Errata

Title & Document Type: **214A Pulse Generator Operating and Service Manual**

Manual Part Number: **00214-90910**

Revision Date: **November 1975**

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HP References in this Manual

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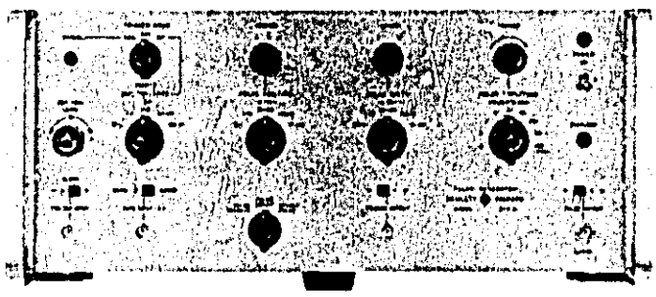
HP214A

OPERATING AND SERVICE MANUAL

PULSE GENERATOR
214A



HEWLETT hp PACKARD

HP214A

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

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OPERATING AND SERVICE MANUAL

MODEL 214A
PULSE GENERATOR

SERIALS PREFIXED: 1239A

Refer To Appendix I For Instruments With Other Serial Prefixes

HEWLETT-PACKARD COMPANY/COLORADO SPRINGS DIVISION
1900 GARDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO, U.S.A.

Manual Part Number 00214-90910
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Table 1-1. Specifications

OUTPUT PULSE

Source Impedance: 50 ohms on the 50-volt and lower ranges: approximately 1500 ohms on the 100-volt range.

Pulse Shape

Rise and Fall Time: < 13 ns on 20-volt and lower ranges and the -50 volt range, < 15 ns on the +50 volt range. Typically < 10 ns with vernier set for maximum attenuation and typically 15 nsec on 100v range.

Pulse Amplitude: 100 volts into 50 ohms. An attenuator provides 0.2 to 100 volts in a 1,2, 5, 10 sequence (9 ranges). Vernier reduces output of 0.2 V setting to 80 mV and provides continuous adjustment between ranges.

Polarity: Positive or negative.

Overshoot: < 5%, both leading and trailing edges.

Pulse Top Variations: < 5%.

Droop: < 6%.

Preshoot: < 2%.

Pulse Width: 50 ns to 10 ms in 5 decade ranges. Continuously adjustable vernier.

Width Jitter: < 0.05% of pulse width + 1 ns.

Pulse Position: 0 to 10 ms advance or delay, with respect to trigger output (5 decade ranges). Continuously adjustable vernier.

Position Jitter: < 0.05% of advance or delay setting +1 ns (between trigger pulse and output pulse).

REPETITION RATE AND TRIGGER

Internal

Repetition Rate: 10 cps to 1 Mc (5 ranges), continuously adjustable vernier.

Rate Jitter: < 0.5% of the period.

Manual: Pushbutton single pulse, 2 cps maximum rate.

External

Repetition Rate: DC to 1 Mc

Sensitivity: 0.5 V pk

Slope: Positive or negative

Level: Adjustable from -40 V to +40 V.

Delay: Delay between input trigger and leading edge of pulse out is approximately 250 ns in Pulse Advance mode (approx. 420 ns minimum in Pulse Delay mode).

External Gating: +8 volt signal gates pulse generator on. Maximum signal, +40 V peak.

Double Pulse

Minimum Spacing: 1 us on the 0.05 to 1 μsec pulse width range. On all other ranges 25% of upper limit of width range.

Trigger Output

Amplitude: > 10 V open circuit.

Width: 0.05 μsec, nominal.

Polarity: Positive or negative.

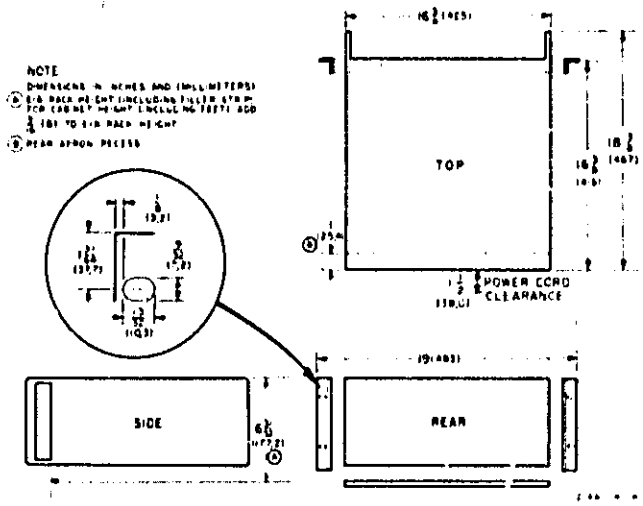
Source Impedance: Approximately 50 ohms

GENERAL

Maximum Duty Cycle: 10% on 100- and 50-volt ranges; 25% on 20-volt range; 50% on 10-volt and lower ranges.

Power: 115 or 230 V ± 10%, 50 to 30 cps, 325 watts.

Dimensions:



Weight: Net 35 lbs. (15.8 kg). Shipping 41 lbs. (18.5 kg).

SECTION I
GENERAL INFORMATION

1-1. INSTRUMENT DESCRIPTION.

1-2. The Model 214A Pulse Generator (Figure 1-1) is a versatile instrument providing variable repetition rate, variable width, variable amplitude, positive or negative, pulses with a rise and fall time of less than 15 nanoseconds. The complete specifications are given in Table 1-1. Pulse power of up to 200 watts is available when using a 50-ohm load. The Model 214A output impedance matches an external system of 50 ohms on all ranges of 50 volts amplitude and below, thus minimizing reflections. The maximum pulse amplitude is 100 volts (with a source impedance of 1500 ohms) and the amplitude may be set as low as 80 millivolts using the vernier and the lowest range. For pulse amplitudes of 10 volts and less, the duty cycle may be set as high as 50% (see Table 1-1 for duty cycle limits at other amplitudes), providing a square wave output.

1-3. Pulses may be obtained from the Model 214A at a rate of dc to 1 Mc using an external trigger source or from 10 cps to 1 Mc with an internal generator. For external triggers, positive or negative signals of 0.5 volt peak may be used and trigger slope and level may be selected to determine the triggering point on the waveform. A single pulse may be obtained from an internal circuit each time a manual button is pushed. Gating of pulses is done easily by applying an external signal and an output occurs only when the gating signal reaches a positive 8 volt level. Three modes of pulse operation allow: (1) setting of the output pulse to occur from 0 to 10 ms before (advance) the trigger output, (2) setting of the output pulse to occur from 0 to 10 ms after (delay) the trigger output, or (3) a double pulse output with variable spacing between the two pulses.

1-4. The Hewlett-Packard modular instrument enclosure system provides advantages in maintenance and operation. Easy removal of instrument covers allows access to all chassis and circuit components. As a bench type instrument the modular design provides mechanical stability even when several instruments are stacked together. The bench type instrument is readily converted for use in standard width

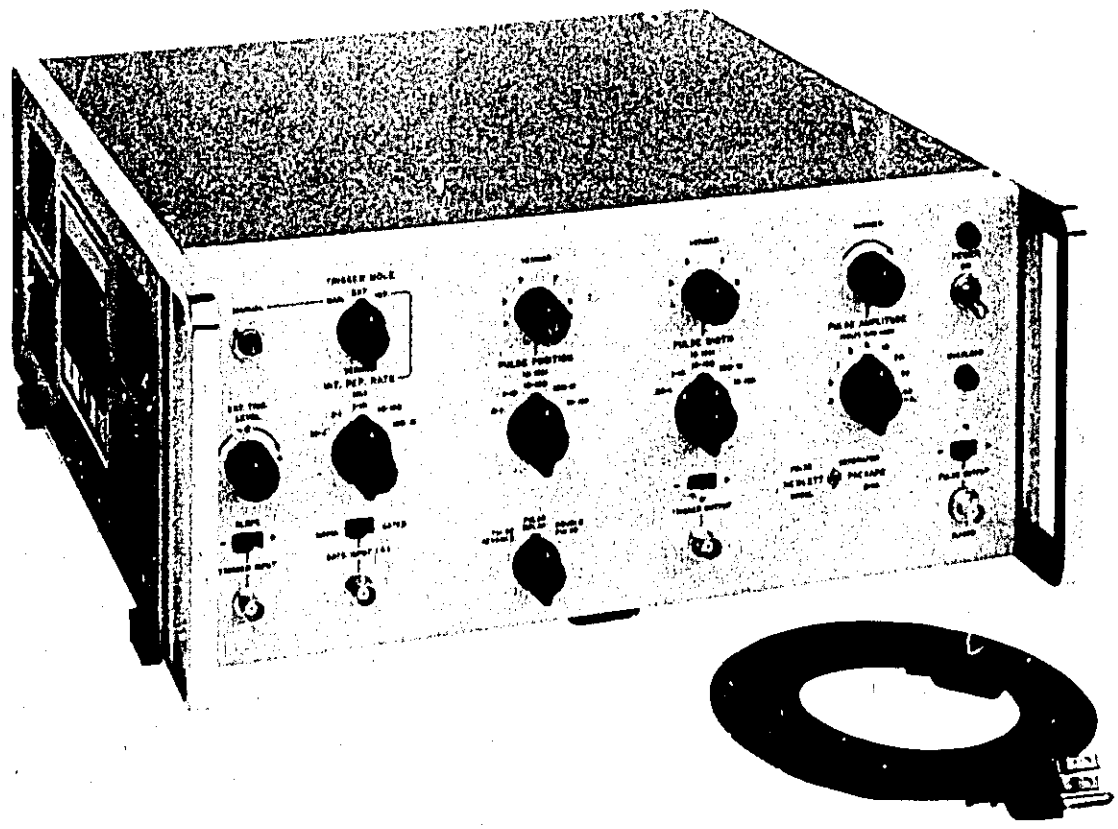


Figure 1-1. Model 214A Pulse Generator

rack using hardware shipped with the instrument. Paragraph 2-11 explains the details of converting to either the rack or bench version.

1-5. INSTRUMENT APPLICATIONS.

1-6. With its variable pulse characteristics the Model 214A is useful as a general purpose laboratory or production line test instrument. The high peak current output available, 2 amps, is useful for testing current driven devices such as magnetic memory cores, high power modulators, and power amplifiers. Fast rise and fall time combined with high power output pulses facilitate checking switching time of high power semiconductors. The positive or negative pulse output, with identical characteristics, provides an easy technique for checking either npn or pnp type transistors. By gating the Model 214A output, a burst of pulses may be obtained for making computer logic measurements. The double pulse feature may also be used for pulse resolution tests of amplifiers and memory cores.

1-7. EQUIPMENT AND ACCESSORIES AVAILABLE.

1-8. A complete line of electronic test equipment is available from the Hewlett-Packard Company for use in making test measurements with, or maintaining, the Model 214A. Also available are cables, connectors, adapters and other accessory items for use in various test or measurement applications. For information on specific items, consult the hp Catalog or your hp Field Engineer.

1-9. DIFFERENCES BETWEEN INSTRUMENTS.

1-10. This manual applies directly to Model 214A instruments with a serial prefix number as listed on the manual title page. The serial prefix number is the first group of digits in the instrument serial number. The instrument serial number is on a tag located on the rear panel.

1-11. Check the serial prefix number of the instrument. If the serial prefix number is different from that listed on the title page of this manual, refer to Appendix I for instructions to adapt this manual for proper instrument coverage.

SECTION II

PREPARATION FOR USE

2-1. INITIAL INSPECTION.

2-2. Upon receipt of the Model 214A, verify that the contents are intact and complete as ordered. Inspect the instrument for any physical damage such as a scratched panel surface, broken knob or connector, etc., incurred in shipping. To facilitate possible reshipment, keep the original packing material if reusable (see Paragraph 2-15), until a satisfactory operational check (Paragraph 5-3) is completed. If damage is found, file a claim with the freight carrier and refer to the warranty page in this manual. Section V outlines the recommended adjustment and troubleshooting procedures needed for normal maintenance or recalibration.

2-3. AC POWER CONSIDERATIONS.

2-4. POWER SOURCE REQUIREMENTS.

2-5. The Model 214A may be operated from an ac source of 115 or 230 volts (±10%), at 50 to 60 cps. With the instrument power cord disconnected, move the slide switch (located on the rear panel) until the desired voltage numbers (115 or 230) are visible. A narrow-blade screwdriver may be used to operate the switch. Fuse F1 (holder on rear panel) should be 4 amperes, slow-blow for 115v operation or 2 amperes, slow-blow for 230v operation.

2-6. THREE-CONDUCTOR POWER CABLE.

2-7. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument and cabinet be grounded. The Model 214A is supplied with a detachable three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument to the power line ground. The round pin on the power cable 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.

2-8. VENTILATION REQUIREMENTS.

2-9. GENERAL. The cooling fan and air filter are located on the rear panel of the Model 214A. Leave adequate clearance (at least 2 to 3 inches) behind and at both sides of the instrument for free movement of air. The path of air flow is through the filter and intake fan then out of the perforated side covers. It is important to keep the air intake area free of dust and small particles which could clog the filter. Section V provides maintenance information for fan and filter. In a rack installation be sure that recirculation of warm air within the rack cabinet does not produce an ambient temperature high enough to affect instrument operation.

2-10. COATING FILTER. Before placing the instrument in use, the air filter should be coated with a filter adhesive preparation. A recommended preparation is No. 3 Filter Coat, made by Research Products Company, and available in sprayer cans at heating-supply stores. This may also be obtained by contacting your hp Field Engineer (see maps at back of this manual) or by ordering directly from hp Customer Service. Hewlett-Packard stock number is 3150-0002.

2-11. RACK/BENCH CONVERSION.

2-12. The Model 214A is shipped as a bench-type instrument (even when ordered as a rack type) with plastic feet and tilt stand in place. The hp modular instrument enclosure system allows easy conversion to either bench or rack mode. Refer to the appropriate following procedure for conversion.

2-13. CONVERSION TO RACK MODEL.

a. Detach the tilt stand and all the plastic feet. Tilt stand removes by pressing away from the front feet. Remove feet by depressing metal release button and sliding feet free.

b. Using a thin-blade tool, loosen and remove the plastic trim strip (with adhesive back) from each side of the instrument (directly behind front handles). Removal of strip exposes threaded nuts pressed in the side casting.

c. Attach the rack-mounting flanges, with the screws provided, in the space where the trim strip was adhered. Each flange extends slightly below the front panel when attached correctly.

d. If the instrument is to be placed in a rack above or below another hp modular instrument, attach the filler strip between the front panels. Insert Model 214A in the rack and secure flanges to rack.

2-14. CONVERSION TO BENCH.

a. Remove instrument from rack, detach rack-mounting flanges and filler strip, if used between front panels.

b. Attach trim strip (in slots where rack flanges were located), plastic feet, and tilt stand. A fifth plastic foot at center-front of the instrument provides extra stability when the Model 214A is stacked atop another hp modular bench-type instrument.

2-15. REPACKAGING FOR SHIPMENT.

2-16. PACKAGING SUGGESTIONS.

2-17. To package an instrument for shipment, some types of original packing materials may be reused, or your hp Field Engineer will provide assistance in obtaining suitable packaging. The types of original

packing materials which may be reused are: (1) foam enclosure pads, (2) cardboard layers separated by foam supports, and (3) laminated cardboard cut to desired packing shape. Original packing materials which are a cardboard "accordion-like" filler are not recommended for shipment since the useful cushioning qualities are usually gone after one use. If packing materials listed above are not available, first protect the instrument surfaces with heavy paper or sheets of cardboard flat against the instrument. Then place instrument in a durable carton, pad all sides with approximately 4 inches of new packaging material designed specifically for package cushioning, mark carton clearly for proper handling, and insure adequately before shipping.

2-18. RETURNING FOR SERVICE OR REPAIR.

2-19. Contact your Hewlett-Packard Company Field Office for shipping instructions. All correspondence should refer to an instrument by model number and the full (eight-digit) serial number.

SECTION III
OPERATING INSTRUCTIONS

3-1. GENERAL.

3-2. The Model 214A is self-protected and no combination of front panel control settings or connections to external circuits can damage the instrument, providing the overload relay circuitry is operating properly. An overload will be indicated if the limits on duty cycle specified in Table 1-1 are exceeded. The limits and combinations of settings which result in an overload indication are described in Paragraph 3-4. Other specific operating considerations are given in Paragraphs 3-7 and 3-9. Figure 3-3 illustrates and explains the function of all the front panel fixtures. The ac power connector, fuse, and line voltage switch are on the rear panel. Proper fuse size is: 4 amps slow-blow for 115v and 2 amps slow-blow for 230v operation. Setting line switch and other ac power information is given in Paragraph 2-3.

3-3. OPERATING CONSIDERATIONS.

3-4. DUTY CYCLE LIMITATION.

3-5. Duty cycle of operation is determined by front panel control settings. Duty cycle is defined as the ratio of duration of pulse (i.e. pulse width) to the total duration of one complete cycle. Figure 3-1 shows the relationship which determines the duty cycle. The time for one cycle is defined as the period, and the period is related to repetition rate by:

$$\text{Period} = \frac{1}{\text{Rep Rate}}$$

Thus the product of pulse width and frequency times 100 determines the percent duty cycle. For example if INT. REP. RATE is set to 1-10, VERNIER set to give a rate of 6 kc (or if the external trigger rate is 6 kc), and PULSE WIDTH and VERNIER are set to give a pulse 70 μsec wide, the percent duty cycle is:

$$(70 \times 10^{-6})\ (6 \times 10^{3}) \times 100 = 42\%$$

The same limits on duty cycle apply for external trigger operation or internal repetition rate. The limits are 50% for PULSE AMPLITUDE settings of 10 volts or less, 25% on 20 volts amplitude, and 10% on 50 to 100 volt amplitude. The maximum duty cycle will decrease slightly at repetition rates slower than 20 cps on the 50v and 100v PULSE AMPLITUDE ranges. At these slow repetition rates the overload relay reacts if there were a higher average voltage than that actually present.

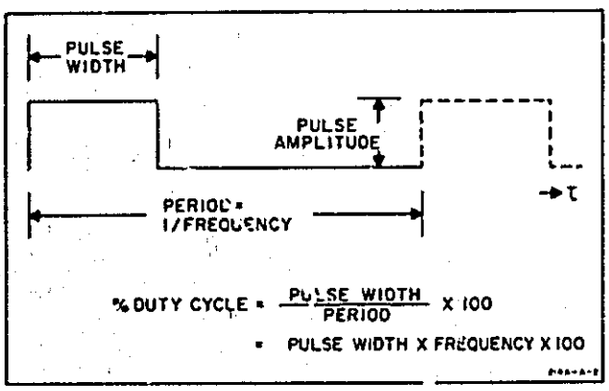


Figure 3-1. Defining Pulse Characteristics

3-6. If maximum duty cycle is exceeded for any pulse amplitude, the front panel light, OVERLOAD, will flash on and off and an internal relay will be heard as a clicking sound. No damage will occur to the instrument when this overload circuit is operating properly. When an overload is indicated it may be stopped by reducing either the frequency or the PULSE WIDTH setting. Usually this may be done easiest by turning the Width VERNIER counterclockwise, or by reducing the Width range setting. In DOUBLE PULSE operation the duty cycle limit is one half that for PULSE ADVANCE or PULSE DELAY. The expression for duty cycle using DOUBLE PULSE is given in Figure 3-2.

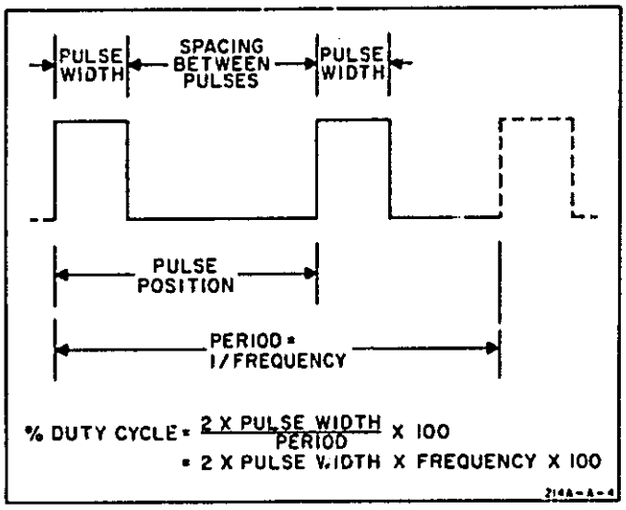


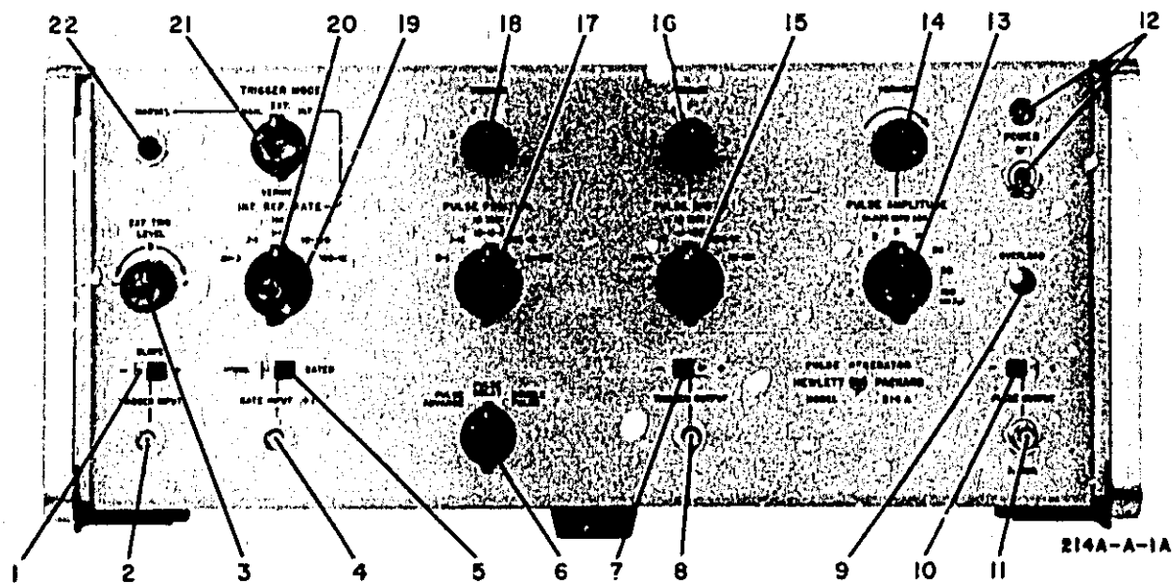
Figure 3-2. DOUBLE PULSE Operation

3-7. PULSE POSITION VS. RATE.

3-8. In either PULSE ADVANCE or PULSE DELAY operation, the PULSE POSITION setting should always be less than the period (i.e. 1 divided by the frequency). For example if the repetition rate is 25 kc, the period is:

$$\text{Period} = \frac{1}{25\ \text{kc}} = 40\ \mu\text{sec}$$

and the PULSE POSITION range combined with VERNIER setting should not exceed 40 μsec. For DOUBLE



1. SLOPE. Allows setting for triggering to occur on either negative-going or positive-going slope of external trigger-source waveform.
2. TRIGGER INPUT. Connector for external triggering signals.
3. EXT. TRIG. LEVEL. Sets voltage level on external trigger-source waveform at which triggering occurs.
4. GATE INPUT (+). Connector for gating voltage which then allows pulse outputs only when input is at +8 volts or more; 40V maximum.
5. NORM./GATED. Set to GATED when the duration of pulse output is to be controlled by a gating voltage.
6. PULSE ADVANCE/PULSEDELAY/DOUBLE PULSE. Set to PULSE ADVANCE for pulse output before trigger output. Set to PULSE DELAY for pulse output after trigger output. DOUBLE PULSE gives two pulses at output.
7. TRIGGER OUTPUT polarity. Determines polarity of trigger output pulse.
8. TRIGGER OUTPUT connector. Provides 10 volt synchronizing pulses across 1000 ohms.
9. OVERLOAD. Indicator lights when duty cycle limit is exceeded.
10. PULSE OUTPUT polarity. Determines polarity of main pulse output.
11. PULSE OUTPUT connector. Provides output pulse with characteristics set by front panel controls (see Table 1-1 for specifications).
12. POWER switch and indicator. Switch controls ac power to instrument; indicator lights in ON position. 115-230 volt switch on rear panel.
13. PULSE AMPLITUDE. Controls amplitude range of pulse output.
14. VERNIER. Provides continuous overlapping adjustment between setting of PULSE AMPLITUDE and next lower range.
15. PULSE WIDTH. Changes limits of VERNIER control over output pulse width.
16. VERNIER. Provides continuous, semi-calibrated, adjustment between limits set by PULSE WIDTH switch.
17. PULSE POSITION. Changes limits of VERNIER control over output pulse position with respect to the trigger output pulse.
18. VERNIER. Provides continuous, semi-calibrated, adjustment between limits set by PULSE POSITION switch.
19. INT. REP. RATE. Changes limits of VERNIER control over internal repetition rate circuit.
20. VERNIER. Provides continuous adjustment between limits set by INT. REP. RATE switch.
21. TRIGGER MODE. Selects mode of generating pulses. MANual push button, EXTernal trigger source, or INTernal repetition rate.
22. MANUAL. Push button provides single pulse output when TRIGGER MODE is set to MAN.

Figure 3-3. Model 214A Front Panel Description

PULSE operation, the minimum allowable PULSE POSITION setting depends on the PULSE WIDTH used; this is explained in Paragraph 3-9.

3-9. MINIMUM SPACING WITH DOUBLE PULSES.

3-10. In DOUBLE PULSE operation, the PULSE POSITION control sets the spacing between the start of the first pulse and the start of the second pulse. For proper operation without affecting pulse shape, there are minimum spacing limits between the two pulses, and these limits depend on the PULSE WIDTH setting. For a 0.05-1 setting the minimum spacing between pulses is 1 μsec. For other PULSE WIDTH settings, the minimum spacing is 25% of the upper limit of range selected. For example, if PULSE WIDTH is set to 100-1K, the minimum spacing between pulses is 25% of 1K microseconds, or 250 microseconds. Figure 3-2 shows the output pulse characteristics as set by the Model 214A controls in DOUBLE PULSE mode. Note from Figure 3-2 that the setting of PULSE POSITION and PULSE WIDTH controls the actual spacing between pulses. The spacing between pulses is then the PULSE POSITION setting minus the PULSE WIDTH setting.

3-11. GATING OF PULSES

3-12. By applying a positive signal voltage to the GATE INPUT (+) connector and sliding the switch to GATED, pulses will occur at the output only when the gating signal is at +8 volts or greater. The maximum gating signal amplitude is +40 volts. To ensure that output pulses occur when the gate signal just reaches +8v, a fast rise time input should be used. If a gating sine wave signal is used, a larger amplitude (but less than 40 volts peak) will generally provide better results. For synchronized pulse trains, the gating signal and repetition rate must be locked together. Figure 3-4 illustrates the result of gating the pulse output.

3-13. OPERATING PROCEDURES.

3-14. MANUAL TRIGGER MODE.

3-15. When TRIGGER MODE is set to MAN. and the MANUAL button is pushed, a single pulse output will occur. Other front panel controls are set to obtain the desired pulse characteristics. The same operating considerations apply as explained in Paragraphs 3-4, 3-7, and 3-9. The maximum rate for pushbutton pulses is 2 cps.

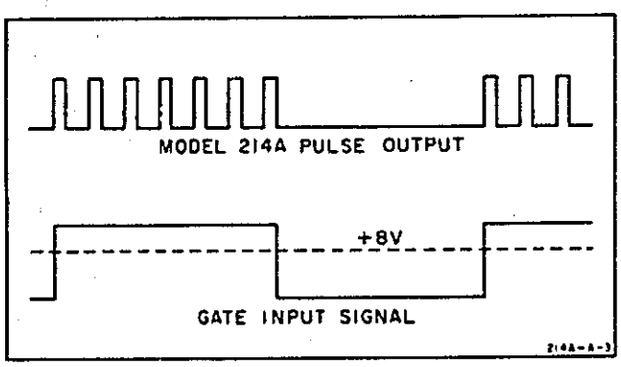


Figure 3-4. Gating Pulse Output

3-16. EXTERNAL TRIGGER MODE.

3-17. With TRIGGER MODE set to EXT., an external triggering signal from dc to 1 Mc with 0.5 volts peak amplitude is required to generate pulses in the Model 214A. Refer to Paragraphs 3-4, 3-7, and 3-9 and proceed as follows:

a. Set TRIGGER MODE to EXT. and connect signal to TRIGGER INPUT.

b. Select + or - SLOPE setting.

c. Set EXT. TRIG. LEVEL to obtain desired triggering level on input waveform. Polarity of EXT. TRIG. LEVEL must agree with SLOPE setting.

d. Set GATED/NORM. switch to NORM. unless using an external gating signal.

e. Select setting for PULSE ADVANCE/PULSE DELAY/DOUBLE PULSE. PULSE ADVANCE or PULSE DELAY means the output pulse will occur advanced or delayed in time, with respect to the trigger output pulse. DOUBLE PULSE provides two pulses out at a rate determined by the TRIGGER MODE circuits.

f. Select polarity of TRIGGER OUTPUT and connect coaxial cable to external circuit being triggered.

g. Select PULSE AMPLITUDE range. Note that these amplitudes are volts into a 50 ohm load at the PULSE OUTPUT connector. The 100 v range will not produce a pulse without the 50 ohm termination.

h. Select PULSE WIDTH range and adjust VERNIER. Observe duty cycle limit for amplitude range.

i. Select polarity of PULSE OUTPUT and connect coaxial cable to external test circuit.

j. Select PULSE POSITION range and adjust VERNIER as desired. With PULSE ADVANCE or PULSE DELAY operation, PULSE POSITION setting is the spacing between the pulse output and the trigger output pulse. With DOUBLE PULSE, PULSE POSITION sets the spacing between the two pulses.

k. Adjust VERNIERS if necessary to obtain exact position, width, and amplitude characteristics.

3-18. INTERNAL TRIGGER MODE.

3-19. With TRIGGER MODE set to INT., the Model 214A will generate pulses at a rate set by the INT. REP. RATE range and VERNIER. This repetition rate is adjustable from 10 cps to 1 Mc. Refer to Paragraphs 3-4, 3-7, and 3-9 and proceed as follows:

a. Turn instrument POWER switch to ON and allow several minutes for warmup.

b. Set TRIGGER MODE to INT.

c. Set INT. REP. RATE range and VERNIER to approximate position for frequency desired (maximum frequency is fully clockwise).

d. Complete steps d through k of Paragraph 3-16.

