1035			R: fxd comp 10 kΩ 5% 1/4 W	01121	CB1035
R54	0683-3025		9	R: fxd comp 3000 Ω 5% 1/4 W	01121	CB3025
R55, R56				Not assigned		
R57	0757-0193		1	R: fxd met flm 3.32 kΩ 1% 1/2 W	75042	CEC
R58	0811-0145		1	R: fxd ww 2150 Ω 0.2% 1/4 W	07088	EP-21
R59	03440-82601		1	R: fxd ww 370 740 and 1480 Ω	-hp-	
R60	2100-0324		1	R: var ww 500 Ω lin 10% 1/4 W	09145	114 06
R61	0811-0144		1	R: fxd 25 kΩ 0.2% 1/4 W	05347	510A
R62	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB1035
R63	0683-1545			R: fxd comp 150 kΩ ±5% 1/4 W	01121	CB1545
R64	0683-2235			R: fxd comp 22 kΩ ±5% 1/4 W	01121	CB2235
R65	0683-1235		4	R: fxd comp 12 kΩ ±5% 1/4 W	01121	CB1235

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A4	03440-60401		1	Assembly: Polarity Board	-hp-		
C1	0140-0194			C: fxd mica 110 pf 5% 300 vdcw	14655	CD15F111J	
C2	0140-0198		1	C: fxd mica 200 pf 5% 300 vdcw	14655	RDM15F201J3C	
C3	0150-0096		1	C: fxd cer 0.05 μF 100 vdcw	91418	TA	
C4, C5				Not assigned			
C6, C7	0140-0175		2	C: fxd mica 39 pf 2% 300 vdcw	14655	CD15E390G	
C8, C9				Not assigned			
C10	0140-0225		1	C: fxd mica 300 pf 1% 300 vdcw	14655	RDM15F301F3C	
C11				Not assigned			
C12	0140-0194			C: fxd mica 110 pf 5% 300 vdcw	14655	CD15F111J	
CR5, CR6	1901-0025			Semicon Device: diode junction	93332	D3072	
CR7				Not assigned			
CR8, CR9	1901-0025			Semicon Device: diode junction	93332	D3072	
CR10	1910-0015		21	Semicon Device: diode Ge	73293	HD-1409	
CR11 thru CR17				Not assigned			
CR18	1901-0025			Semicon Device: diode junction	93332	D3072	
DS1	1970-0012		1	Digit Display Tube: neon (±)	-hp-		
DS2 Assy	03440-69501		1	Exciter: photoconductor polarity includes: DS2, block, MP1 and MP2			
MP1	0905-0043		1	Gasket: photoconductor included in A4DS4	99538		obd
MP2	0905-0051		1	Light Mask: felt included in A4DS4	78471		obd
MP3	5212A-83C		1	Cover: photoconductor	-hp-		
Q1	1850-0062			TSTR: GE PNP selected	-hp-		
Q2, Q3	1853-0016		3	TSTR: Si PNP	07263	2N3638	
Q4	1851-0017			TSTR: 2N1304	01295	2N1304	
Q5				Not assigned			
Q6, Q7	1850-0062			TSTR: GE PNP selected	-hp-		
Q8, Q9	1850-0111			TSTR: GE PNP	01295	2N404A	
R1	0683-5635			R: fxd comp 56 kΩ 5% 1/4 W	01121	CB5635	
R2	0683-4725		9	R: fxd comp 4700 Ω 5%	01121	CB4725	
R3	0683-1535			R: fxd comp 15 kΩ 5% 1/4 W	01121	CB1535	
R4, R5	0683-3925		42	R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925	
R6	0683-4735			R: fxd comp 47 kΩ 5% 1/4 W	01121	CB4735	
R7	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925	
R8				Not assigned			
R9	0683-1835			R: fxd comp 18 kΩ 5% 1/4 W	01121	CB1835	
R10, R11	0683-4725			R: fxd comp 4700 Ω 5% 1/4 W	01121	CB4725	
R12				Not assigned			
R13	0686-2725			R: fxd comp 2700 Ω 5% 1/2 W	01121	CB2725	
R14	0683-2705		1	R: fxd comp 27 Ω 5% 1/4 W	01121	CB2705	
R15	0683-1835			R: fxd comp 18 kΩ 5% 1/4 W	01121	CB1835	
R16	0683-4725			R: fxd comp 4700 Ω 5%	01121	CB4725	
R17, R18				Not assigned			
R19	0687-6831		1	R: fxd 68 kΩ 10% 1/2 W	01121	EB6831	
R20, R21	0683-2745			R: fxd comp 270 kΩ 5% 1/4 W	01121	CB2745	
R22				Not assigned			
R23	0683-3945		18	R: fxd comp 390 kΩ 5% 1/4 W	01121	CB3945	
R24, R25	0683-5635			R: fxd comp 56 kΩ 5% 1/4 W	01121	CB5635	
R26, R27				Not assigned			
R28	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335	
R29	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925	
R30				Not assigned			
R31	0683-4725			R: fxd comp 4700 Ω 5%	01121	CB4725	

