

TYPE 1156-A DECADE SCALER

YPE 1156-A

GENERAL RADIO COMPANY

INSTRUCTION MANUAL

TYPE 1156-A DECADE SCALER

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GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

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CONDENSED OPERATING INSTRUCTIONS

CAUTION

Be sure the LINE switch on the rear of the instrument is set for the proper line voltage.

- a. Connect the Type 1156-A Decade Scaler to the power line and to the frequency meter (or other instrument).
- b. Turn the POWER switch on.
- c. Set the SENSITIVITY control for the desired sensitivity and attach the input signal to the INPUT connector.
- d. Set the TRIGGER LEVEL control for proper triggering. The TRIGGER LEVEL control will normally be set with the white dot straight up.

SPECIFICATIONS



Frequency	Impedance	Remarks
INPUT **Dc to 100 Mc/s		VSWR: 1.1 max at 100 Mc/s (50 Ω). Reflection: 10% max with 0.4-ns step (50 Ω).
OUTPUT Dc to 10 Mc/s	250 Ω	Approximately square-wave output, 20 mA; 1 V into 50 Ω , over 5 V open circuit, all p-to-p.

Sensitivity: 0.1, 0.2, 0.5, and 1 V, p-to-p, at 50 Ω ; 1 V, p-to-p, at 500 Ω. Maximum input is 20 times sensitivity or ½ W, whichever is smaller.

GENERAL

Power Required: 105 to 125 or 210 to 250 V, 50 to 60 c/s, 15 W. Terminals: GR874 Locking Connectors. For connection to other types of coaxial connectors, use a locking adaptor, which locks securely in place, yet is easily removed.

Accessories Supplied: Type CAP-22 Power Cord, spare fuses. Accessories Available: Type 874-K Coupling Capacitor for ac coupling to input or output connectors.

Mechanical Data: Rack-Bench Cabinet

W 7.7	W	idth	He	ight	De	pth	N Wes	et ight	Ship We	ping right
Model	in	mm	in	mm	in	mm	lb	kg	lb	kg
Bench	19	485	2 1/8	54	121/4	315	103/4	4.9	25	11.5
Rack	19	485	1 3/4	45	1 1 3/16*	288	103/4	4.9	25	11.5

General Radio Experimeter reference: Vol 39, No. 9, Sept. 1965 U. S. Patent No. 2,548,457

* Behind panel

^{**} Dc to 125 Mc/s at reduced sensitivity (300 mV).

SECTION

INTRODUCTION

	PURPOSE	
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• 1.1 PURPOSE

The Type 1156-A Decade Scaler extends the upper frequency limit of any General Radio counter, counters of other makes, oscilloscope trigger circuits, analog frequency meters, or any instrument requiring 10-to-1 frequency division.

• 1.2 DESCRIPTION

The Scaler is a completely, self-contained, 100-Mc, direct-counting frequency divider.

The input circuitry consists of a GR874 locking connector, an attenuator with four 50-ohm positions and one 500-ohm position, and an input amplifier, which provides 100-millivolt sensitivity and also isolates the input from noise generated by the switching circuits. The input amplifier is followed by two Schmitt circuits,

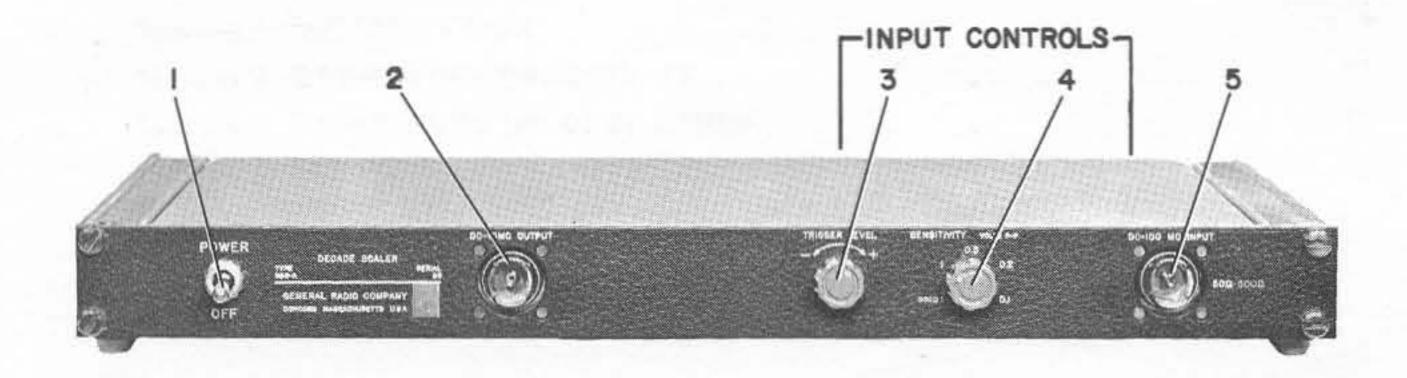
a self-clearing ring that scales by five, and a flip-flop that scales by two. This flip-flop drives a high-current Schmitt circuit, which delivers 30-milliampere square waves to a GR874 locking connector.

A level control permits optimum triggering with a variety of inputs including sine waves, pulses, and noisy signals. The input and output connectors can be attached to either the front or the rear of the instrument.

• 1.3 ACCESSORIES SUPPLIED

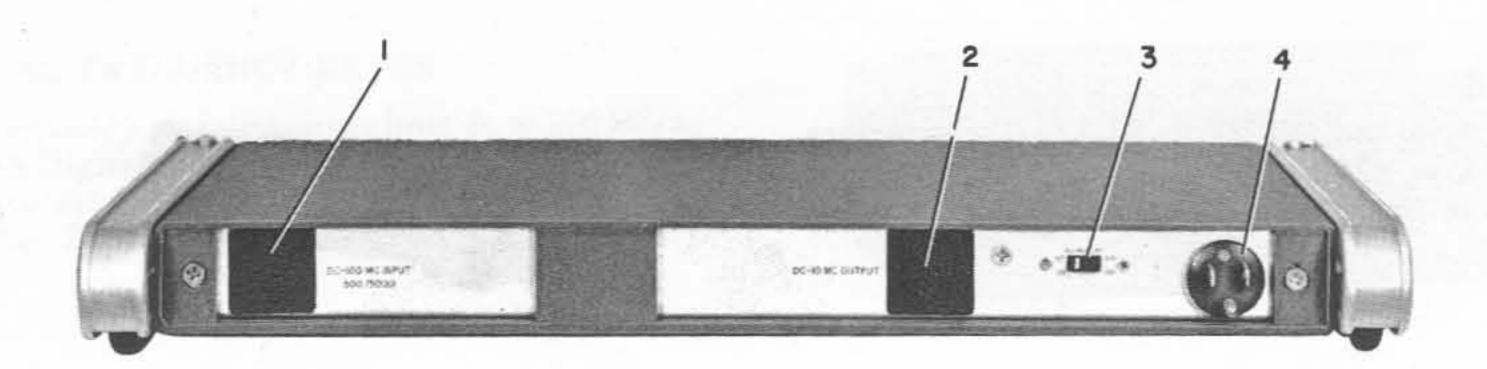
Quant	ity Description	Part Number
1	Instruction manual	1156-0100
2	Cable connectors, Type 874-C58A	0874-9414
1	Power cord, Type CAP-22	4200-9622
1	Fuse, 0.25 A	5330-0700

• 1.4 FRONT-PANEL CONTROLS AND CONNECTORS



- POWER.......Two-position toggle switch. Applies line voltage to instrument.
 OUTPUT.......GR874 recessed locking connector; can be moved to the
- 2 OUTPUT......GR874 recessed locking connector; can be moved to the rear. Output is 30-mA, p-to-p, square waves (1.5V into 50Ω, 5V into open-circuit). Output frequency is dc to 10 Mc/s (1/10 of input frequency).
- 3 TRIGGER LEVEL. Continuously adjustable potentiometer. Adjusts for proper triggering over a wide range of input wave shapes.
- 4 SENSITIVITY..... Five-position rotary switch. Sets input impedance and sensitivity: 0.1, 0.2, 0.5, or 1V, p-to-p, at 50Ω or 1V, p-to-p, at 500Ω .
- 5 INPUT.......GR874 recessed locking connector; can be moved to the rear. Input capability is dc to 100 Mc/s. Maximum input is 20 times SENSITIVITY control setting or ½W, whichever is smaller.

1.5 REAR-PANEL CONTROLS AND CONNECTORS



1		e and snap-in cover plate; optional location of IN- T connector.
2		e and snap-in cover plate; optional location of OUT- T connector.
3		o-position slide switch. Selects line voltage range, V or 230 V.
4	Power connectorThe	ee-pin male connector. For connection to power line.

1.6 ACCESSORIES AND SUPPLEMENTARY EQUIPMENT AVAILABLE

AC COUPLER

For ac coupling to the INPUT or OUTPUT connectors, the Type 874-K or 874-KL (locking connectors). Coupling Capacitor is available.



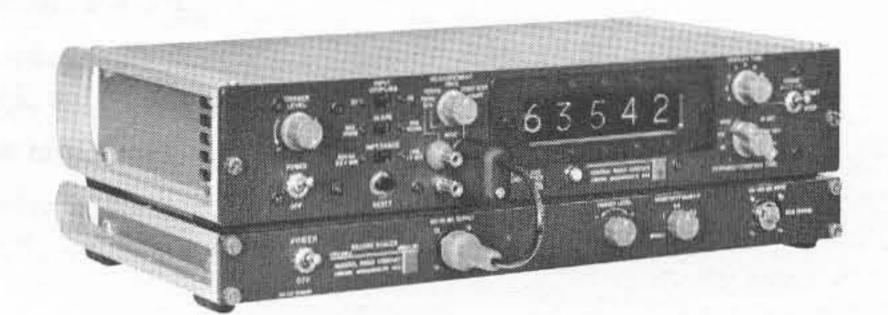
4-Mc DIGITAL FREQUENCY METER

For digital frequency measurements from 10 c/s to 4 Mc/s, the Type 1150 Digital Frequency Meter can be used with the decade scaler.



4-Mc DIGITAL TIME AND FREQUENCY METER

For digital time and frequency measurements from dc to 4 Mc/s, the Type 1151 Digital Time and Frequency Meter can be used with the decade scaler.