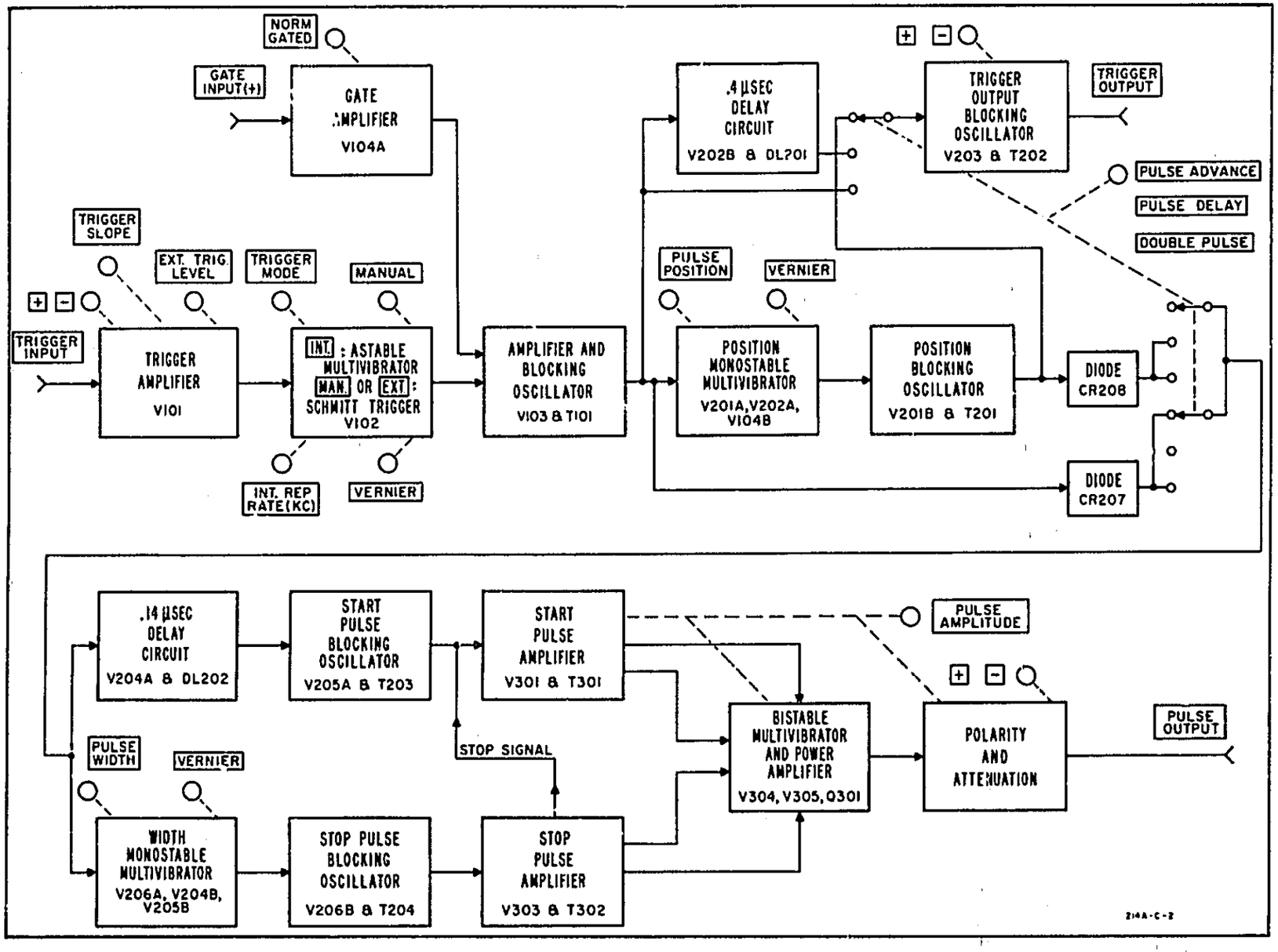


Figure 4-1. Model 214A Block Diagram

SECTION IV
PRINCIPLES OF OPERATION

4-1. GENERAL.

4-2. The complete circuit operation is shown in Figure 4-1. The output pulse is formed by the following general sequence: a trigger pulse from the rate circuit (V102), functioning either as a Schmitt trigger or an astable multivibrator, is applied to blocking oscillator V103, which triggers both the Position Multivibrator (V201A, V202A, V104B) and blocking oscillator V203 for the trigger output pulse. The position Multivibrator triggers Position Blocking Oscillator V201B which in turn triggers both start and stop pulse circuits. The start and stop pulses are used to switch a bistable multivibrator-power amplifier combination (V304, V305, Q301) which forms the output pulse. The details of each block are contained in the schematics, and the following circuit description explains the operation of each circuit, both as to basic type and to the part it plays in the sequence of forming the output pulse.

4-3. INPUT AND RATE GENERATOR.

4-4. EXTERNAL TRIGGER OPERATION.

4-5. With TRIGGER MODE set to EXT. position, a signal of at least 0.5 volts peak will cause Differential Amplifier V101 to amplify the difference between the levels at the control grids, pins 2 and 7. TRIGGER SLOPE switch S101 routes the trigger input to one grid of V101 and also transfers the external trigger level circuit of R105 to the other grid. Resistor R105 sets the grid bias which must be overcome by the trigger input at the other grid to obtain an output at the plate, pin 6 of V101. The output from V101 is coupled through S103A, through a low-impedance network (DS101, R116, and C107), and S103B to R125 and the grid of V102.

4-6. In external trigger operation, V102 functions as a cathode-coupled binary, or Schmitt Trigger, circuit. The plate to grid coupling network is from pin 1 through S103B and the parallel RC combination, R129-C110, to the grid, pin 7. The left half of V102 is normally off and the right half conducting so the output at pin 6 is at a positive level (about 125 volts), less than the +150 supply. As the signal at pin 2 becomes positive enough (upper hysteresis limit), the left half of V102 conducts and regenerative action cuts the right half off. When the input at pin 2 decreases enough (lower hysteresis limit), the left half of V102 is cut off and the circuit returns to the original state. The output at pin 6 then is a positive pulse each time the signal at pin 2 causes the left half to conduct, and the rate at which this occurs is exactly that of the external trigger signal (1 Mc limit on input frequency). The output pulse from pin 6 is coupled through C122 to pin 2 of Blocking Oscillator V103.

4-7. MANUAL TRIGGER OPERATION.

4-8. With TRIGGER MODE set to MAN. position, V102 again functions as a Schmitt Trigger circuit as in external operation, with the parallel RC network R129-C110 coupling between plate and grid. When MANUAL switch S102 is energized, the side of capacitor C106 toward the switch charges toward +150 volts through R120. This positive-going, slow rising exponential voltage is coupled to the grid (pin 2) of V102 and the left half of the tube conducts. The right half of V102 now cuts off and a positive pulse to +150V is the output coupled to the grid of V103.

4-9. INTERNAL TRIGGER OPERATION.

4-10. With TRIGGER MODE set to INT. position, V102 functions as an astable multivibrator. The free-running rate of this circuit is controlled by range capacitors, C113 through C117, coupling between plate (pin 1) and grid (pin 7), and by VERNIER, R137. Breakdown diode CR101 sets the bias at the grid of the left half of V102. This circuit has no stable state and is always changing between two states: (1) left-half cutoff, right-half conducting or (2) left-half conducting, right-half cutoff. The rate at which this changing of states occurs is primarily a function of the capacitors between plate and grid since this determines the exponential rise and decay time of the grid (pin 7). When the grid (pin 7) voltage rises exponentially enough to cause the right half to conduct, the output at pin 6 is about +125 volts. Then as the voltage at pin 7 decays exponentially, the right half cuts off and the output at pin 6 is at the supply voltage, +150v. A regenerative action occurs as the right half of V102 just starts to conduct and the left half starts to cutoff: the increase in voltage at the plate (pin 1) is coupled through the range capacitor to speed turn on of the right half. Symmetry Adjust, R133, changes the grid bias of pin 7 to nearly equal the bias at pin 2 making the two halves of the waveform equal in width.

4-11. TRIGGER BLOCKING OSCILLATOR.

4-12. Tube V103 and transformer T101 function as an amplifier-blocking oscillator, when the output of V102 is not being gated by the circuit of V104A (see Paragraph 4-13). Normal operation of the blocking oscillator is as a monostable circuit being triggered by an amplified signal. The left half of V103 amplifies the positive pulse at its grid and the resulting plate pulse is coupled through transformer T101, reversed in phase, to the grid of the right half. This puts the right half of V103 in conduction and a regene ative action drives the plate (pin 6) voltage down abruptly and the grid voltage (pin 7) abruptly positive. Next the action reverses and as the plate voltage becomes more positive, the grid goes negative and regeneration turns the tube off agian. The output is taken from the cathode (pin 8) and the pulse drives other circuits depending on which pulse mode (advance, delay, or double) is used (see Paragraph 4-15).

4-13. GATE INPUT CIRCUIT.

4-14. When switch S105 is in the NORM. position, Gate Cathode Follower V104A is conducting enough so CR103 is biased off, and the pulse at pin 2 of V103 is unaffected in operation. However, when S105 is moved to GATED, V104A is cut off, biasing the cathode of CR103 more negative than its anode and CR103 conducts, changing V103 input impedance so the rate pulse does not develop enough signal to trigger the blocking oscillator. By applying a positive signal of at least 8 volts (but less than 40) V104A will again conduct, cutting off CR103 and the pulse at V103 triggers the blocking oscillator (explained in Paragraph 4-11).

4-15. ADVANCE, DELAY, DOUBLE PULSE MODES.

4-16. Three modes of pulse operation are obtained by switching the timing pulse from the Trigger Blocking Oscillator V103 through combinations of circuits. These circuits are described below first in terms of general operation (Paragraphs 4-17 through 4-26) and second, as each is used in either PULSE ADVANCE, PULSE DELAY, or DOUBLE PULSE (Paragraphs 4-27 through 4-32).

4-17. PULSE POSITION CIRCUIT.

4-18. POSITION MULTIVIBRATOR. The circuits of tubes V201A and V202A form a monostable multivibrator which controls the position relationship between the output pulses and trigger output or between both output pulses in DOUBLE PULSE operation. This multivibrator substitutes cathode-coupling with a common cathode resistor for the usual coupling between plate of V202A and grid of V201A, but still is a monostable circuit. The width of the multivibrator pulse is controlled by range capacitors, C201 through C205, and the VERNIER control R207. By controlling the time V202A is cut off, with the range capacitor and VERNIER, the delay before triggering the position blocking oscillator V201B is also controlled (V201B is triggered as V202A starts conducting; see Paragraphs 4-19). Tube V104B acts as a screen biasing supply for V202A. The output at pin 9 of V202A is a variable width positive pulse which is coupled through C209 to pin 6 of V201B.

4-19. POSITION BLOCKING OSCILLATOR. The signal from V202A triggers Position Blocking Oscillator V201B at the plate. This signal is coupled through T201 to the grid (pin 7) and the circuit functions in the same way as V103 right half, described in Paragraph 4-11. The output is taken from the cathode as a positive pulse about 30 volts in amplitude.

4-20. PULSE WIDTH MULTIVIBRATOR.

4-21. The circuits of tubes V206A and V204B form a monostable, cathode-coupled multivibrator, and the circuit functions the same as that described in Paragraph 4-18. The time for which V204B remains cutoff is determined by range capacitors C225 through C229 and VERNIER, R257. The output at pin 9 of V204B is used to drive the stop pulse blocking oscillator V206B (see Paragraph 4-26). The time delay obtained from the width multivibrator thus determines how long since the output pulse started before the stop pulse blocking oscillator returns the pulse to zero (this time is the pulse width).

4-22. TRIGGER OUTPUT BLOCKING OSCILLATOR.

4-23. Tube V203 and transformer T202 function as an amplifier-blocking oscillator in a nearly identical circuit as described in Paragraph 4-11 for the circuit of V103. A signal at pin 2 of V203 is amplified and coupled from the plate through T202 to the grid of the right half. For a positive trigger output, S203 routes the cathode signal to J201 and for a negative trigger out, S203 routes the signal from pin 1 of T202 to J201.

4-24. START-STOP PULSE BLOCKING OSCILLATORS.

4-25. START PULSE BLOCKING OSCILLATOR. The circuit of V205A and T203 is another blocking oscillator working the same way as described in Paragraph 4-11. The signal which triggers V205A plate has been amplified by V204A and delayed by 0.14 microseconds by DL202. The output from the cathode of V205A is a positive pulse of about 35 volts which drives the input to V301.

4-26. STOP PULSE BLOCKING OSCILLATOR. The blocking oscillator of V206B and T204 also is of the same type already described in Paragraph 4-11. The signal to trigger V206B comes from the width multivibrator circuit when V204B starts conducting. The output from the cathode of V206B is a positive pulse of about 35 volts and it drives the input to V303, the Stop Pulse Spiker.

4-27. PULSE ADVANCE TIMING LOGIC.

4-28. Figure 4-2 shows the timing logic for PULSE ADVANCE mode of operation. The timing pulse from V103 goes directly through diode CR207 to the start-stop pulse circuits (through V204A to V205A, and through the width multivibrator to V206B). The timing pulse also goes through CR201 to the grid of V201A to operate the position multivibrator. The resulting waveform from the position blocking oscillator is coupled through C216 to pin 2 of V203. Now the position multivibrator is used to effectively delay the trigger output, i.e. the main pulse output occurs in advance of the trigger. The pulse width multivibrator and start-stop pulse blocking oscillators function the same as described previously.

4-29. PULSE DELAY TIMING LOGIC.

4-30. Figure 4-3 shows the timing logic for PULSE DELAY mode of operation. The V103 timing pulse goes directly to Cathode Follower V202B and is taken, delayed by 0.4 microseconds by DL201, through S202B to the trigger output blocking oscillator, to cause a trigger output pulse. The timing pulse has also triggered the position multivibrator circuit through CR201. The output from V201B goes through CR208 and S202B to the width multivibrator and start-stop blocking oscillators. This time the position multivibrator has been used to effectively delay the start of the pulse output with respect to the trigger output.

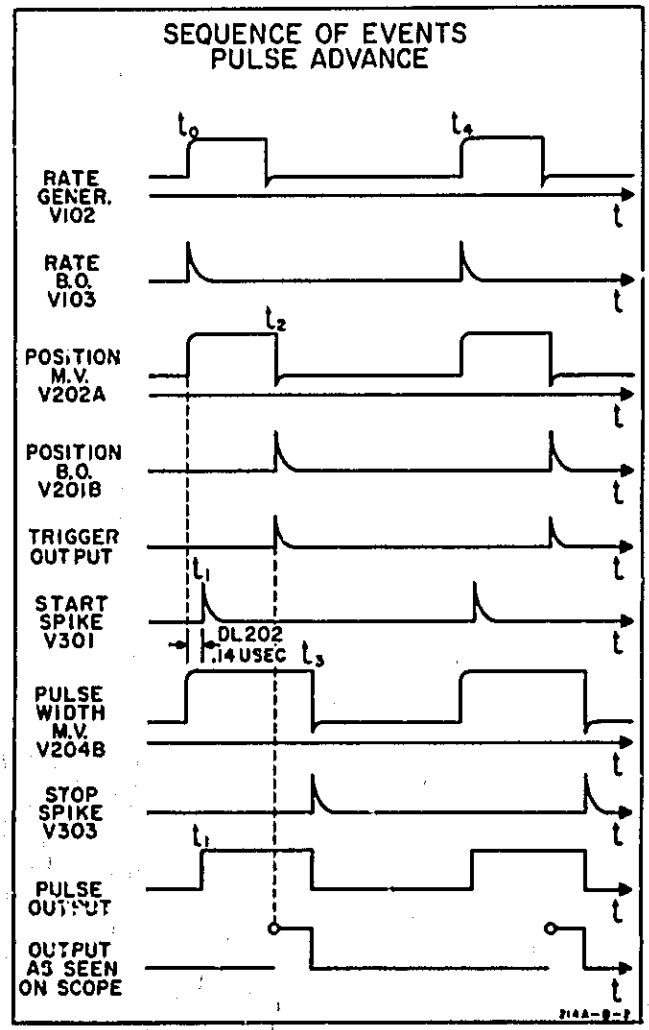


Figure 4-2. PULSE ADVANCE Timing Sequence

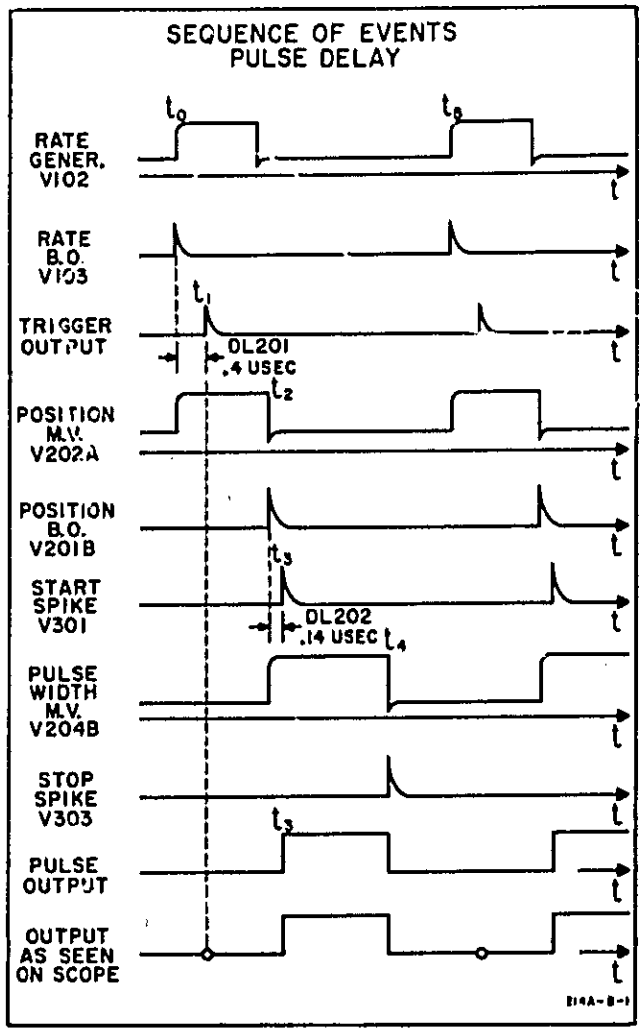


Figure 4-3. PULSE DELAY Timing Sequence

4-31. DOUBLE PULSE TIMING LOGIC.

4-32. Figure 4-4 shows the timing logic for DOUBLE PULSE mode of operation. The V103 timing pulse goes directly through CR201 to the position multivibrator and directly through CR207 to the start pulse and stop pulse circuitry (i.e. through V204A and also through the width multivibrator). This causes one pulse output. Then the delayed timing pulse from the position multivibrator and blocking oscillator comes through CR208 to trigger the start-pulse circuitry a second time and another pulse output is formed. The delayed timing pulse from V201B determines the position in time at which the second pulse occurs (i.e. the time between leading edge of pulses). The pulses have the same variable width since both are controlled by the width multivibrator.

4-33. FORMING AND CONTROLLING OUTPUT PULSE.

4-34. The fast rise and fall time of the output pulse is achieved by rapid charging of the input capacitance represented by the grid of tubes V304 and V305, then rapidly discharging this capacitance to end the pulse. A large current spike waveform is used and the output tubes are held on during the pulse by a bistable type multivibrator circuit. The amplitude of the output pulse is controlled by varying the output tube screen supply, by changing the bias levels of the output circuits, and some attenuation at the output.

4-35. START PULSE SPIKER.

4-36. The positive pulse from V205A is coupled through L301, C301, and CR301 to the control grid of V301. The input circuit of V301 changes the dc level of the start pulse and smoothes the transition from triggered on state to the steady state during the output pulse. Diode CR301 discharges the input circuit after the start spike occurs and C302 discharges through R301 to increase the fall time of the spike. The rise time of the spike is sharpened by clipping diode CR303. Tube V302A is a screen supply for V301. The output of V301 is a current spike which is increased to about 0.5 amp by current step-up transformer T301 and coupled to the input circuit of V304/5 to charge up the input capacitance.

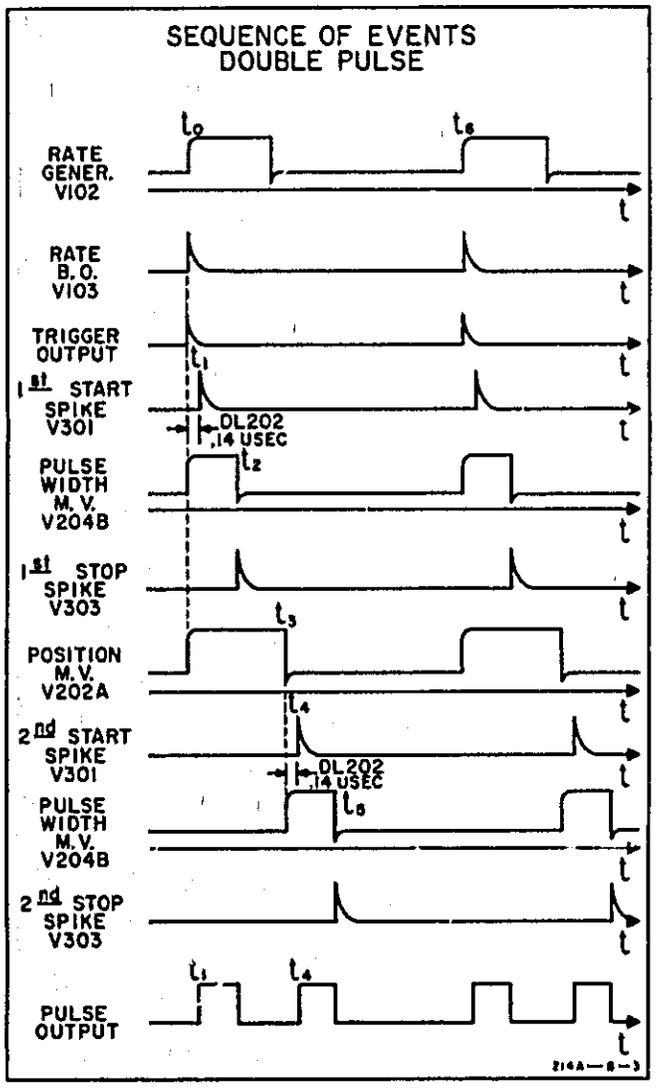


Figure 4-4. DOUBLE PULSE Timing Sequence

4-37. STOP PULSE SPIKER.

4-38. The positive pulse from V206B is coupled through L303, and CR308 to the control grid of V303. The input circuit of V303 is nearly identical to that of V301 and the same result is obtained in a negative current spike at the plate. The output of V303 is coupled by current step-up transformer T302, but reversed in phase to that from T301 which initiated the pulse, to the input circuit of V304/5 to discharge the input capacitance.

4-39. PULSE OUTPUT CIRCUIT.

4-40. Parallel output tubes V304/5 are turned on by the current spike from the top winding (pins 3 and 4) of T301 and then held on by a type of bistable multivibrator circuit which includes the output tubes. Diodes CR324 and CR325 sharpen the rise time of the spike input. The steady state cutoff bias of V304/5 is set by a voltage divider network including breakdown diode CR326. To keep the output tube conducting after the start pulse, CR326 is taken out of the breakdown area by transistor Q301. Transistor Q301 is triggered on by the other winding of T301 (pins 1 and 2) and held on by bias developed across CR327 and CR328. This clamps the collector voltage of Q301 to the emitter, reducing CR326 voltage to less than breakdown. With Q301 conducting, V302B now supplies a steady 11 ma current to keep diodes CR324/5 conducting, holding V304/5 on. Then to turn V304/5 off and end the output pulse, the negative spike from T302 through the top winding (pins 1 and 2) discharges the input capacitance rapidly and the other transformer winding (pins 3 and 4) turns Q301 off. This restores the bias on CR326 and the circuit returns to its original state, ready for the next start spike from V301. The output pulse is taken across a 50 ohm resistance in the plate circuit of V304/5 for all ranges except 100v. This 50 ohm source impedance, consisting of R405 through R408 in parallel, absorbs reflections from an external system mismatch.

4-41. PULSE OUTPUT AMPLITUDE CONTROLS.

4-42. The circuits changed by switch S401 control the output pulse amplitude in various ways. S401C switches different breakdown diodes (CR320-322) into the control grid circuit of the output tubes. S401D changes the bias on screen supply tube V302A in the start pulse spiker circuit. S401A and S401B are in the screen supply for the output tubes and this circuit also affects the pulse amplitude. Increasing the Amplitude VERNIER R360, charges C325 from the cathode of V307 for a quick response to an increase in control voltage. To get a quick response for a decrease in control voltage, V308 discharges C325. Other sections of S401, at the output, switch in attenuator resistors on lower pulse amplitudes.

4-43. REVERSING PULSE POLARITY.

4-44. Either positive or negative output pulses are obtained merely by reversing the connections between center conductor and shield of the coaxial cable carrying the pulse. Switch S402 reverses these connections. This method of reversing polarity is possible because a floating power supply is used allowing the ground reference to be established at any level. Inductors L308, L401, and L402 isolate the voltage supply and prevent the supply from bypassing the pulse. Negative pulse outputs occur when the plates of the output tubes drive the center conductor of the coaxial cable and the shield is tied to the 0V, isolated supply reference. Positive pulses occur by reversing these connections and placing the center conductor at the 0V isolated reference voltage.

SECTION V

MAINTENANCE

5-1. INTRODUCTION.

5-2. This section covers maintenance, troubleshooting, and adjustment of the Model 214A Pulse Generator. The performance check, paragraph 5-3, may be used during incoming inspection or after adjustments have been made to verify that the instrument meets its specifications (table 1-1).

5-3. PERFORMANCE CHECK.

5-4. The performance check is intended to determine whether or not the instrument is operating within its specifications. If adjustment is necessary, refer to paragraph 5-17. Test equipment recommended for the performance check is listed in table 5-1. Similar instruments having the listed characteristics may be substituted.

5-5. EXTERNAL GATING.

a. Connect Model 214A PULSE OUTPUT to high-frequency oscilloscope channel A input.

b. Connect external power supply to Model 214A GATE INPUT.

c. Set Model 214A:

INT. REP RATE	1-10
INT. REP. RATE VERNIER	fully cw
TRIGGER MODE	INT
GATE INPUT	GATED
PULSE WIDTH	10-100
PULSE WIDTH VERNIER	Midrange
PULSE AMPLITUDE	2 VOLTS
PULSE POSITION	10-100
PULSE POSITION VERNIER	fully cw

d. Set oscilloscope and plug-in:

Sweep Time	20 μSEC/CM
Channel A Sensitivity	1 V/CM
Trig Source	INT

e. Increase voltage output of power supply from 0 volts until Model 214A gates on. Gating voltage should be 8 volts or less.

5-6. EXTERNAL TRIGGERING.

a. Connect output of audio oscillator to Model 214A TRIGGER INPUT.

b. Connect Model 214A PULSE OUTPUT to oscilloscope plug-in channel A input.

c. Set Model 214A:

PULSE AMPLITUDE	10 VOLTS
PULSE AMPLITUDE VERNIER	cw
TRIGGER MODE	EXT
PULSE WIDTH	.05-1
PULSE WIDTH VERNIER	3

d. Set oscilloscope and plug-in:

Channel A Sensitivity	2 v/cm with 50-ohm load or 5 v/cm without 50-ohm load
Sweep Time	0.1 μSEC/CM
Trig Source	INT

e. Set oscillator frequency to 200kc and oscillator amplitude for 1/2 volt peak-to-peak.

f. Model 214A should trigger on both + and — slope by adjusting EXT TRIG LEVEL.

5-7. PULSE AMPLITUDE AND WIDTH.

a. Connect pulse output of Model 214A through 20-dB 20-watt attenuator to HF oscilloscope input using a 50-ohm feedthrough lead and 50-ohm cable.

b. Connect oscilloscope trigger input to Model 214A TRIGGER OUTPUT with BNC to BNC cable.

c. Set Model 214A:

INT. REP. RATE	.01-.1
INT. REP. RATE VERNIER	Midrange
PULSE POSITION	1-10
PULSE POSITION VERNIER	1
PULSE WIDTH	1K-10K
PULSE WIDTH VERNIER	fully ccw
PULSE AMPLITUDE	100 VOLTS
PULSE AMPLITUDE VERNIER	fully cw
TRIG MODE	INT

d. Set oscilloscope and plug-in:

Channel Selector	CHANNEL A
Channel A Sensitivity	2 V/CM
Sweep Time	0.2 MSEC/CM
Int Sweep Magnifier	X1
Trig Source	EXT

e. There should be at least 100 volts (5 cm) of vertical display.

Table 5-1. Equipment Required for Tests and Adjustments

Item	Equipment Name	Model or Part No.	No. Req'd.	Required	Ref. Para.	Required Characteristics
1	POWER SUPPLY	6215A	1	Performance Check	5-5	0 to > 8 V output
2	AUDIO OSCILLATOR	200CD	1	Performance Check	5-6	0.5 V P-P 200 kHz
3	SAMPLING OSCILLO-SCOPE	180C 1810A	1 1	Performance Check Performance Check	5-13 thru 5-16	800 MHz 5 mV/CM
4	50-OHM 20-dB 20-WATT ATTENUATOR	MICRO-LINE 766-20	1	Performance Check and Adjustments	5-7 thru 5-16 5-26	LOW SWR to 1 GHz
5	BNC to DUAL BANANA ADAPTER	1250-2277	1	Performance Check	5-6	BNC FEM to DUAL, BANANA
6	BNC FEM to N MALE ADAPTER	1250-0082	1	Performance Check and Adjustments	5-7 thru 5-16 5-26	BNC FEM to N MALE
7	BNC MALE to N FEMALE ADAPTER	1250-0077	1	Performance Check and Adjustments	5-7 thru 5-16 5-26	BNC MALE to N FEM
8	50 OHM FEEDTHRU LOAD	10100C	1	Performance Check	5-7 thru 5-12	LOW SWR to 1 GHz
9	50-OHM 20-dB 2-WATT ATTENUATOR	EMCO A420B	2	Performance Check	5-13, 5-14	LOW SWR to 1 GHz
10	50-OHM CABLE	10503A	2	Performance Check and Adjustments	5-5 thru 5-16 5-23 thru 5-27	BNC to BNC 4 ft.
11	HF OSCILLOSCOPE and PROBES	180C 1801A 1820C	1 1 1	Performance Check and Adjustments	5-5 thru 5-16 5-23 thru 5-27	50-MHz 5 ns/CM GENERAL PURPOSE
12	DC VOLTMETER	34740/ 34702	1	Adjustments	5-21 and 5-26	RANGE 0 - 600 V ± 1% ACCURACY
13	DC MILLI-AMMETER	428B	1	Adjustments	5-25	0 - 50 mA ± 3% ACCURACY

f. Set Model 214A:

PULSE WIDTH	.05-1
PULSE WIDTH VERNIER	ccw
PULSE POSITION	0-1
PULSE POSITION VERNIER	ccw
INT. REP. RATE	10-100
INT. REP. RATE VERNIER	Midrange

g. Set oscilloscope:

Sweep Time	0.1 μSEC/CM
Int Sweep Magnifier	X10

h. There should be 50 nanoseconds (5 cm) or less of horizontal display measured at half amplitude of pulse.

i. Set Model 214A:

INT. REP. RATE	.01-.1
INT. REP. RATE VERNIER	ccw
PULSE AMPLITUDE	.2 volts
PULSE WIDTH	1K-10K
PULSE WIDTH VERNIER	fully cw

j. Set oscilloscope and plug-in:

Channel A Sensitivity	.005 V/CM
Sweep Time	2 MSEC/CM
Int Sweep Magnifier	X1

k. There should be at least 10 msec (5 cm) of horizontal display.

l. Set Model 214A PULSE AMPLITUDE VERNIER fully ccw.

m. There should be 1.6 cm (80 mv) or less of vertical display.

