OPERATING INSTRUCTIONS

Type 1394 HIGH-RATE PULSE GENERATOR

Type 1394-A, 1394-P1

Type 1394-A, 1394-P1

GENERAL RADIO COMPANY

C

INSTRUCTION MANUAL

Type 1394 HIGH-RATE PULSE GENERATOR

Form 1394-0100-A
ID 1160
September, 1966

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

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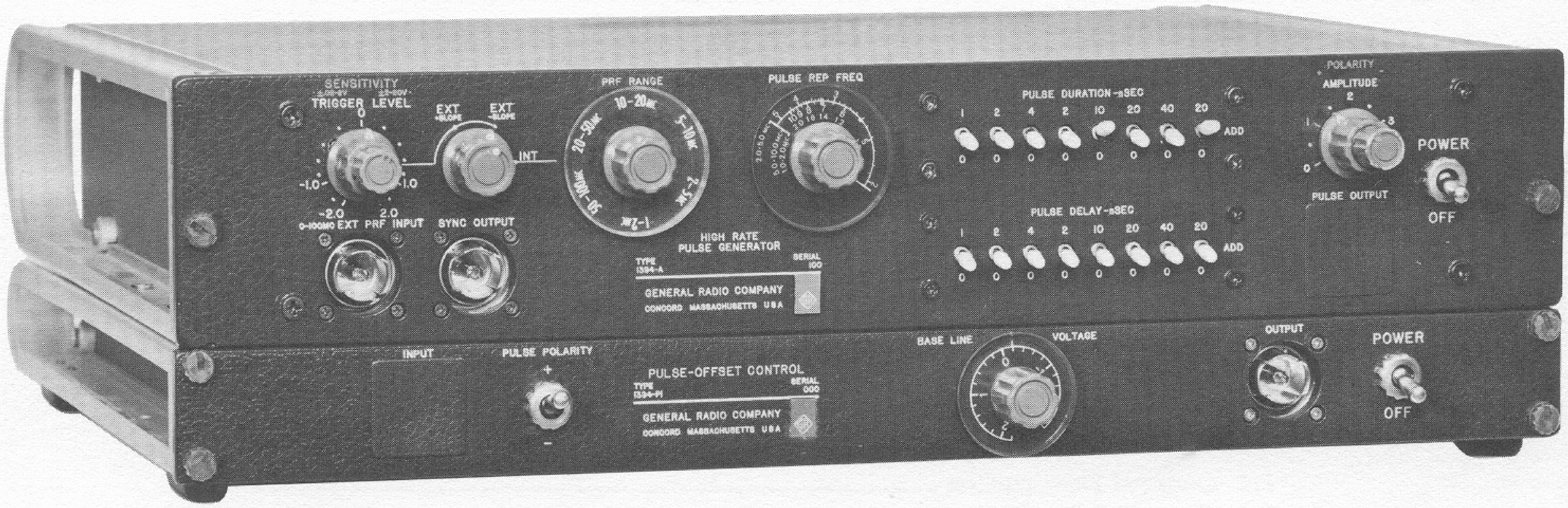


Figure 1-1. Type 1394 High-Rate Pulse Generator.

SPECIFICATIONS

Type 1394-A

PULSE REPETITION FREQUENCY
Internally Generated: 1.0 Mc/s to 100 Mc/s, six ranges in 1-2, 2-5, 5-10 sequence. Continuous coverage, ±5% of setting. Jitter, 0.1 ns, peak.
Externally Controlled: dc to 100 Mc/s. 0.4 to 4.0 V, p-to-p, amplitude range plus 10 to 1 attenuator, 1 W max. 50 Ω, choice of ± slope, and trigger level from -2 to +2 V.

SYNCHRONIZING-PULSE CHARACTERISTICS
Description: Bipolar pairs, leading edge of positive pulse is reference.
Duration: 4 ns. **Amplitude:** 250 mV, p-to-p, into 50 Ω.
Delay (between sync pulse and leading edge of output pulse): 0 to 99 ns in 1-ns steps, ±2.5% + 1-ns accuracy. No restriction on ratio delay/period. Jitter, less than 0.1 ns, peak.
Residual Delay: 35 ns, typically.

OUTPUT-PULSE CHARACTERISTICS (all specifications apply to 50-Ω load)
Duration: 4 to 99 ns in 1-ns steps, ±2.5% + 1-ns accuracy. Jitter, less than 0.1 ns, peak.
Rise and Fall Times: 2.0 ns ±20%.
Voltage: Ac coupled. 0 to 4 V in calibrated ½-volt steps. Plus or minus polarity.
Duty Ratio: Limited only by rise-plus-fall time.
Overshoot: 12% typically. **Droop:** Less than 10%

GENERAL
Power Required: 100 to 125/200 to 250 V; 50 to 400 c/s; 20 W.
Accessories Supplied: Type CAP-22 Power Cord; spare fuses.
MECHANICAL DATA: Rack-Bench Cabinet.

Model	*Width*		*Height*		*Depth**		*Net Wt*		*Ship Wt*	
	in	*mm*	*in*	*mm*	*in*	*mm*	*lb*	*kg*	*lb*	*kg*
Bench	19	485	3 15/16	100	16 ¾	425	21 ½	10	34	15
Rack	19	485	3 ½	89	14 ½	370	21 ½	10	34	15

*Behind panel.

Catalog Number	*Description*
1394-9801	**Type 1394-A High-Rate Pulse Generator,** Bench Model
1394-9811	**Type 1394-A High-Rate Pulse Generator,** Rack Model

Type 1394-PI

(All specifications apply with 50-Ω load)
BASE-LINE VOLTAGE
Amplitude: Base line continuously adjustable from −2 to + 2 V.
Accuracy: Error less than ±100 mV (without pulse) ±100 mV with pulses whose duty ratio is less than 90%.
Polarity: Positive (negative pulse) or negative (positive pulse) base line can be controlled.
DISTORTION (introduced in pulse-generator output)
Rise-Time Deterioration: <0.2 ns.
Droop Increase: <2%.
GENERAL
Power Required: 100 to 125/200 to 250 V; 50 to 400 c/s, 4.5 watts.
Accessories Supplied: Type CAP-22 Power Cord, coaxial patch cord.
Mounting: Rack-Bench Cabinet.
Dimensions: Bench, width 19, height 2⅛, depth 16¾ inches (485, 54, 425 mm); rack, width 19, height 2⅛, depth behind panel 14½ inches (485, 54, 370 mm), over-all.
Net Weight: 12¼ lb (6 kg).
Shipping Weight: 17 lb (8 kg).

Catalog Number	*Description*
1394-9611	**Type 1394-P1 Pulse-Offset Control,** Bench Model
1394-9621	**Type 1394-P1 Pulse-Offset Control,** Rack Model

General Radio Experimenter: Vol. 40, No. 7, July 1966.
U. S. Patent No. 2,548,457

SECTION **1**

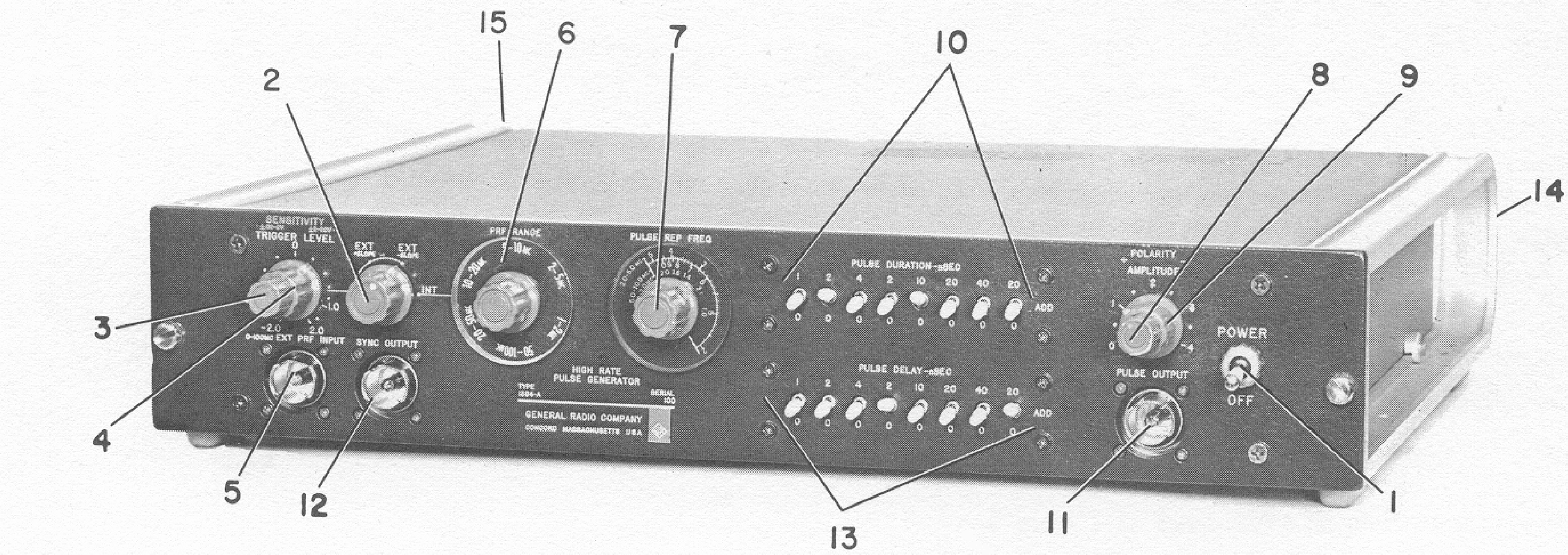
INTRODUCTION

1.1 GENERAL DESCRIPTION.

The Type 1394 High Rate Pulse Generator (Figure 1-1) is capable of producing fast-transition (2-nanosecond) pulses of up to 4 volts amplitude into 50 ohms at a repetition rate as high as 100 megacycles per second. The repetition rate may be controlled by the instrument's internal oscillator or may be determined by an external 0.4- to 40-volt signal. The TRIGGER LEVEL and SLOPE controls allow the operator to select the point on the external waveform at which the pulse will be triggered. Timing circuits employing the stable delay properties of coaxial cable afford precisely controlled pulse duration (4 to 99 nanoseconds) and pulse delay (20 to 119 nanoseconds) with no duty-cycle limitation. In addition to the main pulses, the Type 1394 produces synchronizing pulses to facilitate use of an oscilloscope with the instrument. For a detailed description of the controls and connectors on the Type 1394, refer to paragraph 1.2. An accessory instrument, the Type 1394-P1 Pulse-Offset Control, can be used to control the dc level of the otherwise ac coupled output of the High Rate Pulse Generator. The pulse generator is available in two models, a rack model, and a bench model. The pulse generator and the offset control are available together as the Type 1394-Z High Rate Pulse Generator. The combination is available in either rack or bench configuration.

1.2 CONTROLS AND CONNECTORS.

The controls and connectors in the Type 1394-A and Type 1394-P1 are shown in Figure 1-2 and described in Table 1-1.



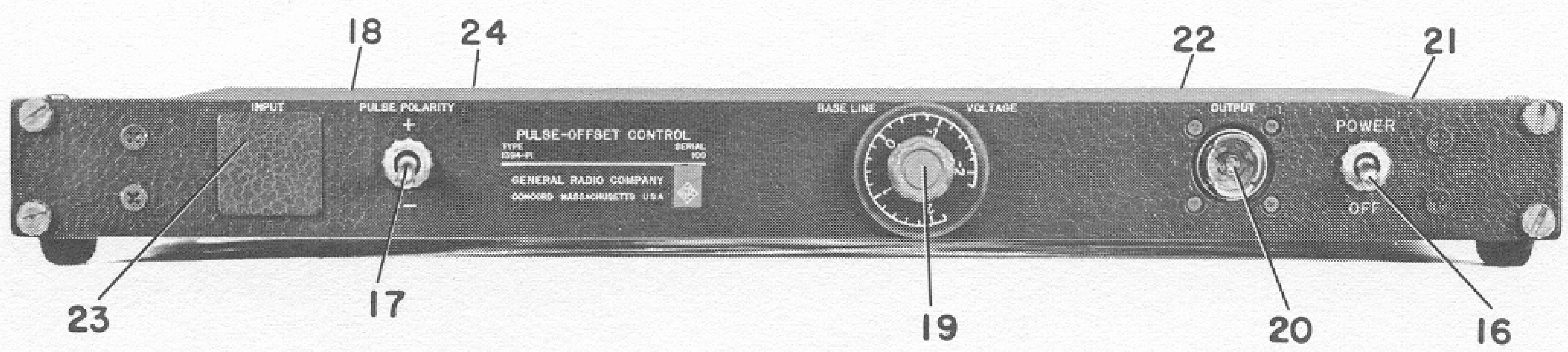


Figure 1-2.
Controls and connectors for Type 1394-A (top) and Type 1394-P1 (bottom).

Table 1-1

CONTROLS AND CONNECTORS ON THE TYPE 1394-A HIGH-RATE PULSE GENERATOR AND ON THE TYPE 1394-P1 PULSE-OFFSET CONTROL

Ref. No.	*Name*	*Description*	*Function*
1	POWER	Toggle switch	Disconnects both sides of line from power transformer when in OFF position.
2	Input Selector	3-position rotary switch	Determines whether pulse repetition frequency (PRF) is to be set by the instrument's internal oscillator or by an external signal. Determines whether pulse is triggered by positive- or negative-going (EXT + or EXT-) portion of signal.
3	SENSITIVITY	2-position rotary switch	Inserts a 10-to-1 attenuator before the input amplifier when in the ±2-20 V-position (for input signals of 4-40 V p-p). Should be in ±0.2-2.0 V position for signals of 4 V p-p or less.
4	TRIGGER LEVEL	Continuous rotary control	Determines at what voltage level of the input signal a pulse will be triggered.
5	EXT PRF INPUT	GR874 coaxial connector	For application of external trigger signal to the pulse generator. Presents a dc-coupled 50-Ω load. Outer connector grounded via chassis and third wire of power cord.
6	PRF RANGE	6-position rotary switch	Determines frequency of signal produced by internal oscillator for triggering pulses (when Input Selector (2) set to INT).
7	PULSE REP FREQ	Continuous rotary switch	Determines, with PRF RANGE switch (6), the frequency of the internal oscillator and so the output PRF (Input Selector on INT). Has three calibrated scales, each corresponding to two ranges on the PRF RANGE switch (6).

Table 1-1 (Cont)

Ref No.	*Name*	*Description*	*Function*
8	POLARITY	2-position rotary switch	Determines polarity of OUTPUT pulses.
9	AMPLITUDE	9-position rotary switch	Inserts 50-Ω attenuation pads in series with output for output amplitude of 0 to 4 V in 1/2 V steps. In 0 V position, OUTPUT connector is disconnected from generator and terminated in a 50-Ω resistor.
10	PULSE DURATION	8 toggle switches	Switches connect calibrated delay lines additively to determine pulse duration. (Refer to paragraph 4.4 for details.)
11	PULSE OUTPUT	GR874 coaxial connector	Presents ac-coupled output signal of up to 4 V into 50 Ω. Outer connector grounded via chassis and third wire of power cord.
12	SYNC OUTPUT	GR874 coaxial connector	Presents 250-mV (behind 50 Ω) bipolar synchronizing pulses. The positive-going part of the pulse occurs at a variable time (20nSEC + PULSE DELAY setting) before the output pulse.
13	PULSE DELAY	8 toggle switches	Switches connect calibrated delay lines additively to determine delay between leading edge of SYNC OUTPUT pulse and OUTPUT pulse. Delay = 20 nSEC + PULSE DELAY switch settings.
14	Power plug (Not shown)	3-terminal male connector	For application of external ac power via the 3-wire power cord supplied. Third wire connects chassis to ground.
15	EXT PRF INPUT SYNC OUTPUT PULSE OUTPUT (Not shown)	1 1/16" holes cut in back panel	For relocation of front panel connectors. Associated with each are four tapped (4-40) holes and one pop-out cover.
16	POWER	Toggle switch	Disconnects both sides of line from power transformer when in OFF position.
17	PULSE POLARITY	Toggle switch	Determines polarity of OUTPUT pulses.
18	INPUT	GR874 coaxial connector (relocated)	For application of pulses from the PULSE OUTPUT (11) terminal of the Type 1394.
19	BASELINE VOLTAGE	Continuous rotary control	Determines the voltage level from which output pulses rise or fall (PUSLE POLARITY set + or -). This level is accurately indicated by the dial calibrations when the Type 1394-P1 OUTPUT load is 50 Ω.
20	OUTPUT	GR874 coaxial connector	Presents 4-V, p-p, output pulses behind 50 Ω with a dc offset of ±2.0 V, depending on setting of BASELINE VOLTAGE control (19).
21	Power Plug	3-terminal male connector	For application of external ac power via the 3-wire power cord supplied. (Third wire connects chassis to ground.)
22	LINE	Slide switch	Connects power transformer for operation from either 100 to 125-V or 200 to 250-V line.
23 24	INPUT OUTPUT	1 1/16" hole cut in panel	For relocation of panel connectors. Associated with hole are 4 tapped (4-40) holes and one pop-out cover.

1.3 ACCESSORIES SUPPLIED.

The accessories supplied with the Type 1394-A High Rate Pulse Generator are listed in Table 1-2. Those supplied with the Type 1394-P1 Pulse-Offset Control are listed in Table 1-3. The Type 1394-Z rack or bench model, consists of the rack or bench models of the Type 1394 and the Type 1394-P1. The bench model has, in addition, a set of hardware for stack mounting the two instruments. This set appears in Table 1-4.

Table 1-2
ACCESSORIES SUPPLIED WITH THE TYPE 1394-A HIGH-RATE PULSE GENERATOR

Quantity	*Description*	*Part No.*
1	Instruction book	1394-0100
1	Power cord, 3-wire, Type CAP-22	4200-9622
4	Fuses, 0.25-A for 115-V operation	5330-0700
(2)	or 0.125-A for 230-V operation	5300-0450
For bench model:		
1	End-frame set	5310-9624
For rack model:		
1	Rack-support set	7863-9624

Table 1-3
ACCESSORIES SUPPLIED WITH THE TYPE 1394-P1 PULSE-OFFSET CONTROL

Quantity	*Description*	*Part No.*
1	Instruction book	1394-0100
1	Power cord, 3-wire, Type CAP-22	4200-9622
1	Patch cord, GR874 to GR874	0874-4220
1	Fuse, 1/16-A	5330-0300
For bench model:		
1	End-frame set	5310-9614
For rack model:		
4	Screw, Type 10-32	7270-6210

Table 1-4
STACK MOUNTING HARDWARE FOR THE TYPE 1394-Z, BENCH MODEL

Quantity	*Description*	*Part No.*
4	Spacers, 15/32" high	7660-2015
4	Screws, 10-31 x 7/8"	7080-2900
4	Lockwashers, No. 10	8040-2400
4	Nuts, No. 10	5810-3300

1.4 ACCESSORIES AVAILABLE.

The input and output impedances of both the Type 1394 High Rate Pulse Generator and the Type 1394-P1 Pulse-Offset Control are 50 Ω. The high frequencies and fast rise times of the signals produced by these instruments necessitate the use of shielded cables and matched impedances. For these reasons, the GR874 connectors and cables are recommended for use with the Type 1394 and Type 1394-P1. GR874 connectors have a characteristic impedance of 50 Ω and are mechanically sexless, i.e., any two, although identical, can be plugged together. A list of GR874 connectors and patch cords is presented in Table 1-5.

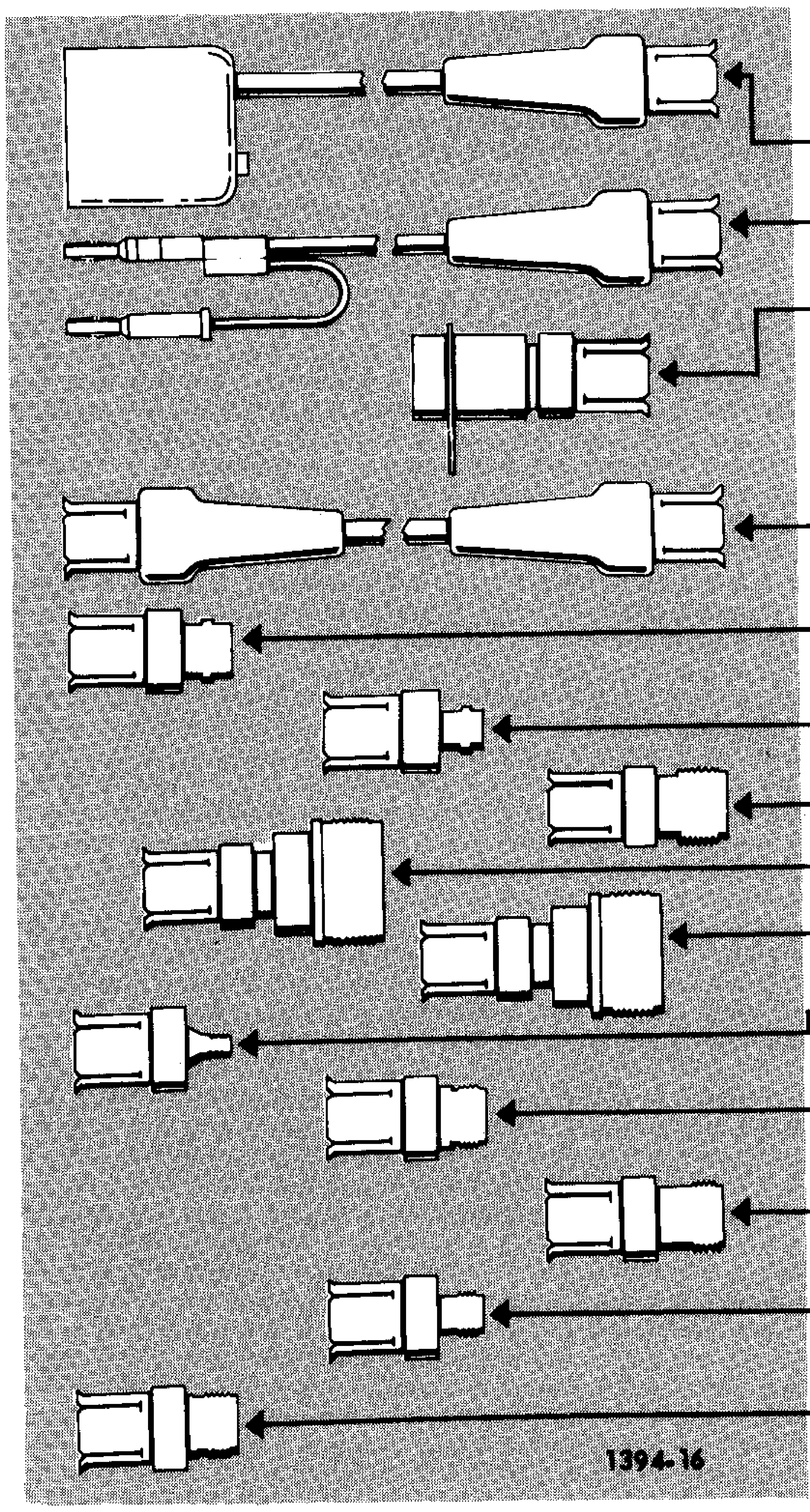


Table 1-5
GR874 PATCH CORDS AND CONNECTORS

874-R34	Coaxial patch cord, double plug to GR874, 36'' long	0874-9692
874-R33	Coaxial patch cord, two plugs to GR874, 36'' long	0874-9690
874-Q9	Adaptor, double plug to GR874	0874-9874
874-R20A	Coaxial patch cord, low-loss	0874-9680
874-R20LA	Coaxial patch cord, low-loss cable, locking connectors	0874-9681
874-R22A	Coaxial patch cord, general-purpose cable	0874-9682
874-R22LA	Coaxial patch cord, general-purpose cable, locking connectors	0874-9683
874-QBJA	Adaptor, GR874 to Type BNC	0874-9700
874-QBJL	Locking adaptor, GR874 to Type BNC	0874-9701
874-QCJA	Adaptor, GR874 to Type C	0874-9702
874-QCJL	Locking adaptor, GR874 to Type C	0874-9703
874-QHJA	Adaptor, GR874 to Type HN	0874-9704
874-QLJA	Adaptor, GR874 to Type LC	0874-9706
874-QLTJ	Adaptor, GR874 to Type LT	0874-9708
874-QMDJ	Adaptor, GR874 to Type Microdot	0874-9720
874-QMDJL	Locking adaptor, GR874 to Type Microdot	0874-9721
874-QNJA	Adaptor, GR874 to Type N	0874-9710
874-QNJL	Locking adaptor, GR874 to Type N	0874-9711
874-QSCJ	Adaptor, GR874 to Type SC	0874-9712
874-QSCJL	Locking adaptor, GR874 to Type SC	0874-9713
874-QTNJ	Adaptor, GR874 to Type TNC	0874-9716
874-QTNJL	Locking adaptor, GR874 to Type TNC	0874-9717
874-QUJ	Adaptor, GR874 to Type UHF	0874-9718
874-QUJL	Locking adaptor, GR874 to Type UHF	0874-9719

1.5 APPLICATIONS.

The High Rate Pulse Generator will find application wherever high-repetition-rate pulses are required. It is designed for testing systems that use high-speed digital circuitry, for example, computers, data-transmission systems, radar systems, and nuclear instrumentation. In such cases, the pulse generator is used primarily to simulate signals from equipment not yet designed or otherwise unavailable in order to examine the succeeding circuitry. Most of these applications involve high-speed switching, consequently, testing requires a pulse generator whose pulse transitions are at least as fast as the switching speed of the tested device.

To test digital circuits such as flip-flops, gates, and pulse amplifiers, two different methods can be employed: testing with pulse bursts or testing with a continuous pulse train such as that produced by the Type 1394. The continuous pulse train method tests every high-rep-rate characteristic, e.g., resolution, that the burst method checks plus two that it cannot test – power dissipation and self-biasing. Testing a circuit continuously will show the effects of temperature rise due to power dissipation, and the effects of self-biasing under actual operating conditions.

With the Type 1394-P1 Pulse-Offset Control the Type 1394 can be used to make continuous threshold-level tests of Schmitt circuits and other level detectors.

The High Rate Pulse Generator can also be used for component testing. The output characteristics of pulse transformers, for example, can be measured using the pulse generator as a signal source. The 1394-A/P1 combination is an excellent signal source for testing integrated circuits. In this application the calibrated controls allow quick identification of the maximum frequency of operation, minimum pulse width, etc.

SECTION **2**

INSTALLATION

2.1 LOCATION.

The Type 1394 and the Type 1394-P1 will operate in any location where ambient temperature is between 0° C (32° F) and 50° C (122° F). The instrument specifications still apply when the openings in the top and bottom of the case are blocked.

2.2 DIMENSIONS.

The dimensions of the Type 1394 are shown in Figure 2-1. Those of the Type 1394-P1 are shown in Figure 2-2.

2.3 MOUNTING.

2.3.1 BENCH/RACK CONVERSION.

The Type 1394 High Rate Pulse Generator and the Type 1394-P1 Pulse-Offset Control are supplied in two models, bench-mount and rack-mount. Either model of the Type 1394 can be converted to the other by the installation of a simple conversion set (Table 2-1). The rack mounted Type 1394-P1 can be converted to the bench mounted model with a conversion set (Table 2-1), and, since the rack model is just the instrument itself,

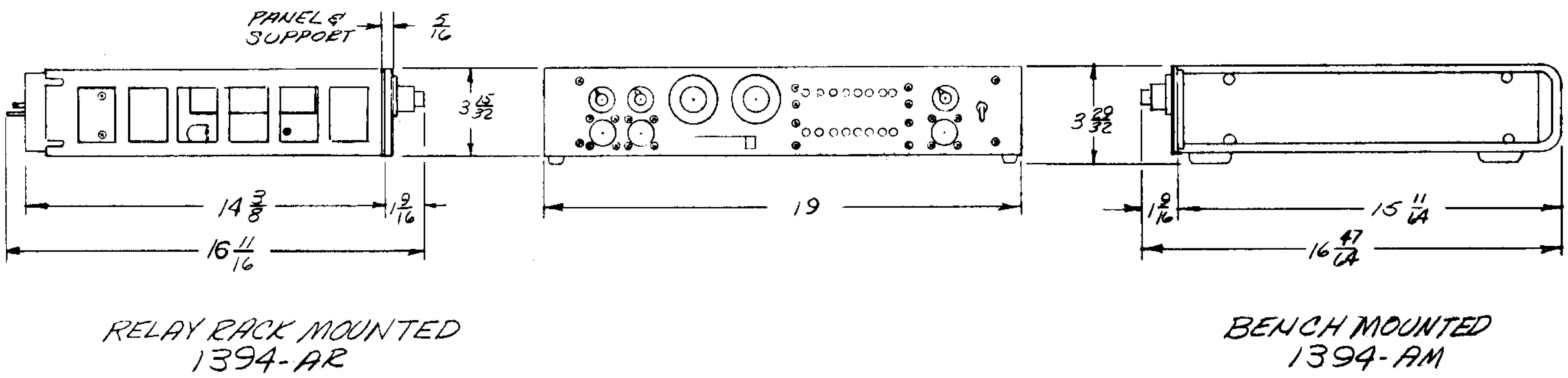


Figure 2-1. Dimensions of the Type 1394-A High-Rate Pulse Generator.

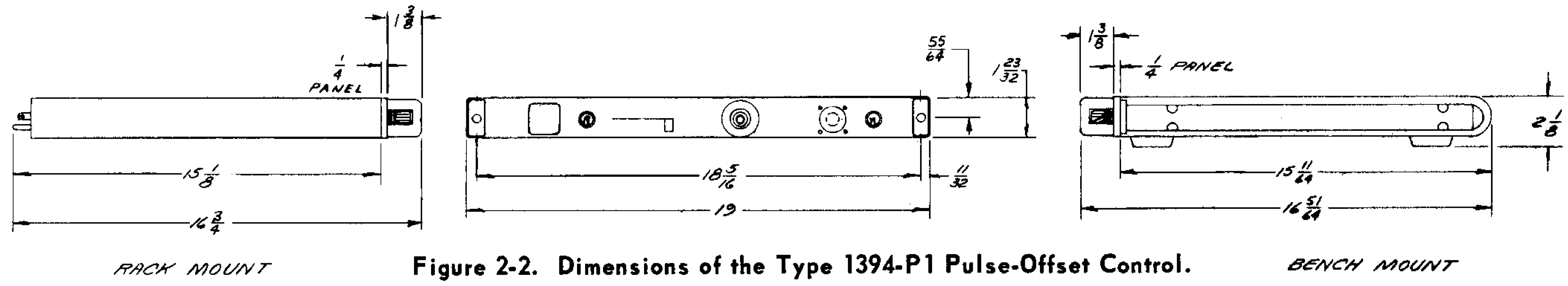


Figure 2-2. Dimensions of the Type 1394-P1 Pulse-Offset Control.

Table 2-1
CONVERSION SETS

Model	*Use*	*Conversion Set*
Type 1394 (bench)	For bench mounting and stack mounting	7863-9624 rack support set, converts bench model to rack model
Type 1394 (rack)	For rack mounting in a standard 19-inch relay	5310-9624 end frame set, converts rack model to bench model
Type 1394-P1 (rack)	For rack mounting in a standard 19-inch relay	5310-9614 end frame set, converts rack model to bench model
Type 1394-Z (rack)	For rack mounting in a standard 19-inch relay	5310-9624 and 5310-9614 end frame sets plus stack mounting hardware (see Table 1-3), converts rack model to bench model

held in the rack by 4 front panel screws, no conversion set is necessary.