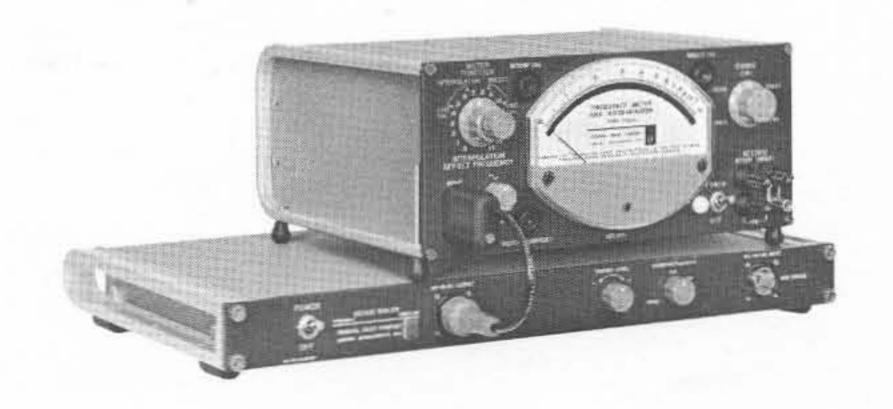
10-Mc DIGITAL FREQUENCY METER

For digital frequency measurements from dc to 10 Mc/s the Type 1150-BH Digital Frequency Meter can be used with the decade scaler.



15-Mc ANALOG FREQUENCY METER

For analog frequency measurements from 3 c/s to 15 Mc/s, the Type 1142 Frequency Meter and Discriminator can be used with the decade scaler.



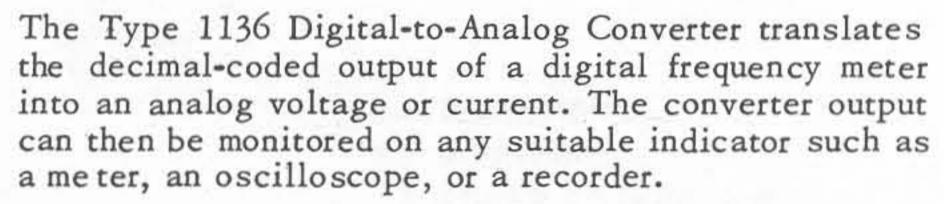
100-Mc DIGITAL FREQUENCY METER

For digital frequency measurements from dc to 100 Mc/s, the Type 1153 Digital Frequency Meter can be used with the decade scaler. This combination is available as an assembly, the Type 1144 100-Mc Digital Frequency Meter.



RECORDERS AND CONVERTERS

The Type 1137 Data Printer converts the decimalcoded output of a digital frequency meter into permanent, printed form.



The Type 1521 Graphic Level Recorder permanently records the analog data from a Type 1142 Frequency Meter and Discriminator or a Type 1136 Digital-to-Analog Converter.

A combination of the Type 1136 Digital-to-Analog Converter and the Type 1521 Graphic Level Recorder is available as an assembly, the Type 1510 Digital-to-Graphic Recording Assembly.

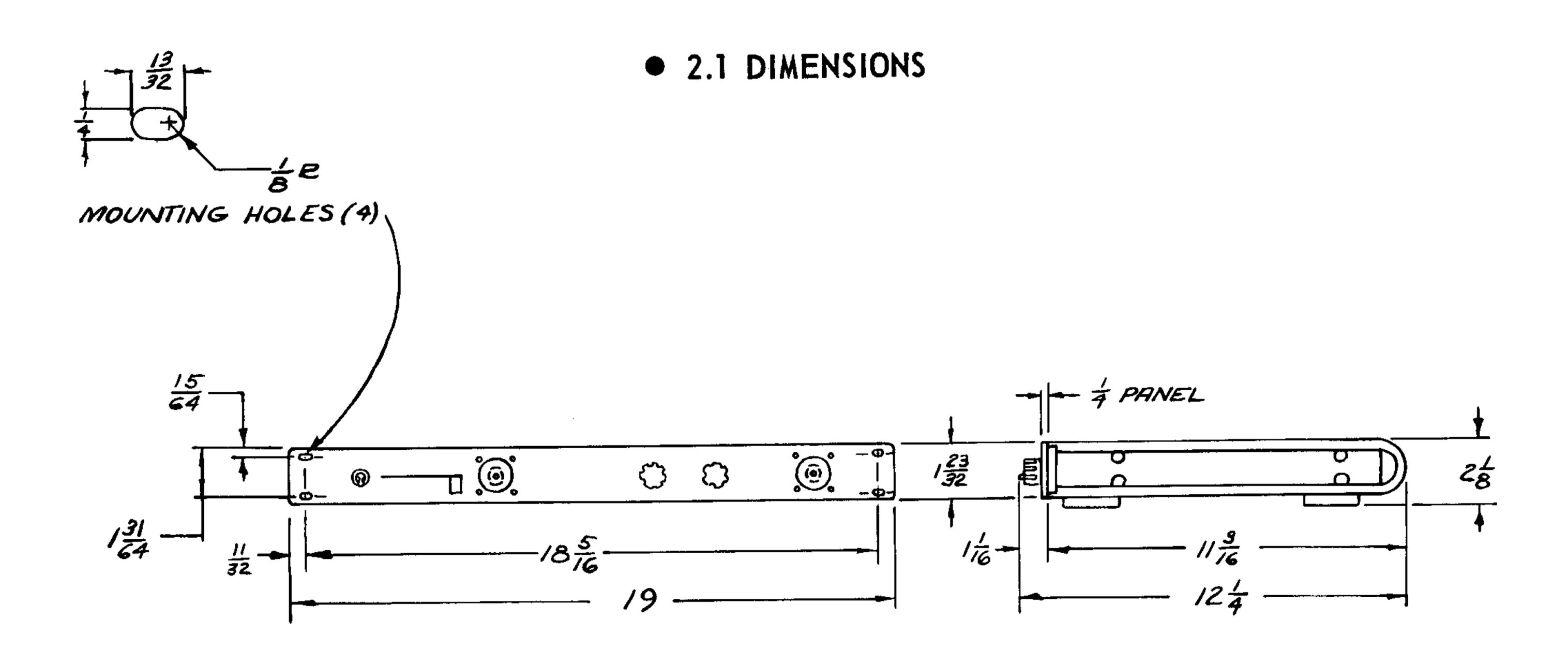




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2.2 MOUNTING

2.2.1 BENCH/RACK CONVERSION

The Type 1156-A Decade Scaler is supplied in two models, bench mount and rack mount. Either model can be converted to the other by the installation of a conversion set.

CONVERSION SETS

Model	Use	Conversion Set
Bench	For bench mounting or stack mounting	None required. Simply remove end frames and secure to rack with panel screws.
Rack	For mounting in standard	5310-9610 end frame

set converts rack model

to bench model.

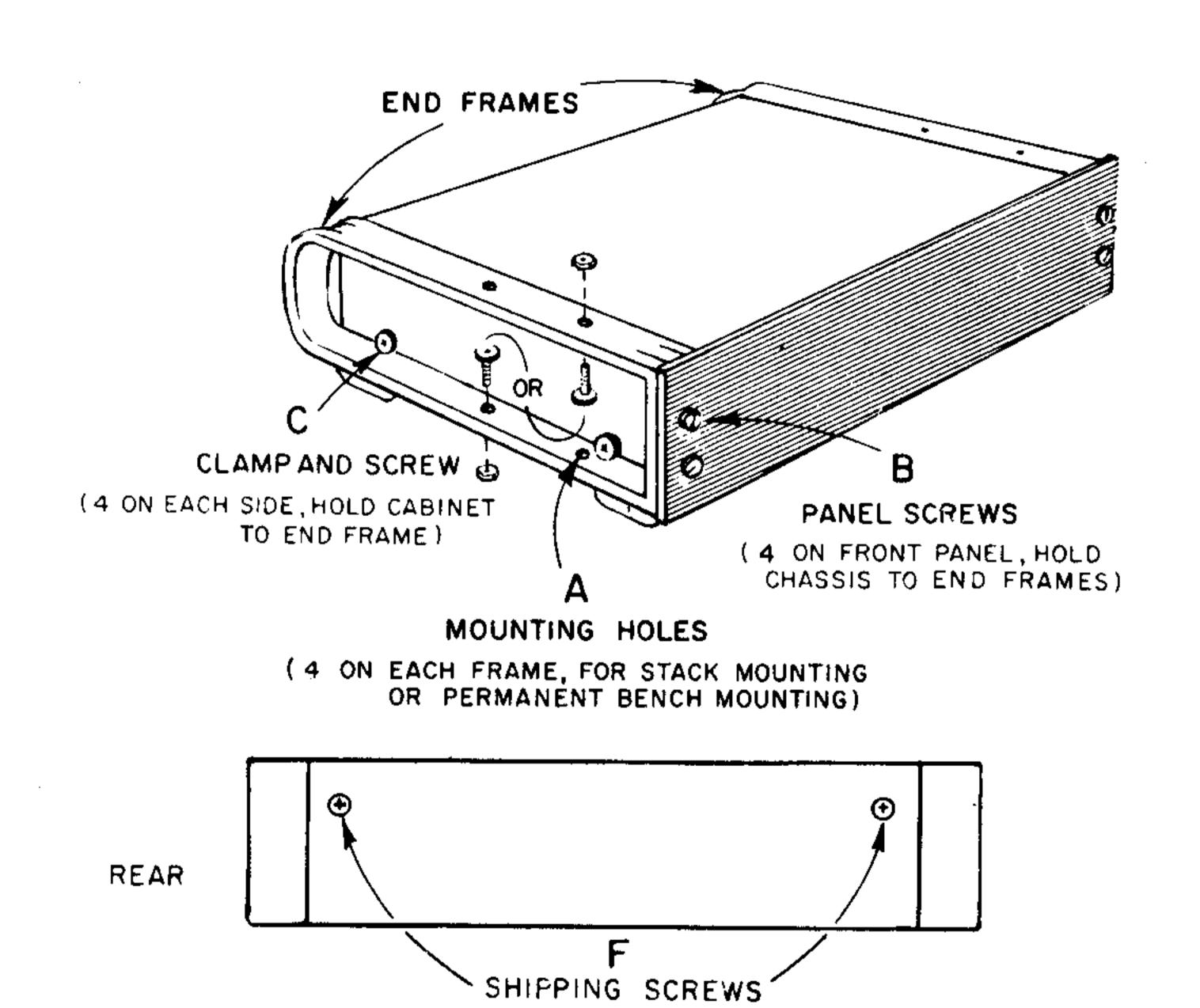
19-inch relay rack

2.2.2 BENCH MOUNTING (bench model)

The scaler normally rests on four rubber feet on top of a bench or shelf. However, holes (A) are provided in each end frame to allow permanent mounting on top or under a bench or shelf.

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 can be discarded.

This type of mounting permits either the chassis or the cabinet 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 cabinet. To remove the cabinet and leave the chassis mounted, remove the eight clamps and screws (C) and pull the cabinet back off the chassis from the rear of the instrument.