5-8. PULSE POSITION.

a. Connect pulse output of Model 214A through 20-dB 20-watt attenuator to HF oscilloscope input using a 50-ohm feedthrough load and 50-ohm cable.

b. Connect a BNC tee to oscilloscope Trigger Input. Connect tee to Model 214A TRIGGER OUTPUT with BNC to BNC cable. Connect tee to oscilloscope plug-in channel B input with BNC to BNC cable.

c. Set Model 214A:

PULSE AMPLITUDE	10 VOLTS
PULSE AMPLITUDE VERNIER	fully ccw
PULSE WIDTH	10-100
PULSE WIDTH VERNIER	fully ccw
TRIGGER OUTPUT	+
PULSE OUTPUT	+
PULSE POSITION	10-100
PULSE POSITION VERNIER	fully ccw
ADVANCE/DELAY/DOUBLE	PULSE DELAY
INT. REP. RATE	1-10
INT. REP. RATE VERNIER	fully ccw

d. Set oscilloscope and plug-in:

Channel A Sensitivity	1 V/CM
Channel B Sensitivity	5 V/CM
Channel Selector	ALTERNATE
Trigger Source	EXT AC
Trigger Slope	+
Sweep Time	20 μSEC/CM
Int Sweep Magnifier	X1

e. Position channel A and channel B traces on oscilloscope graticule.

f. By adjusting Model 214A PULSE POSITION VERNIER from fully ccw to fully cw, the pulse on channel A should sweep 100 μsec (5 cm).

g. Reverse cables to Model 214A PULSE OUTPUT and TRIGGER OUTPUT.

h. Set ADVANCE/DELAY/DOUBLE to PULSE ADVANCE.

i. By adjusting Model 214A PULSE POSITION VERNIER from fully ccw to fully cw the trigger spike displayed on channel A should sweep 100 μsec (5 cm).

j. Reverse cables to Model 214A PULSE OUTPUT and TRIGGER OUTPUT (original position).

5-9. DOUBLE PULSE AND MANUAL TRIGGERING.

a. Connect pulse output of Model 214A through 20-dB 20-watt attenuator to HF oscilloscope input using a 50-ohm feedthrough load and 50-ohm cable.

b. Connect oscilloscope Trigger Input to the Model 214A TRIGGER OUTPUT with BNC to BNC cable.

c. Set Model 214A:

INT. REP. RATE	.01-.1
INT. REP. RATE VERNIER	Midrange
PULSE POSITION	100-1K
PULSE POSITION VERNIER	cw
PULSE WIDTH	10-100
PULSE WIDTH VERNIER	Midrange
PULSE AMPLITUDE	10 V
PULSE AMPLITUDE VERNIER	cw
ADVANCE/DELAY/DOUBLE	DOUBLE PULSE

d. Set oscilloscope and plug-in

Channel Selector	Channel A
Channel Sensitivity	2 V/CM
Sweep Time	.1 MS/CM
Magnifier	X1
Trigger	EXT
Trigger Slope	+

e. Adjust Model 214A PULSE POSITION VERNIER fully ccw. Spacing between pulses should be 100 μsec (1 cm) or less.

f. Set Model 214A TRIGGER MODE to MAN. position.

g. One complete cycle should be observed on oscilloscope CRT each time MANUAL pushbutton is pressed (double pulse).

5-10. INTERNAL REP RATE.

a. Connect pulse output of Model 214A through 20-dB 20-watt attenuator to HF oscilloscope input using a 50-ohm feedthrough load and 50-ohm cable.

b. Connect oscilloscope Trigger Input to the Model 214A TRIGGER OUTPUT with BNC to BNC cable.

c. Set Model 214A:

INT. REP. RATE	.01-.1
INT. REP. RATE VERNIER	fully ccw
PULSE AMPLITUDE	10 VOLT
PULSE AMPLITUDE VERNIER	fully cw
PULSE WIDTH	1K-10K
PULSE WIDTH VERNIER	fully cw
PULSE OUTPUT	+
PULSE POSITION	0-1
PULSE POSITION VERNIER	fully ccw
ADVANCE/DELAY/ DOUBLE	PULSE DELAY

d. Set oscilloscope and plug-in:

Channel Selector	CHANNEL A
Channel A Sensitivity	2 V/CM
Sweep Time	20 MSEC/CM

e. There should be no more than 2 pulses displayed in 10 cm of sweep.

f. Set Model 214A:

PULSE WIDTH	.05-1
PULSE WIDTH VERNIER	3
INT. REP. RATE	100-1K
INT. REP. RATE VERNIER	fully cw

g. Set oscilloscope Sweep Time to 1 μsec/cm.

h. At least 10 pulses should be displayed in 10 cm of sweep.

5-11. DUTY CYCLE.

a. Connect pulse output of Model 214A through 20-dB 20-watt attenuator to HF oscilloscope input using a 50-ohm feedthrough load and 50-ohm cable.

b. Connect oscilloscope Trigger Input to the Model 214A TRIGGER OUTPUT with BNC to BNC cable.

c. Set Model 214A:

INT. REP. RATE	1-10
INT. REP. RATE VERNIER	fully ccw
TRIGGER OUTPUT	+
TRIGGER MODE	INT
PULSE WIDTH	10-100
PULSE WIDTH VERNIER	fully ccw
PULSE OUTPUT	—
PULSE AMPLITUDE	10 VOLTS
PULSE AMPLITUDE VERNIER	fully cw
PULSE POSITION	1-10
PULSE POSITION VERNIER	fully ccw

d. Set oscilloscope and plug-in:

Channel Selector	CHANNEL A
Channel A Sensitivity	2 V/CM
Channel A Input	DC
Trigger Slope	+
Trigger Source	EXT
Sweep Time	10 μSEC/CM
Int Sweep Magnifier	X1

e. Adjust PULSE POSITION VERNIER until leading edge of first pulse lines up with first vertical line of oscilloscope graticule.

f. Adjust INT. REP. RATE VERNIER until leading edge of second pulse lines up with last vertical line of oscilloscope graticule.

g. Adjust PULSE WIDTH VERNIER; no overload should occur until pulse width is at least 50 μsec (5 cm).

h. Set:

Model 214A PULSE WIDTH VERNIER	fully ccw
Model 214A PULSE AMPLITUDE	20 VOLTS
Oscilloscope Channel A Sensitivity	5 V/CM

i. Adjust PULSE WIDTH VERNIER; no overload should occur until pulse width is at least 25 μsec (2.5 cm).

j. Set:

Model 214A PULSE WIDTH VERNIER	fully ccw
Model 214A PULSE AMPLITUDE	50 VOLTS
Oscilloscope Channel A Sensitivity	10 V/CM

k. Adjust PULSE WIDTH VERNIER; no overload should occur until pulse width is at least 10 μsec (1 cm).

m. Set Model 214A PULSE AMPLITUDE to 100 V. With pulse width at 10 μsec (1 cm) the Model 214A should not overload.

5-12. PULSE DROOP.

a. Connect pulse output of Model 214A through 20-dB 20-watt attenuator to HF oscilloscope input using a 50-ohm feedthrough load and 50-ohm cable.

b. Set Model 214A:

INT. REP. RATE	.01-1
INT. REP. RATE VERNIER	CCW
PULSE POSITION	1K-10K
PULSE POSITION VERNIER	3
PULSE WIDTH	1K-10K
PULSE WIDTH VERNIER	CCW
PULSE AMPLITUDE	50 V
PULSE AMPLITUDE VERNIER	50-V output

c. Set oscilloscope plug-in:

Sweep Time	1 MSEC/CM
Vert. Sensitivity	0.5 V/CM

d. Adjust oscilloscope sensitivity vernier to obtain 6 cm of vertical deflection.

e. Adjust Model 214A PULSE WIDTH VERNIER until pulse width is 5 msec (5 cm).

f. Pulse droop should be less than 6% (.36 cm).

5-13. OVERSHOOT, PRESHOOT, AND PULSE TOP VARIATION.

a. Connect pulse output of Model 214A through 20-dB 20-watt attenuator, and through 20-dB 2-watt attenuator to sampling plug-in using 50-ohm cables.

b. Connect trigger output of Model 214A through a 20-dB attenuator to external trigger input on sampler plug-in using 50-ohm cables.

c. Set Model 214A:

INT. REP. RATE	10-100
INT. REP. RATE VERNIER	CCW
PULSE POSITION	As Required
PULSE POSITION VERNIER	As Required
PULSE WIDTH	.05-1
PULSE WIDTH VERNIER	Midrange
PULSE AMPLITUDE	10 V
PULSE AMPLITUDE VERNIER	10-V output
TRIGGER OUTPUT	+

d. Set sampling plug-in:

Time Base	1 μsec/CM
Sweep Expand	0.1 μsec/CM
Trigger Slope	+
Vertical Sensitivity	200 mV/CM
Trigger	EXT. NORM

e. Adjust sampling plug-in for 8-cm display as shown in figures 5-1 and 5-2.

f. Positive and negative pulse overshoot < 5% (0.4 cm).

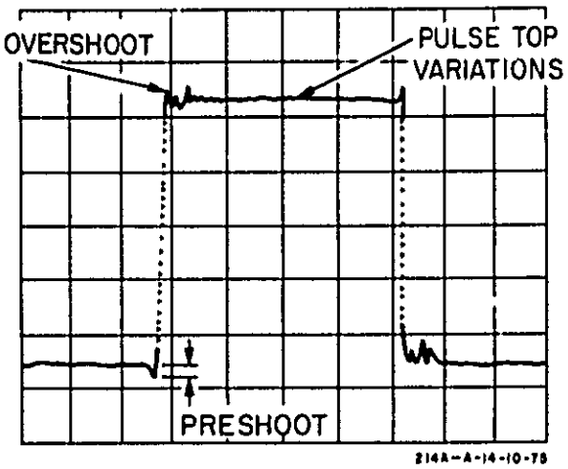


Figure 5-1. Positive Pulse Shape 10-V Amplitude

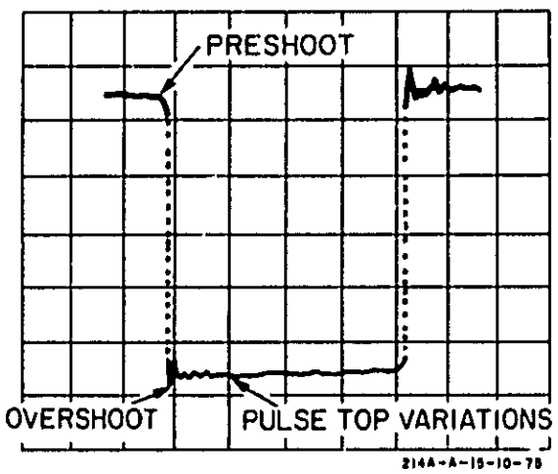


Figure 5-2. Negative Pulse Shape 10-V Amplitude

g. Positive and negative preshoot < 2% (0.16 cm).

h. Positive and negative pulse top variations < 5% (0.4 cm).

5-14. RISE TIME AND FALL TIME.

a. Connect pulse output of Model 214A through 20-dB 20-watt attenuator, and through 20-dB 2-watt attenuator to the sampling plug-in using 50-ohm cables.

b. Connect trigger output of Model 214A through a 20-dB attenuator to the external trigger input on the sampler plug-in using 50-ohm cables.

c. Set Model 214A:

INT. REP. RATE	10-100
INT. REP. RATE VERNIER	Midrange
PULSE POSITION	As Required
PULSE POSITION VERNIER	As Required
PULSE WIDTH	.05-1
PULSE WIDTH VERNIER	Midrange

PULSE AMPLITUDE ..... 50 V
PULSE AMPLITUDE
VERNIER ..... 50-V output
TRIGGER OUTPUT ..... +

d. Set sampling plug-in:

Vertical Sensitivity ..... 100 mV/CM
Trigger ..... Ext Normal
Trigger Slope ..... +
Time Base ..... .1 μSEC/CM
Expanded Sweep ..... 5 nsec/CM

e. Adjust sampling plug-in gain for 8-cm display as shown in figures 5-3 and 5-4.

f. Rise and fall time of positive pulse should be < 15 nsec.

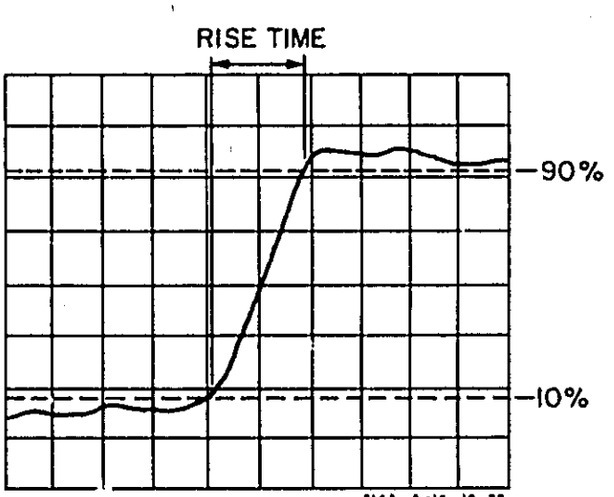


Figure 5-3. Positive Pulse Rise Time 10-V Amplitude

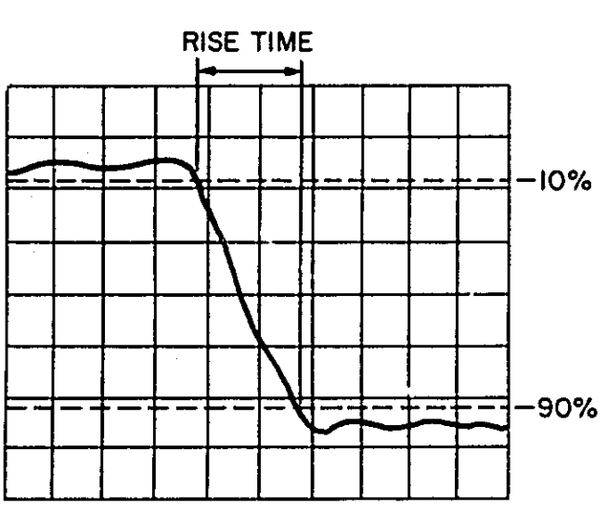


Figure 5-4. Negative Pulse Rise Time 10-V Amplitude

g. Rise and fall time of negative pulse should be < 13 nsec.

h. Repeat above procedure for the 20-volt and 10-volt ranges of the Model 214A. Rise time and fall time should both be < 13 nsec for each range.

5-15. RATE AND WIDTH JITTER.

Connect output pulse of Model 214A through 20-dB 20-watt attenuator to sampling plug-in using 50-ohm cable.

b. Set Model 214A:

INT. REP. RATE 100-1K
INT. REP. RATE VERNIER ..... Midrange
PULSE POSITION 0-1
PULSE POSITION VERNIER ..... CCW
PULSE WIDTH 05-1
PULSE WIDTH VERNIER 10
PULSE AMPLITUDE 1
PULSE AMPLITUDE VERNIER ..... CW
PULSE OUTPUT ..... —

c. Set sampling plug-in:

Trigger Slope ..... —
Time Base ..... .5 μ sec/CM
Expanded Sweep ..... 10 nsec/CM
Trigger ..... internal

d. Adjust expanded sweep position control on the sampling plug-in to view the leading edge of the second pulse. Rate jitter should be < 10 nsec (1 cm).

e. Set sampling plug-in:

Time Base ..... 100 nsec/CM
Expanded sweep .. .. 1 nsec/CM

f. Adjust expanded sweep position control on the sampling plug-in to view the trailing edge of the first pulse. Width jitter should be < 1.5 nsec (1.5 cm).

5-16. OUTPUT PULSE TO TRIGGER OUTPUT JITTER.

a. Connect output pulse of the Model 214A through 20-dB 20-watt attenuator to sampling plug-in using 50-ohm cable.

b. Connect trigger output of Model 214A to trigger input on sampling plug-in.

c. Set Model 214A:

INT. REP. RATE 100-1K
INT. REP. RATE VERNIER ..... CCW
PULSE POSITION 0-1
PULSE POSITION VERNIER 10
ADVANCED/DELAY/
DOUBLE ..... PULSE DELAY

PULSE WIDTH 1-10
PULSE WIDTH VERNIER 5
PULSE AMPLITUDE 1
PULSE AMPLITUDE VERNIER ..... CW
TRIGGER OUTPUT ..... +

d. Set sampling plug-in:

Trigger Slope ..... +
Time Base ..... 100 nsec/CM
Expanded Sweep ..... 1 nsec/CM
Trigger ..... External Normal

e. Adjust expanded sweep position on sampling plug-in to position leading edge of pulse near center screen. Jitter should be < 1.5 nsec (1.5 cm).

5-17. ADJUSTMENTS.

5-18. Paragraphs 5-22 through 5-28 give a complete adjustment procedure for the Model 214A. Since some adjustments interact with others, follow the procedures in the step sequence given. If difficulty is encountered in making any adjustment, refer to paragraph 5-29 for troubleshooting procedures.

5-19. EQUIPMENT REQUIRED. Test equipment recommended for the adjustment procedure is listed in table 5-1. Similar instruments having the listed characteristics may be substituted.

5-20. LOCATION OF ADJUSTMENTS. Figure 5-5 shows the location of all internal adjustments in the Model 214A.

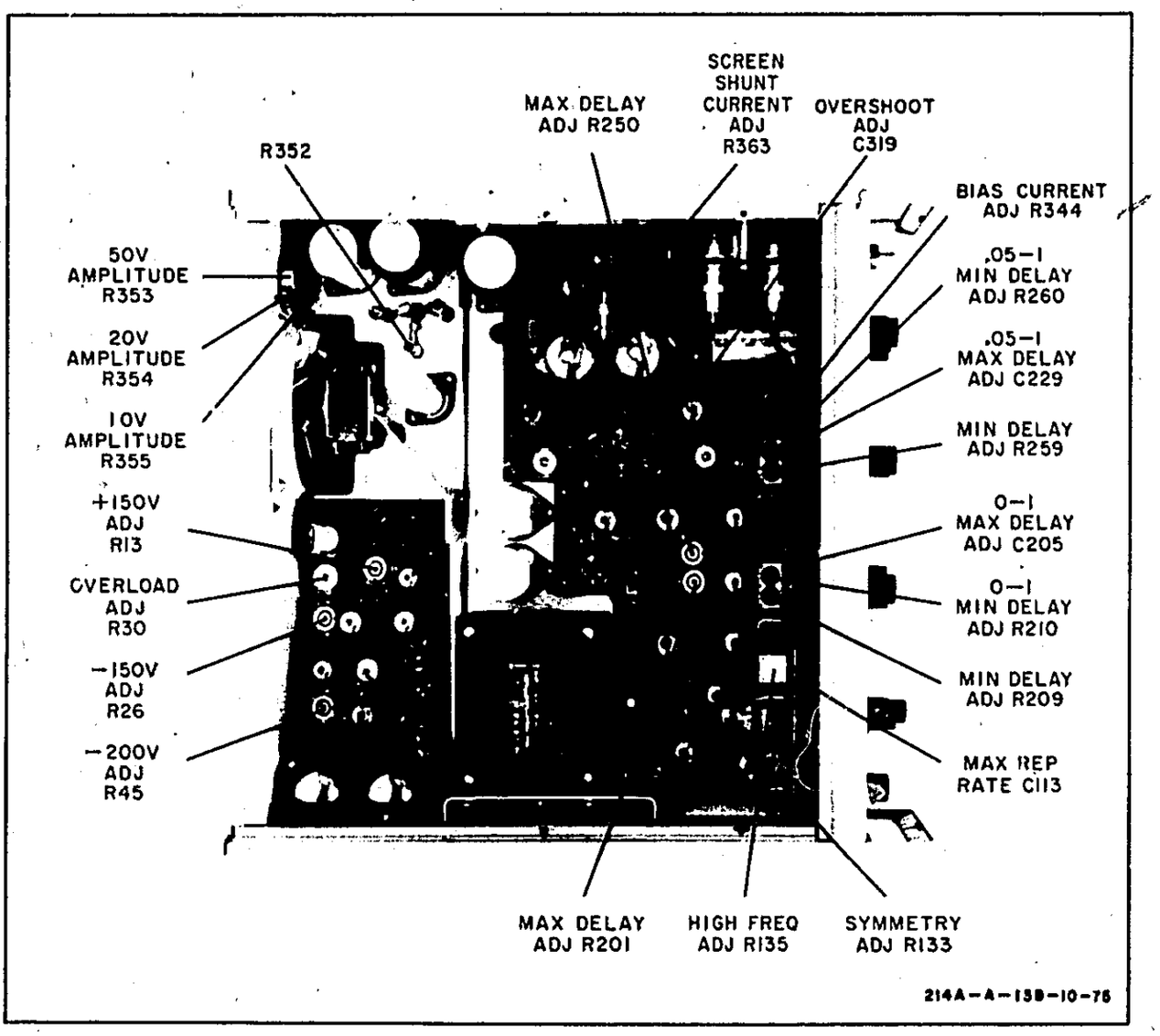


Figure 5-5. Location of Adjustments

Table 5-2. Power Supply Voltage Adjustments

Supply Voltage	Voltage Test Point Wire Color	Reference Point Wire Color	Adjustment
—150	vio	blk (chassis)	R26
+150	red	blk (chassis)	R13
—220	wht-yel-vio	wht-blk-blu (0 V)	R45
—350	wht-vio	wht-blk-blu (0 V)	None
—505	wht-blk-vio	wht-blk-blu (0 V)	None

5-21. POWER SUPPLY ADJUSTMENTS.

5-22. Measure and adjust each supply with dc voltmeter in the order given in table 5-2, using wire colors to locate each voltage test point and reference point. The —350 volt and —505 volt supplies are not regulated and may vary as much as ± 10% at normal line voltage.

5-23. RATE MULTIVIBRATOR.

a. Set Model 214A controls as follows:

TRIGGER MODE ..... INT
INT. REP. RATE 1-10
INT. REP. RATE VERNIER ..... Midrange
ADVANCE/DELAY/
DOUBLE ..... PULSE ADVANCE
PULSE POSITION 0-1
PULSE POSITION VERNIER ..... CCW
WIDTH 0.05-1
WIDTH VERNIER ..... ccw

b. Set oscilloscope and plug-in controls as follows:

Channel Selector ..... CHANNEL A
Sensitivity (Vernier to
Calibrated) ..... 1 VOLT/CM
AC/DC Coupling ..... AC
Polarity ..... + UP
Trigger Slope ..... +
Trigger Level ..... +
Trigger Source ..... INT.
Sweep Mode ..... PRESET
Sweep Time (Vernier in
Cal) ..... 20 μSEC/CM
Horizontal Display X1

c. Attach oscilloscope probe to pin 1 of V102 (tube side of R126, 860 Ω) of the Model 214A. The waveform amplitude should be about 30 volts (3 cm). If no waveform appears, turn symmetry adjustment R133 fully ccw.

d. Set INT. REP. RATE VERNIER to obtain one complete cycle in 10 cm on oscilloscope.

e. Adjust Symmetry Adj R133 to obtain a symmetrical waveshape. Turn INT. REP. RATE VERNIER to retain one cycle in 10 cm while setting symmetry with R133.

f. Set Model 214A INT. REP. RATE to 100-1K and INT. REP. RATE VERNIER fully ccw.

g. Set oscilloscope sweep time to 2 μSEC/CM.

h. Connect oscilloscope probe to pin 8 of V103 (tube side of R144, 150 Ω).

i. Adjust Max Rep Rate C113 to set spacing between pulses of about 11 μsec (5.5 cm). Pulse amplitude should be about 35 volts.

j. Set oscilloscope sweep time to 1 μSEC/CM. Rotate Model 214A INT. REP. RATE VERNIER fully cw.

k. Adjust High Freq. Adj. R135 to obtain 11 periods/10 cm on oscilloscope.

l. Repeat above procedure starting with step f to minimize interaction between C113 and R135.

m. To check above adjustment, set scope sweep time to 2 μSEC/CM, Model 214A INT. REP. RATE to 10-100 and VERNIER fully cw. Pulse spacing should be less than 10 μsec (5 cm). Next set oscilloscope sweep time to 20 μSEC/CM and Model 214A INT. REP. RATE VERNIER fully ccw. Pulse spacing should now be greater than 100 μsec (5 cm).

5-24. PULSE POSITION MULTIVIBRATOR.

a. Set Model 214A controls as follows:

TRIGGER MODE ..... INT.
INT. REP. RATE 1-10
INT. REP. RATE VERNIER ..... ccw
PULSE POSITION 10-100
PULSE POSITION VERNIER .... fully cw
ADVANCE/DELAY/
DOUBLE ..... PULSE DELAY
TRIGGER OUTPUT ..... +
PULSE OUTPUT ..... +
PULSE WIDTH 1-10
PULSE WIDTH VERNIER ..... ccw
PULSE AMPLITUDE 10
AMPLITUDE VERNIER ..... ccw

b. Set oscilloscope and plug-in controls as follows:

Channel Selector	ALTERNATE
Sensitivity Channel A (Vernier in CAL)	2 VOLTS/CM
Sensitivity Channel B (Vernier in CAL)	10 VOLTS/CM
AC/DC Coupling (Channel A)	DC
AC/DC Coupling (Channel B)	AC
Polarity (Channels A & B)	+ UP
Trigger Slope	+
Trigger Level	+
Trigger Source	EXT. AC
Sweep Mode	PRESET
Sweep Time (Vernier in CAL)	20 μSEC/CM
Horizontal Display	X1

c. Connect channel A oscilloscope probe to pin 3 of V205 (grn wire at end of R244, 150 Ω).

d. Use BNC to BNC cable to connect Model 214A TRIGGER OUTPUT to Oscilloscope Channel B Input.

e. Connect divider probe to pin 8 of V103 (tube side of R144, 150 Ω) and probe cable to oscilloscope trig input.

f. Check to see that when PULSE POSITION VERNIER is fully clockwise, arrow on knob points to the black dot on the front panel. If not, loosen set screws, slip knob to proper position, and tighten screws.

g. Set PULSE POSITION VERNIER fully cw.

h. Adjust Max Delay Adj R201 to obtain 120 μsec (6 cm) spacing between the channel A and channel B displayed pulses. (Channel B pulse should remain stationary while channel A pulse will move.)

i. Set PULSE POSITION VERNIER fully ccw. Change oscilloscope sweep time to 2 μSEC/CM.

j. Adjust Min Delay Adj R209 to obtain about 4 μsec (2 cm) spacing between channel A and channel B pulses.

k. Repeat above procedure starting with step g to minimize interaction between R201 and R209.

l. Make the following changes in settings of Model 214A:

INT. REP. RATE	100-1K
INT. REP. RATE VERNIER	Midrange
PULSE POSITION	0-1
PULSE POSITION VERNIER	cw
PULSE WIDTH	.05-1
PULSE WIDTH VERNIER	1

m. Change oscilloscope sweep time to .2 μSEC/CM. Other oscilloscope settings remain same as for previous steps.

n. Adjust 0-1 Max Delay Adj C205 to obtain about 1.2 μsec (6 cm) spacing between channel A and channel B pulses.

o. Change oscilloscope sweep time to .1 μSEC/CM; Model 214A PULSE POSITION VERNIER fully ccw.

p. Adjust 0-1 Min Delay Adj R210 to obtain a delay of 0 ± .02 μsec between channel A and channel B pulses.

q. Repeat above procedure starting with step m to minimize interaction between C205 and R210.

r. Set ADVANCE/DELAY/DOUBLE to PULSE ADVANCE.

s. Now channel A pulse should remain stationary and channel B pulse will move to the right from 0 to more than 1 μsec as the PULSE POSITION VERNIER is turned from the ccw to the cw position.

t. Measure trigger output amplitude of Model 214A with position mode switch in DELAY, ADVANCE and DOUBLE pulse settings. The positive and negative trigger pulses should be at least 12 volts into an open circuit.

5-25. OUTPUT BIAS CURRENT.

a. Set Model 214A TRIGGER MODE switch to EXT. (or set GATE INPUT to GATED position). This is to ensure that no signal can trigger output tubes V304 and V305 during this adjustment procedure.

CAUTION

If step a is not followed, damage to Model 214A circuit components may result.

b. Refer to figure 5-6 and locate the wire loop on the bottom side of the output circuit board, A301. The current flowing in this loop is to be measured and an adjustment made if necessary.

c. If using an HP Model 428B, clip the current probe around the wire loop, with arrow on the probe pointing to the nearest side panel. If a conventional milliammeter is used, the wire loop must be opened and the milliammeter inserted in series. To open the loop, either unsolder one end of the wire from the circuit board, or slide the insulation to one end and clip the wire.

d. Adjust R344 for an indication of 43 to 47 ma.

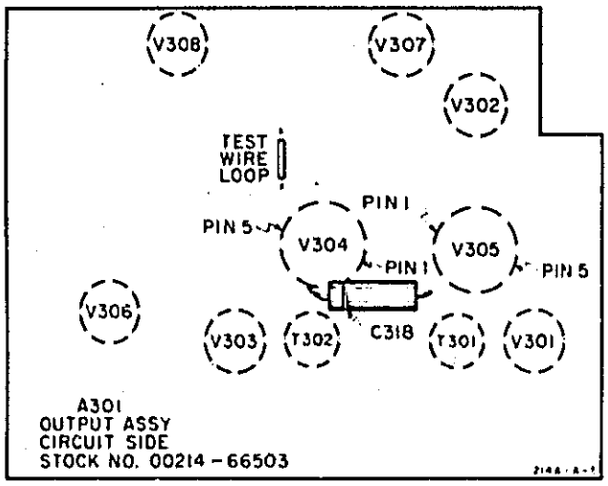


Figure 5-6. Assembly A301 Circuit Side

e. If the wire loop has been opened, carefully resolder wire to the circuit board or solder the two ends of the wire together.