2.3.2 BENCH MOUNTING (Figure 2-3).

The bench model of the Type 1394 or Type 1394-P1 normally rests on four rubber feet on top of a bench or shelf. Holes are provided in each end frame, however, to allow it to be mounted permanently over or under a bench or shelf.

Either the chassis or the cabinet of the bench model can be withdrawn independently. To remove the chassis and leave the cabinet mounted, loosen the two (four for the Type 1394-P1) panel screws (B) and the two shipping screws (F), and slide the instrument forward out of the cabinet. To remove the cabinet and leave the chassis mounted, remove the eight clamps and screws (C) and the shipping screws (F) and pull the cabinet back off the chassis from the rear of the instrument.

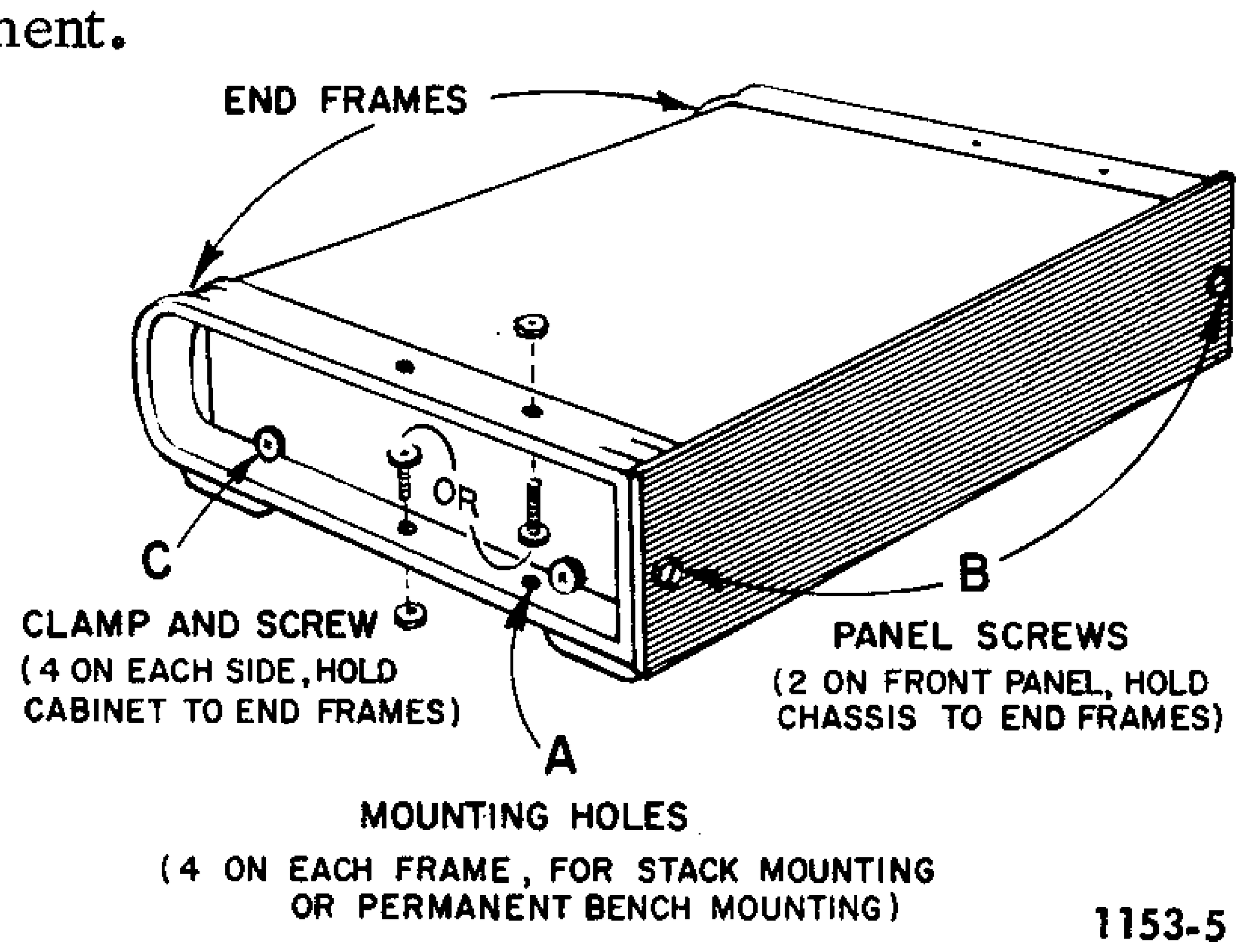


Figure 2-3. Bench mounting the Type 1394-A.

2.3.3 STACK MOUNTING (Figure 2-4).

The pulse generator, bench model, can be permanently assembled with another rack/bench instrument, such as the Type 1394-P1, bench model. This assembly is performed as follows:

a. Place the pulse generator above or below the other instrument as desired.

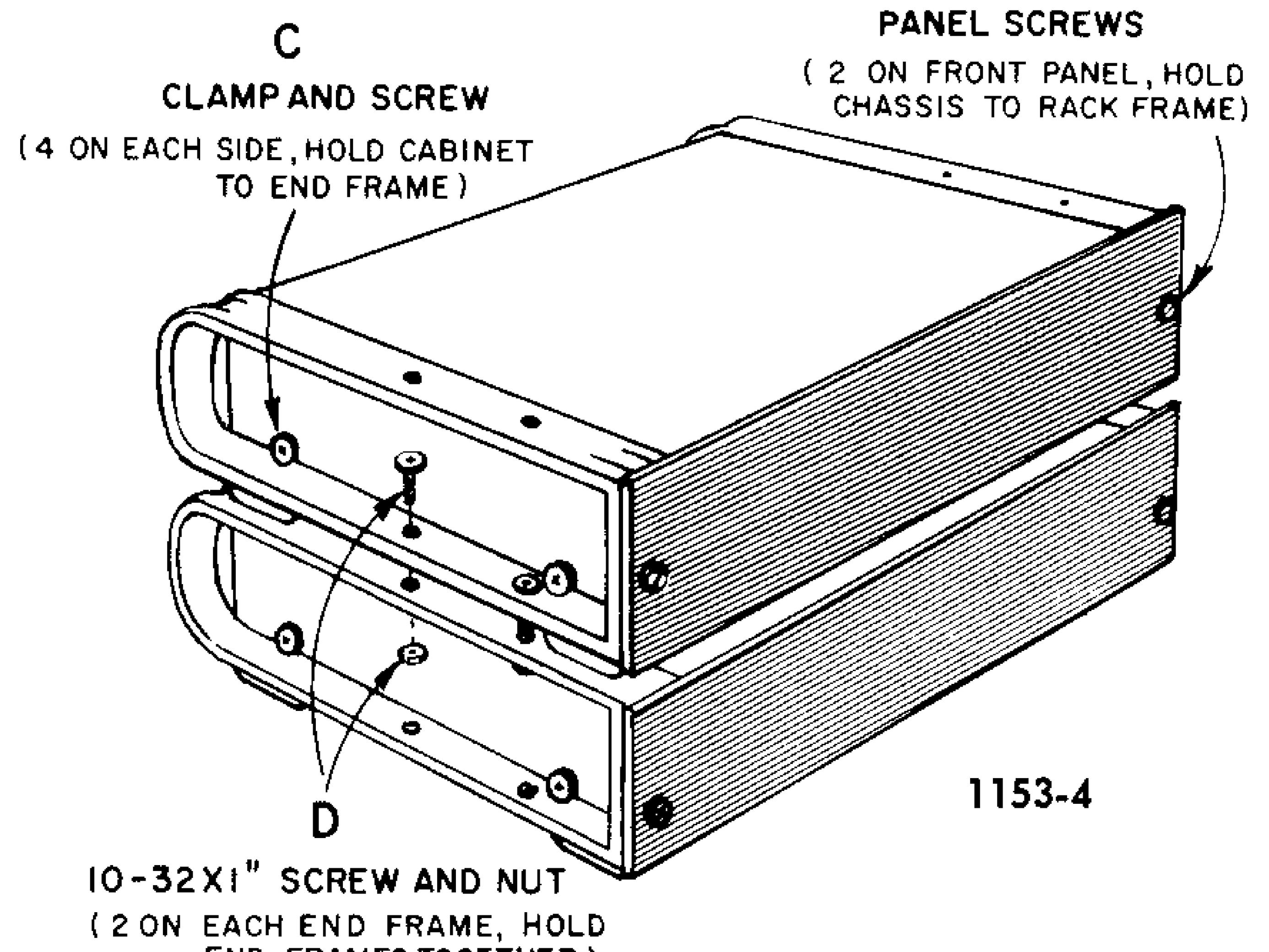


Figure 2-4. Stack mounting.

b. Place spacers between the end frames, insert 10-32 screws (D) through the end frames and spacers, install lock washers and nuts, and tighten.

This type of mounting permits the chassis of each instrument to be withdrawn independently. To remove the chassis, loosen the two (or four) panel screws (B), remove the two shipping screws (F), and slide the instrument forward out of the cabinet.

2.3.4 RACK MOUNTING (Figure 2-5).

To install the pulse generator in a relay rack, proceed as follows:

a. Attach each support bracket to the rack with two 10-32 binder-head screws (E). Use the inside holes on the brackets. Face the bracket lips in.

b. Slide the instrument onto the brackets as far as it will go.

c. Insert the two panel screws with attached washers (B) through the front panel and support brackets and screw then into the rack.

d. At the rear of the instrument remove the two 10-32 binder-head shipping screws that hold the cabinet to the chassis. These are used only for shipment and

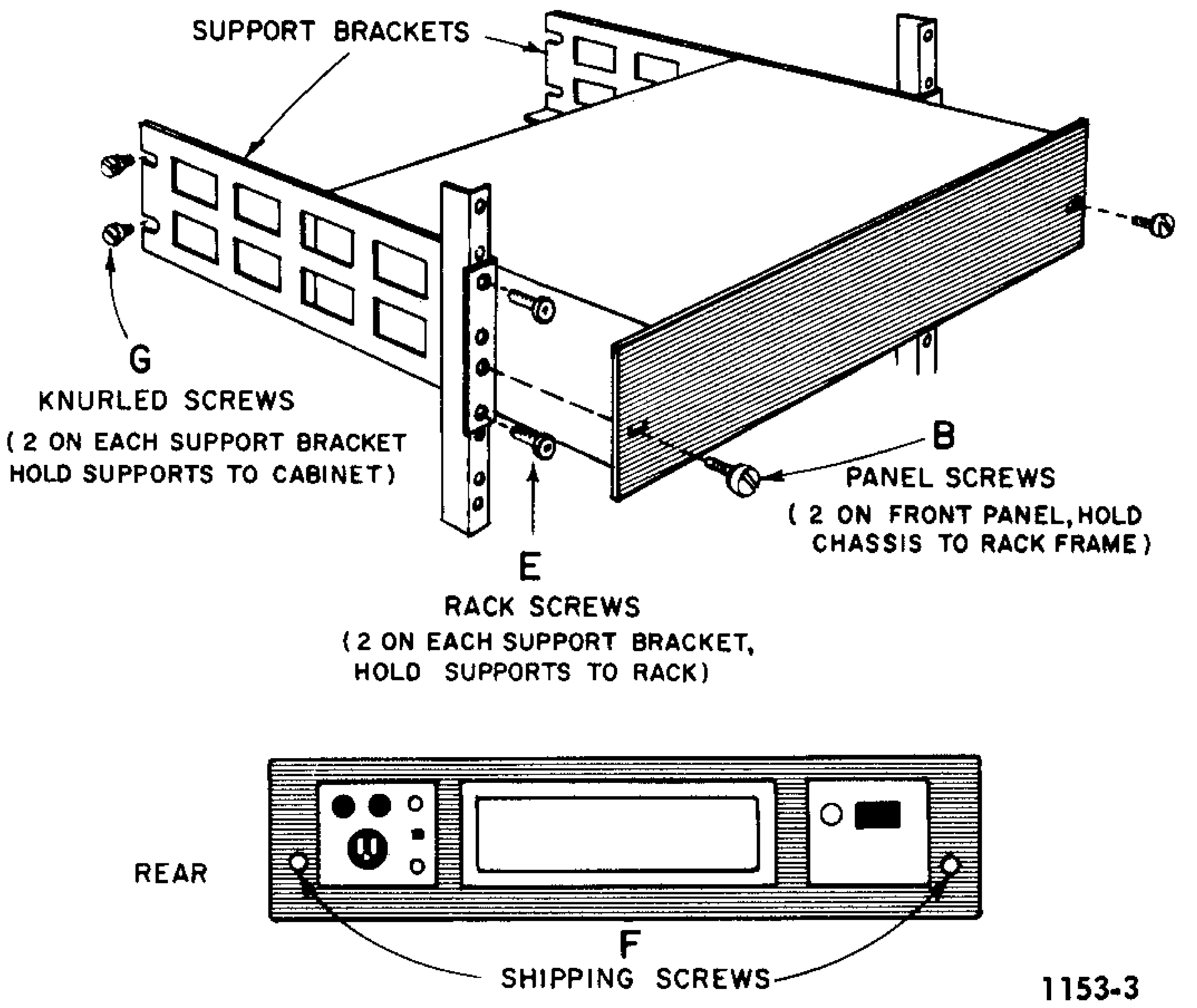


Figure 2-5. Rack mounting the Type 1394-A.

may be discarded. Two of the four 10-32 knurled screws (G) can be used to secure the cabinet to the chassis, if necessary, for subsequent reshipments.

e. Insert the four knurled screws (G) through the slots in the rear of the support brackets and screw them into the cabinet.

This type of mounting permits either the cabinet or the chassis to be withdrawn independently. To remove the chassis and leave the cabinet mounted, loosen the four panel screws (B) and slide the instrument forward out of the rack. To remove the cabinet and leave the chassis mounted, remove the four knurled screws (G) and pull the cabinet back off the chassis from the rear of the rack.

To install the Pulse-Offset Control in a relay rack proceed as follows:

a. Remove the two end frames, if attached, retaining the four panel screws.

b. Attach the instrument to the rack using the four panel screws removed in step a.

This type of mounting permits the cabinet to be withdrawn while the chassis remains in the relay rack. To do this, remove the two shipping screws holding the cabinet to the chassis at the rear of the instrument, and slide the cabinet back off the chassis from the rear of the rack.

2.4 INTERCONNECTIONS.

The three GR874 coaxial connectors on the front panel of the Type 1394 may be relocated at the rear of the instrument for convenient, semi-permanent interconnection of input or output from the back of one instrument to another. This will prove handy in relay-rack installations and in the permanent attachment of the Type 1394-P1 Pulse-Offset Control to the pulse generator. To perform the relocation:

a. Remove the instrument from its cover by removing the two Phillips screws on the back and sliding the cover off.

b. Remove the connector to be moved from the front panel by unscrewing the four small Phillips screws around it.

c. Snap the gray cover plate out of the appropriate labelled space on the back of the instrument, insert the connector, and fasten it in with the four small screws taken from the front panel.

d. Snap the cover plate into the vacated space on the front panel and replace the cover on the instrument.

The two connectors on the front panel of the Type 1394-P1 Pulse-Offset Control can be relocated in the rear of the instrument in the same way as can those of the pulse generator. Figure 2-6 shows the interconnections of the rack mounted Type 1394 and 1394-P1 with the connectors relocated in this manner.

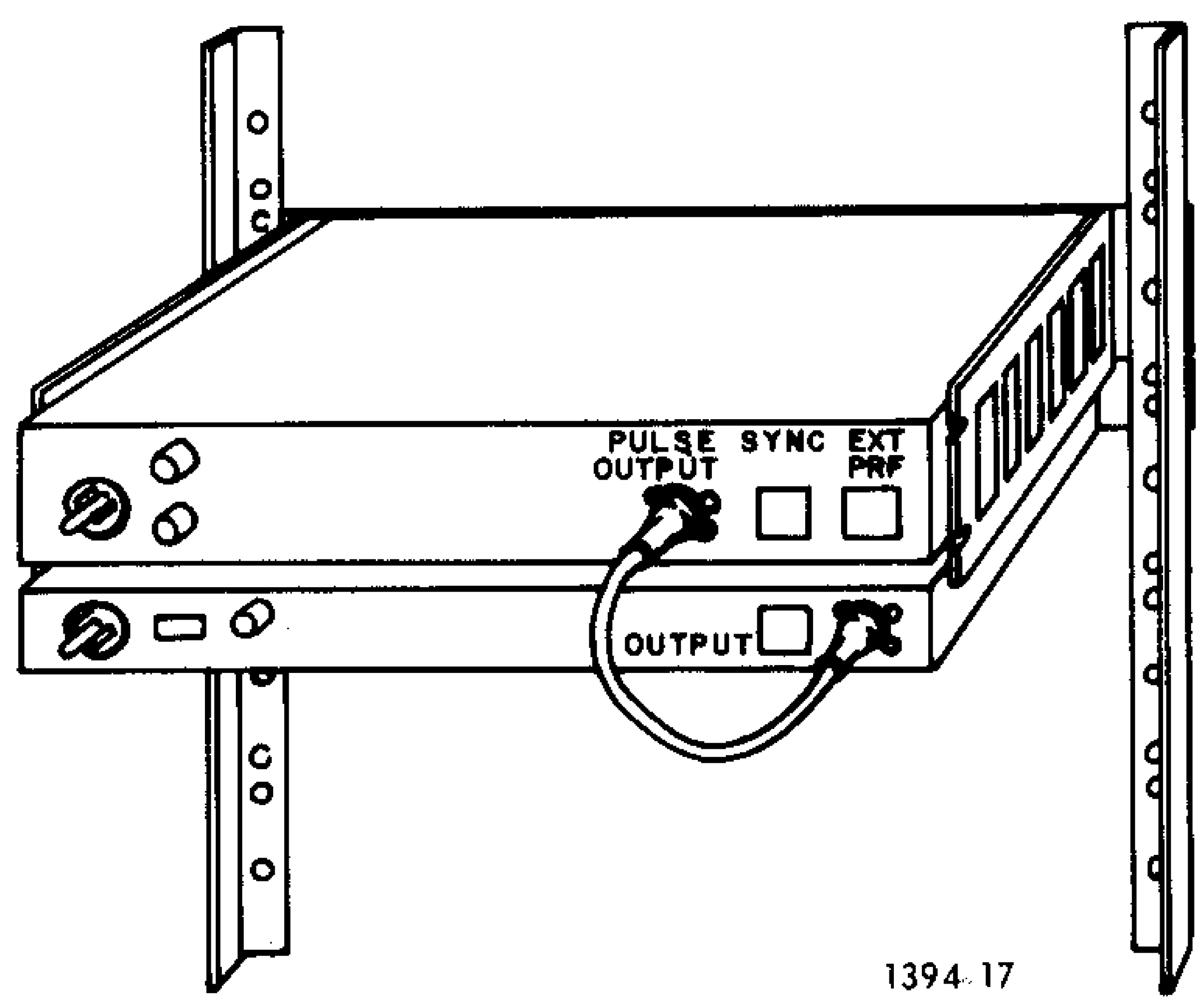


Figure 2-6. Rear panel view of the Type 1394-A and Type 1394-P1 rack mounted.

2.5 CONNECTION TO POWER SOURCE.

2.5.1 THE HIGH RATE PULSE GENERATOR.

Connect the Type 1394 to a source of power as indicated by the legend at the power-input socket at the rear of the instrument, using the three-wire power cord provided. The third wire grounds the instrument frame and thereby the outer conductor of the coaxial connectors. While normally supplied for 115-volt operation, the power transformer can be reconnected for 220- and 230-volt service (see schematic diagram, Figure 5-6). When changing connections, be sure to replace line fuses with those for the new input voltage (refer to the Parts List). Measures should be taken so that the legend indicates the new voltage. New name-plates may be ordered from General Radio (Type 5590-0500 for 115 volts, Type 5590-1688 for 220 volts, and Type 5590-1664 for 230 volts).

2.5.2 THE PULSE-OFFSET CONTROL.

Set the slide switch near the power input plug at the rear of the Type 1394-P1 to indicate the ac voltage of the power source employed (this switch automatically connects the transformer wiring for the indicated voltage input). Connect the instrument to the power source with the three-wire cord provided. The third wire grounds the instrument frame and outer part of coaxial connectors.

SECTION **3**

OPERATING PROCEDURE

3.1 THE TYPE 1394 HIGH-RATE PULSE GENERATOR.

INPUT

1. Flip the POWER switch to the "on" position (up). The pilot lamp should light.

2. For externally generated pulse repetition frequency (PRF):

a. Set the SENSITIVITY switch to the expected input signal-level range.

b. Set the Input Selector switch to EXT + SLOPE or EXT - SLOPE, depending on which part of the input waveform is to trigger the output pulse.

c. Set the TRIGGER LEVEL control to 0.

d. Connect the external signal source to the PRF INPUT connector of the pulse generator via a shielded cable. The minimum input voltage for proper operation is 0.4 volts, peak-to-peak. The input impedance of the Type 1394 is 50 Ω. Power input should not exceed 1/4 watt.

e. Adjust the TRIGGER LEVEL control to trigger the pulses at the desired point on the input signal while monitoring the signals with an oscilloscope, if necessary.

3. For internally generated pulse repetition frequency (PRF):

a. Set the Input Selector switch to INT.

b. Set the PRF RANGE switch to the desired frequency range.

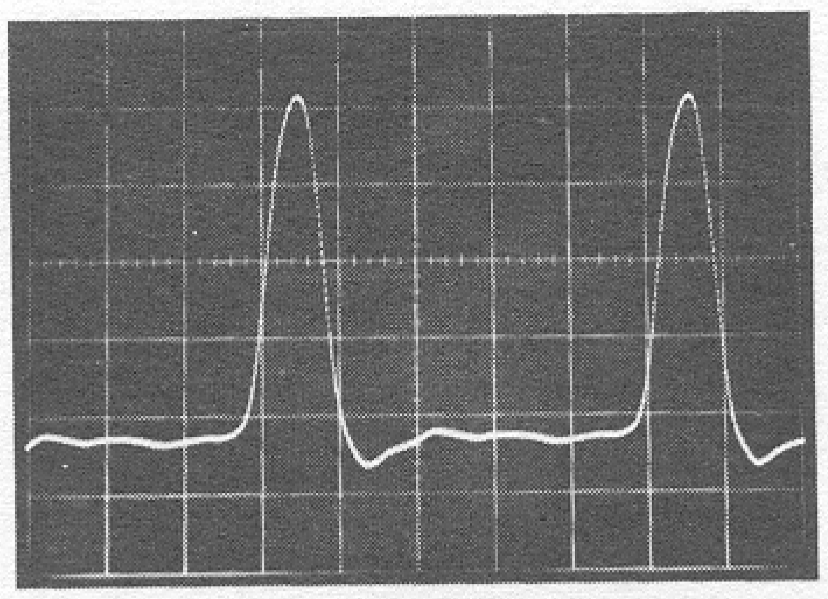
c. Adjust the PULSE REP FREQ dial for the exact output frequency required. Use the scale marked 2.0-5.0 MC (the outer calibration marks) for RANGE settings of 2-5 MC and 20-50 MC; use the scale marked 5.0-10.0 MC (the calibration marks inside the line) for RANGE settings of 5-10 MC and 50-100 MC; use the scale marked 1.0-2.0 MC (the calibration marks inside the line and the innermost numbers) for RANGE settings of 1-2 MC and 10-20 MC.

OUTPUT

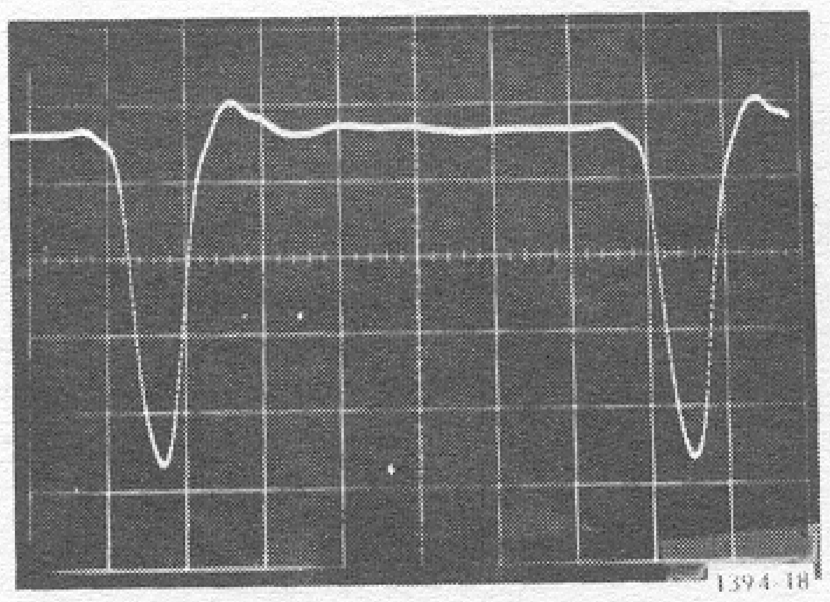
1. Set the POLARITY switch to the polarity desired for the output pulses.

2. Flip all the PULSE DURATION toggle switches to the 0 (down) position.
Then flip up as many switches as required for the duration of the output pulses. For example, if a 77 millisecond pulse duration is required, flip up each of the switches labelled 40, 20, 10, 4, 2, and 1. The brevity of extremely short pulses is limited to 4 ns by the transition times of the pulse generator output stage, which are about 2 ns.

Take care not to set the pulse duration at a value greater than the period T of the pulse (1/PRF): otherwise, the output pulse duration will not correspond to the set value. For example, if the duration of pulses having a repetition rate of 40 MHz (T = 25 ns) is set to 30 ns, an output signal with a pulse duration of around 21 ns results, and the apparent polarity of the pulses is reversed (see Figure 3-1).



Duration = 30 ns
Period = 26 ns
1V/div
5 ns/div



Duration = 30 ns
Period = 34 ns
1V/div
5 ns/div

Figure 3-1. The result of setting the PRF so that the period (1/PRF) is shorter than the setting of the PULSE DURATION switches.

(top) Positive (POLARITY set +) output pulse with period (26 ns) 4 ns less than duration (30 ns).

(bottom) Positive (POLARITY set +) output pulse with period (34 ns) 4 ns greater than duration (30 ns).

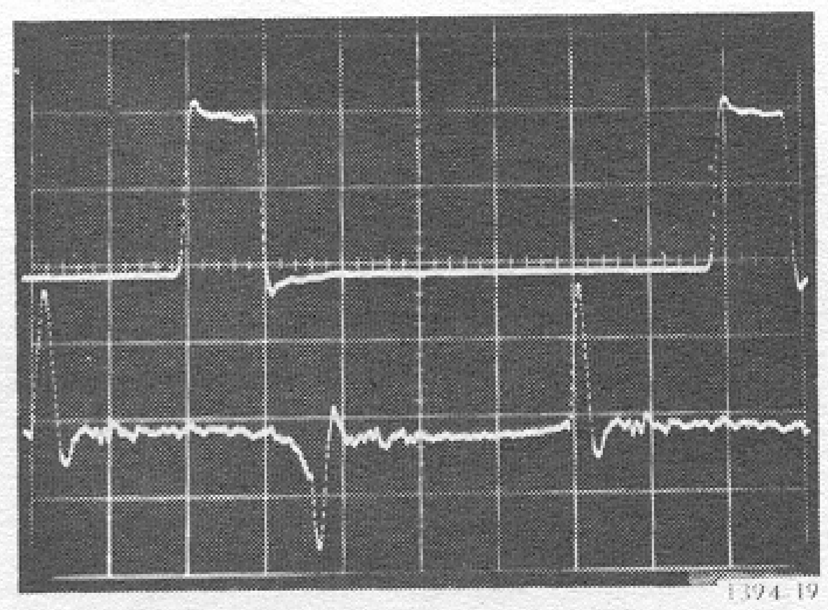
3. Adjust the AMPLITUDE control for the desired output voltage. Peak output amplitude (in volts) will correspond with the indicated setting of the control when the output signal is applied to a 50-Ω load.

4. Connect the OUTPUT connector of the pulse generator to the input of the device under test via a shielded cable. For best results, the impedance presented by the device should be 50 Ω. Optimum cable length will be 3 feet or more. If unwanted reflections occur at the pulse generator output, a change of cable length may be advisable. If the output of the pulse generator is applied to a device whose input impedance does not match the 50-ohm source impedance of the generator, the reflections caused by the mismatch impedance will be progressively reduced as the attenuation is increased. The pulse output of the Type 1394 is transformer-coupled, so the output signal it produces has no dc component, and the pulses have less than 10% rampoff. If the duration or prf (that is, the duty ratio) changes, the baseline voltage changes.

SYNC OUTPUT

1. Connect the SYNC OUTPUT connector of the pulse generator to the sync input of an oscilloscope or to the input of a counter, etc. via a shielded cable. A typical sync pulse is shown in Figure 3-2.

2. Flip all the PULSE DELAY toggle switches to 0 (down). Flip up as many switches as needed to add up to the desired delay between the leading edge (positive-going part) of the SYNC OUTPUT pulse and the start of the pulse at the PULSE OUTPUT connector. For example, if the required delay is 93 ns, flip up one each of the switched marked 40, 10, 2, and 1, and the two switches marked 20.



Output pulse @ 2V/div
Delay = 0
SYNC pulse @ 50mV/div
Sweep = 20 ns/div
Duration = 20 ns

Figure 3-2. Output of Type 1394 at 7 Mc/s.

3.2 THE TYPE 1394-P1 PULSE-OFFSET CONTROL.

1. Flip the POWER switch to the "on" position (up). The pilot lamp should light.

2. Set the POLARITY switch to the polarity indicated by the POLARITY switch on the pulse generator.

3. Connect the OUTPUT connector of the pulse generator to the INPUT connector of the Type 1394-P1 using the patch cord provided.

4. Set the BASE LINE VOLTAGE control to the desired base line voltage (the voltage from which the positive pulses rise and the negative pulses fall). When the AMPLITUDE control of the pulse generator is set to 4 and the BASE LINE VOLTAGE control of the Type 1394-P1 is set to 1, for example, the pulses of the OUTPUT of the Type 1394-P1 will start from +1.0 V, rise to +5.0 V, and fall back to +1.0 V.

5. Connect the OUTPUT connector of the Type 1394-P1 to the input of the device under test via a shielded cable.

SECTION **4**

PRINCIPLES OF OPERATION

4.1 GENERAL.

Figure 4-1 is a simplified block diagram of the Type 1394 High Rate Pulse Generator. The complete schematic diagrams of all component sections are in Section 5. The pulse repetition rate of the instrument is obtained from an internal oscillator or from an external signal source. In either case, the signal is formed by the input circuits into bipolar pulse pairs, such as that in Figure 3-2. The leading edge of the positive part of the pulse corresponds either to the zero crossing of the internal oscillator or to the selected trigger point on the external waveform.

The positive- and negative-going spikes appear at the SYNC OUTPUT connector and serve as a reference for the time delay generated in the delay-cable unit. The bipolar pulse pairs are delayed in the delay-cable unit by integer steps from 1 to 99 ns.

The high-frequency content of the trigger signals is attenuated in passing through the delay cable unit and is regenerated by a tunnel-diode pulse-regeneration circuit.

