222A PULSE GENERATOR

OPERATING AND SERVICE MANUAL

HEWLETT hp PACKARD

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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

All Hewlett-Packard products are 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. No other warranty is expressed or implied. We are not liable for consequential damages.

For any assistance contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND SERVICE MANUAL

MODEL 222A
PULSE GENERATOR

SERIALS PREFIXED: 549- & 607-

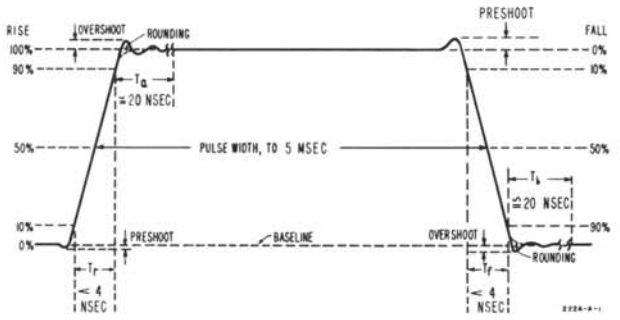
For Instruments With Other
Serial Prefixes, See Section I.

02543-2

PRINTED: FEBRUARY 1966

Table 1-1. Specifications

OUTPUT PULSE



SOURCE IMPEDANCE: 50 ohms ±3% shunted by approximately 15 pf at any output voltage up to 12 volts.

PULSE SHAPE:

LEADING EDGE CHARACTERISTICS: (Measured at 10 volts into 50 ohms)

RISE TIME: Less than 4 ns.

OVERSHOOT AND RINGING: Less than 4% peak of pulse amplitude.

CORNER ROUNDING: Occurs no sooner than 95% of pulse amplitude.

TIME TO SETTLE WITHIN 3% OF FLAT TOP: Less than 20 ns.

PRESHOOT: Less than 2%.

TRAILING EDGE CHARACTERISTICS: (Measured at 10 volts into 50 ohms)

FALL TIME: Less than 4 ns.

PRESHOOT: Less than 4%.

OVERSHOOT AND RINGING: Less than 4% peak of pulse amplitude.

CORNER ROUNDING: Occurs no sooner than 95% of pulse amplitude.

TIME TO SETTLE WITHIN 2% OF BASE LINE: Less than 20 ns.

PERTURBATIONS ON FLAT TOP: Less than 3% of pulse amplitude.

AMPLITUDE:

PEAK VOLTAGE: 10 volts across 50 ohms; 12 v volts maximum usable amplitude into open circuit. Output circuit protected, cannot be damaged by shorting.

ATTENUATOR: Provides seven steps from 0.1 to 10 volts in a 1, 2, 5 sequence.

VERNIER: Provides continuous adjustment between ranges; minimum output less than 0.05 volts into 50 ohms. Rotating vernier to minimum (ccw) increases trailing edge preshoot to about 10%.

POLARITY: Positive or negative.

PULSE WIDTH:

RANGE: Continuously variable from 30 ns to 5 ms in six ranges.

MAXIMUM DUTY CYCLE: At least 50% from 100 cps (Hz) to 10 Mc (MHz); 5 ms maximum pulse width decreases duty cycle at repetition rates below 100 cps (Hz).

WIDTH JITTER: (Measured at 10 volts into 50 ohms) Less than 0.2% of maximum width on any width setting.

REPETITION RATE AND TRIGGER

INTERNAL:

REPETITION RATE: Continuously variable from 10 cps (Hz) to 10 Mc (10 MHz) in six ranges.

PERIOD JITTER: Less than 0.2% of maximum period on any repetition rate setting.

MANUAL: Pushbutton for single pulses.

EXTERNAL:

TRIGGERING: AC coupled; sine waves from 10 cps (Hz) to 10 Mc (MHz), pulses from 0 to 10 Mc (MHz), either positive or negative slope.

SENSITIVITY: 1 volt p-p minimum; external pulses must be at least 10 ns wide; maximum input 20 volts peak, 0.25 watt maximum average power.

INPUT IMPEDANCE: Approximately 500 ohms.

EXTERNAL TRIGGER DELAY: Less than 20 ns between leading edge of external input pulse and leading edge of trigger output pulse.

TRIGGER OUTPUT PULSE: (Suitable for triggering another Model 222A)

WIDTH: 22 (±8) ns at 50% points.

AMPLITUDE: At least 1 volt into 50 ohms.

POLARITY: Negative.

PULSE DELAY: Pulse delay from trigger output continuously variable from less than 100 ns to 5 ms in six ranges.

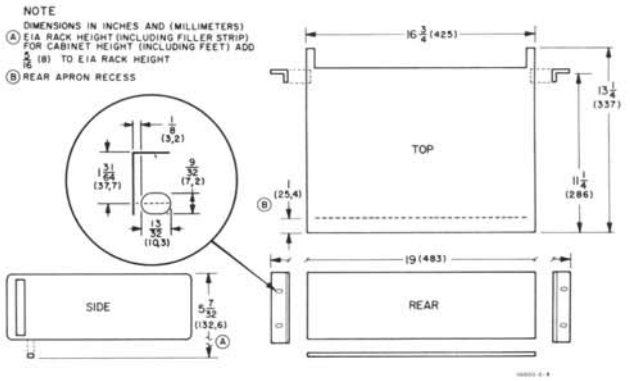
DELAY JITTER: Less than 0.2% of maximum delay on any delay setting.

GENERAL

POWER: 115 or 230 volts ±10%, 50 to 60 cps (Hz), 80 watts.

WEIGHT: Net 18 lbs (8 kg); shipping 24 lbs (11 kg).

DIMENSIONS:



SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Company Model 222A Pulse Generator (Figure 1-1) is a versatile, yet easy-to-use, general purpose instrument providing variable repetition rate; variable pulse delay, width, and amplitude; and positive or negative pulses with a rise and fall time of less than 4 nanoseconds. Complete specifications for the Model 222A are listed in Table 1-1. The Model 222A output impedance matches an external system of 50 ohms on all ranges, thus minimizing error-producing reflections. The maximum usable output pulse amplitude is approximately 12 volts into an open circuit or 10 volts into 50 ohms, and may be set at less than 50 millivolts by using the vernier and the lowest amplitude range. A duty cycle of 50% may be set for frequencies of 100 cps (Hz)* to 10 Mc (MHz) (see Table 1-1 for limits), providing a square wave output.

1-3. Pulses may be obtained from the Model 222A at a rate of dc to 10 Mc (MHz) using an external trigger source, or from 10 cps (Hz) to 10 Mc (MHz) using the internal rate generator. For external triggers, positive or negative signals of 0.5 volts peak may be used. A single pulse may be obtained from an internal circuit each time the manual pushbutton is pressed.

1-4. INSTRUMENT IDENTIFICATION.

1-5. The Hewlett-Packard Company uses an eight-digit serial number to identify instruments. The first three digits (followed by a dash) are a serial prefix number, and the last five digits identify a specific instrument. The serial number is stamped on a plate located on the instrument rear panel. All correspondence with the Hewlett-Packard Sales/Service Offices in regard to your instrument should include the complete serial number.

1-6. SCOPE OF MANUAL.

1-7. This manual provides operating and maintenance instructions for the Model 222A Pulse Generator. Information in this manual applies directly to Model 222A instruments with serials prefixed by 549- and 607- (see title page) as manufactured. If the serial prefix of a Model 222A is not 549- or 607-, Appendix I or a change sheet supplied with the manual will define differences between that Model 222A and the one described in this manual. Technical corrections to the manual, due to any known errors in print, are called Errata and are listed on the separate change sheet (if any) supplied with the manual. For information pertaining to manual coverage of any hp instrument, contact the nearest Sales/Service Office.

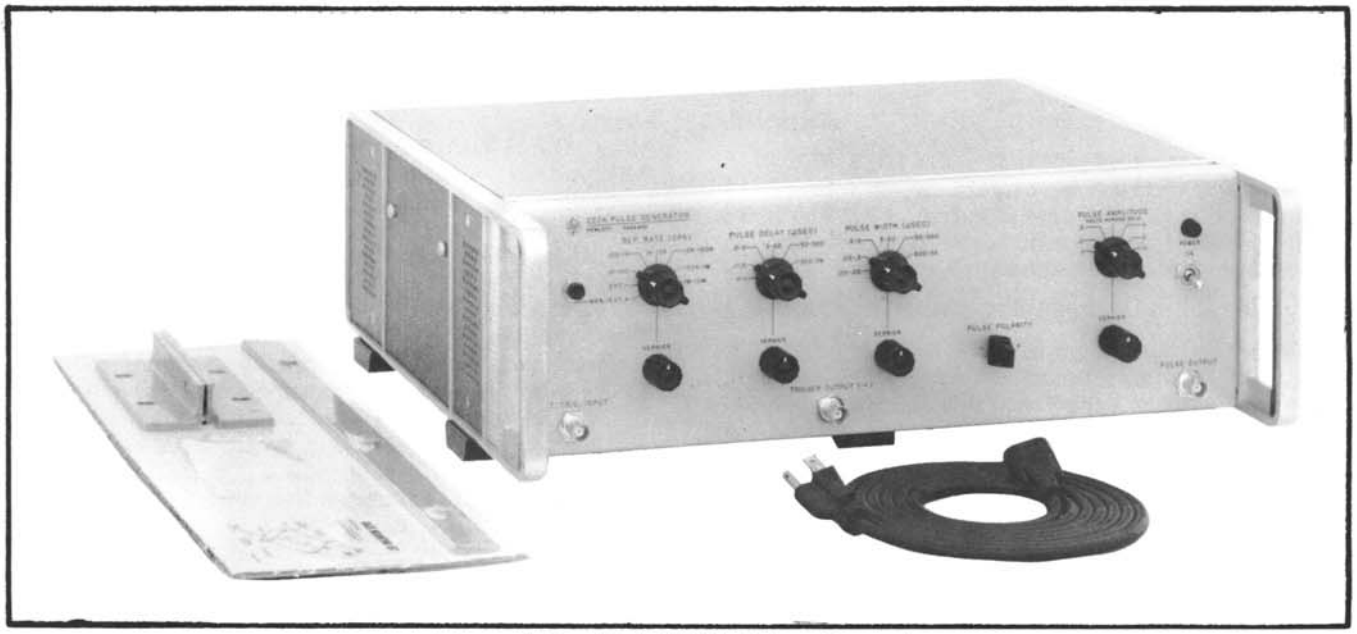


Figure 1-1. Model 222A Pulse Generator

*This manual incorporates the new international unit Hertz, abbreviated Hz, for frequency (cps).

SECTION II
INSTALLATION

2-1. INITIAL INSPECTION.

2-2. MECHANICAL CHECK. If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the instrument for external damage such as broken controls or connectors, and dents or scratches on the panel surfaces. If damage is evident, see Paragraph 2-4 for recommended claim procedure and repackaging information. If the shipping carton is not damaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. If the instrument appears undamaged, perform the electrical check given in the following paragraph.

2-3. ELECTRICAL CHECK. Check the electrical performance of the Model 222A as soon as possible after receipt. Paragraphs 5-5 through 5-18 contain performance check procedures which will verify instrument operation within the specifications listed in Table 1-1. This check is also suitable for incoming quality control inspection. If the Model 222A does not perform within the specifications when received, refer to Paragraph 2-4 for recommended claim procedure and repackaging information.

2-4. CLAIMS AND REPACKAGING.

2-5. If physical damage is evident, or if the instrument does not meet specifications when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office (see list at rear of this manual). The Sales/Service Office will arrange for repair or replacement without waiting for settlement of a claim with the carrier. The certification and warranty statements for all hp instruments are on the inside front cover of this manual.

2-6. The original shipping carton and packing material, with the exception of the accordion-pleated pads, should be used for reshipment. The accordion-pleated pads are fatigued with one use and are not reusable. The Hewlett-Packard Sales/Service Office will also provide information and recommendations on materials to be used if the original packaging material is not available or is not reusable. Materials used should include: (1) a double-walled carton (check with a freight carrier for test strength required), (2) heavy paper or sheets of cardboard to protect all instrument surfaces; use extra material around projecting parts of the instrument, (3) at least four inches of tightly-packed shock-absorbing material surrounding the instrument. Close the carton securely with durable shipping tape. If the instrument is to be shipped to a hp Sales/Service Office for repair, attach a tag showing owner, model, serial number, and repairs required.

2-7. PREPARATION FOR USE.

2-8. AC POWER CONSIDERATION.

2-9. POWER SOURCE REQUIREMENTS. The Model 222A may be operated from an ac source of 115 or 230 volts (±10%), at 50 to 60 cps (Hz). 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 should be 1 amp for 115 v operation, or 1/2 amp for 230 v operation.

2-10. THREE-CONDUCTOR POWER CABLE. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument and cabinet be grounded. The Model 222A 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.

2-11. VENTILATION REQUIREMENTS.

2-12. GENERAL. The cooling fan and air filter are located on the rear panel of the Model 222A. Leave adequate clearance (at least two 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. The Model 222A operates within its specifications when the ambient temperature is between 0° C and 55° C. Ambient temperatures in excess of 55° C could affect the accuracy of the instrument and cause damage to the circuits. In a rack installation, ensure that recirculation of warm air within the rack cabinet does not produce an ambient temperature high enough to affect instrument operation.

2-13. AIR FILTER. The air filter used on the Model 222A is of a new and improved design which allows increased air flow and still maintains air cleaning efficiency. Application of filter coating materials is not required or recommended for this new type filter.

2-14. RACK/BENCH CONVERSION.

2-15. The Model 222A is shipped as a bench-type instrument with plastic feet and tilt stand in place. The hp modular instrument enclosure system allows easy conversion to either bench or rack model. Refer to the following procedures for conversion instructions.

2-16. CONVERSION TO RACK MODEL.

a. Detach the tilt stand and all plastic feet. Tilt stand is removed by pressing away from the front feet. Remove feet by depressing the 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 the front handles).

Removal of this strip exposes threaded nuts pressed into the side casting.

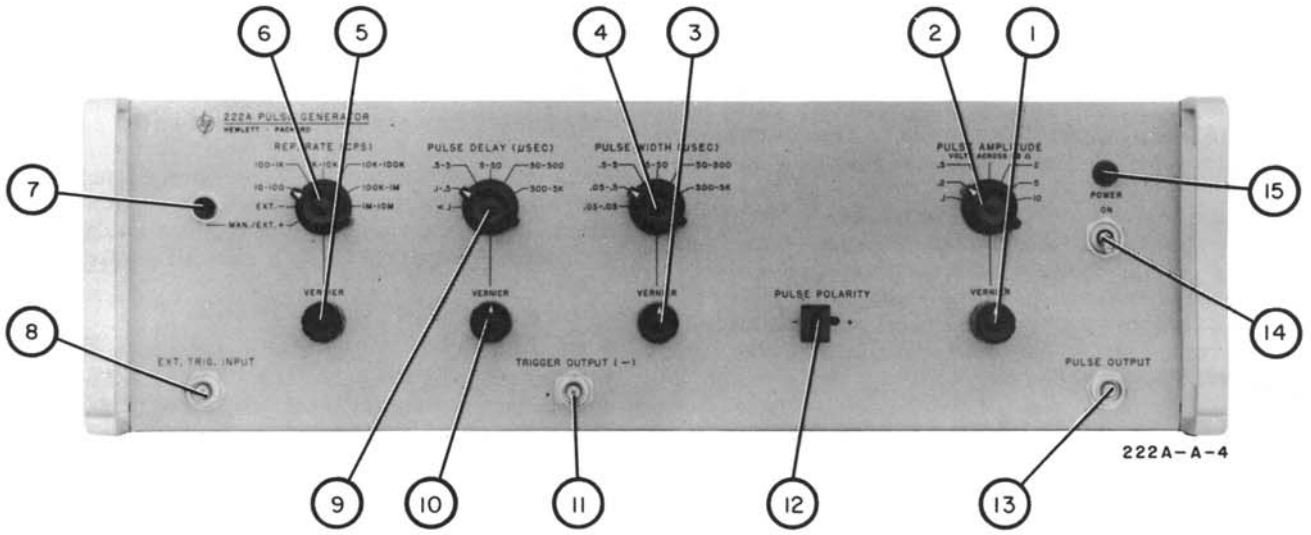
c. Attach the rack-mounting flanges, with the screws provided, in the space where the trim strip was adhered. Each flange extends slightly below the front panel when installed correctly.

d. If the instrument is to be mounted in a rack above or below another hp modular instrument, attach the filler strip between the front panels. Insert the Model 222A into the rack and secure flanges to the rack frame.

2-17. CONVERSION TO BENCH MODEL.

a. Remove instrument from the rack, detach the rack-mounting flanges and remove the filler strip (if used).

b. Attach trim strip (in slots where rack-mounting flanges were located), plastic feet, and tilt stand. A fifth plastic foot at the center-front of the instrument provides extra stability when the Model 222A is stacked atop another hp modular bench-type instrument.



(1) PULSE AMPLITUDE VERNIER control. Provides continuous overlapping adjustment between setting of PULSE AMPLITUDE selector switch and next lower range.

(2) PULSE AMPLITUDE selector switch. Selects amplitude range of output pulse.

(3) PULSE WIDTH (μSEC) VERNIER control. Adjusts output pulse width to any point within limits set by PULSE WIDTH selector switch.

(4) PULSE WIDTH (μSEC) selector switch. Selects output pulse width.

(5) REP RATE (CPS) VERNIER control. Adjusts repetition rate to any point within limits set by REP RATE selector switch.

(6) REP RATE (CPS) selector switch. Selects external triggering or internal repetition rate.

(7) Manual pushbutton switch. Triggers single pulse output when REP RATE selector switch is in either of the EXT positions.

(8) EXT TRIG INPUT connector. Input connector for external triggering signals.

(9) PULSE DELAY (μSEC) selector switch. Selects output pulse delay time with respect to TRIGGER OUTPUT pulses.

(10) PULSE DELAY (μSEC) VERNIER control. Adjusts output pulse delay to any point within limits set by PULSE DELAY selector switch.

(11) TRIGGER OUTPUT (-) connector. Supplies negative synchronizing pulses.

(12) PULSE POLARITY selector. Selects either negative or positive output pulse polarity.

(13) PULSE OUTPUT connector. Supplies output pulse with characteristics as set by front panel controls (see Table 1-1 for specifications).

(14) ON switch. Controls ac power to instrument.

(15) POWER indicator. Indicator lights when power is ON.

16 115/230 switch (on rear panel). Selects power input mode for either 115 v or 230 v input voltage.

Figure 3-1. Model 222A Controls and Connectors

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section contains the operating instructions for the Model 222A Pulse Generator. This instrument has been designed for general purpose laboratory requirements with ease-of-use as a prime consideration. Therefore, the operating procedure is quite simple. Figure 3-1 identifies and briefly describes the purpose of each panel control and connector on the instrument. Operation limits of the Model 222A are as specified in Table 1-1.

3-3. DUTY CYCLE.

3-4. Duty cycle of operation for the Model 222A is determined by the front panel control settings.

3-5. DEFINITION.

3-6. The following paragraphs define duty cycle and explain its limitations. Duty cycle is defined as the ratio of pulse duration (i. e. pulse width) to the total duration of one complete cycle. Figure 3-2 shows the relationships which determine 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 multiplied by 100 determines the duty cycle percentage. For example: if REP RATE is set to 1K-10K, and the REP RATE VERNIER is adjusted to produce a rate of 6 kc (kHz) (or if the external trigger input rate is 6 kc), and PULSE WIDTH and VERNIER are set to produce a pulse of 70 μsec wide, the percent of duty cycle will be:

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

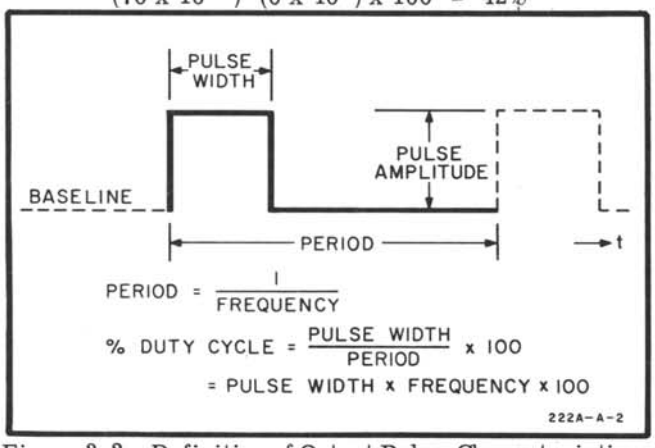


Figure 3-2. Definition of Output Pulse Characteristics

3-7. LIMITATIONS.

3-8. The duty cycle limitations must be kept in mind at all times when operating the Model 222A. There is no combination of panel settings that will damage the instrument; however, settings are possible which will exceed the duty cycle limits. There is no panel indication that the duty cycle limits have been exceeded. Basically, the only indication of having exceeded the duty cycle limits is that the output frequency will go to a sub-multiple of the REP RATE setting on the front panel. It should be noted that the frequency will react in the same way if a delay of more than one half the period is attempted. The same limits on duty cycle apply for operation with external triggering or internal repetition rate generation. The duty cyle at repetition rates of less than 100 cps is limited by the maximum PULSE WIDTH setting of 5 milliseconds. Figure 3-3 provides a graph which gives the maximum width vs frequency settings that may be selected without going over 50% duty cycle. Figure 3-3 also shows the relationship between duty cycle and pulse delay, i. e. the maximum frequency vs delay settings that may be used. The following examples illustrate the use of Figure 3-3.

a. If an output frequency of 50 kc (kHz) is required, any pulse width up to 10 μsec may be selected.

b. If an output pulse width of 5 μsec is required, any frequency up to 100 kc (kHz) may be selected.

c. If an output frequency of 100 kc (kHz) is being used, any delay up to 5 μsec may be selected.

3-9. The Model 222A will, in some cases, function accurately at slightly more than 50% duty cycle; however, if this is attempted, the operator must be alert for indications that the instrument capabilities have been exceeded. To obtain maximum stability at high duty cycles, select width range which allows maximum clockwise rotation of the width vernier.

3-10. OPERATING PROCEDURES.

3-11. The Model 222A can be operated in three different modes; internal trigger, external trigger, or manual trigger. The procedures are detailed in Paragraphs 3-12 through 3-17.

3-12. INTERNAL TRIGGER MODE.

3-13. The Model 222A will generate internally any repetition rate from 10 cps (Hz) to 10 Mc (MHz). The repetition rate is established by setting the REP RATE selector to any of the six internal ranges, and then adjusting the REP RATE VERNIER to the specific rate desired. Refer to Paragraphs 3-3 through 3-9 and proceed as follows:

a. Set instrument power switch to ON and allow approximately 30 seconds for warm-up.

b. Set REP RATE selector to desired range, and adjust VERNIER to approximate position for frequency desired.

Note

Maximum end of range on all VERNIER controls is fully clockwise.

c. Set PULSE DELAY selector and adjust VERNIER for desired delay. This setting provides for a delay

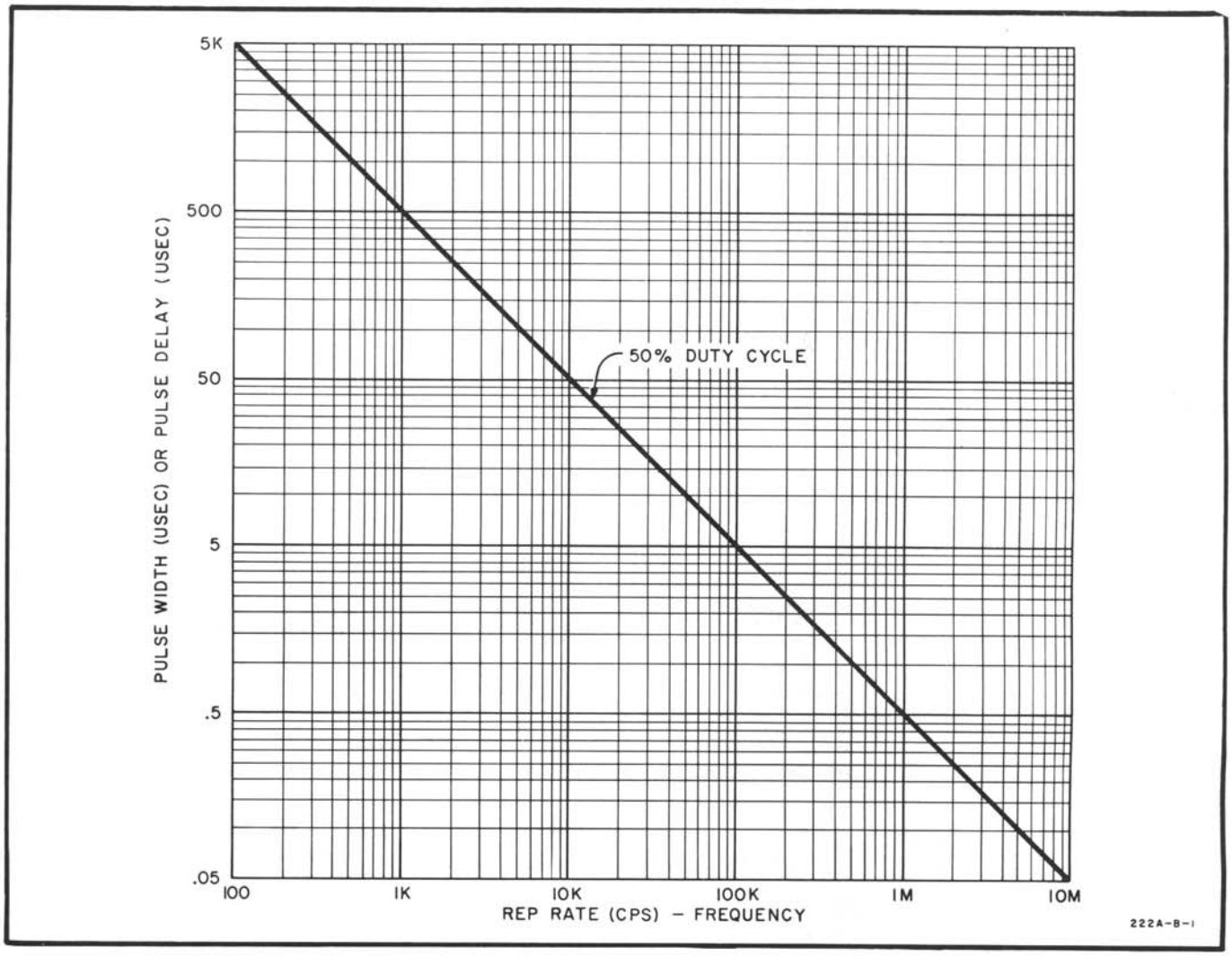


Figure 3-3. 50% Duty Cycle Limit

(in time) of the output pulse with respect to the TRIGGER OUTPUT signal. (Note limits given in Figure 3-3.)

d. Select PULSE WIDTH range and adjust VERNIER. (Note limits given in Figure 3-3.)

e. Select PULSE AMPLITUDE range and adjust VERNIER fully ccw. Note that these amplitudes are into a 50-ohm load at the PULSE OUTPUT connector. Do not exceed 12 volts maximum output amplitude into any load.

CAUTION

Do not apply greater than 1 volt to the PULSE OUTPUT connector.

f. Select PULSE POLARITY and connect the PULSE OUTPUT connector to the external test circuit using a coaxial cable.

g. Adjust VERNIER controls, if necessary, to obtain the exact output pulse characteristics desired.

3-14. EXTERNAL TRIGGER MODE.

3-15. With the REP RATE selector in either of the EXT positions, an external signal from dc to 10 Mc (MHz) with 0.5 volts peak amplitude is required to generate pulses in the Model 222A. Refer to Paragraphs 3-3 through 3-9 and proceed as follows:

a. Set instrument power switch to ON and allow approximately 30 seconds for warm-up.

b. Set REP RATE selector to either EXT position (corresponding to polarity of the input signal) and connect the external trigger source to the EXT TRIG INPUT connector.

Note

When a fast rise time (less than 20 ns) pulse exceeding 6 volts in amplitude is used to drive the EXT TRIG INPUT, care must be taken to reduce any extraneous signals between pulses which can cause multiple triggering. These signals can be reflections resulting from an impedance mismatch between the trigger source and the 500 ohm EXT TRIG INPUT.

c. Set PULSE DELAY selector and adjust VERNIER for desired delay. This setting provides for a delay (in time) of the output pulse with respect to the TRIGGER OUTPUT signal. (Note limits given in Figure 3-3.)

d. Select PULSE WIDTH range and adjust VERNIER. (Note limits given in Figure 3-3.)

e. Select PULSE AMPLITUDE range and adjust VERNIER fully ccw. Note that these amplitudes are volts into a 50-ohm load at the PULSE OUTPUT connector. Do not exceed 12 volts maximum output amplitude into any load.

CAUTION

Do not apply greater than 1 volt to the PULSE OUTPUT connector.

f. Set PULSE POLARITY and connect the PULSE OUTPUT connector to the external test circuit using a coaxial cable.

g. Adjust delay, width, and amplitude VERNIER controls, if necessary, to obtain the exact output pulse characteristics desired.

3-16. MANUAL TRIGGER MODE.

3-17. With the REP RATE selector in either of the EXT positions, a single output pulse is generated by the Model 222A each time the MANUAL pushbutton is pressed. The manual pulse is generated internally and no external trigger is required. Maximum rate for MANUAL pulses is 2 cps (Hz). Refer to Paragraphs 3-3 through 3-9 and proceed as follows:

a. Set instrument power switch to ON and allow approximately 30 seconds for warm-up.

b. Set REP RATE selector to either EXT position.

c. Set PULSE DELAY selector and adjust VERNIER for desired delay. This setting provides for a delay (in time) of the output pulse with respect to the TRIGGER OUTPUT signal.

d. Set PULSE WIDTH range and adjust VERNIER.

e. Select PULSE AMPLITUDE range and adjust VERNIER fully ccw. Note that these amplitudes are volts into a 50-ohm load at the PULSE OUTPUT connector. Do not exceed 12 volts maximum output amplitude into any load.

CAUTION

Do not apply greater than 1 volt to the PULSE OUTPUT connector.

f. Select PULSE POLARITY and connect the PULSE OUTPUT connector to the external test circuit using a coaxial cable.

g. Press MANUAL pushbutton to obtain a single output pulse.

h. Adjust delay, width, and amplitude VERNIER controls, if necessary, to obtain the exact output characteristics desired.

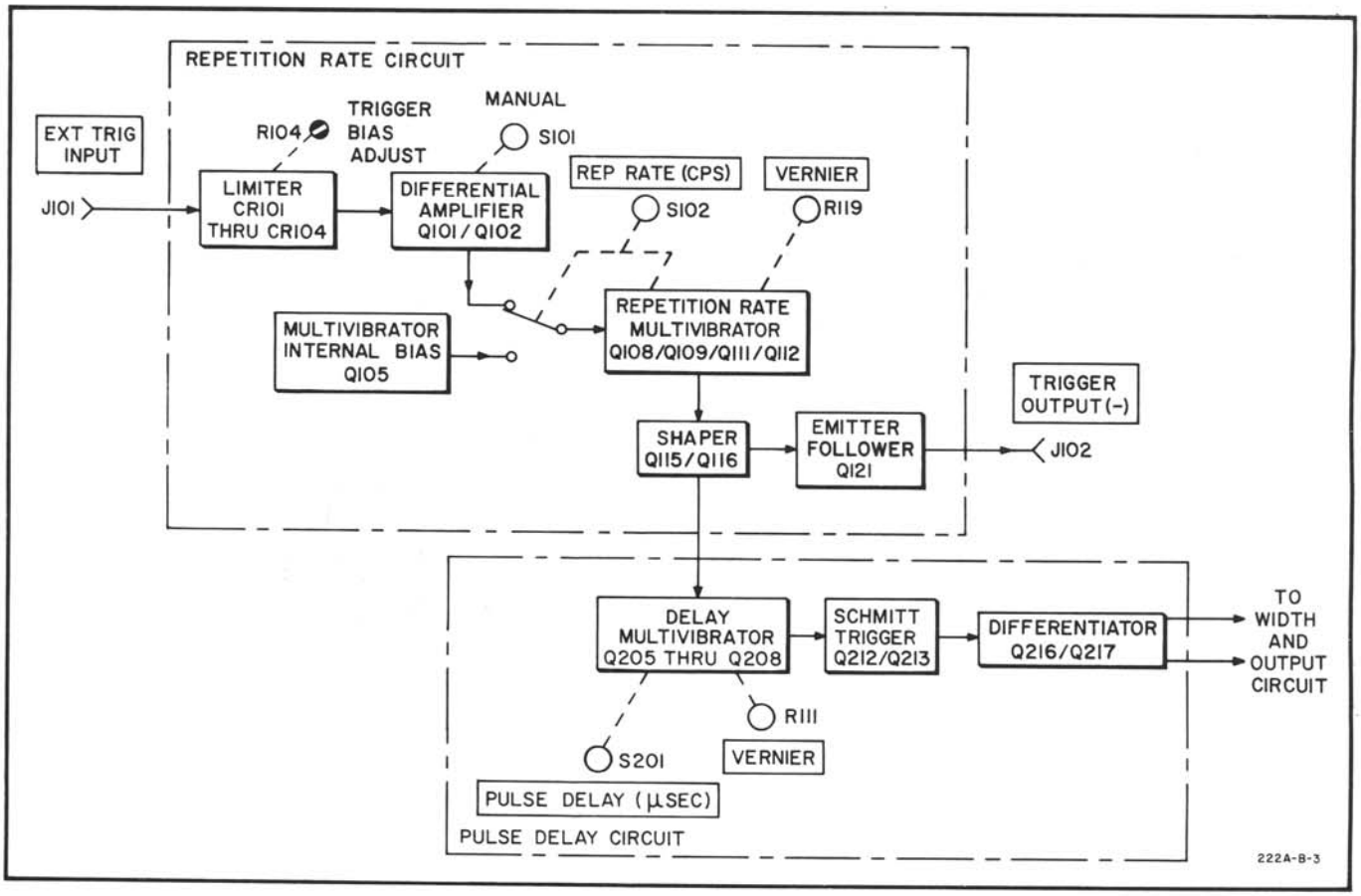


Figure 4-1. Rate and Delay Circuits Block Diagram

SECTION IV
PRINCIPLES OF OPERATION

4-1. GENERAL.