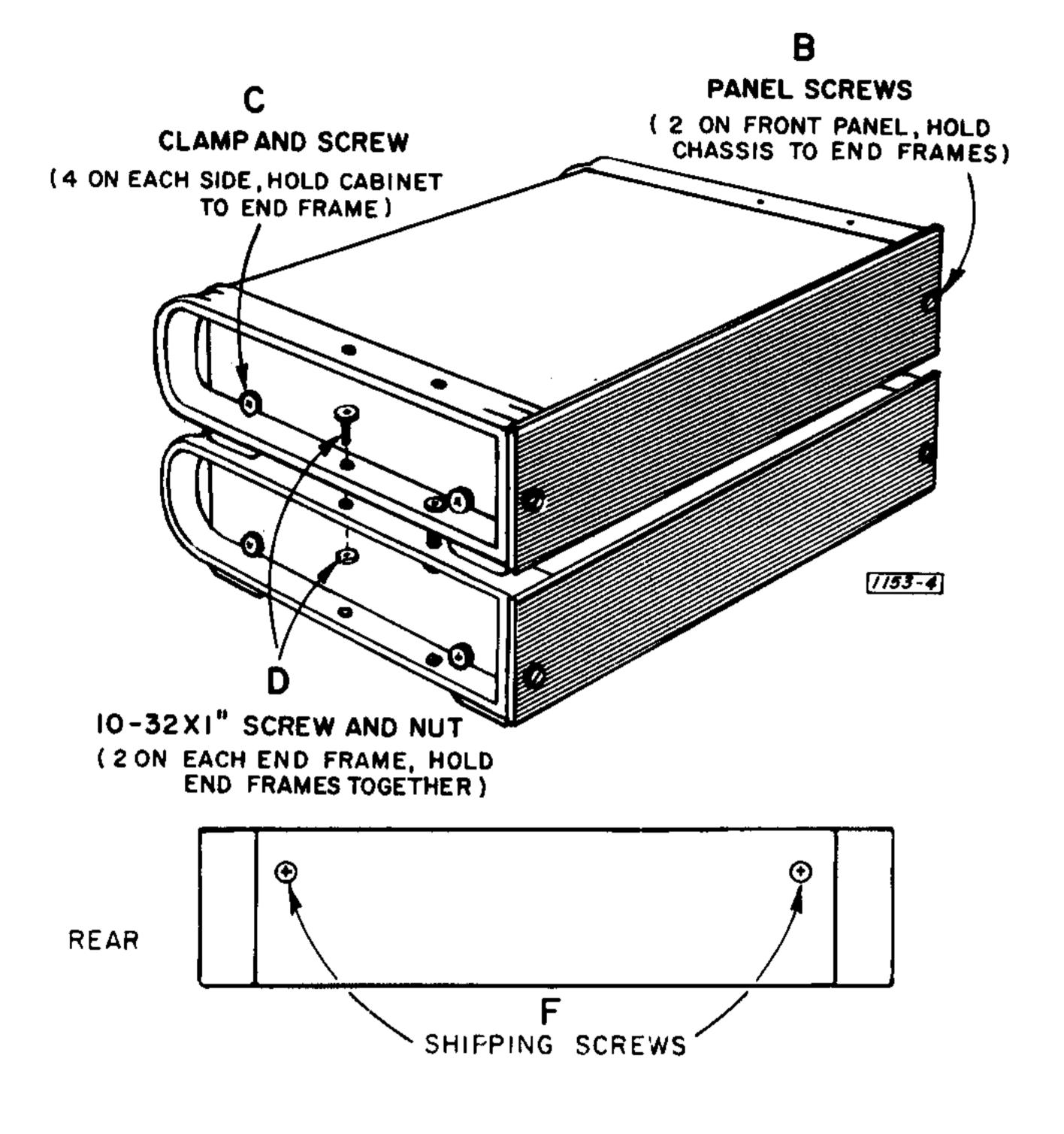


2.2.3 STACK MOUNTING (bench model)

The scaler can be permanently assembled with another rack-bench instrument, such as the Type 1153-A Digital Frequency Meter, by bolting the end frames together with four 10-32 x 1-inch screws and four 10-32 nuts.

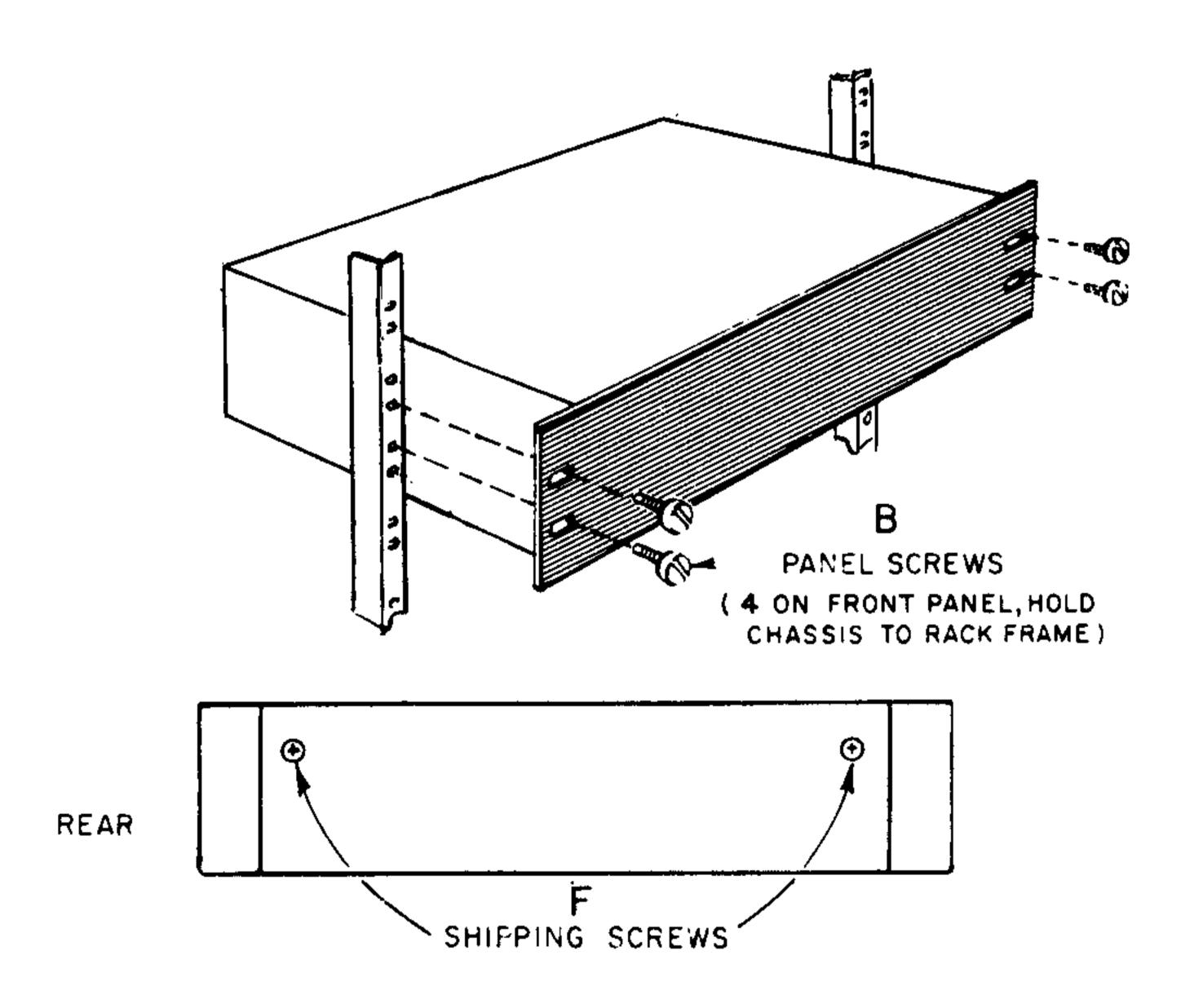
At the rear of the instrument, remove the two 10-32 binder-head shipping screws that hold the cabinet to the chassis. These are used only for shipment and can be discarded.

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



2.2.4 RACK MOUNTING (rack model)

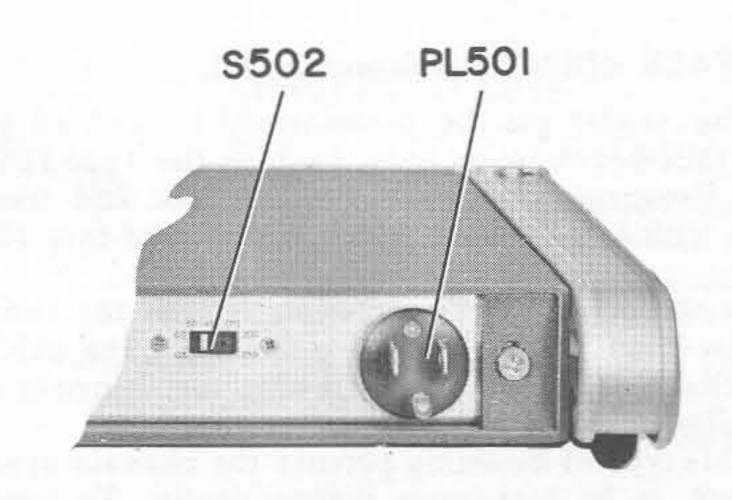
Hold the scaler into position in the rack, Insert the four panel screws with attached washers (B) through the front panel and screw them into the rack. The washers are provided to protect the face of the instrument.



2.3 POWER CONNECTION

Power requirements are 105 to 125 volts or 210 to 250 volts, 50 to 60 cycles, 15 watts, A LINE switch, S502, is provided on the rear of the instrument to convert from one line-voltage range to the other. Fuses remain the same for either range.