Pulse duration is established by routing the delayed positive- and negative-going trigger directly through

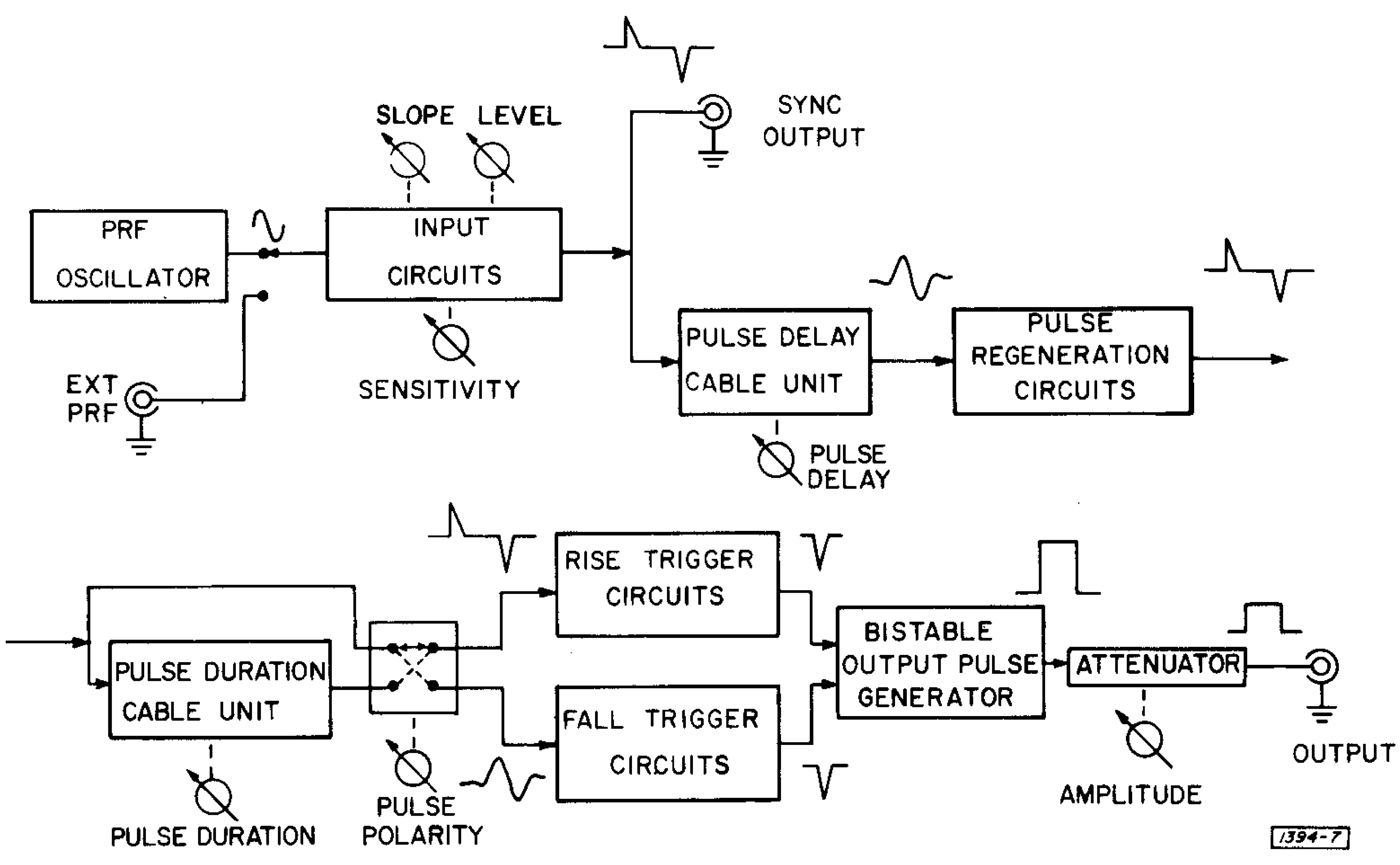


Figure 4-1. Simplified block diagram of the Type 1394-A High Rate Pulse Generator.

one signal path and through a delay-cable unit in another signal path. The direct and delayed trigger signals are then fed to separate regeneration and clipping circuits.

The POLARITY switch determines whether the direct trigger signal is applied to the rise pulse regeneration and clipping circuit or to the fall pulse circuit. If, for example, the POLARITY switch is set to +, the direct trigger is applied to the rise circuit and the delayed trigger to the fall circuit. The output from each regeneration circuit is a negative-going spike, one spike being delayed from the other by the delay introduced by the PULSE DURATION cable unit. These signals are applied to a bistable output amplifier which generates the output pulse, the duration of which is determined by the delay between spikes.

If the earlier-occuring signal comes from the rise regeneration-and-clipping circuit, the output rises from its quiescent voltage level by a positive increment and returns to this quiescent value when the delayed pulse from the fall circuit is applied. If the earlier signal comes from the fall regeneration and clipping circuit, the output first drops by a negative increment and then returns to its quiescent level on reception of a pulse from the rise circuit. Figure 4-2 shows the relative position in time of the various signals throughout the pulse generator.

The equivalent circuit of the output amplifier and attenuator is shown in Figure 4-3. This circuit can be considered an 80-mA current source shunted by a 60-μH inductance. Since the pulse is transmitted via 50-ohm coaxial line, it is desirable to terminate in a 50-ohm load in order to prevent reflections.

The AMPLITUDE switch inserts 50-ohm attenuation pads, which cause the output impedance to approach 50 ohms as the amplitude is decreased.

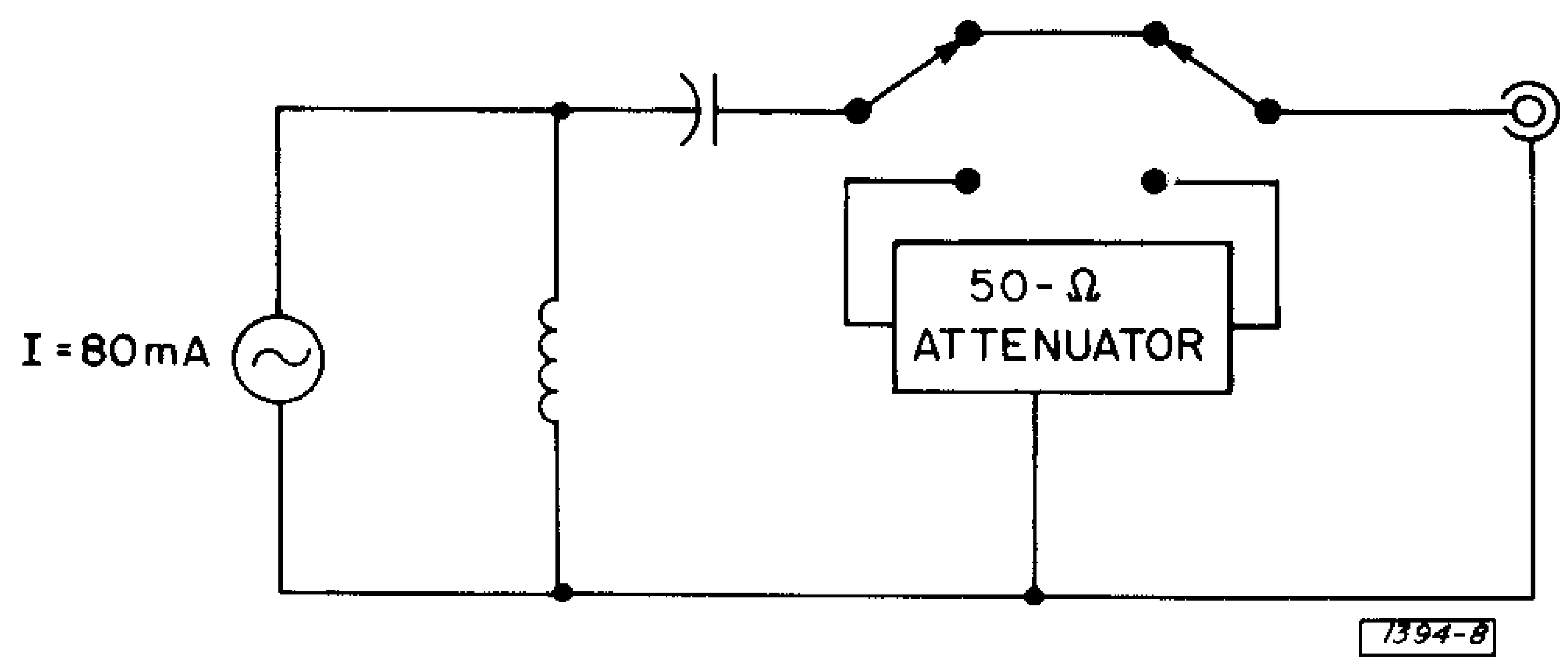


Figure 4-3. Equivalent circuit of the output amplifier and attenuator.

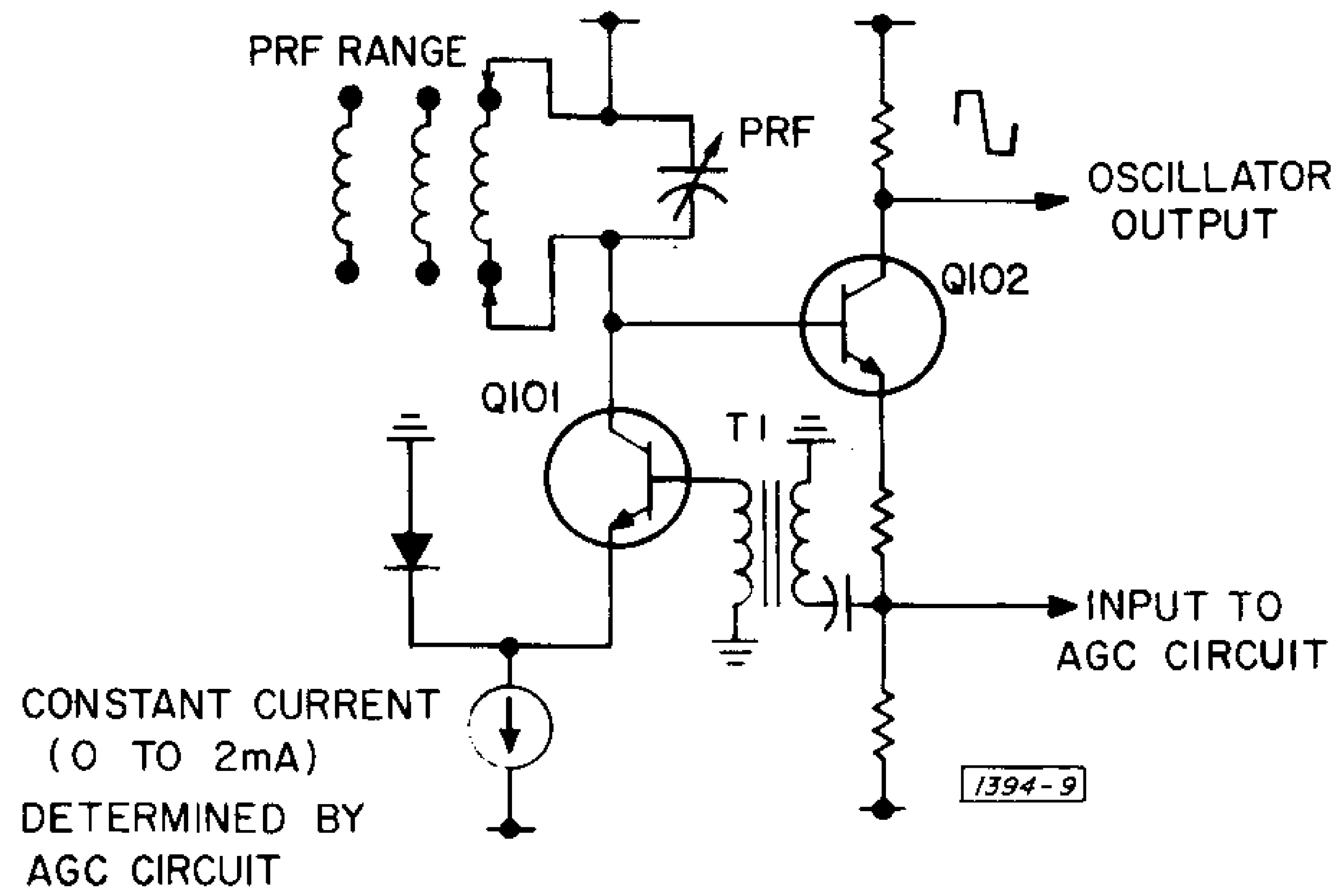


Figure 4-4. Basic PRF oscillator circuit.

4.2 THE PRF OSCILLATOR AND AUTOMATIC GAIN CONTROL CIRCUIT.

The prf generator of the Type 1394 is an L-C feedback oscillator, the simplified circuit for which appears in Figure 4-4. The frequency of oscillation is the resonant frequency of the tank circuit, which consists of an inductor switched in by the PRF RANGE switch and a variable capacitor, the PRF control. The input for the pulse generator is taken from the collector of Q102, while input for the automatic gain control (AGC) circuit is taken from the emitter of Q102. The AGC circuit controls the amount of current flowing through the feedback amplifier Q101 of the oscillator circuit, which sets the amplitude of the square-wave current-drive to the L-C circuit, and hence the amplitude of the oscillation. A large sinusoidal voltage swing at the base of transistor Q101 causes the current-source current to switch between Q101 and diode CR102, thus producing square-wave collector-current excitation of the tuned circuit, which tunes out all sinusoidal voltage components except the fundamental. This component is amplified by Q102 and applied through phase-inverting transformer T101 to the base of Q101 to complete the regenerative loop.

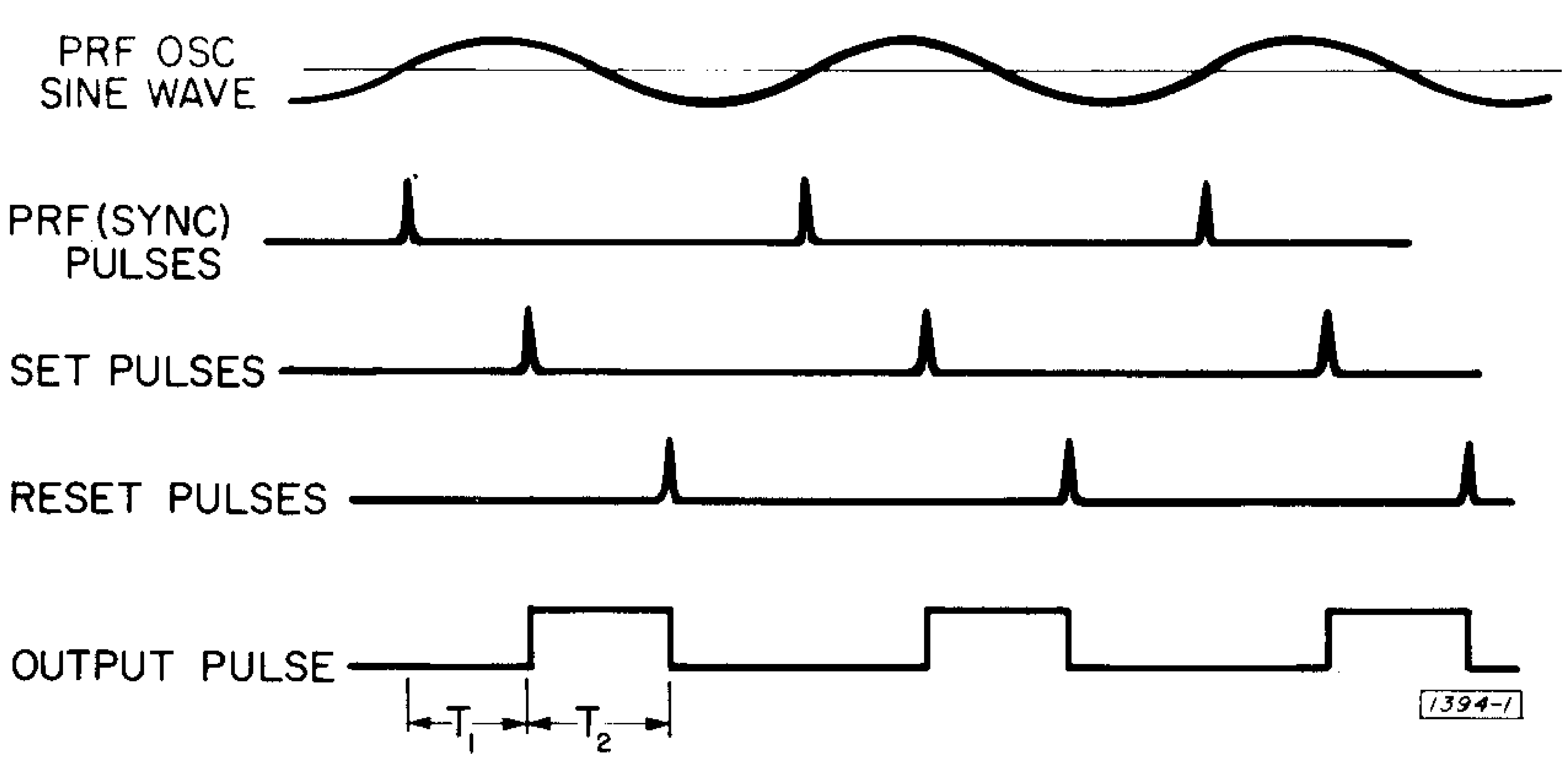


Figure 4-2. Idealized waveforms of the Type 1394-A.

The AGC circuit (see Figure 4-5) is a differential amplifier, one input of which is a fixed dc voltage; the other input is the rectified output of the oscillator. When the oscillator amplitude is excessive, this input voltage exceeds the dc reference, and the current through the amplifier shifts from Q103 to Q104. A reduced current through Q101 results, and the amplitude of oscillation is cut. If the oscillator output amplitude is too low, this process is reversed, and increased gain of Q101 results.

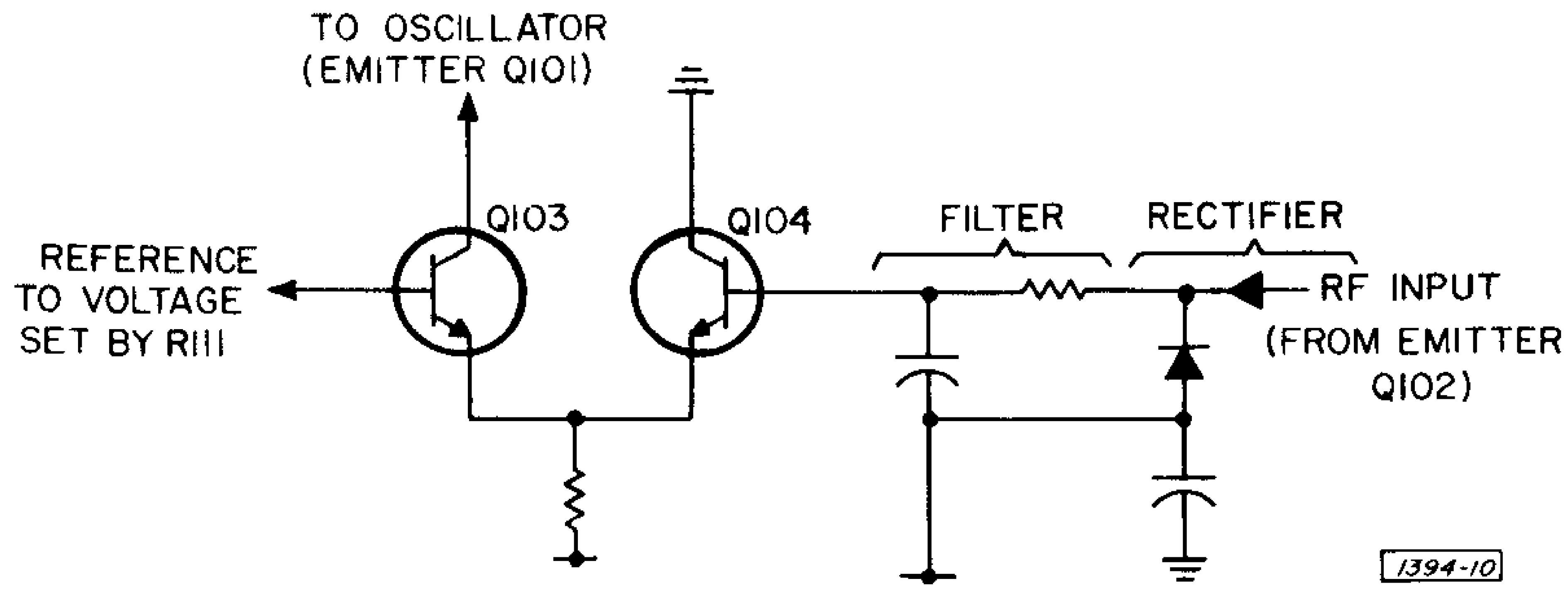


Figure 4-5. The automatic gain control circuit.

4.3 THE INPUT SELECTOR SWITCH AND CIRCUITS.

4.3.1 THE INPUT SELECTOR SWITCH.

Figure 4-6 is a simplified diagram of the various switches and controls associated with the input of the pulse generator. The input selector switch, in the position shown (+ SLOPE), applies the external frequency-determining signal to one side of a balanced or differential amplifier and a dc reference voltage to the other side. The external prf signal is applied either directly or through a 50-ohm times – 10 attenuator, depending on the setting of the SENSITIVITY switch. When the input selector switch is set to -SLOPE, the dc reference switches sides also.

The external signal, for proper impedance matching, is applied to a 50-ohm input on either side of the amplifier. It is not desirable that the dc reference be applied across 50 ohms, however, so a blocking capacitor C is added to the 50-ohm terminating resistor on either side. An RL branch having a time constant equal to that of the RC combination is shunted across it. These two branches then have an equivalent input impedance of 50 ohms at all frequencies. When the switch is set to INTERNAL, the prf signal generated by the internal oscillator is applied directly to the balanced amplifier.

4.3.2 THE BALANCED AMPLIFIER AND BISTABLE TUNNEL DIODE.

Transistors Q201 and Q202, shown in the simplified schematic diagram of Figure 4-7, form a very sensitive balanced or difference amplifier. A very small potential difference (less than a volt) between the two inputs will cause the output current to shift completely from one transistor to the other. Thus an input signal of almost any shape, when applied to one side of the amplifier, will produce a square-wave output signal, the initial transition of which can be precisely controlled by varying the reference voltage applied to the other side. The output signal is transformed into a rapid-transition pulse by tunnel diode CR201 included in the collector circuit of Q202. Each time the current through the balanced amplifier shifts from one transistor to the other, the resulting voltage change causes the tunnel diode to snap rapidly from one of its two stable voltage states to the other. This action is similar to that illustrated in Figure 4-9.

4.3.3 THE OTHER AMPLIFIERS.

Differentiating amplifier Q203 is an ordinary common-emitter amplifier with a clipping-line collector load formed by a shorted length of 50-ohm coaxial cable. It amplifies the rapidly rising and falling pulse produced by the tunnel diode and, since its collector load is a short clipping line, converts this signal to a bipolar

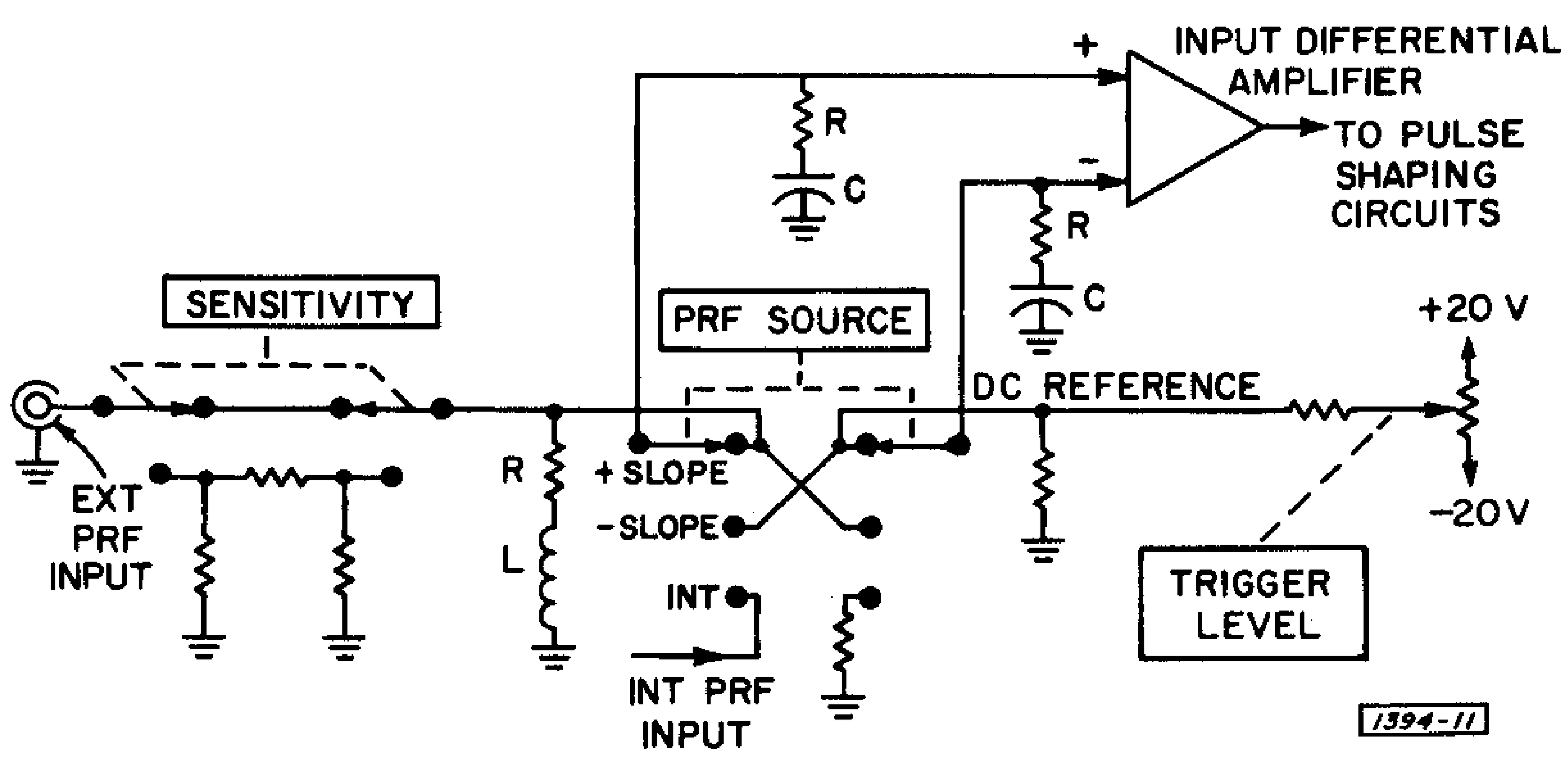


Figure 4-6. Simplified schematic diagram of the input switches and controls.

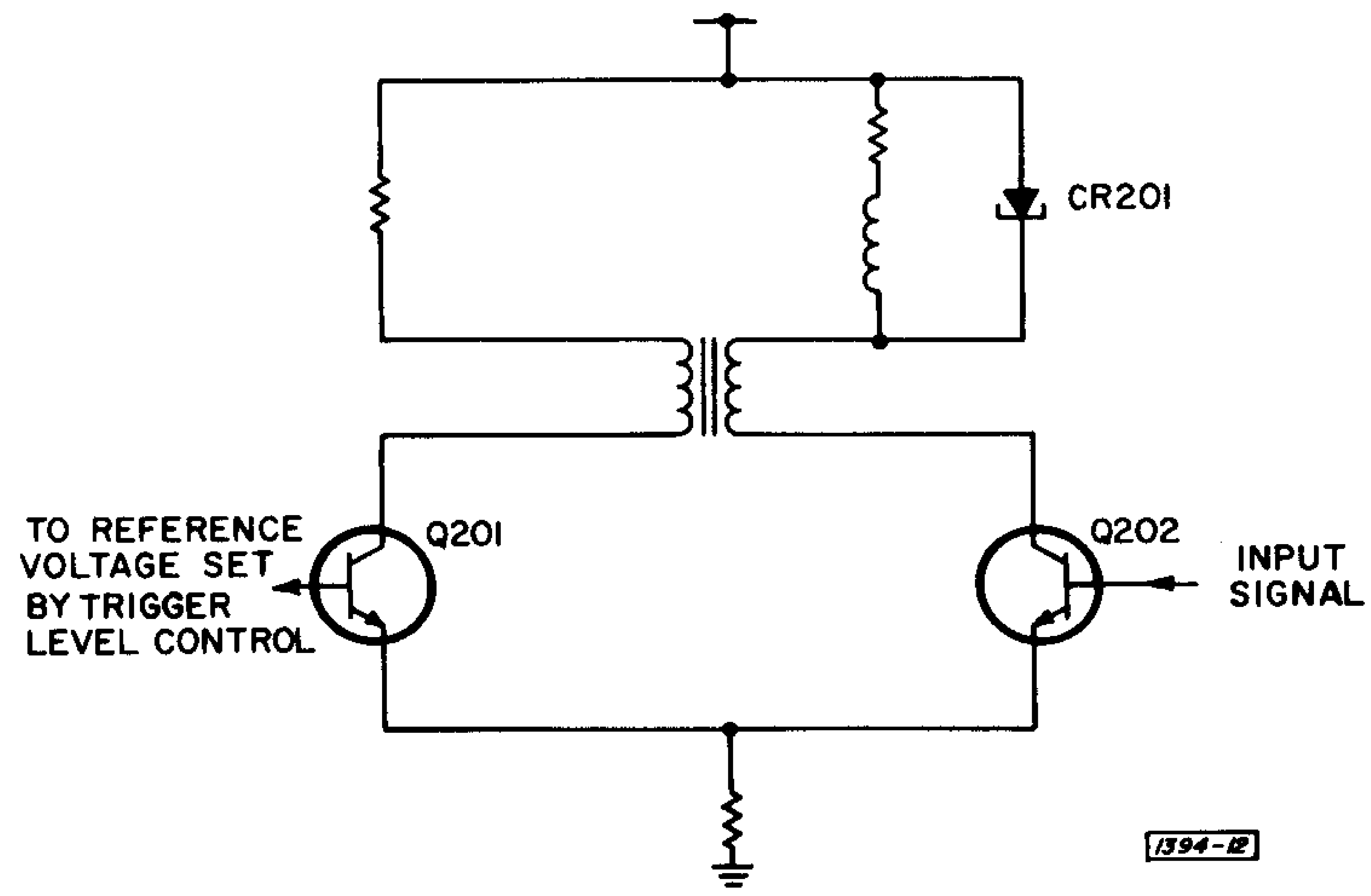


Figure 4-7. The balanced amplifier and bistable tunnel diode.

pulse pair, a particularly useful pulse shape since its dc component does not change with frequency – or more precisely, with duty ratio. The bipolar pulse pair is then applied to the inputs of two amplifiers, each of which consists of two cascaded common-emitter transistor amplifiers. Q206 and Q207 amplify the pulse for the SYNC OUTPUT: Q204 and Q205 prepare the pulse for its trip through the pulse delay cable unit.

4.4 THE PULSE-DELAY AND PULSE-REGENERATION CIRCUITS.

The amplified pulse appearing at the collector of Q205 is sent through a number of coaxial cables (zero to eight, depending on the setting of the PULSE DELAY switches), which delay the pulse by an amount of time which is both stable and accurate. This type of pulse delay circuit, being composed of passive elements, imposes no duty-ratio or recovery-time restrictions on the signal.

The pulse may be somewhat attenuated after passing through the delay cables, so it is amplified by Q208 and regenerated before being sent to the next stage of the pulse generator. The pulse regeneration circuit shown in simplified form in Figure 4-8, consists of a bistable tunnel diode, CR202, a differentiating amplifier, Q209, and an emitter follower, Q210. CR202 operates in the same manner as CR201; that is, it is set into its high-voltage state by the positive spike of the bipolar pulse received from the collector of Q208 and appearing across resistor R, and reset into its low voltage state by the negative spike (see Figure 4-9). When the input voltage reaches E1, a current just exceeding I_P (the peak diode current) in R causes the diode to switch from A to B. When the input voltage reaches E2, the current falls to I_V (the "valley current" of the tunnel diode) and the diode switches from C to D.