5-26. PULSE AMPLITUDE AND WIDTH.

a. Restore the equipment setup described in paragraph 5-8a and b

b. Make the following changes to the settings of Model 214A controls:

PULSE WIDTH	10-100
PULSE WIDTH VERNIER	cw
INT. REP. RATE	.1-1
INT. REP. RATE VERNIER	ccw
PULSE OUTPUT	—
PULSE AMPLITUDE	50
PULSE AMPLITUDE VERNIER	cw

c. Set oscilloscope and plug-in controls as follows:

Channel Selector	CHANNEL A
Vertical Sensitivity	10 VOLTS/CM
Sweep Time	.2 mSEC/CM

d. Adjust R353 for a pulse of 54 volts.

e. Set VERNIER to 50 volts and TRIGGER MODE to EXT.

f. Adjust R363 until voltage across R352 is 20 volts.

g. Switch back to INTERNAL and check to see if the 50-volt pulse amplitude has changed. If it has, repeat steps d through g until the 50-volt and 20-volt amplitudes do not change.

h. When the 50-volt range is set, switch to the 100-volt range and check to see that the amplitude can be set to higher than 100 volts. Change the output tubes and repeat steps d through g if this requirement cannot be met.

i. Set VERNIER for 50 volts on the 50-volt range. Leave the VERNIER at this position and switch to the 20-volt range. Adjust R354 for a 20-volt output pulse. Switch to the 10-volt range and adjust R355 for a 10-volt output pulse. Check the 5-volt, 2-volt, 1-volt, .5-volt and .2-volt ranges for the proper output. Be sure the VERNIER is not turned after it has been set for 50 volts.

j. Restore the equipment setup described in paragraphs 5-8a and b. Make the following changes to the settings of the 214A controls:

TRIGGER OUTPUT	POSITIVE
TRIGGER MODE	INT
INT. REP. RATE	1-10
INT. REP. RATE VERNIER	ccw
PULSE WIDTH	10-100
PULSE WIDTH VERNIER	cw
PULSE OUTPUT	—
PULSE AMPLITUDE	10
PULSE AMPLITUDE VERNIER	cw

k. Set oscilloscope and plug-in controls as follows:

Channel Selector	CHANNEL A
Vertical Sensitivity	2 VOLTS/CM
Input	DC
Trigger Slope	POSITIVE
Trigger Source	EXT.
Sweep Time	20 μsec/cm
Horizontal Display	X1

l. With the PULSE WIDTH VERNIER fully cw, see that the arrow points to dot marked on panel.

m. Adjust potentiometer R250 for a pulse width of about 120 μsec (6 cm) on the oscilloscope.

n. Set the oscilloscope sweep time to 2 μsec/cm.

o. Set the PULSE WIDTH VERNIER fully ccw and adjust R259 for a pulse width of approximately 4 μsec (2 cm).

p. Repeat steps m through q and readjust R250 and R259 if necessary.

q. Set Model 214A controls as follows:

PULSE WIDTH	.05-1
PULSE WIDTH VERNIER	fully cw
INT. REP. RATE VERNIER	fully cw

r. Set the oscilloscope sweep time to .2 μsec/cm.

s. Adjust C229 for a pulse width of approximately 1.2 μsec (6 cm).

t. Set Model 214A PULSE WIDTH VERNIER fully ccw, and Oscilloscope Sweep Time to .1 μsec/cm. Adjust R260 for a pulse width of approximately .04 μsec (4mm) at the half-amplitude points.

u. Repeat steps m through v if necessary.

v. Set the oscilloscope sweep Sweep Time to 10 nsec/cm.

w. Set the ADVANCE/DELAY/DOUBLE switch to PULSE DELAY.

x. Adjust the PULSE WIDTH VERNIER for a 50-nsec pulse.

y. Set the ADVANCE/DELAY/DOUBLE switch to PULSE ADVANCE.

z. The displayed pulse width should be 50 ±5 nsec.

aa. If the pulse width is not 50 ± 5 nsec, select a new value for resistor R143 so that pulse width meets specifications. Resistor R143 normally ranges between 220 and 560 ohms with 470 ohms nominal.

bb. Set the PULSE WIDTH VERNIER fully ccw. The pulse width in both PULSE ADVANCE and PULSE DELAY should be less than 50 nsec.

5-27. PULSE OVERSHOOT ADJUST.

a. Perform paragraph 5-13, steps a through e.

b. See figure 5-1. The displayed overshoot should be < 5%. Adjust OVERSHOOT ADJUST (C319) if necessary.

5-28. OVERLOAD RELAY ADJUST.

a. Set Model 214A controls as follows:

TRIGGER MODE	INT.
INT. REP. RATE	1-10
INT. REP. RATE VERNIER	Midrange
NORM./GATED	NORM
PULSE POSITION	1-10
PULSE POSITION VERNIER	Midrange
ADVANCE/DELAY/ DOUBLE	PULSE DELAY
TRIGGER OUTPUT	+
PULSE AMPLITUDE	10
PULSE AMPLITUDE VERNIER	10 V output
PULSE WIDTH	10-100
PULSE WIDTH VERNIER	fully ccw
PULSE OUTPUT	+

b. Set oscilloscope and plug-in controls as follows:

Channel Selector	CHANNEL A
Sensitivity (Vernier to CAL)	1 VOLT/CM
AC/DC Coupling	DC
Polarity	+ UP
Trigger Slope	+
Trigger Source	EXT. AC
Sweep Mode	PRESET
Sweep Time (Vernier in CAL)	10 μSEC/CM
Horizontal Display	X1

c. Attach a 50-ohm coaxial cable to the Model 214A PULSE OUTPUT. Connect the other end of the cable directly to the oscilloscope channel A input through a 50-ohm load. Connect a coaxial cable between the Model 214A TRIGGER OUTPUT and the oscilloscope trig input.

d. Adjust Model 214A PULSE POSITION VERNIER and oscilloscope horizontal position control until the leading edge of the pulse is at the left edge of the scope graticule.

e. Adjust Model 214A INT. REP. RATE VERNIER until the leading edge of the second pulse is at the right edge of the oscilloscope graticule.

f. Adjust Model 214A PULSE WIDTH VERNIER to obtain a pulse 55 μsec (5.5 cm) wide observed on the oscilloscope. This corresponds to a duty cycle of about 55%.

g. If overload relay K1 is clicking (front panel OVERLOAD light should also operate), rotate Overload Adj R30 clockwise until it stops. Then rotate R30 counterclockwise until relay K1 just begins operation.

h. Rotate PULSE WIDTH VERNIER ccw to stop overload relay operation. Relay should operate again as pulse width reaches about 55 μsec (5.5 cm).

5-29. TROUBLESHOOTING.

5-30. The information suggested in paragraphs 5-31 through 5-35 is provided as a front panel check to aid in locating possible faulty components in the shortest possible time. In each solution it is assumed that active components such as tubes, transistors, and diodes are defective, which may not be true in every case. Waveforms, dc voltages and ohmeter checks in that order can be used to locate faulty passive components such as resistors and capacitors. In locating any problem in the Model 214A, check power supply voltages first since they affect several circuits.

5-31. TRIGGER MODE CHECKS.

a. If the Model 214A can be triggered with TRIGGER MODE set to INT. but not in EXT. or MANUAL positions, replace DS101.

b. If the Model 214A can be triggered with TRIGGER MODE set to INT. or MANUAL but not in EXT. position, replace V101.

c. If the Model 214A can be triggered with TRIGGER MODE set to EXT. or MANUAL but not in INT. positions, replace CR101.

d. If the Model 214A can not be triggered in any of the TRIGGER MODE positions, check waveforms 1 through 4 in that order to locate faulty component.

e. If the Model 214A will not gate on a minimum of 8 volts, check V103.

f. If V103, pin 8, has no output, check the —7.8 V bias on V103 pins 2 and 7, and check the cathode potential on CR103 (should be positive).

5-32. PULSE CONTROL CHECKS.

a. If a trigger can be obtained at the TRIGGER OUTPUT when PULSE ADVANCE/PULSE DELAY/ DOUBLE PULSE control is set to PULSE ADVANCE or DOUBLE PULSE, but not when set to PULSE DELAY, replace V202.

b. If a trigger can not be obtained with PULSE ADVANCE/PULSE DELAY/DOUBLE PULSE control in any position, replace V203 or check waveforms 10 through 12.

c. If PULSE POSITION control does not reposition pulse, check waveforms 4 through 8 to locate faulty component.

d. If PULSE WIDTH control does not vary pulse width, check waveforms 17 through 22 to locate faulty component.

e. If pulse width or pulse position suddenly changes greatly when the VERNIERS are varied, replace diodes CR202/203 or CR212/213, depending on which circuit is faulty.

f. If there are no start or stop spikes (plates of V301 and V302) check diodes in grid circuits (CR301, 302, 303, and CR306, 307, 308, and 309).

5-33. OUTPUT CIRCUIT CHECKS.

a. If a pulse is present at TRIGGER OUTPUT but not at PULSE OUTPUT, check waveforms 13 through 16 and 23 through 26 in the Start-Stop Pulse circuits, and dc voltages in the output circuit to locate faulty components.

b. If output pulse amplitude will increase but does not decrease, replace V308.

c. If output pulse will not hold its amplitude (sags), check for blown fuse F2, or C325 for leakage.

d. If the output pulse appears as two spikes (start and stop spikes), check Q301, CR326, CR327, and CR328.

e. Poor rise time is usually caused by weak V301 or faulty diodes CR324 and CR325.

f. If Amplitude pots, R353, R354, or R355 will not adjust the 10 V, 20 V, or 50 V ranges, respectively, to the required amplitude, first check diodes CR320 through CR322. The check bias adjustments R344 (paragraph 5-25) and R363 (paragraph 5-26, steps m through p) for proper bias on output tubes, V304 and V305.

g. If excessive overshoot exists on high amplitude ranges, replace CR324 or CR325.

5-34. POWER SUPPLY CHECKS.

5-35. The power supplies can be checked for malfunctions by making dc voltage measurements. If front panel control settings are made, as indicated in Schematic Notes, before measurements are made "0" reference and chassis ground will be the same.

5-36. REPAIR AND REPLACEMENT.

5-37. GENERAL.

5-38. Refer to figures 5-6 through 5-11 for locations and identification of components on etched circuit boards in the Model 214A. For components not identified in these figures, determine the circuit location in the instrument and refer to the schematic diagrams for reference designator. Section VI contains a complete list of reference designators for electrical components and the Hewlett-Packard Company stock number for the item.

5-39. SERVICING ETCHED CIRCUIT BOARDS.

5-40. Etched circuit boards used in the Model 214A have components on one side of the board with a plated conductive layer of metal through component holes. HP Service Note M-20D contains useful information on etched circuit repair. The important steps and considerations are:

a. Use a low heat (30 to 47.5 watts, less than 800° F idling temperature), slightly bent chisel tip (1/16 to 1/8 inch diameter) soldering iron, and a small diameter, high tin content solder. If a rosin solder is used, clean the area thoroughly after soldering.

b. Components may be removed by placing the soldering iron on the component lead on either side of the board and pulling up on the lead. If heat is

applied to the component side of the board, greater care is required to avoid damage to the component (especially true for diodes). If heat damage may occur, grip the lead with a pair of pliers to provide a heat sink between the soldering iron and component.

c. If a component is obviously damaged or faulty, clip the leads to the component and then unsolder the leads from the board.

d. Large components such as potentiometers and tube sockets may be removed by rotating the soldering iron from lead to lead and applying steady pressure to lift the part free (the alternate is to clip the leads of a damaged part).

e. Since the conductor part of the etched circuit boards is a metal plated surface, covered with solder, use care to avoid overheating and lifting the conductor from the board. A conductor may be cemented back in place with a quick-drying acetate base cement (use sparingly) having good insulating properties. Another method for repair is to solder a section of good conducting wire along the damaged area.

f. Clear the solder from the circuit board hole before inserting a new component lead. Heat the solder in the hole, remove the iron, and quickly insert a pointed non-metallic object, such as a toothpick.

g. Shape the new component leads and clip to proper length. Insert the leads in the holes and apply heat solder, preferably on the conductor side.

5-41. PERIODIC MAINTENANCE.

5-42. GENERAL.

5-43. The air intake fan motor needs little lubrication or preventive maintenance. About once a year, place one or two drops of light oil on the shaft at the front and rear bearing supports. It is also recommended as preventive maintenance that the interior of the instrument be cleared of any accumulated dust when necessary.

5-44. CLEANING AIR FILTER.

5-45. Inspect the air filter (rear of instrument) regularly and clean it before dust can restrict air flow. Air flows from outside the instrument in through the filter.

a. Remove the filter and wash it in warm water and detergent.

b. Dry the filter thoroughly and coat with filter adhesive preparation recommended in paragraph 2-10.