4-2. This section contains the basic principles of operation for the Model 222A Pulse Generator. The Model 222A contains the same basic functions as most pulse generators, as shown in Figure 4-2. The output pulse is formed in the following general sequence. The repetition rate (or frequency) is established by an external triggering source or is generated internally by a multivibrator. The repetition rate circuit also supplies a negative trigger output. The signal then passes through the delay circuit which sets up delay of the output signal with respect to the trigger output signal. Pulse width is then established before the signal goes through both the output circuit and the attenuator which controls the output pulse amplitude. The following paragraphs and diagrams provide a more detailed discussion of each basic circuit.

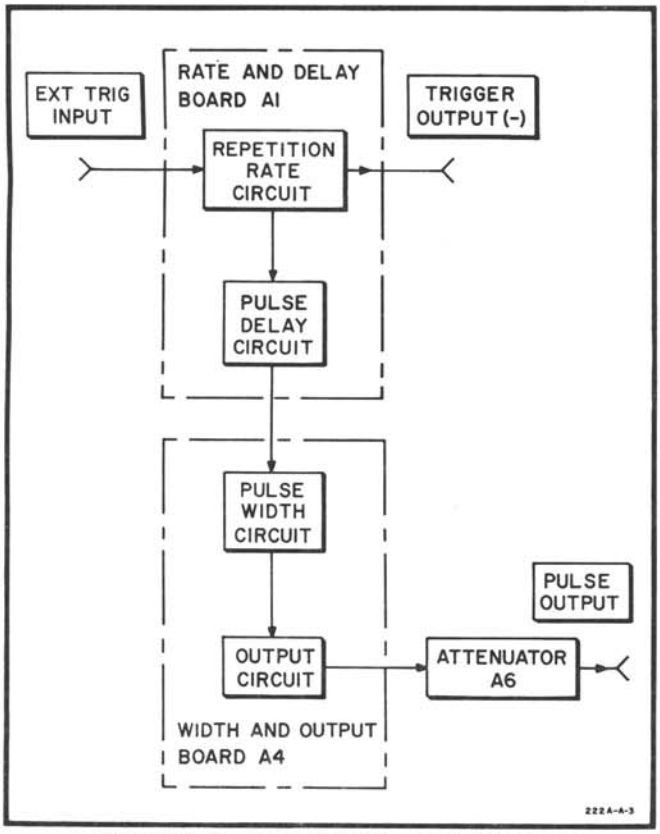


Figure 4-2. Model 222A Block Diagram

4-3. REPETITION RATE CIRCUIT.

4-4. Mode of operation for the Model 222A is established in this circuit (i.e. internal triggering, external triggering, or manual triggering), depending on the setting of S102 REP RATE (CPS) selector switch.

4-5. INTERNAL TRIGGERING.

4-6. For this operation mode, REP RATE switch S102 is set to any of the six internal rate settings (refer to Figures 4-1 and 5-6). In this condition the Limiter and Differential Amplifier are eliminated from the circuit, with bias for Q111 being supplied by Multivibrator Internal Bias Q105. This Circuit (Q105) also supplies bias for Q108 which is the current source for Q111, and Q109 which is the current source for Q112. The Repetition Rate Multivibrator is an astable multivibrator which free-runs at the frequency selected by REP RATE switch S102 and REP RATE VERNIER control R119. Refer to Figure 4-3 for a simplified schematic and typical waveforms of the Repetition Rate Multivibrator. At t_0 Q111 is turning on and its collector is going negative. This negative going signal appears on the base of Q112, which causes Q112 to start turning off. As Q112 turns off, a positive spike is generated on the collector of Q112 due to the action of L111. The emitter of Q112 is also going negative by the same amount as the Q111 collector, which reverse biases CR112. Therefore, all current drawn by Q109 must come from Q111 which charges C_r at a constant rate. The collector of Q109 begins to ramp down due to the C_r charging action. When the Q109 collector reaches a point (t_1) which forward biases CR112 regeneration of the circuit is initiated. Regeneration occurs when Q112 starts turning on and supplying current to Q109 and, therefore, less current is drawn through Q111 and Q111 starts turning off. As Q111 turns off, its collector and Q112 base go positive and the emitter of Q112 follows, turning Q112 on harder. As Q112 turns on its collector goes negative, producing a negative spike at the output. When regeneration is completed, CR111 is reverse biased and all current flow in the circuit is now from Q112 through CR112 to Q109; and through C_r to Q108, again charging C_r at a constant rate. As C_r charges, the collector of Q108 ramps down. When the Q108 collector reaches a point (t_2) which forward biases CR111, Q111 starts turning on again and the cycle repeats. The repetition rate is varied by the action of R119 which controls Q111 collector voltage excursion.

4-7. The output of the multivibrator is routed through the Shaper Circuit, which further ensures a constant signal (amplitude and shape) before passing on to the delay circuitry from Q116. The Shaper is very similar to a Schmitt trigger, but is ac-coupled from Q115 collector to Q116 base. The trigger output signal is obtained at this point from the collector of Q115. Emitter Follower Q121 is designed to produce a negative-going signal at the TRIGGER OUTPUT jack.

4-8. EXTERNAL TRIGGERING.

4-9. For this operation mode, REP RATE switch S102 is set to either EXT- or MAN/EXT+. When S102 is set to MAN/EXT+ the Model 222A will be triggered by the positive-going slope of the external triggering signal, while the negative-going slope will provide the triggering if S102 is set to EXT-. The external trigger is applied through J101 to a Diode Limiter which supplies an approximately constant amplitude signal to the base of Q101 regardless of the

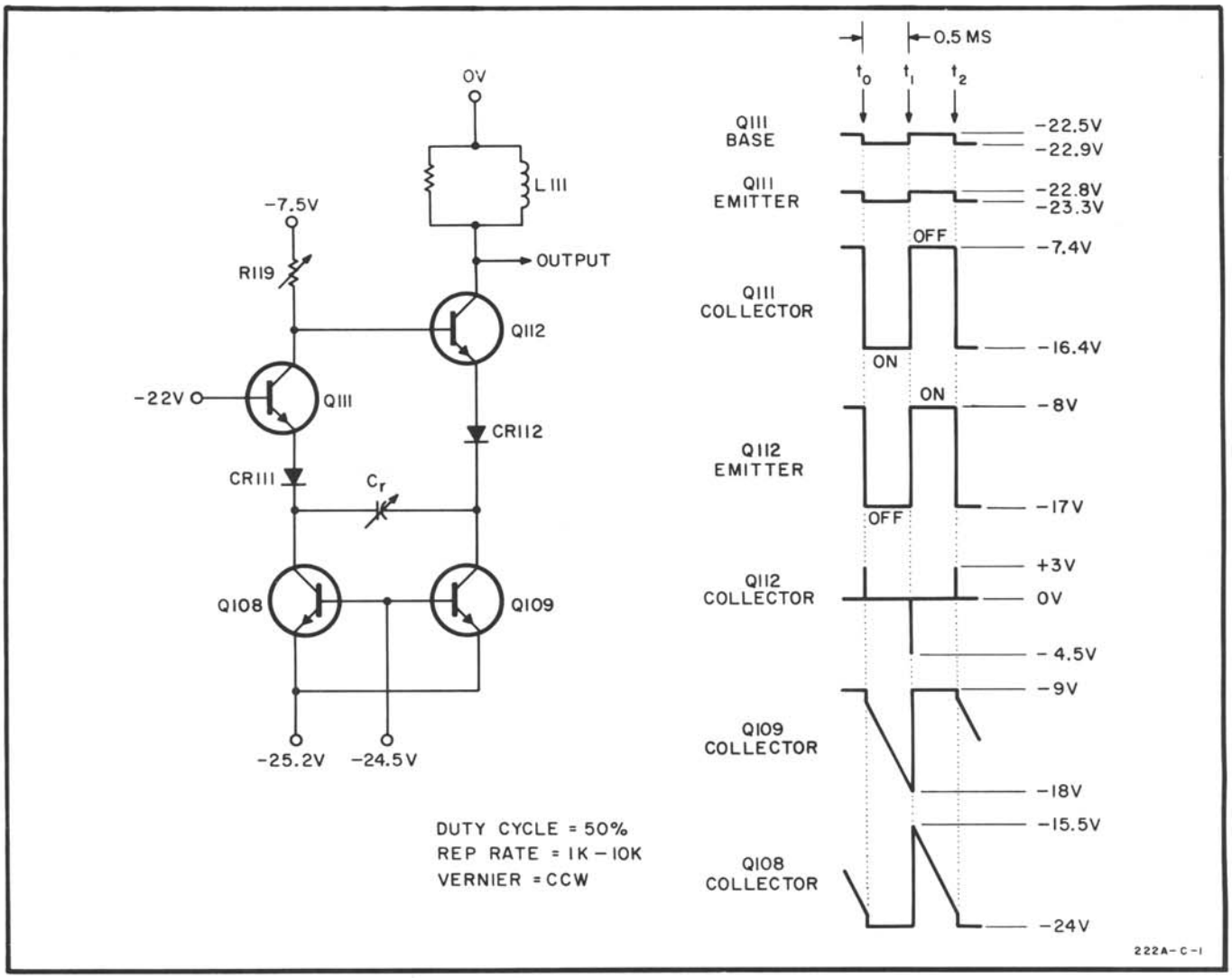


Figure 4-3. Rate Multivibrator Simplified Schematic and Waveforms

input amplitude. Differential Amplifier Q101/Q102 is a single-ended input differential amplifier which supplies the positive signal (if S102 is correctly set) required to trigger Q111. Bias voltage for Q102 is a fixed voltage supplied by Multivibrator Internal Bias Q105, and the bias for Q101 is controlled by R104. Trigger Bias Adj R104 is adjusted so that the collector voltages of Q101 and Q102 are exactly equal. When the Model 222A is operated using an external trigger, Q111 (which is biased off) and Q112 (which is biased on) function as a regenerative amplifier since CR115 replaces the timing capacitors on S102. The output of Q112 is, again, negative and positive spikes due to the action of L111. The balance of the repetition rate circuit functions the same as described in Paragraph 4-6.

4-10. MANUAL TRIGGERING.

4-11. For this operation mode, REP RATE switch S102 is set to either EXT- or MAN/EXT+. All repetition rate circuit stages function as described in Paragraph 4-9 except for the Differential Amplifier Q101/Q102. When the MANUAL pushbutton S101 is pressed, the collector voltage of both Q101 and Q102 increases by approximately three volts. This voltage increase is the positive step which triggers Q111 to produce a single pulse.

4-12. PULSE DELAY CIRCUIT.

4-13. This circuit establishes delay of the output signal with respect to the trigger output signal (refer to Figure 4-1 and 5-9). The delay time is established by the setting of PULSE DELAY selector switch S201 and PULSE DELAY VERNIER control R211. Refer to Figure 4-4 for a simplified schematic and typical waveforms of the Delay Multivibrator. The Delay Multivibrator is a monostable multivibrator which goes through one complete cycle of operation each time it is triggered. In the initial stage, Q205 is reverse biased and Q206 is forward biased. At t_0 the incoming positive trigger from the Repetition Rate circuit turns on Q205, causing the collector voltage to go down rapidly while the emitter is held at approximately -30 volts by the base. The negative swing on the Q205 collector appears on the base of Q206, and the Q206 emitter tries to follow it. As the Q206 emitter voltage ramps down toward the base voltage it charges C_d, while at the same time Q206 has turned off and its collector voltage rises. When the Q206 emitter voltage reaches the same level as the base voltage, the base-emitter junction is no longer reverse

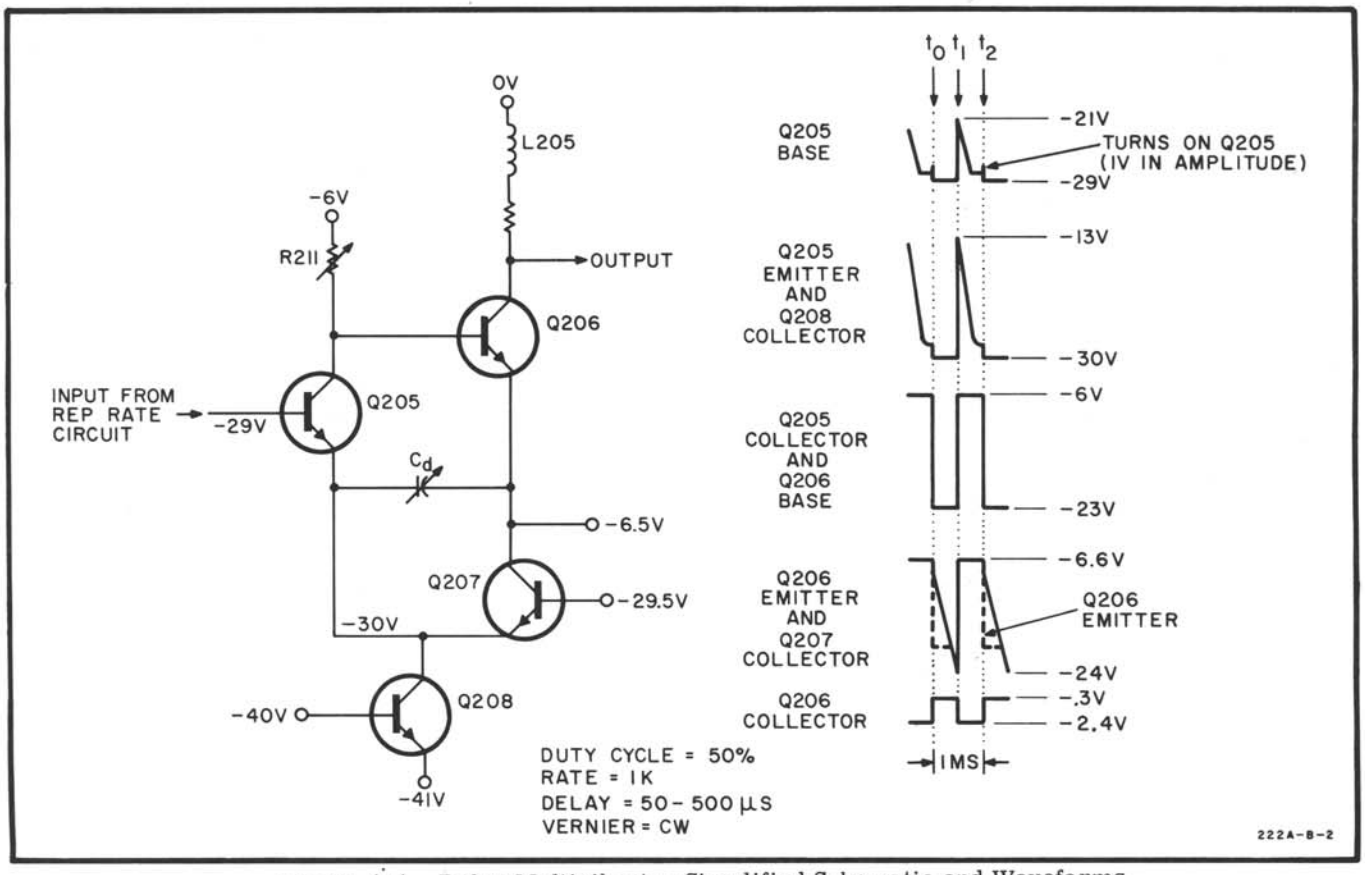


Figure 4-4. Delay Multivibrator Simplified Schematic and Waveforms

biased and Q206 turns back on. When Q206 turns on (t_1), its collector voltage goes down as current flows into the collector. Current flow for Q206 is controlled by Q207, which is biased by Current Source Q209 so that it is turned on at all times. Since total current in the circuit is fixed by Q208, the Q205 collector current must decrease. The resulting increase in Q205 collector voltage causes Q206 to turn on harder. Regeneration continues as the Q206 emitter voltage rise is coupled across C_d to raise the Q205 emitter voltage, which causes Q205 to further turn off. At this point the cycle is completed and the circuit remains in the quiescent state until triggered again (t_2). Output of the Delay Multivibrator is a rectangular pulse with constant amplitude but variable width depending on the delay setting.

4-14. The output of the Delay Multivibrator is then routed through Schmitt Trigger Q212/Q213 which stabilizes the multivibrator output to provide a more constant signal. The signal is then applied to the Differentiator Q216/Q217 which converts the signal into differential positive and negative spikes for triggering the Pulse Width Circuit.

4-15. PULSE WIDTH CIRCUIT.

4-16. This circuit establishes the width of the output pulse (refer to Figure 4-5 and 5-13). The pulse width is established by the setting of PULSE WIDTH selector switch S301 and PULSE WIDTH VERNIER control R311. The width circuit receives the signal developed in the delay circuit through Differential Amplifier Q301/Q302. A positive spike signal is developed on the collector of Q301 which is used to trigger the Width Multivibrator. The Width Multivibrator functions identically to the Delay Multivibrator as discussed in Paragraph 4-13. The output of the Width Multivibrator is stabilized by Schmitt Trigger Q312/Q313 to provide a constant signal input to the output circuit.

4-17. OUTPUT CIRCUIT.

4-18. This circuit establishes the amplitude of the output signal (refer to Figures 4-5 and 5-16). The signal amplitude is controlled by the setting of PULSE AMPLITUDE selector switch S402 and PULSE AMPLITUDE VERNIER control R447. The entire output circuit functions as a power switch with variable amplitude capability. Refer to Figure 4-6 for a simplified schematic and typical waveforms for the output circuit. Output from the width circuit is applied to the output circuit through three stages of emitter followers (the first of which is omitted in Figure 4-6). In the initial state Q_3 and Q_4 are reverse biased. When the input signal reaches the base of Q_3 (t_0), it has an amplitude of approximately two volts. The positive-going portion of the signal (t_1) strongly forward biases Q_3, thus saturating Q_3 and turning on Q_4. The circuit remains in this state until the input signal again goes negative (t_2) turning Q_3 and Q_4 off, and then the cycle repeats. The output

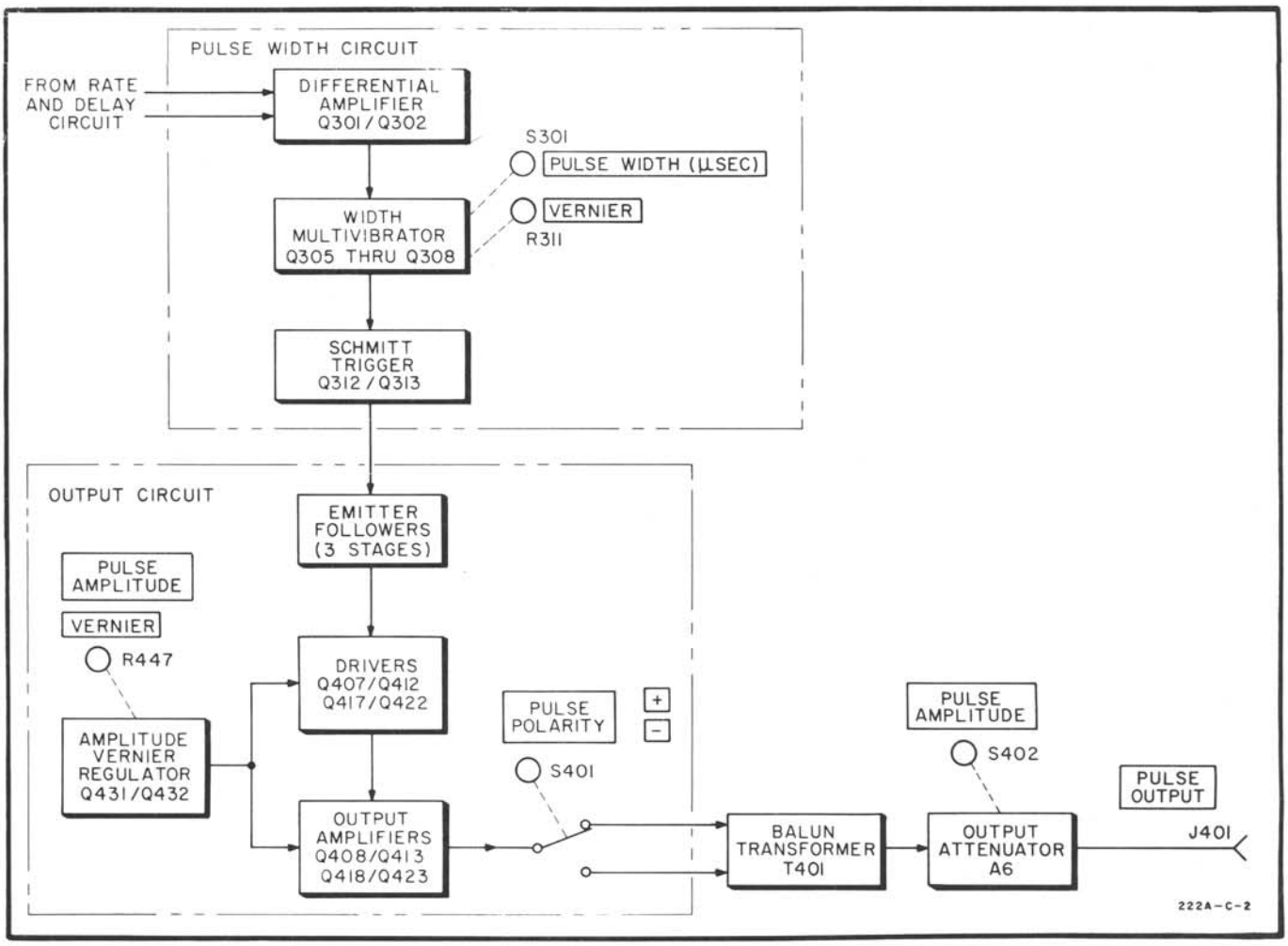


Figure 4-5. Width and Output Circuits Block Diagram

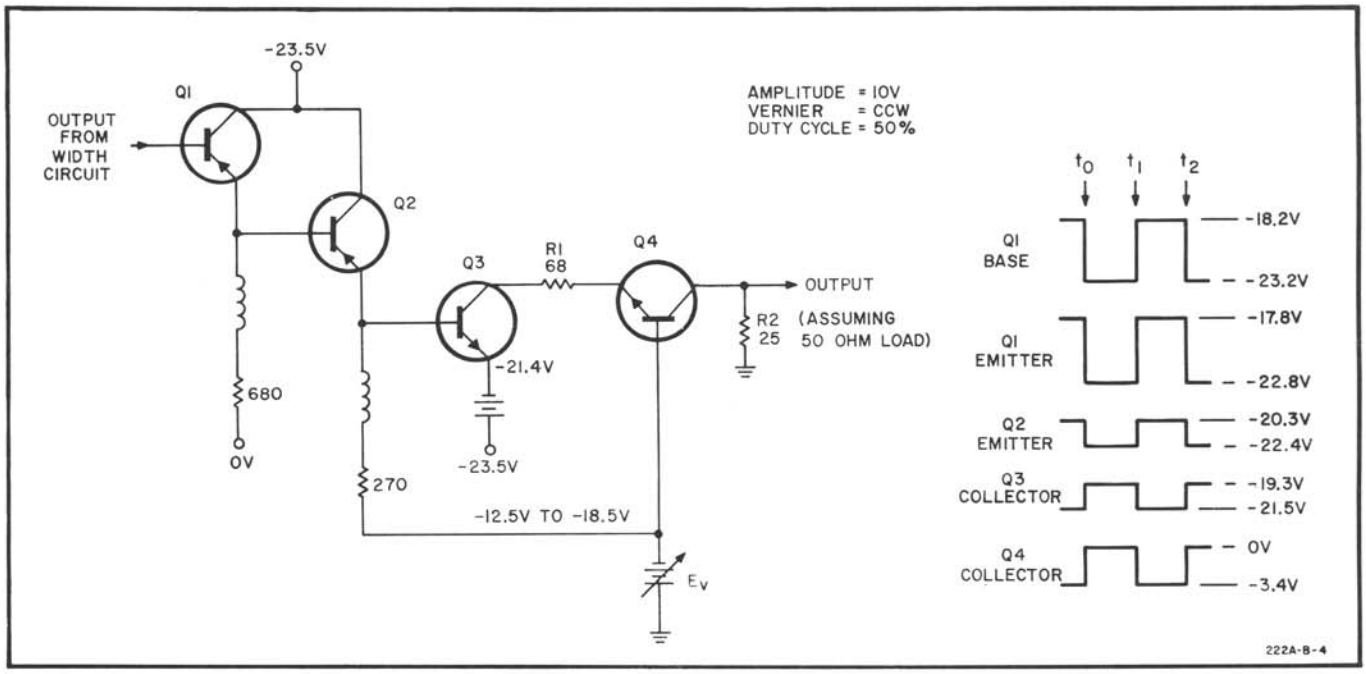


Figure 4-6. Output Circuit Simplified Schematic and Waveforms

signal amplitude is varied by means of Amplitude Vernier Regulator Q431/Q432, which is simply a variable bias supply (E_v on Figure 4-6). The amplitude vernier control circuit (E_v) supplies the bias voltage for Q_3 and Q_4, thereby controlling current flow through R_1 and R_2 (load).

4-19. The output pulse polarity is also controlled in this circuit by PULSE POLARITY switch S401 which reverses the input to Balun Transformer T401, thus reversing the Attenuator input polarity. It should be noted that the entire Width and Output board is floating above ground, which allows the output pulse polarity reversal. Further control of the output pulse amplitude is provided by Output Attenuator A6. The Output Attenuator is designed to provide a 50-ohm input and output impedance, and the proper division ratios for various output amplitude ranges.

4-20. POWER SUPPLY CIRCUIT.

4-21. The power supply for the Model 222A (refer to Figures 4-7 and 5-18) is a standard regulated power supply which is self protected to prevent excessive current flow. Power leads for Width and Output board A4 (which is floating) are decoupled by the action of Trifilar Coil L1.

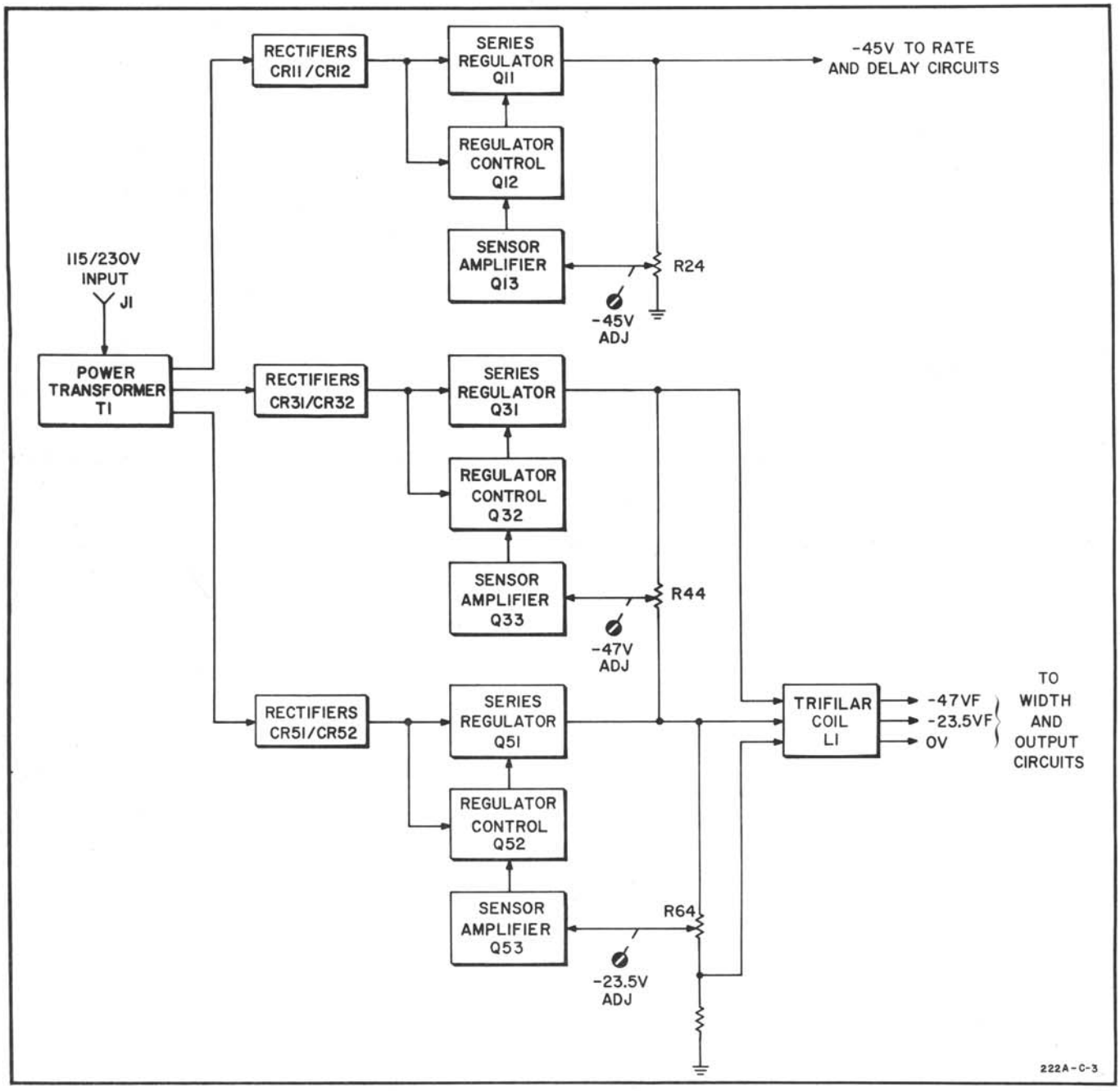


Figure 4-7. Power Supply Circuit Block Diagram

Table 5-1. Required Test Equipment

Recommended Instrument		Required Characteristics	Required for
Type	Model		
Sampling Oscilloscope	hp185B with 187C	1 Gc (GHz) Bandwidth	Performance Check
10:1 Divider	hp10214A	1 Gc (GHz) Bandwidth	Performance Check
50-ohm Tee	hp10221A	1 Gc (GHz) Bandwidth	Performance Check
50-ohm Load	GR 874-W50	1 Gc (GHz) Bandwidth, 1 w Minimum Power Rating	Performance Check
BNC Adapter	hp10218A	1 Gc (GHz) Bandwidth	Performance Check
High Frequency Oscilloscope	hp175A with 1750B and 1780A	50 Mc (MHz) Bandwidth, 50 Mv/cm Sensitivity	Trouble-shooting
50-ohm Feed-through Termination	hp10100A	BNC to BNC Connectors	Trouble-shooting
DC Voltmeter	hp412A	0.1 v to 30 v Voltage Range, 1% Accuracy	Adjustments and Trouble-shooting
Test Oscillator	hp651A	10 cps (Hz) to 10 Mc (MHz) Output Range, 1 v Output	Performance Check

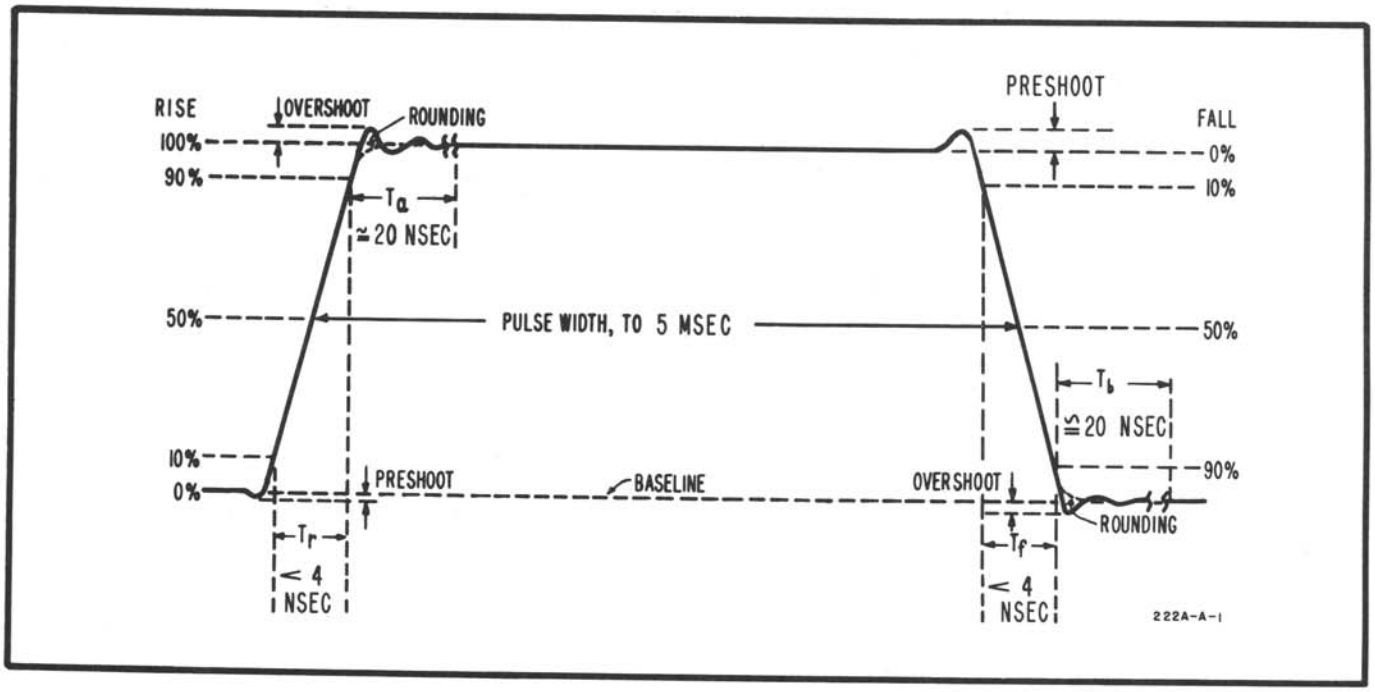


Figure 5-1. Output Pulse Characteristics

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides maintenance and service information for the Model 222A Pulse Generator. Performance check, adjustment procedures, trouble-shooting, and repair and replacement information are the major areas covered in this section. Component location and schematic diagrams are also included at the rear of the section.