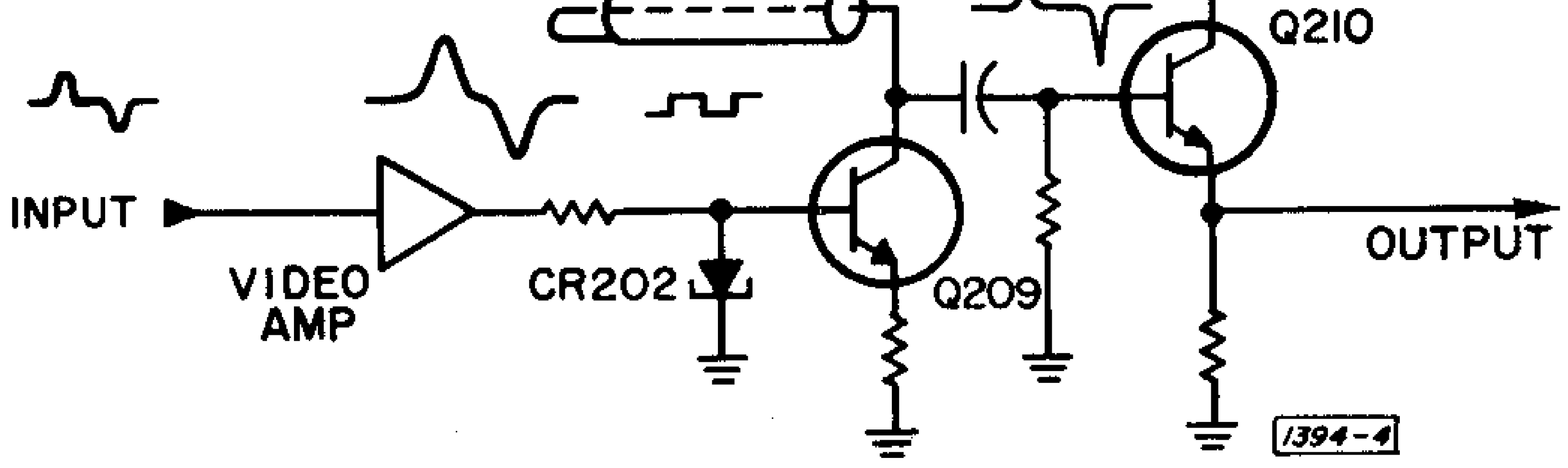


Figure 4-8. The pulse regeneration circuit.

The square wave produced by CR202 is differentiated by the amplifier circuit which follows it and which operates in the same manner as the differentiating amplifier circuit of Q203. Emitter follower Q210 is used to drive two output cables with identical pulse signals via a hybrid transformer that prevents reflections in one output cable from entering the other cable. One signal is sent to the pulse duration unit and the other to the POLARITY switch, S901B.

The pulse duration unit consists of a set of delay cables which is exactly similar to the set of cables in the pulse delay unit. Thus the output of the pulse duration unit is a somewhat attenuated bipolar pulse which arrives at the POLARITY switch a precisely determined amount of time after the signal from the first pulse regeneration circuit.

4.5 THE RISE AND FALL PULSE GENERATION CIRCUIT.

If the output pulses of the Type 1394 are to be positive-going, the undelayed pulse from the first regeneration circuit is sent to the rise-pulse generator, and the delayed pulse is sent to the fall-pulse generator. This routing is accomplished by the POLARITY switch, S901B. If negative-going pulses are required, this switch is changed from + to -, and the earlier pulses are sent to the fall-pulse generator.

The two pulse generation circuits are exactly similar except for one output capacitor. They consist of a two-stage amplifier; a pulse-regeneration circuit, consisting of a tunnel diode followed by a differentiating amplifier and a single-stage pulse amplifier; and a pulse-clipping circuit, consisting of a transistor and two diodes. The pulse-regeneration circuit is similar to that following the pulse delay cable unit. The clipping circuit is a common-emitter amplifier, Q305 (or Q305F), with a rectifier diode, CR302 (or CR302F) in the emitter

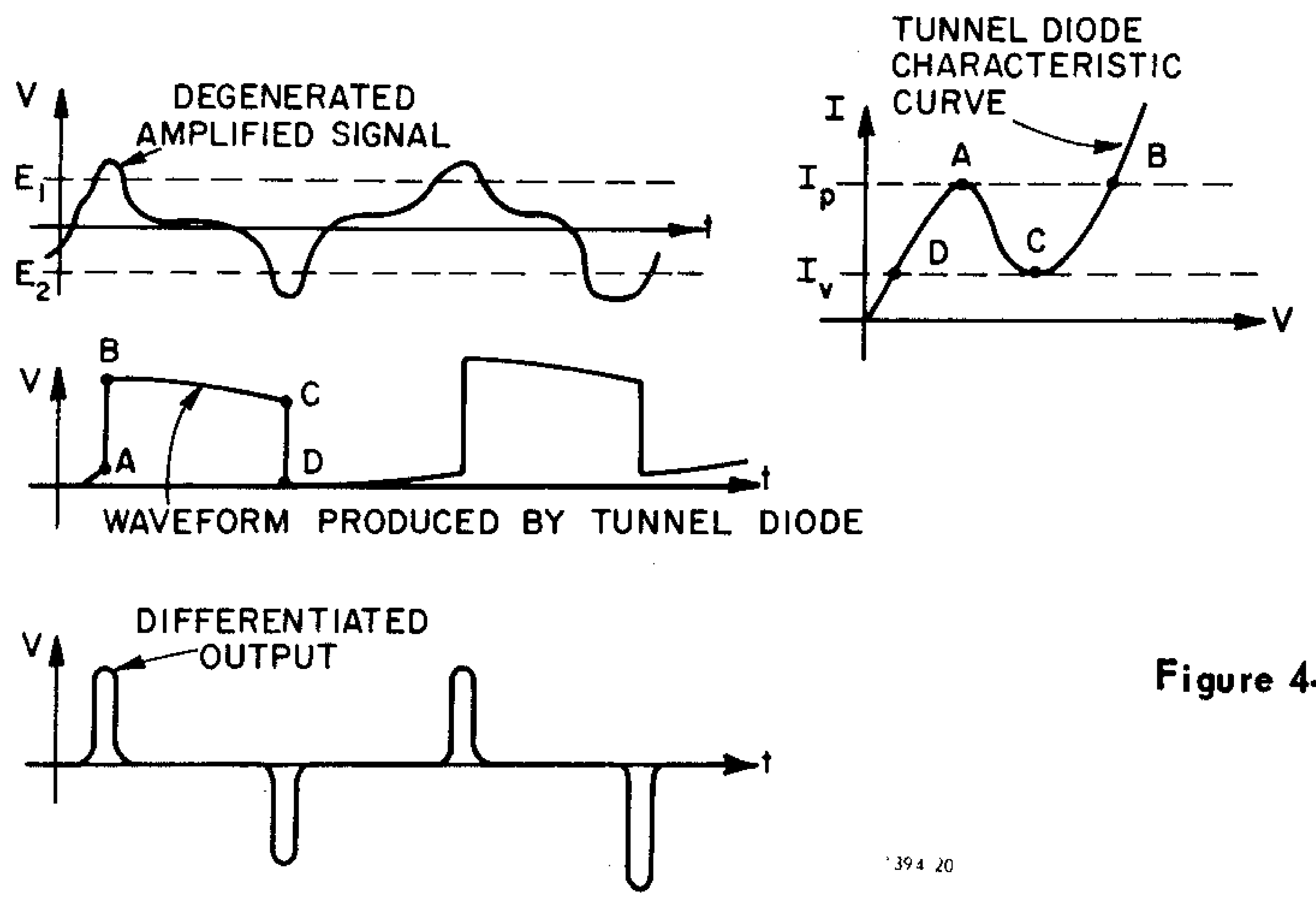


Figure 4-9. Typical switching action of a tunnel diode.

for stable biasing, and a Zener diode CR303 (or CR303F) in the output line to keep the collector voltage level independent of frequency. The amplifier is normally biased into cutoff, so that only the positive tips of the input signal are amplified to produce fast negative output pulses.

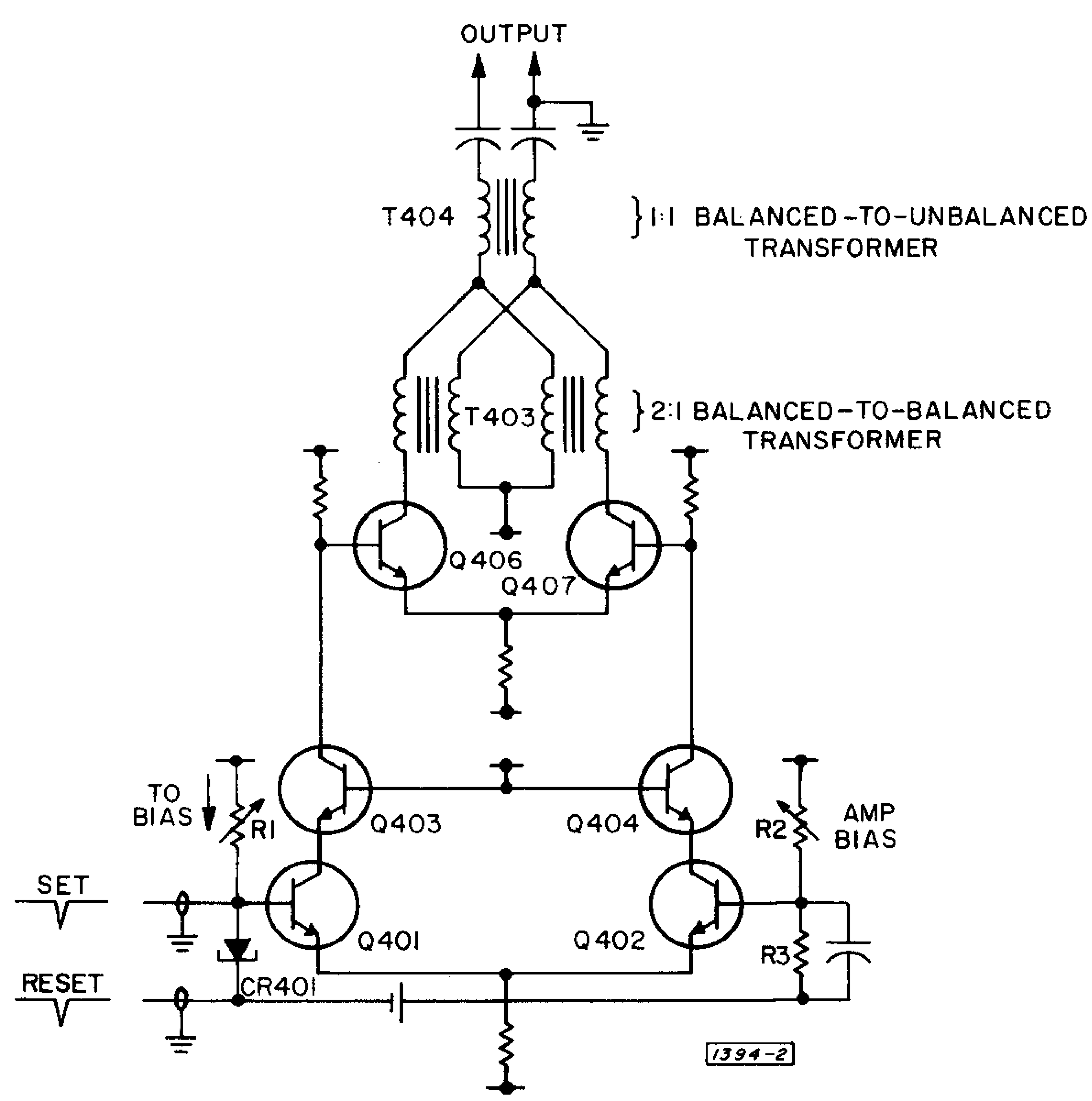
4.6 THE OUTPUT CIRCUITS.

The output amplifier stages of the pulse generator are shown in simplified form in Figure 4-10. These stages are a bistable tunnel diode CR401, a balanced two-stage amplifier and a push-pull output amplifier.

CR401 works in the same way as the other bistable tunnel diodes in the pulse generator, except that instead of being switched from state to state by opposite-polarity pulses applied to one end of the diode, it is triggered by negative pulses applied to first one end and then the other. The bias current for CR401 (about 8 mA) is supplied through R1 by the positive 20-volt power supply. The voltage change produced by CR401 must be nearly symmetric between the bases of Q401 and Q402, so a second bias current is applied through R2 and the bypassed R3 to shift the tunnel diode's quiescent voltages such that this is the case.

The output of CR401 is applied across the inputs of the balanced amplifier consisting of Q401 and Q402, which form a "long-tailed pair," and of Q403 and Q404, which form a balanced common-base amplifier. This second amplifier, due to its low input impedance, helps to minimize the high-frequency loss caused by the collector-base capacitance of Q401 and Q402.

Figure 4-10. Simplified schematic diagram of the output stage.



The push-pull output amplifier consists of two transistors, Q406 and Q407, each of which conducts a maximum of 40 mA, so that the input into each side of the output transformer is 40 mA for a total single-ended output of 80 mA. The output load of this circuit is 50 ohms; therefore, the maximum output voltage is 4 volts. The output voltage can be varied from this value down to zero volts by switching in the appropriate attenuator with the AMPLITUDE switch.

4.7 THE POWER SUPPLY.

The power supply is comprised of a full-wave rectifier, a filtering capacitor, and a current regulator, which consists of a Zener diode, CR505, and transistor Q901, followed by two filter capacitors. Since the loads upon the plus and minus 20-V supplies are constant, a constant-current regulator is used to produce stable voltage levels. The current regulator is adjusted by the setting of R502 so that, when the normal load current is being drawn, the output voltages are +20 volts and -20 volts.

4.8 THE TYPE 1394-P1 PULSE-OFFSET CONTROL.

The Type 1394-P1 Pulse-Offset Control consists of a peak-voltage detector, a reference-voltage generator, and a high-gain control amplifier which inserts a dc component in the pulse output of the Type 1394 High Rate Pulse Generator, such that the base line of the pulse is regulated to be equal to the reference voltage.

The peak-voltage detector circuit is shown in Figure 4-11. Capacitor C104 is charged with a voltage proportional to the positive peak value of the pulse minus the voltage drop across CR105. Since this drop is not constant, but proportional to temperature, a voltage equal to the drop is supplied by CR107 in conjunction with R119 R120 and the reference-voltage supply. Since the voltage drops across the diodes have the same temperature dependance, they always cancel. C103 charges to the negative peak potential, and diodes CR104 and CR106 correspond in function to CR105 and CR107.

The first stage of the control amplifier (Figure 3-12) is a differential amplifier consisting of Q101A and Q101B, which are packaged in the same case for thermal stability. One of the outputs from the peak-voltage detector is applied via the PULSE POLARITY

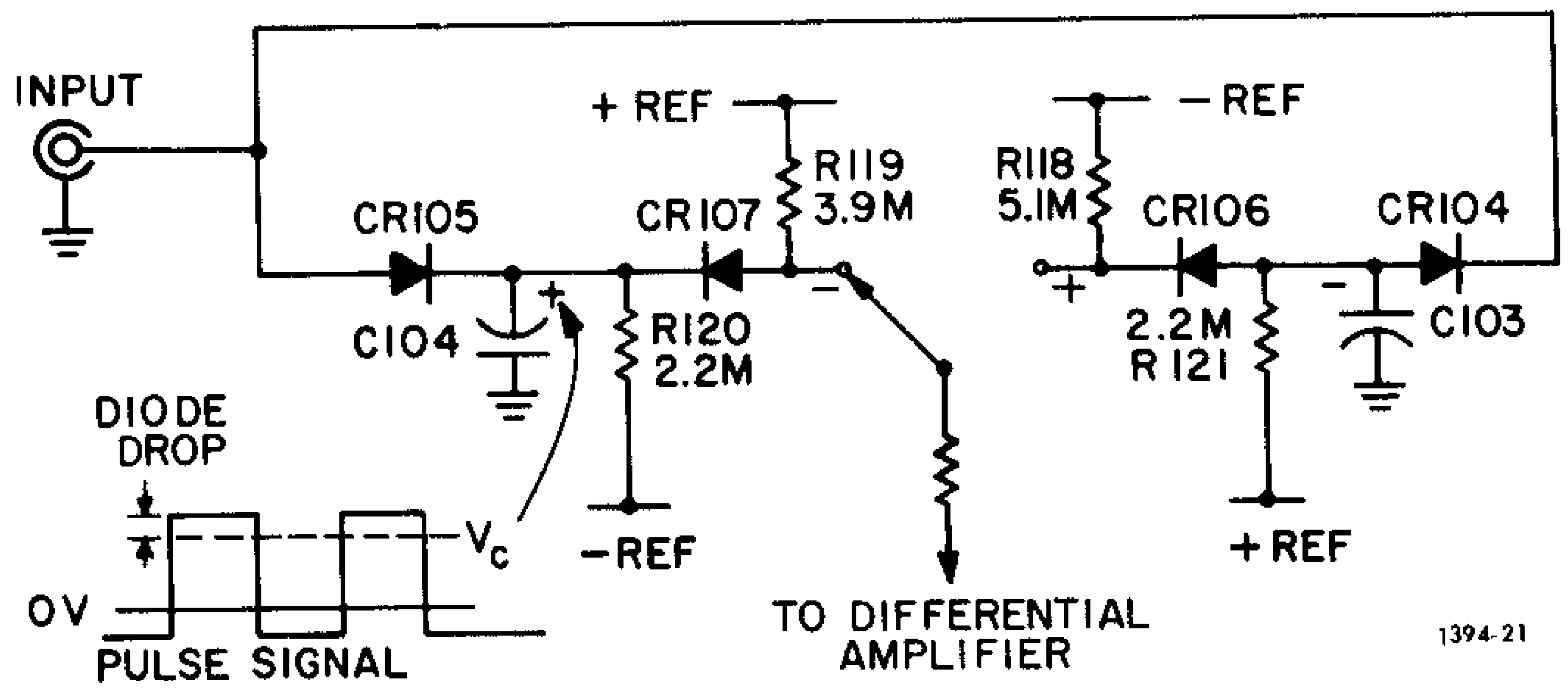


Figure 4-11. The peak voltage detector circuit of the Type 1394-P1.

switch to one side of the differential input, and the reference voltage generated by two Zener diodes across the dc power supply (Figure 5-19) is applied to the other side of the input. The differential amplifier produces a voltage which is proportional to the difference between the reference voltage set by the BASE LINE VOLTAGE control (R106, Figure 5-19) and the positive or negative offset detected by the peak-voltage detector circuit.

The difference voltage is inverted and amplified by the complimentary pair of dc amplifiers, Q102 and Q103, and applied to the bases of output transistors, Q104 and Q105, another PNP-NPN pair. The dc output voltage is taken from the emitters of Q104 and Q105 through chokes L101, L102, and L103.

To illustrate the operation of the Type 1394-P1 with a specific example: suppose the pulse generator is producing 50-nanosecond negative pulses with a PRF of 10 megacycles per second and an amplitude of 4 volts, peak, and negative pulses with a zero base line are required. The pulses are applied to the INPUT connector of the Type 1394-P1, the PULSE POLARITY switch is set to -, and the BASE LINE VOLTAGE dial is set to zero.

The amplifier output feeds enough current into the input-output cable to produce the required voltage offset (-2 V in this case). When the proper output is obtained, the peak-voltage detector produces a signal which almost exactly equals the reference voltage (0 V in this case). The very small difference between these two voltages, the error signal, is applied to the amplifier input and is sufficient to maintain the required output. Thus the circuits form a control-circuit or servo-loop which automatically inserts enough offset to make the peak-voltage equal the reference voltage.

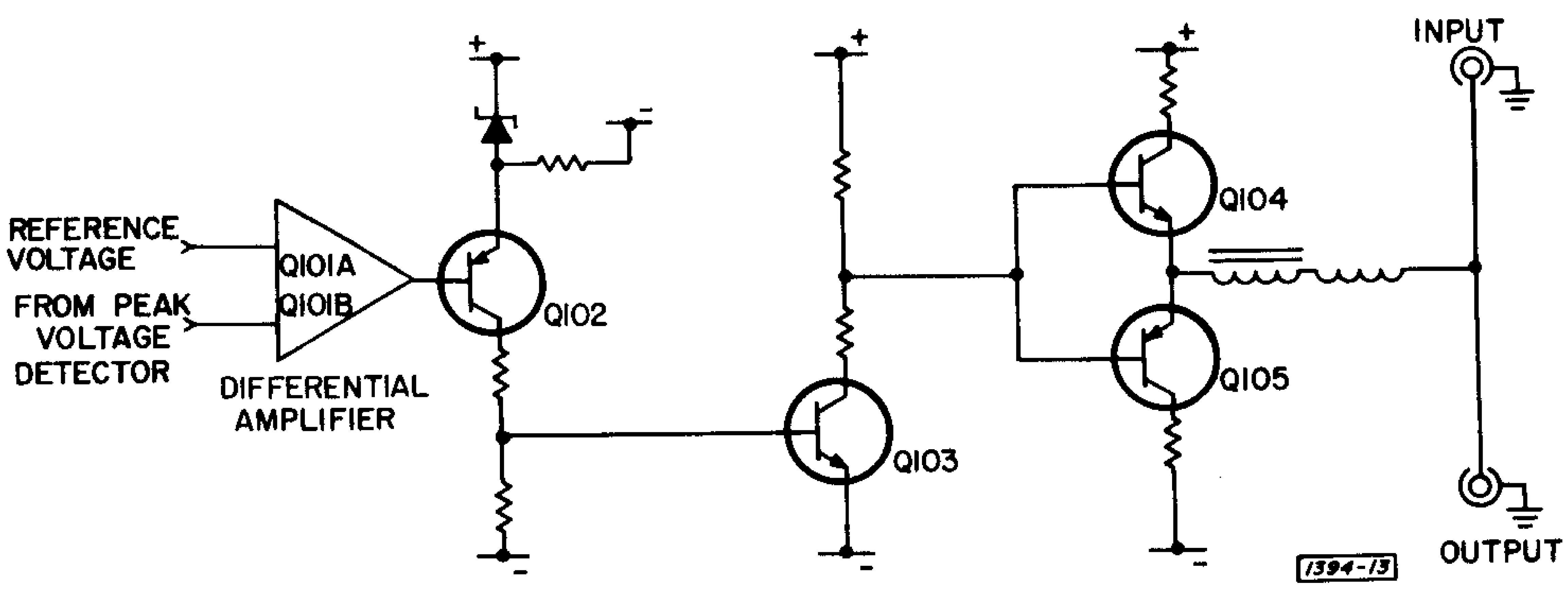


Figure 4-12. Simplified schematic diagram of the Type 1394-P1 control amplifier circuit.

SECTION **5**

SERVICE AND MAINTENANCE

5.1 WARRANTY.

We warrant that each new instrument manufactured and sold by us is free from defects in material and workmanship and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards, after examination by our factory, Sales Engineering Office, or authorized repair agency personnel, will be repaired or, at our option, replaced without charge, except for tubes and batteries that have given normal service.

5.2 SERVICE.

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by the use of the following service instructions, please write or phone our Service Department (see rear cover), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type number of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest Sales Engineering Office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.3 ACCESS TO COMPONENTS.

To remove the dust cover from the instrument, remove the two shipping screws on the rear of the instrument and, holding the front panel with one hand, slide the cover back and off.

5.4 MAINTENANCE.

No routine maintenance of this instrument is necessary.

5.5 CALIBRATION.

The bias levels of the tunnel diodes in the rise and fall pulse generator boards (CR301 and CR301F) must be adjusted so that the pulses produced by these two sets of circuits occur simultaneously when the PULSE DURATION switches are all set to zero. The procedure for doing this is as follows:

a. With the instrument turned off, disconnect the center conductor of the WH-GY cable from AT307 and the center conductor of the WH-BL cable from AT307F.

b. Short out CR301 and CR301F with clip leads.

c. Turn on the Type 1394 and, using a 20,000-Ω/V volt-ohmeter, set the voltage at the junction of R312 and R313 to 1.0 volt dc by adjusting R311.

d. Similarly adjust R311F.

e. Remove the clip leads.

f. Set the controls of the Type 1394 as follows:

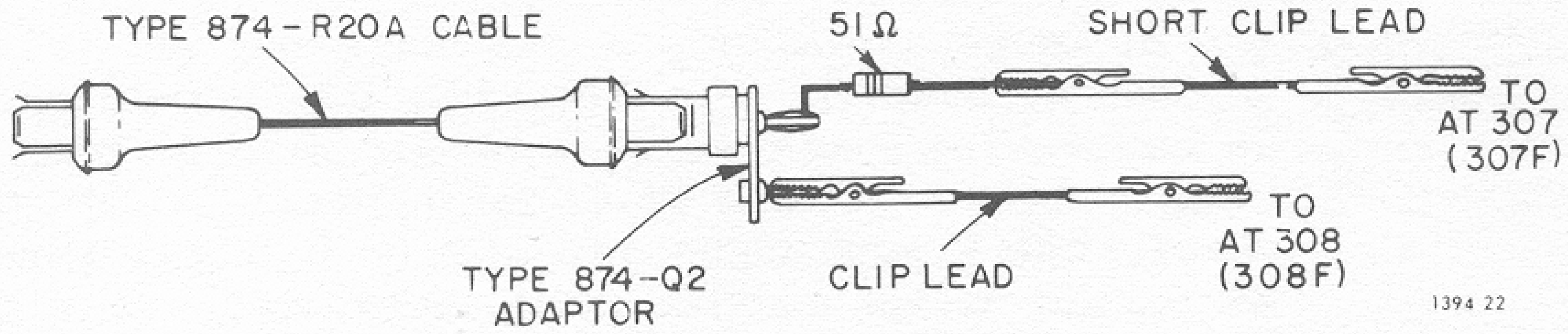


Figure 5-1a. Special cable used in calibrating the Type 1394.

Input Selector . . . . INT
PRF RANGE . . . . 2-5 MC
PRF dial . . . . 5 (5 Mc/s)
PULSE DURATION 0
PULSE DELAY 0
POLARITY . . . . +

g. Set the controls of a dual-trace sampling oscilloscope, such as the Tektronix Model 564 with a Type 3T-77 and a Type 3S76 Plug-In Unit, to operate as follows:

Mode . . . . dual trace
Sweep speed . . . . 10 ns/div
Vertical sensitivity (both channels) . . . 200 mV/div

h. Using two special cables such as the one shown in Figure 5-1a, view the signals produced by the Type 1394 at terminal AT307 and terminal AT307F.

i. Set each pulse to 0.6 volts, peak-to-peak, by adjusting R324 and R324F.

j. Set the sweep speed of the oscilloscope to 1 ns/div.

k. The separation between the pulses should be less than 0.25 ns. Now set the POLARITY switch of the Type 1394 to -. The separation between pulses should still be less than 0.25 ns (see Figure 5-1b). Ideally, there should be no separation between the pulses. The best practical adjustment, however, will be such that one pulse leads a bit at one POLARITY setting, and lags by the same amount of time at the other POLARITY setting. The adjustment is made by trimming resistors R311 and R311F, which adjust tunnel diode bias and are, therefore, capable of changing pulse timing.

l. If the pulse separation is greater than 0.25 ns, adjust R311 to correct about half of the timing error, then adjust R311F to make the final correction. Both potentiometers are adjusted in this way so that the bias current in both tunnel diodes will stay as close to the initial static current as possible.

m. If adjustments of R311 and R311F were necessary, with the instrument off, short out CR301 and CR301F with clip leads, as in step b, and, with the instrument back on, measure the voltage at the junction of R312 and R313 (and the junction of R312F and R313F). This voltage should be between 0.8 and 1.2 volts dc. (If this is not the case, first check the +20-V supply, then suspect the tunnel diode involved.)

n. Reconnect the cable unsoldered in step a.

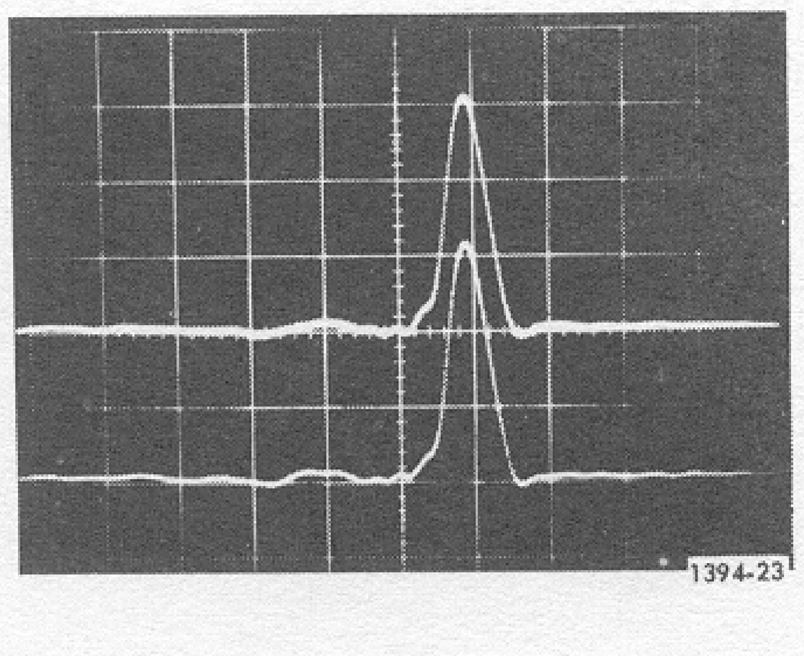


Figure 5-1b. Waveform obtained in calibration of the Type 1394.

5.6 TROUBLE-SHOOTING THE TYPE 1394.

5.6.1 VISUAL CHECK.

If the High Rate Pulse Generator does not operate properly when connected to a source of power as indicated on the tag over the power input connector and adjusted to produce pulses according to Section 3 of this book, perform the following visual checks to locate any immediately obvious failures:

a. Look for any sign of damaged components, such as broken resistors, burned capacitors, and the like.

b. Look for loose conductors, e.g., screws, bits of solder, that may have fallen into the instrument.

c. Look for broken cables. Sometimes a broken wire is held in place by its insulation, so that it is necessary to apply a slight pulling pressure to the wire to find a break. Perform this test on the wires on the anchor terminals.

5.6.2 USING THE TEST TABLES.

If there are no visually obvious faults, yet the instrument does not operate properly, the following Test Tables can be used to determine the source of the difficulty. Use Table 5-1 to localize the fault, then refer to the indicated sections of Table 5-2 through 5-6 in Section 5.9 to isolate the malfunction. When using these Tables first in sequence perform only the tests indicated by a star (★). When a fault is found, perform the remaining tests for that section of the instrument, starting with the first test in the section and referring to the pertinent paragraphs in Section 4 and to the schematic diagrams and etched-board layouts accompanying the tables in Section 5.9. Figures 5-2 and 5-3 will be helpful in locating components and test points.

All voltages are measured with nominal line voltage (115, 220, or 230 volts) applied to the instrument, and with the POWER on. The metal instrument frame is at ground potential. The abbreviation AT indicates an anchor terminal on an etched-circuit board.

Measurements are made with a standard 20-kΩ/volt multimeter or vacuum-tube instrument unless noted. To observe waveforms, a sampling oscilloscope is necessary. Use of a probe with 10-MΩ resistance and 4-pF (or less) capacitance with a X 10 attenuator is recommended. Be careful to avoid short-circuits to ground on measurements between two points which are not at ground potential.

5.7 SERVICING THE PULSE-OFFSET CONTROL TYPE 1394-P1.

Refer to paragraph 4.8 for an explanation of how the pulse-offset control operates. Use Table 5-7 in conjunction with the schematic diagram of Figure 5-19 to locate the source of any failure. Figures 5-17 and 5-18 will aid in the location of components and test points.