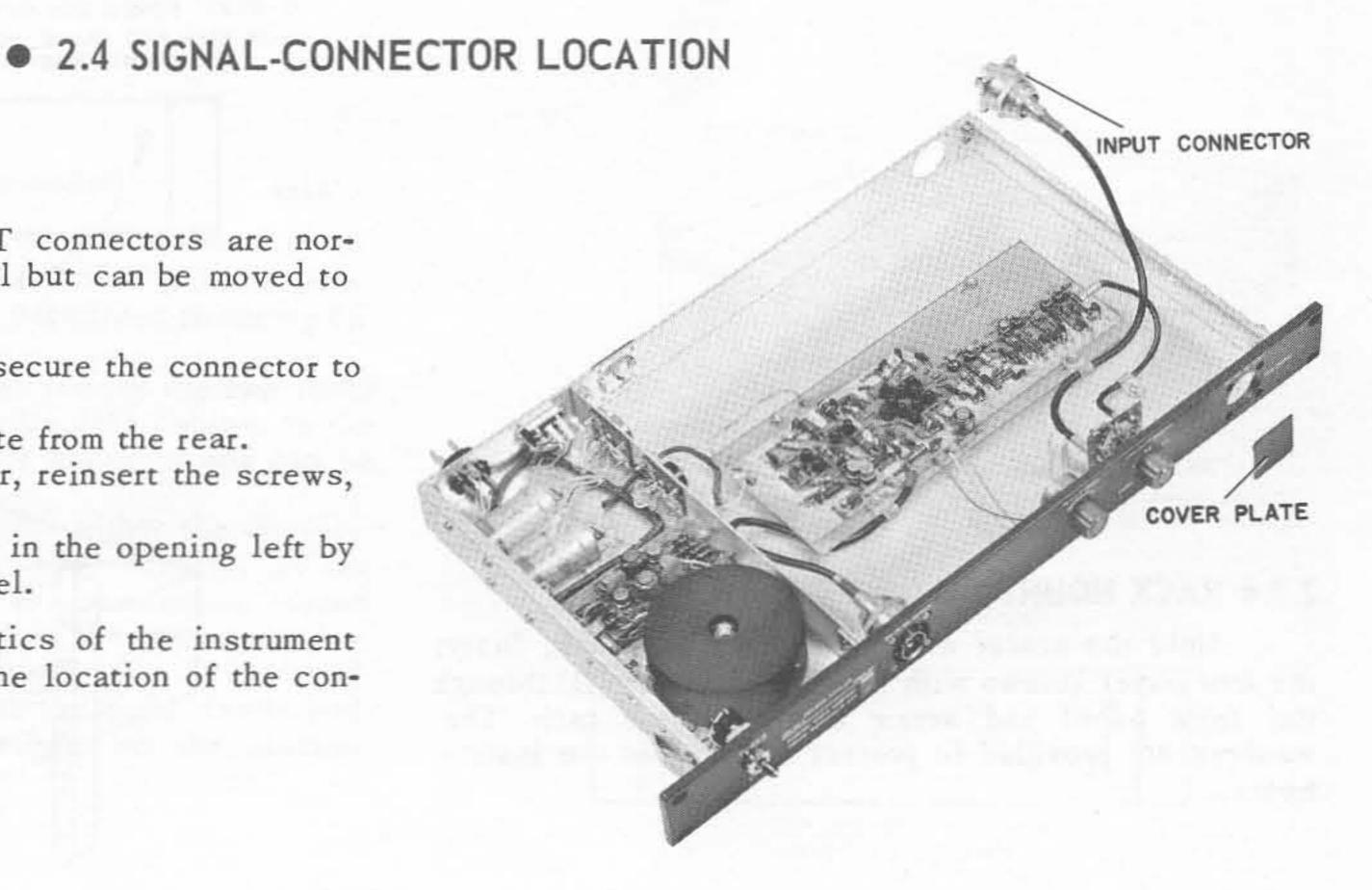
Connection to the power line is made by means of a three-wire power cord which attaches to the power input plug, PL501, on the rear of the instrument.



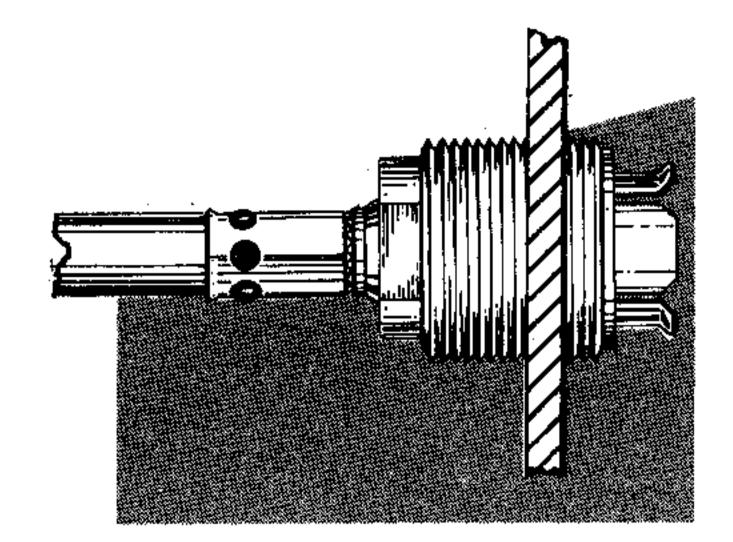
The INPUT and OUTPUT connectors are normally mounted on the front panel but can be moved to the rear as follows:

- a. Remove the four screws that secure the connector to the front panel.
- b. Remove the snap-in cover plate from the rear.
- c. Move the connector to the rear, reinsert the screws, and secure in place.
- d. Snap the cover plate in place in the opening left by the connector on the front panel.

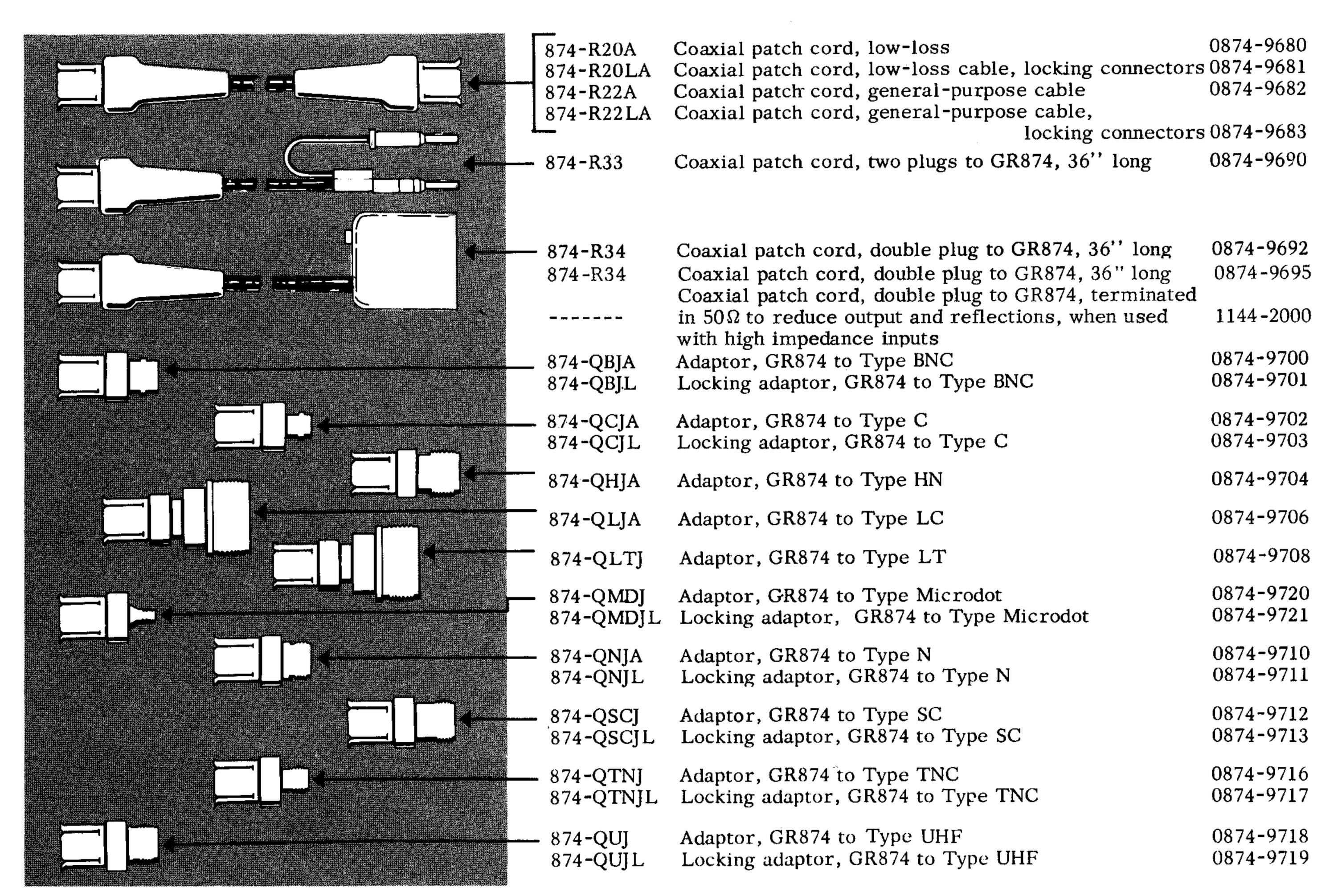
The operating characteristics of the instrument remain the same regardless of the location of the connectors.



• 2.5 SIGNAL CONNECTIONS



The INPUT and OUTPUT connectors are GR874 Recessed Locking connectors. These 50-ohm coaxial connectors are hermaphrodite, i.e., any two, although identical, can be plugged together. A full line of adaptors is also available to convert the connectors for use with nearly every type of commercial and military coaxial connector.



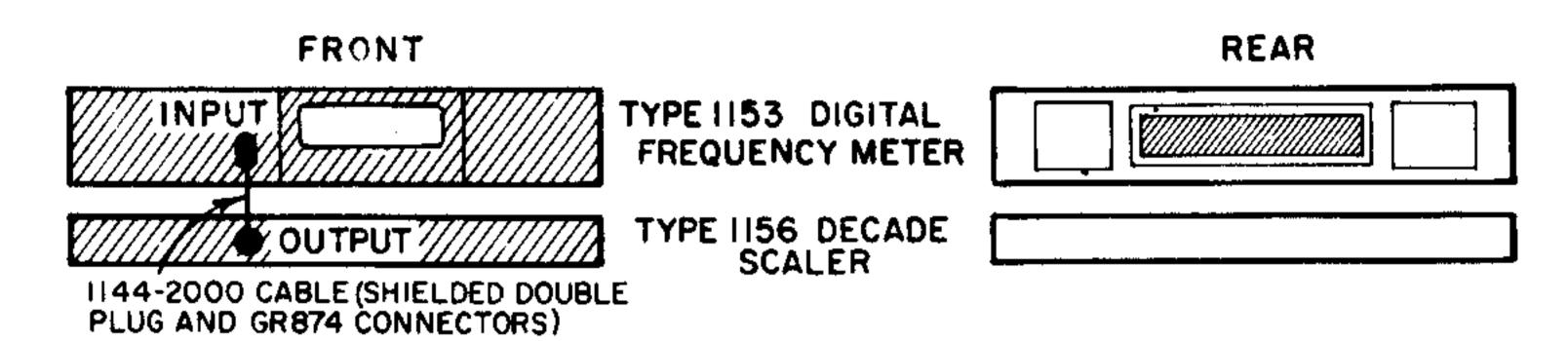
1156-30

• 2.6 INTER-UNIT CONNECTIONS

PLUG AND GR874 CONNECTORS)