5-3. TEST EQUIPMENT.

5-4. Test equipment required for maintaining and checking the performance of the Model 222A is listed in Table 5-1. Test equipment having characteristics similar to those listed in the table may be substituted for the performance check and adjustments.

5-5. PERFORMANCE CHECK.

5-6. The performance check verifies whether or not the Model 222A is operating within the specifications as stated in Table 1-1. This check may be used as part of an incoming quality control inspection, as a periodic operational check, or after repairs and/or adjustments have been made. Recently calibrated test equipment should be used when performing this check. A Performance Check Record form is included in this manual on Page 5-2a/b. When the initial Performance Check is performed, the actual readings should be entered on the form. The form should then be removed from the manual and filed in a safe place, so that readings taken at a later date can be compared with the original readings. The performance check must be performed in the sequence given below. Do not attempt to start the checkout in mid-sequence, as succeeding steps are dependent on control settings and results of previous steps.

5-7. REPETITION RATE.

5-8. The following procedure provides the initial test set-up for the Model 222A and test equipment, and checks the repetition rate upper limit specification. Proceed as follows:

a. Connect a 50-ohm Tee, loaded with 50-ohm load, to the Model 222A PULSE OUTPUT connector.

b. Connect Sampling Oscilloscope to the 50-ohm Tee through a 10:1 divider.

c. Set Sampling Oscilloscope controls as follows:

TIME SCALE	100 ns/cm
TIME SCALE MAGNIFIER	X5
SENSITIVITY	100 mv/cm

d. Connect Model 222A TRIGGER OUTPUT (-) connector to Sampling Oscilloscope TRIGGER INPUT connector.

e. Set Model 222A controls as follows:

REP RATE (CPS)	1M-10M
VERNIER	cw
PULSE DELAY (μSEC)	<.1
VERNIER	ccw
PULSE WIDTH (μSEC)	.03-.05
VERNIER	ccw
PULSE POLARITY	+ (plus)
PULSE AMPLITUDE	10
VERNIER	Adjust for 10 v output

f. Adjust Sampling Oscilloscope triggering for a stable display.

g. The pulse period should not be more than 5 cm (100 ns).

5-9. PULSE POLARITY.

5-10. The pulse polarity check is performed as follows:

a. Set the Model 222A PULSE POLARITY control to - (minus).

b. A negative pulse not less than 10 cm (10 volts) in amplitude should be obtained.

c. Set the PULSE POLARITY control back to + (plus).

5-11. PULSE SHAPE.

5-12. The following procedure verifies the pulse shape characteristics. Refer to Figure 5-1 for identification of characteristics.

a. Set Model 222A REP RATE (CPS) control to 100K-1M, and REP RATE VERNIER control to ccw.

b. Set Sampling Oscilloscope TIME SCALE control to 20 ns/cm and TIME SCALE MAGNIFIER control to X1.

c. Adjust Model 222A PULSE DELAY VERNIER control for display of a pulse leading edge on the CRT.

d. Adjust Model 222A PULSE WIDTH VERNIER control to obtain a pulse width of 5 cm on CRT.

e. Adjust Model 222A PULSE AMPLITUDE VERNIER control for pulse amplitude of 10 cm on CRT.

f. Set Oscilloscope TIME SCALE MAGNIFIER control to X5.

g. The following leading edge characteristics should be observed:

Preshoot	No more than 2 mm (2%)
Overshoot and Ringing	No more than 4 mm peak (4%)
Rise Time	No more than 1 cm (4 ns)

h. Adjust Oscilloscope DELAY control for display of pulse trailing edge.

i. The following trailing edge characteristics should be observed:

Preshoot	No more than 4 mm (4%)
Overshoot and Ringing	No more than 4 mm peak (4%)
Fall Time	No more than 1 cm (4 ns)

5-13. PULSE AMPLITUDE.

5-14. This check verifies that the output pulse amplitude is within specifications. Proceed as follows:

a. Set the Oscilloscope TIME SCALE MAGNIFIER control to X1.

b. Set Model 222A PULSE AMPLITUDE VERNIER control fully ccw.

c. The Oscilloscope display should be no more than 4 cm (4 volts) in amplitude. If 4 cm or less is observed, the ratio between cw and ccw is at least 2.5 to 1. Therefore, at a .1 volt pulse amplitude setting, the minimum of .05 volts output can be obtained.

5-15. PULSE DELAY.

5-16. Check the Model 222A pulse delay as follows:

a. Set Model 222A PULSE DELAY (μSEC) control to .1-.5.

b. Set the Oscilloscope TIME SCALE control to 100 ns/cm, and the TIME SCALE MAGNIFIER control to X1.

c. Adjust the Model 222A PULSE DELAY VERNIER control from ccw to cw.

d. The oscilloscope display pulse should move at least 4 cm (.4 μs).

5-17. EXTERNAL TRIGGER.

5-18. The following check verifies that the Model 222A will trigger externally as specified. Proceed as follows:

a. Set the Model 222A PULSE DELAY VERNIER control to obtain a pulse on the Oscilloscope CRT.

b. Set the Model 222A REP RATE (CPS) control to EXT-.

c. Connect the Test Oscillator output to the Model 222A EXT TRIG INPUT connector, and set the Oscillator controls for a frequency of 10 cps (Hz) at 1 v p-p amplitude.

d. The Oscilloscope should display a slow moving trace of the same pulse displayed previously when the Model 222A repetition rate was 100K.

e. Set Model 222A controls as follows:

PULSE WIDTH (μSEC) 03-.05
VERNIER . . . . . ccw
PULSE DELAY (μSEC) . . . . . <.1
VERNIER . . . . . ccw

f. Set Oscillator controls for frequency of 10 Mc (MHz).

g. Pulses of 1 cm (100 ns) period should appear on the oscilloscope CRT.

5-19. ADJUSTMENTS.

5-20. Procedures for making adjustments to the Model 222A are presented in the following paragraphs. The adjustment controls are identified and their location shown in Figure 5-2. All adjustments are made from the top of the instrument, after the top cover has been removed.

5-21. POWER SUPPLY.

5-22. Measure and adjust each supply voltage with the DC Voltmeter, using wire colors (identified by color-code numbers on schematic) to identify each voltage test point. Appropriate wires are easily accessible at the emitters of the series regulator transistors which are located on the fan shroud. All voltages are measured with reference to chassis ground. Adjust the supply voltages in order given in Table 5-2.

Table 5-2. Power Supply Adjustments

Supply	Voltage Test Point Wire Color	Adjustment Control
-45 v	violet	R24
-47 v	white-violet	R44
-23.5 v	white-black-violet	R64

5-23. TRIGGER BIAS.

5-24. Connect the leads of the DC Voltmeter to the collector leads of Q101 and Q102. These leads are easily accessible as the white-brown and white-yellow wires on repetition rate switch S102. Adjust R104 to obtain zero volts between these circuit points.

5-25. TROUBLESHOOTING.

5-26. To locate trouble in the Model 222A, start with a thorough visual inspection and then proceed to electrical checkout as necessary. During the visual inspection look for burned or loose components, loose wire connections, or any other similar condition which suggests a source of trouble. Repair any faulty component or connection that is isolated during the visual inspection and check instrument performance before continuing to troubleshoot the instrument.

5-27. If no obvious fault is located during the visual inspection proceed with the electrical checkout. Use the detailed block diagrams in Section IV and the typical waveforms provided near each schematic diagram as aids in isolating the trouble to a particular circuit. Begin checking waveforms (in numerical order) in the repetition rate circuit, shown in Figure 5-5, and then proceed along the signal path through the output circuit using waveforms shown in Figures 5-8, 5-12, and 5-15. Conditions for measurment of waveforms and dc voltages are given in Table 5-3. When an improper waveform (or no waveform at all) is detected along the signal path, the trouble will most likely be in that circuit area. When trouble appears probable in a particular circuit, check the dc voltages given on the schematic diagram to further isolate the defect. Refer to Table 5-4 for schematic diagram notes.

WARNING

Power fuse is hot, even though power switch is off.

5-28. REPAIR AND REPLACEMENT.

5-29. Repair of the Model 222A consists basically of replacing defective components located during troubleshooting. The following paragraphs provide information

PERFORMANCE CHECK RECORD

Paragraph Reference	Check	Results Required	Results Actual
5-8 step g	Internal Repetition Rate Upper Limit	≦5 cm	
5-10 step b	Pulse Polarity Reversal	≧10 cm	
5-12 step g	Leading Edge Characteristics		
	Preshoot	≦2 mm	
	Overshoot and Ringing	≦4 mm	
	Rise Time	≦1 cm	
	Trailing Edge Characteristics		
	Preshoot	≦4 mm	
	Overshoot and Ringing	≦4 mm	
	Fall Time	≦1 cm	
5-14 step c	Pulse Amplitude	≦4 cm	
5-16 step d	Pulse Delay	≧4 cm	
5-18 step d	External Trigger Lower Limit	10 cps	
5-18 step g	External Trigger Upper Limit	10 Mc	

CUT ALONG DOTTED LINE

on the identification and location of all components in the Model 222A, and basic considerations when repairing etched circuit boards. If satisfactory operation or repair cannot be accomplished, contact your nearest Hewlett-Packard Sales/Service Office (addresses given at rear of this manual). If shipment of the instrument to the Sales/Service Office for repair is recommended, refer to Paragraph 2-6 for repackaging information. Refer to Section VI for part numbers of replaceable parts and ordering instructions.

5-30. COMPONENT IDENTIFICATION.

5-31. All electrical components in the Model 222A are identified on the schematics with a reference designation. Location of components mounted on etched circuit boards or switches is provided in the component location figures preceding the schematic diagram of the circuit concerned. All electrical components not mounted on etched circuit boards or switches are identified in Figure 5-2.

5-32. In addition to the component location figures, each semiconductor in the instrument is identified by its reference designation etched on the circuit board near the component. To help with proper replacement of semiconductors, the emitter or cathode connection is identified by a small dot etched on the circuit board beside the connection point.

5-33. SERVICING ETCHED CIRCUIT BOARDS.

5-34. Etched circuit boards used in the Model 222A have components mounted on one side of the board, conductive strips on both sides, and plated-through component mounting holes. Hewlett-Packard Service Note M-20D contains useful information on etched circuit board repair. Important considerations are as follows:

a. Use a low heat (37 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 semiconductors). 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 close to the component and then unsolder the leads from the board.

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

e. Since the conductor part of the etched circuit board is a metal plated surface covered with solder, use care to avoid overheating and lifting of the conductor from the board. A lifted 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 component hole before inserting a new component lead. Heat the solder in the hole, remove the iron, and quickly insert a pointed non-metalic object, such as a toothpick.

g. Shape the new component leads and clip to proper length. Insert the leads into the holes, apply heat and solder (preferably on the side opposite the component).

5-35. PERIODIC MAINTENANCE.

5-36. GENERAL.

5-37. The air intake fan motor needs little lubrication or preventive maintenance. About twice 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.

5-38. AIR FILTER.

5-39. Inspect the air filter (rear of instrument) regularly and clean it before dust can restrict the air flow. To clean the air filter, remove it and tap gently on a hard surface to remove accumulated dirt, then replace. It should be noted that this new improved filter is more serviceable in that coating the filter is not necessary and is not recommended.

Table 5-3. Conditions for Waveform and DC Voltage Measurements

DC VOLTAGE MEASUREMENTS

Model 222A controls set as follows:

REP RATE (CPS) . . . . . EXT-
PULSE POLARITY . . . . . - (negative)
PULSE AMPLITUDE VERNIER . . . . . 3 o'clock

Position of all other controls has no effect on readings.

Connect 50-ohm Load to PULSE OUTPUT connector.

All voltages measured with reference to chassis ground.

Voltage readings are considered normal if within ±10% of voltage given.

WAVEFORMS

Model 222A controls set as follows:

REP RATE (CPS) 100K-1M
VERNIER . . . . . ccw
PULSE DELAY (USEC) 5-5
VERNIER . . . . . 12 o'clock
PULSE WIDTH (USEC) 5-5
VERNIER . . . . . 12 o'clock
PULSE AMPLITUDE 10
VERNIER . . . . . 3 o'clock
PULSE POLARITY . . . . . - (negative)

Oscilloscope controls set as follows:

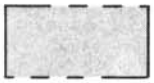
SWEEP TIME . . . . . 5 usec/cm
TRIGGER SOURCE . . . . . EXT
TRIGGER LEVEL . . . . . - (negative)

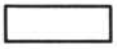
All waveforms are referenced to show time relationships. Time reference A is an arbitrary point which corresponds to the positive-going output of the repetition rate multivibrator (Q112 collector). Position of time reference B is related to A and is a function of the delay setting.

Table 5-4. Schematic Diagram Notes

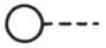
Refer to MIL-STD-15-1 for schematic symbols not listed in this table.

Unless otherwise indicated:
capacitance in picofarads
inductance in microhenries
resistance in ohms

 = Etched circuit board

 = Front panel marking

 = Rear panel marking

 = Front panel control

 = Screwdriver Adjustment

CW = Clockwise end of variable resistor

 = Primary signal path

 = Feedback path

 = Waveform test point (with number)

 = Common point (with letter)

 = Avalanche (zener) diode

 = Tunnel diode

 = Step recovery diode

Numbers in parentheses indicate wire color using resistor color code, e.g. WHT-RED-GRN is (9·2·5).

0 - Black	5 - Green
1 - Brown	6 - Blue
2 - Red	7 - Violet
3 - Orange	8 - Gray
4 - Yellow	9 - White

P/O = Part of

* = Optimum value selected at factory, average value shown; part may have been omitted.

 = Single pin interconnection connector

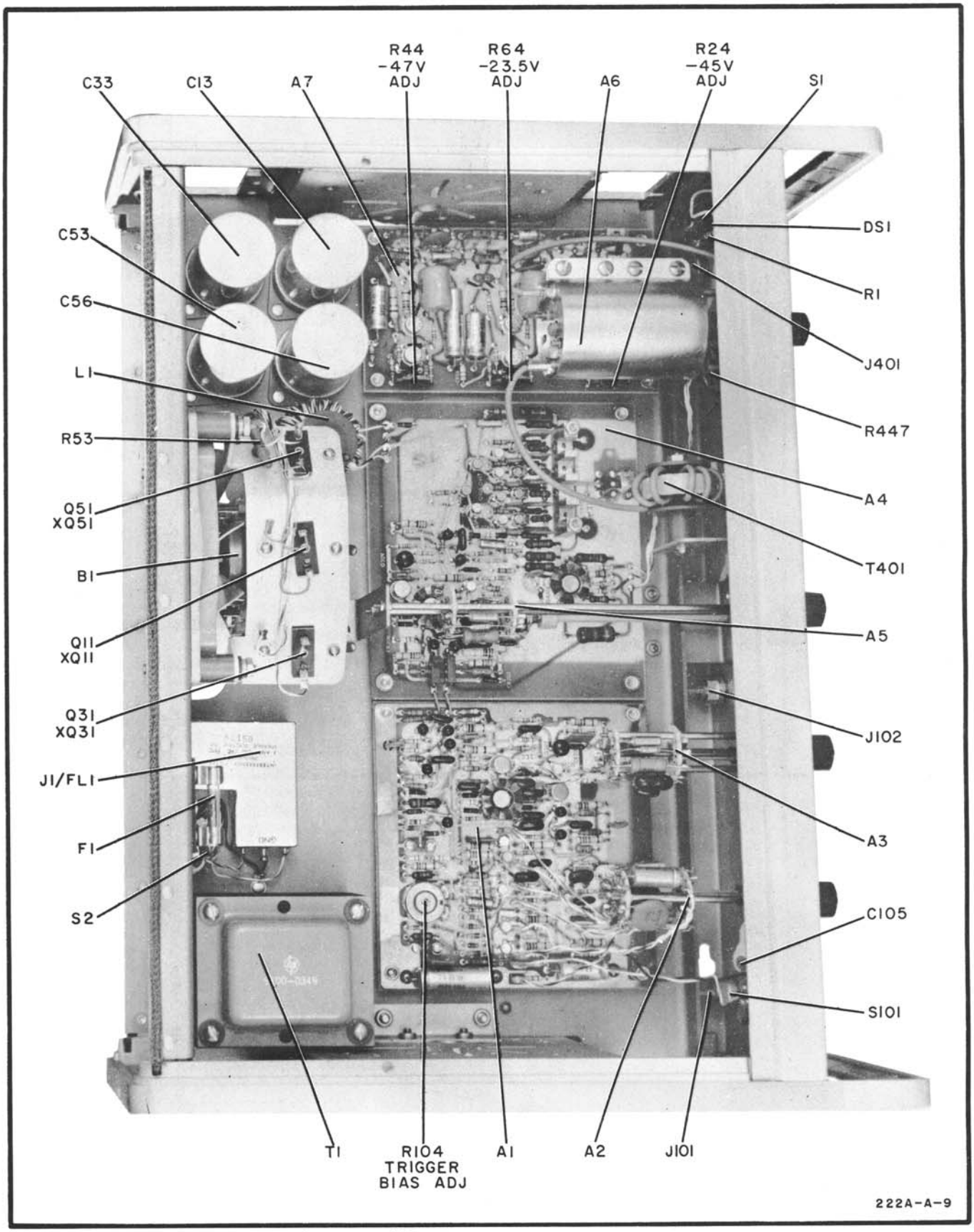
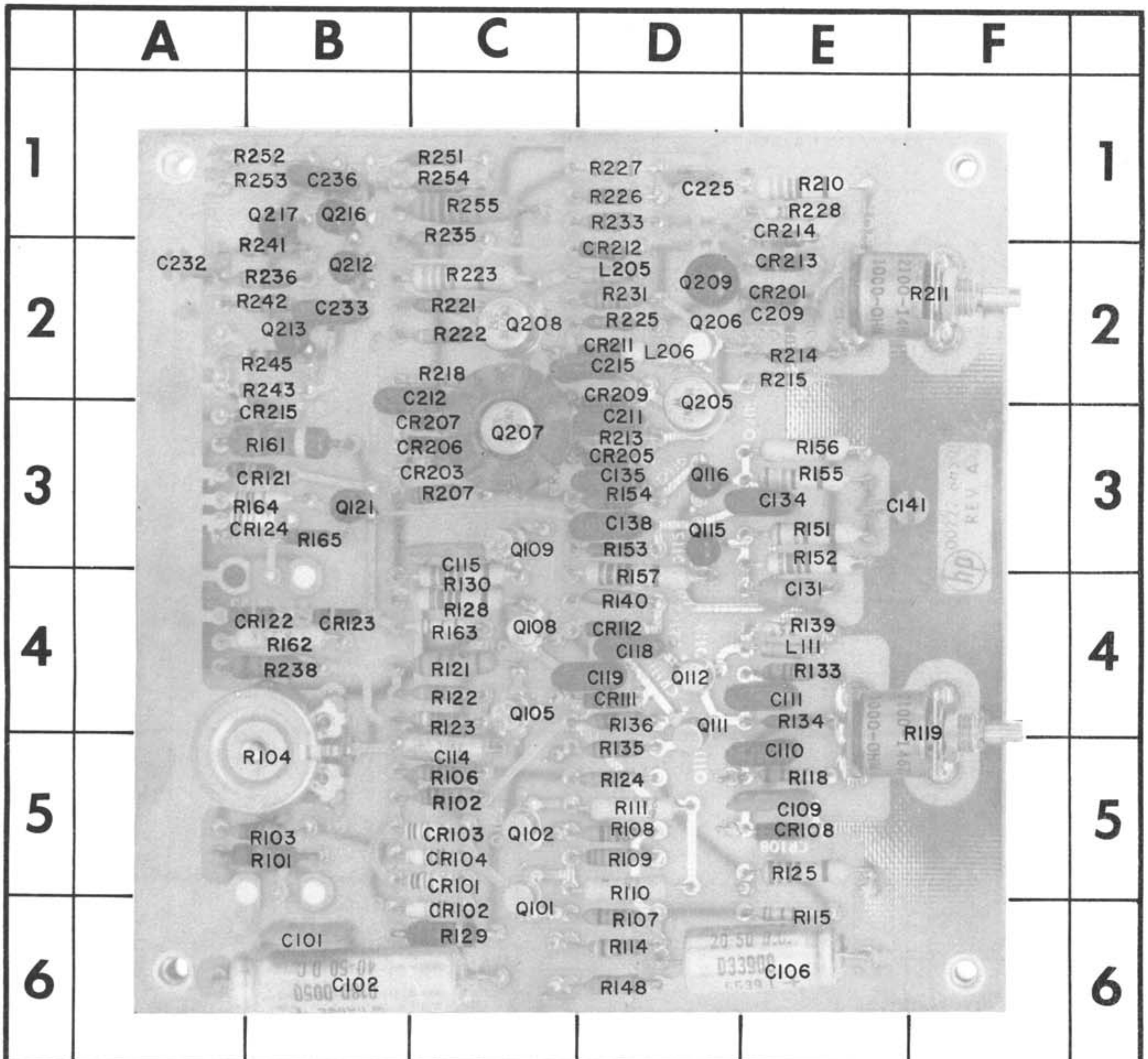


Figure 5-2. Model 222A Component Location and Adjustments



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C101	B-6	C212	C-2	CR201	E-2	Q108	C-4	R102	C-5	R125	E-5	R157	D-4	R226	D-1
C102	B-6	C215	D-2	CR203	C-3	Q109	C-3	R103	B-5	R128	C-4	R161	B-3	R227	D-1
C106	E-6	C225	D-1	CR205	D-3	Q111	D-4	R104	B-5	R129	C-6	R162	B-4	R228	E-1
C109	E-5	C232	A-2	CR206	C-3	Q112	D-4	R106	C-5	R130	C-4	R163	C-4	R231	D-2
C110	E-5	C233	B-2	CR207	C-3	Q115	D-3	R107	D-6	R133	E-4	R164	B-3	R233	D-1
C111	E-4	C236	B-1	CR209	D-2	Q116	D-3	R108	D-5	R134	E-4	R165	B-3	R235	C-1
C114	C-5	CR101	C-5	CR211	D-2	Q121	B-3	R109	D-5	R135	D-5	R207	C-3	R236	B-2
C115	C-3	CR102	C-6	CR212	D-2	Q205	D-3	R110	D-5	R136	D-4	R210	E-1	R238	B-4
C118	D-4	CR103	C-5	CR213	E-2	Q206	D-2	R111	D-5	R139	E-4	R211	F-2	R241	B-2
C119	D-4	CR104	C-5	CR214	E-1	Q207	C-3	R114	D-6	R140	D-4	R213	D-3	R242	B-2
C131	E-4	CR108	E-5	CR215	B-3	Q208	C-2	R115	E-6	R148	D-6	R214	E-2	R243	B-2
C134	E-3	CR111	D-4	L111	E-4	Q209	D-2	R118	E-5	R151	E-3	R215	E-2	R245	B-2
C135	D-3	CR112	D-4	L205	D-2	Q212	B-2	R119	F-5	R152	E-3	R218	C-2	R251	C-1
C138	D-3	CR121	B-3	L206	D-2	Q213	B-2	R121	C-4	R153	D-3	R221	C-2	R252	B-1
C141	F-3	CR122	B-4	Q101	C-6	Q216	B-1	R122	C-4	R154	D-3	R222	C-2	R253	B-1
C209	E-2	CR123	B-4	Q102	C-5	Q217	B-1	R123	C-4	R155	E-3	R223	C-2	R254	C-1
C211	D-3	CR124	B-3	Q105	C-4	R101	B-5	R124	D-5	R156	E-3	R225	D-2	R255	C-1

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Figure 5-3. Component Locations on A1, Rate and Delay Circuit Board