Table 5-1
PRELIMINARY DIAGNOSIS OF POSSIBLE ILLS

Symptom	*Possible Failure*	*Refer to Table*
Pilot lamp fails to light	Blown fuse (Power Supply) Defective lamp	5-2 (first star)
No output pulses and no sync pulses		5-2 (fourth star)
PRF source switch: either position	Power Supply Input circuit up to Q207	5-2 5-3
INT Only	PRF oscillator, AGC circuit	5-4
EXT Only	Inadequate input signal or improper setting of input controls Defect in input switches, controls	(Paragraph 3.1) 5-3
Output pulses present but no sync pulses	Pulse Amplifier (Q207)	5-3 (first star)
Sync pulses present but no output pulses	Any pulse regeneration circuit either trigger channel board	5-3 (★#2), 5-5 (★#4), 5-6 5-5
Output pulses present but erratic	Pulse duration set longer than period Power Supply Output circuit board Any preceding circuit group	(Paragraph 3.1) 5-2 5-6 Start with 5-3 and perform starred tests until trouble is localized.
Output present but output voltage levels unstable	Power Supply Output circuit board	5-2 5-6

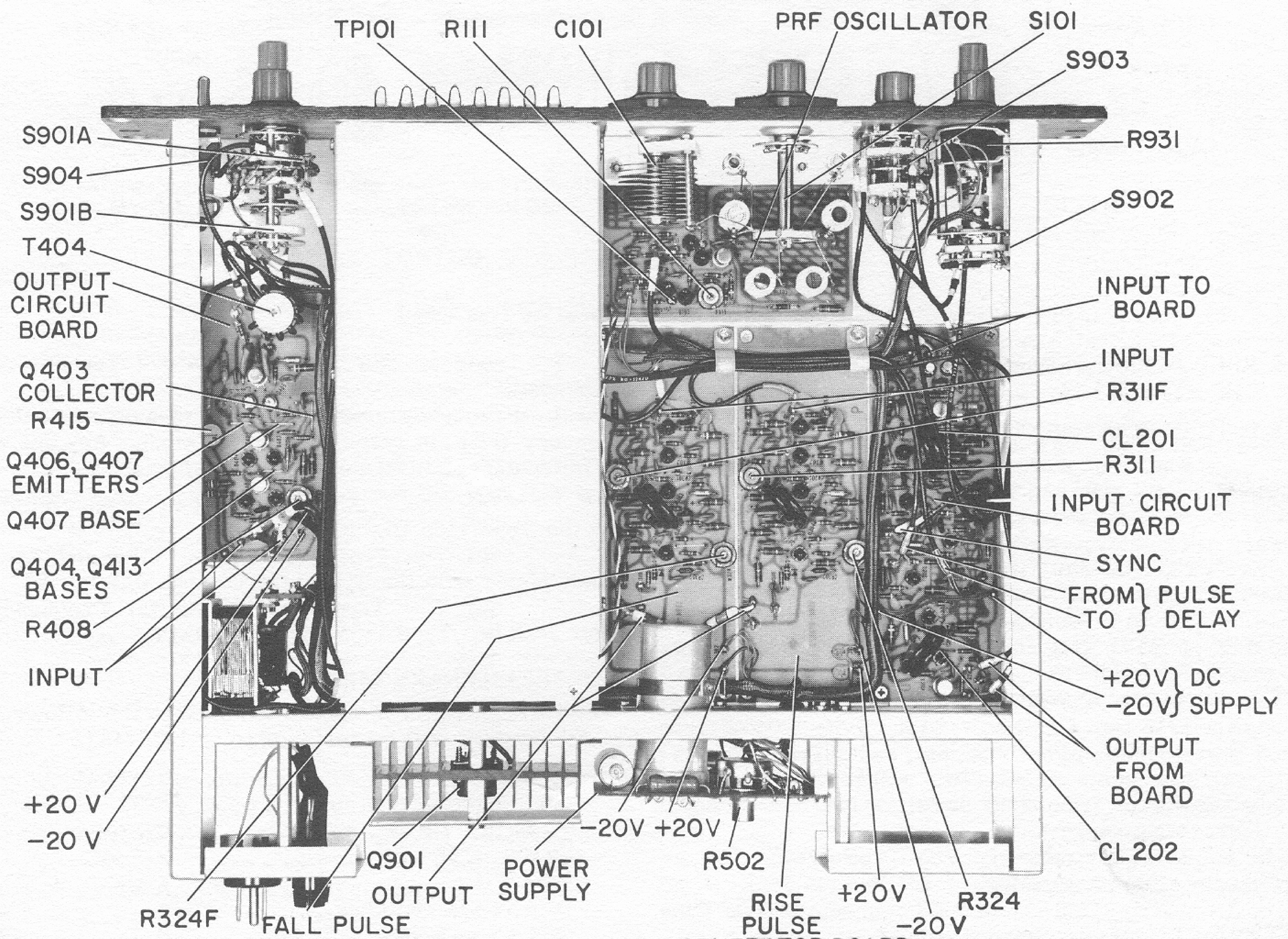


Figure 5-2. Top interior view of the Type 1394-A.

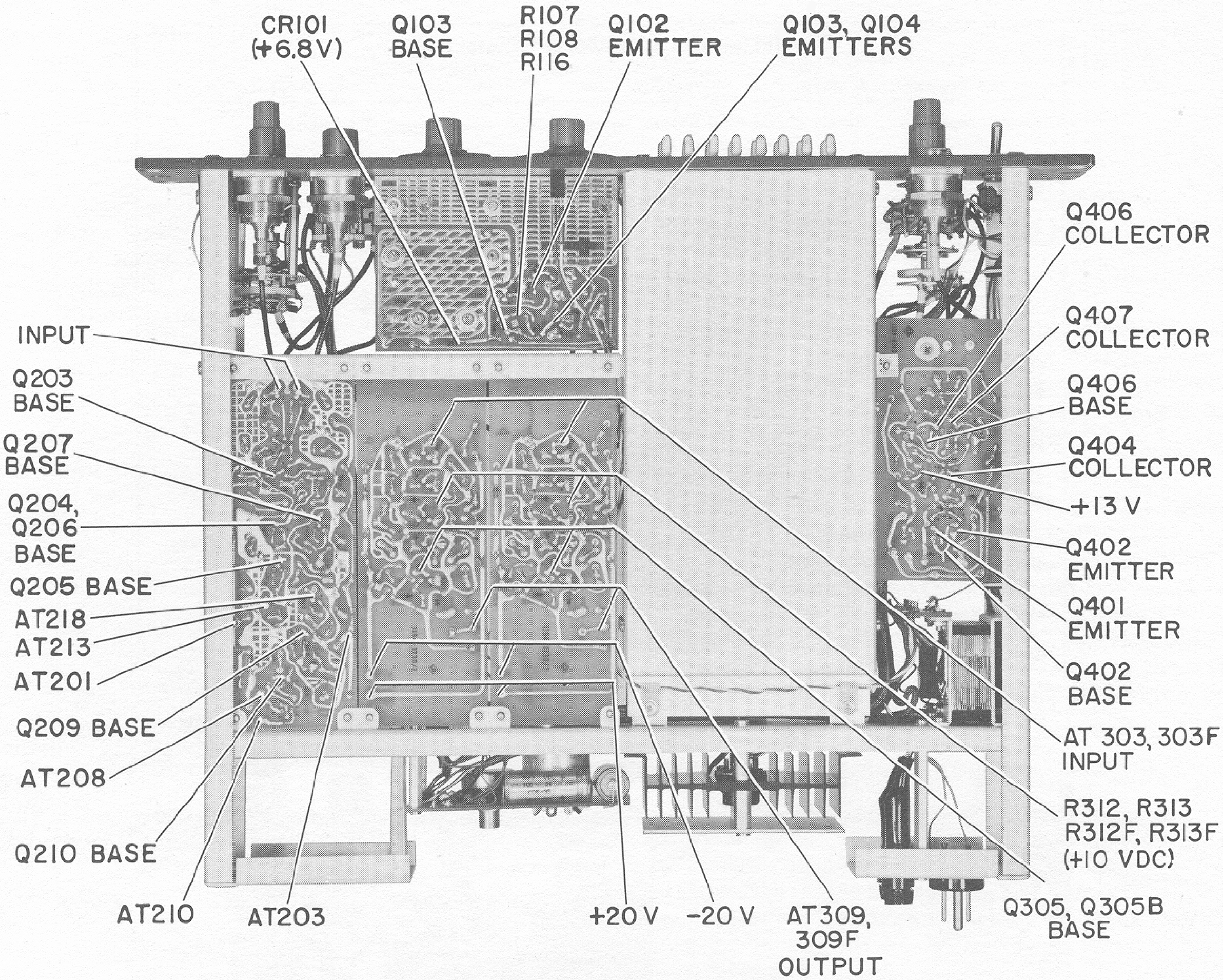


Figure 5-3. Bottom interior view of the Type 1394-A.

5.8 MINIMUM PERFORMANCE SPECIFICATIONS FOR THE TYPE 1394-A.

5.8.1 TEST EQUIPMENT REQUIRED.

1 – Source of metered (in watts) ac power. The Type W5MT3W Metered Variac is recommended.

1 – Volt-ohmmeter, (VOM) with at least 3% accuracy of resistance measurement.

1 – Cathode-ray oscilloscope (CRO) capable of dual-trace sampling operation. The Tektronix Type 561 or Type 564 Oscilloscope break, with a Type 3S76 and a Type 3T77 Plug-In Unit and a Type P6032 Probe is recommended.

1 – Source of 1 to 100 Mc/s, 0.2 to 2.0-V, signal. The Type 1215 Unit Oscillator, with a Type 1201 or Type 1203 Unit Regulated Power Supply, and a Type 1310 Oscillator are recommended. (This will leave a gap in the frequency range from 2 to 50 Mc/s, but this is not a critical testing range.)

2 – 20-dB attenuators. The Type 874-G20 Fixed Attenuator is recommended.

1 – Adaptor, GR874 to BNC connector. The Type 874-QBPA Adaptor is recommended.

1 – Adaptor, GR874 to binding posts. The Type 874-Q2 Adaptor is recommended.

1 – Tee connector. The Type 874-T Tee is recommended.

1 – Frequency meter capable of measuring pulse frequency (PRF) at rates of 0 to 100 Mc/s. Any one of the following combinations is recommended:

(a) The Type 1153 Digital Frequency Meter with the Type 1156 Digital Scaler

(b) The Type 1130 Digital Time and Frequency Meter with the Type 1156 Digital Scaler

(c) The Type 1150-BH Digital Frequency Meter with two Type 1156 Digital Scalers.

5.8.2 PRELIMINARY NOTES.

Throughout these specification tests the following control settings will be referred to as NORMAL:

SENSITIVITY	±2-20 V
Input Selector Switch	INT
TRIGGER LEVEL control	Center
PRF RANGE switch	2-5 MC
PRF dial	5 MC
DURATION switches	0
DELAY switches	0
POLARITY switch	+
AMPLITUDE switch	4

After each test, return all controls to NORMAL unless specified. Whenever the PULSE OUTPUT is to be observed on the oscilloscope, use a 20-dB pad in series with the oscilloscope input. Unless otherwise stated, all measurements concerning the leading or trailing edge of a pulse will be made at the half-amplitude point.

NOTE

The tolerances to be applied to the test results in the following paragraph are based on performance characteristics of the Type 1394 exclusively. It may be necessary in some cases to adjust the tolerances to allow for the accuracy and resolution limits of the test equipment used, in particular, those of the CRO.

5.8.3 POWER REQUIRED.

Connect the Type 1394 to a source of ac power via the Metered Variac. Set the voltage to 115 V, rms. Power input should be 20 W ±15%.

5.8.4 SYNC OUTPUT.

a. Set the controls of the CRO as follows:

Time/div . . . . . 20 ns
mV/div 50
Sync . . . . internal, positive

b. Set the Type 1394 controls to NORMAL and connect its SYNC OUTPUT to the CRO vertical input. The peak height of the SYNC OUTPUT pulse is typically 250 mV, and the individual pulses of the pair should be 4 ns (+1, -1.5) wide. If the peak amplitude of the whole pulse is less than 150 mV, the instrument is not functioning properly.

c. Set the PRF of the Type 1394 to 100 Mc/s and the CRO controls as follows:

Time/div . . . . . 2 ns
mV/div 100
Sync . . . . internal, positive

d. The pulses should have the same characteristics as described in b.

5.8.5 OUTPUT CIRCUIT CALIBRATION.

Set the DURATION switches to 4 ns and all the other controls of the Type 1394 to NORMAL. Synchronize the CRO to the SYNC OUTPUT of the Type 1394 using a 20-dB pad in series with the CRO input.

Pulse Width. Observe the pulse width on the CRO to be between 3.5 and 4.5 ns at the following settings:

POLARITY	PRF
+	1 MC
-	1 MC
+	100 MC
-	100 MC
+	Slowly vary from 20 MC to 100 MC
-	Slowly vary from 20 MC to 100 MC

Amplitude. Set all the DURATION switches to the "on" or up position (99 ns). All the other controls should be in the NORMAL position. The output pulse amplitude as seen on the CRO should be 4.0 V ±5%, peak. If necessary, adjust R415 on the output circuit etched board (see Figures 5-15, 5-16, and 5-2) to obtain this value. Turn the AMPLITUDE control to 0, noting the pulse amplitude at each position to be within the following limits:

AMPLITUDE (Type 1394)	mV/div CRO	Division Limits	Amplitude Limits (V)
4.0	50	7.6 to 8.4	3.8 to 4.2
3.5	50	6.7 to 7.3	3.4 to 3.6
3.0	50	5.7 to 6.3	2.9 to 3.1
2.5	50	4.8 to 5.2	2.4 to 2.6
2.0	50	3.8 to 4.2	1.9 to 2.1
1.5	20	7.2 to 7.8	1.45 to 1.55
1.0	20	4.8 to 5.2	0.95 to 1.05
0.5	10	4.8 to 5.2	0.48 to 0.52
0	10	<0.5	<50 mV

5.8.6 TRANSITION TIME AND OVERSHOOT.

Observe the OUTPUT pulse of the Type 1394 on the CRO as above. Set the controls as follows:

Type 1394	DURATION	50 ns
	PRF	10 MC
	All other controls . .	NORMAL
CRO	Time/div	20 ns
	mV/div	100

a. Adjust the variable mV/div control on the CRO for a vertical deflection of 5 major divisions (ignoring overshoot). Set the time/div to 1 ns.

b. Measure the rise time between the 10- and 90-% points to be between 1.6 and 2.4 ns.

c. Set the POLARITY control to - and repeat b.

d. Set the CRO controls as follows:

Time/div . . . . . 20 ns
mV/div . . . . . . 10 (Do not change the variable mV/div control.)

e. Each major vertical division is now 2% of the total pulse amplitude. The overshoot, both positive and negative, is typically 12%.

f. Set the POLARITY to + and repeat e.

5.8.7 RINGING, NOISE, AND DROOP.

a. Leave the controls of the CRO as they were in 5.8.6 f. Do not change the variable mV/div control.

b. Set the DURATION switches of the Type 1394 for 99-ns pulses and all the other controls to NORMAL.

c. Observe on the CRO that all noise on the flat portion of the pulse is less than 5%, peak-to-peak, (2.5 divisions) within 30 ns after the positive and negative transitions. No ringing or oscillations should exist.

d. Set the POLARITY switch to - and repeat c.

e. Set the Type 1394 PRF to 1 MC and measure the droop of the output pulse to be less than 8% (4.0 divisions).

f. Set the POLARITY to + and repeat e.

g. Set the CRO mV/div control back to the calibrated position.

5.8.8 INTERNAL OSCILLATOR CALIBRATION.

Measure the PRF of the OUTPUT PULSE of the Type 1394 using a Type 1156 Decade Scaler and a frequency counter. The results of the measurement of PRF should be within the following limits:

PRF RANGE	PRF dial	PRF (Mc/s) Limits
1-2	1.2	1.14 to 1.26
	1.0	1.95 to 1.05
	1.4	1.33 to 1.47
	1.6	1.52 to 1.68
	2.0	1.90 to 2.10
2-5	3.0	2.85 to 3.15
	2.0	1.90 to 2.10
	2.5	2.37 to 2.63
	3.5	2.32 to 3.68
	4.0	3.80 to 4.20
	5.0	4.75 to 5.25
5-10	6	5.70 to 6.30
	5	4.75 to 5.25
	7	6.65 to 7.35
	8	7.60 to 8.40
	9	8.55 to 9.45
	10	9.50 to 10.50
10-20	1.2	11.40 to 12.60
	1.0	9.50 to 10.50
	1.4	13.30 to 14.70
	1.6	15.20 to 16.80
	2.0	19.00 to 21.00
20-50	3.0	28.5 to 3.15
	2.0	19.0 to 21.0
	2.5	23.75 to 26.25
	3.5	33.25 to 36.75
	4.0	38.0 to 42.0
	5.0	47.5 to 52.5
50-100	6	57.0 to 63.0
	7	66.5 to 73.5
	8	76.0 to 84.0
	9	85.5 to 94.5
	10	95.0 to 105.0

5.8.9 EXTERNAL OPERATION.

a. Set the SENSITIVITY switch of the Type 1394 to .2-2 V. Measure the resistance from the EXT PRF INPUT center conductor to ground to be 50 Ω ±10%.

b. Repeat step a with the SENSITIVITY switch at 2-20 V.

c. Connect the output of the Type 1215, which is to be replaced subsequently with the Type 1310, to the EXT PRF INPUT of the Type 1394 using a 20-dB pad. Monitor the input provided by the signal generator with the VTVM (it will be necessary to use the tee connector to do this).

d. Connect the INPUT of the Type 1156 Decade Scaler, which is used in combination with a frequency meter, to the PULSE OUTPUT of the Type 1394.

e. Set the DURATION switches of the Type 1394 for 4-ns pulses.

f. Note that the reading of the counter agrees with the oscillator setting under the conditions of the following table. The count must be stable.

5.8.10 RESIDUAL DELAY.

a. Set the DURATION switches of the Type 1394 for 20-ns pulses, and set all other controls to NORMAL. Set the CRO sweep speed to 5 ns/div and switch to internal synchronization (INT +). Apply the SYNC pulses to the channel that is triggering the CRO.

b. Observe the Type 1394 SYNC OUTPUT on one channel of the CRO and the PULSE OUTPUT on the other channel (using the 20-dB pads).

c. Set the leading edge of the SYNC pulse to the left edge of the graticule. The OUTPUT pulse will occur 35 ns later, typically.

5.8.11 DURATION AND DELAY TESTS.

Connect the Type 1215 Unit Oscillator output to the INPUT of the Type 1394 and, using a tee connector, to the channel "A" input of the CRO. Apply the output of the Type 1394 to the input of the other CRO channel. Synchronize the oscilloscope sweep with the Type 1394 SYNC OUTPUT pulses. Set the controls of the various instruments as follows:

Type 1394	Input Selector Switch	EXT-
	SENSITIVITY	0.2-2 V
	DELAY	0
	DURATION	10 ns
	All other controls	NORMAL
Type 1215	FREQUENCY	100 Mc/s ±0.1%
	Output level	0.2 V
CRO	Synchronization	External, positive
	mV/div (channel A)	5
	mV/div (channel B)	100
	Time/div	10 ns
	Horizontal magnification ..	X 10
	Mode	Dual trace

Delay.

a. Adjust the CRO horizontal position and delay controls so that the leading edge of the Type 1394 output pulse appears on the screen. Adjust the Type 1394 TRIGGER LEVEL and the Channel A horizontal position control so that the half-amplitude point of the leading edge of the Type 1394 pulse coincides with a convenient point on a Type 1215 cycle; this point will henceforth be referred to as point A.

Type 1394 SENSITIVITY	Type 1215 Frequency (Mc/s)	Type 1806 Voltage (V)	Type 1394 TRIGGER LEVEL*	Type 1394 POLARITY	Remarks
0.2-2	100	1.4	-0.2 to 0.2	-	
0.2-2	100	1.4	-0.2 to 0.2	+	Remove pad.
2-20	100	1.4	-2.0 to 2.0	-	
2-20	100	1.4	-2.0 to 2.0	+	
	Type 1310 Frequency (c/s)				
0.2-2	500 k	1.4	-0.2 to 0.2	-	Remove the scale and place a 50-Ω resistor across the counter INPUT. Apply the PULSE OUTPUT to the counter.
0.2-2	2**	1.4	-0.2 to 0.2	+	DURATION and DELAY to 99 ns.

*(-0.2 to 0.2) implies that the Type 1394 must operate somewhere within this range, but not over the entire range.

**Set the counter to COUNT (vs FREQ) and see that it counts 2 pulses per second.

b. Using the CRO delay control, move the pattern to the left so that point A occurs at the left edge of the graticule. Note that the next Type 1215 cycle crosses the horizontal center of the graticule at the right edge of the graticule. Adjust the CRO horizontal gain, if necessary, to achieve this.

c. Point A of the Type 1215 cycle is now the reference point, and all measurements will be made with respect to it.

d. Individually actuate the 1, 2, 4, 2 DELAY switches of the Type 1394, noting that the pulse is delayed by the amount listed below:

Switch	Delay Limits (ns)
1	0.25 to 2
2	1 to 3
4	3 to 5
2	1 to 3

e. Similarly, actuate the 10, 20, 40, 20 DELAY switches, noting that the pulse is delayed by the proper number of Type 1215 pulses within the following tolerance. Use the CRO delay control to move the complete pattern.

Switch	Type 1215 Pulses	Limits
10	1	±1 ns
20	2	±1 ns
40	4	±1 ns
20	2	±1 ns

f. Actuate all of the DELAY switches simultaneously and note that the pulse is delayed by 99 ±3 ns.

Duration.

a. Set the Type 1394 DELAY to 0 ns and the DURATION switches for 10-ns pulses. The pulse duration as measured on the CRO must be 10 ±1 ns.

b. Using the CRO delay control, set the trailing edge of the Type 1394 pulse to the left edge of the graticule.

c. Individually actuate the 1, 2, 4, 2 DURATION switches of the Type 1394, noting that the duration increases as follows:

Switch	Duration Increase (ns)
1	0.25 to 2
2	2 to 3
4	3 to 5
2	2 to 3

d. Check the 20, 40, 20 DURATION switches as you did the 10-ns switch in a. The following limits must be met:

Switch	Duration (ns)
20	18.5 to 21.5
40	38 to 42
20	18.5 to 21.5

NOTE

Durations are always measured to the half-amplitude points. When the pulse duration is changed, the vertical portion of the Type 1394 pulse will shift. This must be compensated for before the measurement is made.

e. Set the Type 1215 frequency to 90.0 Mc/s and the Type 1394 DURATION to 99 ns.

f. Realign point A of the Delay Test, step a, using the TRIGGER LEVEL control of the Type 1394. The duration of the pulse must now be within 3 ns of the ninth Type 1215 peak (99 ±3 ns).

g. Remove the Type 1215 signal from the CRO and the Type 1156 output from the Type 1394.

5.8.12 DUTY-CYCLE TESTS.

Observe the Type 1394 output pulse on the CRO, using a 20-dB pad. Synchronize the CRO with the Type 1394 SYNC OUTPUT. Set the controls as follows:

Type 1394	DURATION	50 ns
	All other controls ..	NORMAL
CRO	Time/div	1 ns
	Horizontal mult	X 1

Adjust the CRO controls so that the trailing edge of the pulse can be seen.

a. Increase the Type 1394 PRF until the leading edge of the next pulse can be seen on the raster. Slowly continue to increase the PRF noting that before "Failure" (the pulses disappear) occurs, the pulses are within 5 ns of each other at the half amplitude points.

5.8.13 JITTER CHECK.

Set the controls of the CRO and Type 1394 as follows:

Type 1394	PRF	11 MC
	DURATION	80 ns
	All other controls ...	NORMAL
CRO	Synchronization	Internal, positive (Channel A)
	mV/div	100
	Vertical position	Center

Observe the Type 1394 output pulse. As the CRO delay control is turned from full CW to full CCW, the leading edges of two pulses should be visible.

a. Observe the first (CCW) leading edge. Adjust the CRO delay and dc offset controls so that the half-amplitude point intersects the center of the graticule.

b. Set the CRO horizontal magnification to X 10. Using the CRO delay control, reposition the pulse so that the leading edge again intersects the center of the graticule.

c. Set the CRO mV/div to 10. Adjust the dc offset control so that the leading edge again intersects the center. Note that the jitter is less than one major division.

d. Turn the CRO delay control slowly CW until the trailing edge of the pulse is observed. The jitter must be less than two divisions.

e. Continue turning the delay control CW until the next leading edge is visible. The jitter must be less than two divisions.

5.9 TEST TABLES, SCHEMATIC DIAGRAMS, AND PARTS LISTS.

CONTENTS

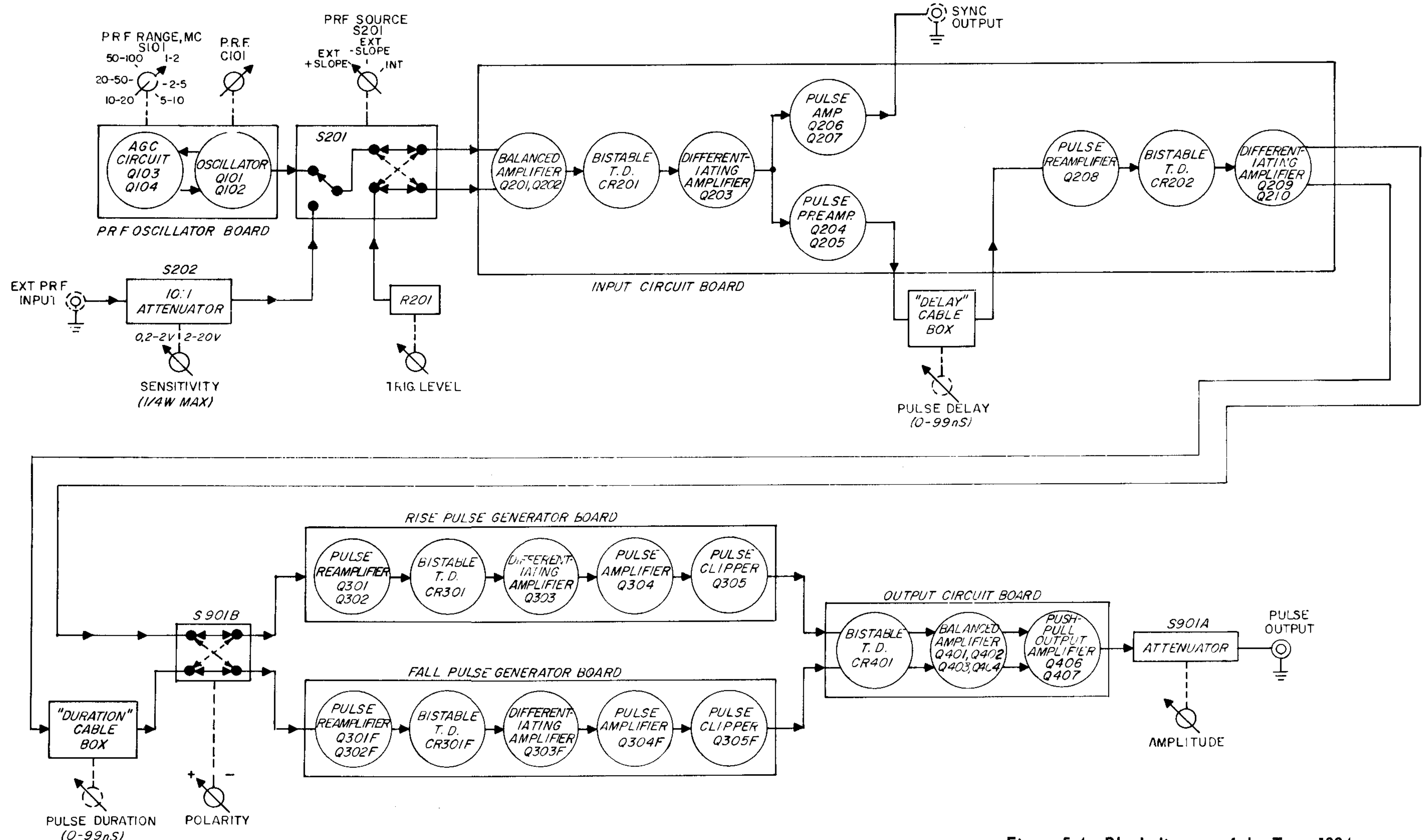


Figure 5-4. Block diagram of the Type 1394.