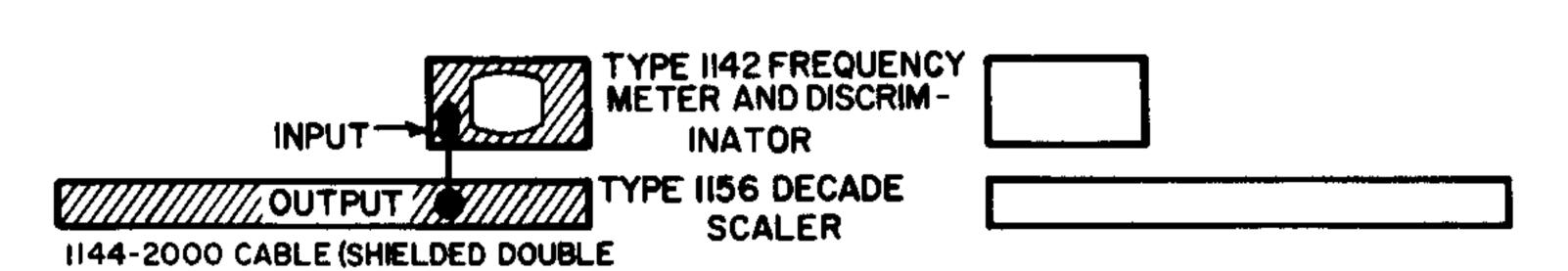
100-Mc DIGITAL FREQUENCY METER

Connections to the Type 1153 Digital Frequency Meter



15-Mc ANALOG FREQUENCY METER

Connections to the Type 1142 Frequency Meter and Discriminator

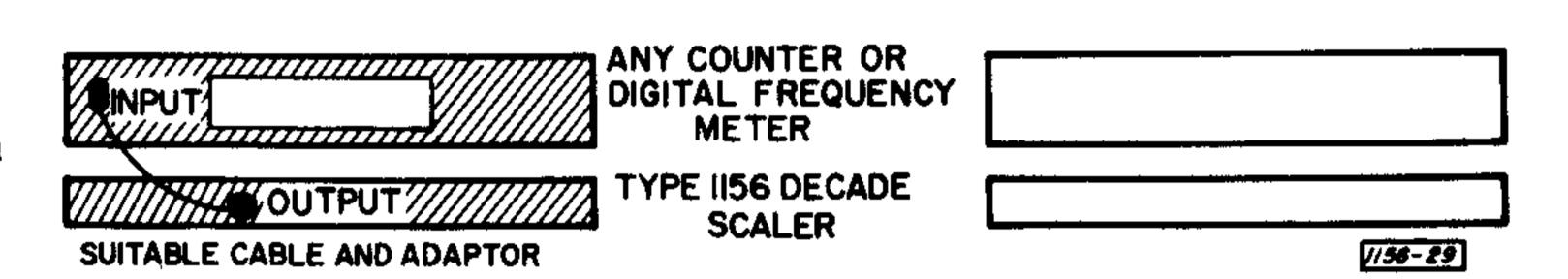


UNIVERSAL RANGE EXTENDER

The scaler OUTPUT is sufficient to drive any known counter over its entire range.

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SECTION 3

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OPERATING PROCEDURE

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CAUTION

Be sure the LINE switch on the rear of the instrument is set for the proper line voltage.

• 3.1 OPERATION

- a. Connect the Type 1156-A Decade Scaler to the power line and to the frequency meter (or other instrument).
- b. Turn the POWER switch on.
- c. Set the SENSITIVITY control for the desired sensitivity and attach the input signal to the INPUT connector.
- d. Set the TRIGGER LEVEL control for proper triggering. The TRIGGER LEVEL control will normally be set with the white dot straight up.

3.2 CHARACTERISTICS

3.2.1 INPUT

Frequency:

Dc to 100 Mc/s

Impedance:

Set by SENSITIVITY control; four 50ohm positions and one 500-ohm posi-

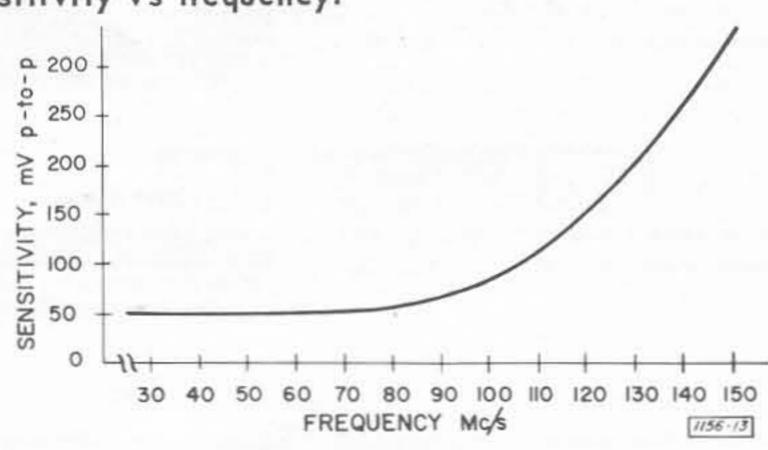
tion.

Maximum input: Maximum input voltage is determined by attenuator resistors and base-toemitter breakdown voltage of input transistor (2 volts, conservatively).

SENSITIVITY		Maximum inputs			
control setting	Dc	*pulse peak	sinewave, rms		
0.1V	± 2 V	± 2V	1.4V		
0.2V	± 4 V	± 4V	2.8V		
0.5V	± 5 V	$\pm 10V$	5 V		
1.0V	± 5 V	±20V	5 V		
1.0V (500 Ω)	±15.8V	±20V	14 V		

^{*} Duty ratio such that average input power is < 1/2 W.

Sensitivity vs frequency:



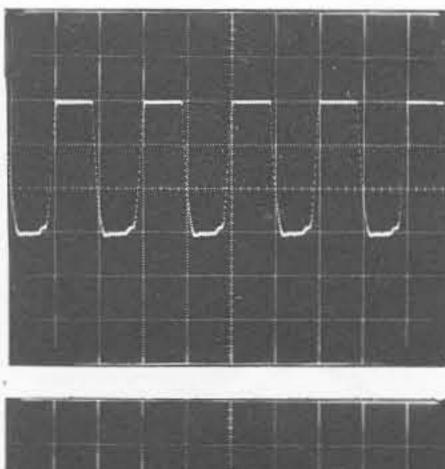
The input circuit is dc coupled. A Type GR874-K or GR874-KL Coupling Capacitor is recommended when ac coupling is necessary.

3.2.2 OUTPUT

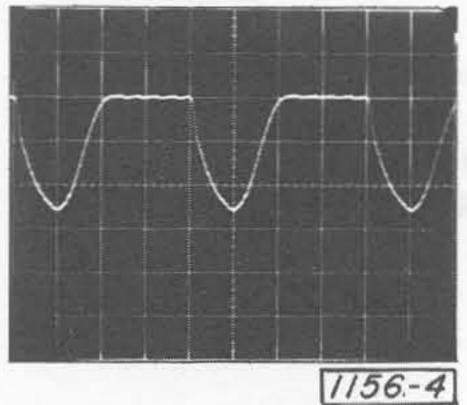
The OUTPUT signal approximates a square wave and is one-tenth the INPUT frequency or repetition rate. The output circuit is a current source and provides typically 30 mA peak-to-peak with a source resistance

RESISTIVE TERMINATION

OUTPUT terminated in 50Ω . Vertical deflection factor is 0.5 volt per division.

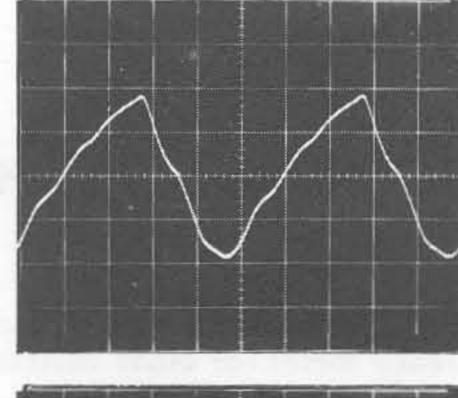


5Mc/s (50-Mc INPUT)

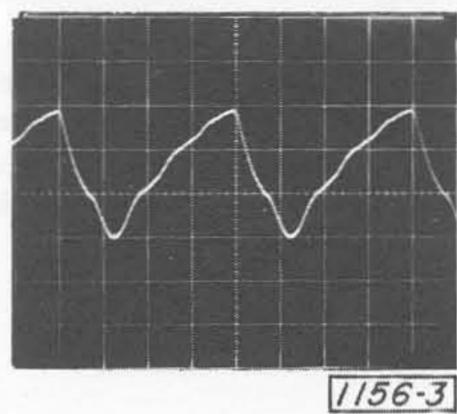


12.5 Mc/s (125-Mc INPUT) of 250 ohms (open-circuit output voltage is approximately 7 volts). The output circuit is dc coupled. A Type GR874-K or GR874-KL Coupling Capacitor is recommended when ac coupling is necessary.

REACTIVE TERMINATION (simulates most counter inputs) OUTPUT connected to 3-foot 50-ohm cable (GR Type 874-R22) terminated in 47pF. Vertical deflection factor is 1 volt per division.



10 Mc/s (100-Mc INPUT)

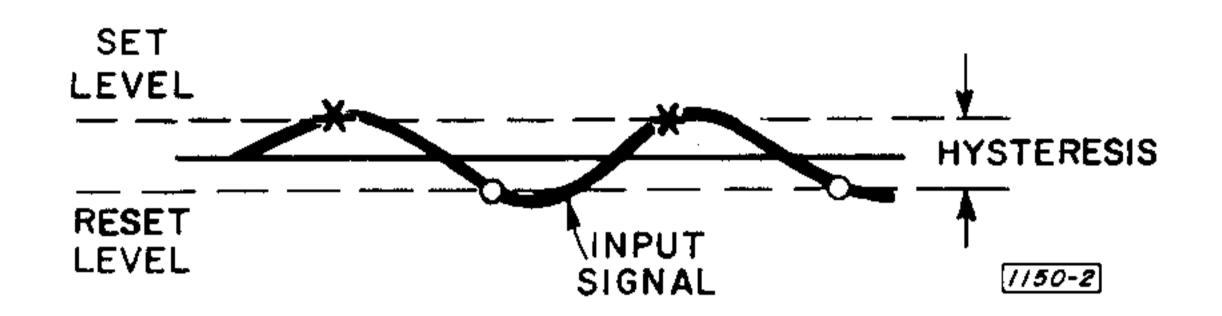


12.5 Mc/s (125-Mc INPUT)

• 3.3 TRIGGER LEVEL CONTROL

3.3.1 DESCRIPTION

The trigger circuit consists of a Schmitt multivibrator which exhibits a hysteresis effect. That is, after the circuit has triggered on the positive-going transition of the input signal, the input signal must then swing to a less positive level to reset the trigger circuit. The maximum sensitivity of the instrument is the magnitude of this hysteresis voltage (100 mV, p-to-p).