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A4 (Cont'd)						
R32, R33				Not assigned		
R34, R35	0683-7525			R: fxd comp 7500 Ω 5% 1/4 W	01121	CB7525
R36	0683-1815		18	R: fxd comp 180 Ω 5% 1/4 W	01121	CB1815
R37, R38				Not assigned		
R39	0683-4725			R: fxd comp 4700 Ω 5% 1/4 W	01121	CB4725
R40	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R41	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925
R42, R43				Not assigned		
R44	0683-5635			R: fxd comp 56 kΩ 5% 1/4 W	01121	CB5635
R45	0683-3945			R: fxd comp 390 kΩ 5% 1/4 W	01121	CB3945
R46	0683-5635			R: fxd comp 56 kΩ 5% 1/4 W	01121	CB5635
R47	0683-2745			R: fxd comp 270 kΩ 5% 1/4 W	01121	CB2745
R48	0683-4735			R: fxd comp 47 kΩ 5% 1/4 W	01121	CB4735
R49				Not assigned		
R50	0683-4735			R: fxd comp 47 kΩ 5% 1/4 W	01121	CB4735
R51	0683-1535			R: fxd comp 15 kΩ 5% 1/4 W	01121	CB1535
R52	0683-2235			R: fxd comp 22 kΩ 5% 1/4 W	01121	CB2235
R53	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R54	0683-4725			R: fxd comp 4700 Ω 5% 1/4 W	01121	CB4725
R55, R56				Not assigned		
R57, R58	0683-7525			R: fxd comp 7500 Ω 5% 1/4 W	01121	CB7525
R59	0683-1815			R: fxd comp 180 Ω 5% 1/4 W	01121	CB1815
R60				Not assigned		
R61	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R62	0683-4725			R: fxd comp 4700 Ω 5%	01121	CB4725
V1	1990-0010		1	Plate: Photoconductor Matrix	-hp-	
XDS1	5212L-83C		1	Socket: Digit Display Tube	-hp-	
A4A1	03440-69502		1	Photoconductor Assembly: Polarity includes: DS2, V1, XDS1 and MP3	-hp-	
A5	05212-6016		4	Assembly: Decimal Used in instruments Serial No. 637-08626 and up, and is direct replacement for 05212L-4A. (See Appendix C)	-hp-	
C1	0140-0190		4	C: fxd mica 39 pf ±5%	04062	RDM15E390J3C
C2	0140-0145		4	C: fxd mica 22 pf ±5%	04062	RDM15C220J5C
C3, C4	0140-0193		12	C: fxd mica 82 pf ±5%	04062	RDM15E820J3C
C5	0140-0204		4	C: fxd mica 47 pf ±5%	04062	RDM15E470J5C
C6	0140-0197		8	C: fxd mica 180 pf ±5%	04062	RDM15F181J3C
C7	0160-2203		8	C: fxd 91 pf	04062	obd
C8	0140-0192		4	C: fxd mica 68 pf ±5%	04062	RDM15E680J3C
C9	0140-0197			C: fxd mica 180 pf ±5%	04062	RDM15F181J3C
C10	0140-0217		4	C: fxd mica 140 pf ±2%	04062	RDM15F141G3C
C11	0160-2203			C: fxd 91 pf	04062	obd
C12	0140-0193			C: fxd mica 82 pf ±5%	04062	RDM15E820J3C
C13	0160-2206		8	C: fxd mica 160 pf ±5%	04062	RDM15F161J3C
C14	0140-0195		4	C: fxd mica 130 pf ±5%	04062	RDM15F131J3C
C15	0160-2206			C: fxd mica 160 pf ±5%	04062	RDM15F161J3C
CR1 thru CR8	1901-0025		32	Diode: Si junction 100 mA 100 wiv 12 pf	93332	D3072
CR9 thru CR18	1910-0016		41	Diode: Ge point contact 60 wiv 1 ms	03877	S3185G
DS1 thru DS4				Not separately replaceable, p/o A5A1 assy		
DS5	1970-0009		1	Tube: indicator digit	83594	B5991
Q1 thru Q8	1850-0062			TSTR: Ge PNP 2N404	-hp-	

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A5 (Cont'd)						
R1	0686-4735		4	R: fxd comp 47 kΩ ±5% 1/2 W	01121	EB4735
R2	0845-0001		4	Network Resistor: set of 10 270 kΩ ±2% 1/4 W	-hp-	
R3 thru R5				Not assigned		
R6 thru R9	0683-3945			R: fxd comp 390 kΩ ±5% 1/4 W	01121	CB3945
R10	0686-7525		32	R: fxd comp 7.5 kΩ ±5% 1/2 W	01121	EB7525
R11, R12	0683-5635			R: fxd comp 56 kΩ ±5% 1/4 W	01121	CB5635
R13	0686-7525			R: fxd comp 7.5 kΩ ±5% 1/2 W	01121	EB7525
R14, R15	0683-4735			R: fxd comp 47 kΩ ±5% 1/4 W	01121	CB4735
R16	0683-3925			R: fxd comp 3.9 kΩ ±5% 1/4 W	01121	CB3925
R17	0683-1815			R: fxd comp 180 Ω ±5% 1/4 W	01121	CB1815
R18	0683-4735			R: fxd comp 47 kΩ ±5% 1/4 W	01121	CB4735
R19	0683-3925			R: fxd comp 3.9 kΩ ±5% 1/4 W	01121	CB3925
R20	0683-1045			R: fxd comp 100 kΩ ±5% 1/4 W	01121	CB1045
R21	0683-3025			R: fxd comp 3 kΩ ±5% 1/4 W	01121	CB3025
R22, R23	0683-4735			R: fxd comp 47 kΩ ±5% 1/4 W	01121	CB4735
R24	0683-3025			R: fxd comp 3 kΩ ±5% 1/4 W	01121	CB3025
R25	0686-7525			R: fxd comp 7.5 kΩ ±5% 1/2 W	01121	EB7525
R26, R27	0683-5635			R: fxd comp 56 kΩ ±5% 1/4 W	01121	CB5635
R28	0686-7525			R: fxd comp 7.5 kΩ ±5% 1/2 W	01121	EB7525
R29, R30	0683-4735			R: fxd comp 47 kΩ ±5% 1/4 W	01121	CB4735
R31, R32	0683-3925			R: fxd comp 3.9 kΩ ±5% 1/4 W	01121	CB3925
R33	0683-1815			R: fxd comp 180 Ω ±5% 1/4 W	01121	CB1815
R34	0683-4735			R: fxd comp 47 kΩ ±5% 1/4 W	01121	CB4735
R35	0683-3925			R: fxd comp 3.9 kΩ ±5% 1/4 W	01121	CB3925
R36	0683-8225		8	R: fxd comp 8.2 kΩ ±5% 1/4 W	01121	CB8225
R37	0683-1045			R: fxd comp 100 kΩ ±5% 1/4 W	01121	CB1045
R38	0686-7525			R: fxd comp 7.5 kΩ ±5% 1/2 W	01121	EB7525
R39, R40	0683-5635			R: fxd comp 56 kΩ ±5% 1/4 W	01121	CB5635
R41	0686-7525			R: fxd comp 7.5 kΩ ±5% 1/2 W	01121	EB7525
R42, R43	0683-4735			R: fxd comp 47 kΩ ±5% 1/4 W	01121	CB4735
R44	0683-8225			R: fxd comp 8.2 kΩ ±5% 1/4 W	01121	CB8225
R45	0683-3925			R: fxd comp 3.9 kΩ ±5% 1/4 W	01121	CB3925
R46	0683-1815			R: fxd comp 180 Ω ±5% 1/4 W	01121	CB1815
R48	0683-3925			R: fxd comp 3.9 kΩ ±5% 1/4 W	01121	CB3925
R49	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB1035
R50	0683-1045			R: fxd comp 100 kΩ ±5% 1/4 W	01121	CB1045
R51	0686-7525			R: fxd comp 7.5 kΩ ±5% 1/2 W	01121	EB7525
R52, R53	0683-5635			R: fxd comp 56 kΩ ±5% 1/4 W	01121	CB5635
R54	0686-7525			R: fxd comp 7.5 kΩ ±5% 1/2 W	01121	EB7525
R55, R56	0683-4735			R: fxd comp 47 kΩ ±5% 1/4 W	01121	CB4735
R57	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB1035
R58	0683-3925			R: fxd comp 3.9 kΩ ±5% 1/4 W	01121	CB3925
R59	0683-1815			R: fxd comp 180 Ω ±5% 1/4 W	01121	CB1815
R60	0683-4735			R: fxd comp 47 kΩ ±5% 1/4 W	01121	CB4735
R61	0683-3925			R: fxd comp 3.9 kΩ ±5% 1/4 W	01121	CB3925
R62	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB1035
R63	0683-6835			R: fxd comp 68 kΩ ±5% 1/4 W	01121	CB6835
R64	0683-1045			R: fxd comp 100 kΩ ±5% 1/4 W	01121	CB1045
R65	0683-2025		4	R: fxd comp 2 kΩ ±5% 1/4 W	01121	CB2025
A5A1	05212-6011		4	Readout Block Assembly, includes V1A thru V1L, R2A thru R2K, and DS1 thru DS4	-hp-	
A6				Same as A5		
A7				Same as A5		
A8				Same as A5		