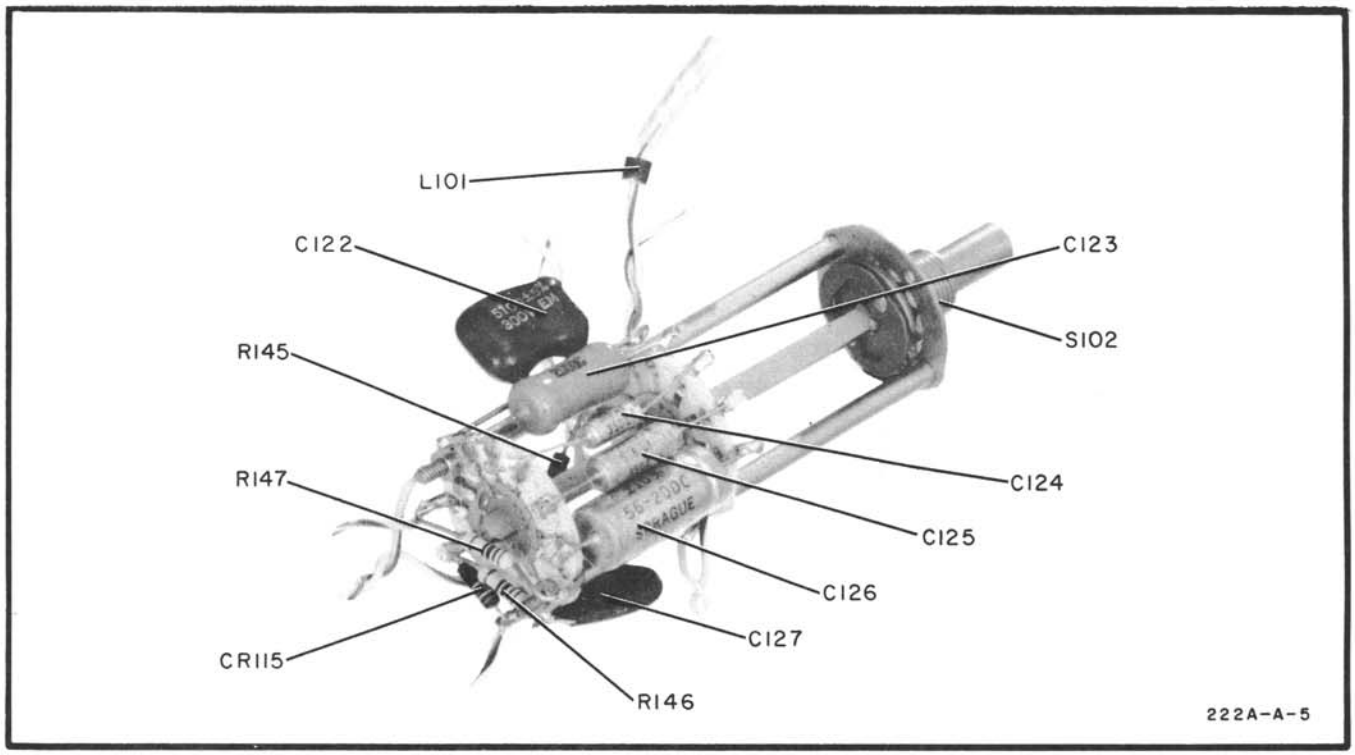


Figure 5-4. Component Locations on A2, Repetition Rate Switch

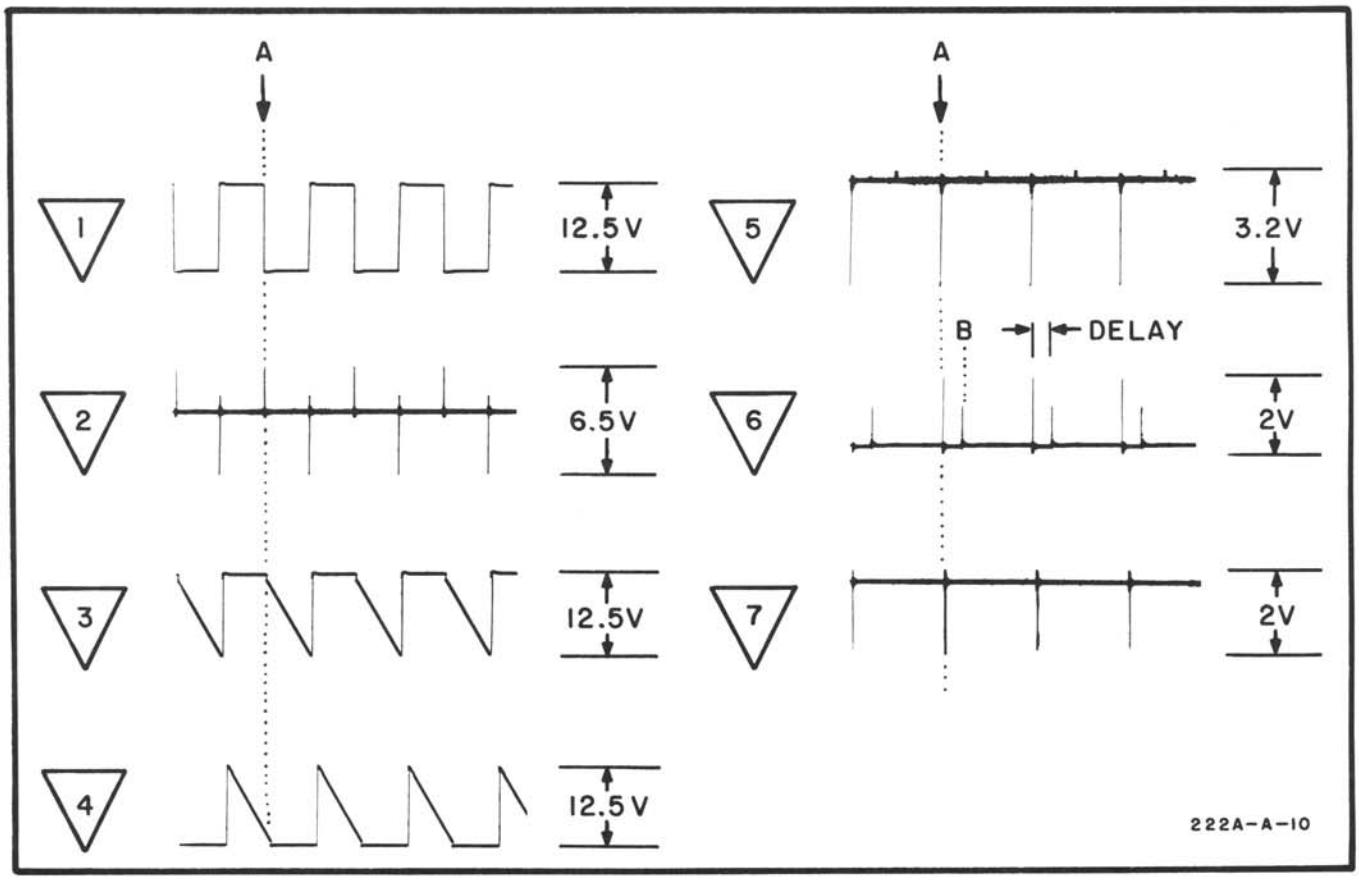
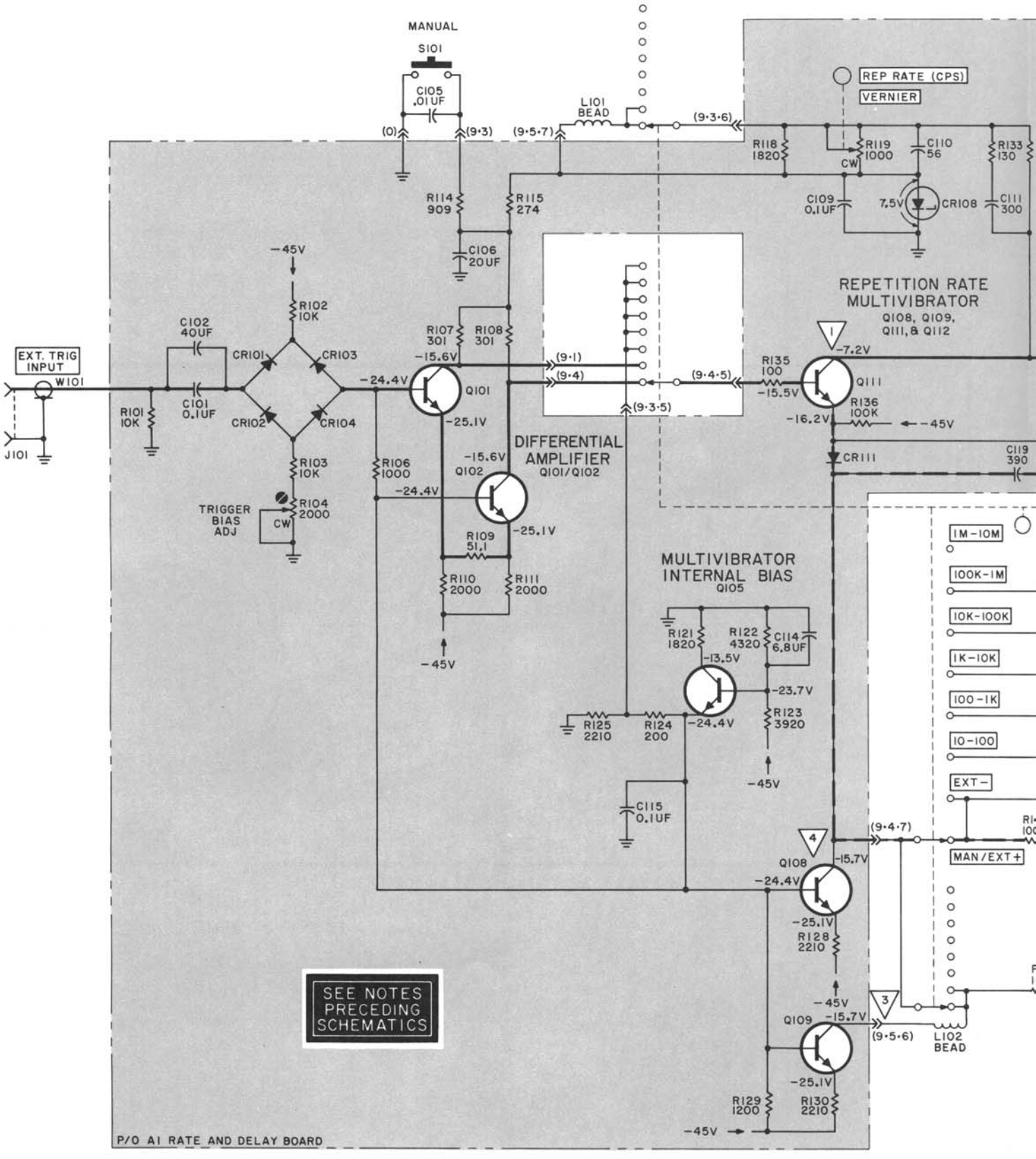
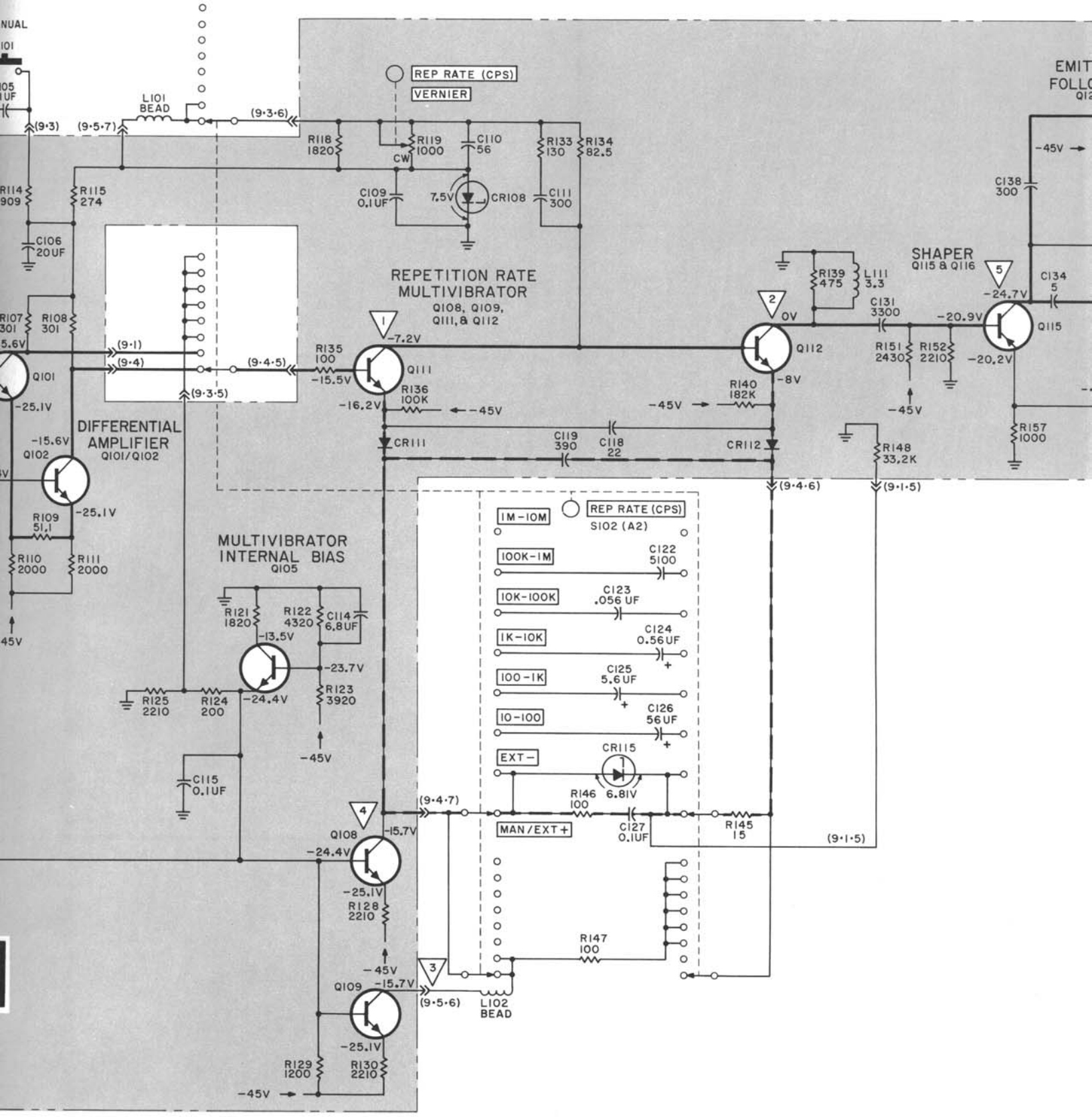
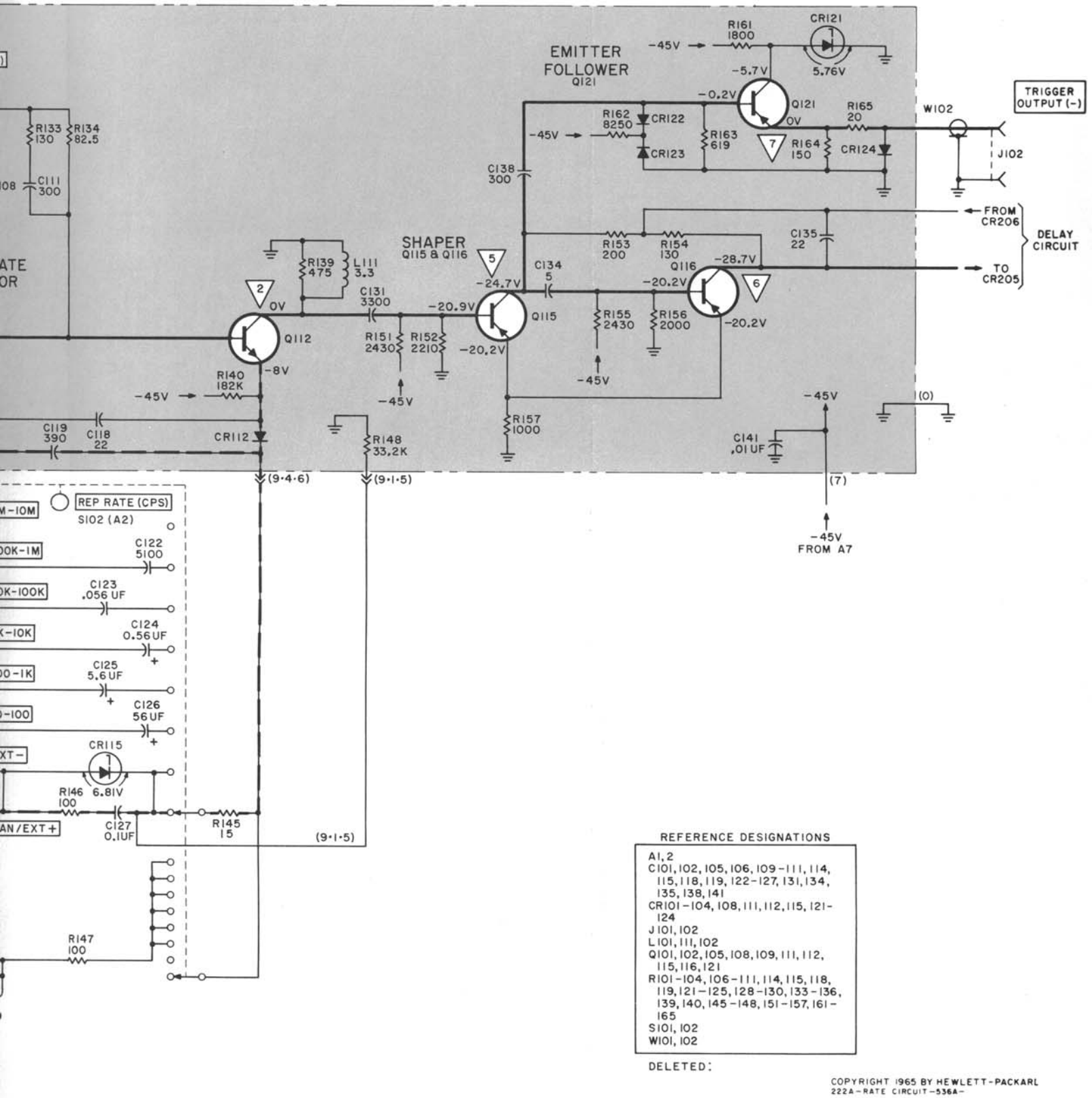


Figure 5-5. Waveforms at Testpoints in Repetition Rate Circuit


MANUAL
S101
C105
.01 UF
L101
BEAD
(0)
(9·3)
(9·5·7)
(9·3·6)
REP RATE (CPS)
VERNIER
R118
1820
R119
1000
CW
C110
56
R133
130
C109
0.1UF
7.5V
CR108
C111
300
R114
909
R115
274
C106
20UF
-45V
R102
10K
C102
40UF
CR101
CR103
CR102
CR104
EXT. TRIG
INPUT
W101
J101
R101
10K
C101
0.1UF
R103
10K
TRIGGER
BIAS
ADJ
CW
R104
2000
R107
301
R108
301
-15.6V
-24.4V
Q101
-25.1V
R106
1000
-24.4V
Q102
-15.6V
-25.1V
R109
51.1
R110
2000
R111
2000
-45V
DIFFERENTIAL
AMPLIFIER
Q101/Q102
(9·1)
(9·4)
(9·4·5)
(9·3·5)
REPETITION RATE
MULTIVIBRATOR
Q108, Q109,
Q111, & Q112
1
-7.2V
R135
100
Q111
-15.5V
R136
100K
-16.2V
-45V
CR111
C119
390
MULTIVIBRATOR
INTERNAL BIAS
Q105
R121
1820
R122
4320
C114
6.8UF
-13.5V
-23.7V
R123
3920
R125
2210
R124
200
-24.4V
-45V
C115
0.1UF
1M-10M
100K-1M
10K-100K
1K-10K
100-1K
10-100
EXT-
MAN/EXT+
(9·4·7)
4
Q108
-15.7V
-24.4V
-25.1V
R128
2210
-45V
3
Q109
-15.7V
(9·5·6)
L102
BEAD
-25.1V
R129
1200
R130
2210
-45V
SEE NOTES
PRECEDING
SCHEMATICS
P/O A1 RATE AND DELAY BOARD


REP RATE (CPS)
VERNIER
L101 BEAD
R118 1820
R119 1000
CW
C110 56
R133 130
R134 82.5
C109 0.1UF
7.5V
CR108
C111 300
R114 909
R115 274
C106 20UF
REPETITION RATE MULTIVIBRATOR
Q108, Q109, Q111, & Q112
SHAPER
Q115 & Q116
R139 475
L111 3.3
C131 3300
C138 300
C134 5
-45V
-24.7V
-20.9V
Q115
-20.2V
R157 1000
R107 301
R108 301
5.6V
Q101
-25.1V
(9·1)
(9·4)
(9·3·5)
(9·4·5)
R135 100
-15.5V
Q111
-16.2V
R136 100K
-45V
Q112
0V
-8V
R140 182K
R151 2430
R152 2210
CR111
CR112
C119 390
C118 22
R148 33.2K
DIFFERENTIAL AMPLIFIER
Q101/Q102
-15.6V
Q102
-25.1V
R109 51.1
R110 2000
R111 2000
(9·4·6)
(9·1·5)
MULTIVIBRATOR INTERNAL BIAS
Q105
R121 1820
R122 4320
C114 6.8UF
-13.5V
-23.7V
R123 3920
R125 2210
R124 200
-24.4V
-45V
C115 0.1UF
1M-10M
REP RATE (CPS)
S102 (A2)
100K-1M
C122 5100
10K-100K
C123 .056 UF
1K-10K
C124 0.56UF
100-1K
C125 5.6UF
10-100
C126 56UF
EXT-
CR115
R146 100
6.81V
C127 0.1UF
R145 15
MAN/EXT+
(9·4·7)
(9·1·5)
Q108
-15.7V
-24.4V
-25.1V
R128 2210
R147 100
Q109
-15.7V
(9·5·6)
L102 BEAD
-25.1V
R129 1200
R130 2210
-45V



REFERENCE DESIGNATIONS

A1, 2
C101, 102, 105, 106, 109-111, 114, 115, 118, 119, 122-127, 131, 134, 135, 138, 141
CR101-104, 108, 111, 112, 115, 121-124
J101, 102
L101, 111, 102
Q101, 102, 105, 108, 109, 111, 112, 115, 116, 121
R101-104, 106-111, 114, 115, 118, 119, 121-125, 128-130, 133-136, 139, 140, 145-148, 151-157, 161-165
S101, 102
W101, 102

DELETED:

Figure 5-6. Repetition Rate Circuit Schematic Diagram

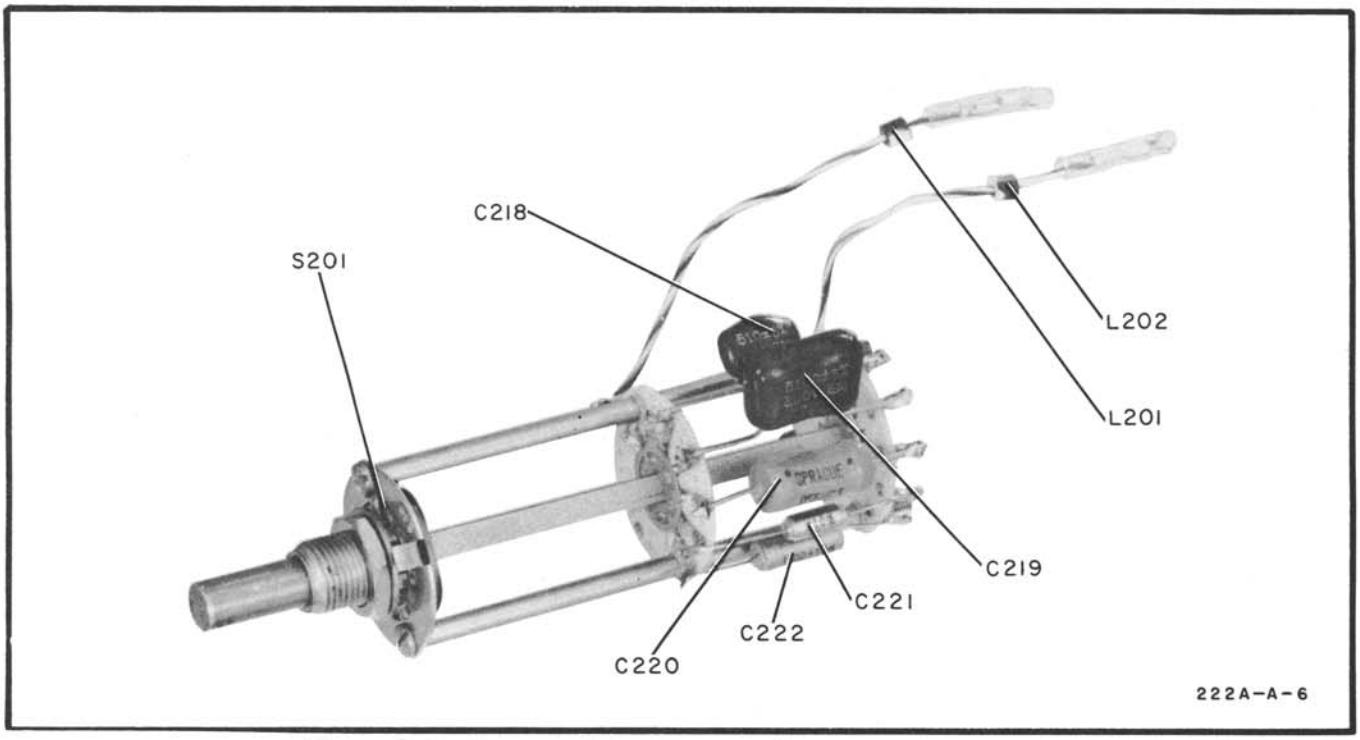


Figure 5-7. Component Locations on A3, Pulse Delay Switch

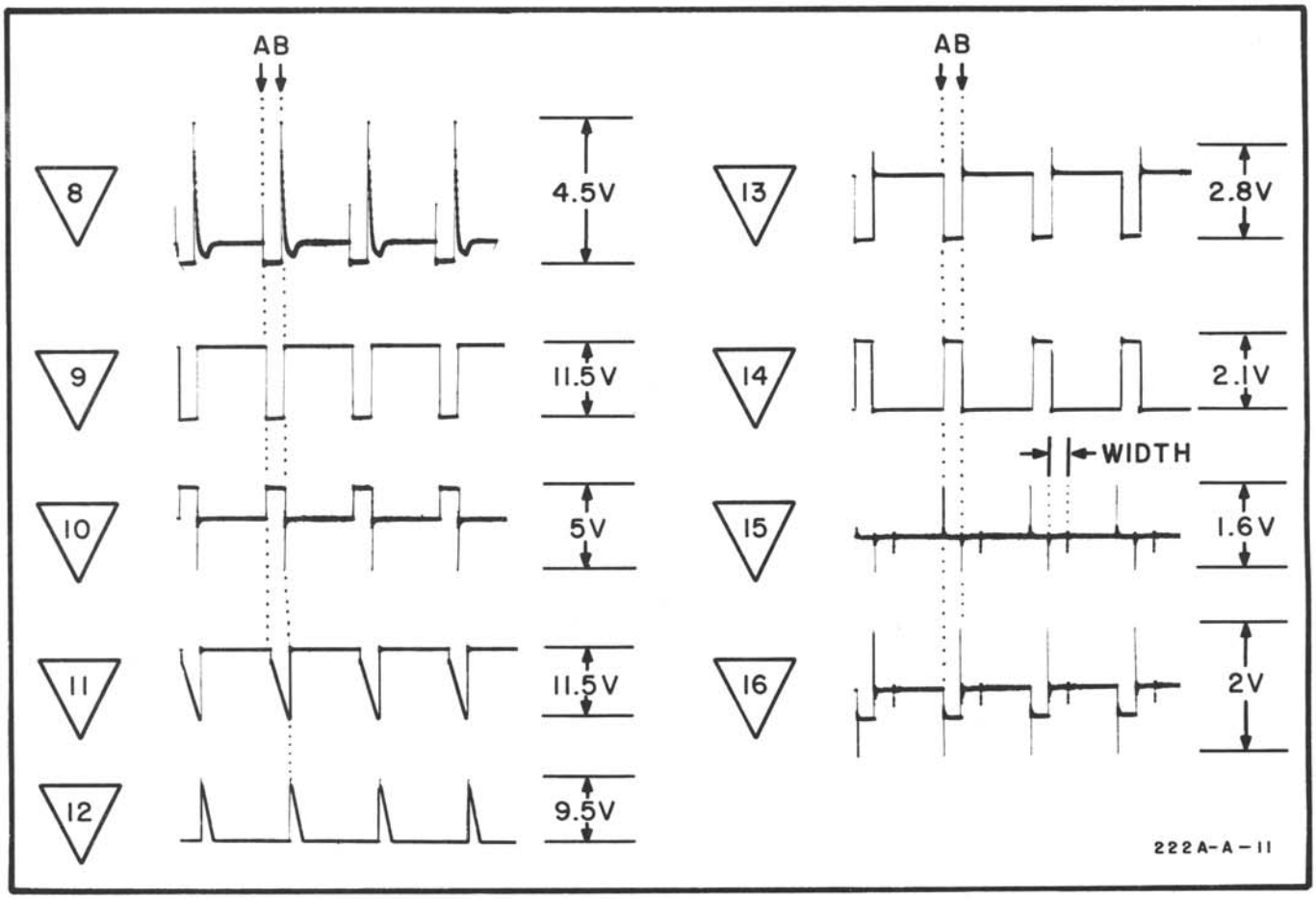
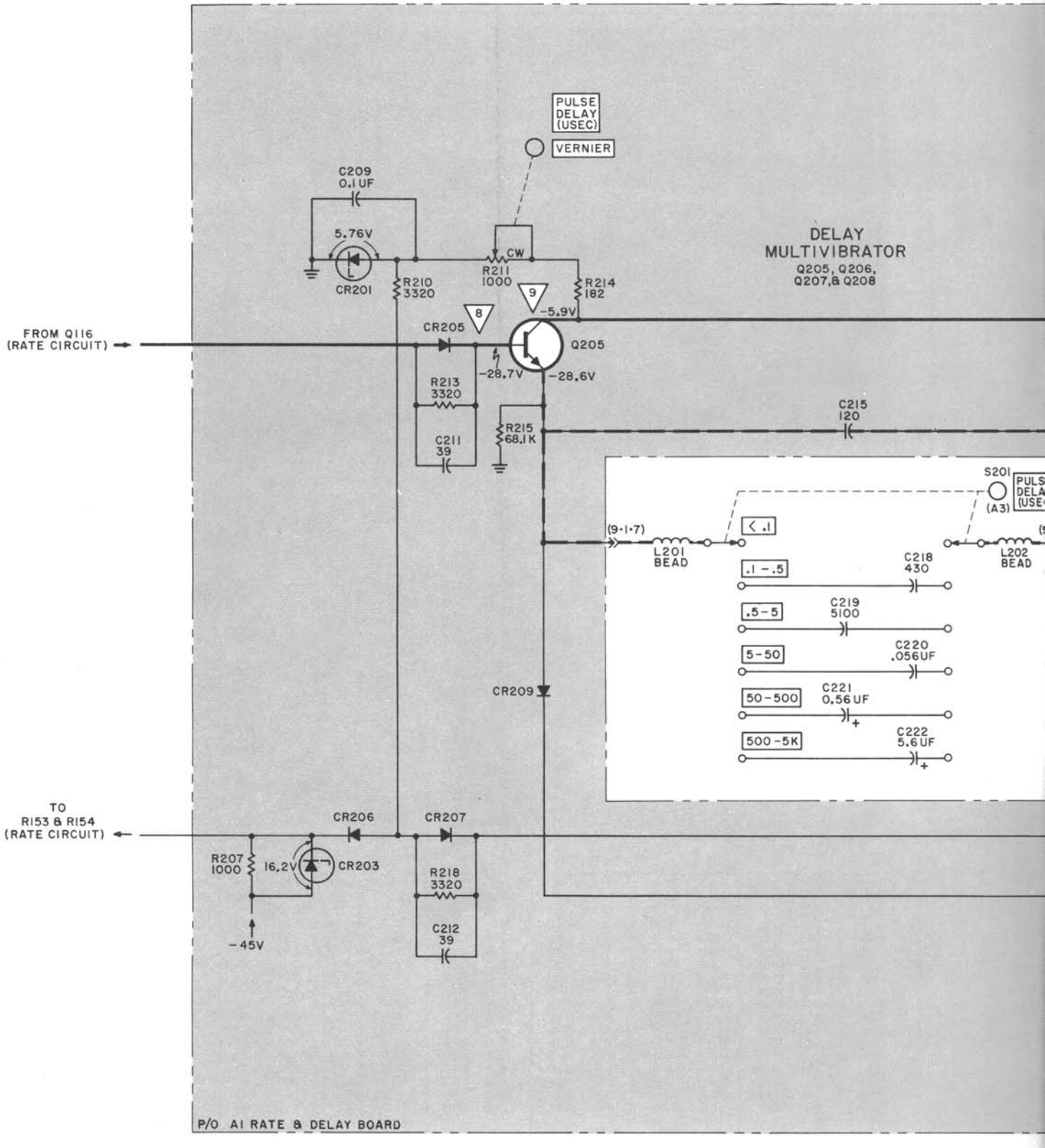
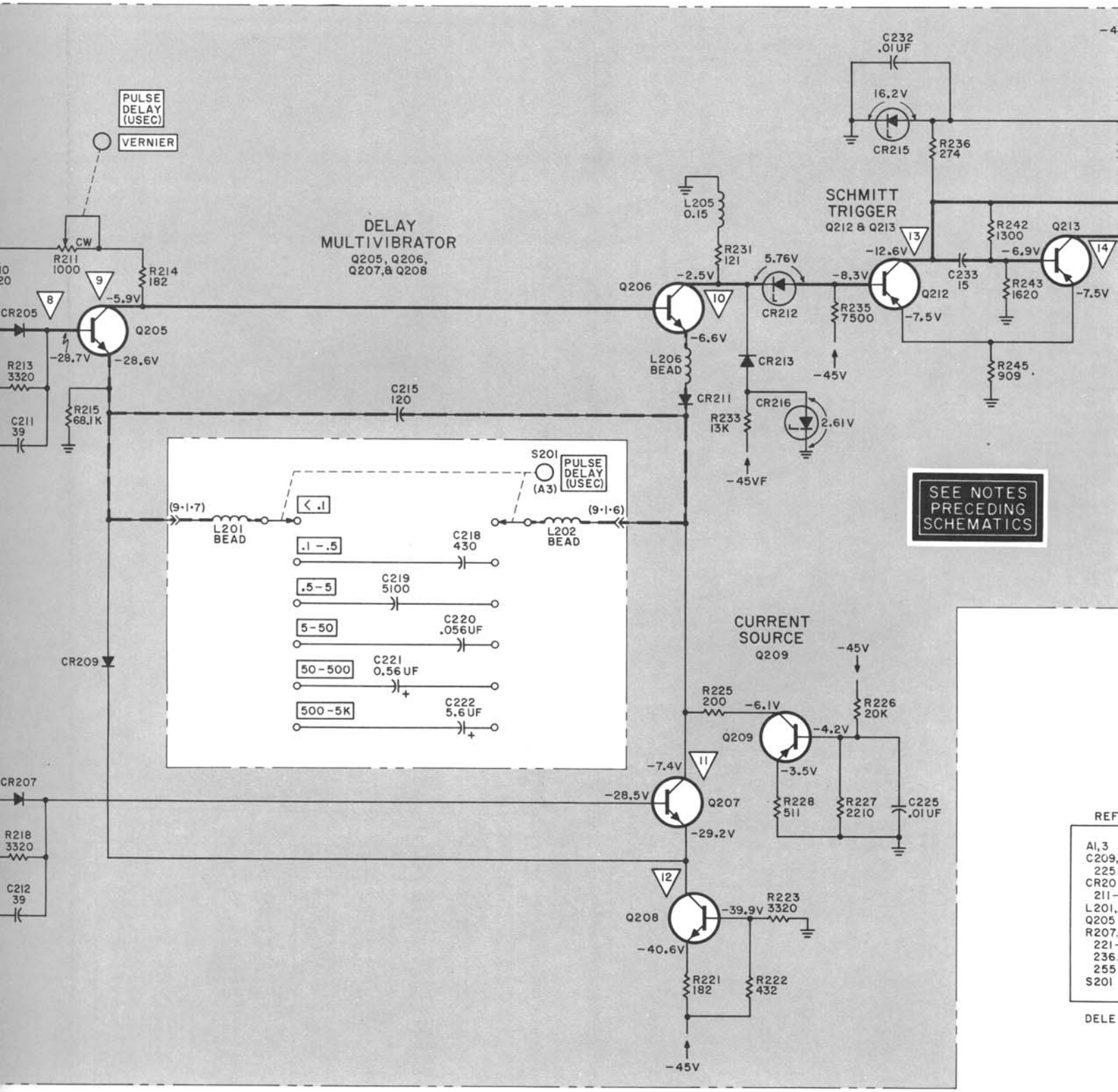
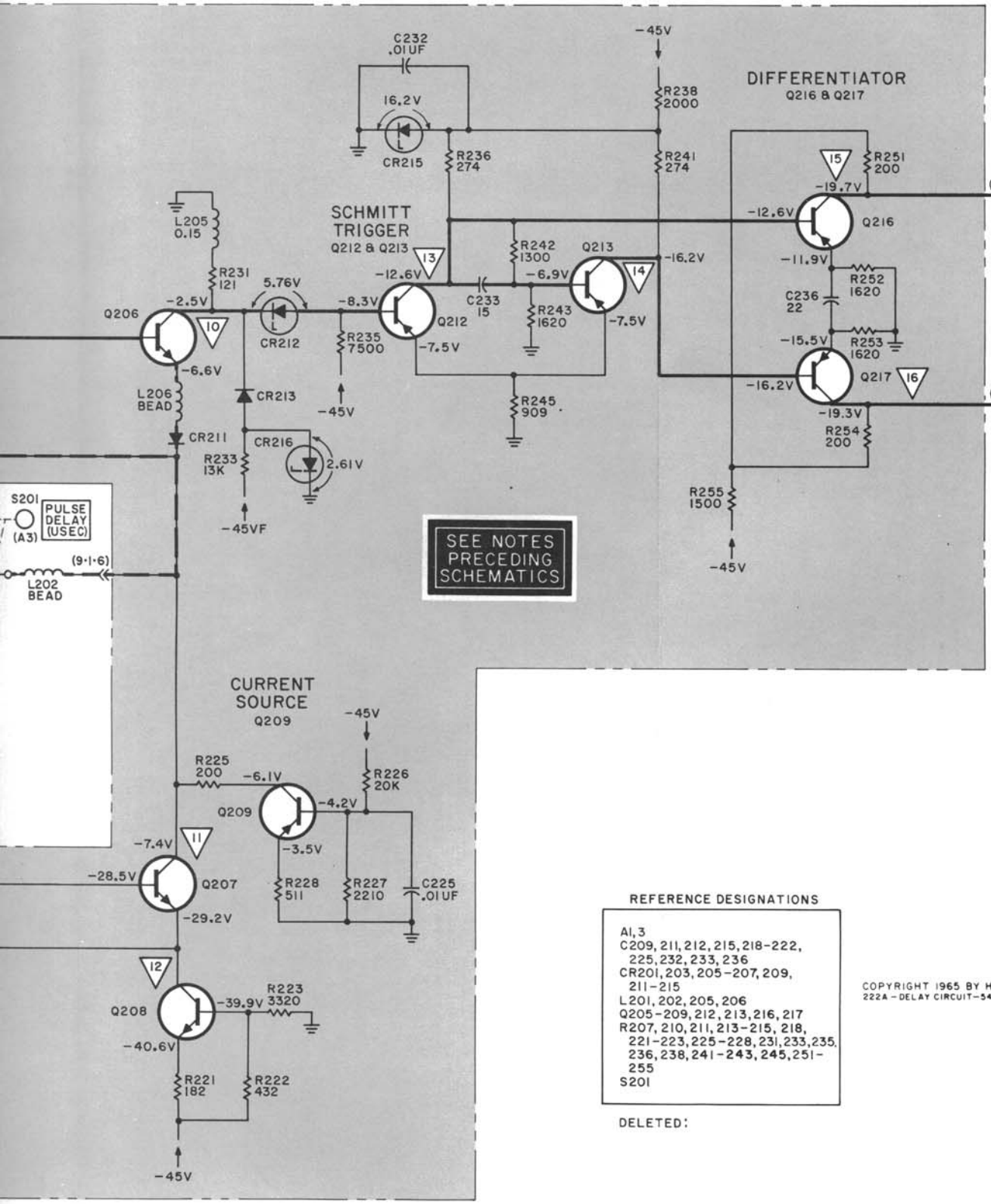


Figure 5-8. Waveforms at Testpoints in Pulse Delay Circuit


PULSE DELAY (USEC)
VERNIER
C209 0.1 UF
5.76V
CR201
R210 3320
R211 1000 CW
R214 182
DELAY MULTIVIBRATOR Q205, Q206, Q207, & Q208
9
-5.9V
8
CR205
FROM Q116 (RATE CIRCUIT)
Q205
-28.7V
-28.6V
R213 3320
C211 39
R215 68.1K
C215 120
S201
(A3)
(9-1-7)
L201 BEAD
< .1
.1 - .5
C218 430
.5 - 5
C219 5100
5 - 50
C220 .056UF
50 - 500
C221 0.56 UF
500 - 5K
C222 5.6 UF
L202 BEAD
CR209
TO R153 & R154 (RATE CIRCUIT)
CR206
CR207
R207 1000
16.2V
CR203
R218 3320
C212 39
-45V
P/O A1 RATE & DELAY BOARD