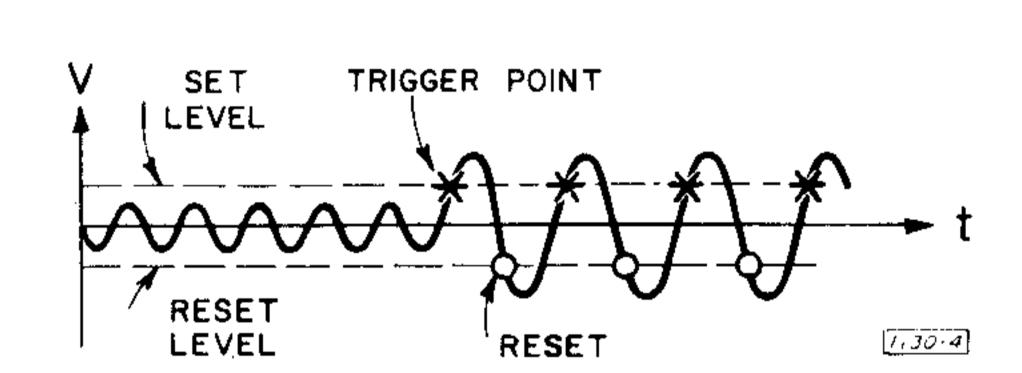


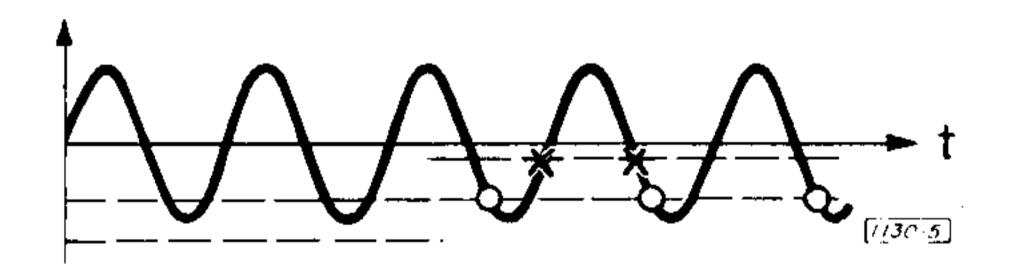
3.3.2 USES

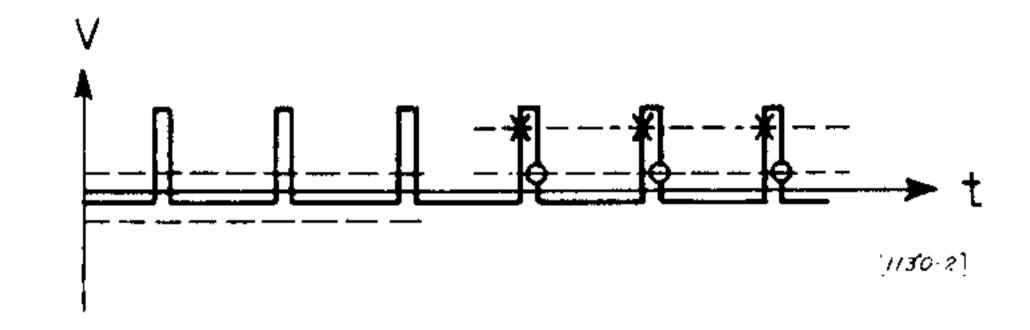
Signal too small; must be increased.

Too large a negative offset to the TRIGGER LEVEL control. Corrected by reducing offset.

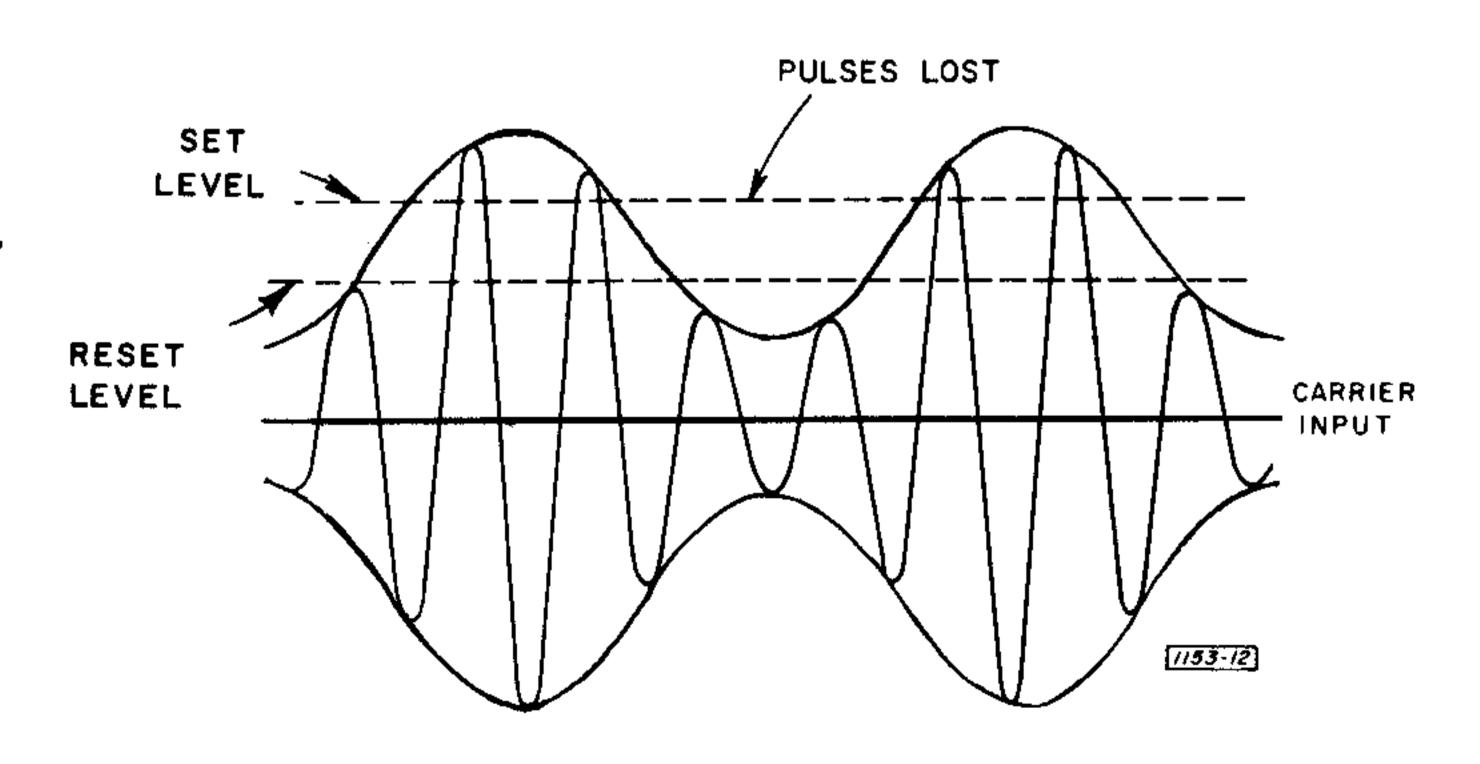
Low duty-ratio pulse signal. Corrected by raising triggering level.







A-M error with trigger level offset.



• 3.4 APPLICATIONS

3.4.1 COUNTER RANGE-EXTENSION

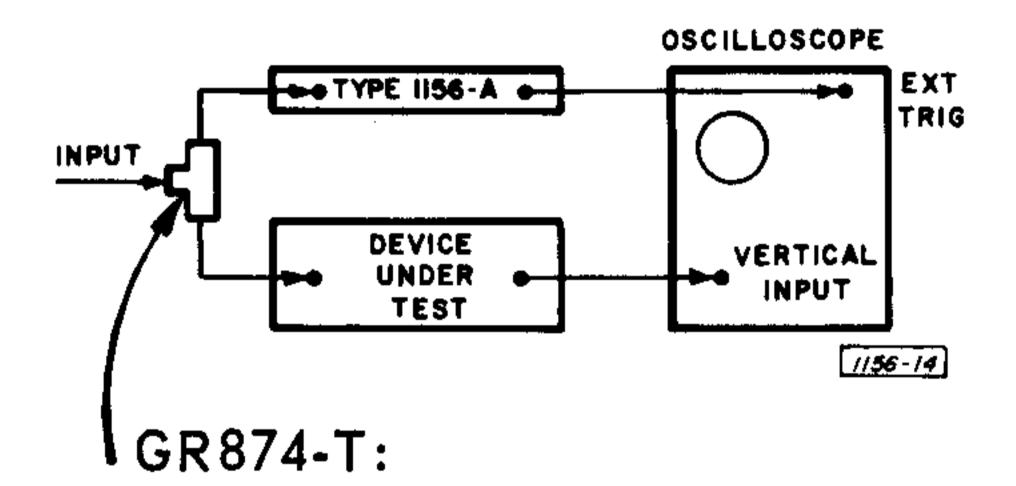
When the Type 1156-A Decade Scaler is used to extend the frequency range of a counter, the frequency to be measured is applied to the INPUT of the Type 1156-A and the OUTPUT of the Type 1156-A is applied to the input of the counter. The scaler OUTPUT is sufficient to drive any known counter over its entire range.

The frequency is read from the counter by moving the decimal point in the counter display one place to the right. The accuracy of the measurement is not affected by the scaler. Accuracy is strictly a function of the counter and is usually specified as ±1 count ± crystaloscillator stability.

3.4.2 OSCILLOSCOPE TRIGGER

The Type 1156-A is especially valuable in the trigger path of an oscilloscope whose trigger capabilities are inadequate to properly lock all signals within its vertical passband.

It is equally useful in the testing of scalers or frequency dividers even at lower frequencies. If the trigger is taken from the output of the device under test and the output waveform changes or the device fails, the trigger is lost. But if the trigger is taken ahead of the device the trigger is independent of the device. This is also an advantage when making time relationship measurements of several points in the device since the output from the Type 1156-A can be used as a time reference.



Type 874-T, Tee connector	0874-9910
Type 874-TL, Tee connector with locking	0874-9911
connectors	
*Type 874-TPD, Power divider	0874-9912
*Type 874-TPPL, Power divider with	0874-9913
locking connectors	

^{*} Coaxial tee; matched at any port when the other two ports are terminated in 50 ohms.