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A9	03440-66501		1	Board Assembly: Power Supply and Oscillator	-hp-	
C1	0170-0024		1	C: fxd my 0.022 μf 20% 200 vdcw	56289	192P22302A
C2, C3	0180-0050		2	C: fxd elect 40 μf -15 % +100% 50 vdcw	56289	D32538
C4, C5				Not assigned		
C6	0180-0091		1	C: fxd elect 10 μf 1000 vdcw	56289	30D106G100DD4
C7	0180-0050			C: fxd elect 40 μf -15% +100% 50 vdcw	56289	D32538
C8	0180-0061		1	C: fxd elect 100 μf +100% -10% 15 vdcw	56289	30D172A1
C9 thru C12				Not assigned		
C13	0160-0223		1	C: fxd mica 33 pf 5% 500 vdcw	72982	315,000,R3A0330J
C14	0130-0001		1	C: var 7-45 pf 500 vdcw	72982	50300D2PO-33R
C15	0160-0191		1	C: fxd mica 272.2 pf 1% 300 vdcw	14655	CD19E(272PF)F
C16	0140-0172		1	C: fxd mica 0.003 μf 1% 100 vdcw	72136	DM19F302F
C17, C18				Not assigned		
C19	0170-0055		1	C: fxd my 0.1 μf 20% 200 vdcw	56289	192P10402A
C20	0150-0050			C: fxd cer 1000 pf 600 vdcw		
C21	0140-0208			C: fxd mica 680 pf 5% 300 vdcw	14655	RDM15F681J3C
C22	0150-0121			C: fxd cer 0.1 μf 50 vdcw	56289	obd
C23	0150-0023		1	C: fxd cer 0.002 μf 20% 1000 vdcw	56289	19C203A
CR1 thru CR4	1901-0158		4	Semicon Device: diode Si	04713	SR1358-3
CR5				Not assigned		
CR6 thru CR9	1901-0029		4	Diode: Si piv 600 V 1 avg 0.75A 1N3255	04713	SR1358-10
CR10				Not assigned		
CR11	1902-0048		1	Semicon Device: diode breakdown	04713	SZ10939-134
CR12	1902-0031		1	Semicon Device: diode avalanche	04713	SZ10939-212
CR13, CR14				Not assigned		
CR15	1910-0016			Semicon Device: diode GE	03877	S3185G
L1	9140-0118		1	Coil: fxd 500 μH 5%	99800	2500-14
Q1, Q2	1850-0062			TSTR: GE PNP selected	-hp-	
Q3				Not assigned		
Q4	1850-0062			TSTR: GE PNP selected	-hp-	
Q5	1851-0017			TSTR: 2N1304	01295	2N1304
Q6	1853-0016			TSTR: GE PNP selected	07263	2N3638
Q7, Q8	1853-0062		2	TSTR: GE	07263	2N3645
R1	0761-0026		1	R: fxd met ox flm 220 Ω 5% 1 W	07115	C32
R2	0758-0024		1	R: fxd met flm 100 Ω 5% 1/2 W	07115	C20
R3	0687-5621		1	R: fxd comp 5600 Ω 10% 1/2 W	01121	EB5621
R4, R5				Not assigned		
R6	0683-1235			R: fxd comp 12 kΩ 5% 1/4 W	01121	CB1235
R7	0683-1025			R: fxd comp 1000 Ω 5% 1/4 W	01121	CB1025
R8	0683-2745			R: fxd comp 270 kΩ 5% 1/4 W	01121	CB2745
R9				Not assigned		
R10	0758-0004		1	R: fxd met flm 2700 Ω 5% 1/2 W	07115	C20
R11	0758-0002		1	R: fxd met flm 560 Ω 5% 1/2 W	07115	C20
R12	2100-0238		1	R: var ww 250 Ω 20% lin 1-1/4 W	71450	110
R13	0813-0019		1	R: fxd ww 0.47 Ω 10% 1/2 W	75042	BNH
R14				Not assigned		
R15, R16	0687-1221		1	R: fxd comp 1200 Ω 10% 1/2 W	01121	EB1221
R17				Not assigned		
R18	0683-1245		2	R: fxd comp 120 kΩ 5% 1/4 W	01121	CB1245
R19, R20	0683-1015		2	R: fxd comp 100 Ω 5% 1/4 W	01121	CB1015
R21 thru R23				Not assigned		
R24	0683-1035			R: fxd comp 10 kΩ 5% 1/4 W	01121	CB1035
R25	0683-6835			R: fxd comp 68 kΩ 5% 1/4 W	01121	CB6835