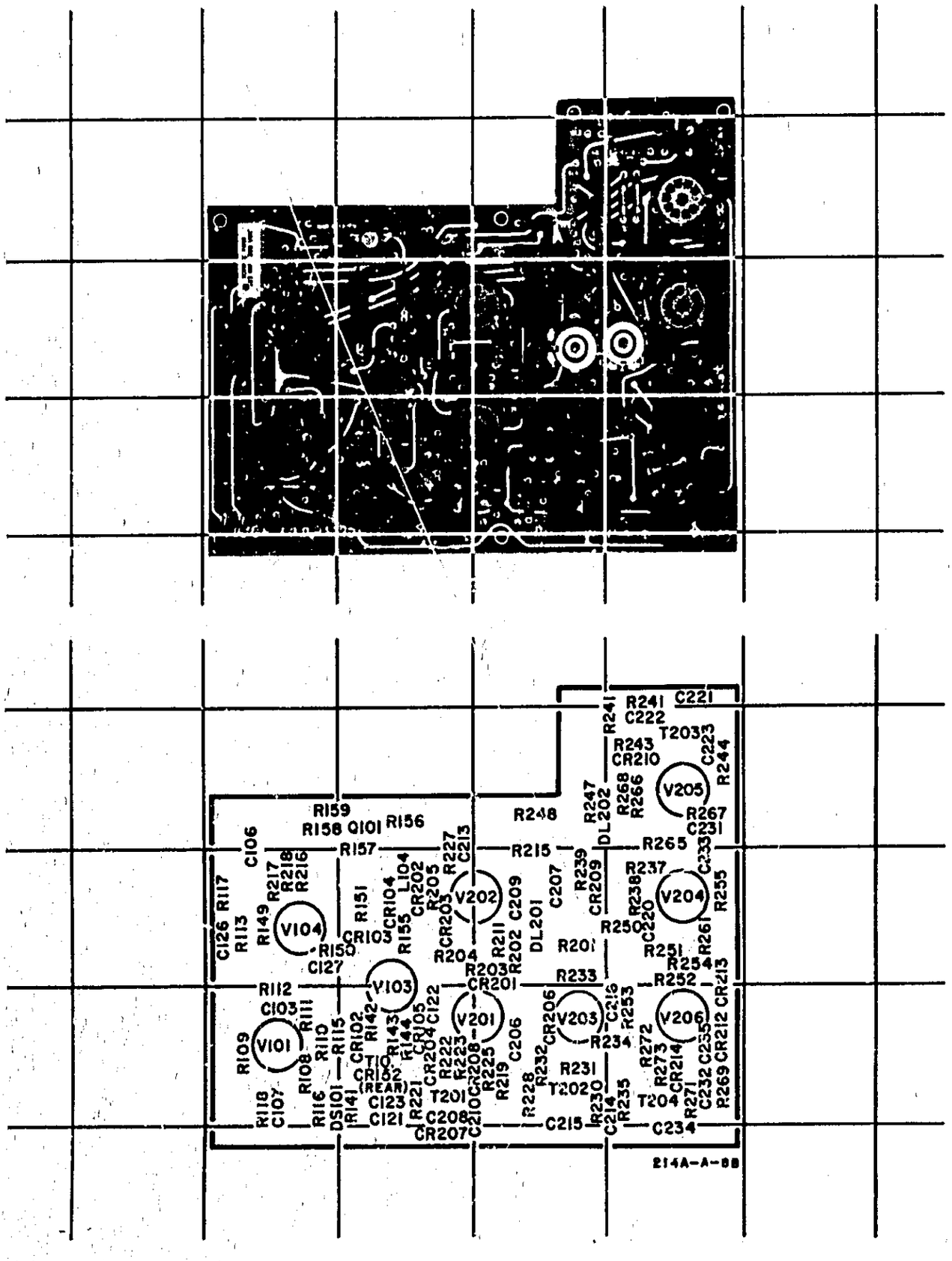


Figure 5-7. Assembly A101 Component Location

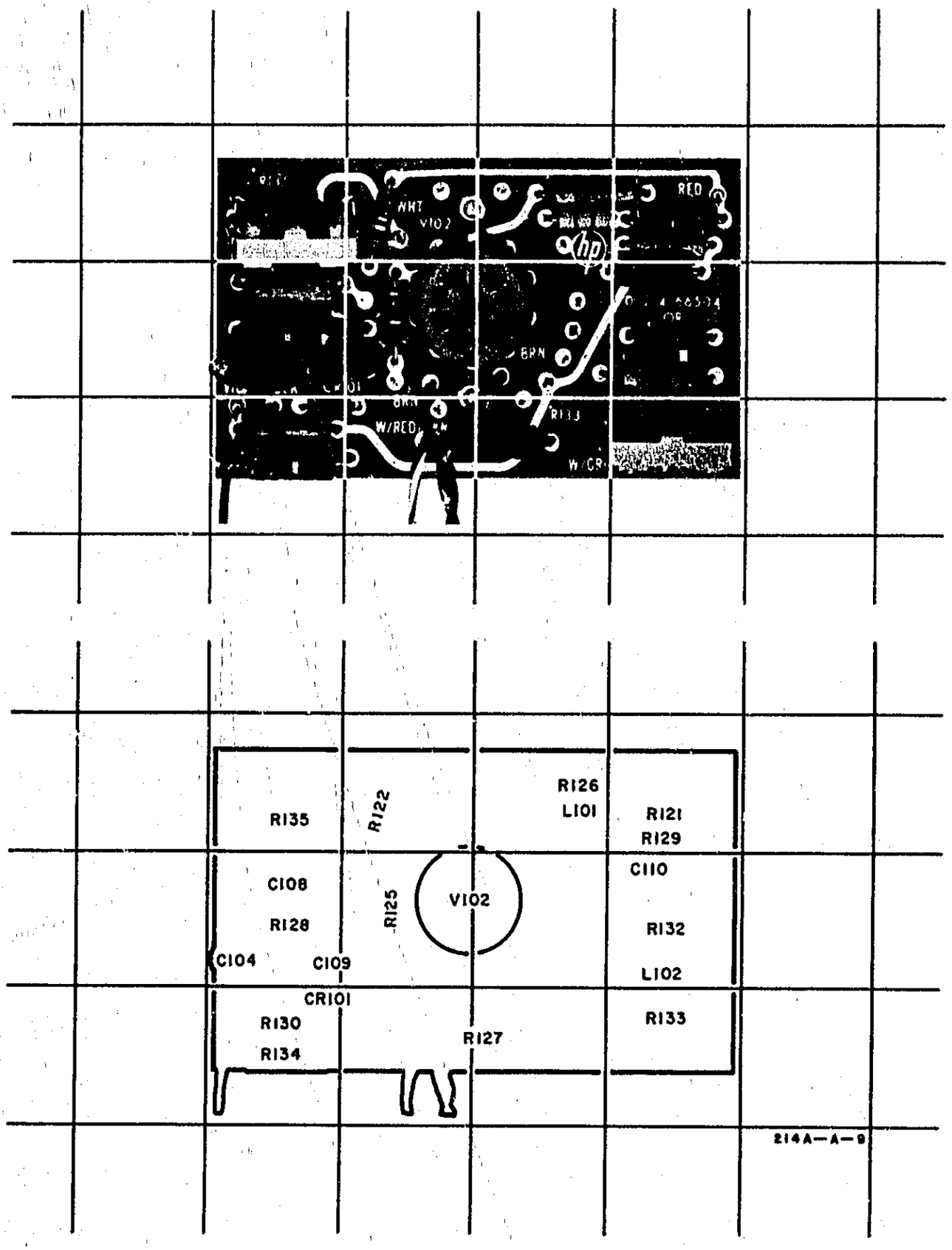


Figure 5-8. Assembly A102 Component Location

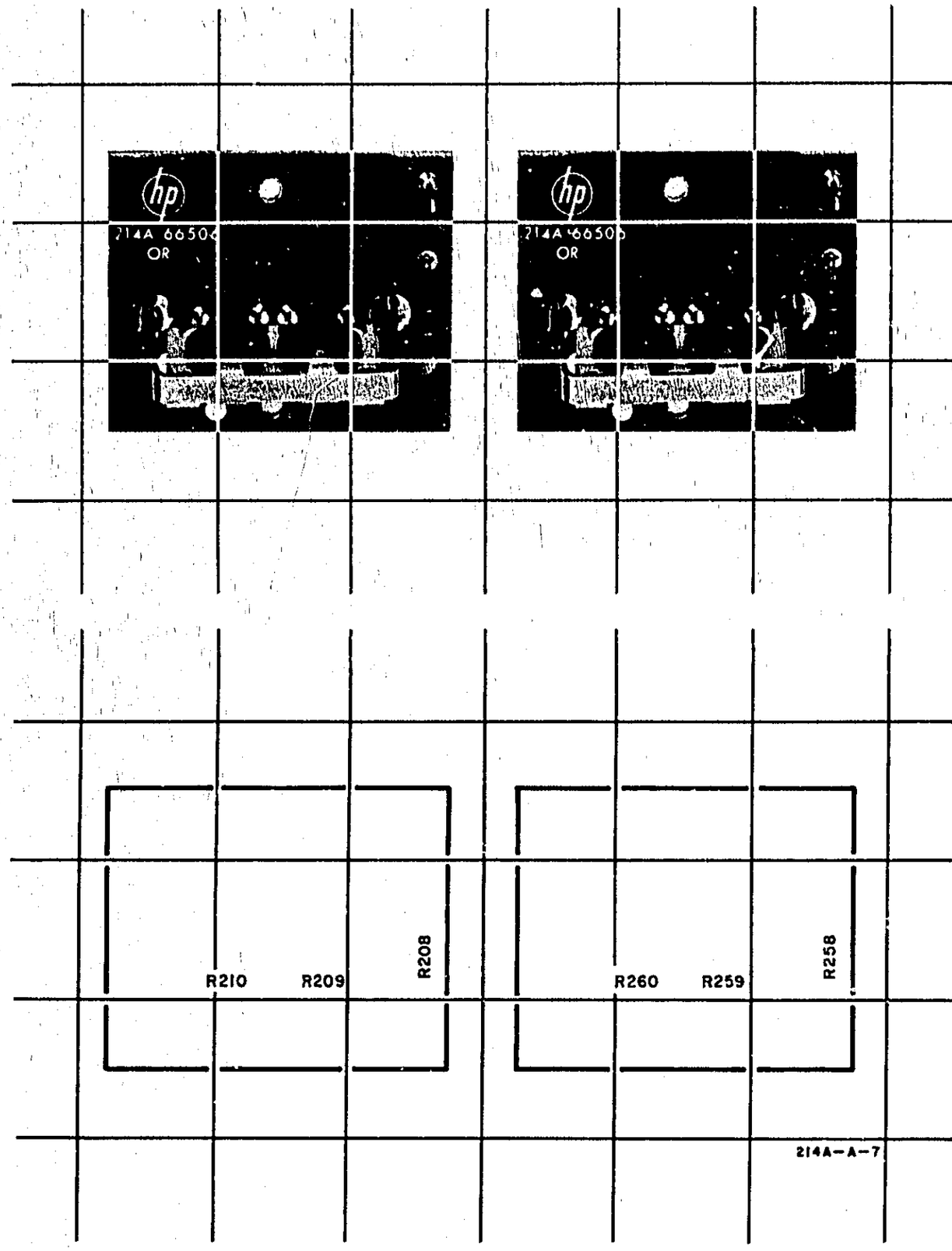


Figure 5-9. Assemblies A202 and A204 Component Location

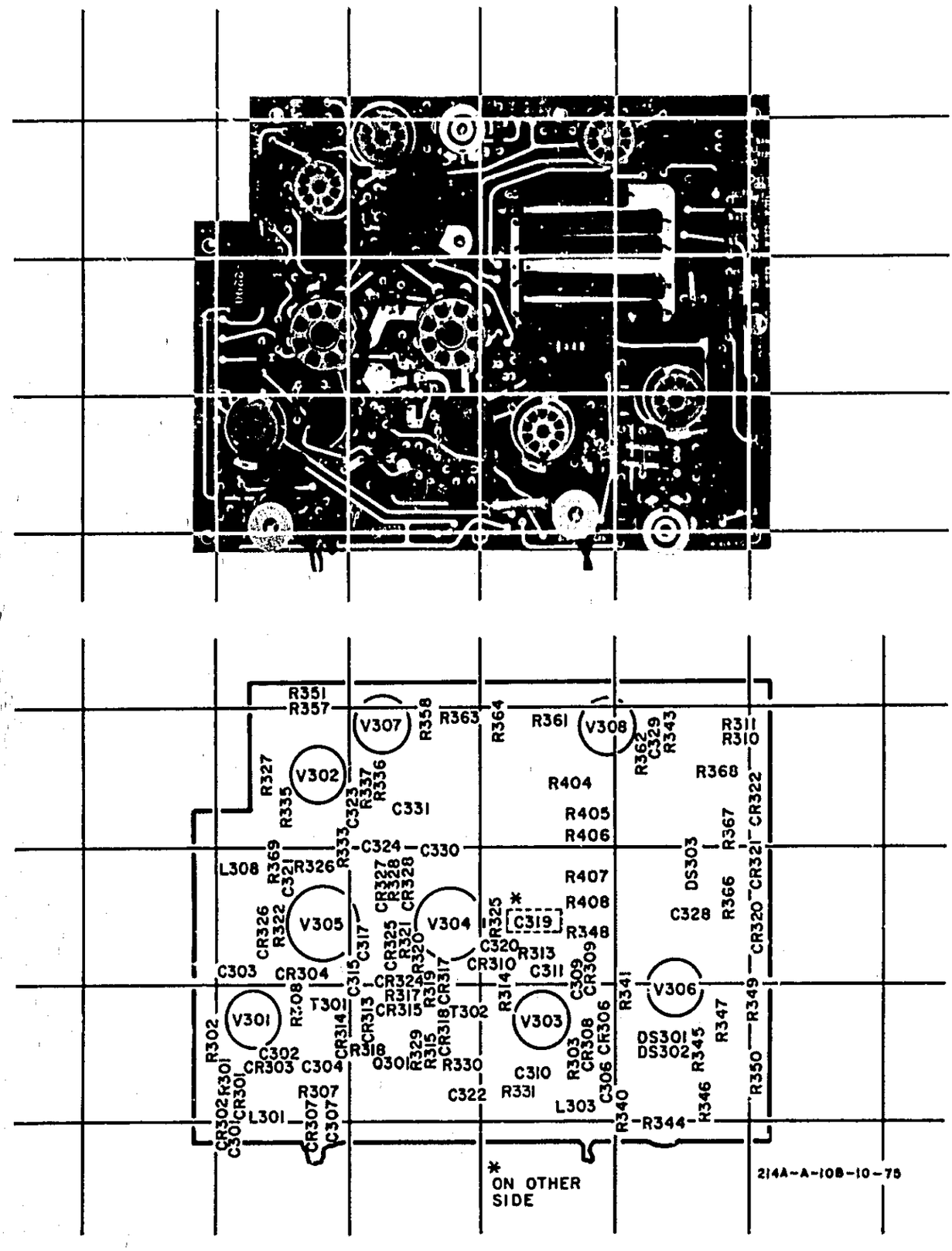


Figure 5-10. Assembly A301 Component Location

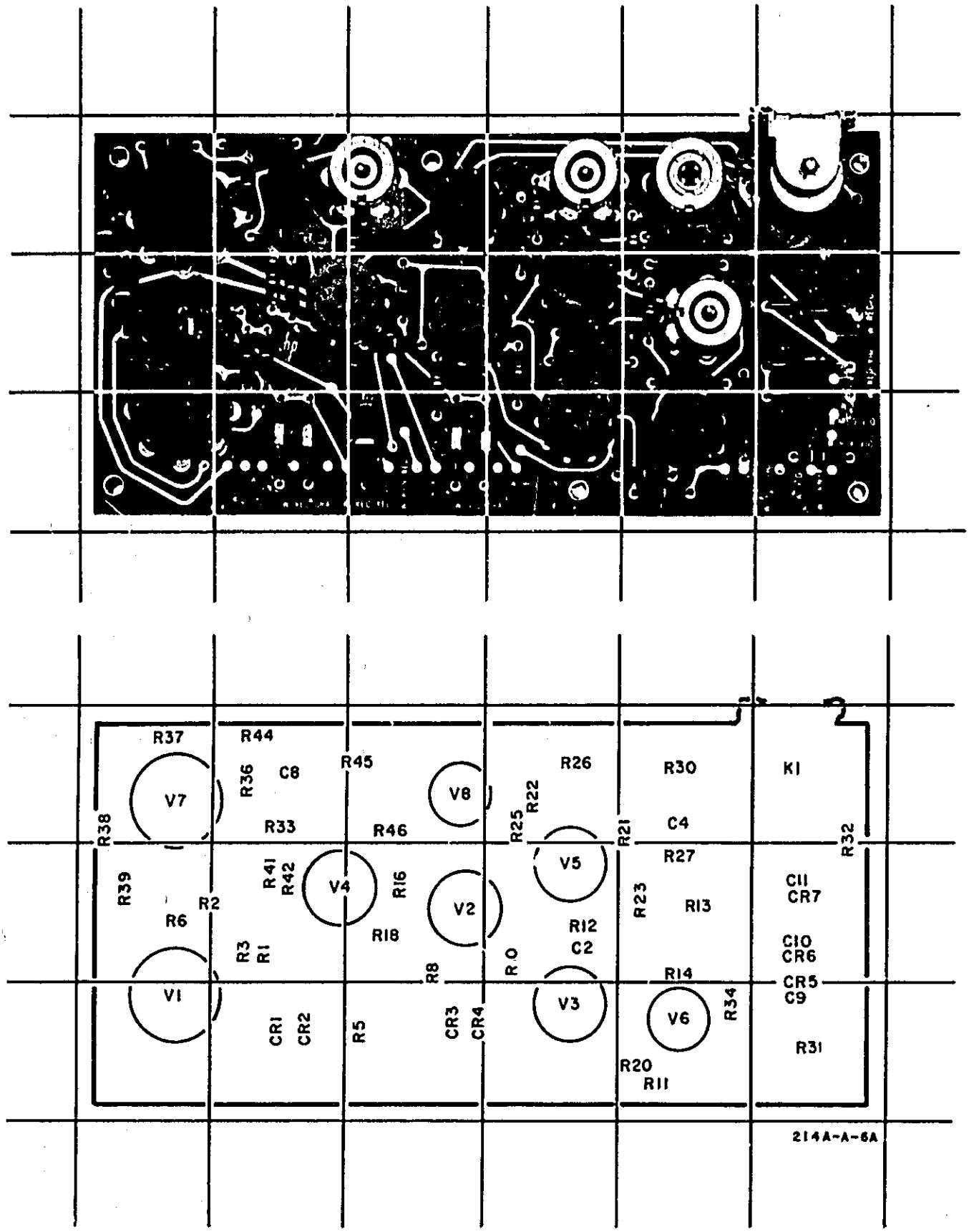


Figure 5-11. Assembly A1 Component Location

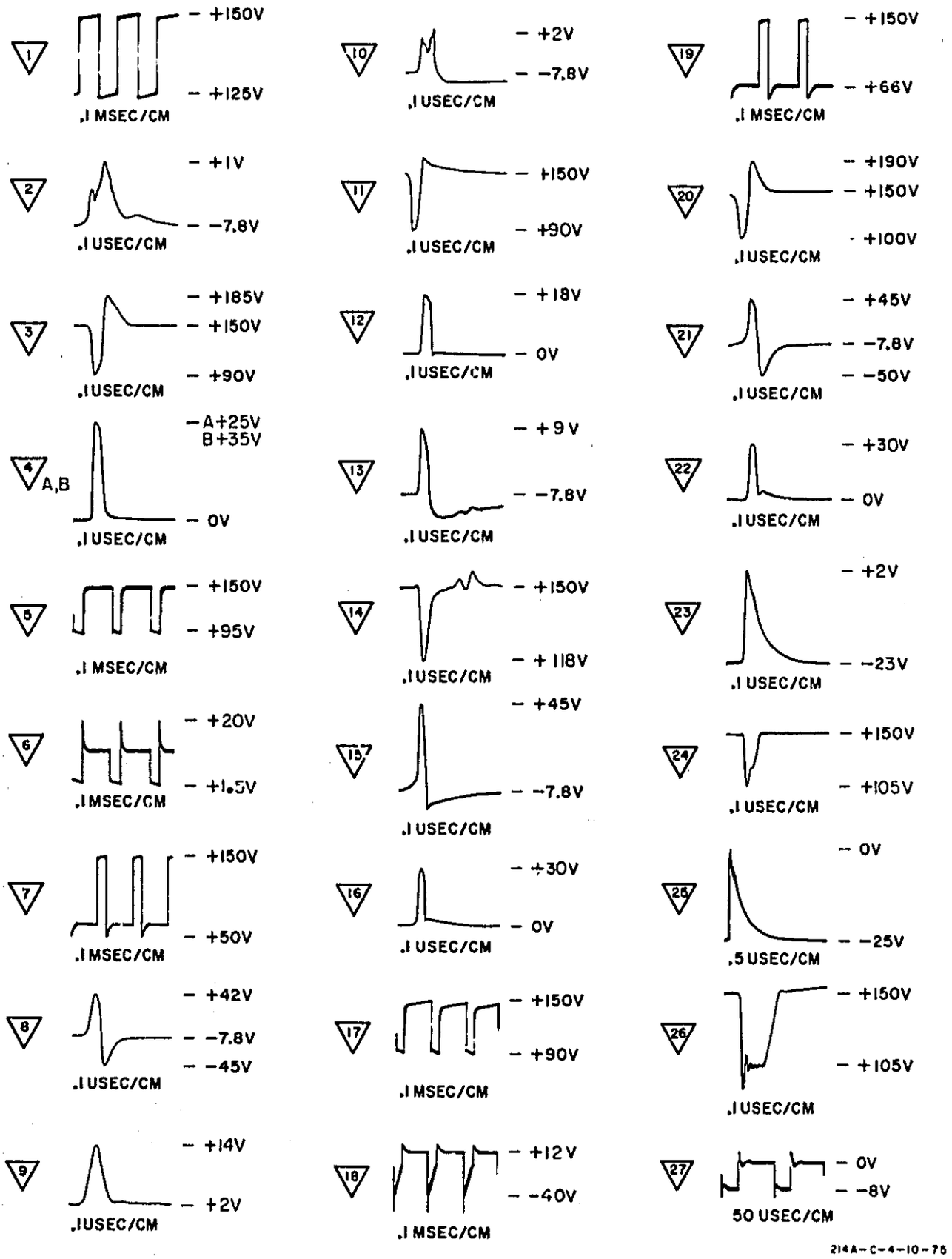


Figure 5-12. Typical Waveforms (See Schematic and Schematic Notes)

SCHEMATIC DIAGRAM NOTES

1. Except as indicated: capacitance in microfarads; inductance in microhenries; resistance in ohms.

2. Touching test probe at this point causes transient pulse and OVERLOAD indication. To avoid: turn power off, attach test probe, turn power on, and take measurement.

3. DC Voltage Measurement Conditions:
   a. Set SLOPE, TRIGGER OUTPUT, and PULSE OUTPUT to -.
   b. Set GATE INPUT switch to NORM.
   c. Set PULSE ADVANCE/PULSE DELAY/DOUBLE PULSE to PULSE ADVANCE.
   d. Set TRIGGER MODE to EXT.
   e. Set all remaining switches, controls, and VERNIERS to 12 o'clock position (i.e. indicator on knob points toward top of front panel).
   f. Voltages shown are typical values, may vary ± 10% from that shown. Voltages should be measured with a high impedance dc voltmeter.

4. Waveform Measurement Conditions:
   a. Set SLOPE, TRIGGER OUTPUT, and PULSE OUTPUT to -.
   b. Set GATE INPUT switch to NORM.
   c. Set PULSE ADVANCE/PULSE DELAY/DOUBLE PULSE to PULSE ADVANCE.
   d. Set TRIGGER MODE to INT.
   e. Set all remaining switches, controls, and VERNIERS to 12 o'clock positions (i.e. indicator on knob points toward top of front panel).
   f. Waveforms shown are typical and were measured using a 10:1 divider probe and the oscilloscope with plug-in units indicated in Table 5-2. Test points are indicated by number in triangle and keyed to Figure 5-12.

5. Schematics are drawn showing switches in following positions:

TRIGGER MODE	INT.
INT. REP. RATE	100-1K
ADVANCE, DELAY, DOUBLE	PULSE ADVANCE
PULSE POSITION	0-1
PULSE WIDTH	0.05-1
PULSE AMPLITUDE	100

6. P/O = Part of

   V_I = Isolated Voltage Supply

7. Switch sections are identified by letters following the schematic designator (e.g. S401C). Letters refer to a specific switch wafer, where A = front side of wafer nearest front panel, B = rear side of wafer nearest panel, C = front side of second wafer, etc.

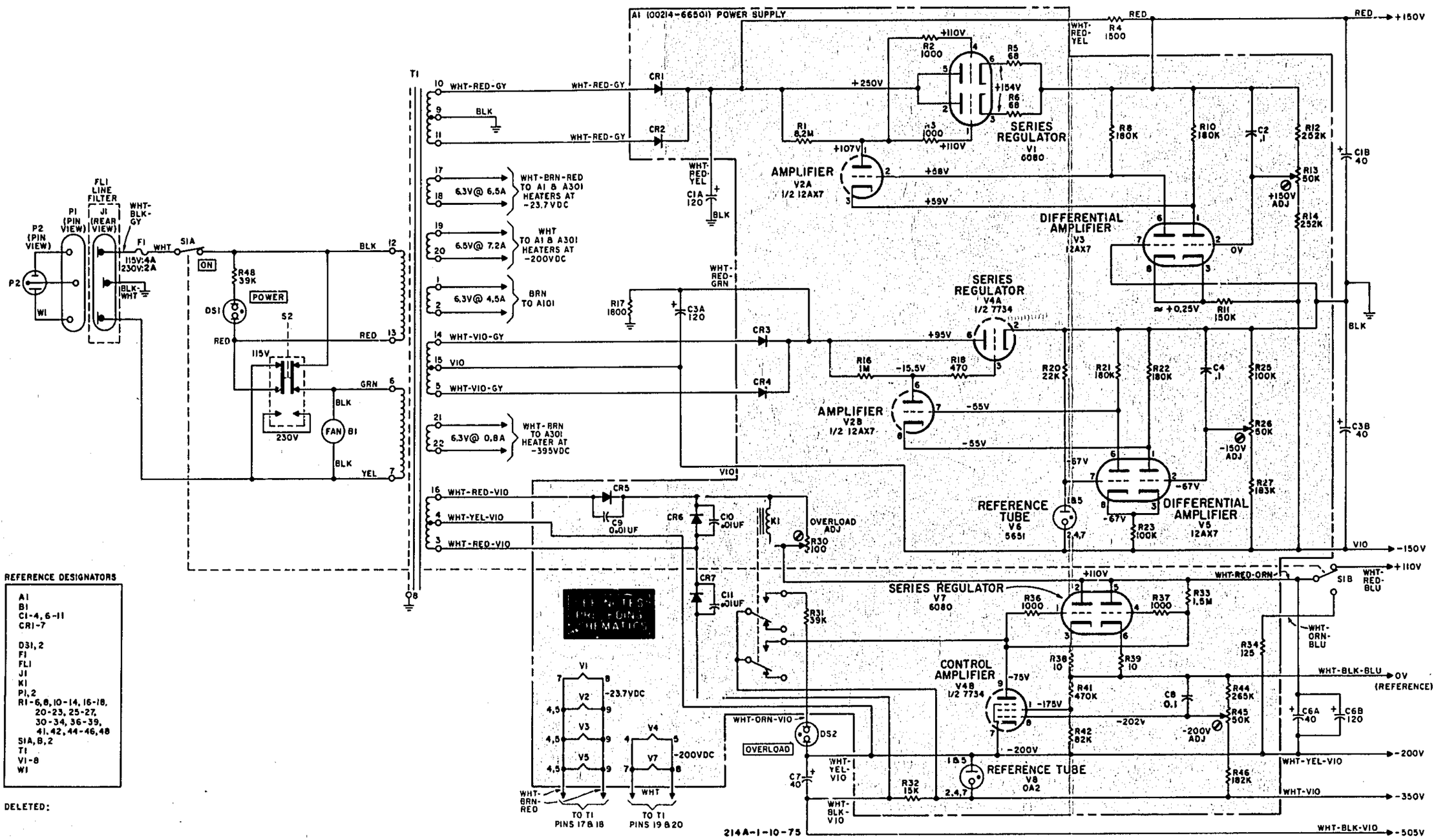


Figure 5-13. Power Supply

J2056-4

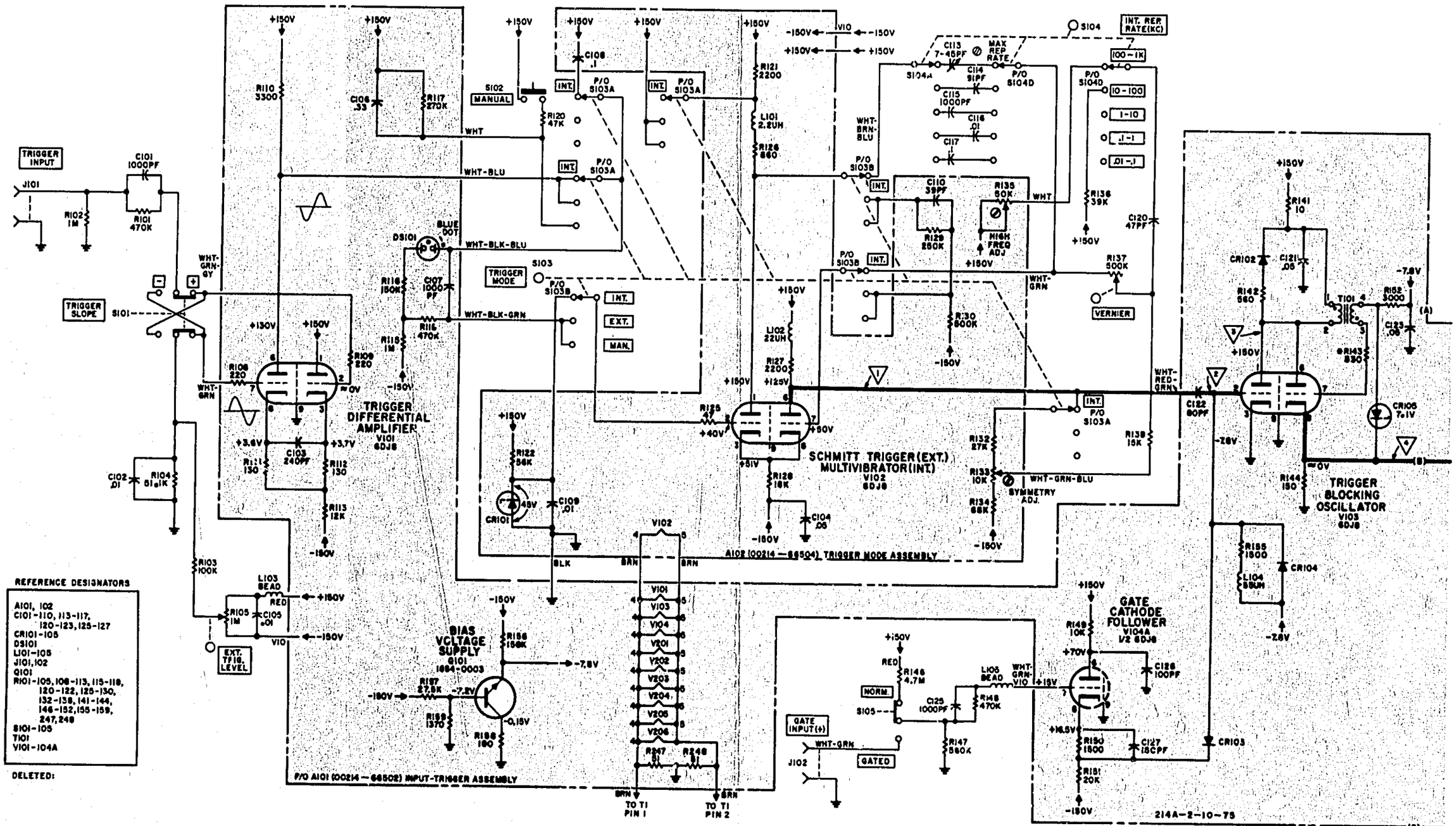


Figure 5-14. Trigger Input Circuit

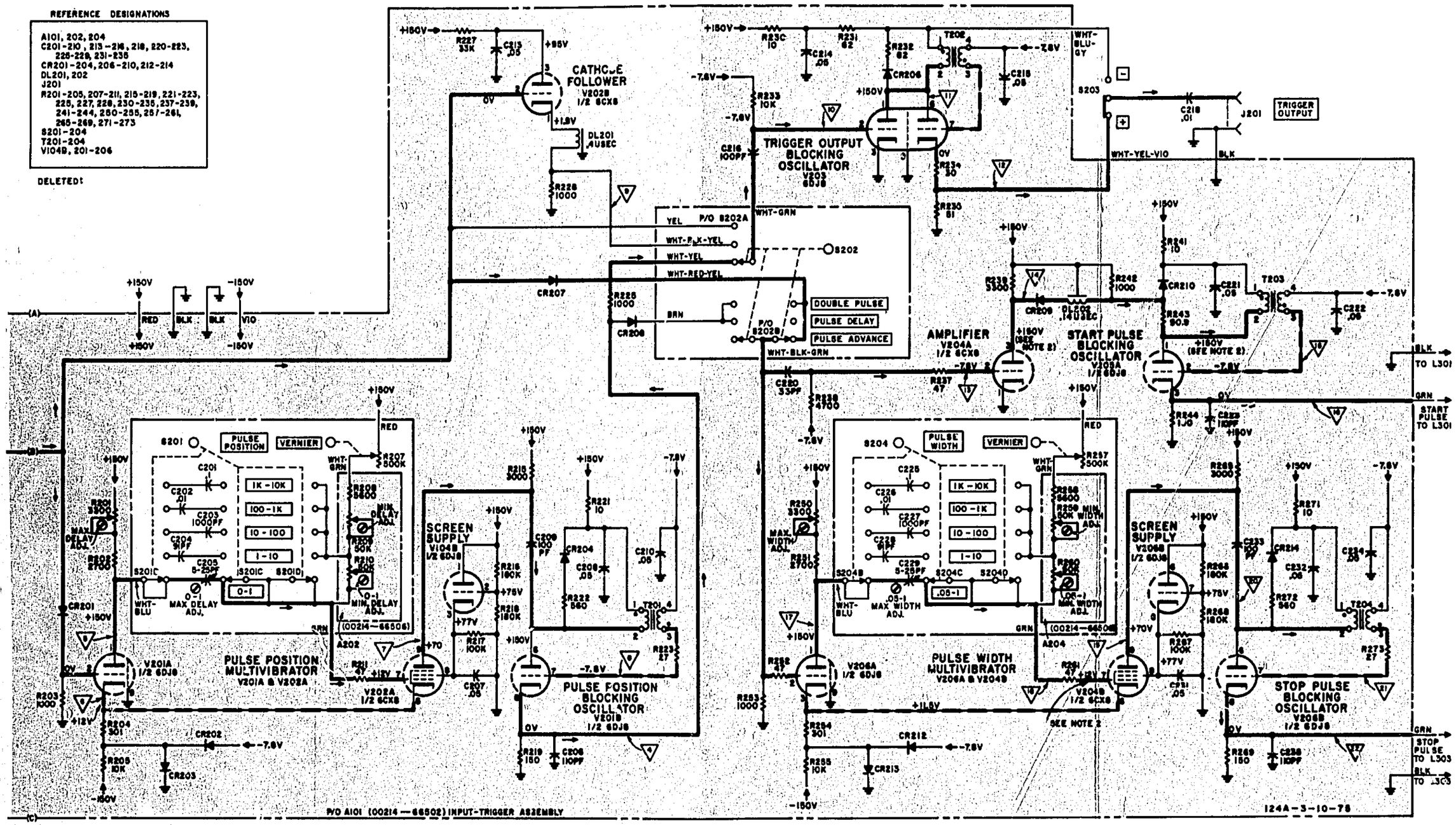


Figure 5-15. Pulse Control Circuit

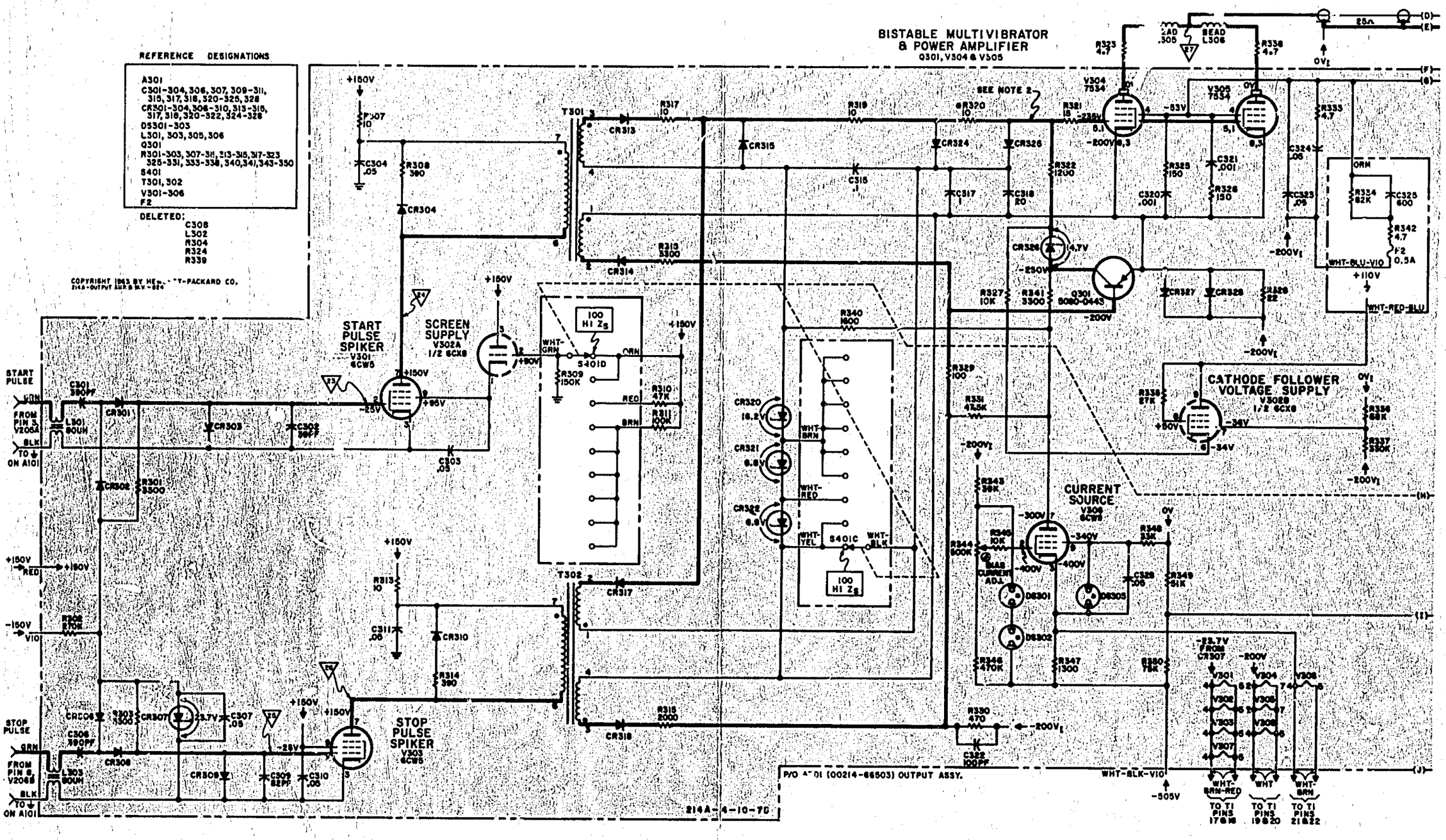


Figure 5-16. Start-stop Pulse Circuit

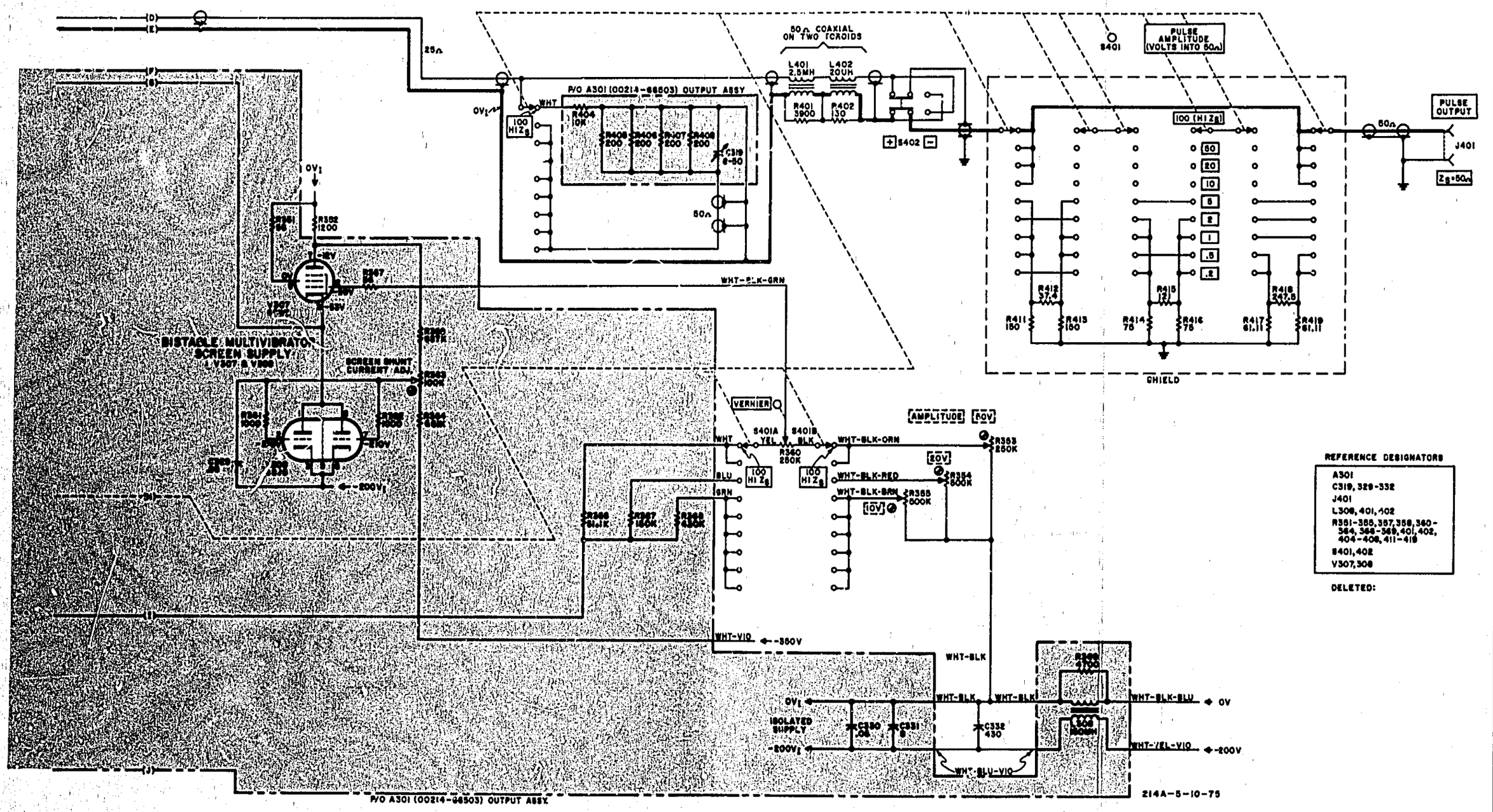


Figure 5-17. Output Circuit
5-25/5-26

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designations and indicates the description and ⓗ stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their ⓗ stock 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 list of manufacturers in Table 6-3.

c. Manufacturer's part number.

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

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office (see maps at rear of this manual for addresses). Identify parts by their Hewlett-Packard stock numbers.

6-6. 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.