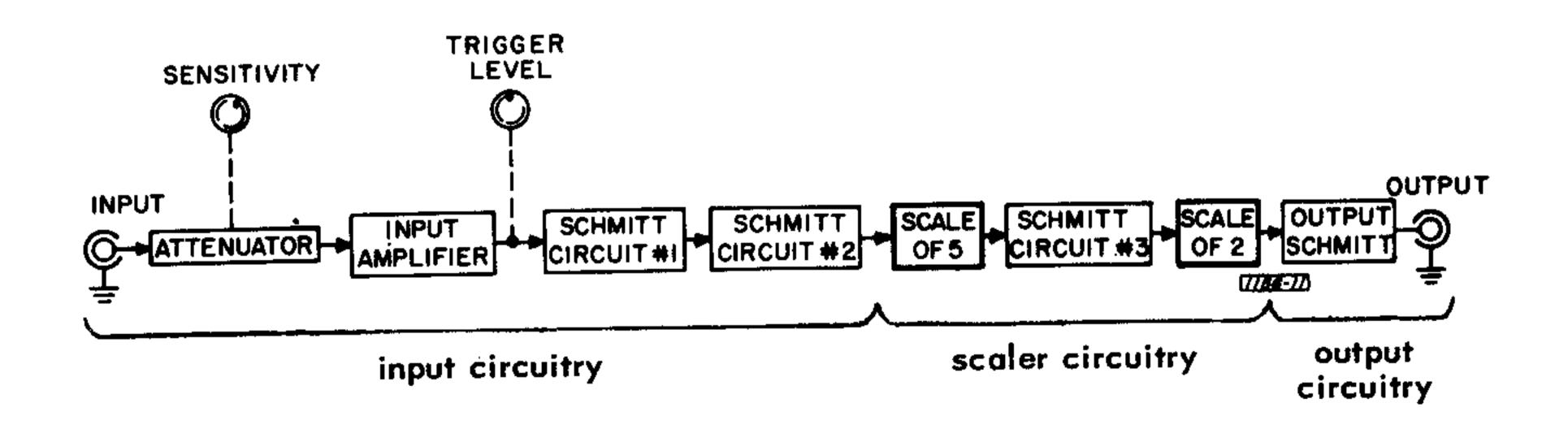
3.4.3 1-Mc OUTPUT

Two Type 1156-A Decade Scalers can be connected in series to provide 100-to-1 frequency division (the upper limit remains 100-Mc/s, however).

SECTION 4 PRINCIPLES OF OPERATION

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• 4.1 BLOCK



The input circuitry consists of a GR874 locking connector, an attenuator with four 50-ohm positions and one 500-ohm position, and an input amplifier which provides 100-millivolt sensitivity and also isolates the input from noise generated by the switching circuits.

The input amplifier is followed by two Schmitt circuits, a self-clearing ring that scales by five, and a flip-flop that scales by two. This flip-flop drives a high-current Schmitt circuit, which delivers 30-milliampere square waves to a GR874 locking connector.

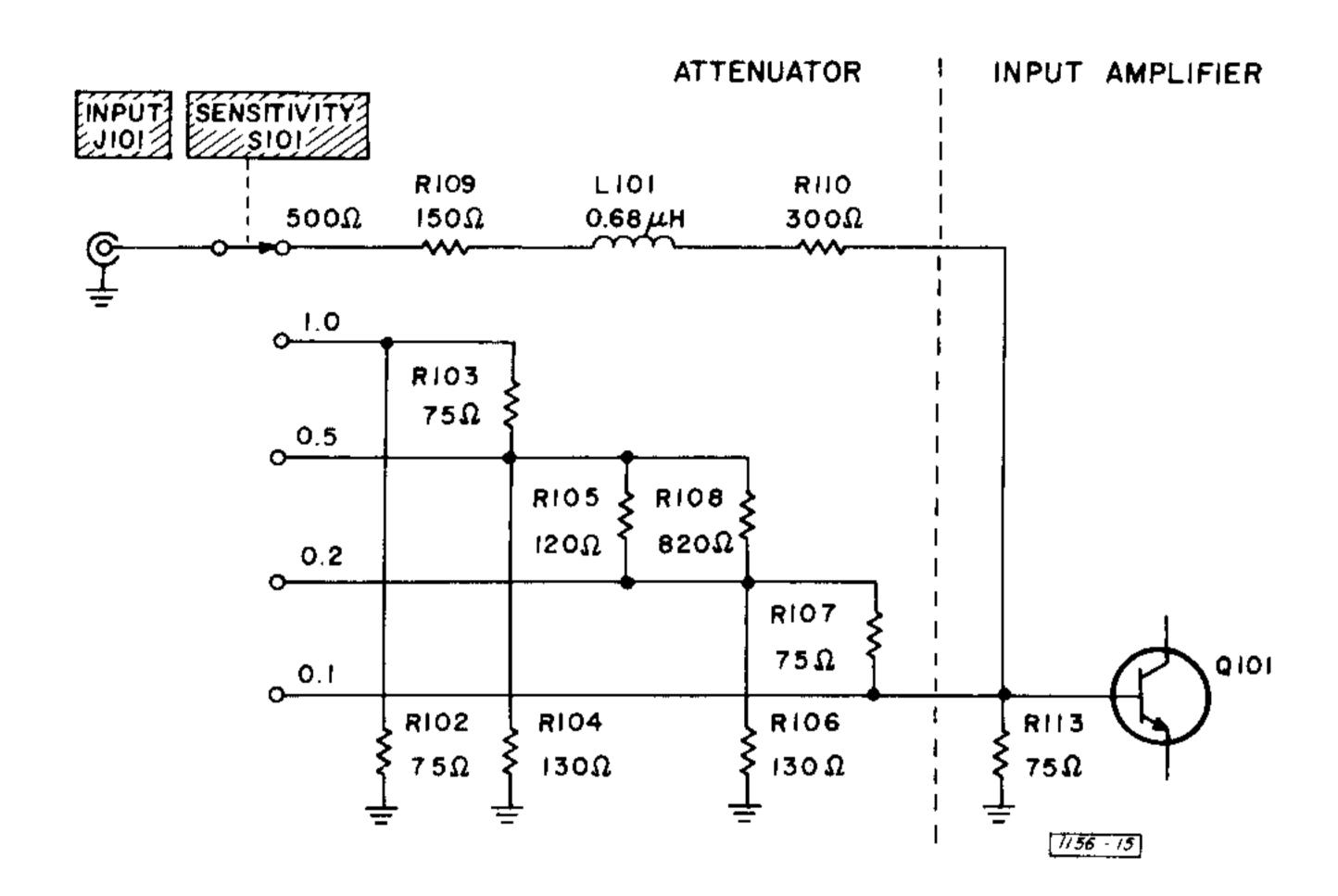
• 4.2 ATTENUATOR

A ladder-type attenuator reduces the level of signals applied to the INPUT connector to allow noisy signals to be measured and large amplitude signals to be applied without damage to the input circuitry.

In the 500- Ω position, the input impedance is 500 ohms and is made up of the series combination of R109, R110, and R113 (R113 is in the base circuit of the input stage, Q101). The ratio of R109 and R110 to 500Ω is 9:10 so that the signal applied to the INPUT connector is attenuated by a factor of 10 before it reaches the input stage.

In the 50- Ω positions (1, 0.5, 0.2, and 0.1), the input impedance is 50 ohms and is made up of the series and parallel combinations of R113 and R102 through R108. The configuration is such that the signal is attenuated by a factor of 10 in the 1 position, 5 in the 0.5 position, 2 in the 0.2 position, and 1 (straight through or no attenuation) in the 0.1 position.

Attenuator components are carefully placed with respect to a well-defined ground plane and coaxial cables with special fittings are used to connect the assembly to the INPUT connector and the input amplifier to insure low VSWR and low reflections at all frequencies within the passband of the instrument.

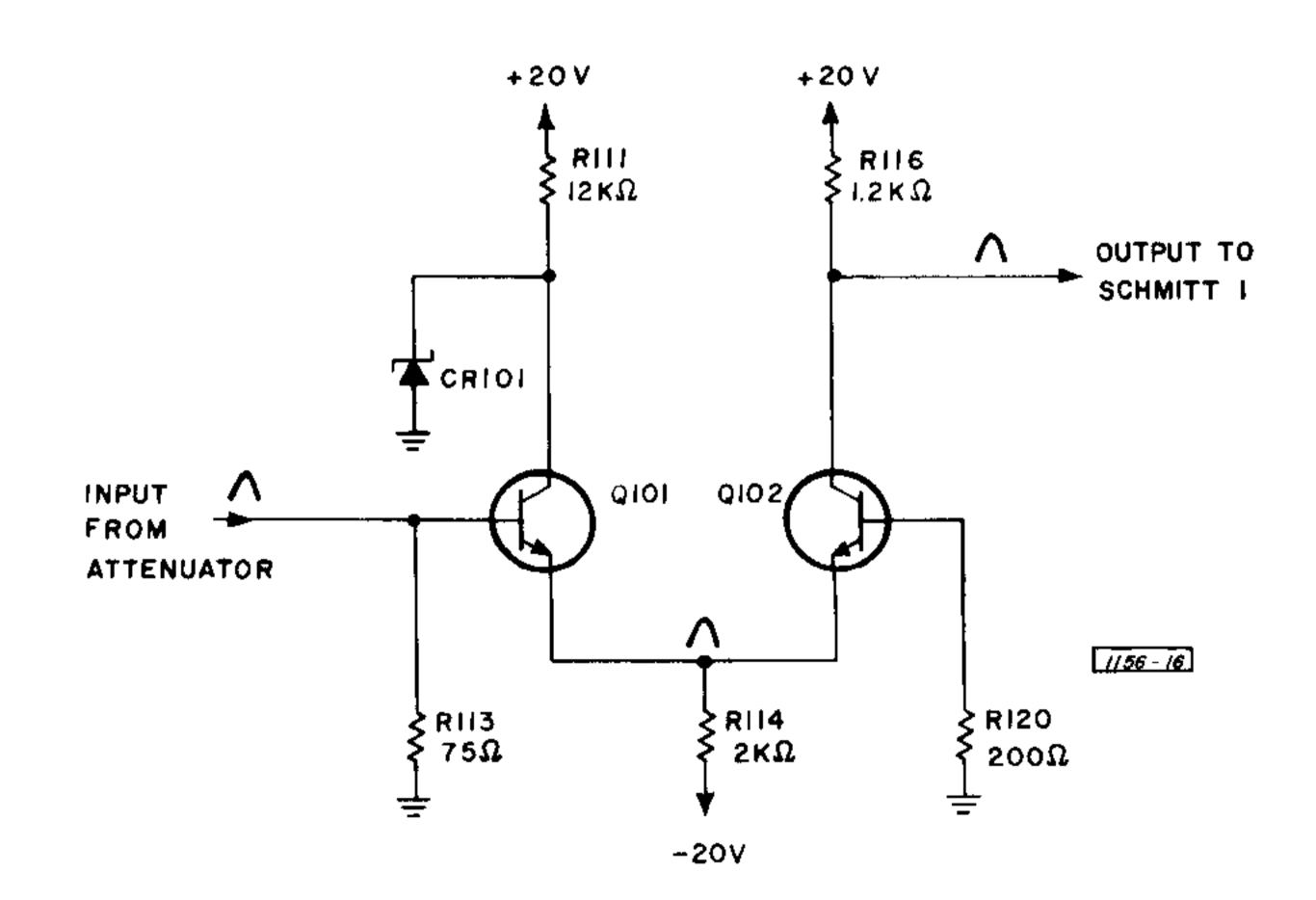


• 4.3 INPUT AMPLIFIER

The input amplifier increases the INPUT-signal level to drive the next stage, Schmitt 1, and provides isolation between the INPUT connector and the switching transients generated by Schmitt 1.