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A9 (Cont'd)							
R26, R27				Not assigned			
R28	0683-1245		2	R: fxd comp 120 kΩ 5% 1/4 W	01121	CB1245	
R29	0683-2215			R: fxd comp 220 Ω 5% 1/4 W	01121	CB2215	
R30	0683-1235			R: fxd comp 12 kΩ 5% 1/4 W	01121	CB1235	
R31	0683-4725			R: fxd comp 4700 Ω 5% 1/4 W	01121	CB4725	
R32				Not assigned			
R33, R34	0683-1035			R: fxd comp 10 kΩ 5% 1/4 W	01121	CB1035	
R35	0683-1235			R: fxd comp 12 kΩ 5% 1/4 W	01121	CB1235	
R36	0683-5625			R: fxd comp 5600 Ω 5% 1/4 W	01121	CB5625	
R37				Not assigned			
R38, R39	0683-5625			R: fxd comp 5600 Ω 5% 1/4 W	01121	CB5625	
R40	0683-2225			R: fxd 2.2 kΩ 5% 1/4 W	01121	CB2225	
R41	0683-4705		1	R: fxd comp 47 Ω 5% 1/4 W	01121	CB4705	
R42	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925	
TP1	0360-0124			Terminal			
A10	03440-66505		1	Assembly: Decimal Board	-hp-		
CR1, CR2	1901-0025			Semicon Device: diode junction	93332	D3092	
R1	0683-6835			R: fxd comp 68 kΩ 5% 1/4 W	01121	CB6835	
R2	0683-1055		6	R: fxd comp 1 MΩ 5% 1/4 W	01121	CB1055	
R3	0683-6835			R: fxd comp 68 kΩ 5% 1/4 W	01121	CB6835	
R4	0683-1055			R: fxd comp 1 MΩ 5% 1/4 W	01121	CB1055	
R5	0683-6835			R: fxd comp 68 kΩ 5% 1/4 W	01121	CB6835	
R6	0683-1055			R: fxd comp 1 MΩ 5% 1/4 W	01121	CB1055	
A11	03440-66506		1	Assembly: Function Board	-hp-		
CR1	1901-0025			Semicon Device: diode junction	93332	D3092	
R1, R2				Not assigned			
R3	0683-6835			R: fxd comp 68 kΩ 5% 1/4 W	01121	CB6835	
R4	0683-8255		1	R: fxd comp 1 MΩ 5% 1/4 W	01121	CB8255	
R5	0683-6835			R: fxd comp 68 kΩ 5% 1/4 W	01121	CB6835	
R6	0683-1055			R: fxd comp 1 MΩ 5% 1/4 W	01121	CB1055	
R7, R8	0683-6835			R: fxd comp 68 kΩ 5% 1/4 W	01121	CB6835	
R9, R10	0683-1055			R: fxd comp 1 MΩ 5% 1/4 W	01121	CB1055	
				MISCELLANEOUS			
	0370-0133		1	Knob: Round blk 5/8" w/arrow	-hp-		
	0390-0006		1	Spacer: Nylon	71002	6549B	
	1000-0017		1	Window: Polaroid	47904		obd
	1200-0081		1	Insulator: Bushing	26365	974 Special	
	1200-0091		1	Insulator: Transistor 800 V	91506	9023-1P1	
	1410-0094		1	Bushing: Panel	98278		obd
	1490-0030		1	Stand: Tilt	-hp-		
	5000-0051		1	Trim: fluted aluminum	-hp-		
	5000-0732		2	Rear Side Cover: 5 x 11 fm	-hp-		
	5000-0733		2	Front Side Cover: 5 x 11 fm	-hp-		
	5060-0739		1	Cover Assembly: Top 11L fm	-hp-		
	5060-0751		1	Cover Assembly: Bottom 11L fm	-hp-		
	5060-0222		2	Handle Assembly: Side	-hp-		
	5060-0766		2	Retainer: Handle Assy	-hp-		
	5060-0767		5	Foot Assembly: fm	-hp-		

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR PART NO.
				MISCELLANEOUS (Cont'd)		
	9211-0248		1	Carton: Shipping	-hp-	
	9223-0040		4	Foam: Polyethylene "Post Pak"	-hp-	
	03440-00204		1	Panel: Front	-hp-	
	03440-00203		1	Panel: Rear	-hp-	
	03440-00601		1	Shield: Divider	-hp-	
	03440-01201		1	Bracket: PC Board	-hp-	
	03440-01202		1	Bar: Readout	-hp-	
	03440-01203		1	Bracket: DCU	-hp-	
	03440-01204		1	Bar: Support	-hp-	
	03440-01205		1	Bracket: Connector	-hp-	
	03440-24701		1	Support: Readout	-hp-	
	03440-24702		1	Bar: Retainer	-hp-	
	03440-48301		2	Guide: Plug-in	-hp-	
	03440-48302		1	Insert: Units readout	-hp-	
	03440-48303		1	Bezel: Window	-hp-	
	03440-48304		1	Readout: Units	-hp-	
	03440-48305		1	Support: Readout	-hp-	
	03440-84401		1	Kit: Accessory	-hp-	
	03440-90004		1	Operating and Service Manual	-hp-	
	5212L-83D		1	Holder: Decimal	-hp-	