PULSE DELAY (USEC)
VERNIER
CW
R211 1000
R214 182
9
-5.9V
8
CR205
Q205
-28.7V
-28.6V
R213 3320
C211 39
R215 68.1K
DELAY MULTIVIBRATOR
Q205, Q206, Q207, & Q208
C215 120
S201
PULSE DELAY (USEC)
(A3)
(9-1-7)
L201 BEAD
< .1
.1 - .5
C218 430
.5 - 5
C219 5100
5 - 50
C220 .056UF
50 - 500
C221 0.56 UF
500 - 5K
C222 5.6 UF
(9-1-6)
L202 BEAD
CR209
CR207
R218 3320
C212 39
L205 0.15
R231 121
Q206
-2.5V
10
-6.6V
L206 BEAD
CR211
CR213
R233 13K
-45VF
5.76V
CR212
-8.3V
R235 7500
-45V
C232 .01UF
16.2V
CR215
R236 274
SCHMITT TRIGGER
Q212 & Q213
13
-12.6V
Q212
-7.5V
C233 15
R242 1300
-6.9V
Q213
14
-7.5V
R243 1620
R245 909
CR216
2.61V
SEE NOTES PRECEDING SCHEMATICS
CURRENT SOURCE
Q209
-45V
R225 200
-6.1V
R226 20K
Q209
-4.2V
-3.5V
R228 511
R227 2210
C225 .01UF
11
-7.4V
-28.5V
Q207
-29.2V
12
Q208
-39.9V
R223 3320
-40.6V
R221 182
R222 432
-45V



REFERENCE DESIGNATIONS

A1, 3
C209, 211, 212, 215, 218-222, 225, 232, 233, 236
CR201, 203, 205-207, 209, 211-215
L201, 202, 205, 206
Q205-209, 212, 213, 216, 217
R207, 210, 211, 213-215, 218, 221-223, 225-228, 231, 233, 235, 236, 238, 241-243, 245, 251-255
S201

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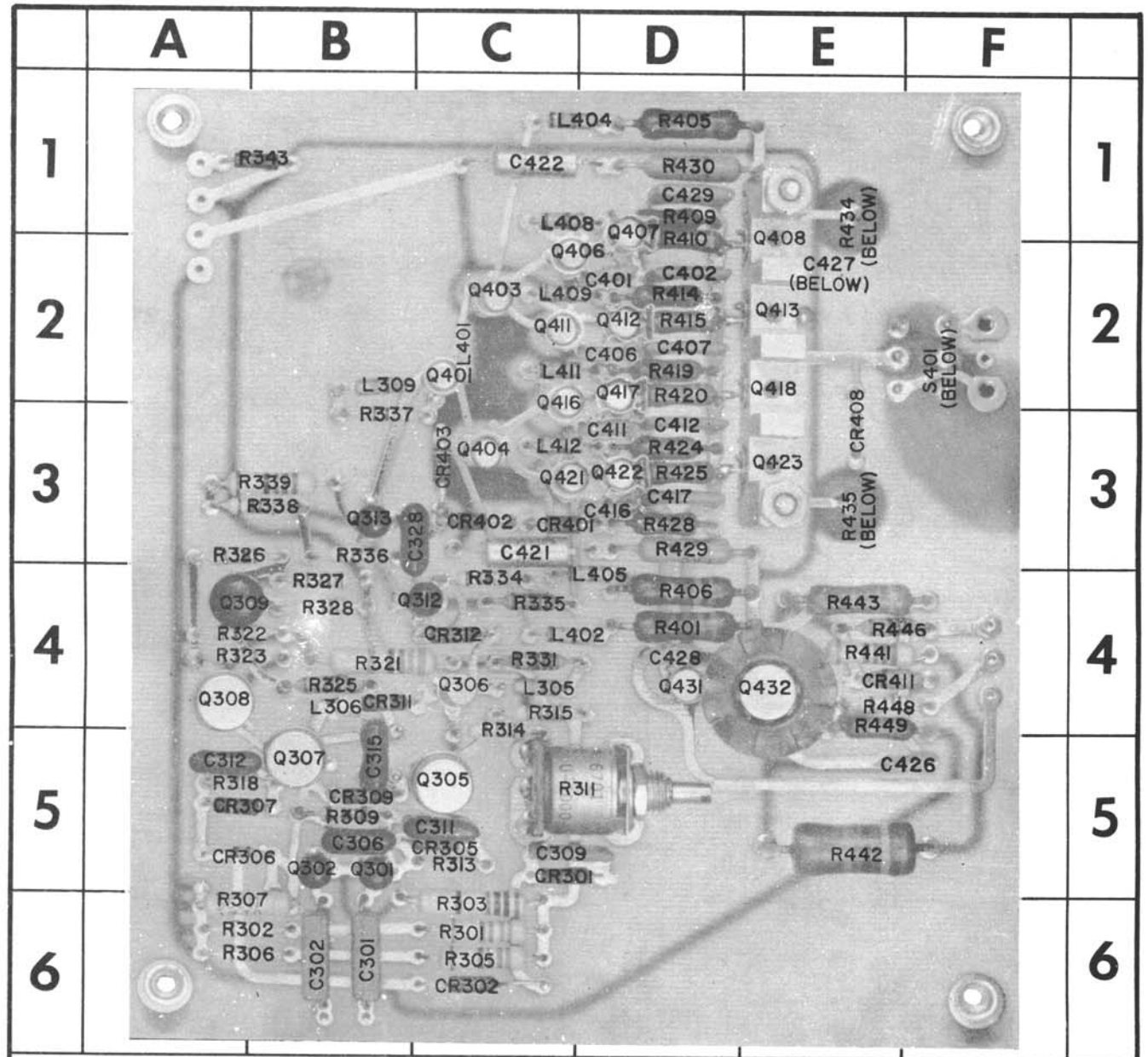
222A - DELAY CIRCUIT-542-

Figure 5-9. Pulse Delay Circuit Schematic Diagram



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C301	B-6	C417	D-3	CR401	C-4	L412	C-3	Q408	E-1	R305	C-6	R328	B-4	R415	D-2
C302	B-6	C421	C-3	CR402	C-3	Q301	B-5	Q411	C-2	R306	A-6	R331	C-4	R419	D-2
C306	B-5	C422	C-1	CR403	C-3	Q302	B-5	Q412	D-2	R307	A-6	R334	C-4	R420	D-2
C309	C-5	C426	F-5	CR408	E-3	Q305	C-5	Q413	E-2	R309	B-5	R335	C-4	R424	D-3
C311	C-5	C427	E-2	CR411	E-4	Q306	C-4	Q416	C-2	R311	D-5	R336	B-3	R425	D-3
C312	A-5	C428	D-4	L305	C-4	Q307	B-5	Q417	D-2	R313	C-5	R337	B-3	R428	D-3
C315	B-5	C429	D-1	L306	B-4	Q308	A-4	Q418	E-2	R314	C-4	R338	B-3	R429	D-3
C328	B-3	CR301	C-5	L309	B-2	Q309	A-4	Q421	C-3	R315	C-4	R339	B-3	R430	D-1
C401	D-2	CR302	C-6	L401	C-2	Q312	C-4	Q422	D-3	R318	A-5	R343	B-1	R434	E-1
C402	D-2	CR305	C-5	L402	C-4	Q313	B-3	Q423	E-3	R321	B-4	R401	D-4	R435	E-3
C406	D-2	CR306	A-5	L404	C-1	Q401	C-2	Q431	D-4	R322	A-4	R405	D-1	R441	E-4
C407	D-2	CR307	A-5	L405	D-4	Q403	C-2	Q432	E-4	R323	A-4	R406	D-4	R442	E-5
C411	D-3	CR309	B-5	L408	C-1	Q404	C-3	R301	C-6	R325	B-4	R409	D-1	R443	E-4
C412	D-3	CR311	B-4	L409	C-2	Q406	C-2	R302	A-6	R326	A-3	R410	D-1	R446	E-4
C416	D-3	CR312	C-4	L411	C-2	Q407	D-1	R303	C-6	R327	B-4	R414	D-2	R448	E-4
														R449	E-4
														S401	F-2

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Figure 5-10. Component Locations on A4, Width and Output Circuit Board

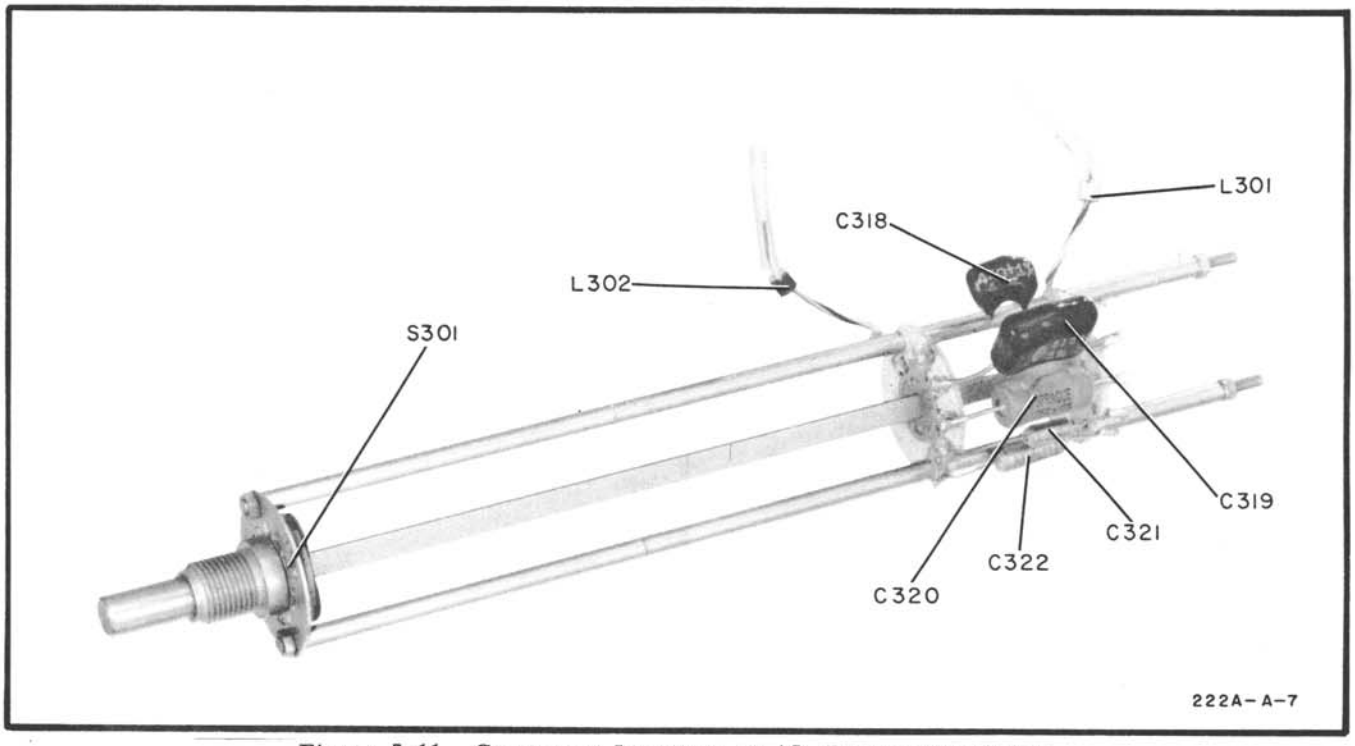


Figure 5-11. Component Locations on A5, Pulse Width Switch

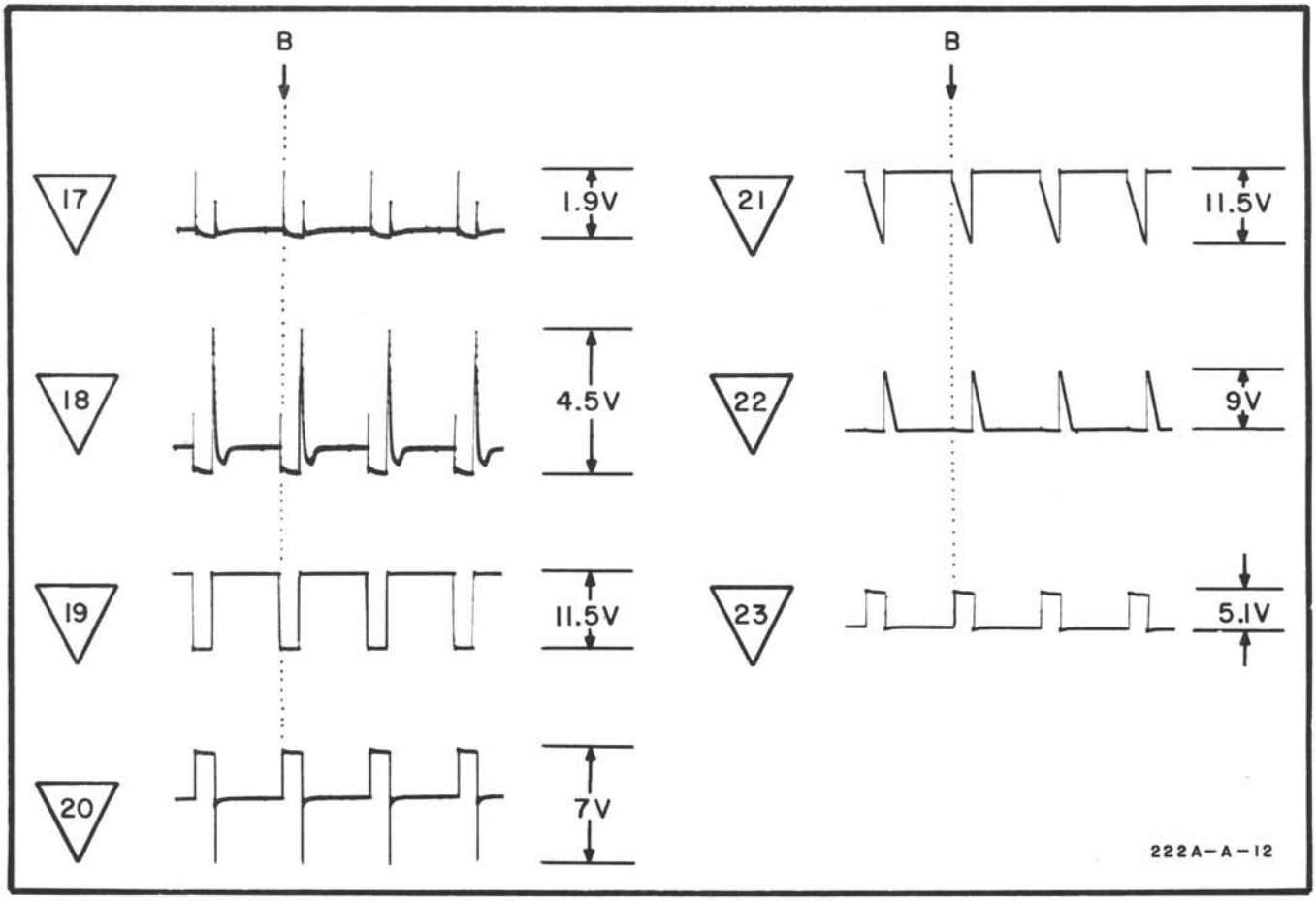
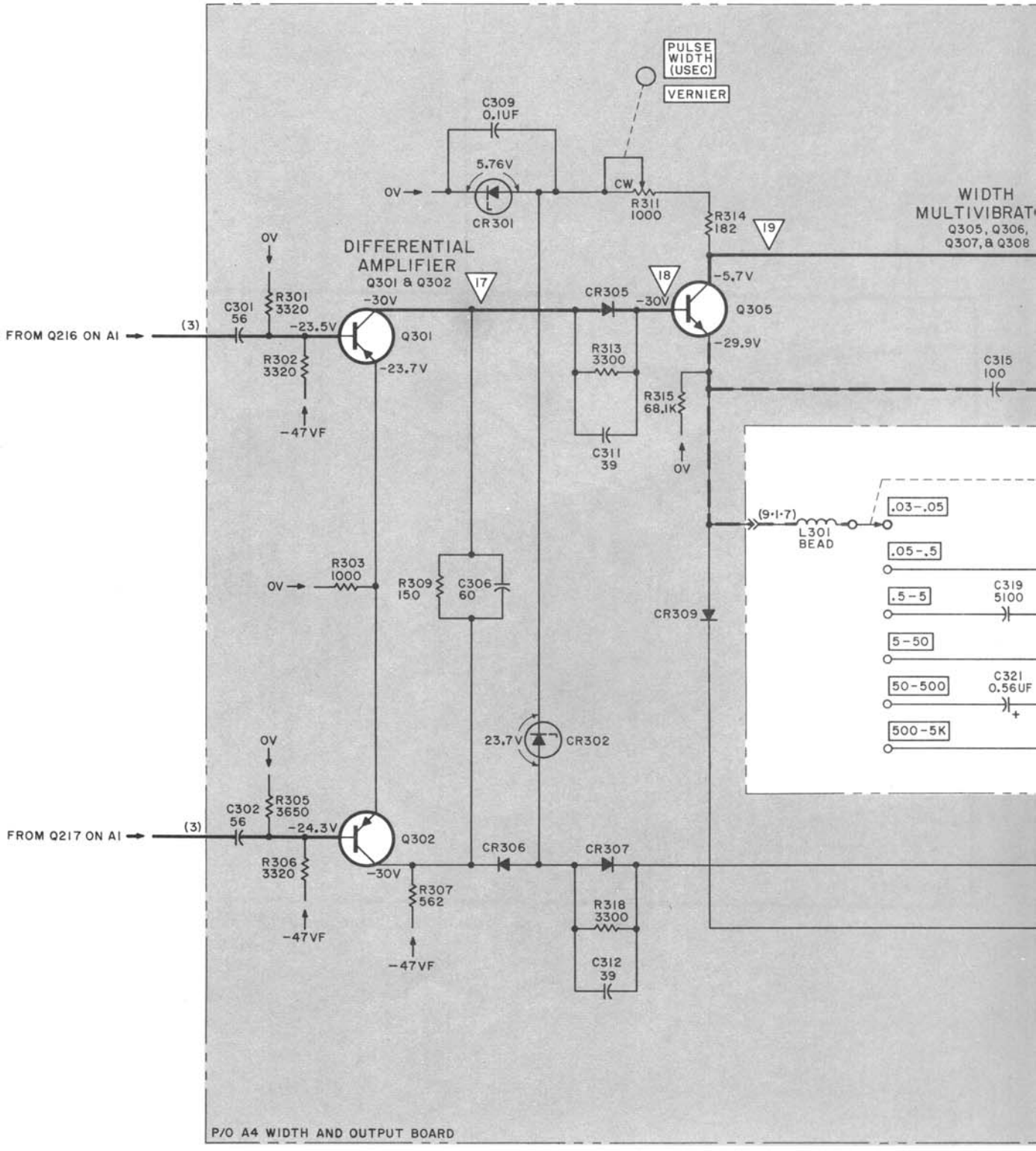
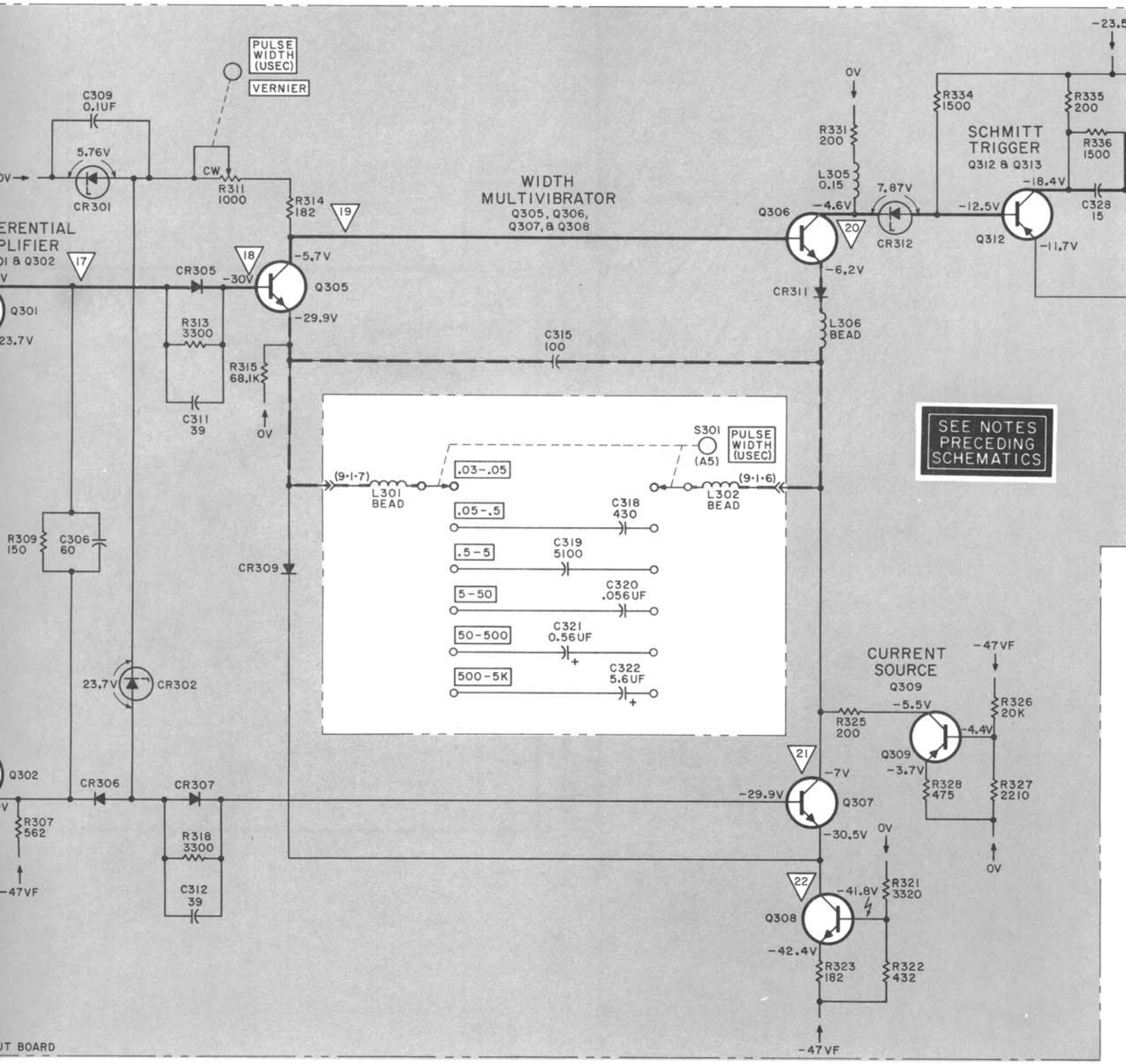
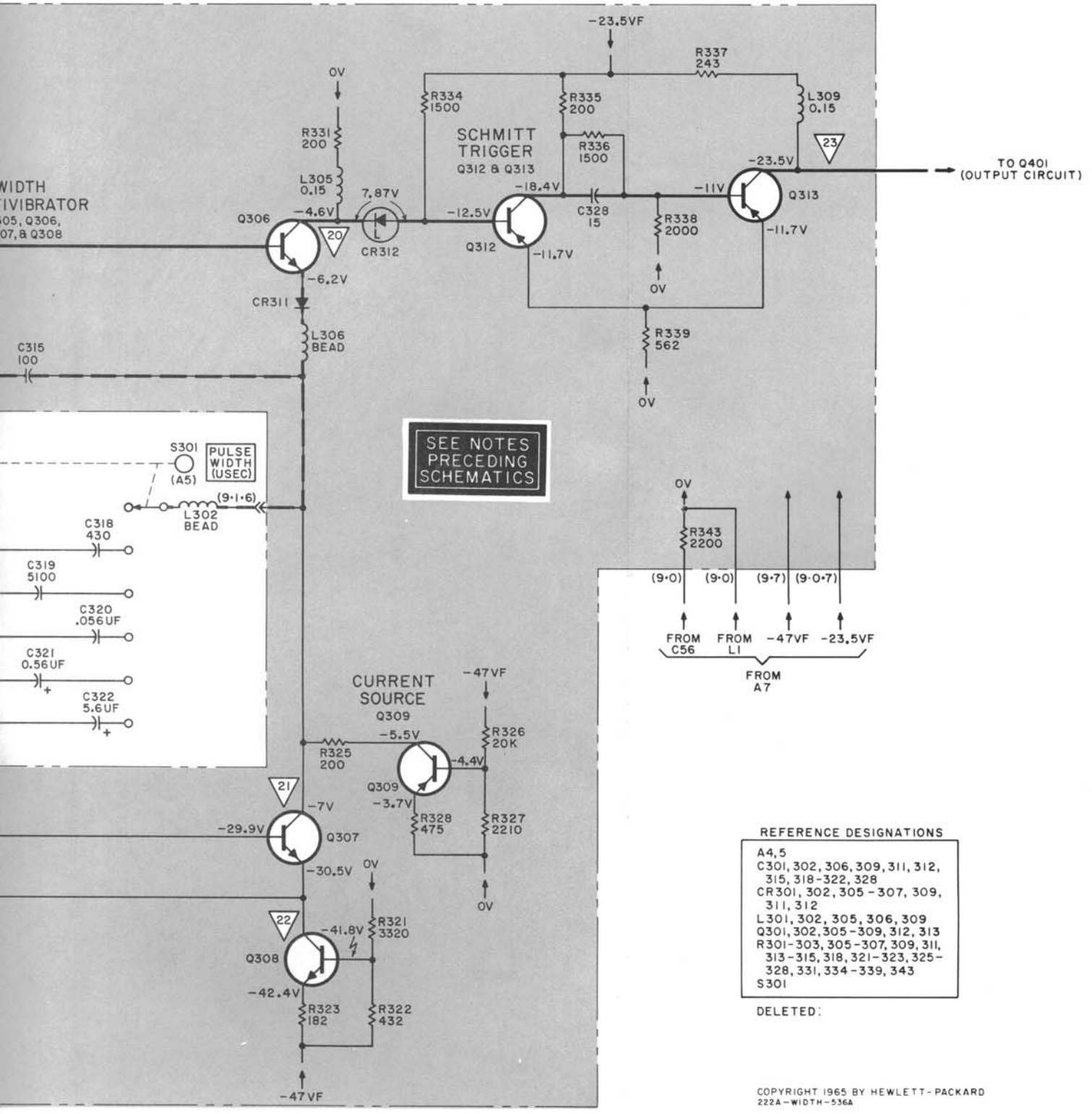


Figure 5-12. Waveforms at Testpoints in Pulse Width Circuit


PULSE WIDTH (USEC)
VERNIER
C309 0.1UF
5.76V
0V
CR301
CW
R311 1000
R314 182
19
WIDTH MULTIVIBRAT
Q305, Q306, Q307, & Q308
DIFFERENTIAL AMPLIFIER
Q301 & Q302
17
18
-5.7V
-30V
CR305
Q305
-29.9V
C315 100
FROM Q216 ON A1
(3)
C301 56
R301 3320
-23.5V
Q301
-23.7V
R302 3320
-47VF
R313 3300
C311 39
R315 68.1K
0V
(9-1-7)
L301 BEAD
.03-.05
.05-.5
.5-5
C319 5100
5-50
50-500
C321 0.56UF
500-5K
R303 1000
R309 150
C306 60
CR309
23.7V
CR302
FROM Q217 ON A1
C302 56
R305 3650
-24.3V
Q302
R306 3320
-30V
CR306
CR307
R307 562
R318 3300
C312 39
P/O A4 WIDTH AND OUTPUT BOARD


PULSE WIDTH (USEC)
VERNIER
C309 0.1UF
5.76V
CR301
CW
R311 1000
R314 182
19
WIDTH MULTIVIBRATOR
Q305, Q306, Q307, & Q308
0V
R331 200
L305 0.15
7.87V
CR312
R334 1500
R335 200
R336 1500
SCHMITT TRIGGER
Q312 & Q313
-18.4V
-12.5V
Q312
C328 15
-11.7V
Q306
-4.6V
20
-6.2V
CR311
L306 BEAD
ERENTIAL
PLIFIER
01 & Q302
17
18
CR305
-30V
Q305
-5.7V
-29.9V
Q301
23.7V
R313 3300
C311 39
R315 68.1K
0V
C315 100
S301
(A5)
PULSE WIDTH (USEC)
(9-1-7)
L301 BEAD
.03-.05
.05-.5
.5-5
5-50
50-500
500-5K
C318 430
C319 5100
C320 .056UF
C321 0.56UF
C322 5.6UF
(9-1-6)
L302 BEAD
SEE NOTES PRECEDING SCHEMATICS
R309 150
C306 60
CR309
23.7V
CR302
CURRENT SOURCE
Q309
-47VF
R326 20K
-5.5V
R325 200
-4.4V
Q309
-3.7V
R328 475
R327 2210
0V
21
-7V
-29.9V
Q307
-30.5V
Q302
CR306
CR307
R307 562
R318 3300
C312 39
-47VF
22
-41.8V
R321 3320
Q308
-42.4V
R323 182
R322 432
-47VF
UT BOARD



REFERENCE DESIGNATIONS

A4,5
C301, 302, 306, 309, 311, 312, 315, 318-322, 328
CR301, 302, 305-307, 309, 311, 312
L301, 302, 305, 306, 309
Q301, 302, 305-309, 312, 313
R301-303, 305-307, 309, 311, 313-315, 318, 321-323, 325-328, 331, 334-339, 343
S301

DELETED:

Figure 5-13. Pulse Width Circuit Schematic Diagram

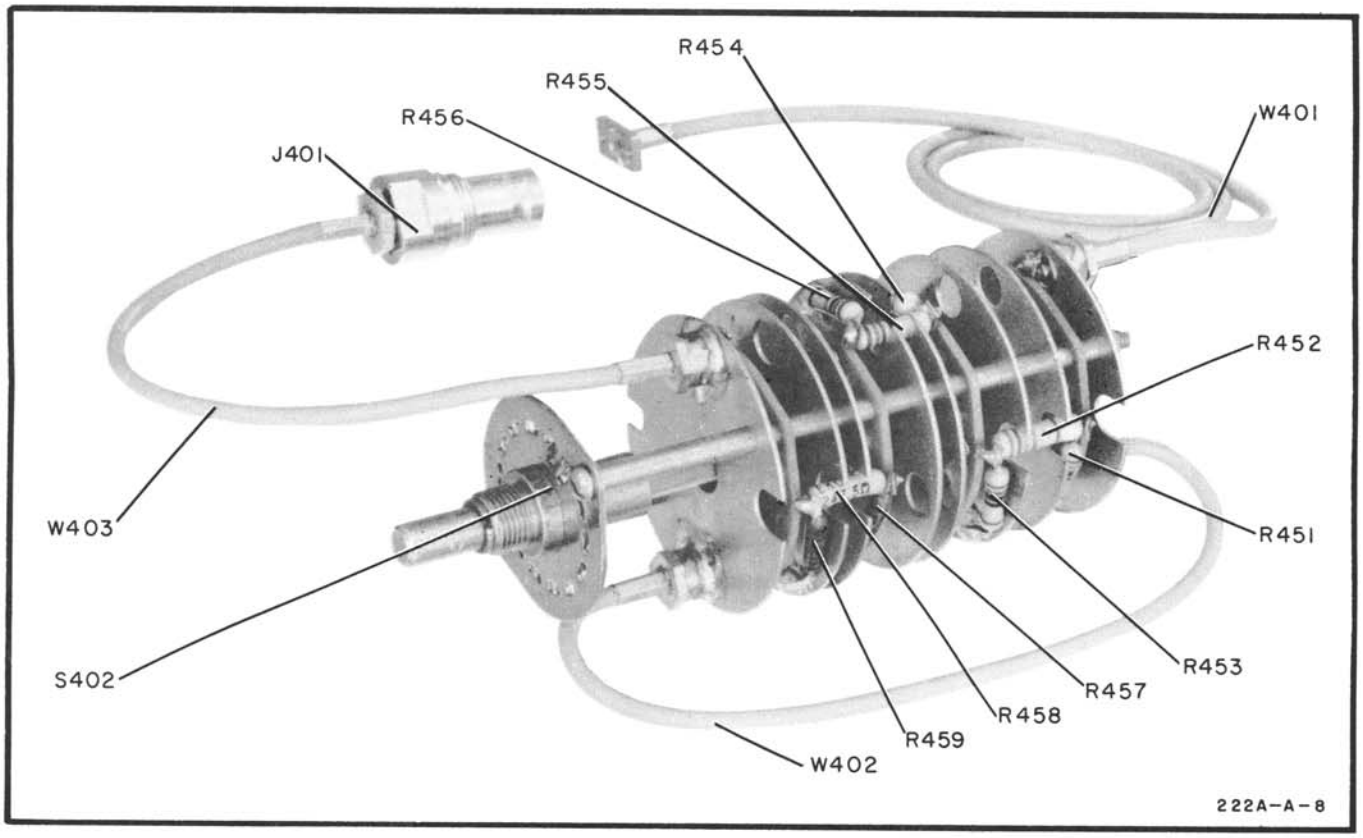


Figure 5-14. Component Locations on A6, Pulse Amplitude Switch

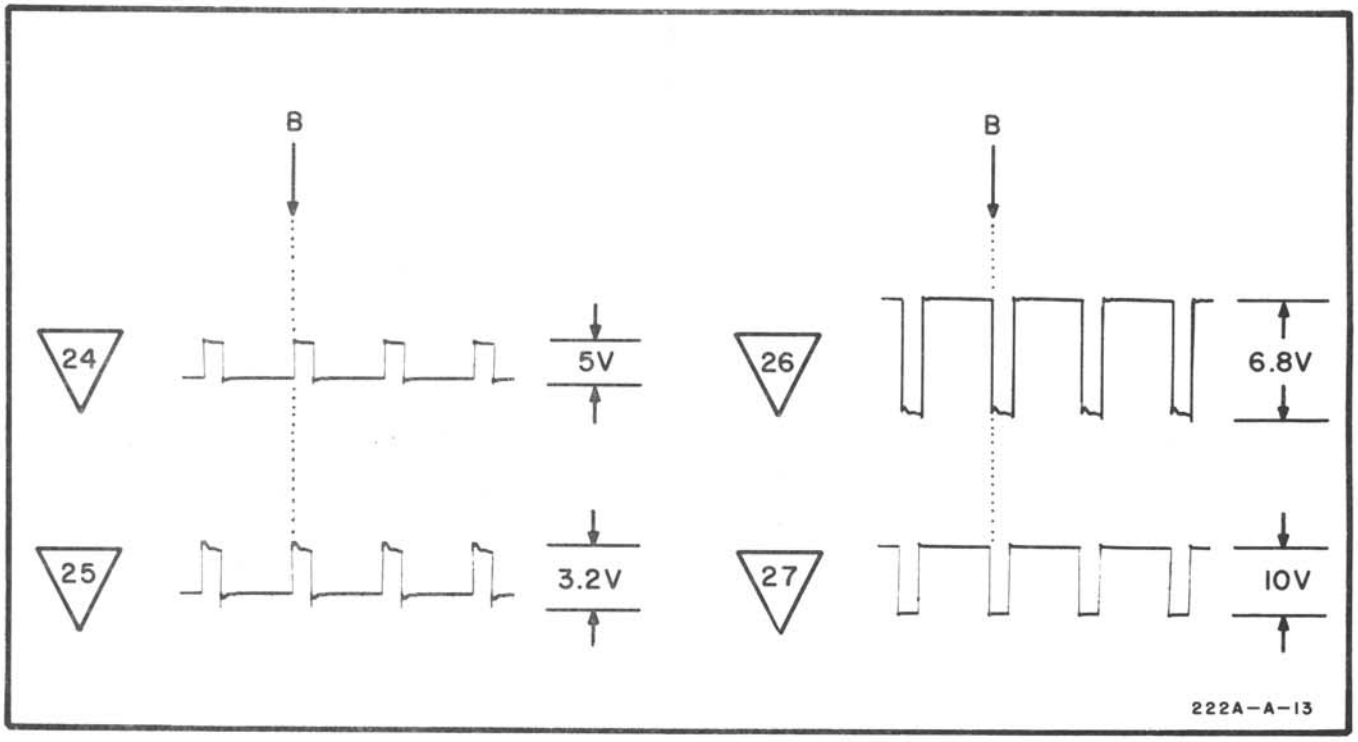
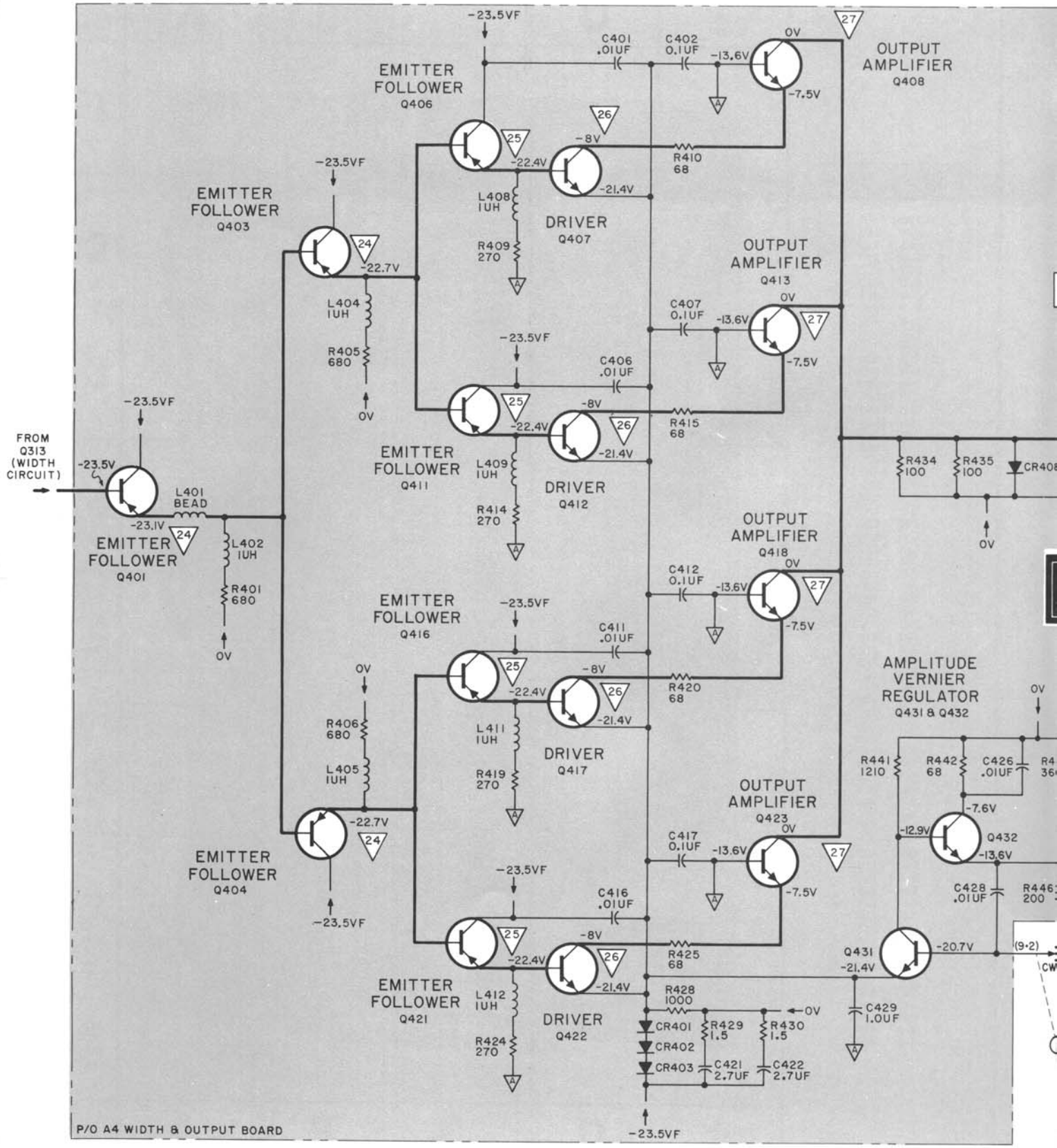
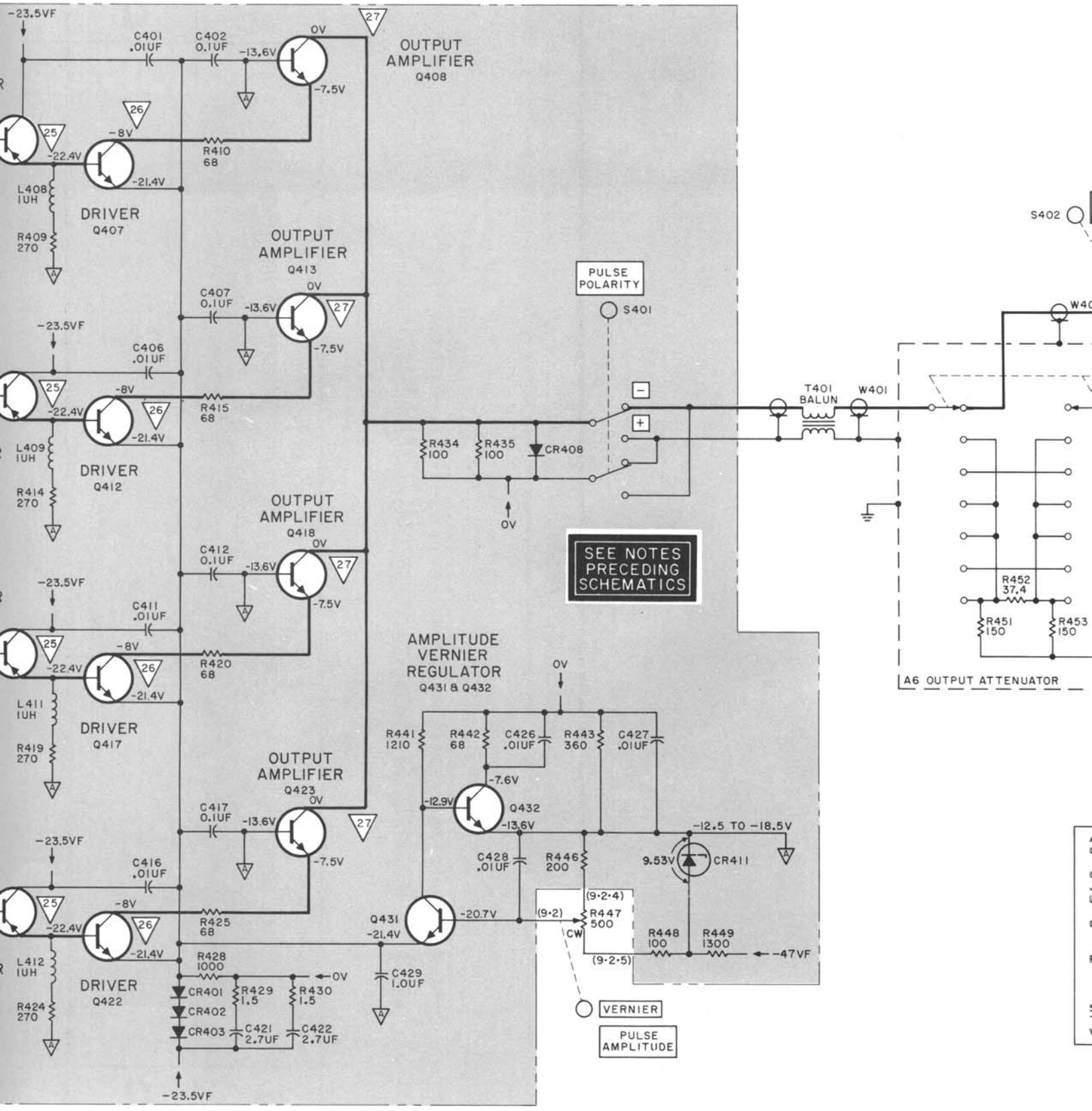
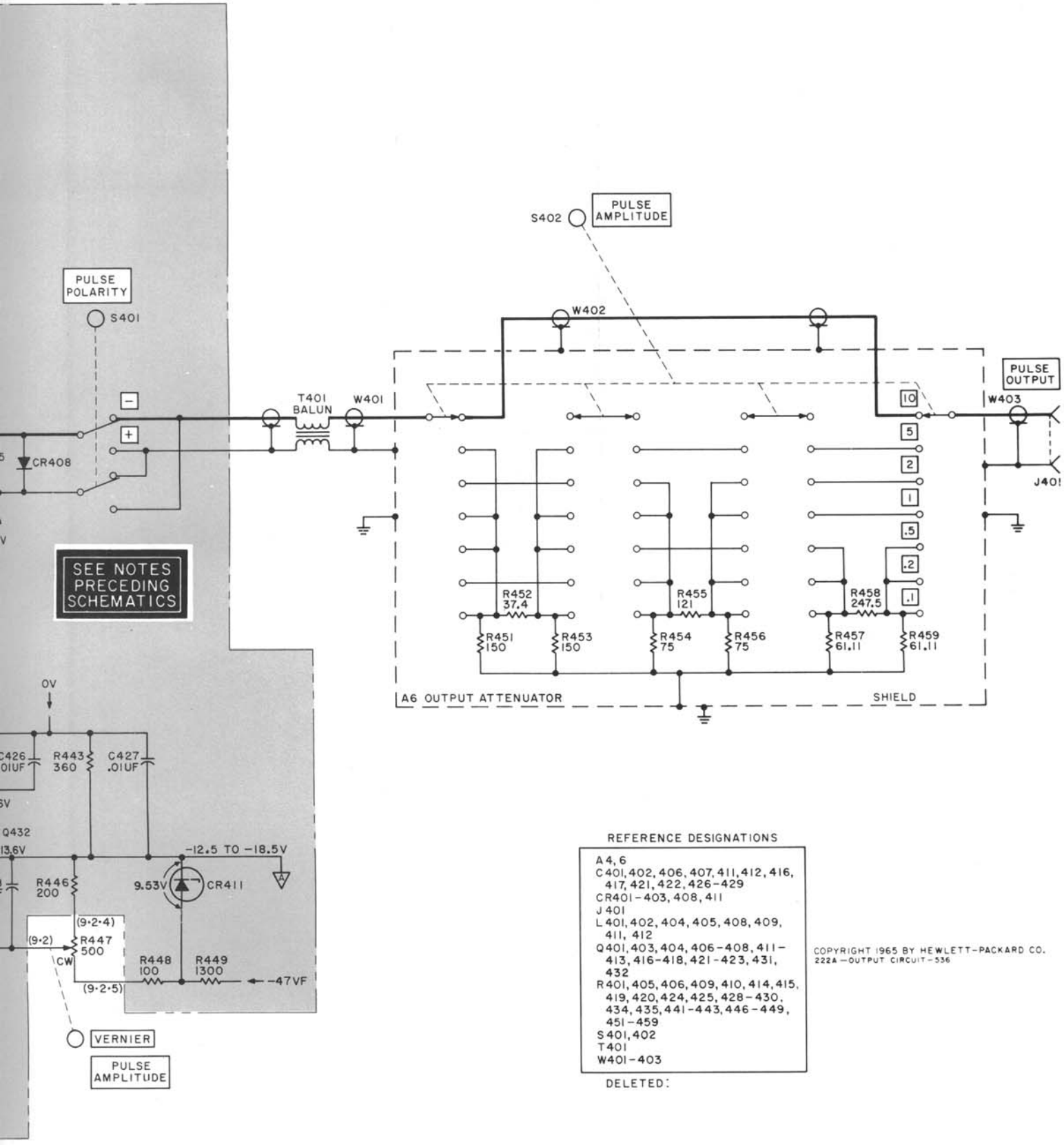


Figure 5-15. Waveforms at Testpoints in Output Circuit


FROM Q313 (WIDTH CIRCUIT)
-23.5V
L401 BEAD
-23.1V
EMITTER FOLLOWER Q401
L402 1UH
R401 680
0V
-23.5VF
EMITTER FOLLOWER Q403
L404 1UH
R405 680
-22.7V
EMITTER FOLLOWER Q404
R406 680
L405 1UH
-22.7V
EMITTER FOLLOWER Q406
C401 .01UF
C402 0.1UF
-13.6V
0V
-7.5V
OUTPUT AMPLIFIER Q408
-8V
R410 68
-22.4V
-21.4V
L408 1UH
R409 270
DRIVER Q407
OUTPUT AMPLIFIER Q413
C407 0.1UF
C406 .01UF
R415 68
EMITTER FOLLOWER Q411
L409 1UH
R414 270
DRIVER Q412
OUTPUT AMPLIFIER Q418
C412 0.1UF
EMITTER FOLLOWER Q416
C411 .01UF
R420 68
L411 1UH
R419 270
DRIVER Q417
OUTPUT AMPLIFIER Q423
C417 0.1UF
EMITTER FOLLOWER Q421
C416 .01UF
R425 68
L412 1UH
R424 270
DRIVER Q422
R428 1000
CR401
CR402
CR403
R429 1.5
R430 1.5
C421 2.7UF
C422 2.7UF
C429 1.0UF
R434 100
R435 100
CR408
AMPLITUDE VERNIER REGULATOR Q431 & Q432
R441 1210
R442 68
C426 .01UF
-7.6V
-12.9V
Q432
-13.6V
C428 .01UF
Q431
-20.7V
-21.4V
(9-2)
CW
P/O A4 WIDTH & OUTPUT BOARD


-23.5VF
C401 .01UF
C402 0.1UF
-13.6V
0V
-7.5V
27
OUTPUT AMPLIFIER Q408
26
25
-8V
-22.4V
-21.4V
R410 68
L408 1UH
DRIVER Q407
R409 270
OUTPUT AMPLIFIER Q413
C407 0.1UF
C406 .01UF
R415 68
L409 1UH
DRIVER Q412
R414 270
OUTPUT AMPLIFIER Q418
C412 0.1UF
C411 .01UF
R420 68
L411 1UH
DRIVER Q417
R419 270
OUTPUT AMPLIFIER Q423
C417 0.1UF
C416 .01UF
R425 68
L412 1UH
DRIVER Q422
R424 270
R428 1000
CR401
CR402
CR403
R429 1.5
R430 1.5
C421 2.7UF
C422 2.7UF
C429 1.0UF
PULSE POLARITY
S401
R434 100
R435 100
CR408
T401 BALUN
W401
S402
SEE NOTES PRECEDING SCHEMATICS
R452 37.4
R451 150
R453 150
A6 OUTPUT ATTENUATOR
AMPLITUDE VERNIER REGULATOR Q431 & Q432
R441 1210
R442 68
C426 .01UF
R443 360
C427 .01UF
-7.6V
-12.9V
Q432
-13.6V
-12.5 TO -18.5V
C428 .01UF
R446 200
9.53V
CR411
Q431
-20.7V
-21.4V
(9·2)
(9·2·4)
R447 500
CW
(9·2·5)
R448 100
R449 1300
-47VF
VERNIER
PULSE AMPLITUDE



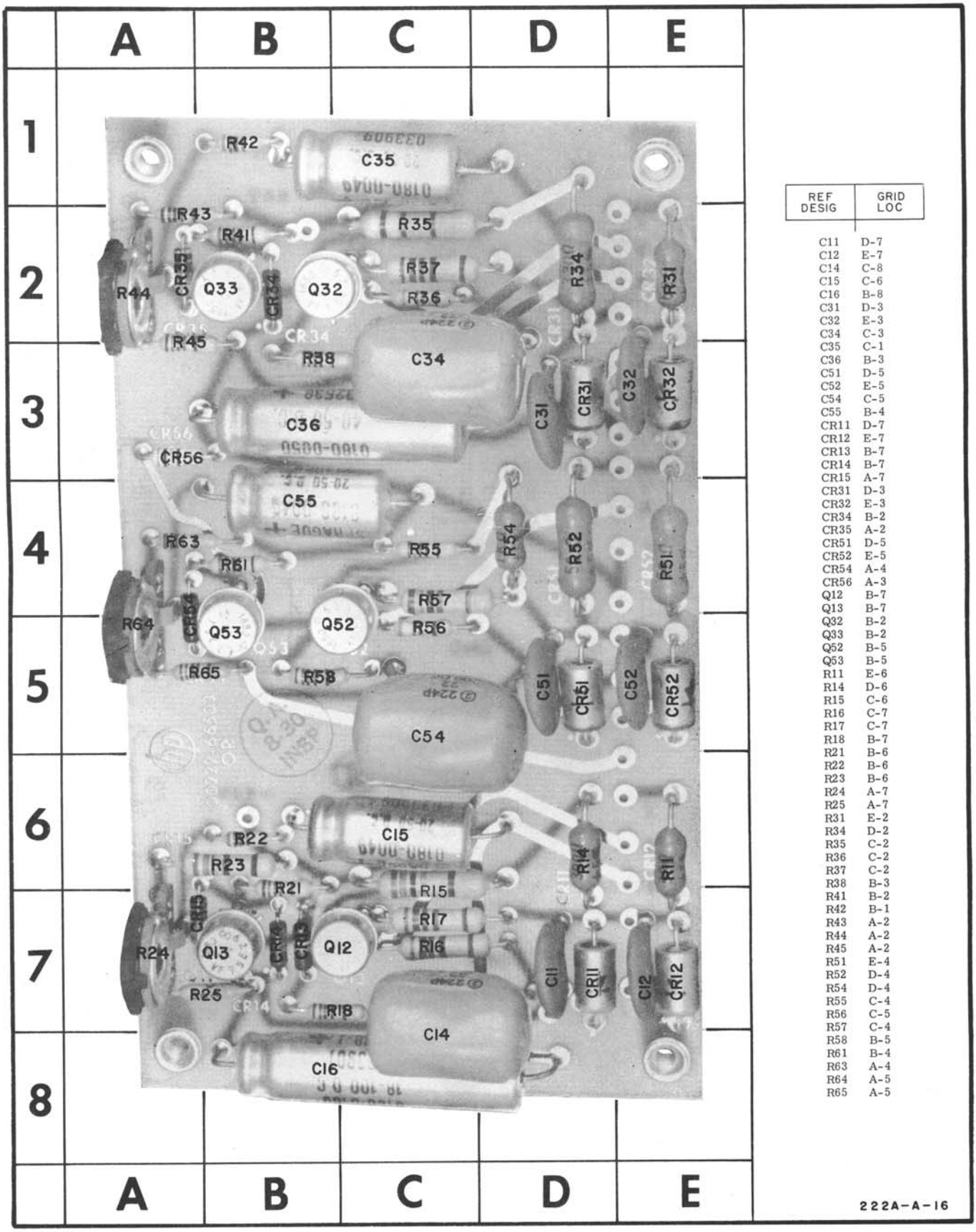
REFERENCE DESIGNATIONS

A4, 6
C401, 402, 406, 407, 411, 412, 416, 417, 421, 422, 426-429
CR401-403, 408, 411
J401
L401, 402, 404, 405, 408, 409, 411, 412
Q401, 403, 404, 406-408, 411-413, 416-418, 421-423, 431, 432
R401, 405, 406, 409, 410, 414, 415, 419, 420, 424, 425, 428-430, 434, 435, 441-443, 446-449, 451-459
S401, 402
T401
W401-403

DELETED:

222A—OUTPUT CIRCUIT—536

Figure 5-16. Output and Attenuator Circuits Schematic Diagram



REF DESIG	GRID LOC
C11	D-7
C12	E-7
C14	C-8
C15	C-6
C16	B-8
C31	D-3
C32	E-3
C34	C-3
C35	C-1
C36	B-3
C51	D-5
C52	E-5
C54	C-5
C55	B-4
CR11	D-7
CR12	E-7
CR13	B-7
CR14	B-7
CR15	A-7
CR31	D-3
CR32	E-3
CR34	B-2
CR35	A-2
CR51	D-5
CR52	E-5
CR54	A-4
CR56	A-3
Q12	B-7
Q13	B-7
Q32	B-2
Q33	B-2
Q52	B-5
Q53	B-5
R11	E-6
R14	D-6
R15	C-6
R16	C-7
R17	C-7
R18	B-7
R21	B-6
R22	B-6
R23	B-6
R24	A-7
R25	A-7
R31	E-2
R34	D-2
R35	C-2
R36	C-2
R37	C-2
R38	B-3
R41	B-2
R42	B-1
R43	A-2
R44	A-2
R45	A-2
R51	E-4
R52	D-4
R54	D-4
R55	C-4
R56	C-5
R57	C-4
R58	B-5
R61	B-4
R63	A-4
R64	A-5
R65	A-5

Figure 5-17. Component Locations on A7, Power Supply Circuit Board

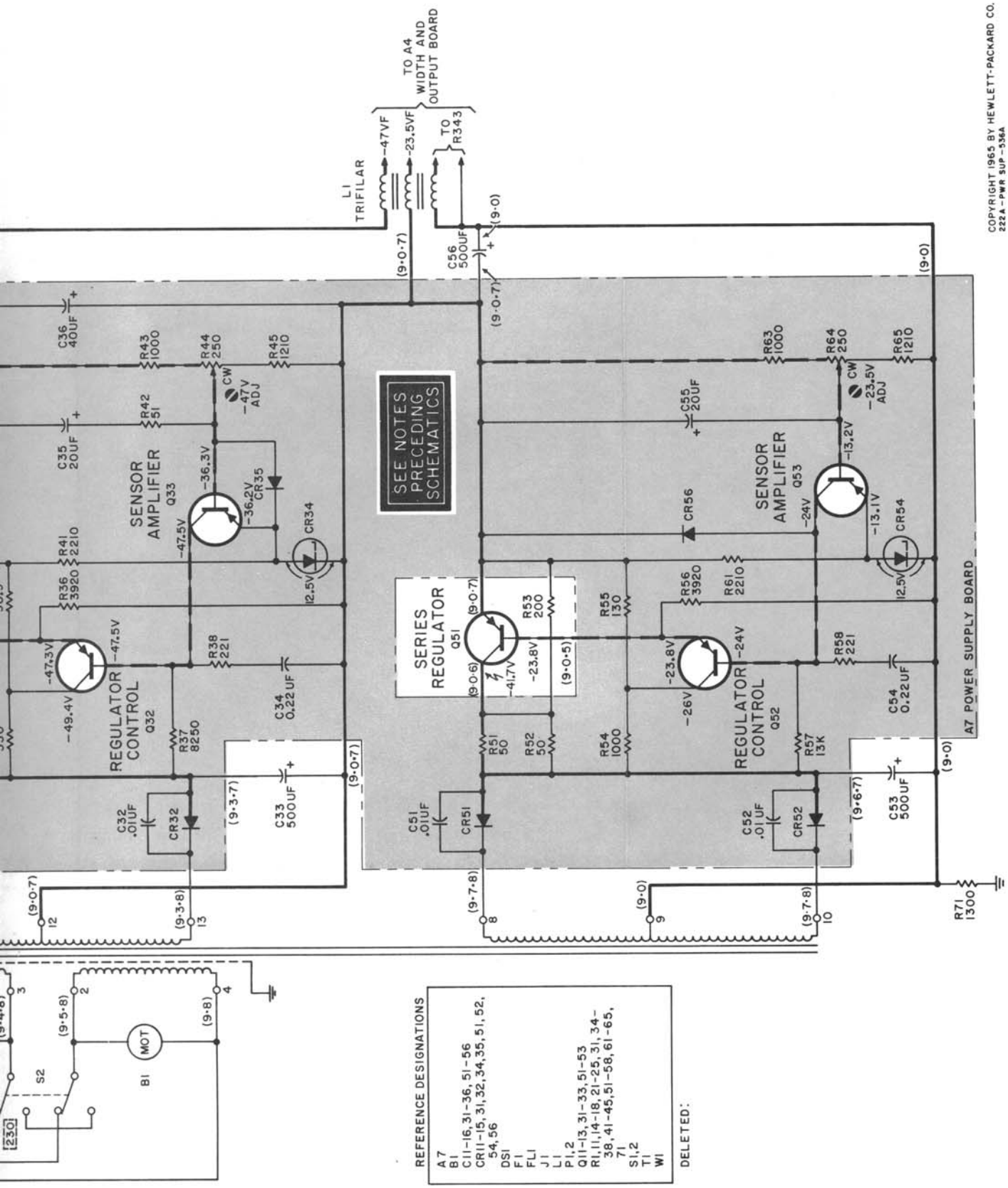
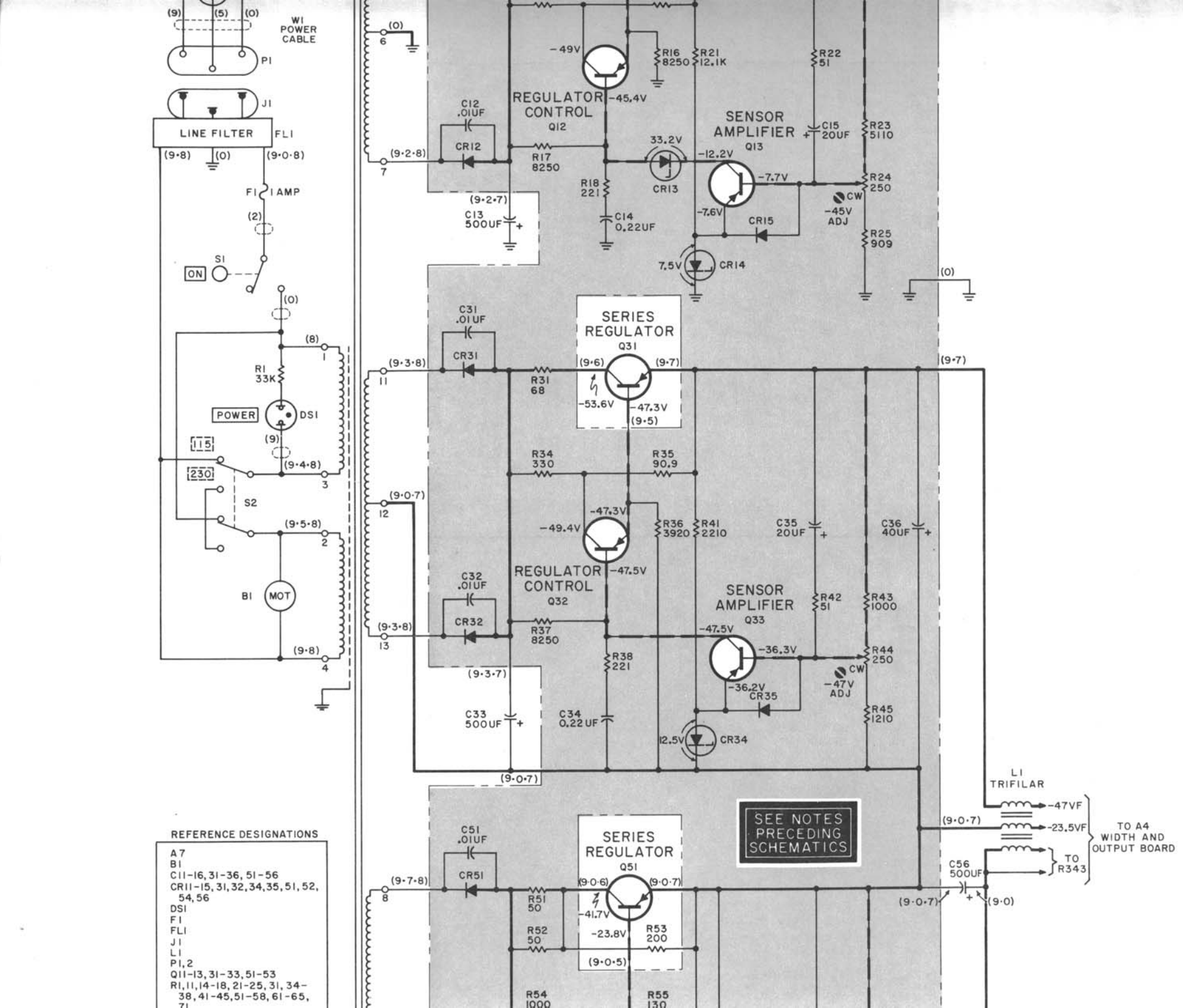
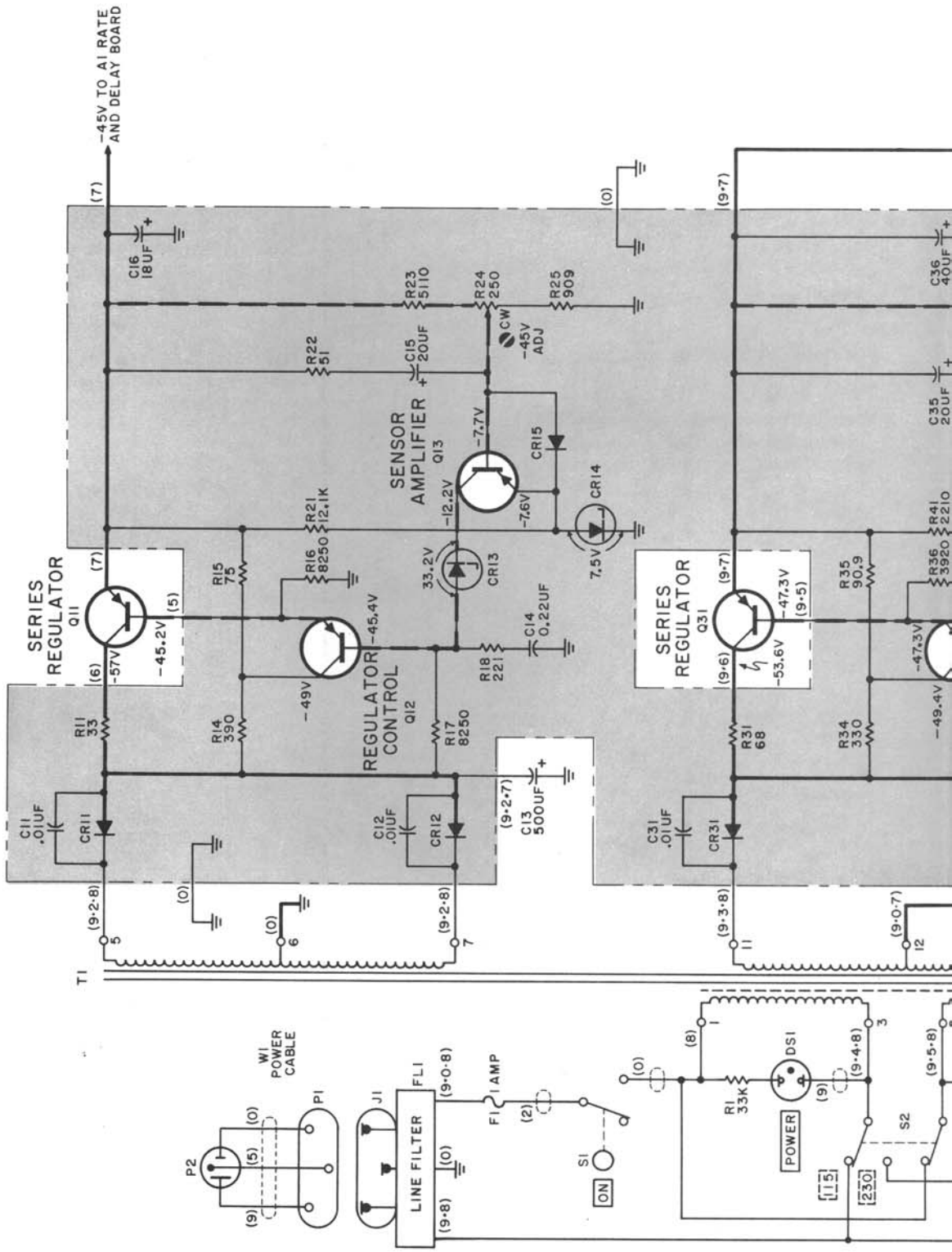


Figure 5-18. Power Supply Circuit Schematic Diagram



REFERENCE DESIGNATIONS

A7
B1
C11-16, 31-36, 51-56
CR11-15, 31, 32, 34, 35, 51, 52, 54, 56
DS1
F1
FL1
J1
L1
P1, 2
Q11-13, 31-33, 51-53
R1, 11, 14-18, 21-25, 31, 34-38, 41-45, 51-58, 61-65, 71


-45V TO A1 RATE AND DELAY BOARD
SERIES REGULATOR Q11
REGULATOR CONTROL Q12
SENSOR AMPLIFIER Q13
SERIES REGULATOR Q31
-45V ADJ
POWER
115
230
ON
LINE FILTER
W1 POWER CABLE
1 AMP
T1

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 hp part number of each component, together with any applicable notes. Parts not identified by a reference designation are listed under miscellaneous at the end of Table 6-1. Table 6-2 lists parts in numerical order of their hp part number and provides the following information for each item:

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

b. Typical manufacturer of the part in a five-digit code, except where Hewlett-Packard Company is the manufacturer. See list of manufacturer codes in Table 6-3.

c. Manufacturer's part number.