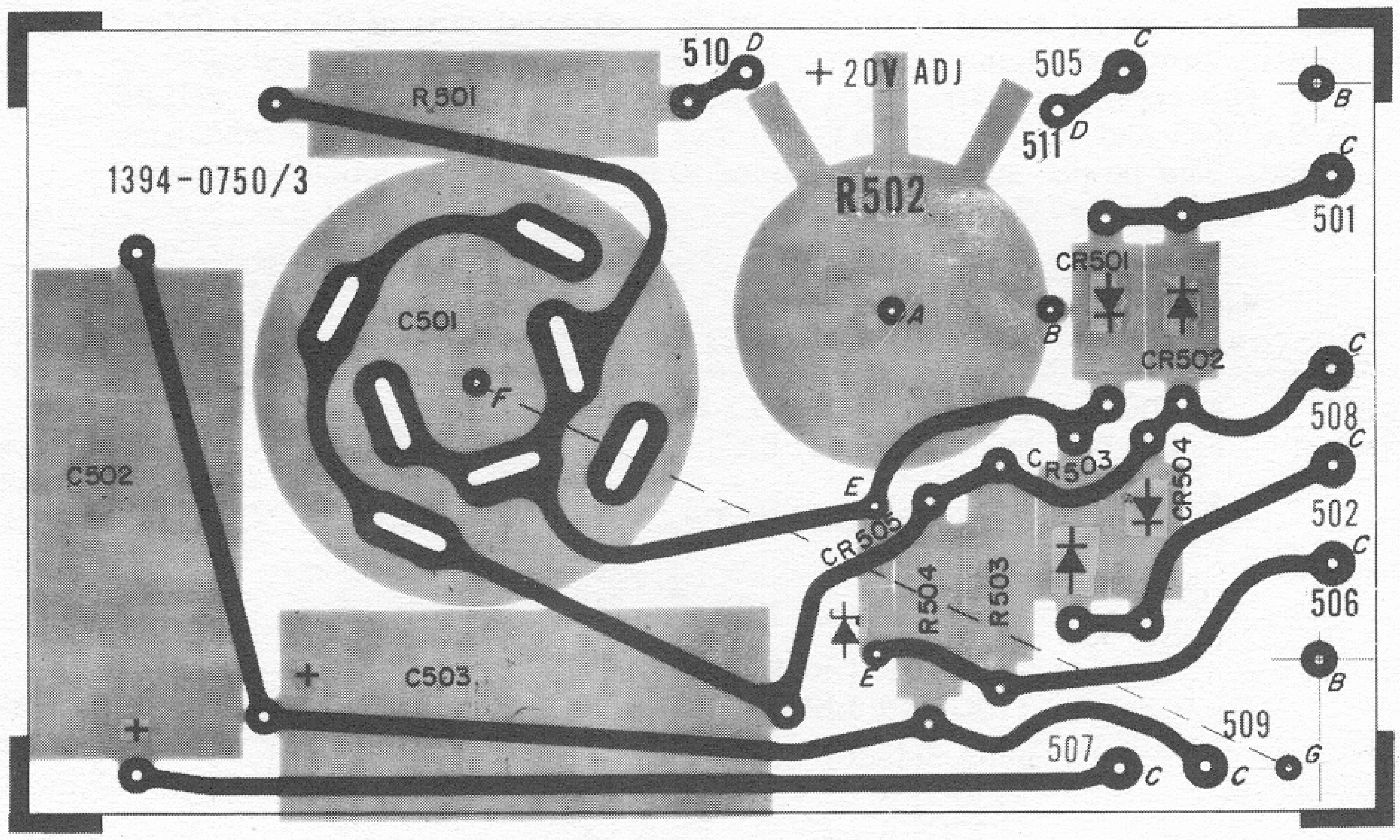
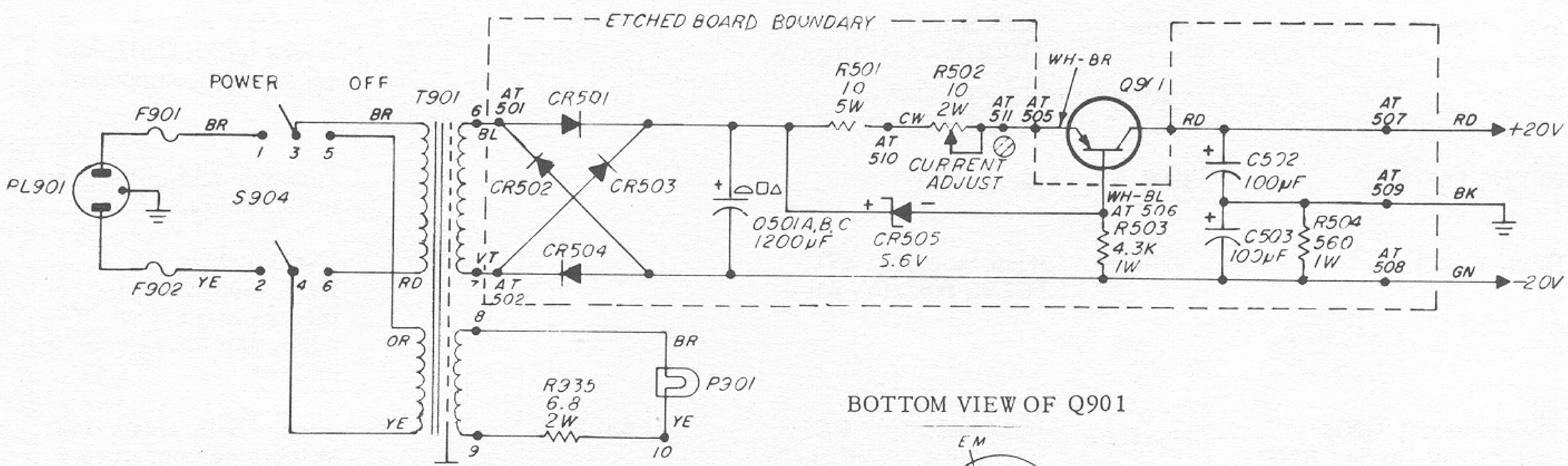
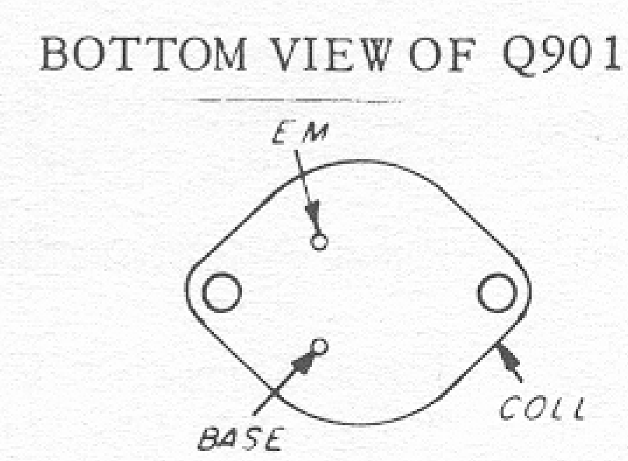


Figure 5-5. Power supply etched board assembly.





FOR 115V OPERATION CONNECT
S904, 3 TO 5 8 4 TP 6
F901 8 F902 = 0.25 AMP SLO BLO

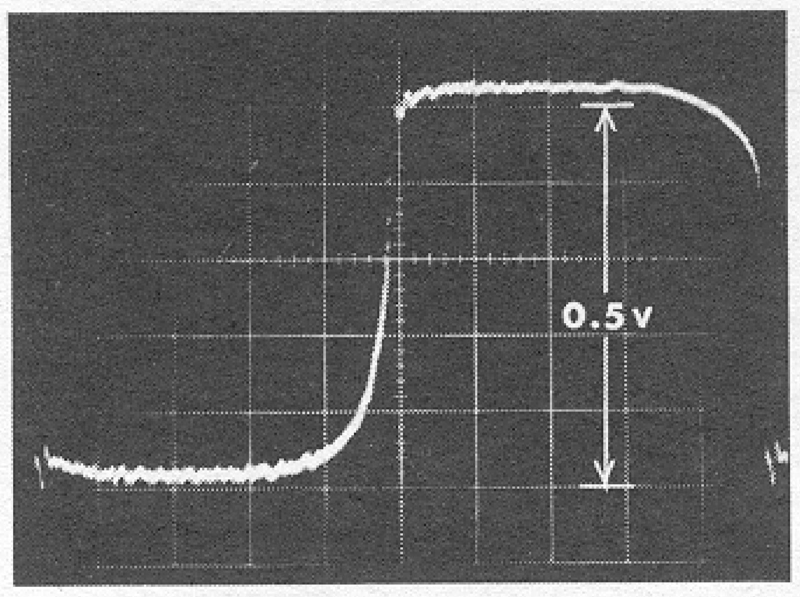
FOR 220-230V OPERATION CONNECT
S904 5 TO 6
F901 8 F902 = 0.125 AMP SLO BLO

Figure 5-6. Power supply circuit diagram.

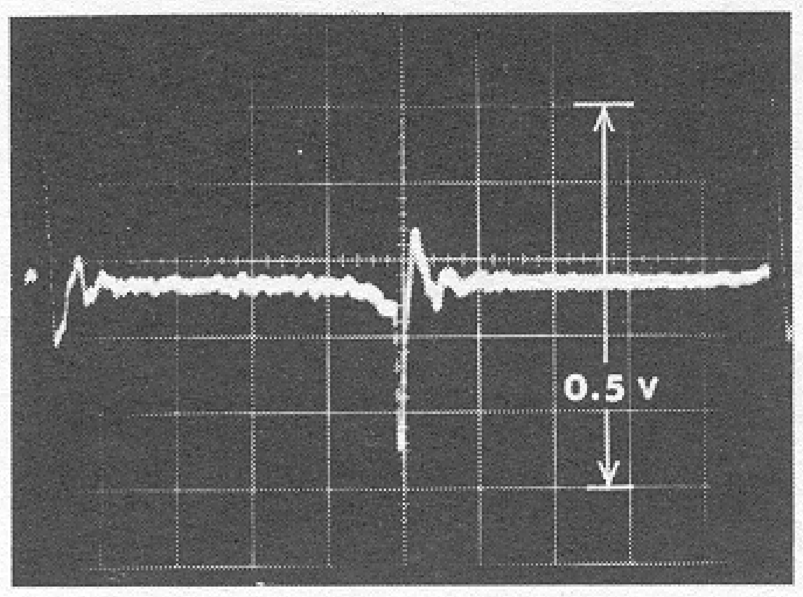
Table 5-3
INPUT CIRCUIT TESTS

The input circuit board is located on the left-hand side of the instrument directly behind the input controls. The SENSITIVITY switch is set to ±0.2-2 V. The repetition rate, when internally controlled, is 5 Mc/s. PULSE DURATION and PULSE DELAY switches are all set to 0 unless otherwise stated. The power supply is assumed to be adjusted and functioning properly (Figures 5-7 through 5-9).

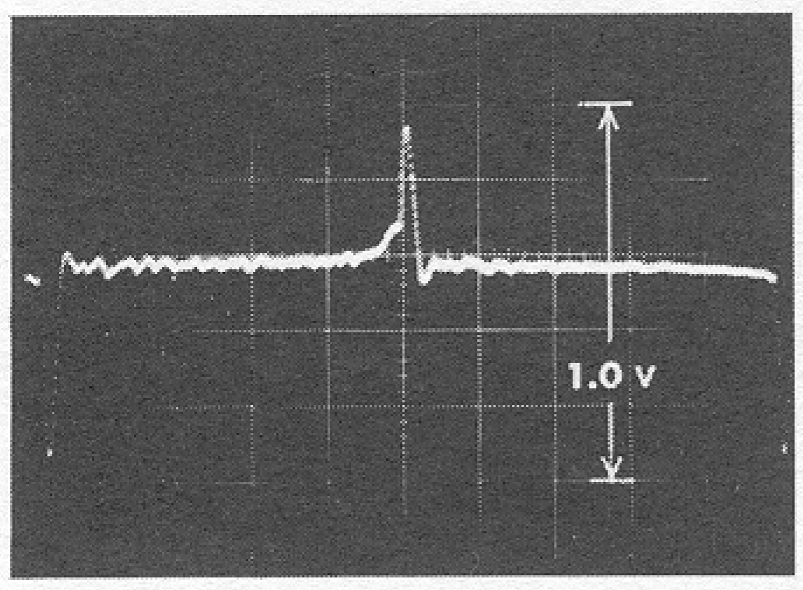
Test	*Measurement to Ground From*	*Control Setting*	*Typical DC Voltage*	*Waveform See Figure 5-7*	*If Test Fails*
Balanced Amplifier and TRIGGER LEVEL Control	AT204 (Q201-B)	TRIGGER LEVEL: Fully CW Input Selector: EXT+	2.0 V		Check R931, compare the wiring of S903 to the schematic (Figure 5-9).
	AT206 (Q202-B)	Input Selector: EXT -	-2.0 V		
	Q202-C (T201-4)	Input Selector: EXT+	5.5 V		
		TRIGGER LEVEL: Fully CW TRIGGER LEVEL: Fully CCW	5.0 V 7.0 V		Check Q201, Q202, and associated components.
		Input Selector: EXT - TRIGGER LEVEL: Fully CW TRIGGER LEVEL: Fully CCW	4.5 V 7.8 V		
Bistable Tunnel Diode CR201	Q203-B	Input Selector: EXT INT	-0.4 V	A	Check CR201, Q201, Q202, and Q203.
Differentiating Amplifier Q203	Q203-C	Input Selector: EXT TRIGGER LEVEL: CW	5.0 V		Check Q203, CL201, and associated components.
	Q204-B, Q206-B	Input Selector: EXT Input Selector: INT	-0.08 V	B	
Pulse Preamp Q204, Q205	Q204-C	Input Selector: EXT TRIGGER LEVEL: CW	4.3 V		Check Q204, Q205, and associated components.
	Q205-C Q205-B	same as above Input Selector: INT	4.0 V	C	
Sync Pulse Amplifier Bias	Q206-C	Input Selector: EXT - TRIGGER LEVEL: CW	4.5 V		Check Q206, Q207, and associated components.
	Q207-C Q207-B	Same as above Input Selector: INT	11.5 V	D	
★SYNC OUTPUT	J902	Same as above		E	Perform remaining tests in this table.
Delay Cable	Q208-B	Input Selector: INT PULSE DELAY: All 0		F	Check cables for loose connection by tugging slightly on cable just above connection
Pulse Preamp Q208 and Tunnel Diode CR202	Q208-C	Input Selector: EXT - TRIGGER LEVEL: CW	5.0 V		Check Q209, Q210, and associated components.
	Q209-B	Input Selector: INT		G	
Differentiating Amplifier	Q209-C	Input Selector: EXT - TRIGGER LEVEL: CW	5.0 V		Check Q209, CR202, and associated components.
	Q210-C	Same as above	8.0 V		
	Q210-B	Input Selector: INT		H	
★Output from Input Circuit Board	AT210 (AT208)	Same as above		I	Perform all tests in Table 5-4.



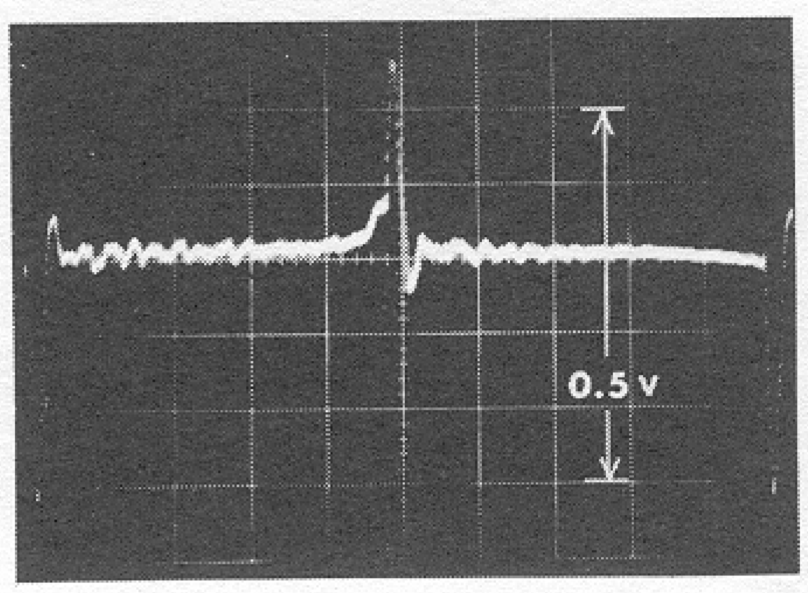
a. Q203-B (CR201)



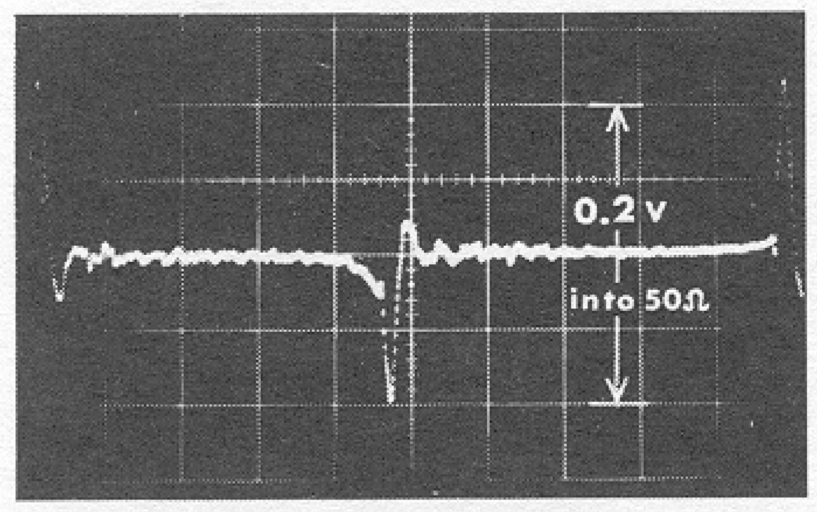
b. Q204-B, Q206-B



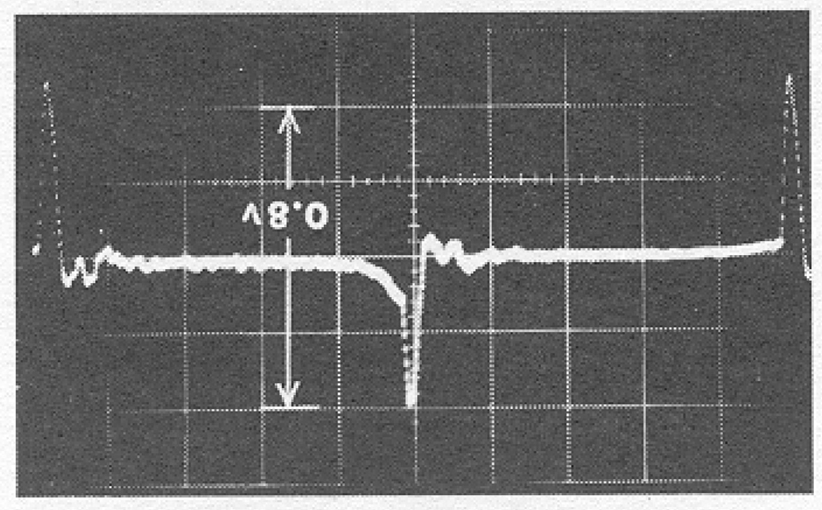
c. Q205-B



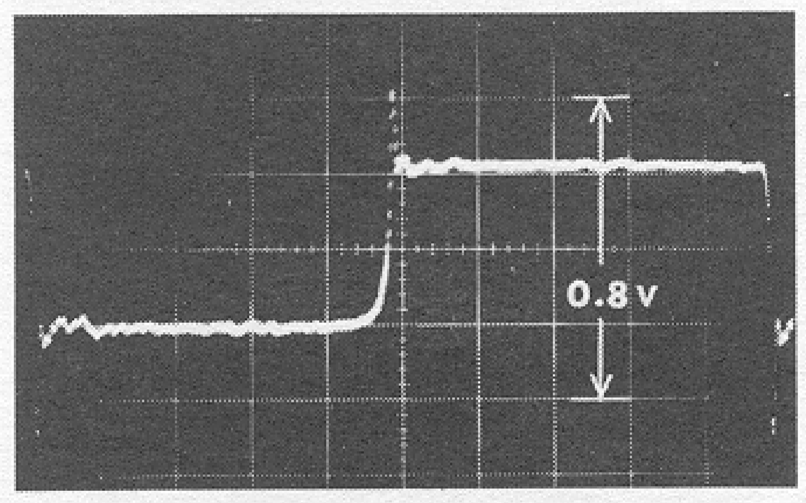
d. Q207-B



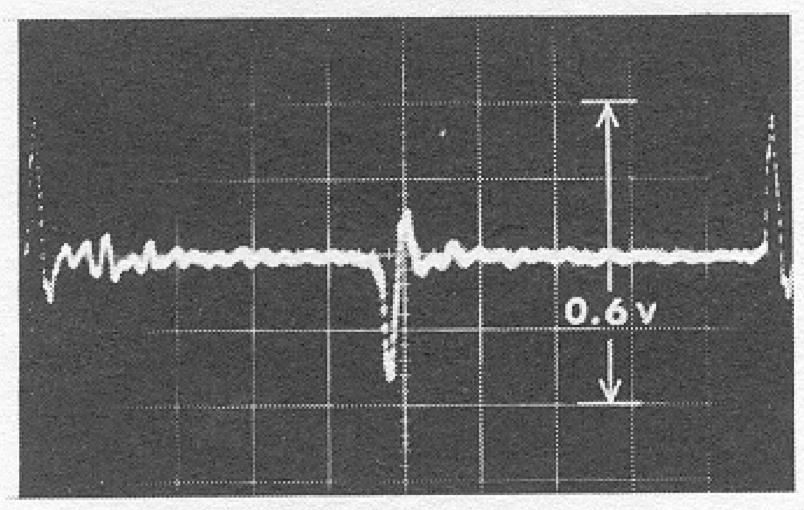
e. SYNC OUTPUT



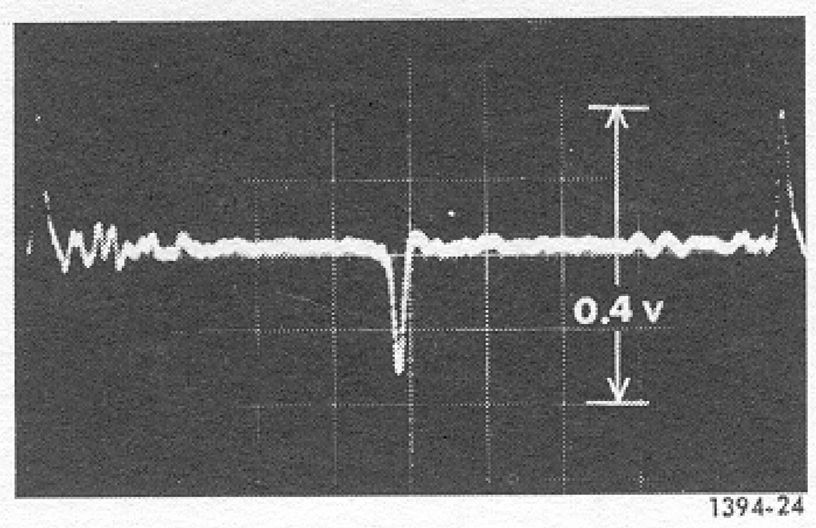
f. Q208-B,
PULSE DELAY: 0



g. Q209-B



h. Q210-B



i. AT210
(S901B, 107R)
(Q301B)

Figure 5-7. Input circuit waveforms. Sweep speed = 10 ns/div.

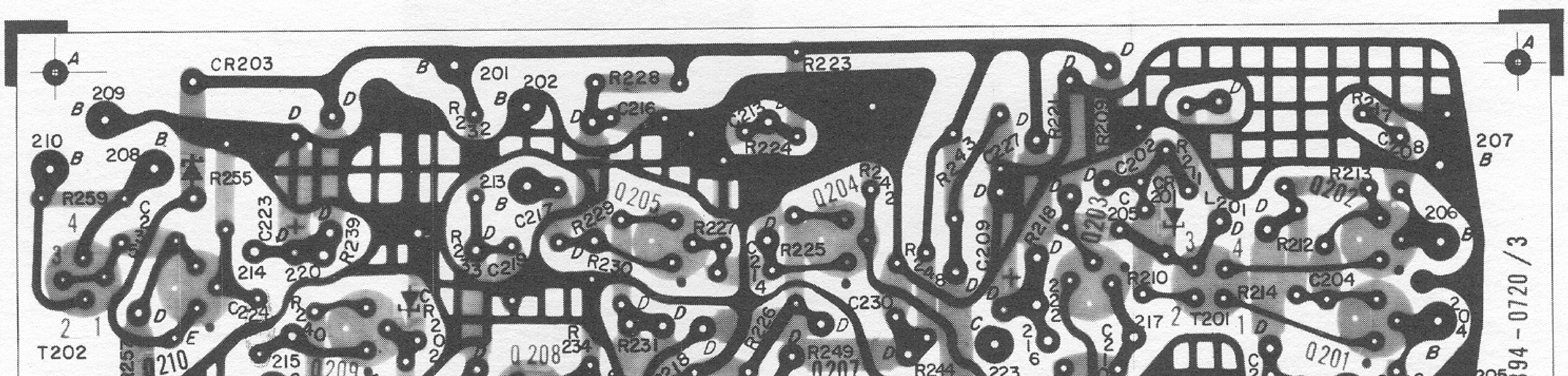


Figure 5-8. Input circuit etched board assembly.

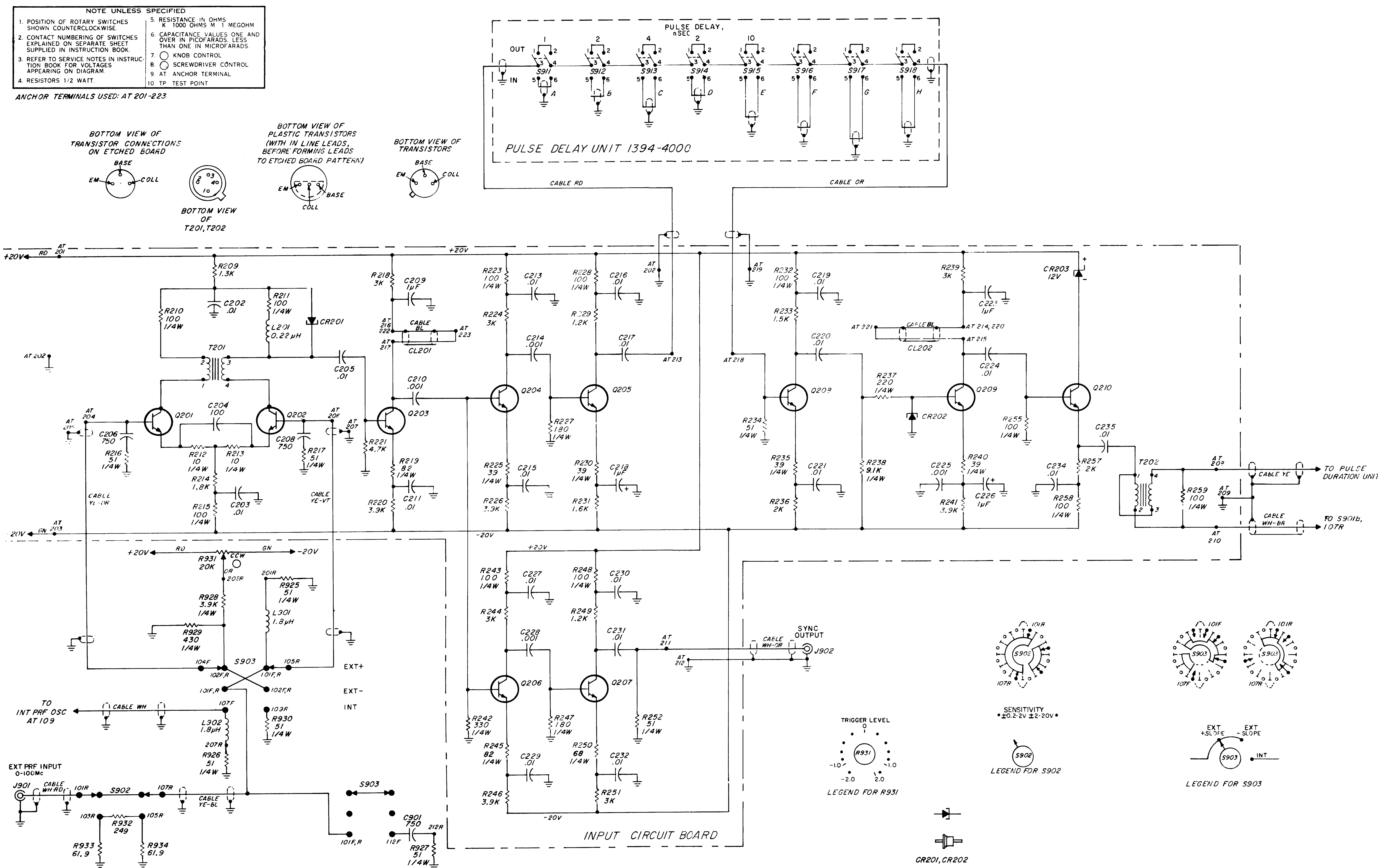


Figure 5-9. Input circuit diagram.

Table 5-4

PRF OSCILLATOR TEST TABLE

The oscillator and AGC circuits are located on the etched board directly below the PRF RANGE switch and PULSE REP FREQ control. If it has been ascertained that the power supply is adjusted and functioning properly, set the Input Selector Switch to INT, the FREQUENCY control for an output at 5 Mc/s, the PULSE DURATION switches to 0, and the PULSE DELAY switches to 0, unless otherwise stated (Figures 5-10 and 5-11).

Test	*Measurement to Ground From*	*Typical DC Voltage (volts)*	*If Test Fails*
Bias Voltage	AT111	+6.8	Replace CR101
AGC Circuit	Q103-E Q104-E	10.5	Remove and test Q103 and Q104
PRF Oscillator Typical Voltages	Q102-C Q102-E	+11.5 +6.4	Remove and test Q102
	Q103-B Q103-C	-9.9 -0.4	Remove and test Q103
	Q104-B Q104-C	-9.8 -2.0	Remove and test Q104
Voltages of Non-oscillating, but Non-defective Circuit. (This condition may be brought about by connecting with clip-leads an 0.47-μF capacitor from AT110 to S101, 102F. See Figure 5-2).	Junction of R107, R116, and R108	-0.8	Test Q101 and CR102
★PRF Oscillator Output	AT109		Adjust R111 to obtain 0.6-volt, peak-to-peak, sinewave. If no oscillations, or output voltage incorrect, perform above tests until fault located.
	AT109		As a check, the output should be about 1 volt, peak-to-peak with the FREQUENCY controls set for a 50-Mc/s output.