REFERENCE DESIGNATORS

A = assembly	E = misc electronic part	MP = mechanical part	TB = terminal board
B = motor	F = fuse	P = plug	TP = test point
C = capacitor	FL = filter	Q = transistor	V = vacuum tube, neon bulb, photocell, etc.
CP = coupling	J = jack	R = resistor	
CR = diode	K = relay	RT = thermistor	W = cable
DL = delay line	L = inductor	S = switch	X = socket
DS = device signaling (lamp)	M = meter	T = transformer	Y = crystal

ABBREVIATIONS

A = amperes	GE = germanium	N/C = normally closed	RMO = rack mount only
A.F.C = automatic frequency control	GL = glass	NE = neon	RMS = root-mean-square
AMPL = amplifier	GRD = ground(ed)	NI PL = nickel plate	
		N/O = normally open	S-B = slow-blow
B.F.O. = beat frequency oscillator	H = henries	NPO = negative positive zero (zero temperature coefficient)	SCR = screw
BE CU = beryllium copper	HEX = hexagonal		SE = selenium
BH = binder head	HG = mercury		SECT = section(s)
BP = bandpass	HR = hour(s)	NRFR = not recommended for field replacement	SEMICON = semiconductor
BRS = brass			SI = silicon
BWO = backward wave oscillator	IF = intermediate freq	NSR = not separately replaceable	SIL = silver
	IMPG = impregnated		SL = slide
CCW = counter-clockwise	INCD = incandescent		SPL = special
CER = ceramic	INCL = include(s)	OBD = order by description	SST = stainless steel
CMO = cabinet mount only	INS = insulation(ed)	OH = oval head	SR = split ring
COEF = coefficient	INT = internal	OX = oxide	STL = steel
COM = common	K = kilo = 1000	P = peak	TA = tantalum
COMP = composition	LIN = linear taper	PC = printed circuit	TD = time delay
CONN = connector	LK WASH = lock washer	PF = picofarads = 10^{-12} farads	TGL = toggle
CP = cadmium plate	LOG = logarithmic taper	PH BRZ = phosphor bronze	TI = titanium
CRT = cathode-ray tube	LPF = low pass filter	PHL = Phillips	TOL = tolerance
CW = clockwise	M = milli = 10^{-3}	PIV = peak inverse voltage	TRIM = trimmer
	MEG = meg = 10^{6}	P/O = part of	TWT = traveling wave tube
DEPC = deposited carbon	METFLM = metal film	POLY = polystyrene	U = micro = 10^{-6}
DR = drive	MFR = manufacturer	PORC = porcelain	
	MINAT = miniature	POS = position(s)	VAR = variable
ELECT = electrolytic	MOM = momentary	POT = potentiometer	VDCW = dc working volts
ENCAP = encapsulated	MTG = mounting	PP = peak-to-peak	
EXT = external	MY = "mylar"	PT = point	W/ = with
		RECT = rectifier	W = watts
F = farads	N = nano (10^{-9})	RF = radio frequency	WW = wirewound
FH = flat head		RH = round head	W/O = without
FIL H = fillister head			
FXD = fixed			

01194-9

Table 6-1. Reference Designation Index

Reference Designation	Stock No.	Description #	Note
A1	00214-66501	ETCHED CIRCUIT ASSEMBLY (POWER SUPPLY)	
A2	00214-61902	TRIGGER MODE SWITCH ASSEMBLY INCLUDES A102 AND S103	
A3	00214-61903	SWITCH ASSEMBLY INT. REP. RATE INCLUDES A7	
A4	00214-61904	SWITCH ASSEMBLY:PULSE POSITION INCLUDES A202 S201 AND MOUNTED COMP	
A5	00214-63401	ATTENUATOR ASSEMBLY INCLUDES CABLES,CONNECTORS,S401	
A6	00214-66001	COAXIAL COIL ASSEMBLY INCLUDES L401,L402,R401,R402.	
A7		NOT ASSIGNED	
A8	00214-61904	SWITCH ASSEMBLY PULSE WIDTH INCLUDES A204,S204	
A9 THRU A100		NOT ASSIGNED	
A101	00214-66502	ETCHED CIRCUIT ASSEMBLY TRIGGERCIRCUIT	
A102	00214-66504	ETCHED CIRCUIT ASSEMBLY TRIGGER MODE,PART OF A2	
A103 THRU A201		NOT ASSIGNED	
A202	00214-66506	ETCHED CIRCUIT ASSEMBLY PULSE POSITION ,PART OF A4	
A203		NOT ASSIGNED	
A204	00214-66506	ETCHED CIRCUIT ASSEMBLY PULSE WIDTH,PART OF A8	
A205 THRU A300		NOT ASSIGNED	
A301	00214-66503	ETCHED CIRCUIT ASSEMBLY (OUTPUT)	
B1	3160-0097	FAN:TUBE AXIAL 50-60 CYCLE	
C1	0180-0030	C:FXD ELECT 120 X40 UF 450VDCW	
C2	0160-0168	C:FXD MY 0.1UF 20% 200VDCW	
C3	0180-0030	C:FXD ELECT 120 X40 UF 450VDCW	
C4	0160-0168	C:FXD MY 0.1UF 20% 200VDCW	
C5		NOT ASSIGNED	
C6	0180-0030	C:FXD ELECT 120 X40 UF 450VDCW	
C7	0180-0024	C:FXD ELECT 40UF 450VDCW	
C8	0160-0050	C:FXD MY 0.1UF 10% 400VDCW	
C9, C10,C11	0150-0012	C:FXD CER .01UF 20% 1000VDCW	
C12 - C100		NOT ASSIGNED	
C101	0140-0152	C:FXD MICA 1000 PF 5% 300 VDCW	
C102	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C103	0140-0199	C:FXD MICA 240PF 5% 300VDCW	
C104	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C105	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C106	0160-2128	C:FXD MYLAR 0.33UF 20% 200VDCW	
C107	0140-0152	C:FXD MICA 1000 PF 5% 300 VDCW	
C108	0160-0168	C:FXD MY 0.1UF 20% 200VDCW	
C109	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
C110	0140-0116	C:FXD MICA 39 PF 2% 500 VDCW	
C111 THRU C112		NOT ASSIGNED	
C113	0130-0001	C:VAR 7-45 PF 500VDCW	
C114	0160-0208	C:FXD MICA 91PF 2% 300WVDC	
C115	0140-0152	C:FXD MICA 1000 PF 5% 300 VDCW	
C116	0160-0207	C:FXD MYLAR 0.01UF 5% 200VDCW	
C117	0170-0019	C:FXD MY 0.1 UF 5% 200VDCW	
C118 THRU C119		NOT ASSIGNED	
C120	0140-0204	C:FXD 47PF 5% NPO 500 VDCW	
C121	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C122	0140-0215	C:FXD MICA 80PF 2% 300VDCW	
C123	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C124		NOT ASSIGNED	
C125	0140-0152	C:FXD MICA 1000 PF 5% 300 VDCW	
C126	0140-0176	C:FXD MICA 100 PF 2% 300 VDCW	
C127	0140-0196	C:FXD MICA 150 PF 5% 300 VDCW	
C128 THRU C200		NOT ASSIGNED	
C201	0170-0019	C:FXD MY 0.1 UF 5% 200VDCW	
C202	0160-0207	C:FXD MYLAR 0.01UF 5% 200VDCW	
C203	0140-0152	C:FXD MICA 1000 PF 5% 300 VDCW	
C204	0160-0208	C:FXD MICA 91PF 2% 300WVDC	
C205	0130-0014	C:VAR CER 5-25 PF NPO	
C206	0140-0194	C:FXD MICA 110 PF 5%	
C207	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C208	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C209	0140-0176	C:FXD MICA 100 PF 2% 300 VDCW	
C210	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C211 THRU C212		NOT ASSIGNED	
C213	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C214	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C215	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C216	0140-0176	C:FXD MICA 100 PF 2% 300 VDCW	
C217		NOT ASSIGNED	
C218	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C219		NOT ASSIGNED	
C220	0160-2150	C:FXD MICA 33 PF 5% 300 VDCW	
C221	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C222	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C223	0140-0194	C:FXD MICA 110 PF 5%	
C224		NOT ASSIGNED	
C225	0170-0019	C:FXD MY 0.1 UF 5% 200VDCW	
C226	0160-0207	C:FXD MYLAR 0.01UF 5% 200VDCW	
C227	0140-0152	C:FXD MICA 1000 PF 5% 300 VDCW	
C228	0160-0208	C:FXD MICA 91PF 2% 300WVDC	
C229	0130-0014	C:VAR CER 5-25 PF NPO	
C230		NOT ASSIGNED	
C231	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
C232	0150-0052	C:FXD CER 0.05UF 20% 400VDCW	
C233	0140-0176	C:FXD MICA 100 PF 2% 300 VDCW	
C234	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C235	0140-0194	C:FXD MICA 110 PF 5%	
C236 THRU C300		NOT ASSIGNED	
C301	0140-0200	C:FXD MICA 390 PF 5% 300VDCW	
C302	0140-0175	C:FXD MICA 39 PF 2% 300 VDCW	
C303	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C304	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C305		NOT ASSIGNED	
C306	0140-0200	C:FXD MICA 390PF 5% 300VDCW	
C307	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C308		NOT ASSIGNED	
C309	0140-0193	C:FXD MICA 82 PF 5% 300 VDCW	
C310	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C311	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C312 THRU C314		NOT ASSIGNED	
C315	0150-0121	C:FXD CER 0.1UF 50 VDCW	
C316		NOT ASSIGNED	
C317	0160-0127	C:FXD CER 1.0 UF 20% 25VDCW	
C318	0180-0049	C:FXD ELECT 20UF 50VDCW	
C319	0130-0017	C:VAR 8-50 PF	
C320	0160-3448	C:FXD CER 1000PF 10% 1000 WVDC	
C321	0160-3448	C:FXD CER 1000PF 10% 1000 WVDC	
C322	0140-0176	C:FXD MICA 100 PF 2% 300 VDCW	
C323	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C324	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C325	0180-0046	C:FXD ELECT 600UF 200VDCW	
C326 THRU C327		NOT ASSIGNED	
C328	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C329	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C330	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C331	0180-0051	C:FXD ELECT 8UF 350VDCW	
C332	0180-0154	C:FXD ELECT 430UF +100-10% 250VDCW	
CR1	1901-0030	SEMICON DEVICE DIODE JUNCTION	
CR2	1901-0030	SEMICON DEVICE DIODE JUNCTION	
CR3	1901-0030	SEMICON DEVICE DIODE JUNCTION	
CR4	1901-0030	SEMICON DEVICE DIODE JUNCTION	
CR5	1901-0036	SEMICON DEVICE DIODE	
CR6	1901-0036	SEMICON DEVICE DIODE	
CR7	1901-0036	SEMICON DEVICE DIODE	
CR8 THRU CR100		NOT ASSIGNED	
CR101	1902-0065	SEMICONDUCTOR DEVICE:DIODE, AVALANCHE	
CR102	1910-0002	SEMICON DEVICE DIODE 1N38B	
CR103	1910-0016	SEMICON DEVICE DIODE GERMANIUM	
CR104	1901-0040	SEMICON DEVICE DIODE SILICON	
CR105	1902-0074	SEMICON DEVICE: SI DIODE 7.1V	
CR106 THRU CR200		NOT ASSIGNED	

See list of abbrevictions in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
CR201	1910-0016	SEMICON DEVICE:DIODE GERMANIUM	
CR202	1910-0016	SEMICON DEVICE:DIODE GERMANIUM	
CR203	1901-0040	SEMICON DEVICE:DIODE SILICON	
CR204	1910-0002	SEMICON DEVICE:DIODE 1N38B	
CR205		NOT ASSIGNED	
CR206	1910-0002	SEMICON DEVICE:DIODE 1N38B	
CR207	1910-0016	SEMICON DEVICE:DIODE GERMANIUM	
CR208	1910-0016	SEMICON DEVICE:DIODE GERMANIUM	
CR209	1910-0016	SEMICON DEVICE:DIODE GERMANIUM	
CR210	1901-0050	SEMICON DEVICE:DIODE SILICON	
CR211		NOT ASSIGNED	
CR212	1910-0016	SEMICON DEVICE:DIODE GERMANIUM	
CR213	1901-0040	SEMICON DEVICE:DIODE SILICON	
CR214	1910-0002	SEMICON DEVICE:DIODE 1N38B	
CR215 THRU CR300		NOT ASSIGNED	
CR301	1910-0016	SEMICON DEVICE:DIODE GERMANIUM	
CR302	1910-0016	SEMICON DEVICE:DIODE GERMANIUM	
CR303	1901-0050	SEMICON DEVICE:DIODE SILICON	
CR304	1901-0050	SEMICON DEVICE:DIODE SILICON	
CR305		NOT ASSIGNED	
CR306	1910-0016	SEMICON DEVICE:DIODE GERMANIUM	
CR307	1902-3256	SEMICON DEVICE:SI DIODE 23.7V 5%	
CR308	1901-0040	SEMICON DEVICE:DIODE SILICON	
CR309	1901-0050	SEMICON DEVICE:DIODE SILICON	
CR310	1901-0050	SEMICON DEVICE:DIODE SILICON	
CR311 THRU CR312		NOT ASSIGNED	
CR313	1901-0050	SEMICON DEVICE:DIODE SILICON	
CR314	1910-0016	SEMICON DEVICE:DIODE GERMANIUM	
CR315	1901-0050	SEMICON DEVICE:DIODE SILICON	
CR316		NOT ASSIGNED	
CR317	1901-0050	SEMICON DEVICE:DIODE SILICON	
CR318	1901-0050	SEMICON DEVICE:DIODE SILICON	
CR319		NOT ASSIGNED	
CR320	1902-0224	SEMICON DEVICE:DIODE AVALANCHE	
CR321	1902-0048	SEMICON DEVICE:DIODE BREAKDOWN	
CR322	1902-0048	SEMICON DEVICE:DIODE BREAKDOWN	
CR323		NOT ASSIGNED	
CR324	1901-0050	SEMICON DEVICE:DIODE SILICON	
CR325	1901-0050	SEMICON DEVICE:DIODE SILICON	
CR326	1902-0055	SEMICON DEVICE:SI DIODE 14.7V 10%	
CR327	1901-0041	SEMICON DEVICE:DIODE SILICON	
CR328	1901-0041	SEMICON DEVICE:DIODE SILICON	
DL201	9190-0008	DELAY LINE:1000 OHM 0.4USEC	
DL202	9190-0007	DELAY LINE:1000 OHM 0.14USEC	
DS1	1450-0419	LIGHT:INDICATOR, 115V	
DS2	1450-0419	LIGHT:INDICATOR WHITE NEON	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
DS3 THRU DS100		NOT ASSIGNED	
DS101	2140-0083	LAMP- NEON	
DS102 THRU DS300		NOT ASSIGNED	
DS301	2140-0030	LAMP:GLOW T2 BULB 10 UA 65V	
DS302	2140-0030	LAMP:GLOW T2 BULB 10 UA 65V	
DS303	2140-0030	LAMP:GLOW T2 BULB 10 UA 65V	
F1	2110-0014	FUSE:CARTRIDGE 4 AMP 125V MAX SLOW BLOW 115V OPERATION	
F1	2110-0006	FUSE:CARTRIDGE 2 AMP SLOW BLOW 230V OPERATION	
F2	2110-0046	FUSE:CARTRIDGE 1/2 AMP	
FL1	9100-3173	FILTER:LINE	
J1	1251-2357	CONNECTOR, MALE, 3 PIN	
J2 THRU J100		NOT ASSIGNED	
J101	1250-0083	CONNECTOR: BNC	
J102	1250-0083	CONNECTOR: BNC	
J103 THRU J200		NOT ASSIGNED	
J201	1250-0083	CONNECTOR: BNC	
J202 THRU J400		NOT ASSIGNED	
J401	1250-0140	CONNECTOR:BODY	
K1	0490-0047	RELAY:DPDT 4AMP	
L101	9140-0098	COIL:FXD RF 2.2 UH	
L102	9140-0115	COIL:FXD RF 22UH 10%	
L103	9170-0013	BEAD: TOROID	
L104	9140-0023	COIL:FXD RF 55 UH	
L105	9170-0013	BEAD: TOROID	
L106 THRU L300		NOT ASSIGNED	
L301	00214-66002	FIXED COIL:80 UH	
L302		NOT ASSIGNED	
L303	00214-66002	FIXED COIL:80 Uh	
L304		NOT ASSIGNED	
L305	9170-0016	BEAD:MAGNETIC	
L306	9170-0016	BEAD:MAGNETIC	
L307		NOT ASSIGNED	
L308	9110-0063	REACTOR:AUDIO	
L309 THRU L400		NOT ASSIGNED	
L401		NOT SEPARATELY REPLACEABLE PARTOF A6	
L402		NOT SEPARATELY REPLACEABLE PARTOF A6	
P1		NOT SEPARATELY REPLACEABLE PART OF A1	
P2		NOT SEPARATELY REPLACEABLE PART OF A1	
Q101	1854-0003	TRANSISTOR:NPN SILICON	
Q102 THRU Q300		NOT ASSIGNED	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
Q301	5080-0443	TRANSISTOR:PNP SILICON	
R1	0687-8251	R:FXD COMP 8.2M OHMS 10% 1/2W	
R2	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R3	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R4	0819-0016	R:FXD WW 1500 OHMS 5% 10W	
R5	0693-6801	R:FXD COMP 68 OHMS 10% 2W	
R6	0693-6801	R:FXD COMP 68 OHMS 10% 2W	
R7		NOT ASSIGNED	
R8	0687-1841	R:FXD COMP 180K OHMS 10% 1/2W	
R9		NOT ASSIGNED	
R10	0687-1841	R:FXD COMP 180K OHMS 10% 1/2W	
R11	0687-1541	R:FXD COMP 150K OHMS 10% 1/2W	
R12	0727-0228	R:FXD DEPC 252K OHM 1% 1/2W	
R13	2100-0094	R:VAR COMP 50K OHMS 30% LIN 1/5W	
R14	0727-0228	R:FXD DEPC 252K OHM 1% 1/2W	
R15		NOT ASSIGNED	
R16	0687-1051	R:FXD COMP 1MEG OHM 10% 1/2W	
R17	0815-0012	R:FXD WW 1800 OHMS 5% 10W	
R18	0687-4711	R:FXD COMP 470 OHM 10% 1/2W	
R19		NOT ASSIGNED	
R20	0687-2231	R:FXD COMP 22K OHMS 10% 1/2W	
R21	0687-1841	R:FXD COMP 180K OHMS 10% 1/2W	
R22	0687-1841	R:FXD COMP 180K OHMS 10% 1/2W	
R23	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R24		NOT ASSIGNED	
R25	0757-0342	R:FXD MET FLM 100K OHMS 1% 1/4W	
R26	2100-0094	R:VAR COMP 50K OHMS 30% LIN 1/5W	
R27	0727-0220	R:FXD DEPC 183K OHM 1% 1/2W	
R28 THRU R29		NOT ASSIGNED	
R30	2100-0281	R:VAR WW 100 OHMS 20% LIN 1 1/4W	
R31	0687-3931	R:FXD COMP 39K OHMS 10% 1/2W	
R32	0767-0010	R:FXD MET FLM 15K OHMS 5% 3W	
R33	0687-1551	R:FXD COMP 1.5MEGOHMS 10% 1/2W	
R34	0813-0009	R:FXD WW 125 OHMS 10% 2W	
R35		NOT ASSIGNED	
R36	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R37	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R38	0690-1001	R:FXD COMP 10 OHMS 10% 1W	
R39	0690-1001	R:FXD COMP 10 OHMS 10% 1W	
R40		NOT ASSIGNED	
R41	0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	
R42	0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	
R43		NOT ASSIGNED	
R44	0727-0229	R:FXD DEPC 265K OHM 1% 1/2W	
R45	2100-0094	R:VAR COMP 50K OHMS 30% LIN 1/5W	
R46	0727-0219	R:FXD DEPC 182K OHM 1% 1/2W	
R47		NOT ASSIGNED	
R48	0687-3931	R:FXD COMP 39K OHMS 10% 1/2W	
R49 THRU R100		NOT ASSIGNED	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
R101	0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	
R102	0687-1051	R:FXD COMP 1MEG OHM 10% 1/2W	
R103	0757-0342	R:FXD MET FLM 100K OHMS 1% 1/4W	
R104	0757-0769	R:FXD MET FLM 51.1K OHMS 1% 1/4W	
R105	2100-0074	R:VAR COMP 1MEG OHM 30% LIN 1/4W	
R106 THRU R107		NOT ASSIGNED	
R108	0687-2211	R:FXD COMP 220 OHM 10% 1/2W	
R109	0687-2211	R:FXD COMP 220 OHM 10% 1/2W	
R110	0761-0011	R:FXD MET FLM 3300 OHM 5% 1W	
R111	0686-1315	R:FXD COMP 130 OHM 5% 1/2W	
R112	0686-1315	R:FXD COMP 130 OHM 5% 1/2W	
R113	0767-0009	R:FXD MET FLM 12K OHM 3W	
R114		NOT ASSIGNED	
R115	0687-1051	R:FXD COMP 1MEG OHM 10% 1/2W	
R116	0687-1541	R:FXD COMP 150K OHMS 10% 1/2W	
R117	0687-2741	R:FXD COMP 270K OHMS 10% 1/2W	
R118	0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	
R119		NOT ASSIGNED	
R120	0687-4731	R:FXD COMP 47K OHM 10% 1/2W	
R121	0761-0005	R:FXD MET OX 2200 OHM 5% 1W	
R122	0687-5631	R:FXD COMP 56K OHM 10% 1/2W	
R123 THRU R124		NOT ASSIGNED	
R125	0687-4701	R:FXD COMP 47 OHMS 10% 1/2W	
R126	0727-0092	R:FXD DEPC 860 OHM 1% 1/2W	
R127	0761-0005	R:FXD MET OX 2200 OHM 5% 1W	
R128	0764-0006	R:FXD MET FLM 18K OHM 5% 2W	
R129	0727-0226	R:FXD DEPC 250K OHM 1% 1/2W	
R130	0757-0052	R:FXD MET FLM 500K OHMS 1% 1/2W	
R131		NOT ASSIGNED	
R132	0757-0074	R:FXD MET FLM 27K OHMS 5% 1/4W	
R133	2100-0379	R:VAR COMP 10K OHM 30% LIN 1/4W	
R134	0689-6835	R:FXD COMP 68K OHMS 5% 1W	
R135	2100-0964	R:VAR COMP 50K OHM 30% 1/4W L KNOB TYPE	
R136	0687-3931	R:FXD COMP 39K OHMS 10% 1/2W	
R137		NSR PART OF A7	
R138	0758-0018	R:FXD MET FLM 15K OHMS 5% 1/2W	
R139 THRU R140		NOT ASSIGNED	
R141	0687-1001	R:FXD COMP 10 OHM 10% 1/2W	
R142	0687-5611	R:FXD COMP 560 OHM 10% 1/2W	
R143	0687 3311	R:FXD COMP 330 OHMS 10% 1/2W (RANGE 220-500 OHMS)	
R144	0690-1511	R:FXD COMP 150 OHMS 10% 1W	
R145		NOT ASSIGNED	
R146	0686-4755	R:FXD COMP 4.7 MEGOHM 5% 1/2W	
R147	0687-5641	R:FXD COMP 560K OHMS 10% 1/2W	
R148	0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	
R149	0761-0006	R:FXD MET FLM 10K OHM 5% 1W	
R150	0757-0197	R: FXD MET FLM 1500 OHMS 1% 1/2W	
R151	0767-0011	R:FXD MET FLM 20K OHM 5% 3W	
R152	0758-0035	R:FXD MET FLM 3000 OHMS 5% 1/4W	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
R153 AND R154		NOT ASSIGNED	
R155	0687-1521	R:FXD COMP 1500 OHMS 10% 1/2W	
R156	0687-1541	R:FXD COMP 150K OHMS 10% 1/2W	
R157	0730-0044	R:FXD DEPC 27.5K OHMS 1% 1W	
R158	0687-1811	R:FXD COMP 180 OHMS 10% 1/2W	
R159	0727-0321	R:FXD DEPC 1370 OHMS 1% 1/2W	
R160 THRU R200		NOT ASSIGNED	
R201	2100-0182	R:VAR COMP 3300 OHMS 10% LIN 3W	
R202	0690-2721	R:FXD COMP 2700 OHM 10% 1W	
R203	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R204	0757-0334	R:FXD MET FLM 301 OHMS 1% 1/4W	
R205	0773-0004	R:FXD MET FLM 10K OHMS 5% 5W	
R206		NOT ASSIGNED	
R207	2100-0043	R:VAR COMP 500K OHM 10% LIN 2W	
R208	0758-0057	R:FXD MET FLM 5600 OHMS 5% 1/2W	
R209	2100-0424	R:VAR COMP 50K OHM 20% 1/4W (INCLUDES R210)	
R210	2100-0424	R:VAR COMP 50K OHM 20% 1/4W (PART OF R209)	
R211	0687-4701	R:FXD COMP 47 OHMS 10% 1/2W	
R212 THRU R214		NOT ASSIGNED	
R215	0767-0016	R:FXD MET OX 3K OHM 5% 3W	
R216	0727-0218	R:FXD DEPC 180K OHM 1% 1/2W	
R217	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R218	0727-0218	R:FXD DEPC 180K OHM 1% 1/2W	
R219	0690-1511	R:FXD COMP 150 OHMS 10% 1W	
R220		NOT ASSIGNED	
R221	0687-1001	R:FXD COMP 10 OHM 10% 1/2W	
R222	0687-5611	R:FXD COMP 560 OHMS 10% 1/2W	
R223	0687-2701	R:FXD COMP 27 OHMS 10% 1/2W	
R224		NOT ASSIGNED	
R225	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R226		NOT ASSIGNED	
R227	0690-3331	R:FXD COMP 33K OHMS 10% 1W	
R228	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R229		NOT ASSIGNED	
R230	0687-1001	R:FXD COMP 10 OHM 10% 1/2W	
R231	0758-0094	R:FXD MET FLM 62 OHMS 5% 1/4W	
R232	0687-8201	R:FXD COMP 82 OHM 10% 1/2W	
R233	0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	
R234	0686-3005	R:FXD COMP 30 OHM 5% 1/2W	
R235	0689-5105	R:FXD COMP 51 OHMS 5% 1W	
R236		NOT ASSIGNED	
R237	0687-4701	R:FXD COMP 47 OHMS 10% 1/2W	
R238	0687-4721	R:FXD COMP 4700 OHMS 10% 1/2W	
R239	0687-3321	R:FXD COMP 3300 OHMS 10% 1/2W	
R240		NOT ASSIGNED	
R241	0687-1001	R:FXD COMP 10 OHM 10% 1/2W	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
R242	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R243	0757-0712	R:FXD MET FLM 90.9 OHMS 1% 1/4W	
R244	0690-1511	R:FXD COMP 150 OHMS 10% 1W	
R245 THRU R246		NOT ASSIGNED	
R247	0757-0086	R:FXD MET FLM 51 OHMS 2% 1/2W	
R248	0757-0086	R:FXD MET FLM 51 OHMS 2% 1/2W	
R249		NOT ASSIGNED	
R250	2100-0182	R:VAR COMP 3300 OHMS 10% LIN 3W	
R251	0690-2721	R:FXD COMP 2700 OHM 10% 1W	
R252	0687-4701	R:FXD COMP 47 OHMS 10% 1/2W	
R253	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R254	0757-0334	R:FXD MET FLM 301 OHMS 1% 1/4W	
R255	0773-0004	R:FXD MET FLM 10K OHMS 5% 5W	
R256		NOT ASSIGNED	
R257	2100-0043	R:VAR COMP 500K OHM 10% LIN 2W	
R258	0758-0057	R:FXD MET FLM 5600 OHM 5% 1/2W	
R259	2100-0424	R:VAR COMP 50K OHM 20% 1/4W INCLUDES R260	
R260	2100-0424	R:VAR COMP 50K OHM 20% 1/4W NOT SEPARATELY REPLACEABLE PARTOF R259	
R261	0687-4701	R:FXD COMP 47 OHMS 10% 1/2W	
R262 THRU R264		NOT ASSIGNED	
R265	0767-0016	R:FXD MET OX 3K OHM 5% 3W	
R266	0727-0218	R:FXD DEPC 180K OHM 1% 1/2W	
R267	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R268	0727-0218	R:FXD DEPC 180K OHM 1% 1/2W	
R269	0690-1511	R:FXD COMP 150 OHMS 10% 1W	
R270		NOT ASSIGNED	
R271	0687-1001	R:FXD COMP 10 OHM 10% 1/2W	
R272	0687-5611	R:FXD COMP 560 OHMS 10% 1/2W	
R273	0687-2701	R:FXD COMP 27 OHMS 10% 1/2W	
R274 THRU R300		NOT ASSIGNED	
R301	0684-3321	R:FXD COMP 3300 OHMS 10% 1/4W	
R302	0687-2741	R:FXD COMP 270K OHMS 10% 1/2W	
R303	0684-3321	R:FXD COMP 3300 OHMS 10% 1/4W	
R304 THRU R306		NOT ASSIGNED	
R307	0684-1001	R:FXD COMP 10 OHMS 10% 1/4W	
R308	0684-3911	R:FXD COMP 390 OHMS 10% 1/4W	
R309	0683-1545	R:FXD COMP 150K OHMS 5% 1/4W	
R310	0683-4735	R:FXD COMP 47K OHMS 5% 1/4W	
R311	0683-1045	R:FXD COMP 100K OHM 5% 1/4W	
R312		NOT ASSIGNED	
R313	0684-1001	R:FXD COMP 10 OHMS 10% 1/4W	
R314	0684-3911	R:FXD COMP 390 OHMS 10% 1/4W	
R315	0683-2025	R:FXD COMP 2000 OHMS 5% 1/4W	
R316		NOT ASSIGNED	
R317	0683-1005	R:FXD COMP 10 OHM 5% 1/4W	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
R318	0684-3321	R:FXD COMP 3300 OHMS 10% 1/4W	
R319	0683-1005	R:FXD COMP 10 OHM 5% 1/4W	
R320	0683-1005	R:FXD COMP 10 OHMS 5% 1/4W	
R321	0683-1505	R:FXD COMP 15 OHMS 5% 1/4W	
R322	0683-1225	R:FXD COMP 1200 OHMS 5% 1/4W	
R323	0699-0006	R:FXD COMP 4.7 OHM 10% 1W	
R324		NOT ASSIGNED	
R325	0684-1511	R:FXD COMP 150 OHMS 10% 1/4W	
R326	0684-1511	R:FXD COMP 150 OHMS 10% 1/4W	
R327	0766-0038	R:FXD MET OX 18K OHM 2% 3W	
R328	0687-2201	R:FXD COMP 22 OHMS 10% 1/2W	
R329	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R330	0684-4711	R:FXD COMP 470 OHMS 10% 1/4W	
R331	0757-0852	R:FXD MET FLM 47.5K OHMS 1% 1/2W	
R332		NOT ASSIGNED	
R333	0683-0475	R:FXD COMP 4.7 OHMS 5% 1/4W	
R334	0690-8231	R:FXD COMP 82K OHM 10% 1W	
R335	0687-2731	R:FXD COMP 27K OHMS 10% 1/2W	
R336	0683-6835	R:FXD COMP 68K OHM 5% 1/4W	
R337	0683-3345	R:FXD COMP 330K OHMS 5% 1/4W	
R338	0699-0006	R:FXD COMP 4.7 OHMS 10% 1W	
R339		NOT ASSIGNED	
R340	0698-0027	R:FXD MET FLM 1600 OHM 5% 3W	
R341	0764-0003	R:FXD MET FLM 3300 OHM 5% 2W	
R342	0698-0001	R:FXD COMP 4.7 OHM 5% 1/2W	
R343	0761-0019	R2FXD MET OX 39K OHM 5% 1W	
R344	2100-0102	R:VAR COMP 500K OHMS 30% LIN 1/5W	
R345	0684-1031	R:FXD COMP 10K OHM 10% 1/4W	
R346	0684-4741	F:FXD COMP 470K OHM 10% 1/4W	
R347	0777-0003	R:FXD MET FLM 1300 OHM 10% 7W	
R348	0773-0008	R:FXD MET FLM 33K OHM 5% 5W	
R349	0761-0023	R2FXD MET FLM 51K OHM 5%	
R350	0764-0027	R:FXD MET FLM 75K OHM 5% 2W	
R351	0684-5601	R:FXD COMP 56 OHMS 10% 1/4W	
R352	0811-1714	R:FXD WW 1200 OHM 5% 10W	
R353	2100-0191	R:VAR COMP 250K OHM 20% LIN 1/4W	
R354	2100-0425	R:VAR COMP 500K OHM 30% 1/2W	
R355	2100-0425	R:VAR COMP 500K OHM 30% 1/2W	
R356		NOT ASSIGNED	
R357	0684-5601	R:FXD COMP 56 OHMS 10% 1/4W	
R358	0721-0019	R:FXD DEPC 937K OHMS 1% 1/8W	
R359		NOT ASSIGNED	
R360	2100-0184	R:VAR COMP 250K OHM 10% LIN 2W	
R361	0684-1021	R:FXD COMP 1000 OHM 10% 1/4W	
R362	0684-1021	R:FXD COMP 1000 OHM 10% 1/4W	
R363	2100-0095	R:VAR COMP 100K OHMS 30% LIN 1/5W	
R364	0757-0792	R:FXD MET FLM 681K OHMS 1% 1/4W	
R365		NOT ASSIGNED	
R366	0757-0853	R:FXD MET FLM 51.1K OHMS 1% 1/2W	
R367	0757-0352	R:FXD MET FLM 150K OHMS 1% 1/2W	
R368	0686-4345	R:FXD COMP 430K OHMS 5% 1/2W	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
R369	0687-4721	R:FXD COMP 4700 OHMS 10% 1/2W	
R370 THRU R400		NOT ASSIGNED	
R401	0684-3921	R:FXD COMP 3900 OHMS 10% 1/4W	
R402	0684-1511	R:FXD COMP 150 OHMS 10% 1/4W	
R403		NOT ASSIGNED	
R404	0770-0004	R:FXD MET FLM 10K OHMS 5% 4W	
R405	0775-0007	R:FXD MET OX 200 OHM 2% 7W	
R406	0775-0007	R:FXD MET OX 200 OHM 2% 7W	
R407	0775-0007	R:FXD MET OX 200 OHM 2% 7W	
R408	0775-0007	R:FXD MET OX 200 OHM 2% 7W	
R409 THRU R410		NOT ASSIGNED	
R411	0760-0027	R:FXD MET FLM 150 OHM 2% 1%	
R412	0757-0172	R:FXD MET FLM 37.4 OHM 1% 1/2W	
R413	0757-0801	R:FXD MET FLM 150 OHM 1% 1/2W	
R414	0760-0026	R:FXD MET FLM 75 OHM 2% 1W	
R415	0757-0069	R:FXD MET FLM 121 OHM 1% 1/4W	
R416	0757-0170	R:FXD MET OX 75 OHM 2% 0.5W	
R417	0757-0069	R:FXD MET FLM 121 OHM 1% 1/4W	
R418	0757-0071	R:FXD MET FLM 247.5 OHMS 1% 0.25W	
R419	0757-0069	R:FXD MET FLM 121 OHM 1% 1/4W	
S1	3101-0056	SWITCH:TOGGLE DPDT	
S2	3101-1234	SWITCH:SLIDE 115V-230V	
S3 THRU S100		NOT ASSIGNED	
S101	3101-0011	SWITCH SLIDE DPDT 0.5 AMP 125 VDC	
S102	3101-0014	SWITCH:PUSH SPDT NE	
S103	3100-0415	SWITCH:ROTARY PART OF A2	
S104		NSR:PART OF A7	
S105	3101-0011	SWITCH:SLIDE DPDT 0.5 AMP 125 VDC	
S106 THRU S200		NOT ASSIGNED	
S201	3100-0416	SWITCH:ROTARY PART OF A4	
S202	3100-0415	SWITCH: ROTARY	
S203	3101-0011	SWITCH:SLIDE DPDT 0.5 AMP 125 VDC	
S204	3100-0416	SWITCH:ROTARY PART OF A8	
S205 THRU S400		NOT ASSIGNED	
S401		NSR PART OF A5	
S402	3101-0011	SWITCH:SLIDE DPDT 0.5 AMP 125 VDC	
T1	9100-0181	TRANSFORMER:POWER	
T2 THRU T100		NOT ASSIGNED	
T101	9130-0020	TRANSFORMER:PULSE 1:1 20%	
T102 THRU T200		NOT ASSIGNED	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
T201	9130-0020	TRANSFORMER:PULSE 1:1 20%	
T202	9130-0020	TRANSFORMER:PULSE 1:1 20%	
T203	9130-0020	TRANSFORMER:PULSE 1:1 20%	
T204	9130-0020	TRANSFORMER:PULSE 1:1 20%	
T205 THRU T300		NOT ASSIGNED	
T301	00214-66003	TRANSFORMER:PULSE	
T302	00214-66003	TRANSFORMER:PULSE	
V1	1932-0010	ELECTRON TUBE: 6080 DUAL -TRIODE	
V2	1932-0030	ELECTRON TUBE: 12AX7 TWIN TRIODE 9 PIN MIN	
V3	1932-0030	ELECTRON TUBE: 12AX7 TWIN TRIODE 9 PIN MIN	
V4	1933-0005	ELECTRON TUBE: 7734 TRIODE PENTODE	
V5	1932-0030	ELECTRON TUBE: 12AX7 TWIN TRIODE 9 PIN MIN	
V6	1940-0001	TUBE:ELECTRON 5651	
V7	1932-0010	ELECTRON TUBE: 6080 DUAL-TRIODE	
V8	1940-0004	ELECTRON TUBE: 0A2 VOLTAGE REGULATOR	
V9 THRU V100		NOT ASSIGNED	
V101	1932-0022	ELECTRON TUBE: DUAL TRIODE 6DJ8	
V102	1932-0022	ELECTRON TUBE: DUAL TRIODE 6DJ8	
V103	1932-0022	ELECTRON TUBE: DUAL TRIODE 6DJ8	
V104	1932-0022	ELECTRON TUBE: DUAL TRIODE 6DJ8	
V105 THRU V200		NOT ASSIGNED	
V201	1932-0022	ELECTRON TUBE: DUAL TRIODE 6DJ8	
V202	1933-0006	ELECTRON TUBE: 6CX8 TRIODE PENTODE	
V203	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V204	1933-0006	ELECTRON TUBE: 6CX8 TRIODE PENTODE	
V205	1932-0022	ELECTRON TUBE: DUAL TRIODE 6DJ8	
V206	1932-0022	ELECTRON TUBE: DUAL TRIODE 6DJ8	
V207 THRU V300		NOT ASSIGNED	
V301	1923-0068	ELECTRON TUBE:6CW5 PENTODE	
V302	1933-0006	ELECTRON TUBE: 6CX8 TRIODE PENTODE	
V303	1923-0068	ELECTRON TUBE:6CW5 PENTODE	
V304	1923-0052	ELECTRON TUBE:7534 PENTODE	
V305	1923-0052	ELECTRON TUBE:7534 PENTODE	
V306	1923-0044	ELECTRON TUBE: 6CW5 (EL 86) PENTODE	
V307	1923-0044	ELECTRON TUBE: 6CW5 (EL 86) PENTODE	
V308	1932-0022	ELECTRON TUBE: DUAL TRIODE 6DJ8	
W1	8120-1545	CABLE: POWER SVT-18-3 7.5FT.	
XF1	1400-0084	FUSEHOLDER: EXTRACTOR POST TYPE	
XT301	1200-0053	SOCKET:TUBE 7 PIN MINAT	
XT302	1200-0053	SOCKET:TUBE 7 PIN MINAT	
XV2	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV3	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV4	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV5	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV6	1200-0053	SOCKET:TUBE 7 PIN MINAT	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	⊛ Stock No.	Description #	Note
XV7	1200-0084	SOCKET:TUBE	
XV8	1200-0053	SOCKET:TUBE 7 PIN MINAT	
XV9 THRU			
XV100		NOT ASSIGNED	
XV101	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV102	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV103	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV104	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV105 THRU			
XV200		NOT ASSIGNED	
XV201	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV202	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV203	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV204	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV205	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV206	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV207 THRU			
XV300		NOT ASSIGNED	
XV301	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV302	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV303	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV304	1200-0084	SOCKET:TUBE	
XV305	1200-0084	SOCKET:TUBE	
XV306	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV307	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV308	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
		MISCELLANEOUS	
	310A-838	COVER:TOROID FOR L301 AND L303	
	00214-00206	PANEL:REAR	
	00214-00207	PANEL:FRONT MINT-GRAY	
	00214-66102	COVER:TOP, OLIVE GRAY	
	00214-66504	ETCHED CKT ASSY (TRIGGER MODE)	
	0370-0026	KNOB-BLACK VERNIER5 EXT. TRIG LEVEL	
	0370-0077	KNOB- 5/8 IN BLACK BAR TRIGGER MODE PULSE ADVANCE	
	0370-0112	KNOB- BLACK BAR PULSE WIDTH PULSE AMPLITUDE PULSE POSITION	
	1400-0111	NUT:FUSEHOLDER	
	1400-0112	KNOB:FUSEHOLDER	
	0370-0113	KNOB- CONCENTRIC BLACK BAR INT. REP. RATE	
	0370-0114	KNOB- RED INT. REP. RATE VERNIER	
	1200-0063	LUG:CRIMP ATTACHES WIRES TO POSTS ON P.C. BOARDS	
	1400-0071	CLAMP:TUBE	
	1400-0110	BODY:FUSEHOLDER	
	1490-0030	STAND:TILT	