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

6-3. ORDERING INFORMATION.

6-4. To order a replacement part, address order or inquiry to your local Hewlett-Packard Sales/Service Office (see list of addresses at rear of this manual), and supply the hp part number of the item(s) from the tables.

6-5. To order a part not listed in the tables, provide the following information:

a. Model number of the instrument.

b. Complete serial number (eight digits) of the instrument.

c. Description of the part including function and location.

6-6. To order a part from a manufacturer other than Hewlett-Packard Company, provide the complete part description and the manufacturer's part number from Table 6-2.

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

01194-10

Table 6-1. Reference Designation Index

Reference Designation		ℎp Part No.	Description #	Note
A1		00222-66501	ASSY: ETCHED CKT (RATE and DELAY)	
A2		00222-61901	ASSY: SWITCH (RATE)	
A3		00222-61902	ASSY: SWITCH (DELAY)	
A4		00222-66502	ASSY: ETCHED CKT (WIDTH and OUTPUT)	
A5		00222-61903	ASSY: SWITCH (WIDTH)	
A6		00222-63401	ASSY: SWITCH (ATTENUATOR)	
A7		00222-66503	ASSY: ETCHED CKT (POWER SUPPLY)	
B1		3140-0052	MOTOR: FAN SHADED POLE	
DS1		1450-0048	INDICATOR: NEON RED	
F1		2110-0007	FUSE: 1 AMP SLOW BLOW (for 115 v operation)	
		2110-0008	FUSE: 1/2 AMP SLOW BLOW (for 230 v operation)	
FL1		9110-0082	FILTER: RFI LINE (Includes J1)	
C11		0150-0012	C: FXD CER 0.01 μf 20% 1000VDCW	
C12		0150-0012	C: FXD CER 0.01 μf 20% 1000VDCW	
C13		0180-0047	C: FXD ELECT 500 μf 75VDCW	
C14		0160-2056	C: FXD MY 0.22 μf 20% 200VDCW	
C15		0180-0049	C: FXD ELECT 20 μf 50VDCW	
C16		0180-0109	C: FXD ELECT 18 μf 100VDCW	
C17	THRU			
C30			NOT ASSIGNED	
C31		0150-0012	C: FXD CER 0.01 μf 20% 1000VDCW	
C32		0150-0012	C: FXD CER 0.01 μf 20% 1000VDCW	
C33		0180-0047	C: FXD ELECT 500 μf 75VDCW	
C34		0160-2056	C: FXD MY 0.22 μf 20% 200VDCW	
C35		0180-0049	C: FXD ELECT 20 μf 50VDCW	
C36		0180-0050	C: FXD ELECT 40 μf -15% +100% 50VDCW	
C37	THRU			
C50			NOT ASSIGNED	
C51		0150-0012	C: FXD CER 0.01 μf 20% 1000VDCW	
C52		0150-0012	C: FXD CER 0.01 μf 20% 1000VDCW	
C53		0180-0047	C: FXD ELECT 500 μf 75VDCW	
C54		0160-2056	C: FXD MY 0.22 μf 20% 200VDCW	
C55		0180-0049	C: FXD ELECT 20 μf 50VDCW	
C56		0180-0047	C: FXD ELECT 500 μf 75VDCW	
C57	THRU			
C100			NOT ASSIGNED	
C101		0150-0121	C: FXD CER 0.1 μf -20% +80% 50VDCW	
C102		0180-0050	C: FXD ELECT 40 μf -15% +100% 50VDCW	
C103	AND			
C104			NOT ASSIGNED	
C105		0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	
C106		0180-0049	C: FXD ELECT 20 μf 50VDCW	
C107	AND			
C108			NOT ASSIGNED	

See introduction to this section

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

Reference Designation	℔ Part No.	Description #	Note
C109	0150-0121	C: FXD CER 0.1 μf -20% +80% 50VDCW	
C110	0140-0191	C: FXD MICA 56 PF 5% 300VDCW	
C111	0140-0225	C: FXD MICA 300 PF 1% 300VDCW	
C112 AND C113		NOT ASSIGNED	
C114	0180-0116	C: FXD ELECT TA 6.8 μf 10% 35VDCW	
C115	0150-0121	C: FXD CER 0.1 μf -20% +80% 50VDCW	
C116 AND C117		NOT ASSIGNED	
C118	0140-0145	C: FXD MICA 22 PF 5% 500VDCW	
C119	0140-0200	C: FXD MICA 390 PF 5% 300VDCW	
C120 AND C121		NOT ASSIGNED	
C122	0160-0346	C: FXD MICA 5100 PF 5% 300VDCW	
C123	0160-0165	C: FXD MY 5600 PF 10% 200VDCW	
C124	0180-1713	C: FXD ELECT TA 0.56 μf 5% 35VDCW	
C125	0180-1712	C: FXD ELECT TA 5.6 μf 5% 35VDCW	
C126	0180-1718	C: FXD ELECT TA 56 μf 10% 20VDCW	
C127	0150-0084	C: FXD CER 0.1 μf -20% +80% 50VDCW	
C128 THRU C130		NOT ASSIGNED	
C131	0160-0155	C: FXD MY 3300 PF 10% 200VDCW	
C132 AND C133		NOT ASSIGNED	
C134	0140-0209	C: FXD MICA 5 PF 10% 500VDCW	
C135	0140-0145	C: FXD MICA 22 PF 5% 500VDCW	
C136 AND C137		NOT ASSIGNED	
C138	0140-0225	C: FXD MICA 300 PF 1% 300VDCW	
C139 AND C140		NOT ASSIGNED	
C141	0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	
C142 THRU C208		NOT ASSIGNED	
C209	0150-0121	C: FXD CER 0.1 μf -20% +80% 50VDCW	
C210		NOT ASSIGNED	
C211	0140-0175	C: FXD MICA 39 PF 2% 300VDCW	
C212	0140-0175	C: FXD MICA 39 PF 2% 300VDCW	
C213 AND C214		NOT ASSIGNED	
C215	0140-0216	C: FXD MICA 120 PF 2% 300VDCW	
C216 AND C217		NOT ASSIGNED	
C218	0160-2275	C: FXD MICA 430 PF 1% 500VDCW	
C219	0160-0346	C: FXD MICA 5100 PF 5% 300VDCW	
C220	0160-0165	C: FXD MICA 5600 PF 10% 200VDCW	
C221	0180-1713	C: FXD ELECT TA 0.56 μf 5% 35VDCW	
C222	0180-1712	C: FXD ELECT TA 5.6 μf 5% 35VDCW	
C223 AND C224		NOT ASSIGNED	

See introduction to this section

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

Reference Designation	Part No.	Description #	Note
C225	0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	
C226 THRU			
C231		NOT ASSIGNED	
C232	0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	
C233	0140-0202	C: FXD MICA 15 PF 5% 500VDCW	
C234 AND			
C235		NOT ASSIGNED	
C236	0140-0145	C: FXD MICA 22 PF 5% 500VDCW	
C237 THRU			
C300		NOT ASSIGNED	
C301	0140-0081	C: FXD MICA 56 PF 1% 500VDCW	
C302	0140-0081	C: FXD MICA 56 PF 1% 500VDCW	
C303 THRU			
C305		NOT ASSIGNED	
C306	0140-0214	C: FXD MICA 60 PF 5% 300VDCW	
C307 AND			
C308		NOT ASSIGNED	
C309	0150-0121	C: FXD CER 0.1 μf -20% +80% 50VDCW	
C310		NOT ASSIGNED	
C311	0140-0175	C: FXD MICA 39 PF 2% 300VDCW	
C312	0140-0175	C: FXD MICA 39 PF 2% 300VDCW	
C313 AND			
C314		NOT ASSIGNED	
C315	0140-0176	C: FXD MICA 100 PF 2% 300VDCW	
C316 AND			
C317		NOT ASSIGNED	
C318	0160-2275	C: FXD MICA 430 PF 1% 500VDCW	
C319	0160-0346	C: FXD MICA 5100 PF 5% 300VDCW	
C320	0160-0165	C: FXD MY 5600 PF 10% 200VDCW	
C321	0180-1713	C: FXD ELECT TA 0.56 μf 5% 35VDCW	
C322	0180-1712	C: FXD ELECT TA 5.6 μf 5% 35VDCW	
C323 THRU			
C327		NOT ASSIGNED	
C328	0140-0202	C: FXD MICA 15 PF 5% 500VDCW	
C329 THRU			
C400		NOT ASSIGNED	
C401	0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	
C402	0150-0121	C: FXD CER 0.1 μf -20% +80% 50VDCW	
C403 THRU			
C405		NOT ASSIGNED	
C406	0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	
C407	0150-0121	C: FXD CER 0.1 μf -20% +80% 50VDCW	
C408 THRU			
C410		NOT ASSIGNED	
C411	0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	
C412	0150-0121	C: FXD CER 0.1 μf -20% +80% 50VDCW	

See introduction to this section

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

Reference Designation	Part No.	Description #	Note
C413 THRU			
C415		NOT ASSIGNED	
C416	0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	
C417	0150-0121	C: FXD CER 0.1 μf -20% +80% 50VDCW	
C418 THRU			
C420		NOT ASSIGNED	
C421	0180-0117	C: FXD ELECT TA 2.7 μf 10% 35VDCW	
C422	0180-0117	C: FXD ELECT TA 2.7 μf 10% 35VDCW	
C423 THRU			
C425		NOT ASSIGNED	
C426	0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	
C427	0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	
C428	0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	
C429	0160-0127	C: FXD CER 1 μf 20% 25VDCW	
CR11	1901-0028	DIODE: SILICON	
CR12	1901-0028	DIODE: SILICON	
CR13	1902-3295	DIODE: AVALANCHE 33.2 v	
CR14	1902-0064	DIODE: AVALANCHE 7.5 v	
CR15	1910-0016	DIODE: GE	
CR16 THRU			
CR30		NOT ASSIGNED	
CR31	1901-0026	DIODE: SILICON	
CR32	1901-0026	DIODE: SILICON	
CR33		NOT ASSIGNED	
CR34	1902-0031	DIODE: AVALANCHE 12.7 v	
CR35	1910-0016	DIODE: GE	
CR36 THRU			
CR50		NOT ASSIGNED	
CR51	1901-0026	DIODE: SILICON	
CR52	1901-0026	DIODE: SILICON	
CR53		NOT ASSIGNED	
CR54	1902-0031	DIODE: AVALANCHE 12.7 v	
CR55		NOT ASSIGNED	
CR56	1901-0040	DIODE: SILICON	
CR57 THRU			
CR100		NOT ASSIGNED	
CR101	1910-0016	DIODE: GE	
CR102	1910-0016	DIODE: GE	
CR103	1910-0016	DIODE: GE	
CR104	1910-0016	DIODE: GE	
CR105 THRU			
CR107		NOT ASSIGNED	
CR108	1902-0064	DIODE: AVALANCHE 7.5 v	
CR109 AND			
CR110		NOT ASSIGNED	

See introduction to this section

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

Reference Designation	Part No.	Description #	Note
CR111	1901-0040	DIODE: SILICON	
CR112	1901-0040	DIODE: SILICON	
CR113 AND			
CR114		NOT ASSIGNED	
CR115	1902-0048	DIODE: AVALANCHE 6.81 v	
CR116 THRU			
CR120		NOT ASSIGNED	
CR121	1902-0034	DIODE: AVALANCHE 5.8 v	
CR122	1901-0040	DIODE: SILICON	
CR123	1901-0040	DIODE: SILICON	
CR124	1910-0016	DIODE: GE	
CR125 THRU			
CR200		NOT ASSIGNED	
CR201	1902-0034	DIODE: AVALANCHE 5.8 v	
CR202		NOT ASSIGNED	
CR203	1902-0184	DIODE: AVALANCHE 16.2 v	
CR204		NOT ASSIGNED	
CR205	1901-0040	DIODE: SILICON	
CR206	1901-0040	DIODE: SILICON	
CR207	1901-0040	DIODE: SILICON	
CR208		NOT ASSIGNED	
CR209	1901-0179	DIODE: SILICON	
CR210		NOT ASSIGNED	
CR211	1901-0179	DIODE: SILICON	
CR212	1902-3107	DIODE: AVALANCHE 5.76 v	
CR213	1901-0040	DIODE: SILICON	
CR214	1902-0126	DIODE: AVALANCHE 2.61 v	
CR215	1902-0184	DIODE: AVALANCHE 16.2 v	
CR216 THRU			
CR300		NOT ASSIGNED	
CR301	1902-0034	DIODE: AVALANCHE 5.8 v	
CR302	1902-3256	DIODE: AVALANCHE 23.7 v	
CR303 AND			
CR304		NOT ASSIGNED	
CR305	1901-0040	DIODE: SILICON	
CR306	1901-0040	DIODE: SILICON	
CR307	1901-0040	DIODE: SILICON	
CR308		NOT ASSIGNED	
CR309	1901-0179	DIODE: SILICON	
CR310		NOT ASSIGNED	
CR311	1901-0179	DIODE: SILICON	
CR312	1902-0072	DIODE: AVALANCHE 7.87 v	
CR313 THRU			
CR400		NOT ASSIGNED	
CR401	1901-0194	DIODE: SILICON	

See introduction to this section

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

Reference Designation	Part No.	Description #	Note
CR402	1901-0194	DIODE: SILICON	
CR403	1901-0194	DIODE: SILICON	
CR404 THRU			
CR407		NOT ASSIGNED	
CR408	1901-0040	DIODE: SILICON	
CR409 AND			
CR410		NOT ASSIGNED	
CR411	1902-0173	DIODE: AVALANCHE 9.53 v	
J1		NSR: P/O FL1	
J2 THRU			
J100		NOT ASSIGNED	
J101	1250-0140	CONNECTOR: BNC (P/O W101)	
J102	1250-0140	CONNECTOR: BNC (P/O W102)	
J103 THRU			
J400		NOT ASSIGNED	
J401	1250-0140	CONNECTOR: BNC (P/O W403)	
L1		NSR (consists of power supply leads wound on toroid core)	
L2 THRU			
L100		NOT ASSIGNED	
L101	9170-0029	INDUCTOR: BEAD	
L102	9170-0016	INDUCTOR: BEAD	
L103 THRU			
L110		NOT ASSIGNED	
L111	9140-0143	COIL: RF 3.3 μh	
L112 THRU			
L200		NOT ASSIGNED	
L201	9170-0016	INDUCTOR: BEAD	
L202	9170-0016	INDUCTOR: BEAD	
L203 AND			
L204		NOT ASSIGNED	
L205	9140-0170	COIL: .15 μh	
L206	9170-0016	INDUCTOR: BEAD	
L207 THRU			
L300		NOT ASSIGNED	
L301	9170-0016	INDUCTOR: BEAD	
L302	9170-0016	INDUCTOR: BEAD	
L303 AND			
L304		NOT ASSIGNED	
L305	9140-0170	COIL: .15 μh	
L306	9170-0016	INDUCTOR: BEAD	
L307 AND			
L308		NOT ASSIGNED	
L309	9140-0170	COIL: .15 μh	
L310 THRU			
L400		NOT ASSIGNED	
L401	9170-0016	INDUCTOR: BEAD	
L402	9140-0158	COIL: 1 μh	
L403		NOT ASSIGNED	

See introduction to this section

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

Reference Designation	Part No.	Description #	Note
L404	9140-0158	COIL: 1 μh	
L405	9140-0158	COIL: 1 μh	
L406 AND			
L407		NOT ASSIGNED	
L408	9140-0158	COIL: 1 μh	
L409	9140-0158	COIL: 1 μh	
L410		NOT ASSIGNED	
L411	9140-0158	COIL: 1 μh	
L412	9140-0158	COIL: 1 μh	
P1		NSR: P/O W1	
P2		NSR: P/O W1	
Q11	1850-0098	TRANSISTOR: GE PNP	
Q12	1850-0062	TRANSISTOR: GE PNP	
Q13	1850-0062	TRANSISTOR: GE PNP	
Q14 THRU			
Q30		NOT ASSIGNED	
Q31	1850-0098	TRANSISTOR: GE PNP	
Q32	1850-0062	TRANSISTOR: GE PNP	
Q33	1850-0062	TRANSISTOR: GE PNP	
Q34 THRU			
Q50		NOT ASSIGNED	
Q51	1850-0098	TRANSISTOR: GE PNP	
Q52	1850-0062	TRANSISTOR: GE PNP	
Q53	1850-0062	TRANSISTPR: GE PNP	
Q54 THRU			
Q100		NOT ASSIGNED	
Q101	1854-0019	TRANSISTOR: SILICON NPN	
Q102	1854-0019	TRANSISTOR: SILICON NPN	
Q103 AND			
Q104		NOT ASSIGNED	
Q105	1854-0005	TRANSISTOR: SILICON NPN 2N708	
Q106 AND			
Q107		NOT ASSIGNED	
Q108	1854-0005	TRANSISTOR: SILICON NPN 2N708	
Q109	1854-0005	TRANSISTOR: SILICON NPN 2N708	
Q110		NOT ASSIGNED	
Q111	1854-0019	TRANSISTOR: SILICON NPN	
Q112	1854-0019	TRANSISTOR: SILICON NPN	
Q113 AND			
Q114		NOT ASSIGNED	
Q115	1853-0015	TRANSISTOR: SILICON PNP 2N3640	
Q116	1853-0015	TRANSISTOR: SILICON PNP 2N3640	
Q117 THRU			
Q120		NOT ASSIGNED	
Q121	1853-0015	TRANSISTOR: SILICON PNP 2N3640	
Q122 THRU			
Q204		NOT ASSIGNED	

See introduction to this section

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

Reference Designation	Part No.	Description #	Note
Q205	1854-0213	TRANSISTOR: SILICON NPN 2N2538	
Q206	1854-0019	TRANSISTOR: SILICON NPN	
Q207	1854-0213	TRANSISTOR: SILICON NPN 2N2538	
Q208	1854-0213	TRANSISTOR: SILICON NPN 2N2538	
Q209	1853-0016	TRANSISTOR: SILICON PNP	
Q210 AND			
Q211		NOT ASSIGNED	
Q212	1853-0015	TRANSISTOR: SILICON PNP 2N3640	
Q213	1853-0015	TRANSISTOR: SILICON PNP 2N3640	
Q214 AND			
Q215		NOT ASSIGNED	
Q216	1853-0015	TRANSISTOR: SILICON PNP 2N3640	
Q217	1853-0015	TRANSISTOR: SILICON PNP 2N3640	
Q218 THRU			
Q300		NOT ASSIGNED	
Q301	1853-0015	TRANSISTOR: SILICON PNP 2N3640	
Q302	1853-0015	TRANSISTOR: SILICON PNP 2N3640	
Q303 AND			
Q304		NOT ASSIGNED	
Q305	1854-0213	TRANSISTOR: SILICON NPN 2N2538	
Q306	1854-0019	TRANSISTOR: SILICON NPN	
Q307	1854-0213	TRANSISTOR: SILICON NPN 2N2538	
Q308	1854-0213	TRANSISTOR: SILICON NPN 2N2538	
Q309	1853-0016	TRANSISTOR: SILICON PNP	
Q310 AND			
Q311		NOT ASSIGNED	
Q312	1853-0015	TRANSISTOR: SILICON PNP 2N3640	
Q313	1853-0015	TRANSISTOR: SILICON PNP 2N3640	
Q314 THRU			
Q400		NOT ASSIGNED	
Q401	1850-0099	TRANSISTOR: GE 2N964 PNP	
Q402		NOT ASSIGNED	
Q403	1850-0099	TRANSISTOR: GE 2N964 PNP	
Q404	1850-0099	TRANSISTOR: GE 2N964 PNP	
Q405		NOT ASSIGNED	
Q406	1850-0099	TRANSISTOR: GE 2N964 PNP	
Q407	1854-0204	TRANSISTOR: SILICON NPN	
Q408	1854-0019	TRANSISTOR: SILICON NPN	
Q409 AND			
Q410		NOT ASSIGNED	
Q411	1850-0099	TRANSISTOR: GE 2N964 PNP	
Q412	1854-0204	TRANSISTOR: SILICON NPN	
Q413	1854-0019	TRANSISTOR: SILICON NPN	
Q414 AND			
Q415		NOT ASSIGNED	
Q416	1850-0099	TRANSISTOR: GE 2N964 PNP	

See introduction to this section

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

Reference Designation	Part No.	Description #	Note
Q417	1854-0204	TRANSISTOR: SILICON NPN	
Q418	1854-0019	TRANSISTOR: SILICON NPN	
Q419 AND			
Q420		NOT ASSIGNED	
Q421	1850-0099	TRANSISTOR: GE 2N964 PNP	
Q422	1854-0204	TRANSISTOR: SILICON NPN	
Q423	1854-0019	TRANSISTOR: SILICON NPN	
Q424 THRU			
Q430		NOT ASSIGNED	
Q431	1854-0005	TRANSISTOR: SILICON NPN 2N708	
Q432	1854-0003	TRANSISTOR: SILICON NPN	
R1	0687-3331	R: FXD COMP 33K OHMS 10% 1/2W	
R2 THRU			
R10		NOT ASSIGNED	
R11	0811-1201	R: FXD WW 33 OHMS 5% 2W	
R12 AND			
R13		NOT ASSIGNED	
R14	0811-1206	R: FXD WW 390 OHMS 5% 2W	
R15	0757-0795	R: FXD METFLM 75 OHMS 1% 1/2W	
R16	0757-0752	R: FXD METFLM 8250 OHMS 1% 1/4W	
R17	0757-0752	R: FXD METFLM 8250 OHMS 1% 1/4W	
R18	0757-0282	R: FXD METFLM 221 OHMS 1% 1/8W	
R19 AND			
R20		NOT ASSIGNED	
R21	0757-0444	R: FXD METFLM 12.1K OHMS 1% 1/8W	
R22	0757-0893	R: FXD METFLM 51 OHMS 2% 1/8W	
R23	0757-0747	R: FXD METFLM 5110 OHMS 1% 1/4W	
R24	2100-1426	R: VAR COMP 250 OHMS 20% LIN 1/8W	
R25	0757-0422	R: FXD METFLM 909 OHMS 1% 1/8W	
R26 THRU			
R30		NOT ASSIGNED	
R31	0811-1203	R: FXD WW 68 OHMS 5% 2W	
R32 AND			
R33		NOT ASSIGNED	
R34	0812-0074	R: FXD WW 330 OHMS 5% 3W	
R35	0757-0797	R: FXD METFLM 90.9 OHMS 1% 1/2W	
R36	0757-0435	R: FXD METFLM 3920 OHMS 1% 1/8W	
R37	0757-0752	R: FXD METFLM 8250 OHMS 1% 1/4W	
R38	0757-0282	R: FXD METFLM 221 OHMS 1% 1/8W	
R39 AND			
R40		NOT ASSIGNED	
R41	0757-0430	R: FXD METFLM 2210 OHMS 1% 1/8W	
R42	0757-0893	R: FXD METFLM 51 OHMS 2% 1/8W	
R43	0757-0280	R: FXD METFLM 1000 OHMS 1% 1/8W	
R44	2100-1426	R: VAR COMP 250 OHMS 20% LIN 1/8W	
R45	0757-0274	R: FXD METFLM 1.21K OHMS 1% 1/8W	
R46 THRU			
R50		NOT ASSIGNED	

See introduction to this section

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

Reference Designation	Stock No.	Description #	Note
R51	0811-1202	R: FXD WW 50 OHMS 5% 3W	
R52	0811-1202	R: FXD WW 50 OHMS 5% 3W	
R53	0811-1204	R: FXD WW 200 OHMS 5% 5W	
R54	0812-0071	R: FXD WW 1K OHMS 5% 2W	
R55	0757-0404	R: FXD METFLM 130 OHMS 1% 1 8W	
R56	0757-0435	R: FXD METFLM 3920 OHMS 1% 1 8W	
R57	0757-0756	R: FXD METFLM 13K OHMS 1% 1/4W	
R58	0757-0282	R: FXD METFLM 221 OHMS 1% 1/4W	
R59 AND R60		NOT ASSIGNED	
R61	0757-0430	R: FXD METFLM 2210 OHMS 1% 1/8W	
R62		NOT ASSIGNED	
R63	0757-0280	R: FXD METFLM 1000 OHMS 1% 1/8W	
R64	2100-1426	R: VAR COMP 250 OHMS 20% LIN 1/8W	
R65	0757-0274	R: FXD COMP 1.21K OHMS 1% 1/8W	
R66 THRU R70		NOT ASSIGNED	
R71	0683-1325	R: FXD COMP 1300 OHMS 5% 1/4W	
R72 THRU R100		NOT ASSIGNED	
R101	0758-0006	R: FXD METFLM 10K OHMS 5% 1/2W	
R102	0757-0442	R: FXD METFLM 10K OHMS 1% 1/8W	
R103	0757-0442	R: FXD METFLM 10K OHMS 1% 1/8W	
R104	2100-0090	R: VAR COMP 2000 OHMS 30% LIN 1/3W	
R105		NOT ASSIGNED	
R106	0757-0280	R: FXD METFLM 1000 OHMS 1% 1/8W	
R107	0757-0410	R: FXD METFLM 301 OHMS 1% 1/8W	
R108	0757-0410	R: FXD METFLM 301 OHMS 1% 1/8W	
R109	0757-0394	R: FXD METFLM 51.1 OHMS 1% 1/8W	
R110	0757-0739	R: FXD METFLM 2K OHMS 1% 1/4W	
R111	0757-0739	R: FXD METFLM 2K OHMS 1% 1/4W	
R112 AND R113		NOT ASSIGNED	
R114	0757-0422	R: FXD METFLM 909 OHMS 1% 1/8W	
R115	0757-0409	R: FXD METFLM 274 OHMS 1% 1/8W	
R116 AND R117		NOT ASSIGNED	
R118	0757-0429	R: FXD METFLM 1820 OHMS 1% 1/8W	
R119	2100-1467	R: VAR COMP 1K OHM 10% 2/5W	
R120		NOT ASSIGNED	
R121	0757-0738	R: FXD METFLM 1.82K OHMS 1% 1/4W	
R122	0757-0436	R: FXD METFLM 4320 OHMS 1% 1/8W	
R123	0757-0435	R: FXD METFLM 3920 OHMS 1% 1/8W	
R124	0757-0407	R: FXD METFLM 200 OHMS 1% 1/8W	
R125	0757-0740	R: FXD METFLM 2.21K OHMS 1% 1/4W	

See introduction to this section

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

Reference Designation	hp Part No.	Description #	Note
R126 AND			
R127		NOT ASSIGNED	
R128	0757-0740	R: FXD METFLM 2.21K OHMS 1% 1/4W	
R129	0758-0070	R: FXD METFLM 1200 OHMS 5% 1/2W	
R130	0757-0740	R: FXD METFLM 2.21K OHMS 1% 1/4W	
R131 AND			
R132		NOT ASSIGNED	
R133	0757-0404	R: FXD METFLM 130 OHMS 1% 1/8W	
R134	0757-0399	R: FXD METFLM 82.5 OHMS 1% 1/8W	
R135	0757-0401	R: FXD METFLM 100 OHMS 1% 1/8W	
R136	0757-0465	R: FXD METFLM 100K OHMS 1% 1/8W	
R137 AND			
R138		NOT ASSIGNED	
R139	0757-0415	R: FXD METFLM 475 OHMS 1% 1/8W	
R140	0757-0471	R: FXD METFLM 182K OHMS 1% 1/8W	
R141 THRU			
R144		NOT ASSIGNED	
R145	0683-1505	R: FXD COMP 15 OHMS 5% 1/4W	
R146	0757-0401	R: FXD METFLM 100 OHMS 1% 1/8W	
R147	0757-0401	R: FXD METFLM 100 OHMS 1% 1/8W	
R148	0757-0454	R: FXD METFLM 33.2K OHMS 1% 1/8W	
R149 AND			
R150		NOT ASSIGNED	
R151	0757-0741	R: FXD METFLM 2430 OHMS 1% 1/4W	
R152	0757-0740	R: FXD METFLM 2.21K OHMS 1% 1/4W	
R153	0757-0407	R: FXD METFLM 200 OHMS 1% 1/8W	
R154	0757-0404	R: FXD METFLM 130 OHMS 1% 1/8W	
R155	0757-0741	R: FXD METFLM 2430 OHMS 1% 1/4W	
R156	0757-0739	R: FXD METFLM 2K OHMS 1% 1/4W	
R157	0757-0159	R: FXD METFLM 1000 OHMS 1% 1/2W	
R158 THRU			
R160		NOT ASSIGNED	
R161	0761-0010	R: FXD MET OX 1.8K OHMS 5% 1W	
R162	0757-0752	R: FXD METFLM 8250 OHMS 1% 1/4W	
R163	0757-0418	R: FXD METFLM 619 OHMS 1% 1/8W	
R164	0757-0284	R: FXD METFLM 150 OHMS 1% 1/8W	
R165	0683-2005	R: FXD COMP 20 OHMS 5% 1/4W	
R166 THRU			
R206		NOT ASSIGNED	
R207	0757-0280	R: FXD METFLM 1000 OHMS 1% 1/8W	
R208 AND			
R209		NOT ASSIGNED	
R210	0757-0743	R: FXD METFLM 3.32K OHMS 1% 1/4W	
R211	2100-1466	R: VAR COMP 1K OHM 10% LIN 1/4W	
R212		NOT ASSIGNED	

See introduction to this section

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

Reference Designation	Part No.	Description #	Note
R213	0757-0433	R: FXD MET FLM 3320 OHMS 1% 1/8W	
R214	0757-0406	R: FXD MET FLM 182 OHMS 1% 1/8W	
R215	0757-0461	R: FXD MET FLM 68.1K OHMS 1% 1/8W	
R216 AND R217		NOT ASSIGNED	
R218	0757-0433	R: FXD MET FLM 3320 OHMS 1% 1/8W	
R219 AND R220		NOT ASSIGNED	
R221	0757-0406	R: FXD MET FLM 182 OHMS 1% 1/8W	
R222	0757-0414	R: FXD MET FLM 432 OHMS 1% 1/8W	
R223	0757-0193	R: FXD MET FLM 3.32K OHMS 1% 1/2W	
R224		NOT ASSIGNED	
R225	0757-0407	R: FXD MET FLM 200 OHMS 1% 1/8W	
R226	0757-0449	R: FXD MET FLM 20K OHMS 1% 1/8W	
R227	0757-0430	R: FXD MET FLM 2210 OHMS 1% 1/8W	
R228	0757-0416	R: FXD MET FLM 511 OHMS 1% 1/8W	
R229 AND R230		NOT ASSIGNED	
R231	0757-0403	R: FXD MET FLM 121 OHMS 1% 1/8W	
R232		NOT ASSIGNED	
R233	0757-0445	R: FXD MET FLM 13K OHMS 1% 1/8W	
R234		NOT ASSIGNED	
R235	0757-0440	R: FXD MET FLM 7500 OHMS 1% 1/8W	
R236	0757-0409	R: FXD MET FLM 274 OHMS 1% 1/8W	
R237		NOT ASSIGNED	
R238	0758-0033	R: FXD MET FLM 2000 OHMS 5% 1/2W	
R239 AND R240		NOT ASSIGNED	
R241	0757-0409	R: FXD MET FLM 274 OHMS 1% 1/8W	
R242	0757-0426	R: FXD MET FLM 1300 OHMS 1% 1/8W	
R243	0757-0428	R: FXD MET FLM 1620 OHMS 1% 1/8W	
R244		NOT ASSIGNED	
R245	0757-0422	R: FXD MET FLM 909 OHMS 1% 1/8W	
R246 THRU R250		NOT ASSIGNED	
R251	0757-0407	R: FXD MET FLM 200 OHMS 1% 1/8W	
R252	0757-0428	R: FXD MET FLM 1620 OHMS 1% 1/8W	
R253	0757-0428	R: FXD MET FLM 1620 OHMS 1% 1/8W	
R254	0757-0407	R: FXD MET FLM 200 OHMS 1% 1/8W	
R255	0757-0197	R: FXD MET FLM 1500 OHMS 1% 1/2W	
R256 THRU R300		NOT ASSIGNED	
R301	0757-0743	R: FXD MET FLM 3.32K OHMS 1% 1/4W	
R302	0757-0433	R: FXD MET FLM 3320 OHMS 1% 1/8W	
R303	0757-0159	R: FXD MET FLM 1000 OHMS 1% 1/2W	
R304		NOT ASSIGNED	
R305	0757-0354	R: FXD MET FLM 3650 OHMS 1% 1/8W	
R306	0757-0433	R: FXD MET FLM 3320 OHMS 1% 1/8W	