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U. S. A Common	Any supplier of U. S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N. Y.
00287	Cemco, Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Mictron, Co., Inc.	Valley Stream, N. Y.
00373	Garlock Inc.	Cherry Hill, N. J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N. J.
00809	Croven, Ltd.	Whitby, Ontario, Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00929	Microlab Inc.	Livingston, N. J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01960	Pulse Engineering Co	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.
02116	Wheelock Signals, Inc.	Long Branch, N. J.
02286	Cole Rubber and Plastics Inc	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N. J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Cal.
02875	Hudson Tool & Die	Newark, N. J.
03296	Nylon Molding Corp.	Springfield, N. J.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.
03954	Singer Co., Diehl Div., Finderne Plant	Sumerville, N. J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruus Corp.	Lambertville, N. J.
04062	Arco Electronic Inc.	Great Neck, N. Y.
04217	Essex Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.
04870	P. M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N. Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N. Y.
05729	Metro-Tel Corp.	Westbury, N. Y.
05783	Stewart Engineering Co.	Santa Cruz, Cal.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N. Y.
06402	E. T. A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N. Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N. H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Etmac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07126	Digitran Co.	Pasadena, Cal.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N. Y.
07149	Filmohm Corp.	New York, N. Y.
07233	Cinch-Graphik Co.	City of Industry, Cal.
07256	Silicon Transistor Corp.	Carle Place, N. Y.
07261	Avnet Corp.	Culver City, Cal.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp, The	Monterey Park, Cal.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N. J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., New Jersey Division	Rockaway, N. J.
08145	U. S. Engineering Co.	Los Angeles, Cal.
08289	Blinn, Delbert Co.	Pomona, Cal.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08664	Bristol Co., The	Waterbury, Conn
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N. J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc	Lowell, Mass.
08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Cal.
09097	Electronic Enclosures Inc.	Los Angeles, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09795	Pennsylvania Florocarbon.	Clifton Heights, Penn.
09922	Burndy Corp	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N. Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
11314	National Seal	Downey, Cal.
11453	Precision Connector Corp.	Jamaica, N. Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division Products Group	Newark, N. J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12136	Philadelphia Handle Co.	Camden, N. J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., Data System Div.	Albuquerque, N. M.
12697	Clarostat Mfg. Co.	Dover, N. H.
12728	Elmar Filter Corp	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N. J.
12930	Delta Semiconductor Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13061	Wilco Products	Detroit, Mich.
13103	Thermolloy	Dallas, Texas
13327	Solitron Devices Inc.	Tappan, N. Y.
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	West Palm Beach, Fla.
14493	Hewlett-Packard Company.	Loveland, Colo.
14655	Cornell Dublier Electric Corp	Newark, N. J.
14674	Corning Glass Works	Corning, N. Y.
14752	Electro Cube Inc.	San Gabriel, Cal.
14960	Williams Mfg. Co.	San Jose, Cal.
15106	The Sphere Co., Inc.	Little Falls, N. J.
15203	Webster Electronics Co.	New York, N. Y.
15287	Scionics Corp.	Northridge, Cal.
15291	Adjustable Bushing Co.	N. Hollywood, Cal.
15558	Micron Electronics.	Garden City, Long Island, N. Y.
15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
15631	Cabletronics	Costa Mesa, Cal.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Cal.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mountain View, Cal.
16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N. J.
16554	Electroid Co.	Union, N. J.
16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
16688	Ideal Prec. Meter Co., Inc., De Jur Meter Div.	Brooklyn, N. Y.
16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Cal.
17474	Tranex Company	Mountain View, Cal.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Cal.
17856	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N. H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp.	Sunnyvale, Cal.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18565	Chomerics	Plainville, Mass.
18583	Curtis Instrument, Inc.	Mt. Kisco, N. Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N. J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison	West Orange, N. J.
19589	Concoa	Baldwin Park, Cal.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23020	General Reed Co.	Metuchen, N.J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division, Nela Park, Cleveland, Ohio	
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	HP Co., Med. Elec. Div.	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark, Newark, N.J.	
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap Division	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries, Inc.	Philadelphia, Pa.
73734	Federal Screw Products, Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostran Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Division	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
82209	Magurie Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rolton Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisades Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Cal.
85474	R.M. Bracamonte & Co.	San Francisco, Cal.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Cal.
87034	Marco Industries	Anaheim, Cal.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Cal.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89479	Security Co.	Detroit, Mich.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91673	Epiphone Inc.	New York, N.Y.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Cal.
91886	Malco Mfg., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Pallisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Cal.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95146	Alco Elect. Mfg. Co.	Lawrence, Mass.
95236	Allies Products Corp.	Dianla, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Mfg. Co.	Los Angeles, Cal.
96396	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Cal.
96508	Xcelite, Inc.	Orchard Park, N.Y.
96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
96881	Thomson Ind. Inc.	Long Island, N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Cal.
98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
98278	Microdot, Inc.	So. Pasadena, Cal.
98291	Sealectro Corp.	Mamaronech, N.Y.
98376	Zero Mfg. Co.	Burbank, Cal.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Division of Hewlett-Packard Co.	Palo Alto, Cal.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Cal.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Cal.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Rembrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
99957	Technology-Instrument Corp. of California	Newbury Park, Cal.

The following HP Vendors have no number assigned in the latest supplement to the Federal Supply Code for Manufacturers Handbook.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.
000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Cal.
000NN	A "N" D Mfg. Co.	San Jose, Cal.
000QQ	Cooltron	Oakland, Cal.
000WW	California Eastern Lab	Burlington, Cal.
000YY	S.K. Smith Co.	Los Angeles, Cal.

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TWX: 710-956-0157

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FOR U.S. AREAS NOT LISTED:
Contact the regional office nearest you: Atlanta, Georgia . . . North Hollywood, California . . . Paramus, New Jersey . . . Skokie, Illinois. Their complete addresses are listed above.

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MANUAL BACKDATING CHANGES

MODEL 3440A

DIGITAL VOLTMETER

Manual Serial Prefixed: 919-
-hp- Part No. 03440-90004

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix	Make Manual Changes
421-00925 and below	1 thru 5
637-08625 and below	2 thru 5
919-13650 and below	3 thru 5
951-14050 and below	4, 5

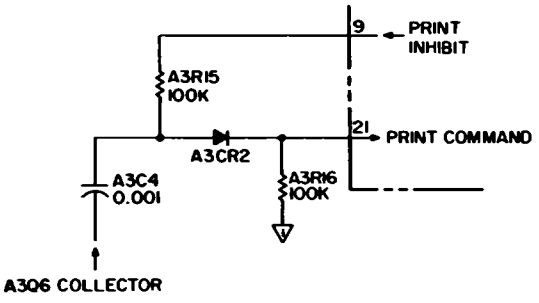
Instrument Serial Prefix	Make Manual Changes
951-14220 and below	5

CHANGE 1

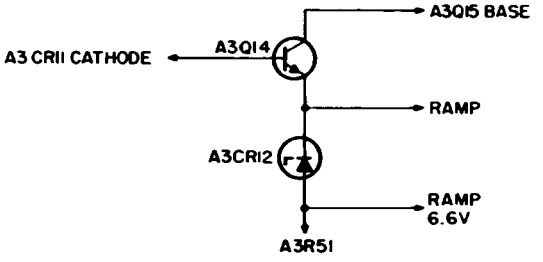
Display and Ramp Assembly, Part No. 03440-66502, was used in instruments with Serial No. 421-00925 and below. The schematic diagram (Figure 6-3) and Table 7-1, Replaceable Parts, apply to A3 Assembly 03440-66502 with the following exceptions:

Delete:	A3R65	R: fxd comp 12 kΩ	0683-1235	1 each
	A3R64	R: fxd comp 22 kΩ	0683-2235	1 each
	A3R63	R: fxd comp 150 kΩ	0683-1545	1 each
	A3Q18	TSTR: 2N2712	1854-0029	1 each
	A3QCR1	TSTR: diode	1820-0001	1 each
	A3CR15, 16	Diode: silicon	1901-0025	2 each
Add:	A3C4	C: fxd 0.001 μF	0150-0050	1 each
	A3R15, 16	R: fxd comp 100 kΩ	0683-1045	2 each
	A3Q14	TSTR: selected	1854-0003	1 each
	A3CR2	Diode: silicon	1901-0025	1 each
	A3CR12	Diode: avalanche	1902-0070	1 each

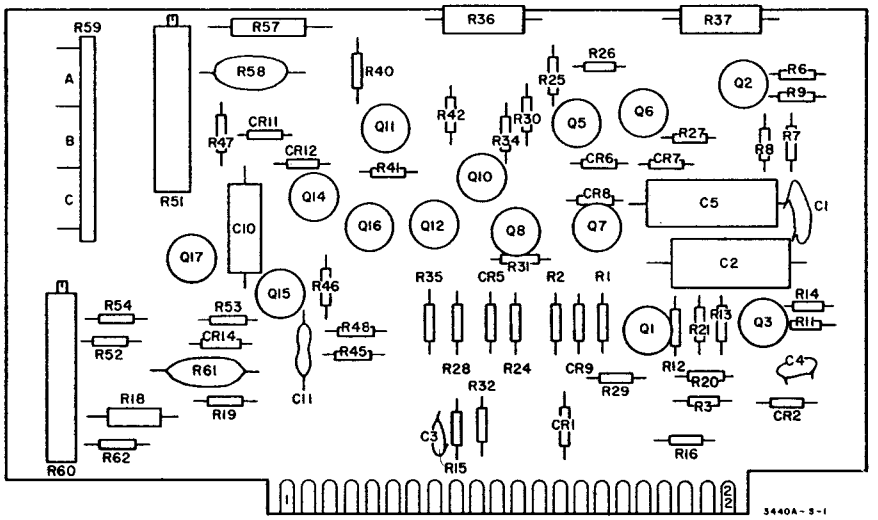
Substitute the following Print Command Circuit in place of A3Q18, A3R63-65, and A3CR15, 16.



A3Q14 and A3CR12 replace A3QCR1 as shown.



Following is the component location drawing for Display and Ramp Assembly 03440-66502.



CHANGE 2

The schematic diagram and Replaceable Parts list on the following pages apply to Decade Counter Assembly, Part No. 5212L-4A, which was used in instruments with Serial No. 637-08625 and below. Later instruments use Part No. 05212-6016, which may be used as direct replacement for 5212L-4A.

CHANGE 3

Beginning with Serial No. 951-13651, the following parts were changed:

J3 changed from 1251-0148 to 1251-2357.
S6 changed from 3101-0033 to 3101-1234.
W1 changed from 8120-0078 to 8120-1348.
Rear panel changed from 03440-00202 to 03440-00203.

Old part numbers must be used in instruments Serial No. 919-13650 and below unless all four parts are replaced with new part numbers to conform to I.E.C. standards (No. 66).

CHANGE 4

A2Q3 changed from 1850-0096 to 1850-0074. New part is recommended replacement for all instruments.

CHANGE 5

Beginning with Serial No. 951-14221, the following changes were made:

R6 changed from 2100-0438 to 2100-2993.
S1, 3101-1244 added.
R10, 0683-3335 added.
Front panel changed from 03440-00201 to 03440-00204.

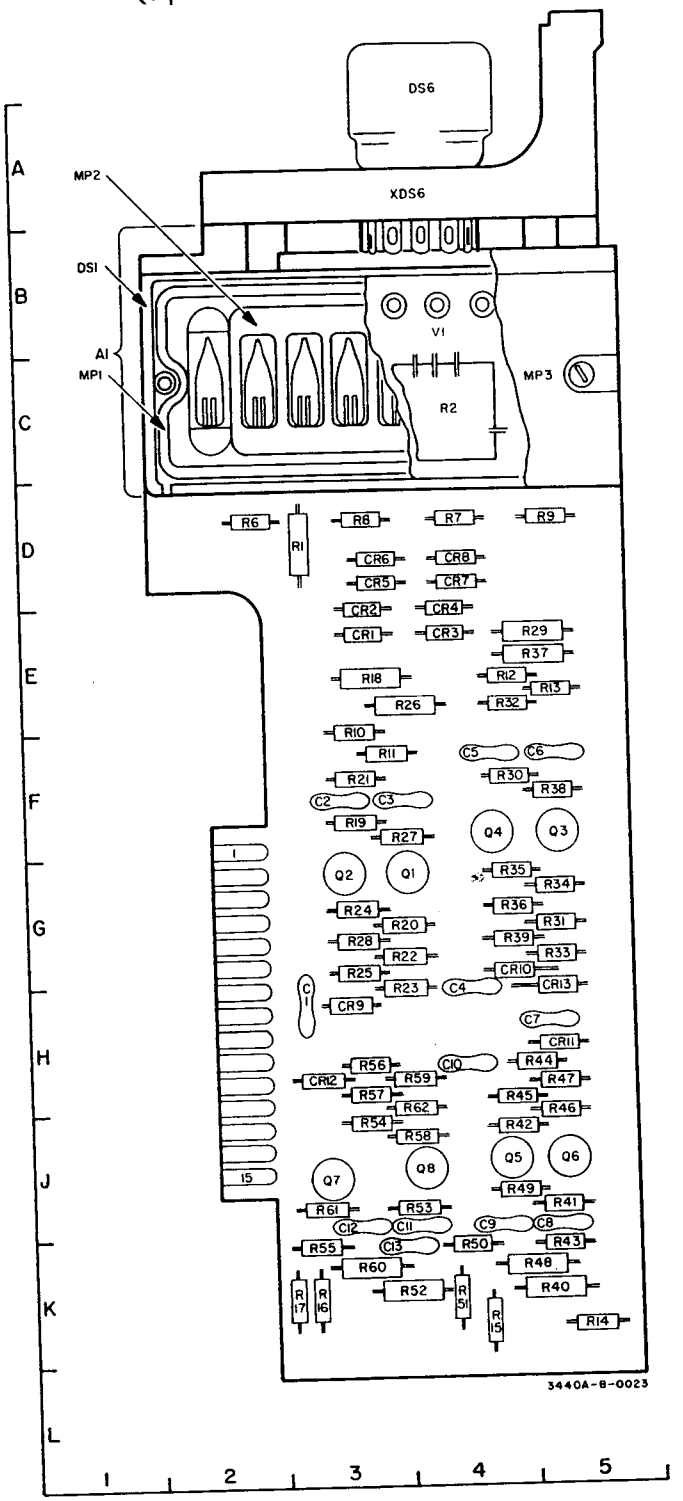
Old part numbers must be used in instruments Serial No. 951-14220 and below unless all parts are replaced with new part numbers to conform to I.E.C. standards (No. 66).