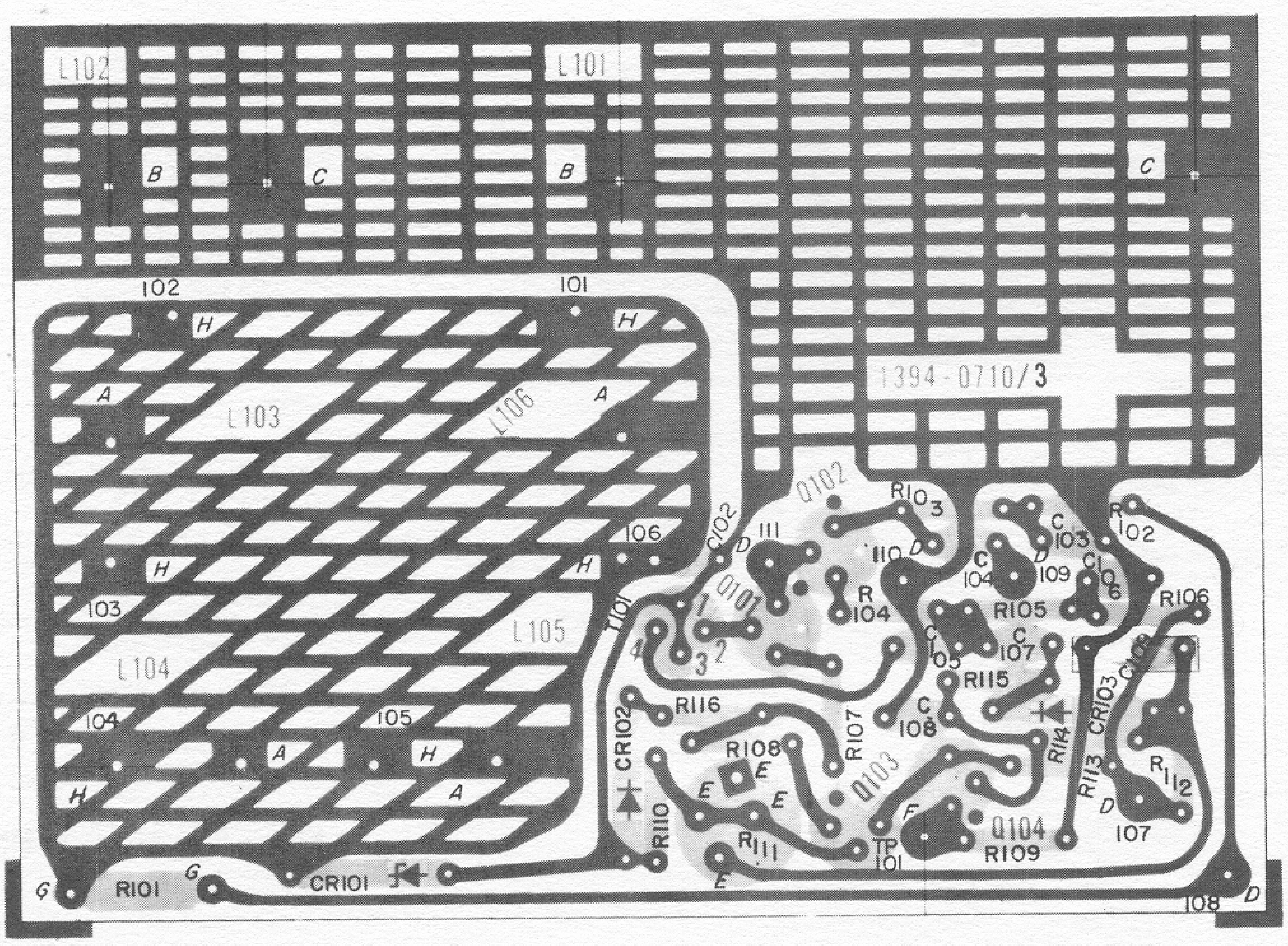
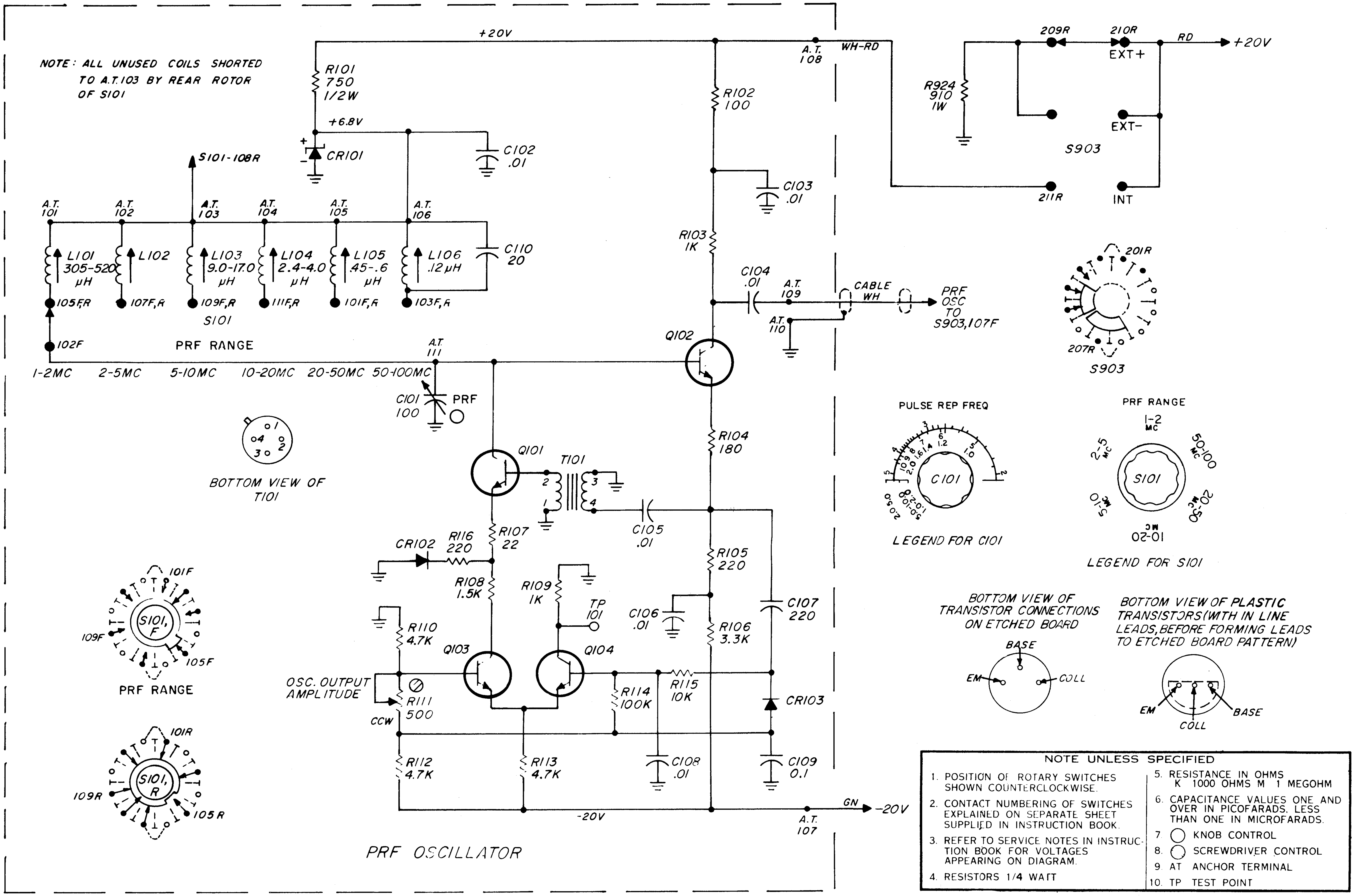


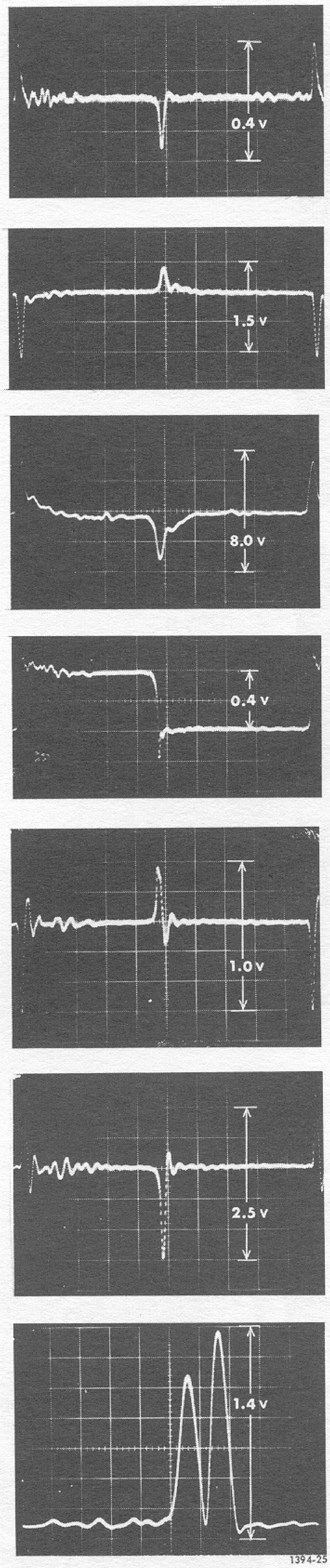
Figure 5-10. PRF Oscillator etched board assembly.



NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT
5. RESISTANCE IN OHMS K 1000 OHMS M 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ◯ SCREWDRIVER CONTROL
9. AT ANCHOR TERMINAL
10. TP TEST POINT

Figure 5-11. PRF Oscillator circuit diagram.



a. Q301-B

b. Q302-B

c. Q302-C

d. Q303-B (output of CR301)

e. Q304-B

f. Q305-B

g. Output from Trigger Channel Board

sweep speed: 10 ns/div

Figure 5-12. Trigger channel waveforms.

Table 5-5

RISE (FALL) PULSE GENERATOR

The pulse generator etched boards are located in the center of the instrument, to the left of the PULSE DURATION and PULSE DELAY cable units. If it has been ascertained that the power supply is adjusted and functioning properly, set the PULSE DURATION switches to 0 and the PULSE DELAY switches to 0. Center the TRIGGER LEVEL control (Figures 5-12 through 5-14).

Test	Measurement to Ground From	Control Settings	Typical Voltage	Waveform (Figure 5-12)	If Test Fails
★Input	Q301-B (Q301F-B)	Input Selector: INT PRF: 5 Mc/s	———	A	Refer to Table 5-3
Pulse Preamp Q301, Q302 (Q301F, Q302F)	Q302-B (Q302F-B)	same as above		B	Test Q301 (Q301F)
Bias	Q301-E (Q301F-E) Q302-E (Q302F-E)	Input Selector: EXT +	-0.8 V dc		Test Q302 (Q302F)
	Q301-C (Q301F-C) Q302-C (Q302F-C)	same as above	+4.5 V dc		Test Q301 (Q301F) Test Q302 (Q302F)
★Output	Q302-C (Q302F-C)	Input Selector: INT PRF: 5 Mc/s	———	C	Test Q302 (Q302F)
★Tunnel Diode CR301 (CR301F)	Q303-B (Q303F-B)	same as above	———	D	Replace CR301 (CR301F)
Differentiating Amplifier Q303, (Q303F)					
Bias	Q303-E (Q303F-E) Q303-C (Q303F-C)	Input Selector: EXT + same as above	-0.76 V dc +5.5 V dc		Test Q303 (Q303F)
★Output	Q304-B (Q304F-B)	Input Selector: INT PRF: 5 Mc/s	———	E	Test Q303 (Q303F)
Pulse Amplifier Q304, (Q304F)					
Bias	Q304-E (Q304F-E) Q304-C (Q304-C)	Input Selector: EXT + same as above	-0.8 V dc +4.7 V dc		Test Q304 (Q304F)
★Output	Q305-B (Q305F-B)	Input Selector: INT PRF: 5 Mc/s	———	F	Test Q304 (Q304F)
Pulse Clipper Q305, (Q305F)					
Bias	Q305-C Q305-E (Q305F-E) Q305F-C	Input Selector: EXT + same as above same as above	+9.5 V dc -0.63 V dc +11.0 V dc		Test Q305 (Q305F) Test Q305F
★Output	AT307 (AT307F)	Input Selector: INT PRF: 5 Mc/s		G	

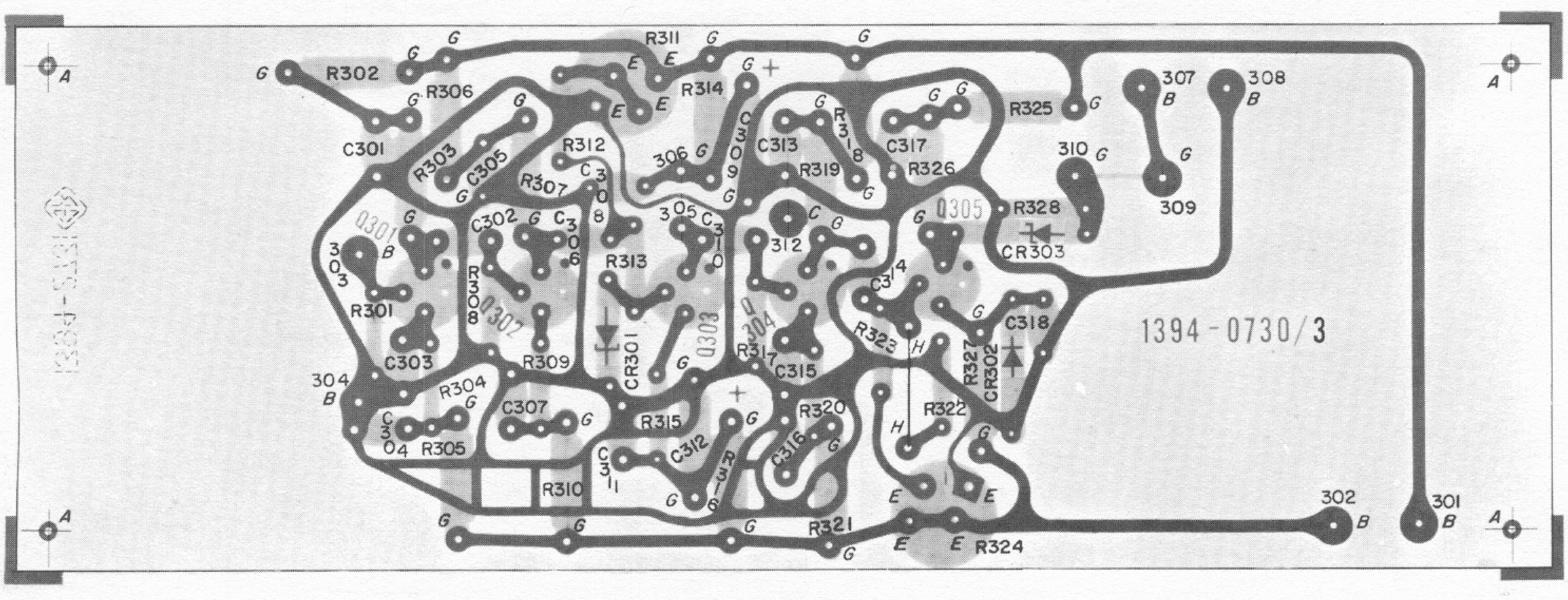


Figure 5-13. Trigger channel etched board assembly.

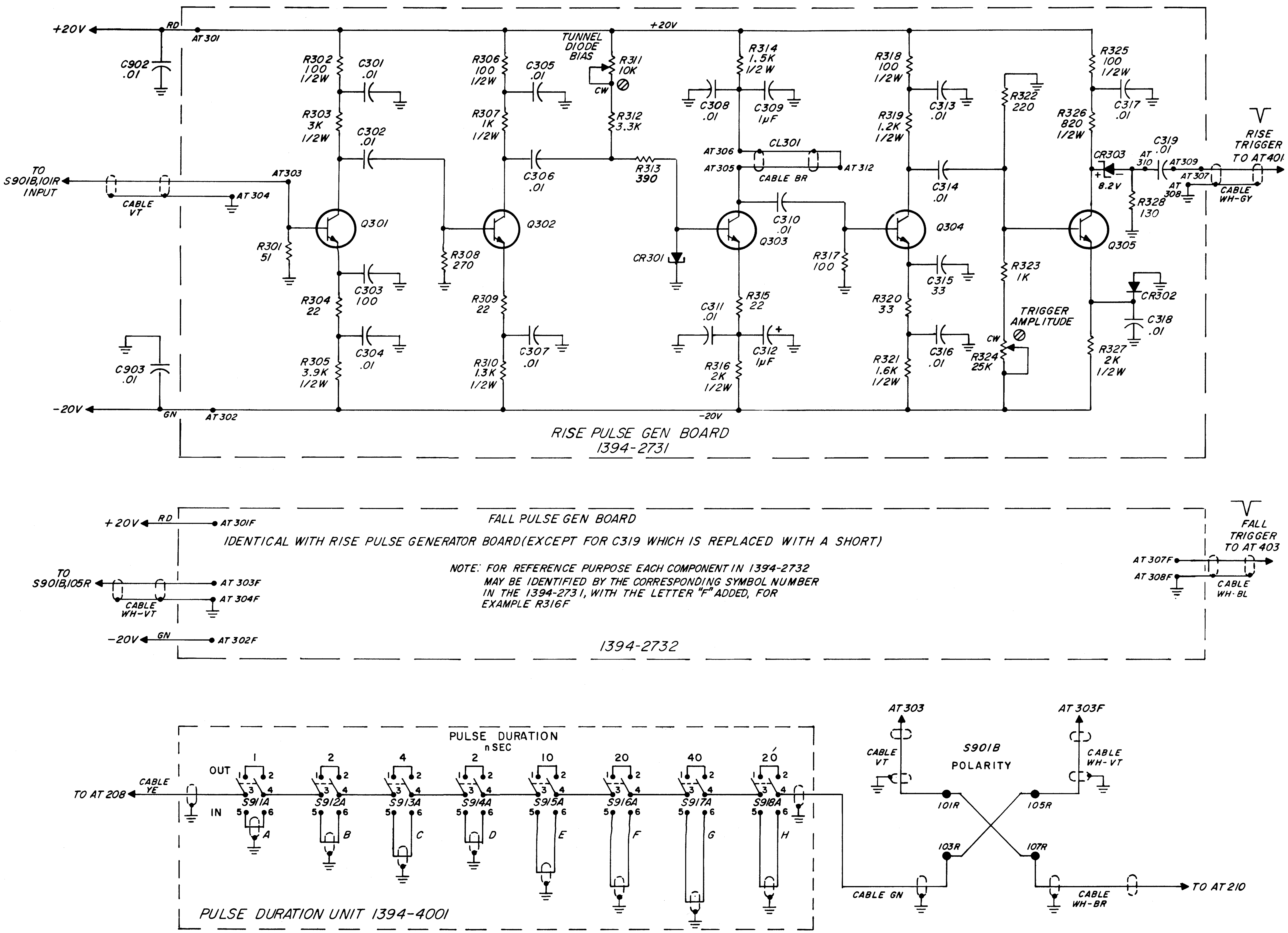


Figure 5-14. Trigger channel circuit diagram.

NOTE UNLESS SPECIFIED	
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.	5. RESISTANCE IN OHMS K 1000 OHMS M 1 MEGOHM
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.	6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.	7. ◯ KNOB CONTROL
4. RESISTORS 1/4 WATT.	8. ◯ SCREWDRIVER CONTROL
	9. AT ANCHOR TERMINAL
	10. TP TEST POINT

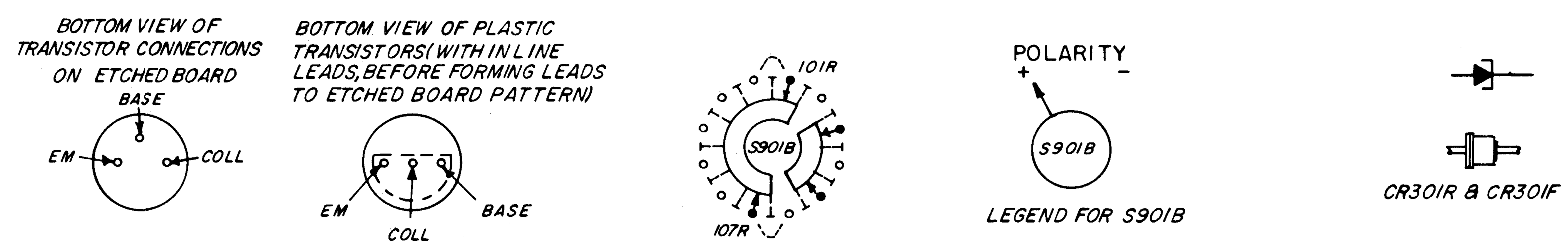


Table 5-6

OUTPUT CIRCUIT TEST TABLE

The output circuit board is located to the right of the PULSE DURATION cable unit and directly behind the AMPLITUDE switch. With the instrument off, short AT401 to AT403 (Figure 5-2) with a clip lead. Assuming that the +20-V and -20-V supply is working, set potentiometer R408 fully clockwise. Turn the Type 1394 on and adjust the OUTPUT AMPLITUDE ADJUST screwdriver control (R415) so that +10.1 volts appear at the emitters of Q406 and Q407 (approximately centered). Table 5-6 is the table of quiescent dc voltages only, so other control settings are inconsequential (Figures 5-15 and 5-16).

Test	*Measurement to Ground From*	*Voltage with R408 Fully Clockwise (volts)*	*Voltage with R408 Fully Counterclockwise (volts)*	*If Test Fails*
Bias Diodes CR402 and CR403	Q403-B and Q404-B	+6.8	+6.8	Replace CR403
	Junction of R417, R412, R411	+13.0	+13.0	Replace CR402
Input Stage Q401 and Q402	Q401-B	+2.53	+2.7	Measure R408 with an ohmeter to make sure its resistance varies properly (no need to remove). Remove and test Q401, Q402.
	Q401-E	+1.73	+2.0	
	Q402-B	+2.5	+3.2	
	Q402-E	+1.7	+2.3	
Ground-Base Stage Q403 and Q404	Q403-E	+6.0	+6.3	Remove and test Q403, Q404.
	Q403-C	+10.6	+12.9	
	Q404-E	+6.1	+6.0	
	Q404-C	+10.9	+8.4	
Output Stage Q406 and Q407	Q406-B	+10.6	+12.9	Remove and test Q406, Q407.
	Q406-C	+17.8	+13.4	
	Q406-E and Q407-E	+10.1	+12.0	
	Q407-B	+10.9	+8.4	
	Q407-C	+13.9	+17.6	

Remove the clip lead from terminals AT401 and AT403.

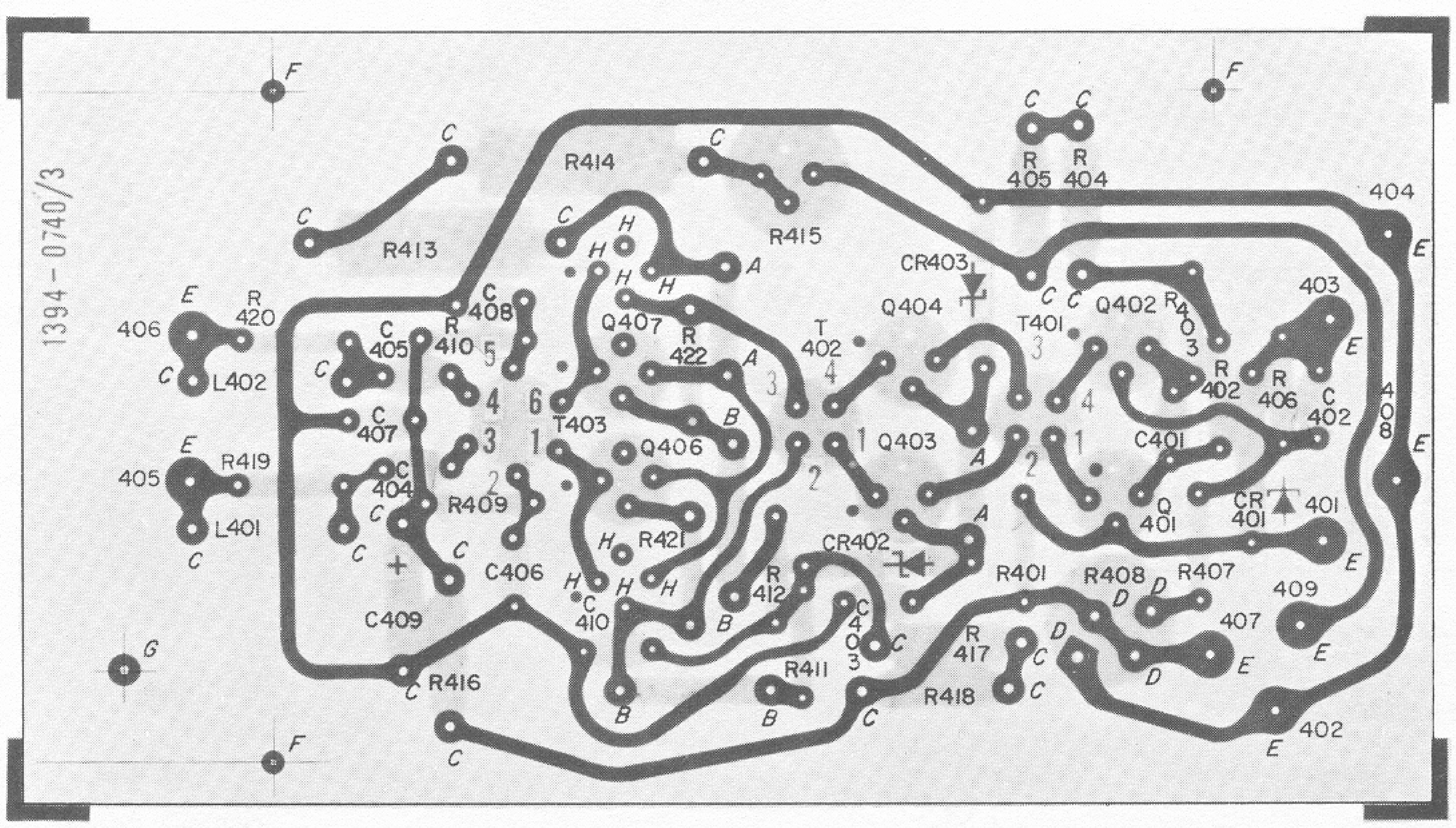


Figure 5-15. Output circuit etched board assembly.

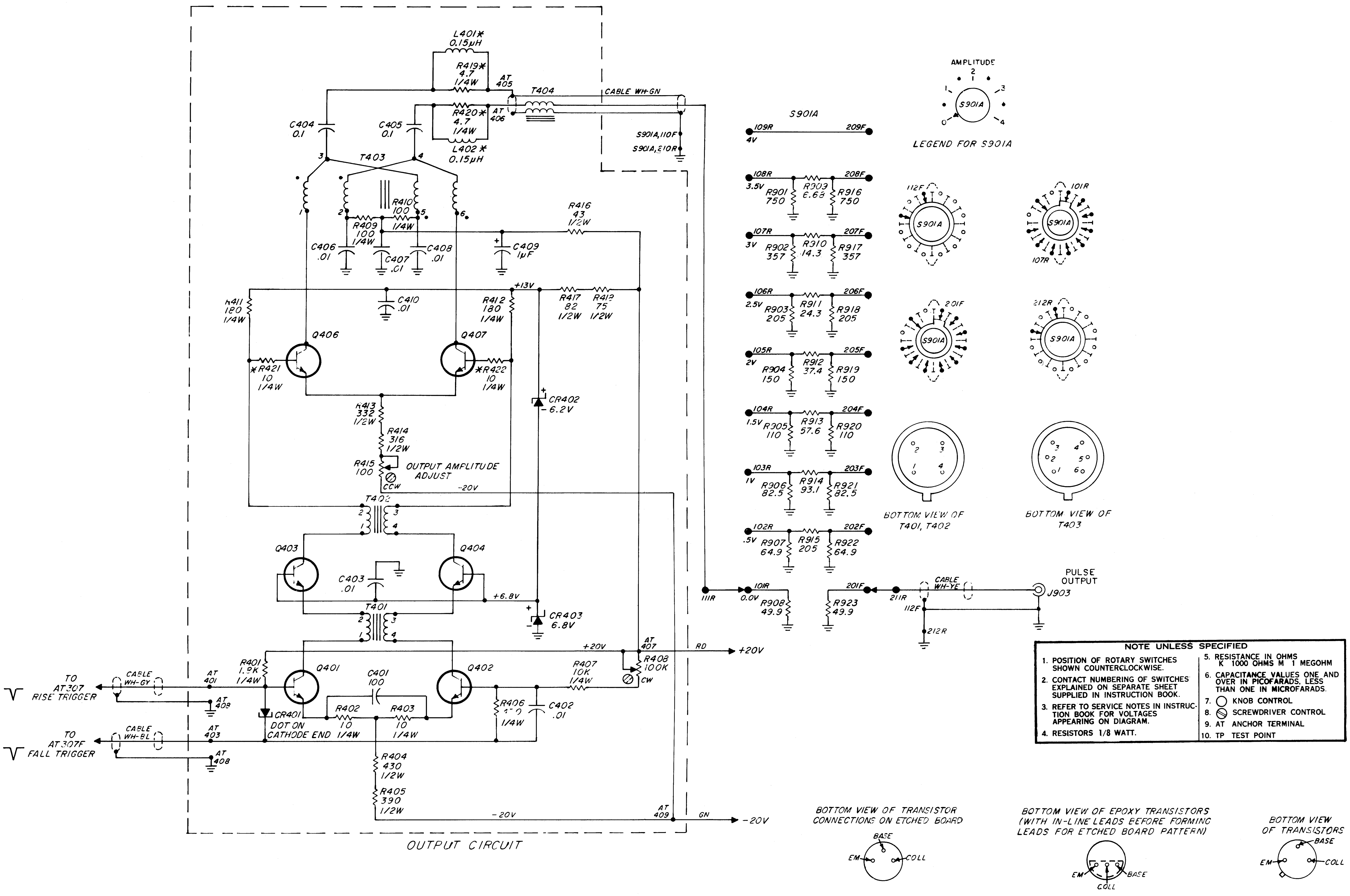


Figure 5-16. Output circuit diagram.

PARTS LIST — 1394-A

REF NO	DESCRIPTION	PART NO
	CAPACITORS	
C101	Variable air	0368-4200
C102 thru C106	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C107	Ceramic, 220 pF ±10% 500 V	4404-1228
C108	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C109	Ceramic, 0.1 μF ±20% 25 V	4400-2050
C110	Ceramic, 20 pF ±5% 500 V NPO	4410-0250
C202	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C203	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C204	Ceramic, 100 pF ±10% 500 V	4404-1108
C205	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C206	Ceramic, 750 pF ±10% 500 V	4405-1758
C208	Ceramic, 750 pF ±10% 500 V	4405-1758
C209	Electrolytic, 1 μF	4400-2070
C210	Ceramic, 0.001 μF ±10% 500 V	4405-2108
C211	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C213	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C214	Ceramic, 0.001 μF ±10% 500 V	4405-2108
C215	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C216	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C217	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C218	Electrolytic, 1 μF ±20% 35 V	4450-4300
C219	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C220	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C221	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C223	Electrolytic, 1 μF ±20% 25 V	4400-2070
C224	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C225	Ceramic, 0.001 μF ±10% 500 V	4405-2108
C226	Electrolytic, 1 μF ±20% 35 V	4450-4300
C227	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C228	Ceramic, 0.001 μF ±10% 500 V	4405-2108
C229 thru C232	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C234	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C235	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C301, C301F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C302, C302F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C303, C303F	Ceramic, 100 pF ±10% 500 V	4404-1108
C304, C304F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C305, C305F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C306, C306F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C307, C307F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C308, C308F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C309, C309F	Electrolytic, 1 μF ±20% 25 V	4400-2070
C310, C310F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C311, C311F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C312, C312F	Electrolytic, 1 μF ±20% 35 V	4450-4300
C313, C313F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C314, C314F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C315, C315F	Ceramic, 33 pF ±5% 500 V N750	4417-0335
C316, C316F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C317, C317F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100

REF NO	DESCRIPTION	PART NO
	CAPACITORS(Cont)	
C318, C318F	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C319	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C401	Ceramic, 100 pF ±10% 500 V	4404-1108
C402	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C403	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C404	Ceramic, 0.1 μF +80-20%	4403-4100
C405	Ceramic, 0.1 μF +80-20%	4403-4100
C406	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C407	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C408	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C409	Electrolytic, 1 μF ±20% 35 V	4450-4300
C410	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C501	Electrolytic, 600-300-300 pF +100-10% 75 V	4450-5606
C502	Electrolytic, 100 μF +100-10% 25 V	4450-2300
C503	Electrolytic, 100 μF +100-10% 25 V	4450-2300
C901	Ceramic, 750 pF ±10%	4405-1758
C902	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
C903	Ceramic, 0.01 μF +80-20% 50 V	4401-3100
	CHOKES	
L101		4290-4300
L102		1394-2110
L103		1394-2100
L104		1394-2101
L105		1394-2102
L106		1394-2103
L201	Metal, 0.22 μH ±20%	4300-0200
L301, L301F	Metal, 0.22 μH ±20%	4300-0220
L401	Metal, 0.15 μH ±20%	4300-0100
L402	Metal, 0.15 μH ±20%	4300-0100
L901	Metal, 1.8 μH ±10%	4300-1100
L902	Metal, 1.8 μH ±10%	4300-1100
	DIODES	
CR101	Zener, Type 1N957A, 6.8-V	6083-1008
CR102	Rectifier, Type 1N3604	6083-1001
CR103	Rectifier, Type 1N994	6082-1017
CR201	Tunnel, STD-694	6085-1001
CR202	Tunnel, STD-694	6085-1001
CR203	Zener, Type 1N759A, 12-V	6083-1014
CR301, CR301F	Tunnel, STD-694	6085-1001
CR302, CR302F	Rectifier, Type 1N645	6082-1016
CR303, CR303F	Zener, Type 1N959B, 8.2-V	6083-1010
CR401	Tunnel, TD-254A	6085-1002
CR402	Zener, Type 1N753A, 6.2-V	6083-1006
CR403	Zener, Type 1N957B, 6.8-V	6083-1009
CR501	Rectifier, Type 1N3253	6081-1001
CR502 thru CR504	Rectifier, Type 1N3253	6081-1001
CR505	Zener, Type 1N752, 5.6-V	6083-1004
	RESISTORS	
R101	Composition, 750 Ω ±5% 1/2 W	6100-1755
R102	Composition, 100 Ω ±10% 1/4 W	6099-1109
R103	Composition, 1 Ω ±10% 1/4 W	6099-2109
R104	Composition, 180 Ω ±10% 1/4 W	6099-1189
R105	Composition, 220 Ω ±10% 1/4 W	6099-1229
R106	Composition, 3.3 kΩ ±10% 1/4 W	6099-2339
R107	Composition, 22 Ω ±10% 1/4 W	6099-0229
R108	Composition, 1.5 kΩ ±10% 1/4 W	6099-2159
R109	Composition, 1 kΩ ±10% 1/4 W	6099-2109
R110	Composition, 4.7 kΩ ±10% 1/4 W	6099-2479

PARTS LIST (Cont)

RESISTORS (Cont)