See introduction to this section

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

Reference Designation	Part No.	Description #	Note
R307	0757-0727	R: FXD MET FLM 562 OHMS 1% 1/4W	
R308		NOT ASSIGNED	
R309	0757-0284	R: FXD MET FLM 150 OHMS 1% 1/8W	
R310		NOT ASSIGNED	
R311	2100-1466	R: VAR COMP 1K OHM 10% LIN 1/4W	
R312		NOT ASSIGNED	
R313	0757-0936	R: FXD MET FLM 3.3K OHMS 2% 1/8W	
R314	0757-0406	R: FXD MET FLM 182 OHMS 1% 1/8W	
R315	0757-0461	R: FXD MET FLM 68.1K OHMS 1% 1/8W	
R316 AND			
R317		NOT ASSIGNED	
R318	0757-0936	R: FXD MET FLM 3.3K OHMS 2% 1/8W	
R319 AND			
R320		NOT ASSIGNED	
R321	0757-0193	R: FXD MET FLM 3.32K OHMS 1% 1/2W	
R322	0757-0414	R: FXD MET FLM 432 OHMS 1% 1/8W	
R323	0757-0406	R: FXD MET FLM 182 OHMS 1% 1/8W	
R324		NOT ASSIGNED	
R325	0757-0407	R: FXD MET FLM 200 OHMS 1% 1/8W	
R326	0757-0449	R: FXD MET FLM 20K OHMS 1% 1/8W	
R327	0757-0430	R: FXD MET FLM 2210 OHMS 1% 1/8W	
R328	0757-0415	R: FXD MET FLM 475 OHMS 1% 1/8W	
R329 AND			
R330		NOT ASSIGNED	
R331	0757-0407	R: FXD MET FLM 200 OHMS 1% 1/8W	
R332 AND			
R333		NOT ASSIGNED	
R334	0757-0427	R: FXD MET FLM 1500 OHMS 1% 1/8W	
R335	0757-0407	R: FXD MET FLM 200 OHMS 1% 1/8W	
R336	0757-0427	R: FXD MET FLM 1500 OHMS 1% 1/8W	
R337	0757-0408	R: FXD MET FLM 243 OHMS 1% 1/8W	
R338	0757-0283	R: FXD MET FLM 2000 OHMS 1% 1/8W	
R339	0757-0727	R: FXD MET FLM 562 OHMS 1% 1/4W	
R340 THRU			
R342		NOT ASSIGNED	
R343	0683-2225	R: FXD COMP 2.2K OHMS 5% 1/4W	
R344 THRU			
R400		NOT ASSIGNED	
R401	0761-0039	R: FXD MET OX 680 OHMS 5% 1W	
R402 THRU			
R404		NOT ASSIGNED	
R405	0761-0039	R: FXD MET OX 680 OHMS 5% 1W	
R406	0761-0039	R: FXD MET OX 680 OHMS 5% 1W	
R407 AND			
R408		NOT ASSIGNED	
R409	0758-0028	R: FXD MET FLM 270 OHMS 5% 1/2W	
R410	0758-0083	R: FXD MET OX 68 OHMS 5% 1/2W	
R411 THRU			
R413		NOT ASSIGNED	

See introduction to this section

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

Reference Designation	Part No.	Description #	Note
R414	0758-0028	R: FXD METFLM 270 OHMS 5% 1/2W	
R415	0758-0083	R: FXD MET OX 68 OHMS 5% 1/2W	
R416 THRU R418		NOT ASSIGNED	
R419	0758-0028	R: FXD METFLM 270 OHMS 5% 1/2W	
R420	0758-0083	R: FXD MET OX 68 OHMS 5% 1/2W	
R421 THRU R423		NOT ASSIGNED	
R424	0758-0028	R: FXD METFLM 270 OHMS 5% 1/2W	
R425	0758-0083	R: FXD MET OX 68 OHMS 5% 1/2W	
R426 AND R427		NOT ASSIGNED	
R428	0758-0003	R: FXD METFLM 1000 OHMS 5% 1/2W	
R429	0727-0001	R: FXD DEPC 1.5 OHMS 2% 1/2W	
R430	0727-0001	R: FXD DEPC 1.5 OHMS 2% 1/2W	
R431 THRU R433		NOT ASSIGNED	
R434	0698-3115	R: FXD CAR FLM 100 OHMS 1% 1W	
R435	0698-3115	R: FXD CAR FLM 100 OHMS 1% 1W	
R436 THRU R440		NOT ASSIGNED	
R441	0757-0734	R: FXD METFLM 1.21K OHMS 1% 1/4W	
R442	0698-3180	R: FXD METFLM 68 OHMS 2% 2W	
R443	0761-0055	R: FXD MET OX 360 OHMS 5% 1W	
R444 AND R445		NOT ASSIGNED	
R446	0757-0407	R: FXD METFLM 200 OHMS 1% 1/8W	
R447	2100-0732	R: VAR COMP 500 OHMS 10% LIN 2-1/4W	
R448	0757-0401	R: FXD METFLM 100 OHMS 1% 1/8W	
R449	0758-0042	R: FXD METFLM 1300 OHMS 5% 1/2W	
R450		NOT ASSIGNED	
R451	0757-0801	R: FXD METFLM 150 OHMS 1% 1/2W	
R452	0757-0172	R: FXD METFLM 37.4 OHMS 1% 1/2W	
R453	0757-0715	R: FXD METFLM 150 OHMS 1% 1/4W	
R454	0757-0795	R: FXD METFLM 75 OHMS 1% 1/2W	
R455	0757-0069	R: FXD METFLM 121 OHMS 1% 1/4W	
R456	0757-0710	R: FXD METFLM 75 OHMS 1% 1/4W	
R457	0757-0067	R: FXD METFLM 61.11 OHMS 1% 1/4W	
R458	0757-0071	R: FXD METFLM 247.5 OHMS 1% 1/4W	
R459	0757-0067	R: FXD METFLM 61.11 OHMS 1% 1/4W	
S1	3103-0036	SWITCH: TOGGLE SPST (ON)	
S2	3101-0033	SWITCH: SLIDE DPDT (115/230)	
S3 THRU S100		NOT ASSIGNED	
S101	3101-0014	SWITCH: PUSHBUTTON SPDT (MANUAL)	
S102		NSR: P/O A2	

See introduction to this section

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

Reference Designation	Part No.	Description #	Note
S103 THRU			
S200		NOT ASSIGNED	
S201		NSR: P/O A3	
S202 THRU			
S300		NOT ASSIGNED	
S301		NSR: P/O A5	
S302 THRU			
S400		NOT ASSIGNED	
S401	3101-0070	SWITCH: SLIDE DPDT (PULSE POLARITY)	
S402		NSR: P/O A6	
T1	9100-0349	TRANSFORMER: POWER	
T2 THRU			
T400		NOT ASSIGNED	
T401		NSR (consists of W401 wound on toroid core)	
W1	8120-0078	ASSY: POWER CABLE (Includes P1 and P2)	
W2 THRU			
W100		NOT ASSIGNED	
W101	00222-61602	ASSY: CABLE (TRIGGER INPUT) (Includes J101)	
W102	00222-61607	ASSY: CABLE (TRIGGER OUTPUT) (Includes J102)	
W103 THRU			
W400		NOT ASSIGNED	
W401	00222-61603	ASSY: CABLE (ATTENUATOR INPUT) (P/O T401)	
W402	00222-61605	ASSY: CABLE (ATTENUATOR SHUNT)	
W403	00222-61604	ASSY: CABLE (ATTENUATOR OUTPUT) (Includes J401)	
XF1	1400-0008	HOLDER: FUSE	
XQ11	1200-0044	SOCKET: TRANSISTOR 2 PIN	
XQ12 THRU			
XQ30		NOT ASSIGNED	
XQ31	1200-0044	SOCKET: TRANSISTOR 2 PIN	
XQ32 THRU			
XQ 50		NOT ASSIGNED	
XQ51	1200-0044	SOCKET: TRANSISTOR 2 PIN	
		MISCELLANEOUS	
	186A-55B	SHIELD: COVER (A6)	
	186A-55B-1	PLATE: CLAMPING SHIELD (A6)	
	5243A-20A	BRACKET: MOUNTING FAN MOTOR	
	0370-0046	KNOB: LEVER BLACK (POLARITY)	
	0370-0077	KNOB: BLACK SKIRTED BAR (SELECTORS)	
	0370-0084	KNOB: BLACK (AMPLITUDE VERNIER)	
	0370-0150	KNOB: BLACK (RATE, DELAY, WIDTH VERNIERS)	
	1205-0011	DISSIPATOR: HEAT (For Q207, Q307, and Q432)	
	1400-0169	CLIP: TRANSISTOR (Used with Q407, Q412, Q417, and Q422)	
	1490-0030	STAND: TILT	

See introduction to this section

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

Reference Designation	℗ Part No.	Description #	Note
	3150-0037	FILTER: AIR	
	3160-0060	IMPELLER: FAN 4 INCH AXIAL	
	5000-0051	PLATE: FLUTED ADHESIVE BACK	
	5000-0734	COVER: REAR SIDE	
	5000-0735	COVER: FRONT SIDE	
	5060-0767	ASSY: FM FOOT	
	5060-0775	KIT: 5H RACK MOUNT	
	9170-0061	CORE: TOROID (P/O L1)	
	9170-0464	CORE: TOROID (P/O T401)	
	00216-21201	SINK: HEAT (For Q408, Q413, Q418, and Q423)	
	00216-24701	SPACER: MOUNTING (toroid)	
	00216-24702	SPACER: MOUNTING (Transistor Mounting Bracket)	
	00222-00101	CHASSIS: MAIN	
	00222-00201	PANEL: FRONT	
	00222-00202	PANEL: REAR	
	00222-01201	BRACKET: MOUNTING POWER TRANSISTOR	
	00222-01202	BRACKET: SUPPORT WIDTH SWITCH (REAR)	
	00222-01203	BRACKET: SUPPORT CHASSIS (FRONT)	
	00222-01204	BRACKET: SUPPORT CHASSIS (LEFT SIDE)	
	00222-04102	COVER: HANDLE RECESS	
	00222-23201	COUPLER: POT SHORT	
	00222-23202	COUPLER: POT LONG	
	00222-24101	RETAINER: TOROID (L1 and T401)	
	00222-60101	ASSY: TOP COVER	
	00222-60102	ASSY: BOTTOM COVER	
	00222-61601	ASSY: MAIN CABLE HARNESS	
	00222-62001	FRAME: SIDE CASTING	
	00222-63201	ASSY: COUPLING SWITCH (POLARITY)	

See introduction to this section

Table 6-2. Replaceable Parts

hp Part No.	Description #	Mfr.	Mfr. Part No.	TQ	
186A-55B	SHIELD: COVER (A6)	hp		1	
186A-55B-1	PLATE: CLAMPING SHIELD (A6)	hp		2	
5243A-20A	BRACKET: MOUNTING FAN MOTOR	hp		1	
0140-0081	C: FXD MICA 56 PF 1% 500VDCW	00853	RCM15E560F	2	
0140-0145	C: FXD MICA 22 PF 5% 500VDCW	04062	RDM15C220J	3	
0140-0175	C: FXD MICA 39 PF 2% 300VDCW	04062	RDM15E390G3C	4	
0140-0176	C: FXD MICA 100 PF 2% 300VDCW	04062	RDM15F101G3C	1	
0140-0191	C: FXD MICA 56 PF 5% 300VDCW	04062	RDM15E560J3C	1	
0140-0200	C: FXD MICA 390 PF 5% 300VDCW	04062	RDM15F391J3C	1	
0140-0202	C: FXD MICA 15 PF 5% 500VDCW	hp		2	
0140-0209	C: FXD MICA 5 PF 10% 500VDCW	04062	RDM15C050D5C	1	
0140-0214	C: FXD MICA 60 PF 5% 300VDCW	04062	RDM15E600J3C	1	
0140-0216	C: FXD MICA 120 PF 2% 300VDCW	04062	RDM15F121G3C	1	
0140-0225	C: FXD MICA 300 PF 1% 300VDCW	04062	RDM15F301F3C	2	
0150-0012	C: FXD CER 0.01 μf 20% 1000VDCW	56289	29C214A3	6	
0150-0084	C: FXD CER 0.1 μf -20% +80% 50VDCW	56289	33C41	1	
0150-0093	C: FXD CER 0.01 μf -20% +80% 100VDCW	91418	TA	11	
0150-0121	C: FXD CER 0.1 μf -20% +80% 50VDCW	56289	5CMOA	9	
0160-0127	C: FXD CER 1 μf 20% 25VDCW	56289	5C13	1	
0160-0155	C: FXD MY 3300 PF 10% 200VDCW	hp		1	
0160-0165	C: FXD MY 5600 PF 10% 200VDCW	hp		3	
0160-0346	C: FXD MICA 5100 PF 5% 300VDCW	hp		3	
0160-2056	C: FXD MY 0.22 μf 20% 200VDCW	56289	224P22402	3	
0160-2275	C: FXD MICA 430 PF 1% 500VDCW	hp		2	
0180-0047	C: FXD ELECT 500 μf 75VDCW	hp		4	
0180-0049	C: FXD ELECT 20 μf 50VDCW	56289	D33909	4	
0180-0050	C: FXD ELECT 40 μf -15% +100% 50VDCW	56289	D32538	2	
0180-0109	C: FXD ELECT 18 μf 100VDCW	24446	40D186F100DH4M1	1	
0180-0116	C: FXD ELECT TA 6.8 μf 10% 35VDCW	56289	150D685X9035B2	1	
0180-0117	C: FXD ELECT TA 2.7 μf 10% 35VDCW	56289	150D275X9035B2	2	
0180-1712	C: FXD ELECT TA 5.6 μf 5% 35VDCW	56289	150D565X5035B2	3	
0180-1713	C: FXD ELECT TA 0.56 μf 5% 35VDCW	56289	150D564X5035A2	3	
0180-1718	C: FXD ELECT TA 56 μf 10% 20VDCW	56289	150D566X9090S2	1	
0370-0046	KNOB: LEVER BLACK (POLARITY)	hp		1	
0370-0077	KNOB: BLACK SKIRTED BAR (SELECTORS)	hp		4	
0370-0084	KNOB: BLACK (AMPLITUDE VERNIER)	hp		1	
0370-0150	KNOB: BLACK (RATE, DELAY WIDTH VERNIERS)	hp		3	
0683-1325	R: FXD COMP 1300 OHMS 5% 1/4W	01121	CB 1325	1	
0683-1505	R: FXD COMP 15 OHMS 5% 1/4W	01121	CB 1505	1	
0683-2005	R: FXD COMP 20 OHMS 5% 1/4W	01121	CB 2005	1	
0683-2225	R: FXD COMP 2.2K OHMS 5% 1/4W	01121	GB 2225	1	
0687-3331	R: FXD COMP 33K OHMS 10% 1/2W	01121	EB 3331	1	
0698-3115	R: FXD CAR FLM 100 OHMS 1% 1W	hp		2	
0698-3180	R: FXD METFLM 68 OHMS 2% 2W	hp		1	

See introduction to this section

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

hp Part No.	Description #	Mfr.	Mfr. Part No.	TQ	
0727-0001	R: FXD DEPC 1.5 OHMS 2% 1/2W	hp		2	
0757-0067	R: FXD METFLM 61.11 OHMS 1% 1/4W	hp		2	
0757-0069	R: FXD METFLM 121 OHMS 1% 1/4W	hp		1	
0757-0071	R: FXD METFLM 247.5 OHMS 1% 1/4W	hp		1	
0757-0159	R: FXD METFLM 1000 OHMS 1% 1/2W	hp		2	
0757-0172	R: FXD METFLM 37.4 OHMS 1% 1/2W	hp		1	
0757-0193	R: FXD METFLM 3.32K OHMS 1% 1/2W	hp		2	
0757-0197	R: FXD METFLM 1500 OHMS 1% 1/2W	hp		1	
0757-0274	R: FXD METFLM 1.21K OHMS 1% 1/8W	hp		2	
0757-0280	R: FXD METFLM 1000 OHMS 1% 1/8W	hp		4	
0757-0282	R: FXD METFLM 221 OHMS 1% 1/8W	hp		3	
0757-0283	R: FXD METFLM 2000 OHMS 1% 1/8W	hp		1	
0757-0284	R: FXD METFLM 150 OHMS 1% 1/8W	hp		2	
0757-0354	R: FXD METFLM 3650 OHMS 1% 1/8W	hp		1	
0757-0394	R: FXD METFLM 51.1 OHMS 1% 1/8W	hp		1	
0757-0399	R: FXD METFLM 82.5 OHMS 1% 1/8W	hp		1	
0757-0401	R: FXD METFLM 100 OHMS 1% 1/8W	hp		4	
0757-0403	R: FXD METFLM 121 OHMS 1% 1/8W	hp		1	
0757-0404	R: FXD METFLM 130 OHMS 1% 1/8W	hp		3	
0757-0406	R: FXD METFLM 182 OHMS 1% 1/8W	hp		4	
0757-0407	R: FXD METFLM 200 OHMS 1% 1/8W	hp		9	
0757-0408	R: FXD METFLM 243 OHMS 1% 1/8W	hp		1	
0757-0409	R: FXD METFLM 274 OHMS 1% 1/8W	hp		3	
0757-0410	R: FXD METFLM 301 OHMS 1% 1/8W	hp		1	
0757-0414	R: FXD METFLM 432 OHMS 1% 1/8W	hp		2	
0757-0415	R: FXD METFLM 475 OHMS 1% 1/8W	hp		2	
0757-0416	R: FXD METFLM 511 OHMS 1% 1/8W	hp		1	
0757-0418	R: FXD METFLM 619 OHMS 1% 1/8W	hp		1	
0757-0422	R: FXD METFLM 909 OHMS 1% 1/8W	hp		3	
0757-0426	R: FXD METFLM 1300 OHMS 1% 1/8W	hp		1	
0757-0427	R: FXD METFLM 1500 OHMS 1% 1/8W	hp		2	
0757-0428	R: FXD METFLM 1620 OHMS 1% 1/8W	hp		3	
0757-0429	R: FXD METFLM 1820 OHMS 1% 1/8W	hp		1	
0757-0430	R: FXD METFLM 2210 OHMS 1% 1/8W	hp		4	
0757-0433	R: FXD METFLM 3320 OHMS 1% 1/8W	hp		4	
0757-0435	R: FXD METFLM 3920 OHMS 1% 1/8W	hp		3	
0757-0436	R: FXD METFLM 4320 OHMS 1% 1/8W	hp		1	
0757-0440	R: FXD METFLM 7500 OHMS 1% 1/8W	hp		1	
0757-0442	R: FXD METFLM 10K OHMS 1% 1/8W	hp		2	
0757-0444	R: FXD METFLM 12.1K OHMS 1% 1/8W	hp		1	
0757-0445	R: FXD METFLM 13K OHMS 1% 1/8W	hp		1	
0757-0449	R: FXD METFLM 20K OHMS 1% 1/8W	hp		2	
0757-0454	R: FXD METFLM 33.2K OHMS 1% 1/8W	hp		1	
0757-0461	R: FXD METFLM 68.1K OHMS 1% 1/8W	hp		2	
0757-0465	R: FXD METFLM 100K OHMS 1% 1/8W	hp		1	
0757-0471	R: FXD METFLM 182K OHMS 1% 1/8W	hp		1	
0757-0710	R: FXD METFLM 75 OHMS 1% 1/4W	hp		1	
0757-0715	R: FXD METFLM 150 OHMS 1% 1/4W	hp		1	

See introduction to this section

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

hp Part No.	Description #	Mfr.	Mfr. Part No.	TQ	
0757-0727	R: FXD MET FLM 562 OHMS 1% 1/4W	hp		2	
0757-0734	R: FXD MET FLM 1.21K OHMS 1% 1/4W	hp		1	
0757-0738	R: FXD MET FLM 1.82K OHMS 1% 1/4W	hp		1	
0757-0739	R: FXD MET FLM 2K OHMS 1% 1/4W	hp		3	
0757-0740	R: FXD MET FLM 2.21K OHMS 1% 1/4W	hp		4	
0757-0741	R: FXD MET FLM 2430 OHMS 1% 1/4W	hp		2	
0757-0743	R: FXD MET FLM 3.32K OHMS 1% 1/4W	hp		2	
0757-0747	R: FXD MET FLM 5110 OHMS 1% 1/4W	hp		1	
0757-0752	R: FXD MET FLM 8250 OHMS 1% 1/4W	hp		4	
0757-0756	R: FXD MET FLM 13K OHMS 1% 1/4W	hp		1	
0757-0795	R: FXD MET FLM 75 OHMS 1% 1/2W	hp		2	
0757-0797	R: FXD MET FLM 90.9 OHMS 1% 1/2W	hp		1	
0757-0801	R: FXD MET FLM 150 OHMS 1% 1/2W	hp		1	
0757-0893	R: FXD MET FLM 51 OHMS 2% 1/8W	hp		2	
0757-0936	R: FXD MET FLM 3.3K OHMS 2% 1/8W	hp		2	
0758-0003	R: FXD MET FLM 1000 OHMS 5% 1/2W	hp		1	
0758-0006	R: FXD MET FLM 10K OHMS 5% 1/2W	hp		1	
0758-0028	R: FXD MET FLM 270 OHMS 5% 1/2W	hp		4	
0758-0033	R: FXD MET FLM 2000 OHMS 5% 1/2W	hp		1	
0758-0042	R: FXD MET FLM 1300 OHMS 5% 1/2W	hp		1	
0758-0070	R: FXD MET FLM 1200 OHMS 5% 1/2W	hp		1	
0758-0083	R: FXD MET OX 68 OHMS 5% 1/2W	hp		4	
0761-0010	R: FXD MET OX 1.8K OHMS 5% 1W	hp		1	
0761-0039	R: FXD MET OX 680 OHMS 5% 1W	hp		3	
0761-0055	R: FXD MET OX 360 OHMS 5% 1W	hp		1	
0811-1201	R: FXD WW 33 OHMS 5% 2W	hp		1	
0811-1202	R: FXD WW 50 OHMS 5% 3W	hp		2	
0811-1203	R: FXD WW 68 OHMS 5% 2W	hp		1	
0811-1204	R: FXD WW 200 OHMS 5% 5W	hp		1	
0811-1206	R: FXD WW 390 OHMS 5% 2W	hp		1	
0812-0071	R: FXD WW 1K OHMS 5% 2W	hp		1	
0812-0074	R: FXD WW 330 OHMS 5% 3W	hp		1	
1200-0044	SOCKET: TRANSISTOR 2 PIN	97913	Type M7 (PB)	3	
1205-0011	DISSIPATOR: HEAT	98978	TXBF-032-025B	3	
1250-0140	CONNECTOR: BNC	hp		3	
1400-0008	HOLDER: FUSE	95915	3510-11	1	
1400-0169	CLIP: TRANSISTOR	08280	100-300-2-4	4	
1450-0048	INDICATOR: NEON RED	hp		1	
1490-0030	STAND: TILT	hp		1	
1850-0062	TRANSISTOR: GE PNP	hp		6	
1850-0098	TRANSISTOR: GE PNP	hp		3	
1850-0099	TRANSISTOR: GE 2N964 PNP	04713	2N964	7	
1853-0015	TRANSISTOR: SILICON PNP 2N3640	07263	2N3640	11	
1853-0016	TRANSISTOR: SILICON PNP	07263	2N3638	2	
1854-0003	TRANSISTOR: SILICON NPN	hp		1	
1854-0005	TRANSISTOR: SILICON NPN 2N708	07263	2N708	4	

See introduction to this section

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

hp Part No.	Description #	Mfr.	Mfr. Part No.	TQ	
1854-0019	TRANSISTOR: SILICON NPN	hp		10	
1854-0204	TRANSISTOR: SILICON NPN	hp		4	
1854-0213	TRANSISTOR: SILICON NPN 2N2538	04713	2N2538	6	
1901-0026	DIODE: SILICON	hp		4	
1901-0028	DIODE: SILICON	hp		2	
1901-0040	DIODE: SILICON	hp		13	
1901-0179	DIODE: SILICON	hp		4	
1901-0194	DIODE: SILICON	hp		3	
1902-0031	DIODE: AVALANCHE 12.7 v	hp		2	
1902-0034	DIODE: AVALANCHE 5.8 v	hp		3	
1902-0048	DIODE: AVALANCHE 6.81 v	hp		1	
1902-0064	DIODE: AVALANCHE 7.5 v	hp		2	
1902-0072	DIODE: AVALANCHE 7.87 v	hp		1	
1902-0126	DIODE: AVALANCHE 2.61 v	hp		1	
1902-0173	DIODE: AVALANCHE 9.53 v	hp		1	
1902-0184	DIODE: AVALANCHE 16.2 v	hp		2	
1902-3107	DIODE: AVALANCHE 5.76 v	hp		1	
1902-3256	DIODE: AVALANCHE 23.7 v	hp		1	
1902-3295	DIODE: AVALANCHE 33.2 v	hp		1	
1910-0016	DIODE: GE	hp		7	
2100-0090	R: VAR COMP 2000 OHMS 30% LIN 1/3W	hp		1	
2100-0732	R: VAR COMP 500 OHMS 10% LIN 2-1/4W	hp		1	
2100-1426	R: VAR COMP 250 OHMS 20% LIN 1/8W	hp		3	
2100-1466	R: VAR COMP 1K OHM 10% LIN 1/4W	hp		2	
2100-1467	R: VAR COMP 1K OHM 10% 2/5W	hp		1	
2110-0007	FUSE: 1 AMP SLOW BLOW (for 115 v oper)	75915	313001	1	
2110-0008	FUSE: 1/2 AMP SLOW BLOW (for 230 v oper)	71400	MDL 1/2	0	
3101-0014	SWITCH: PUSHBUTTON SPDT (MANUAL)	82389	4S-1106	1	
3101-0033	SWITCH: SLIDE DPDT (115/230)	42190	4633	1	
3101-0036	SWITCH: TOGGLE SPST (ON)	88140	8280K16	1	
3101-0070	SWITCH: SLIDE DPDT (PULSE POLARITY)	79727	126-B	1	
3140-0052	MOTOR: FAN SHADED POLE	hp		1	
3150-0037	FILTER: AIR	hp		1	
3160-0060	IMPELLER: FAN 4 INCH AXIAL	hp		1	
5000-0051	PLATE: FLUTED ADHESIVE BACK	hp		2	
5000-0734	COVER: REAR SIDE	hp		2	
5000-0735	COVER: FRONT SIDE	hp		2	
5060-0767	ASSEMBLY: FM FOOT	hp		5	
5060-0775	KIT: 5H RACK MOUNT	hp		1	
8120-0078	ASSEMBLY: POWER CABLE	70903	KH4147	1	
9100-0349	TRANSFORMER: POWER	hp		1	
9110-0082	FILTER: RFI LINE	56289	JN10-1012B	1	
9140-0143	COIL: RF 3.3 μh	99800	1025-32	1	
9140-0158	COIL: 1 μh	99800	1025-20	7	
9140-0170	COIL: .15 μh	78526	11503M	3	

See introduction to this section

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

Part No.	Description #	Mfr.	Mfr. Part No.	TQ	
9170-0016	INDUCTOR: BEAD	02114	56-590-65 3B	8	
9170-0029	INDUCTOR: BEAD	02114	56-590-65-4A	1	
9170-0061	CORE: TOROID	02114	K3 005 01	1	
9170-0464	CORE: TOROID	72636	CF114 "H" Material	1	
00214-21201	SINK: HEAT (For Q408, Q413, Q418. & Q423)	hp		1	
00216-24701	SPACER: MOUNTING (TOROID)	hp		2	
00216-24702	SPACER: MOUNTING (TRANSISTOR MOUNTING BRACKET)	hp		2	
00222-00101	CHASSIS: MAIN	hp		1	
00222-00201	PANEL: FRONT	hp		1	
00222-00202	PANEL: REAR	hp		1	
00222-01201	BRACKET: MOUNTING POWER TRANSISTOR	hp		1	
00222-01202	BRACKET: SUPPORT WIDTH SWITCH (REAR)	hp		1	
00222-01203	BRACKET: SUPPORT CHASSIS (FRONT)	hp		1	
00222-01204	BRACKET: SUPPORT CHASSIS (LEFT SIDE)	hp		1	
00222-04102	COVER: HANDLE RECESS	hp		2	
00222-23201	COUPLER: POT SHORT	hp		2	
00222-23202	COUPLER: POT LONG	hp		1	
00222-24101	RETAINER: TOROID	hp		4	
00222-60101	ASSEMBLY: TOP COVER	hp		1	
00222-60102	ASSEMBLY: BOTTOM COVER	hp		1	
00222-61601	ASSEMBLY: MAIN CABLE HARNESS	hp		1	
00222-61602	ASSEMBLY: CABLE (TRIGGER INPUT) (Includes J101)	hp		1	
00222-61603	ASSEMBLY: CABLE (ATTENUATOR INPUT) (P/O T401)	hp		1	
00222-61604	ASSEMBLY: CABLE (ATTENUATOR OUTPUT) (Includes J401)	hp		1	
00222-61605	ASSEMBLY: CABLE (ATTENUATOR SHUNT)	hp		1	
00222-61607	ASSEMBLY: CABLE (TRIGGER OUTPUT) (Includes J102)	hp		1	
00222-61901	ASSEMBLY: SWITCH (RATE)	hp		1	
00222-61902	ASSEMBLY: SWITCH (DELAY)	hp		1	
00222-61903	ASSEMBLY: SWITCH (WIDTH)	hp		1	
00222-62001	FRAME: SIDE CASTING	hp		2	
00222-63201	ASSEMBLY: COUPLING SWITCH (POLARITY)	hp		1	
00222-63401	ASSEMBLY: SWITCH (ATTENUATOR)	hp		1	
00222-66501	ASSEMBLY: ETCHED CKT (RATE and DELAY)	hp		1	
00222-66502	ASSEMBLY: ETCHED CKT (WIDTH and OUTPUT)	hp		1	
00222-66503	ASSEMBLY: ETCHED CKT (POWER SUPPLY)	hp		1	

See introduction to this section

Table 6-3. Code List of Manufacturers

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.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
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.
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	Ferroxcube 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.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Chicago, Ill.
04404	Dynec 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	Fxton 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.
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.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06475	Western Devices Inc.	Burbank, Calif.
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	Nuclear Corp. of America U.S. Semcor Div.	Phoenix, Arizona
06812	Tortington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Eitel-McCullough Inc.	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	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07283	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher 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	Ti-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	Microwave Electronics Corp.	Palo Alto, Calif.
11534	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	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermolloy	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 Dublier 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.
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.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	Radio Industries	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-Poineer 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	Executone, Inc.	New York, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
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	Grobet File 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.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
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	Wittek Mfg. Co.	Chicago, Ill.
66346	Revere Wollansak Div. Minn. Mining & Mft. 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, Hi-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.
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 Phillips Co., Inc.	Hicksville, N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
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	James Knights Co.	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.
76433	General Instrument Corp., Micamold Div.	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
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	Struthers-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	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.

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H4-1 Dated JULY 1965
H4-2 Dated NOV 1962

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TWX: 810-232-1532

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TWX: 910-563-3734

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TWX: 910-771-2087

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St. Louis 63144
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Eatontown
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391 Grand Avenue
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High Point 27262
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TWX: 510-926-1516

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Cleveland 44129
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TWX: 810-421-8500

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Dayton 45409
Tel: (513) 298-0351
TWX: 810-459-1925

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Portland 97201
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PENNSYLVANIA
Park Place Office Building
Camp Hill
Tel: (717) 737-6791

Monroe Complex
Moss Side Boulevard
Monroeville 15146
Tel: (412) 271-0724
TWX: 710-797-3650

144 Elizabeth Street
West Conshohocken 19428
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TWX: 910-881-2645

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TWX: 710-956-0157

WASHINGTON
11656 N.E. Eighth Street
Bellevue 98004
Tel: (206) 454-3971
TWX: 910-443-2303

FOR AREAS NOT LISTED, CONTACT:
Hewlett-Packard
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Palo Alto, California 94304
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TWX: 910-373-1267
Telex: 34-8461

CANADA

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ONTARIO
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TWX: 610-562-1952

Hewlett-Packard (Canada) Ltd.
1415 Lawrence Avenue West
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TWX: 610-492-2382

QUEBEC
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275 Hymus Boulevard
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Cable: HEWPACK Palo Alto

CENTRAL AND SOUTH AMERICA

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Buenos Aires
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BRAZIL
Ciental, Importacão e Comércio Ltda.
Rua Cleto Campelo, 44 - 5° andar
Recife

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Avenida 13 de Maio, 13-22° andar
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