See list of abbreviations in introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Stock No.	Description #	Note
	3150-0026	FILTER:AIR	
	5000-8719	COVER:SIDE, OLIVE GRAY	
	5040-0417	HOLDER:TUBE CLAMP	
	5060-0222	ASSY:SIDE HANDLE	
	5060-0767	FOOT:ASSY FM	
	5060-8713	COVER:BOTTOM, OLIVE-GRAY	
	5060-8735	ASSY:RETAINER HANDLE OLIVE-GRAY	
	5060-8741	KIT:7H RACK MT., MINT-GRAY	
	6980-0003	TRIM-PLASTIC	

See list of abbreviations in introduction to this section

Table 6-2. Replaceable Parts

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
310A-83B	COVER:TOROID FOR L301 AND L303	28480	310A-83B	1	0
0130-0001	C:VAR 7-45 PF 500 VDCW	72982	50300D2PO	1	1
0130-0014	C:VAR CER 5-25 PF NPO	28480	0130 0014	2	1
0130-0017	C:VAR 7-50 PF	28480	0130-0017	1	
0140-0116	C:FXD MICA 39 PF 2% 500 VDCW	04062	RCM15E390G	1	1
0140-0152	C:FXD MICA 1000 PF 5% 300 VDCW	04062	DM16F102J	6	1
0140-0175	C:FXD MICA 39 PF 2% 300 VDCW	04062	DM15E390G (300V)	1	2
0140-0176	C:FXD MICA 100 PF 2% 300 VDCW	04062	DM15F101G (300V)	6	1
0140-0193	C:FXD MICA 82 PF 5% 300 VDCW	04062	RDM15E820J3C	1	2
0140-0194	C:FXD MICA 110 PF 5% 300 VDCW	28480	0140-0194	3	1
0140-0196	C:FXD MICA 150 PF 5% 300 VDCW	04062	DM15F151J	1	1
0140-0199	C:FXD MICA 240 PF 5% 300 VDCW	04062	DM15F241J 300V	1	1
0140-0200	C:FXD MICA 390 PF 5% 300 VDCW	04062	DM15F391J 300V	2	1
0140-0204	C:FXD 47 PF 5% NPO 500 VDCW	04062	CM15E470J	1	1
0140-0215	C:FXD MICA 80 PF 2% 300 VDCW	04062	DM15E800G 300V	1	1
0150-0012	C:FXD CER 0.01 UF 20% 1000 VDCW	56289	H1038	7	1
0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	56289	33C17A	24	5
0150-0121	C:FXD CER 0.1UF 50 VDCW	56289	5C50A	1	1
0160-0043	C:FXD PAPER 0.051UF 10% 400VDCW	14655	BC4S51 10%	1	1
0160-0127	C:FXD CER 1.0 UF 20% 25VDCW	56289	5C13	1	1
0160-0207	C:FXD MYLAR 0.01UF 5% 200VDCW	28480	0160-0207	3	1
0160-0208	C:FXD MICA 91PF 2% 300WVDC	72136	DM15F (91PF) G (300V)	3	1
0160-2128	C:FXD MYLAR 0.33UF 20% 200VDCW	56289	225' 33402YPWM	1	1
0160-3448	C:FXD CER 1000PF 10% 1000WVDC	56289	C607-B241F102K325-DC	2	1
0170-0019	C:FXD MY 0.1 UF 5% 200VDCW	28480	0170-0019	3	1
0170-0055	C:FXD MY 0.1UF 20% 200VDCW	56289	192P10402	3	1
0180-0024	C:FXD ELECT 40UF 450VDCW	56289	D32441	1	1
0180-0030	C:FXD ELECT 120 X40 UF 450VDCW	28480	0180 0030	3	1
0180-0046	C:FXD ELECT 600UF 200VDCW	56289	D32569	1	1
0180-0049	C:FXD ELECT 20UF 50VDCW	56289	30D198A1	1	1
0180-0051	C:FXD ELECT 8UF 350VDCW	56289	D32551	1	1
0180-0154	C:FXD ELECT 430UF +100-10% 250VDCW	56289	4S488	1	1
0370-0026	KNOB-BLACK	28480	0370-0026	2	0
0370-0077	KNOB- 5/8 IN BLACK BAR	28480	0370-0077	2	0
0370-0112	KNOB- BLACK BAR	28480	0370-0112	5	0
0370-0113	KNOB- CONCENTRIC BLACK BAR	28480	0370-0113	1	0
0370-0114	KNOB- RED	28480	0370-0114	1	0
0490-0047	RELAY:DPDT 4AMP	71482	A-114938	1	1
0683-0475	R:FXD COMP 4.7 OHMS 5% 1/4W	01121	CB 0475	2	1
0683-1045	R:FXD COMP 100K OHM 5% 1/4W	01121	CB 1045	2	1
0683-1225	R:FXD COMP 1200 OHMS 5% 1/4W	01121	CB 1225	1	1
0683-1505	R:FXD COMP 15 OHMS 5% 1/4W	01121	CB 1505	1	1
0683-1545	R:FXD COMP 150K OHMS 5% 1/4W	01121	CB 1545	1	1
0683-2025	R:FXD COMP 2000 OHMS 5% 1/4W	01121	CB 2025	1	1
0683-3345	R:FXD COMP 330K OHMS 5% 1/4W	01121	CB 3345	1	1
0683-4735	R:FXD COMP 47K OHMS 5% 1/4W	01121	CB 4735	1	1
0683-6835	R:FXD COMP 68K OHM 5% 1/4W	01121	CB 6835	1	1
0684-1001	R:FXD COMP 10 OHMS 10% 1/4W	01121	CB 1001	2	1
0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	01121	CB 1011	1	1
0684-1021	R:FXD COMP 1000 OHM 10% 1/4W	01121	CB 1021	2	1
0684-1031	R:FXD COMP 10K OHM 10% 1/4W	01121	CB-1031	1	1

See list of abbreviations in introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0684-1511	R:FXD COMP 150 OHMS 10% 1/4W	01121	CB 1511	3	1
0684-3321	R:FXD COMP 3300 OHMS 10% 1/4W	01121	CB 3321	3	1
0684-3911	R:FXD COMP 390 OHMS 10% 1/4W	01121	CB 3911	2	1
0684-3921	R:FXD COMP 3900 OHMS 10% 1/4W	01121	CB 3921	1	1
0684-4711	R:FXD COMP 470 OHMS 10% 1/4W	01121	CB 4711	1	1
0684-4741	R:FXD COMP 470K OHM 10% 1/4W	01121	CB 4741	1	1
0684-5601	R:FXD COMP 56 OHMS 10% 1/4W	01121	CB 5601	2	1
0686-1315	R:FXD COMP 130 OHM 5% 1/2W	01121	EB 1315	2	1
0686-2735	R:FXD COMP 27K OHM 5% 1/2W	01121	EB2735	1	1
0686-3005	R:FXD COMP 30 OHM 5% 1/2W	01121	EB 3005	1	1
0686-4755	R:FXD COMP 4.7 MEGOHM 5% 1/2W	01121	EB 4755	1	1
0686-5135	R:FXD COMP 51K OHMS 5% 1/2W	01121	EB 5135	1	1
0687-1001	R:FXD COMP 10 OHM 10% 1/2W	01121	EB1001	5	1
0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	01121	EB 1021	9	2
0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	01121	EB 1031	1	1
0687-1041	R:FXD COMP 100K OHM 10% 1/2W	01121	EB 1041	3	1
0687-1051	R:FXD COMP 1MEG OHM 10% 1/2W	01121	EB 1051	3	1
0687-1521	R:FXD COMP 1500 OHMS 10% 1/2W	01121	EB 1521	1	1
0687-1541	R:FXD COMP 150K OHMS 10% 1/2W	01121	EB 1541	3	1
0687-1551	R:FXD COMP 1.5MEGOHMS 10% 1/2W	01121	EB 1551	1	1
0687-1811	R:FXD COMP 180 OHMS 10% 1/2W	01121	EB 1811	1	1
0687-1841	R:FXD COMP 180K OHMS 10% 1/2W	01121	EB 1841	4	1
0687-2201	R:FXD COMP 22 OHMS 10% 1/2W	01121	EB 2201	1	1
0687-2211	R:FXD COMP 220 OHM 10% 1/2W	01121	EB2211	2	1
0687-2231	R:FXD COMP 22K OHMS 10% 1/2W	01121	EB 2231	1	1
0687-2701	R:FXD COMP 27 OHMS 10% 1/2W	01121	EB 2701	2	1
0687-2731	R:FXD COMP 27K OHMS 10% 1/2W	01121	EB 2731	1	1
0687-2741	R:FXD COMP 270K OHMS 10% 1/2W	01121	EB-2741	2	1
0687-3321	R:FXD COMP 3300 OHMS 10% 1/2W	01121	EB 3321	1	1
0687-3931	R:FXD COMP 39K OHMS 10% 1/2W	01121	EB 3931	3	1
0687-4701	R:FXD COMP 47 OHMS 10% 1/2W	01121	EB 4701	5	1
0687-3311	R:FXD COMP 330 OHMS 10% 1/2W	01121	EB-3311	1	1
0687-4721	R:FXD COMP 4700 OHM 10% 1/2W	01121	EB4721	2	1
0687-4731	R:FXD COMP 47K OHM 10% 1/2W	01121	EB4731	1	1
0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	01121	EB 4741	4	1
0687-5611	R:FXD COMP 560 OHM 10% 1/2W	01121	EB 5611	3	1
0687-5631	R:FXD COMP 56K OHM 10% 1/2W	01121	EB 5631	1	1
0687-5641	R:FXD COMP 560K OHMS 10% 1/2W	01121	EB 5641	1	1
0687-8201	R:FXD COMP 82 OHM 10% 1/2W	01121	EB8201	1	1
0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	01121	EB 8231	1	1
0687-8251	R:FXD COMP 8.2M OHMS 10% 1/2W	01121	EB 8251	1	1
0689-5105	R:FXD COMP 51 OHMS 5% 1W	01121	GB 5105	1	1
0689-6835	R:FXD COMP 68K OHMS 5% 1W	01121	GB 6835	1	1
0690-1001	R:FXD COMP 10 OHMS 10% 1W	01121	GB 1001	2	1
0690-1511	R:FXD COMP 150 OHMS 10% 1W	01121	GB 1511	4	1
0690-2721	R:FXD COMP 2700 OHM 10% 1W	01121	GB 2721	2	1

See list of abbreviations in introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0690-3331	R:FXD COMP 33K OHMS 10% 1W	01121	GB 3331	1	1
0690-8231	R:FXD COMP 82K OHMS 10% 1W	01121	GB 8231	1	1
0693-6801	R:FXD COMP 68 OHMS 10% 2W	01121	HB 6801	2	1
0698-0001	R:FXD COMP 4.7 OHMS 5% 1/2W	01121	EB 47G5	1	1
0698-0027	R:FXD MET FLM 1600 OHMS 5% 3W	28480	0698-0027	1	1
0699-0006	R:FXD COMP 4.7 OHMS 10% 1W	01121	GB 47G1	2	1
0721-0019	R:FXD DEPC 937K OHMS 1% 1/8W	19701	CF 1/8	1	1
0727-0033	R:FXD DEPC 61.11 OHM 1% 1/2W	19701	DC 1/2 CR5	2	1
0727-0065	R:FXD DEPC 300 OHM 1% 1/2W	19701	DC 1/2C	2	1
0727-0092	R:FXD DEPC 860 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0208	R:FXD DEPC 100K OHM 1% 1/2W	19701	DC1/2CR5	1	1
0727-0218	R:FXD DEPC 180K OHM 1% 1/2W	19701	DC1/2CR5	4	1
0727-0219	R:FXD DEPC 182K OHM 1% 1/2W	19701	CF 1/2	1	1
0727-0220	R:FXD DEPC 183K OHM 1% 1/2W	19701	DC 1/2C R5	1	1
0727-0226	R:FXD DEPC 250K OHM 1% 1/2W	19701	DC 1/2C R5	1	1
0727-0228	R:FXD DEPC 252K OHM 1% 1/2W	19701	DC 1/2C R5	2	1
0727-0229	R:FXD DEPC 265K OHM 1% 1/2W	19701	DC1/2AR5	1	1
0727-0243	R:FXD DEPC 500K OHM 1% 1/2W	19701	DC 1/2C R5	1	1
0727-0321	R:FXD DEPC 1370 OHMS 1% 1/2W	19701	CF 1/2	1	1
0730-0044	R:FXD DEPC 27.5K OHMS 1% 1W	19701	DC1 R5	1	1
0757-0052	R:FXD MET FLM 500K OHMS 1% 1/2W	28480	0757-0052	1	
0757-0069	R:FXD MET FLM 121 OHMS 1% 1/4W	28480	0757-0069	1	
0757-0071	R:FXD MET FLM 247.5 OHMS 1% 0.25W	19701	MFS 1/4 T-0	1	1
0757-0086	R:FXD MET FLM 51 OHMS 2% 1/2W	07115	C 20	2	1
0757-0170	R:FXD MET OX 75 OHM 2% 0.5W	07115	C20	1	1
0757-0171	R:FXD MET OX 120 OHM 2% 0.5W	07115	C20	1	1
0757-0172	R:FXD MET FLM 37.4 OHM 1% 1/2W	19701	DC 1/2C R5	1	1
0757-0197	R:FXD MET FLM 1500 OHMS 1% 1/2W	28480	0757-0197	1	
0757-0801	R:FXD MET FLM 150 OHM 1% 1/2W	28480	0757-0801	1	1
0757-0334	R:FXD MET FLM 301 OHMS 1% 1/4W	28480	0757-0334	2	
0757-0342	R:FXD MET FLM 100K OHMS 1% 1/4W	28480	0757-0342	2	
0757-0352	R:FXD MET FLM 150K OHMS 1% 1/2W	28480	0757-0352	1	
0757-0712	R:FXD MET FLM 90.9 OHMS 1% 1/4W	28480	0757-0712	1	
0757-0769	R:FXD MET FLM 51.1K OHMS 1% 1/4W	28480	0757-0769	1	
0757-0792	R:FXD MET FLM 681 K OHMS 1% 1/4W	28480	0757-0792	1	
0757-0852	R:FXD MET FLM 47.5K OHMS 1% 1/2W	28480	0757-0852	1	1
0757-0853	R:FXD MET FLM 51.1K OHMS 1% 1/2W	28480	0757-0853	1	
0757-0864	R:FXD MET FLM 301K OHMS 1% 1/2W	28480	0757-0864	1	
0758-0018	R:FXD MET FLM 15K OHMS 5% 1/2W	07115	C 20	1	1
0758-0035	R:FXD MET FLM 3000 OHMS 5% 1/4W	28480	0758-0035		

See list of abbreviations in introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0758-0057	R:FXD MET FLM 5600 OHMS 5% 1/2W	07115	C 20	2	
0758-0074	R:FXD MET FLM 27K OHMS 5% 1/4W	28480	0758-0074	1	
0758-0094	R:FXD MET FLM 62 OHMS 5% 1/4W	28480	0758-0094	1	
0760-0026	R:FXD MET FLM 75 OHM 2% 1W	28480	0760-0026	1	1
0760-0027	R:FXD MET FLM 150 OHM 2% 1W	28480	0760-0027	1	1
0761-0005	R:FXD MET OX 2200 OHM 5% 1W	07115	C32	2	1
0761-0006	R:FXD MET FLM 10K OHM 5% 1W	07115	C 32	1	1
0761-0011	R:FXD MET FLM 3300 OHM 5% 1W	07115	C 32	1	1
0761-0019	R2FXD MET OX 39K OHM 5% 1W	28480	0761-0019	1	1
0761-0023	R2FXD MET FLM 51K OHM 5%	28480	0761-0023	1	1
0764-0003	R:FXD MET FLM 3300 OHM 5% 2W	07115	C 42	1	1
0764-0006	R:FXD MET FLM 18K OHM 5% 2W	07115	C 42S	1	1
0764-0027	R:FXD MET FLM 75K OHM 5% 2W	28480	0764-0027	1	1
0766-0038	R:FXD MET OX 18K OHM 2% 3W	07115	LPI3	1	1
0767-0009	R:FXD MET FLM 12K OHM 3W	07115	LPI-3	1	1
0767-0010	R:FXD MET FLM 15K OHMS 5% 3W	07115	LPI 3	1	1
0767-0011	R:FXD MET FLM 20K OHM 5% 3W	07115	LPI-3	1	1
0767-0016	R:FXD MET OX 3K OHM 5% 3W	28480	0767-0016	2	1
0770-0004	R:FXD MET FLM 10K OHMS 5% 4W	07115	LPI 4	1	1
0773-0004	R:FXD MET FLM 10K OHMS 5% 5W	07115	LPI 5	2	1
0773-0008	R:FXD MET FLM 33K OHM 5% 5W	07115	LPI 5	1	1
0775-0007	R:FXD MET OX 200 OHM 2% 7W	28480	0775-0007	4	1
0777-0003	R:FXD MET FLM 1300 OHMS 10% 7W	07115	LPI 7	1	
0811-1714	R:FXD WW 1200 OHMS 5% 10W	28480	0811-1714	1	
0813-0009	R:FXD WW 125 OHMS 10% 2W	91637	CS 2	1	
0815-0012	R:FXD WW 1800 OHMS 5% 10W	94310	RW29V182	1	
0819-0016	R:FXD WW 1500 OHMS 5% 10W			1	
1200-0053	SOCKET:TUBE 7 PIN MINAT	71785	11151-11	4	
1200-0062	SOCKET:TUBE 9 PIN MINIATURE	71785	1215111060	20	
1200-0063	LUG:CRIMP	28480	1200-0063	1	
1200-0084	SOCKET-TUBE	71785	101-04-11-100	3	
1250-0083	CONNECTOR:BNC	28480	1250-0083	3	
1250-0140	CONNECTOR:BODY	91737	8446-1	1	
1400-0071	CLAMP:TUBE	28480	1400-0071	1	
1400-0084	FUSEHOLDER:EXTRACTOR POST TYPE	75915	342014	1	
1400-0110	BODY:FUSEHOLDER	28480	1400-0110	1	
1400-0111	NUT:FUSEHOLDER	28480	1400-0111	1	
1400-0112	KNOB:FUSEHOLDER	28480	1400-0112	1	
1450-0419	LAMP INDICATOR WHITE NEON	28480	1450-0419	2	
1490-0030	STAND:TILT	28480	1490 0030	1	
1854-0003	TRANSISTOR:NPN SILICON	28480	1854-0003	1	
1901-0030	SEMICON DEVICE:DIODE JUNCTION	28480	1901 0030	4	
1901-0036	SEMICON DEVICE:DIODE	28480	1901 0036	3	
1901-0040	SEMICON DEVICE:DIODE SILICON	28480	1901 0040	4	
1901-0041	SEMICON DEVICE:DIODE SILICON	28480	1901 0041	4	
1901-0050	SEMICON DEVICE:DIODE SILICON	28480	1901 0050	8	
1902-0048	SEMICON DEVICE:DIODE BREAKDOWN	28480	1902 0048	2	
1902-0055	SEMICON DEVICE:SI DIODE 14.7V 10%	28480	1902-0055	1	
1902-0056	SEMICON DEVICE:SI DIODE 23.7V 10%	28480	1902-0056	1	
1902-0065	SEMICONDUCTOR DEVICE:DIODE: AVALANCHE	28480	1902-0065	1	
1902-0224	SEMICON DEVICE:DIODE AVALANCHE	28480	1902-0224	1	
1910-0002	SEMICON DEVICE:DIODE 1N38B	73293	1N38B	4	

See list of abbreviations in introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
1902-0074	SEMICON DEVICE: SI DIODE 7.1V			1	
1910-0016	SEMICON DEVICE:DIODE GERMANIUM	28480	1910-0016	12	
1923-0044	ELECTRON TUBE: 6CW5 (EL 86) PENTODE	73445	EL 86/6CW5	2	
1923-0052	ELECTRON TUBE:7534 PENTODE	73445	7534/E130L	2	
1923-0068	ELECTRON TUBE:6CW5 PENTODE	28480	1923-0068	2	
1932-0010	ELECTRON TUBE: 6080 DUO-TRIODE	86684	803915	2	
1932-0022	ELECTRON TUBE: DUAL TRIODE 6DJ8	73445	6DJ8/ECC 88	9	
1932-0030	ELECTRON TUBE: 12AX7 TWIN TRIODE 9 PIN MIN	00001	12AX7	3	
1933-0005	ELECTRON TUBE: 7734 TRIODE PENTODE	07138	7734	1	
1933-0006	ELECTRON TUBE: 6CX8 TRIODE PENTODE	33173	6CX8	3	
1940-0001	TUBE:ELECTRON 5651	86684	5651	1	
1940-0004	ELECTRON TUBE: 0A2 VOLTAGE REGULATOR	86684	0A2	1	
2100-0043	R:VAR COMP 500K OHM 10% LIN 2W	28480	2100 0043	2	
2100-0074	R:VAR COMP 1MEG OHM 30% LIN 1/4%	28480	2100 0074	1	
2100-0094	R:VAR COMP 50K OHMS 30% LIN 1/5W	28480	2100 0094	3	
2100-0095	R:VAR COMP 100K OHMS 30% LIN 1/5W	28480	2100 0095	1	
2100-0102	R:VAR COMP 500K OHMS 30% LIN 1/5W	28480	2100 0102	1	
2100-0182	R:VAR COMP 3300 OHMS 10% LIN 3W	28480	2100-0182	2	
2100-0184	R:VAR COMP 250K OHM 10% LIN 2W	28480	2100 0184	1	
2100-0191	R:VAR COMP 250K OHM 20% LIN 1/4W	28480	2100 0191	1	
2100-0281	R:VAR WW 100 OHMS 20% LIN 1/4%	28480	2100 0281	1	
2100-0379	R:VAR COMP 10K OHM 30% LIN 1/4W	28480	2100 0379	1	
2100-0424	R:VAR COMP 50K OHM 20% 1/4W	28480	2100-0424	2	
2100-0425	R:VAR COMP 500K OHM 30% 1/2W	28480	2100-0425	2	
2110-0006	FUSE:CARTRIDGE 2 AMP SLOW BLOW	hp		1	
2110-0014	FUSE:CARTRIDGE 4 AMP 125V MAX SLOW BLOW	hp		1	
2110-0046	FUSE:CARTRIDGE 1/2 AMP	28480	2110-0046	1	
2140-0030	LAMP:GLOW T2 BULB 10 UA 65V	24455	NE 83	3	
2140-0083	LAMP:NEON	74276	A 091	1	
3100-0413	SWITCH:ROTARY	28480	3100-0413	1	
3100-0414	SWITCH:ROTARY	28480	3100-0414	1	
3100-0415	SWITCH:ROTARY	28480	3100-0415	1	
3100-0416	SWITCH:ROTARY	28480	3100-0416	2	
3101-0011	SWITCH:SLIDE DPDT 0.5 AMP 125 VDC	42190	4603	4	
3101-0014	SWITCH:PUSH SPDT NE	82389	4S-1106	1	
3101-0033	SWITCH:SLIDE	42190	4633	1	
3101-0056	SWITCH:TOGGLE DPDT	88140	8906K412	1	
3150-0026	FILTER:AIR	28480	3150-0026	1	
3160-0097	FAN-TUBE AXIAL	28480	3160-0097	1	
5000-8719	COVER:SIDE, OLIVE-GRAY	28480	5000-8719	2	
5040-0417	HOLDER:TUBE CLAMP	28480	5040-0417	1	
5060-0222	ASSY:SIDE HANDLE	28480	5060-0222	1	
5060-0767	FOOT ASSY-FM	28480	5060-0767	1	
5060-8713	COVER:BOTTOM, OLIVE-GRAY	28480	5060-8713	1	
5060-8735	RETAINER:HANDLE, OLIVE-GRAY	28480	5060-8735	1	
5060-8741	KIT: 7H RACK MT., MINT-GRAY	28480	5060-8741	1	
6980-0003	TRIM-PLASTIC	28480		1	
8120-0078	CABLE:POWER SVT-18-3 7.5FT.	80509	6A-201	1	
9100-0181	TRANSFORMER:POWER	70903	KH4147	1	
9110-0063	REACTOR:AUDIO	28480	9100-0181	1	
9110-0082	FILTER:LINE	28480	9110-0063	1	
9130-0020	TRANSFORMER:PULSE 1:1 20%	56289	JN10/1012b	1	
9140-0023	COIL:FXD RF 55 UH	56289	31Z861	5	
9140-0098	COIL:FXD RF 2.2 UH	28480	9140-0023	1	
9140-0115	COIL:FXD RF 22UH 10%	28480	9140 0098	1	
		99800	2150-32	1	

See list of abbreviations in introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
9170-0013	BEAD:TORCID	72656	CF102H	2	
9170-0016	BEAD:MAGNETIC	02114	56-590-65138	2	
9190-0007	DELAY LINE:1000 OHM 0.14USEC	28480	9190-0007	1	
9190-0008	DELAY LINE:1000 OHM 0.4USEC	28480	9190-0008	1	
00214-00206	PANEL:REAR	28480	00214-00206	1	
00214-00207	PANEL:FRONT MINT-GRAY	28480	00214-00207	1	
00214-61902	TRIGGER MODE SWITCH ASSEMBLY	28480	00214-61902	2	
00214-61903	SWITCH ASSEMBLY	28480	00214-61903	1	
00214-61904	SWITCH ASSEMBLY:PULSE POSITION	28480	00214-61904	2	
00214-64102	COVER:TOP, OLIVE-GRAY	28480	00214-64102	1	
00214-66001	COAXIAL COIL:ASSEMBLY	28480	00214-66001	1	
00214-66002	FIXED COIL:80 UH	28480	00214-66002	2	
00214-66003	TRANSFORMER:PULSE	28480	00214-66003	2	
00214-66501	ETCHED CIRCUIT ASSEMBLY (POWER SUPPLY)	28480	00214-66501	1	
00214-66502	ETCHED CIRCUIT ASSEMBLY TRIGGERCIRCUIT	28480	00214-66502	1	
00214-66503	ETCHED CIRCUIT ASSEMBLY (OUTPUT)	28480	00214-66503	1	
00214-66504	ETCHED CIRCUIT ASSEMBLY (TRIGGER MODE)	28480	00214-66504	2	
00214-66506	ETCHED CIRCUIT ASSEMBLY	28480	00214-66506	2	
00214-63401	ATTENUATOR ASSEMBLY: INCLUDES CABLES, CONNECTOR, S401	28480	00214-63401	1	

See list of abbreviations in introduction to this section

Table 6-3. 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.
00144	ADC Products Inc Subsidiary of Magnetic Controls Co	Minneapolis, Minn
00213	Sage Electronics Corp	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc., Electronics Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co Capacitor Dept	Gainsville, Fla
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif
02114	Ferrocube Corp. of America	Saugerties, N.Y.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Somerville, N.J
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Chicago, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04713	Motorola, Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp Linde Division Kemet Dept	Cleveland, Ohio
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
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, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., The	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
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	Semcor Div. Components Inc	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc Eimac Div	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Lynch Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn
07387	Burlsher Corp., The	Monterey Park, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Hewlett Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atohm Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Tri-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11438	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Meter Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermoloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dubilier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	So. Pasadena, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15818	Amelco Inc.	Mt. View, Calif.
15909	Daven Div. Thomas A. Edison Ind. McGraw-Edison Co.	Long Island City, N.Y.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Inc.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No Hollywood, Calif.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18476	Ty-Car Mfg. Co., Inc.	Hollision, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	Bendix Corp., The Eclipse-Pioneer Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Keystone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Globet Fyle Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
38443	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Meter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.