A5 thru A8 ASSEMBLY COMPONENT LOCATIONS

	C	CR	Q	R		R
1	H3	E3	G4	D3	34	G5
2	F3	E3	G3	C4	35	G4
3	F3	E4	F5	--	36	G4
4	H4	E4	F4	--	37	E5
5	F4	D3	J4	--	38	F5
6	F5	D3	J5	D2	39	G4
7	H5	D4	J3	D4	40	K5
8	J5	D4	J4	D3	41	J5
9	J4	H3		D5	42	J4
10	H4	G4		F3	43	K5
11	J3	H5		F3	44	H5
12	J3	H3		E4	45	H4
13	K3	H5		E5	46	J5
14				K5	47	H5
15				K4	48	K5
16				K3	49	J4
17				K3	50	K4
18				E3	51	K4
19				F3	52	K4
20				G4	53	J4
21				F3	54	J3
22				G4	55	K3
23				H4	56	H3
24				G3	57	H3
25				G3	58	J4
26				E4	59	H4
27				F4	60	K3
28				G3	61	J3
29				E5	62	H4
30				F4	63	
31				G5	64	
32				E4	65	
33				G5	66	

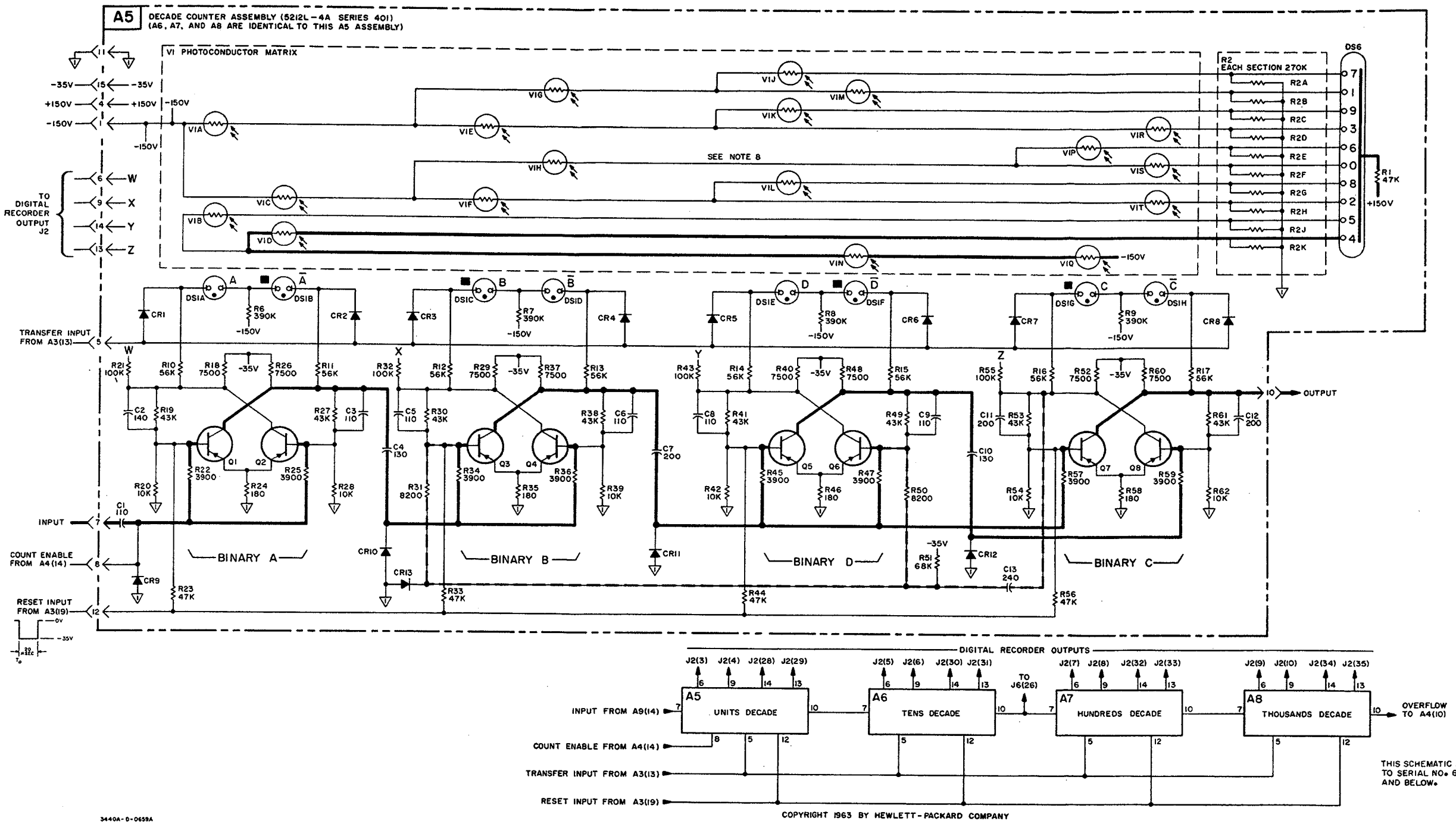
A5 thru A8

(hp Part No. 5212L-4A)



NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
   RESISTANCE IN OHMS
   CAPACITANCE IN PICOFARADS
3. ——— DENOTES ASSEMBLY.
4. — — — DENOTES SUBASSEMBLY.
5. ═══ DENOTES MAIN SIGNAL PATH.
6. ——— DENOTES FEEDBACK PATH.
7. WAVEFORMS SHOWN WITH COUNTER USED AS A UNITS COUNTER.
8. VERTICALLY ALIGNED PHOTOCONDUCTORS ARE ILLUMINATED BY THE LAMP DIRECTLY BELOW.
9. ■ DENOTES LIGHTED NEON LAMP FOR "4" DIGIT.
10. TO TRACE ELECTRICAL PATH FOR A LIGHTED NUMERAL IN DS6 PROCEED FROM NUMERAL THROUGH PHOTOCELLS TO -150 V (SEE EXAMPLE FOR NUMERAL 4).
11. ▽ DENOTES POWER SUPPLY GROUND.
12. ▽ AND ⏚ (SIGNAL GROUND) ARE COMMON ONLY WHEN THE PLUG-IN IS MATED WITH THE MAIN INSTRUMENT.