REF NO	DESCRIPTION	PART NO
R111	Potentiometer, composition 500 Ω ±20%	6040-0300
R112	Composition, 4.7 kΩ ±10% 1/4 W	6099-2479
R113	Composition, 4.7 kΩ ±10% 1/4 W	6099-2479
R114	Composition, 100 kΩ ±10% 1/4 W	6099-4109
R115	Composition, 10 kΩ ±10% 1/4 W	6099-3109
R116	Composition, 220 kΩ ±10% 1/4 W	6099-1229
R209	Composition, 1.3 kΩ ±5% 1/2 W	6100-2135
R210	Composition, 100 Ω ±10% 1/4 W	6099-1109
R211	Composition, 100 Ω ±5% 1/4 W	6099-1105
R212	Composition, 10 Ω ±5% 1/4 W	6099-0105
R213	Composition, 10 Ω ±5% 1/4 W	6099-0105
R214	Composition, 1.8 kΩ ±5% 1/2 W	6100-2185
R215	Composition, 100 Ω ±10% 1/4 W	6099-1109
R216	Composition, 51 Ω ±5% 1/4 W	6099-0515
R217	Composition, 51 Ω ±5% 1/4 W	6099-0515
R218	Composition, 3 kΩ ±5% 1/2 W	6100-2305
R219	Composition, 82 Ω ±5% 1/4 W	6099-0825
R220	Composition, 3.9 kΩ ±5% 1/2 W	6100-2395
R221	Composition, 4.7 kΩ ±5% 1/2 W	6100-2475
R222	Composition, 22 Ω ±5% 1/4 W	6099-0225
R223	Composition, 100 Ω ±10% 1/4 W	6099-1109
R224	Composition, 3 kΩ ±5% 1/2 W	6100-2305
R225	Composition, 39 Ω ±5% 1/4 W	6099-0395
R226	Composition, 3.9 kΩ ±5% 1/2 W	6100-2395
R227	Composition, 180 Ω ±5% 1/4 W	6099-1185
R228	Composition, 100 Ω ±10% 1/4 W	6099-1109
R229	Composition, 1.2 kΩ ±5% 1/2 W	6100-2125
R230	Composition, 39 Ω ±5% 1/4 W	6099-0395
R231	Composition, 1.6 kΩ ±5% 1/2 W	6100-2165
R232	Composition, 100 Ω ±10% 1/4 W	6099-1109
R233	Composition, 1.5 kΩ ±5% 1/2 W	6100-2155
R234	Composition, 51 Ω ±5% 1/4 W	6099-0515
R235	Composition, 39 Ω ±5% 1/4 W	6099-0395
R236	Composition, 2 kΩ ±5% 1/2 W	6100-2205
R237	Composition, 220 Ω ±10% 1/4 W	6099-1229
R238	Composition, 10 kΩ ±5% 1/4 W	6099-3915
R239	Composition, 3 kΩ ±5% 1/2 W	6100-2305
R240	Composition, 39 Ω ±5% 1/4 W	6099-0395
R241	Composition, 3.9 kΩ ±5% 1/2 W	6100-2395
R242	Composition, 330 Ω ±5% 1/4 W	6099-1335
R243	Composition, 100 Ω ±10% 1/4 W	6099-1109
R244	Composition, 3 kΩ ±5% 1/2 W	6100-2305
R245	Composition, 82 Ω ±5% 1/4 W	6099-0825
R246	Composition, 3.9 kΩ ±5% 1/2 W	6100-2395
R247	Composition, 180 Ω ±5% 1/4 W	6099-1185
R248	Composition, 100 Ω ±10% 1/4 W	6099-1109
R249	Composition, 1.2 kΩ ±5% 1/2 W	6100-2125
R250	Composition, 68 Ω ±5% 1/4 W	6099-0685
R251	Composition, 3 kΩ ±5% 1/2 W	6100-2305
R252	Composition, 51 Ω ±5% 1/4 W	6099-0515
R255	Composition, 100 Ω ±5% 1/4 W	6099-1105
R256	Composition, 1.5 kΩ ±5% 1/2 W	6100-2155
R257	Composition, 2 kΩ ±5% 1/2 W	6100-2205
R258	Composition, 100 Ω ±10% 1/4 W	6099-1109
R259	Composition, 100 Ω ±5% 1/4 W	6099-1105
R301, R301F	Composition, 51 Ω ±5% 1/4 W	6099-0515
R302, R302F	Composition, 100 Ω ±5% 1/2 W	6100-1105
R303, R303F	Composition, 3 kΩ ±5% 1/2 W	6100-2305
R304, R304F	Composition, 22 Ω ±5% 1/4 W	6099-0225
R305, R305F	Composition, 3.9 kΩ ±5% 1/2 W	6100-2395
R306, R306F	Composition, 100 Ω ±5% 1/2 W	6100-1105
R307, R307F	Composition, 1 kΩ ±5% 1/2 W	6100-2105
R308, R308F	Composition, 270 Ω ±5% 1/4 W	6099-1275
R309, R309F	Composition, 22 Ω ±5% 1/4 W	6099-0225
R310, R310F	Composition, 1.3 kΩ ±5% 1/2 W	6100-2135
R311, R311F	Potentiometer, composition 10 kΩ ±20%	6040-0700
R312, R312F	Composition, 3.3 kΩ ±10% 1/4 W	6099-2339
R313, R313F	Composition, 390 Ω ±5% 1/4 W	6099-1395
R314, R314F	Composition, 1.5 kΩ ±5% 1/2 W	6100-2155
R315, R315F	Composition, 22 Ω ±5% 1/4 W	6099-0225
R316, R316F	Composition, 2 kΩ ±5% 1/2 W	6100-2205
R317, R317F	Composition, 100 Ω ±5% 1/2 W	6099-1105
R318, R318F	Composition, 100 Ω ±5% 1/2 W	6100-1105
R319, R319F	Composition, 1.2 kΩ ±5% 1/2 W	6100-2125
R320, R320F	Composition, 33 Ω ±5% 1/4 W	6099-0335
R321, R321F	Composition, 1.6 kΩ ±5% 1/2 W	6100-2165
R322, R322F	Composition, 220 Ω ±5% 1/4 W	6099-1225
R323, R323F	Composition, 1 kΩ ±10% 1/4 W	6099-2109
R324, R324F	Potentiometer, composition 25 kΩ ±20%	6040-0800
R325, R325F	Composition, 100 Ω ±5% 1/2 W	6100-1105
R326, R326F	Composition, 820 Ω ±5% 1/2 W	6100-1825
R327, R327F	Composition, 2 kΩ ±5% 1/2 W	6100-2205
R328, R328F	Composition, 130 Ω ±5% 1/4 W	6099-1135
R401	Composition, 1.8 kΩ ±5% 1/4 W	6099-2185
R402	Composition, 10 Ω ±5% 1/4 W	6099-0105
R403	Composition, 10 Ω ±5% 1/4 W	6099-0105
R404	Composition, 430 Ω ±5% 1/2 W	6100-1435
R405	Composition, 390 Ω ±5% 1/2 W	6100-1395
R406	Composition, 470 Ω ±10% 1/4 W	6099-1479
R407	Composition, 10 kΩ ±10% 1/4 W	6099-3109
R408	Potentiometer, composition 100 kΩ ±20%	6040-1000
R409	Composition, 100 Ω ±10% 1/4 W	6099-1109
R410	Composition, 100 Ω ±10% 1/4 W	6099-1109
R411	Composition, 180 Ω ±5% 1/4 W	6099-1185
R412	Composition, 180 Ω ±5% 1/4 W	6099-1185
R413	Composition, 332 Ω ±1% 1/2 W	6450-0332
R414	Composition, 316 Ω ±1% 1/2 W	6450-0316
R415	Potentiometer, wire-wound 100 Ω ±5%	6058-1105
R416	Composition, 43 Ω ±5% 1/2 W	6100-0435
R417	Composition, 82 Ω ±5% 1/2 W	6100-0825
R418	Composition, 75 Ω ±5% 1/2 W	6100-0755
R419	Composition, 4.7 Ω ±5% 1/4 W	6099-9475
R420	Composition, 4.7 Ω ±5% 1/4 W	6099-9475
R421	Composition, 10 Ω ±5% 1/4 W	6099-0105
R422	Composition, 10 Ω ±5% 1/4 W	6099-0105
R501	Power, 10 Ω ±5% 5 W	6660-0105
R502	Potentiometer, wire-wound 10 Ω ±10% 2 W	6050-0600
R503	Composition, 4.3 kΩ ±5% 1 W	6110-2435
R504	Composition, 560 Ω ±5% 1 W	6110-1565
R901	Film, 750 Ω ±1% 1/8 W	6250-0750
R902	Film, 357 Ω ±1% 1/8 W	6250-0357
R903	Film, 205 Ω ±1% 1/8 W	6250-0205
R904	Film, 150 Ω ±1% 1/8 W	6250-0150
R905	Film, 110 Ω ±1% 1/8 W	6250-0110

PARTS LIST (Cont)

REF NO	DESCRIPTION		PART NO
	RESISTORS (Cont)		
R906	Film, 82.5 Ω ±1% 1/8 W		6250-9825
R907	Film, 64.9 Ω ±1 % 1/8 W		6250-9649
R908	Film, 49.9 Ω ±1% 1/8 W		6250-9499
R909	Film, 6.68 Ω ±1% 1/8 W		6249-0668
R910	Film, 14.3 Ω ±1% 1/8 W		6250-9143
R911	Film, 24.3 Ω ±1% 1/8 W		6250-9243
R912	Film, 37.4 Ω ±1% 1/8 W		6250-9374
R913	Film, 57.6 Ω ±1% 1/8 W		6250-9576
R914	Film, 93.1 Ω ±1% 1/8 W		6250-9931
R915	Film, 205 Ω ±1% 1/8 W		6250-0205
R916	Film, 750 Ω ±1% 1/8 W		6250-0750
R917	Film, 357 Ω ±1% 1/8 W		6250-0357
R918	Film, 205 Ω ±1% 1/8 W		6250-0205
R919	Film, 150 Ω ±1% 1/8 W		6250-0150
R920	Film, 110 Ω ±1% 1/8 W		6250-0110
R921	Film, 82.5 Ω ±1% 1/8 W		6250-9825
R922	Film, 64.9 Ω ±1% 1/8 W		6250-9649
R923	Film, 49.9 Ω ±1% 1/8 W		6250-9499
R924	Composition, 910 Ω ±5% 1 W		6110-1915
R925	Composition, 51 Ω ±5% 1/4 W		6099-0515
R926	Composition, 51 Ω ±5% 1/4 W		6099-0515
R927	Composition, 51 Ω ±5% 1/4 W		6099-0515
R928	Composition, 3.9 kΩ ±5% 1/4 W		6099-2395
R929	Composition, 430 Ω ±5% 1/4 W		6099-1435
R930	Composition, 51 Ω ±5% 1/4 W		6099-0515
R931	Potentiometer	TRIGGER LEVEL	0971-4290
R932	Film, 249 Ω ±1% 1/2 W		6450-0249
R933	Film, 61.9 Ω ±1% 1/2 W		6450-9619
R934	Film, 61.9 Ω ±1% 1/2 W		6450-9619
R935	Wire-wound, 6.8 Ω ±5% 2 W		6760-9685
	TRANSFORMERS		
T101			5000-6300
T201			5000-6300
T202			5000-6300
T401			5000-6410
T402			5000-6300
T403			5000-6400
T404			1394-2010
T901	Power		0345-4016
	TRANSISTORS		
Q101	Type 2N918		8210-1066
Q102	Type 2N918		8210-1066
Q103	Type 2N2714		8210-1047
Q104	Type 2N2714		8210-1047
Q201	Type 2N709		8210-1054
Q202	Type 2N709		8210-1054
Q203 thru Q210	Type 2N918		8210-1066
Q301 thru Q305	Type 2N918		8210-1066
Q401 thru Q404	Type 2N918		8210-1066

REF NO	DESCRIPTION		PART NO
	TRANSISTORS (Cont)		
Q406	Type 2N2810A		8210-1115
Q407	Type 2N2810A		8210-1115
Q901	Type 2N2147		8210-1072
	ETCHED BOARD ASSEMBLIES		
	PRF OSCILLATOR CIRCUIT ASSEMBLY		1394-2711
	INPUT CIRCUIT ASSEMBLY		1394-2721
	TRIGGER CHANNEL CIRCUIT ASSEMBLY (Rise Trigger Channel)		1394-2731
	TRIGGER CHANNEL CIRCUIT ASSEMBLY (Fall Trigger Channel)		1394-2732
	OUTPUT CIRCUIT ASSEMBLY		1394-2741
	POWER SUPPLY CIRCUIT ASSEMBLY		1394-2751
	MISCELLANEOUS		
CL201	CLIPPING LINE		1394-0302
CL202	CLIPPING LINE		1394-0302
CL301	CLIPPING LINE		1392-0301
F901 F902	FUSE, 220-230 V 0.1 A		5330-0450
F901 F902	FUSE, 115 V 0.2 A		5330-0450
J901	CONNECTOR, Coaxial	EXT PRF INPUT	0874-4624
J902	CONNECTOR, Coaxial	SYNC OUTPUT	0874-4624
J903	CONNECTOR, Coaxial	PULSE OUTPUT	0874-4624
P901	PILOT LAMP, 6 V AC/DC 0.02 A Mazada No. 1784		5600-1001
PL901	PLUG		4240-0600
S101	SWITCH, Rotary	PRF RANGE	7890-4070
S901A	SWITCH, Rotary	AMPLITUDE	7890-4050
S901B	SWITCH, Rotary	POLARITY	7890-4050
S902	SWITCH, Rotary	SENSITIVITY	7890-4060
S903	SWITCH, Rotary	EXT SLOPE	7890-4080
S904	SWITCH, Toggle	POWER OFF	7910-1500
S905	SWITCH, Toggle		
S911, S911A	SWITCH, Toggle		
S912, S912A	SWITCH, Toggle		
S913, S913A	SWITCH, Toggle	PULSE DURATION	
S914, S914A	SWITCH, Toggle		
S915, S915A	SWITCH, Toggle	PULSE DELAY - nSEC (A)	
S916, S916A	SWITCH, Toggle		
S917, S971A	SWITCH, Toggle		
S918, S918A	SWITCH, Toggle		

NOTE: When or during a replacement etched board circuit assembly, use the assembly number appearing in the parts list, not the one appearing on the foil side of the etched board.

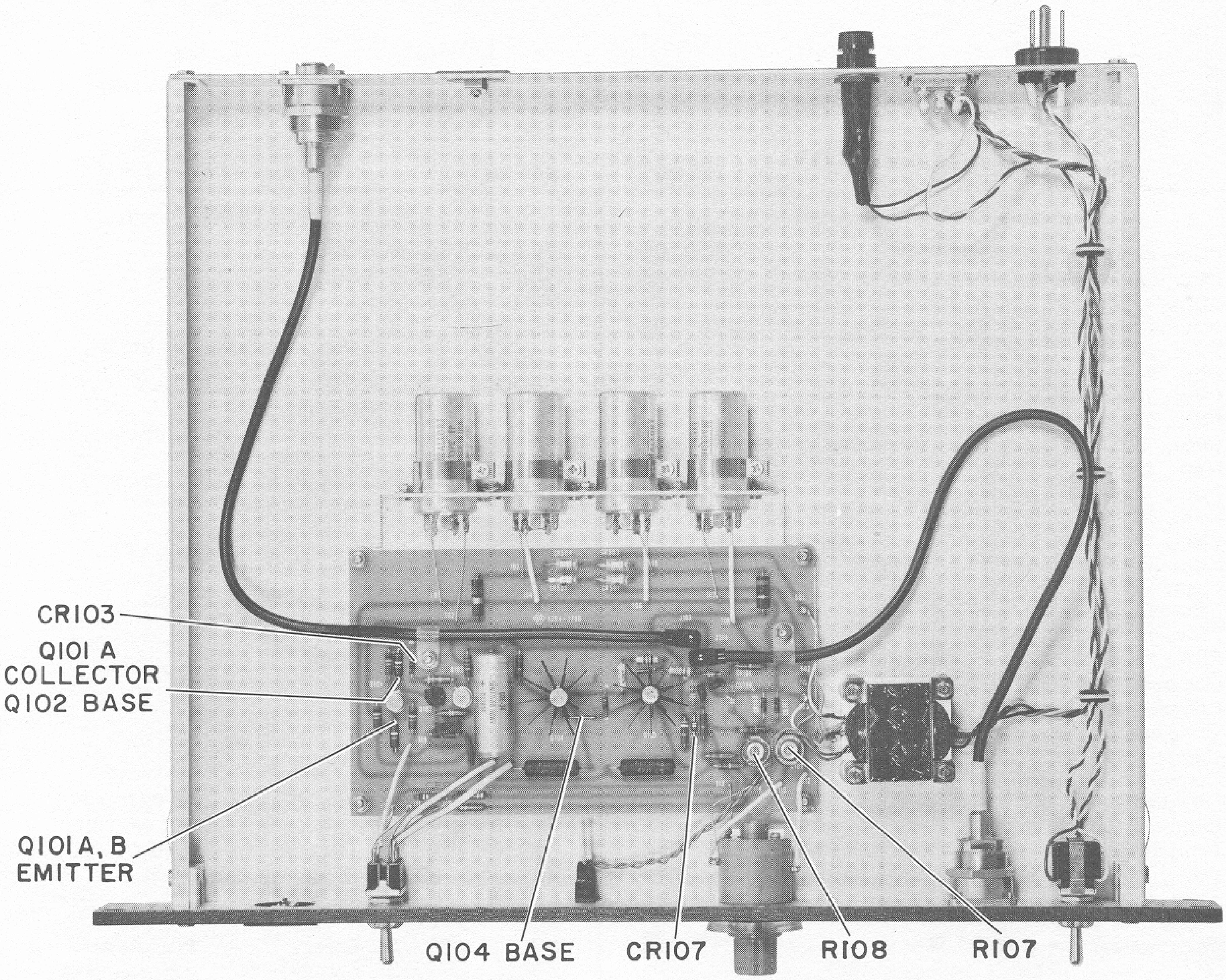


Figure 5-17. Interior view of the Type 1394-P1.

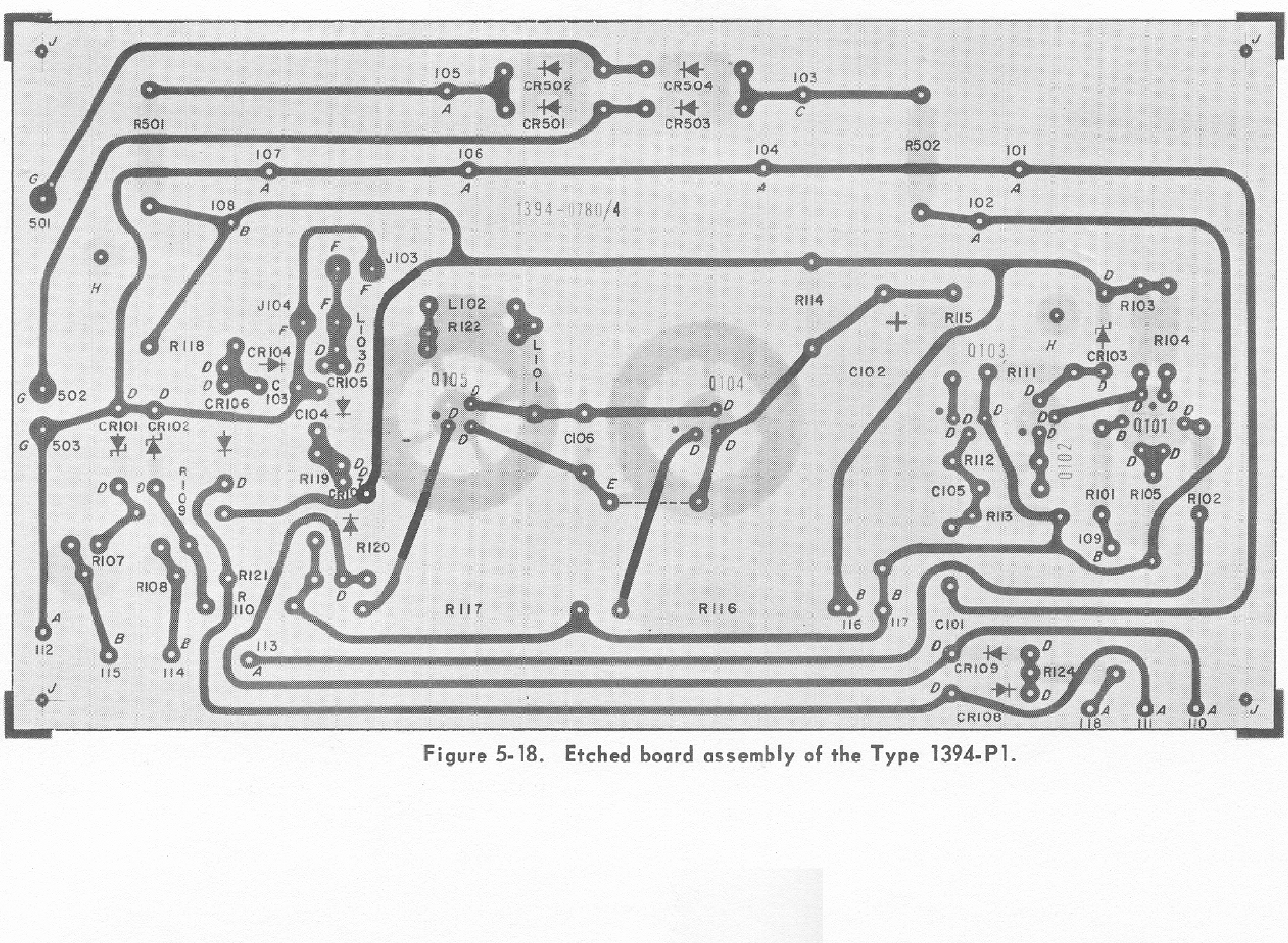


Figure 5-18. Etched board assembly of the Type 1394-P1.

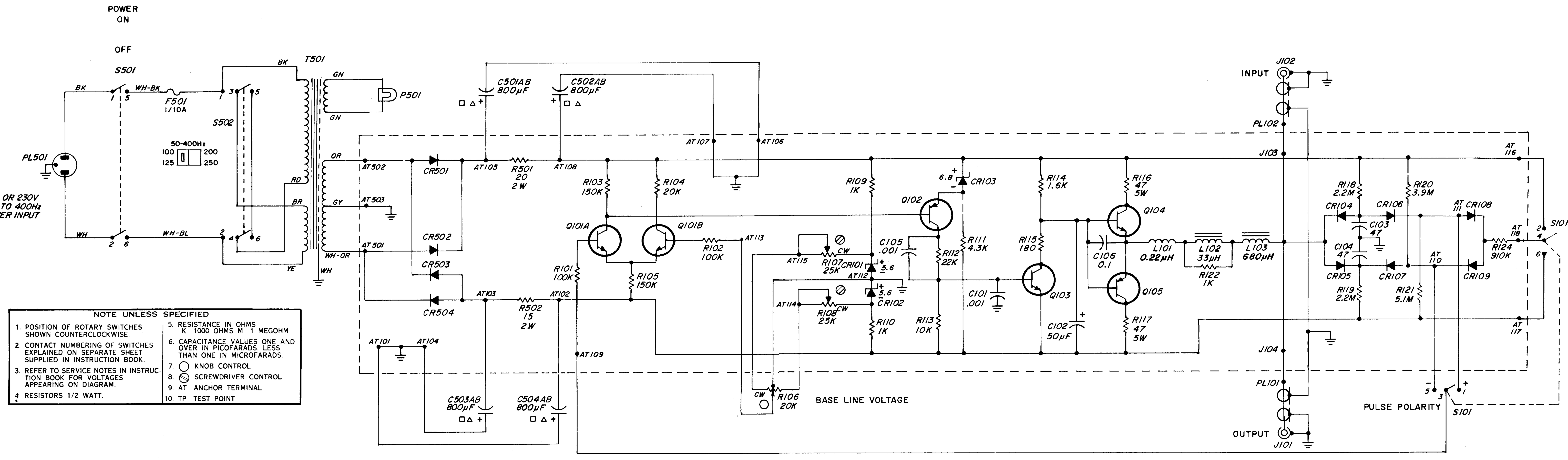
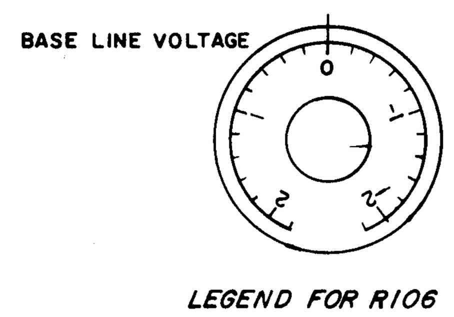
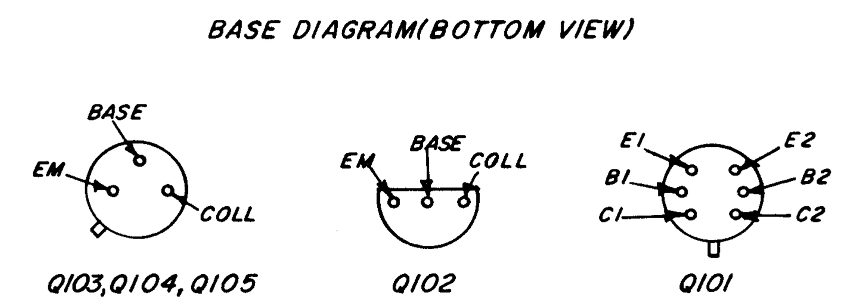


Figure 5-19. Circuit diagram of the Type 1394-P1.





PARTS LIST — 1394-P1

REF NO	DESCRIPTION	PART NO
	CAPACITORS	
C101	Ceramic, 0.001 μF ±10% 500 V	4405-2108
C102	Electrolytic, 50 μF +100-10% 50 V	4450-2200
C103	Ceramic, 47 pF ±10% 500 V	4404-0478
C104	Ceramic, 47 pF ±10% 500 V	4404-0478
C501A C501B	Electrolytic, 800 μF +100-10% 25 V	4450-5621
C502A C502B	Electrolytic, 800 μF +100-10% 25 V	4450-5621
C503A C503B	Electrolytic, 800 μF +100-10% 25 V	4450-5621
C504A C504B	Electrolytic, 800 μF +100-10% 25 V	4450-5621
	RESISTORS	
R101	Composition, 100 kΩ ±5% 1/2 W	6100-4105
R102	Composition, 100 kΩ ±5% 1/2 W	6100-4105
R103	Composition, 150 kΩ ±5% 1/2 W	6100-4155
R104	Composition, 20 kΩ ±5% 1/2 W	6100-3205
R105	Composition, 150 kΩ ±5% 1/2 W	6100-4155
R106	Potentiometer, 20 kΩ ±5%	0972-4070
R107	Potentiometer, composition 25 kΩ ±20%	6040-0800
R108	Potentiometer, composition 25 kΩ ±20%	6040-0800
R109	Composition, 1.0 kΩ ±5% 1/2 W	6100-2105
R110	Composition, 1.0 kΩ ±5% 1/2 W	6100-2105
R111	Composition, 4.3 kΩ ±5% 1/2 W	6100-2435
R112	Composition, 22 kΩ ±5% 1/2 W	6100-3225
R113	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R114	Composition, 1.6 kΩ ±5% 1/2 W	6100-2165
R115	Composition, 180 Ω ±5% 1/2 W	6100-1185
R116	Power, 56 Ω ±5% 5 W	6660-0565
R117	Power, 56 Ω ±5% 5 W	6660-0565
R118	Composition, 2.2 MΩ ±5% 1/2 W	6100-5225
R119	Composition, 2.2 MΩ ±5% 1/2 W	6100-5225
R120	Composition, 3.9 MΩ ±5% 1/2 W	6100-5395
R121	Composition, 5.1 MΩ ±5% 1/2 W	6100-5515
R501	Wire-wound, 20 Ω ±5% 2 W	6760-0205
R502	Wire-wound, 15 Ω ±10% 2 W	6760-0159
	MISCELLANEOUS	
CR101	DIODE, Zener, Type 1N752A (5.6 V)	6083-1004
CR102	DIODE, Zener, Type 1N752A (5.6 V)	6083-1004
CR103	DIODE, Zener, Type 1N957A (6.8 V)	6083-1008
CR104 thru CR107	DIODE, Type HD 5000	6082-1021
CR501 thru CR504	DIODE, Type 1N3253	6081-1001
F501	FUSE, 1/16 A	5330-0300
J101	JACK, 874 Coaxial Connector OUTPUT	0874-4622
J102	JACK, 874 Coaxial Connector INPUT	0874-4622
J103	JACK, Built In	1394-2780
J104	JACK, Built In	1394-2780
L101	CHOKE, Metal, 100 μH ±5%	4300-6392
L102	CHOKE, Metal 15 μH ±10%	4300-2400
L103	CHOKE, Metal, 0.22 μH ±20%	4300-0200
S101	SWITCH, Toggle PULSE POLARITY	7910-0800
S501	SWITCH, Toggle POWER OFF	7910-1300
S502	SWITCH, Slide	7910-0831
T501	TRANSFORMER	0744-4000
Q101	TRANSISTOR, Type 2N2453	8210-1046
Q102	TRANSISTOR, Type 2N3638	8210-1096
Q103	TRANSISTOR, Type 2N2218	8210-1028
Q104	TRANSISTOR, Type 2N2218	8210-1028
Q105	TRANSISTOR, Type 2N2904	8210-1074
	ETCHED BOARD ASSEMBLY	
	Type 1394-P1 ETCHED BOARD ASSEMBLY	1394-2781

Table 5-7

PULSE-OFFSET CONTROL

The voltages listed in this table were measured with a Type 1806 Electronic Voltmeter under the following conditions:

Line voltage: 115 V ac
BASE-LINE VOLTAGE: 0
PULSE POLARITY: +
INPUT terminal: open
OUTPUT terminal: terminated in 50 Ω

Test	*Measurement to Ground from*	*Typical Voltage*	*If Test Fails*
Power Supply	AT501 } AT502 }	50-V, p-p, clipped sine wave	Make sure LINE switch is in proper position. Check fuse F501. Check power cord.
	AT108	+23.0 V dc with 0.015-V, p-p, 120-c/s ripple	If ripple only 60-c/s, either CR501 or CR502 is defective. If no voltage, both defective. If voltage low, or ripple excessive, remove and test C501 and C502.
	AT102	-23.0 V dc, with 0.015-V, p-p, 120-c/s ripple	If ripple only 60 c/s, either CR503 or CR504 is defective. If no voltage, both defective. If voltage low, or ripple excessive, remove and test C503 and C504.
	CR101 cathode	+5.6 V dc	Replace CR101
	CR102 anode	-5.6 V dc	Replace CR102
Differential Amplifier	Q101A, Q101B emitter Q101A base Q101A collector Q101B base Q101B collector	-0.5 V dc -.03 V dc +15.0 V dc -.01 V dc +21.0 V dc	Remove Q101 and test each section. Also check for +.02 V dc at anode of CR108. If test negative, remove and test CR108 and CR106.
DC Amplifier	Q102 emitter	+16.0 V dc	Replace CR103
	Q102 collector	-19.0 V dc	Remove and test Q102
	Q103 base Q103 collector	-22.5 V dc -3.9 V dc	Remove and test Q103
Output Amplifier	Q104, Q105 base Q104, Q105 emitter Q104 collector Q105 collector	-0.6 V dc 0 V +23.0 V dc -23.0 V dc	Remove and test Q104 and Q105
Peak Voltage Detector	CR104 anode	+.09 V dc	Remove and test CR104 and CR106
	CR105 cathode CR109 cathode	+10.0 V dc +10.3 V dc	Remove and test CR105, CR107, and CR109.

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