From: FSC. Handbook Supplements
H4-1 Dated JULY 1965
H4-2 Dated NOV 1962

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Table 6-3. Code List of Manufacturers (Cont'd)

Code No.	Manufacturer	Address
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	Sanborn Company	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 & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
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	Willek Mfg. Co.	Chicago, Ill.
56346	Revere Wallansak Div. Minn. Mining & Mfg. Co.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
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, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema Plant, Pi-Q Div. Aerovox Corp.	Burbank, Calif.
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.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72354	John E. Fast Co., Div. Victoreen Instr. Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
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, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Philips Co., Inc.	Hicksville, 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, Calif.
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 Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	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, Calif.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76529	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Corp., The Bendix Pacific Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
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 Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Shethers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Weeder 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.
80120	Schnitzer Alloy Products Co	Elizabeth, N.J.
80130	Times Telephone Equipment	New York, N.Y.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Ultimax Switch, Div. Mason Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp	Monrovia, Calif.
80583	Hammarlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Mass.
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Speth Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Defense Prod. Division	Clifton, N.J.
82209	Maguire 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	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfg. Co.	Los Angeles, Calif.
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, Calif.
83186	Victory Engineering Corp.	Springfield, N.J.
83294	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
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, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.

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Table 6-3. Code List of Manufacturers. (Cont'd)

Code No.	Manufacturer	Address
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86529	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88421	Federal Telephone & Radio Corp.	Clifton, N.J
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Grayber Electric Co.	Oakland, Calif.
89665	United Transformer Co.	Chicago, Ill.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electron cs, Inc.	Columbus, Nebr.
91662	Elco Corp	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., Inc.	Chicago, Ill
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92196	Universal Industries, Inc. City of Industry, Calif.	
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
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	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94310	Tru-Ohm Products Memcor Components Div.	Huntington, Ind.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gardes Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
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 Tech, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98731	General Mills Inc Electronics Div.	Minneapolis, Minn.
98734	Paeco Div of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Allee Corp.	Winchester, Mass.
99515	Marshall Ind. Elect. Products Div.	San Marino, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Rembrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDOPS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURER' HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000AB	FTA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Coaltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.
06486	North American Electronics, Inc	Lynn, Mass.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
78526	Stonyck Winding Co.	Newburgh, N.Y.

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APPENDIX I
MANUAL CHANGES

Appendix I contains information on changes required to adapt this manual to a Model 214A Pulse Generator manufactured prior to the printing of this manual. Check for your instrument serial prefix in the left-hand column of the table below and make the numbered changes indicated. Make the changes in the order listed. If the serial prefix of the instrument is not 824- or listed below, the information to adapt this manual to that Model 214A will be found in the change sheet supplied with the manual. For information on Errata in the manual, refer to the change sheet.

Note

These changes adapt the manual to cover the standard instrument as manufactured and therefore do not apply to an instrument subsequently modified by the factory or in the field.

Serial Prefix	Make Changes
1206A, 1219A	26
1152A	26, 25
1113A	26 thru 24
921-	26 thru 23
905-	26 thru 22
824-	26 thru 21
812-	26 thru 20
806-	26 thru 19
722-	26 thru 18
715- 704-	26 thru 17
632-	26 thru 16
550-	26 thru 16, 1, 2
545-	26 thru 16, 1 thru 3
539-	26 thru 16, 1 thru 4
506-	26 thru 16, 1 thru 5
449-	26 thru 16, 1 thru 7
443-	26 thru 16, 1 thru 6, 8
414-	26 thru 16, 1 thru 6, 8, 9
350-	26 thru 16, 1 thru 6, 8 thru 10
339-	26 thru 16, 2 thru 6, 8 thru 12
337-	26 thru 16, 2 thru 6, 8 thru 10, 12 thru 14
316-	26 thru 16, 2 thru 6, 8 thru 10, 12 thru 15

CHANGE 1

Page 5-20, Figure 5-14,
R150: Change to 1650 ohms.
Section VI, Replaceable Parts,
R150: Change to HP Stock No. 0727-0111; R: fxd, depc, 1650 ohms, 1%, 1/2W; Mfr 19701; Mfr Part No. DC 1/2 CR5.

CHANGE 2

Page 5-19, Figure 5-13,
V1, V7: Change to 6AS7.
Section VI, Replaceable Parts,
B1: Change to HP Stock No. 3140-0010; Motor: AC, 1/175 HP, 2800 RPM; Mfr 73793; Mfr Part No. ER 6667.
V1, V7: Change to HP Stock No. 1932-0019; Electron Tube: 6AS7GA, Duo-Triode; Mfr 33173; Mfr Part No. 6AS7GA.

CHANGE 3

Page 5-9, Paragraph 5-26,
Delete steps s, t, u, v.
Page 5-23, Figure 5-17,
C319: Change to fixed capacitor, 20 PF.
Replaceable Parts,
C319: Change to HP Stock No. 0150-0035; C: fxd, cer, 20 PF, 10%, 600 VDCW; Mfr 71590; Mfr Part No. DD200.

CHANGE 4

Page 5-22, Figure 5-16,
Change R315 to 820 ohms.
Section VI, Replaceable Parts,
R315: Change HP Stock No. to 0864-8211; R: fxd, comp, 820 ohms, 10%, 1/4W; Mfr 01121; Mfr Part No. CB8211.

CHANGE 5

Page 5-22, Figure 5-16,
Q301: Change 5080-0443 to 2N2190.
Delete R331.
Section VI, Replaceable Parts,
Q301: Change to HP Stock No. 1850-0103; Transistor: 2N2190; Mfr 28480; Mfr Part No. 1850-0103.
Delete R331.

CHANGE 6

Section VI, Replaceable Parts,
CR325: Change to HP Stock No. 1901-0050; Mfr 28480; Mfr Part No. 1901-0050.

CHANGE 7

Page 5-21, Figure 5-15,
R243: Change value to 510 ohms.
Section VI, Replaceable Parts,
R243: Change to HP Stock No. 0686-5115; R: fxd, comp, 510 ohms, 5%, 1/2W; Mfr 01121; Mfr Part No. EB 5115.

CHANGE 8

Page 5-21, Figure 5-15,
Delete C206, C223, C235.
R243: Change value to 68 ohms.
R308, R314: Change value to 56 ohms.
Section VI, Replaceable Parts,
Delete C206, C223, C235.
R243: Change to HP Stock No. 0687-6801; R: fxd, comp, 68 ohms, 10%, 1/2W; Mfr 01121; Mfr Part No. EB 6801.
R308, R314: Change to HP Stock No. 0684-5601; R: fxd, comp, 56 ohms, 10%, 1/4W; Mfr 01121; Mfr Part No. CB 5601.

CHANGE 9

Page 5-22, Figure 5-16,
R323, R338: Change value to 10 ohms.
Add R324 (10 ohms) in parallel with R323.
Add R339 (10 ohms) in parallel with R338.
Section VI, Replaceable Parts,
R323, R338: Change to ℗ Stock No. 0687-1001; R: fxd, comp 10 ohms, 10%, 1/2W; Mfr 01121; Mfr Part No. EB 1001.
Add R324, R339: ℗ Stock No. 0687-1001; R: fxd, comp, 10 ohms, 10%, 1/2W; Mfr 01121; Mfr Part No. EB 1001.

CHANGE 10

Page 5-20, Figure 5-14,
Change value of R122 to 120K ohms.
Page 5-22, Figure 5-16,
Delete F2 and R342. (R334 is connected directly to $-220V_I$.)
Section VI, Replaceable Parts,
Delete R342.
Delete F2.
R122: Change to R: fxd, comp, 120K ohms, 10%, 1/2W; ℗ Stock No. 0687-1241.

CHANGE 11

Page 5-20, Figure 5-14,
Change value of R150 to 2250 ohms.
Section VI, Replaceable Parts.
R150: Change to R: fxd, car. film, 2250 ohms, 1%, 1/2W; ℗ Stock No. 0727-0120.

CHANGE 12

Section VI, Replaceable Parts,
CR308: Change ℗ Stock No. to 1910-0011.

CHANGE 13

Page 5-20, Figure 5-14,
Change value of R150 to 3000 ohms.
Section VI, Replaceable Parts,
R150: Change to R: fxd, car. film, 3000 ohms, 1%, 1/2W; ℗ Stock No. 0727-0124.

CHANGE 14

Page 5-20, Figure 5-14,
Change value of C122 to 47 pf.
Change value of R146 to 8.2 megohms.
Change value of R149 to 20K ohms.
Change value of R151 to 37K ohms.
Page 5-23, Figure 5-17,
Change value of R352 to 1000 ohms.
Section VI, Replaceable Parts,
C122: Change to C: fxd, mica, 47 pf, 5%, 500 vdcw; ℗ Stock No. 0140-0204.
R146: Change to R: fxd, comp, 8.2 megohms, 10%, 1/2W; ℗ Stock No. 0687-8251.
R149: Change to R: fxd, met film, 20K ohms, 1%, 1W; ℗ Stock No. 0761-0004.
R151: Change to R: fxd, car. film, 37K ohms, 1%, 1W; ℗ Stock No. 0730-0049.

CHANGE 14 (Cont'd)

R352: Change to R: fxd, met film, 1000 ohms, 5%, 1W; ℗ Stock No. 0761-0021.

CHANGE 15

Page 5-22, Figure 5-16,
Add Series RLC circuit, R314, L302, C308, as shown in partial schematic Figure I-1.
Change value of R347 to 2000 ohms.
Change value of R348 to 68K ohms.
Section VI, Replaceable Parts,
R347: Change to R: fxd, met film, 2000 ohms, 5%, 7W. ℗ Stock No. 0776-0003.
R348: Change to R: fxd, comp, 68K ohms, 5%, 2W; ℗ Stock No. 0692-6835.
C308: Add C: fxd, cer, .05 µf, 20%, 400 vdcw; ℗ Stock No. 0150-0052.
L302: Add coil, fxd, 27µh; ℗ Stock No. 9140-0107.
R304: Add R: fxd, comp, 2200 ohms, 10%, 1/4W; ℗ Stock No. 0684-2221.

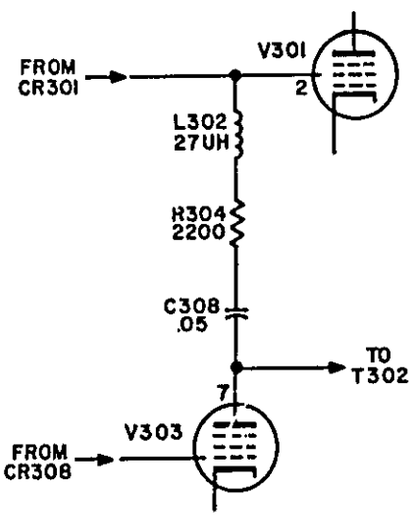
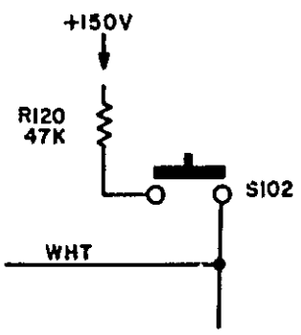


Figure I-1.

CHANGE 16

Page 5-20, Figure 5-14,
L105: Delete
R120: Change location to that shown below.



a/o

CHANGE 16 (cont'd)

Page 5-22, Figure 5-16,
Add R320 (10 ohms) in series along main signal path between cathodes of CR324 and CR325.

CHANGE 17

Page 5-19, Figure 5-13,
C9, C10 and C11: Delete.
Section VI, Replaceable Parts,
C9, C10 and C11: Delete

CHANGE 18

Page 5-9, Paragraph 5-26,
Delete steps dd through ii.
Page 5-12, Figure 5-7,
Delete CR105 and R152.
Page 5-20, Figure 5-14,
Delete R152 and CR105.
R143: Change to 27 ohms.
Page 6-4, Table 6-1,
Delete CR105 entry.
Page 6-8, Table 6-1,
R143: Change to hp Stock No. 0687-2701 R: fxd comp 27 ohms 10% 1/2 w
Delete R152.

CHANGE 19

Page 5-19, Figure 5-13,
R4: Change to 1800.
Page 6-7, Table 6-1,
R4: Change to hp Stock No. 0815-0012 R: fxd ww 1800 ohms 5% 10w.

CHANGE 20

Page 5-8, Paragraph 5-26,
Delete the existing paragraph.
Use the following paragraph 5-26:

5-26. PULSE WIDTH AND AMPLITUDE.

a. Set Model 214A controls as follows:

TRIGGER MODE	INT.
INT. REP. RATE	1-10
Rate VERNIER	fully ccw
NORM./GATED	NORM.
PULSE POSITION	1-10
Position VERNIER	fully ccw
ADVANCE/DELAY/DOUBLE	PULSE DELAY
TRIGGER OUTPUT	+
PULSE WIDTH	10-100
Width VERNIER	fully cw
PULSE AMPLITUDE	5
Amplitude VERNIER	midrange
PULSE OUTPUT	+

CHANGE 20 (cont'd)

b. Set Oscilloscope and plug-in controls as follows:

Channel Selector	
SENSITIVITY (VERNIER in CALIBRATED)	1 VOLT/CM
AC/DC Coupling	DC
POLARITY	+UP
TRIGGER SLOPE	+
TRIGGER SOURCE	EXT. AC
SWEEP MODE	PRESET
SWEEP TIME (VERNIER in CAL.)	20 μSEC/CM
HORIZONTAL DISPLAY	X1

c. Attach a 50 ohm coaxial cable to the Model 214A PULSE OUTPUT. Connect the other end of the cable to a BNC, T-connector at the scope channel A input. Attach a 50 ohm termination (procedure assumes use of a termination capable of dissipating at least 1/2 watt) to the T-connector. Use a coaxial cable and connect the Model 214A TRIGGER OUTPUT to the scope TRIG. INPUT.

d. Check to see that the arrow on the PULSE WIDTH VERNIER points to the black dot on the front panel when fully cw. If not, loosen set screws, slip knob to proper position, and tighten screws.

e. Set PULSE WIDTH VERNIER to 10.

f. Adjust Max Width Adj R250 to obtain a pulse width of 100 μsec (5 cm) observed on the scope.

g. Change scope sweep time to 2 μSEC/CM. Set 214A PULSE WIDTH VERNIER to 1.

h. Adjust Min Width Adj R259 to obtain a pulse width of 10 μsec (5 cm) observed on the scope.

i. Repeat above procedure starting with step e to minimize the interaction between R250 and R259. In checking for interaction, consider the error involved in resetting to the same 1 or 10 VERNIER position used before.

j. Set Model 214A PULSE WIDTH to 10, width VERNIER to 9, PULSE AMPLITUDE to 10, amplitude VERNIER to fully cw. Change scope SENSITIVITY to 2 VOLTS/CM.

k. Adjust 10V amplitude R355 to obtain a 11 V (5.5 cm) pulse observed on the scope (be sure PULSE AMPLITUDE VERNIER is fully cw).

m. Change Model 214A TRIGGER MODE to EXT., and PULSE AMPLITUDE to 50.

n. Connect a dc voltmeter across resistor R352; negative lead at tube side of R352, 1200 ohms, positive lead clipped to the upright metal shield for tubes V304 and V305.

p. Set R353, 50 V Amplitude, to mid-position and adjust Screen Shunt Current Adj R363 until voltmeter indicates 12 volts. Disconnect voltmeter.

q. Set Model 214A TRIGGER MODE to INT. and PULSE AMPLITUDE to 20. Change scope SENSITIVITY to 5 VOLTS/CM.

CHANGE 20 (cont'd)

r. Adjust 20 V Amplitude R354 to obtain a 21 V (4.2 cm) pulse observed on the scope. With VERNIER ccw pulse amplitude should decrease to about 10 V.

s. Set Model 214A controls as follows:
PULSE OUTPUT . . . . . -
PULSE AMPLITUDE . . . . 20, VERNIER cw

t. Set Oscilloscope controls as follows:
SENSITIVITY . . . . . 5 VOLTS/CM
VERNIER . . . . . CAL

u. Adjust Model 214A PULSE AMPLITUDE VERNIER for 4 cm display (20 V). Observe overshoot at end of trailing edge of pulse.

v. Adjust C319 for 4-4.5 mm (4-4-1/2%) overshoot.

Note

C319 should not be adjusted for less than 4% overshoot as over-compensation may result in rise time deterioration.

w. Set Model 214A PULSE AMPLITUDE to 50 and VERNIER fully cw. Change scope SENSITIVITY to 10 VOLTS/CM.

x. Adjust 50 V Amplitude R353 to obtain a 52 V (5.2 cm) pulse observed on the scope. Turning VERNIER ccw should decrease pulse amplitude to about 20 volts.

y. Set Model 214A PULSE WIDTH to .05-1, Width VERNIER to 10, Rate VERNIER fully clockwise and PULSE AMPLITUDE VERNIER for 50V amplitude. Set scope sweep time to .2μ SEC/CM.

z. Adjust .05-1 Max Width Adj C229 to obtain width of 1 μsec (5 cm) observed on the scope.

aa. Set Model 214A PULSE WIDTH VERNIER to 1. Change scope SWEEP TIME to .1 μSEC/CM, HORIZONTAL DISPLAY to X10, and adjust HORIZONTAL POSITION to center trace.

bb. Adjust .05-1 Min Width Adj R260 to obtain a pulse width of 100 nsec (10 cm) observed on the scope. Width of pulse is measured at half amplitude point. Set scope HORIZONTAL DISPLAY back to X1.

cc. Repeat above procedure starting with step y to minimize interaction between C229 and R260. In checking for interaction consider the error involved in resetting VERNIER to same 10 position.

dd. Set the ADVANCE/DELAY/DOUBLE switch to PULSE DELAY.

ee. Set the oscilloscope SWEEP TIME for 10 nsec/cm.

ff. Set the PULSE WIDTH VERNIER for a 50 nsec pulse width.

gg. Set the ADVANCE/DELAY/DOUBLE switch to PULSE ADVANCE.

hh. The width of the displayed pulse is 50±5 nsec at the 50% amplitude point.

CHANGE 20 (cont'd)

ii. If necessary, select a new value for resistor R143 so that the pulse advance mode meets specification. The selection of R143 should be between 200 and 430 ohms.

Page 5-20, Figure 5-14,
R135: Change to 250K.
R143: Change to 330 and delete *.
Page 5-21, Figure 5-15,
R201 and R250: Change to 2000.
Page 5-22, Figure 5-16,
Delete R320.
Page 5-23/5-24, Figure 5-17,
R366: Change to 111K.
R367: Change to 376K.
R368: Change to 683.7K.
Section VI, Tables 6-1 and 6-2,
R135: Change to HP Stock No. 2100-0426; R: VAR COMP 250K OHMS 30% 1/4W
R143: Change to HP Stock No. 0687-3311; R: FXD COMP 330 OHMS 10% 1/2W
R201 and R250: Change to HP Stock No. 2100-0090; R: VAR COMP 2000 OHMS 30% LIN 1/3W
Delete R320.
R366: Change to HP Stock No. 0727-0210; R: FXD DEPC 111K OHMS 1% 1/2W
R367: Change to HP Stock No. 0727-0237; R: FXD DEPC 376K OHMS 1% 1/2W
R368: Change to HP Stock No. 0727-0251; R: FXD DEPC 683.7K OHMS 1% 1/2W

CHANGE 21

Page 6-5, Table 6-1,
CR318: Change to HP Stock No. 1910-0016; SEMICON DEVICE: DIODE GERMANIUM.

CHANGE 22

Page 6-2, Table 6-1,
C8: Change to HP Stock No. 0160-0043; C: FXD PAPER 0.051 UF 10% 400 VDCW.
Page 6-6, Table 6-1,
FL1: Change to HP Stock No. 9110-0082; FILTER: LINE.
Page 5-19, Figure 5-13,
C8: Change value to 0.051 UF.

CHANGE 23

Page 6-6, Table 6-1,
FL1: Change to HP Stock No. 9100-2818; FILTER: LINE.
J1: Delete: HP Stock No. 1251-2357; Add under Description: NOT SEPARATELY REPLACEABLE PART OF FL1.
Page 6-12, Table 6-1,
S2: Change to HP Stock No. 3101-0033; SWITCH: SLIDE.
Page 6-13, Table 6-1,
W1: Change to HP Stock No. 8120-0078; CABLE: POWER SVT-18-3 7.5 FT.
Page 6-14, Table 6-1,
Change HP Stock No. 00214-64101 to HP Stock No. 00214-04401.
Page 6-20, Table 6-2,
Change HP Stock No. 00214-64101 to HP Stock No. 00214-04401.

CHANGE 24

Page 6-14, Table 6-1,
Change HP Stock No. 00214-00207 to HP Stock No. 00214-00201; PANEL FRONT.
Change HP Stock No. 00214-64102 to HP Stock No. 00214-64101; COVER: TOP.
Page 6-15, Table 6-1,
Change HP Stock No. 5000-8719 to HP Stock No. 5000-0743; COVER: SIDE 7 X 16.
Change HP Stock No. 5060-8713 to HP Stock No. 5060-0752; COVER ASSY: BOTTOM.
Change HP Stock No. 5060-8735 to HP Stock No. 5060-0765; RETAINER: HANDLE.
Change HP Stock No. 5060-8741 to HP Stock No. 5060-0776; Kit, 7H RACK MT.
Page 6-20, Table 6-2,
Change HP Stock No. 5000-8719 to HP Stock No. 5000-0743; SIDE COVER - 7 X 16 FM; 28480; 5000-0743; TQ 1.
Change HP Stock No. 5060-8713 to HP Stock No. 5060-0752; BOTTOM COVER ASSY 16 L FM; 28480; 5060-0752; TQ 1.
Change HP Stock No. 5060-8735 to HP Stock No. 5060-0765; ASSY: RETAINER HANDLE; 28480; 5060-0765; TQ 1.
Change HP Stock No. 5060-8741 to HP Stock No. 5060-0776; KIT - RACK MOUNT; 28480; 5060-0776; TQ 1.
Change HP Stock No. 00214-00207 to HP Stock No. 00214-00201; PANEL; FRONT; 28480; 00214-00201; TQ 1.
Change HP Stock No. 00214-64102 to HP Stock No. 00214-64101; COVER: TOP; 28480; 00214-64101; TQ 1.

CHANGE 25

Page 6-2, Table 6-1,
B1: Change to HP Stock No. 3140-0952; MOTOR: 1/175 HP, 3470 RPM.
Page 6-15, Table 6-1,
Add: 3160-0060; FAN BLADE 4-IN. DIAM.
Page 6-20. Table 6-2,
Change HP Stock No. 3160-0097 to HP Stock No. 3140-0701; MOTOR SHADED POLE: 28480; 3140-0701.
Add: HP Stock No. 3160-0060; FAN BLADE 4-IN DIAM.

CHANGE 26

Page 6-5, Table 6-1,
DS2: Change to HP Stock No. 1450-0048; LAMP: PILOT NE 2H OVERLOAD INDICATOR.
Page 6-19, Table 6-2,
Add: HP Stock No. 1450-0048; LAMP: PILOT NE2H; 08717; 858R; TQ 1.
Change: TQ of HP Stock No. 1450-0419 to 1.

STANDARD OPTIONS.

Standard options are modifications installed on HP instruments at the factory, and are available on request. Contact the nearest Hewlett-Packard Sales/Service Office for information concerning standard options.

OPTION 001

This Option prepares the standard Model 214A for operation with 230 VAC power by sliding switch S2 to the 230 V position, and replacing F1 with a 2.0-ampere line fuse.

HP Stock No.	Description
2110-0006	Fuse: CARTRIDGE 2-AMP SLOW-BLOW.

OPTION X95

This Option converts the instrument to the blue-gray color scheme.

HP Stock No.	Description
00214-00201	PANEL: FRONT, LIGHT GRAY
00214-64101	COVER: TOP, LIGHT GRAY
5000-0743	COVER: SIDE 7 X 16 BLUE-GRAY
5060-0752	COVER ASSY: BOTTOM BLUE-GRAY
5060-0765	RETAINER: HANDLE BLUE-GRAY
5060-0776	KIT: 7H RACK MOUNT

OPTION H01-214A

This option modifies a standard Model 214A to provide a TRIGGER OUTPUT pulse amplitude of at least 25 volts positive and 15 volts negative, both into a 2000-ohm load. The circuit is shown in Figure 1-2. The value of R234 is selected to meet the positive trigger pulse voltage. All parts are identical to the standard instrument except those listed below.

HP Stock No.	Description
0687-2201	R234: 22 ohms 10% 1/2W
00214-00208	Front Panel

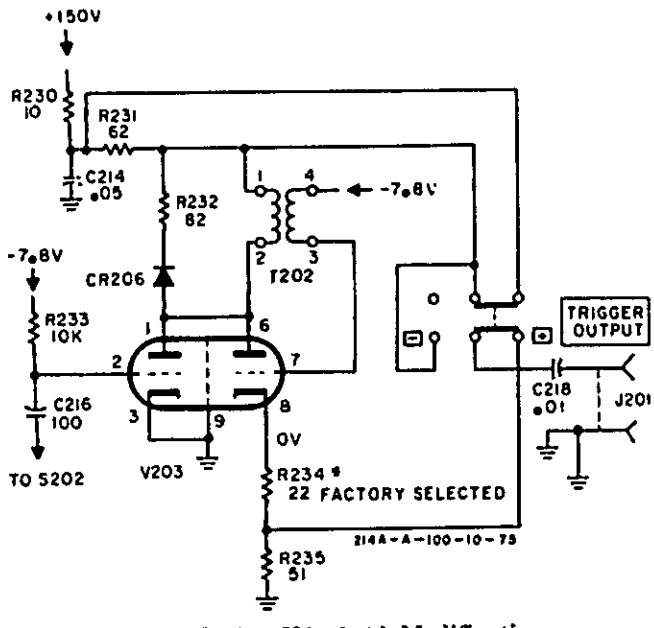


Figure I-2. Option H01-214A Modifications

MANUAL CHANGES

MODEL 214A

PULSE GENERATOR

Manual Serials Prefixed: 1239A
Manual Printed: NOV 1975

Make all changes listed below as Errata. Check the following table for your instrument serial prefix and/or serial number and make listed change(s) to the manual.

Serial Prefix or Number	Make Changes	Serial Prefix or Number	Make Changes
1609A	1		

Δ CHANGE 1

Page 5-17, figure 5-10,
Add: R370 between R361 and R404.
Page 5-24, figure 5-16,
R350: Change value to 62k.
Page 5-25, figure 5-17,
Add: R370 in line between −200VI and junction of pins 3, 9, and 8 of V308.
Table 6-1,
A301: Change HP Stock No. to 00214-66507.
R350: Change to HP Stock No. 0692-6235, R:FXD COMP 62K OHM 5% 2W.
Add: R370, HP Stock No. 0757-0726, R:FXD FLM 511 OHM 1% 1/4W.

Table 6-2,
Add: 0692-6235, R:FXD COMP 62K OHM 5% 2W, Mfr. 01121, Mfr. Part No. HB6235, TQ 1.
Add: 0757-0726, R:FXD FLM 511 OHM 1% 1/4W, Mfr. 24546, Mfr. Part No. C5-1/4-T0-511R-F, TQ 1.
Delete: 0764-0027.

14 April 1976

Supplement A for
00214-90910

Δ = Latest additions to this change sheet.
This change sheet supersedes all prior change sheets for this manual.