THIS SCHEMATIC APPLIES TO SERIAL NO. 637-08625 AND BELOW.

3440A-0-0659A

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A5	5212L-4A			Counter Assembly: Decade	-hp-	
C1	0140-0194			C: fxd mica 110 pf 5% 300 vdcw	14655	CD15F111J
C2	0140-0217			C: fxd mica 140 pf 2% 300 vdcw	14655	RDM15F141G3C
C3	0140-0194			C: fxd mica 110 pf 5% 300 vdcw	14655	CD15F111J
C4	0140-0195			C: fxd mica 130 pf 5% 300 vdcw	14655	RDM15F131J3C
C5, C6	0140-0194			C: fxd mica 110 pf 5% 300 vdcw	14655	CD15F111J
C7	0140-0198			C: fxd mica 200 pf 5% 300 vdcw	14655	RDM15F201J3C
C8, C9	0140-0194			C: fxd mica 110 pf 5% 300 vdcw	14655	CD15F111J
C10	0140-0195			C: fxd mica 130 pf 5% 300 vdcw	14655	RDM15F131J3C
C11, C12	0140-0198			C: fxd mica 200 pf 5% 300 vdcw	14655	RDM15F201J3C
C13	0140-0199			C: fxd mica 240 pf 5% 300 vdcw	14655	RDM15F241J3C
CR1 thru CR8	1901-0025			Semicon Device: diode junction	93332	D3072
CR9 thru CR13	1910-0015			Semicon Device: diode germanium	73293	HD-1409
DS1	05212-6011			Exciter: Photoconductor Matrix		
DS2 thru DS5				Not assigned		
DS6	1970-0009			Tube: 10 digit indicator		
MP1	0905-0043			Gasket: Photoconductor		
MP2	0905-0051			Light Mask: Felt included in A5DS1		
MP3	5212A-83C			Cover: Photoconductor included in A5DS1		
Q1 thru Q8	1850-0062			TSTR: GE PNP selected	-hp-	
R1	0686-4735			R: fxd comp 47 kΩ 5% 1/2 W	01121	EB4735
R2	0845-0001			Network: Resistive	-hp-	
R3 thru R5				Not assigned		
R6 thru R9	0683-3945			R: fxd comp 390 kΩ 5% 1/4 W	01121	CB3945
R10 thru R17	0683-5635			R: fxd comp 56 kΩ 5% 1/4 W	01121	CB5635
R18	0686-7525			R: fxd comp 7500 Ω 5% 1/2 W	01121	EB7525
R19	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R20	0683-1035			R: fxd comp 10 kΩ 5% 1/4 W	01121	CB1035
R21	0683-1045			R: fxd comp 100 kΩ 5% 1/4 W	01121	CB1045
R22	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925
R23	0683-4735			R: fxd comp 47 kΩ 5% 1/2 W	01121	CB4735
R24	0683-1815			R: fxd comp 180 Ω 5% 1/4 W	01121	CB1815
R25	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925
R26	0686-7525			R: fxd comp 7500 Ω 5% 1/2 W	01121	EB7525
R27	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R28	0683-1035			R: fxd comp 10 kΩ 5% 1/4 W	01121	CB1035
R29	0686-7525			R: fxd comp 7500 Ω 5% 1/2 W	01121	EB7525
R30	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R31	0683-8225			R: fxd comp 8200 Ω 5% 1/4 W	01121	CB8225
R32	0683-1045			R: fxd comp 100 kΩ 5% 1/4 W	01121	CB1045
R33	0683-4735			R: fxd comp 47 kΩ 5% 1/4 W	01121	CB4735
R34	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925
R35	0683-1815			R: fxd comp 180 Ω 5% 1/4 W	01121	CB1815
R36	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925
R37	0686-7525			R: fxd comp 7500 Ω 5% 1/2 W	01121	EB7525
R38	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R39	0683-1035			R: fxd comp 10 kΩ 5% 1/4 W	01121	CB1035
R40	0686-7525			R: fxd comp 7500 Ω 5% 1/2 W	01121	EB7525
R41	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R42	0683-1035			R: fxd comp 10 kΩ 5% 1/4 W	01121	CB1035

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A5 (Cont'd)						
R43	0683-1045			R: fxd comp 100 kΩ 5% 1/4 W	01121	CB1045
R44	0683-4735			R: fxd comp 47 kΩ 5% 1/4 W	01121	CB4735
R45	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925
R46	0683-1815			R: fxd comp 180 Ω 5% 1/4 W	01121	CB1815
R47	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925
R48	0686-7525			R: fxd comp 7500 Ω 5% 1/2 W	01121	EB7525
R49	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R50	0683-8225			R: fxd comp 8200 Ω 5% 1/4 W	01121	CB8225
R51	0683-6835			R: fxd comp 68 kΩ 5% 1/4 W	01121	CB6835
R52	0686-7525			R: fxd comp 7500 Ω 5% 1/2 W	01121	EB7525
R53	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R54	0683-1035			R: fxd comp 10 kΩ 5% 1/4 W	01121	CB1035
R55	0683-1045			R: fxd comp 100 kΩ 5% 1/4 W	01121	CB1045
R56	0683-4735			R: fxd comp 47 kΩ 5% 1/4 W	01121	CB4735
R57	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925
R58	0683-1815			R: fxd comp 180 Ω 5% 1/4 W	01121	CB1815
R59	0683-3925			R: fxd comp 3900 Ω 5% 1/4 W	01121	CB3925
R60	0686-7525			R: fxd comp 7500 Ω 5% 1/2 W	01121	EB7525
R61	0683-4335			R: fxd comp 43 kΩ 5% 1/4 W	01121	CB4335
R62	0683-1035			R: fxd comp 10 kΩ 5% 1/4 W	01121	CB1035
V1	1990-0009			Plate: Photoconductor Matrix	-hp-	
XDS6	5212L-83C			Socket: Digit Display Tube	-hp-	
A5A1	05212-6011			Indicator Assembly: Digit Includes: DS1, R2, V1, MP1, MP2, MP3	-hp-	
A6				Same as A5		
A7				Same as A5		
A8				Same as A5		