It is a two-transistor, emitter-coupled, dc amplifier with a gain of four and no phase inversion. A signal of 100 mV, p-to-p, applied to the base of Q101 results in a 400 mV, p-to-p, signal at the collector of Q102 which is sufficient to drive Schmitt 1.

The amplifier will clip signals of over ± 1 V applied to the base of Q101, will operate reliably, with signals of over ± 2 V, but will be damaged by signals of over ± 3 V.

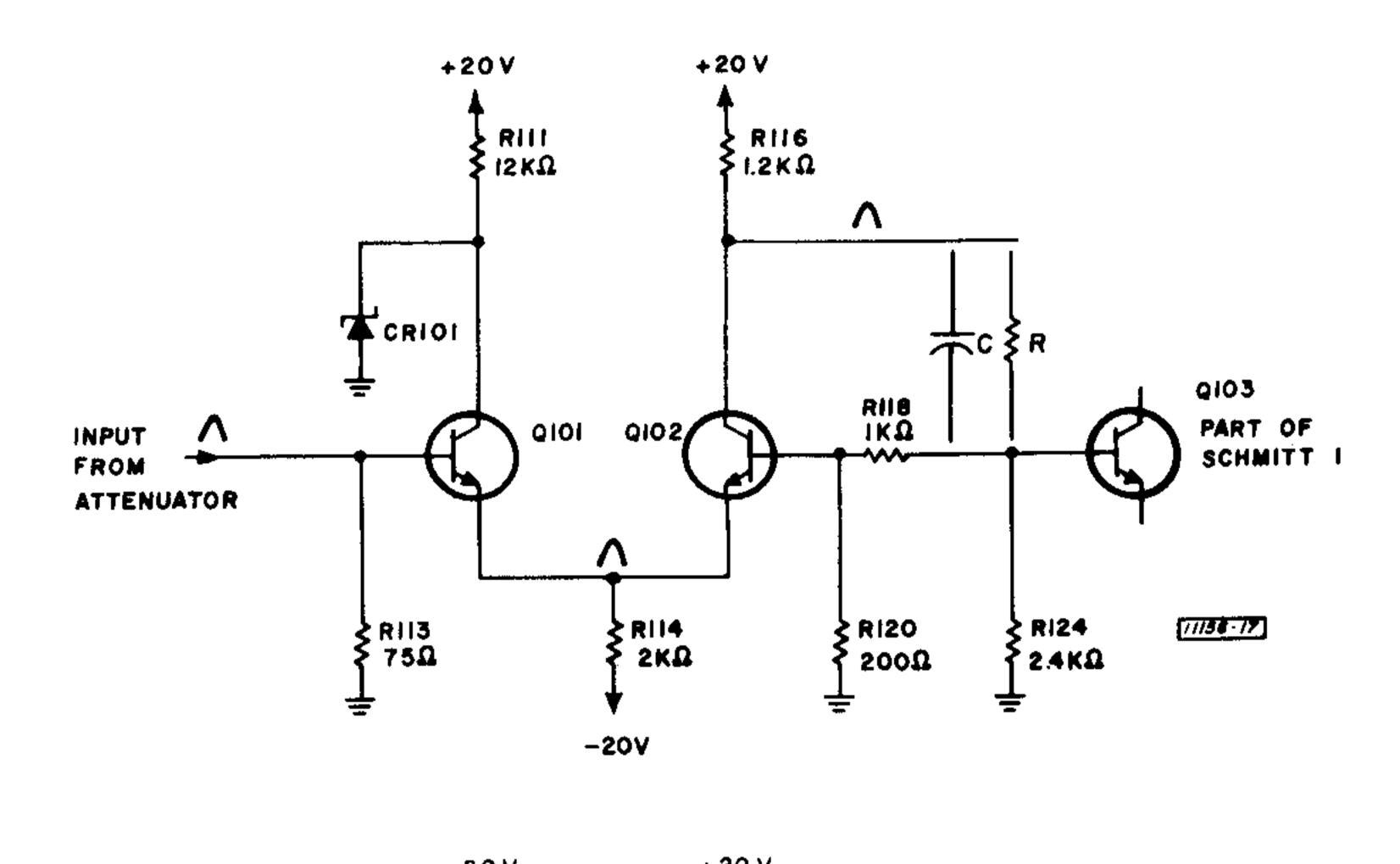


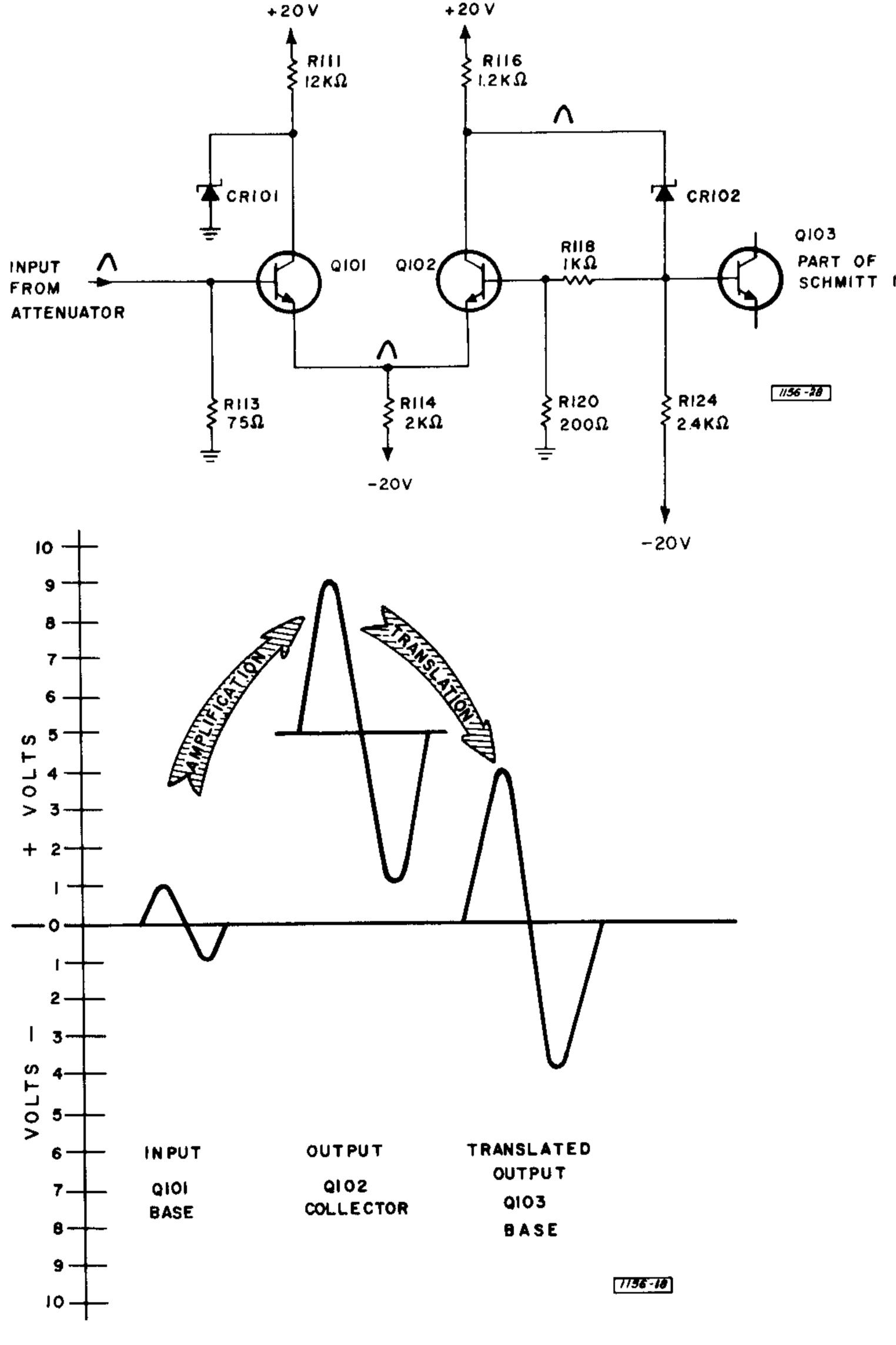
4.3.1 DC TRANSLATION

The input amplifier must accept positive and negative signals (with respect to ground) and is therefore biased class A. This means current flows in both transistors at all times, with or without an input signal, and the collector of Q102 rests at about ±5 V due to the divider action of R116, Q102, R114, CR104, and R124. The base of Q103 in the next stage rests at about 0 V and must maintain this bias level for proper operation. Therefore it is necessary to couple the output of Q102 to the input of Q103 without disturbing the dc potentials at either point.

A zener-diode is used to couple the two points. A zener diode maintains a constant voltage drop across itself within a broad range of currents through it. If a 5-volt zener, CR102, is used for coupling, the voltage at the base of Q103 becomes +5 - 5 = 0 V. If an INPUT signal causes the collector of Q102 to rise to +9 V, the base of Q103 becomes +9 - 5 = +4 V and if the collector of Q102 decreases to +1 V, the base of Q103 becomes +1 - 5 = -4 V.

Thus, CR102 translates a ± 4 -volt swing about a ± 5 -volt baseline to a ± 4 -volt swing about a 0-volt baseline; the dc potentials at the collector of Q102 and the base of Q103 remain intact, and the signal amplitude is not attenuated.





• 4.4 SCHMITT CIRCUITS

All Schmitt circuits used in the Type 1156-A are conventional, emitter-coupled circuits with zener-diode dc translation between the output of the first transistor to the input of the second. Schmitt 1 shapes input signals of arbitrary waveform to square waves with fast transitions for use by the other circuits in the instrument. It differs slightly because the base bias of the first transistor (Q103) is adjustable by means of two potentiometers, R201 (an internal adjustment) and R101 (a front-panel control, TRIGGER LEVEL).

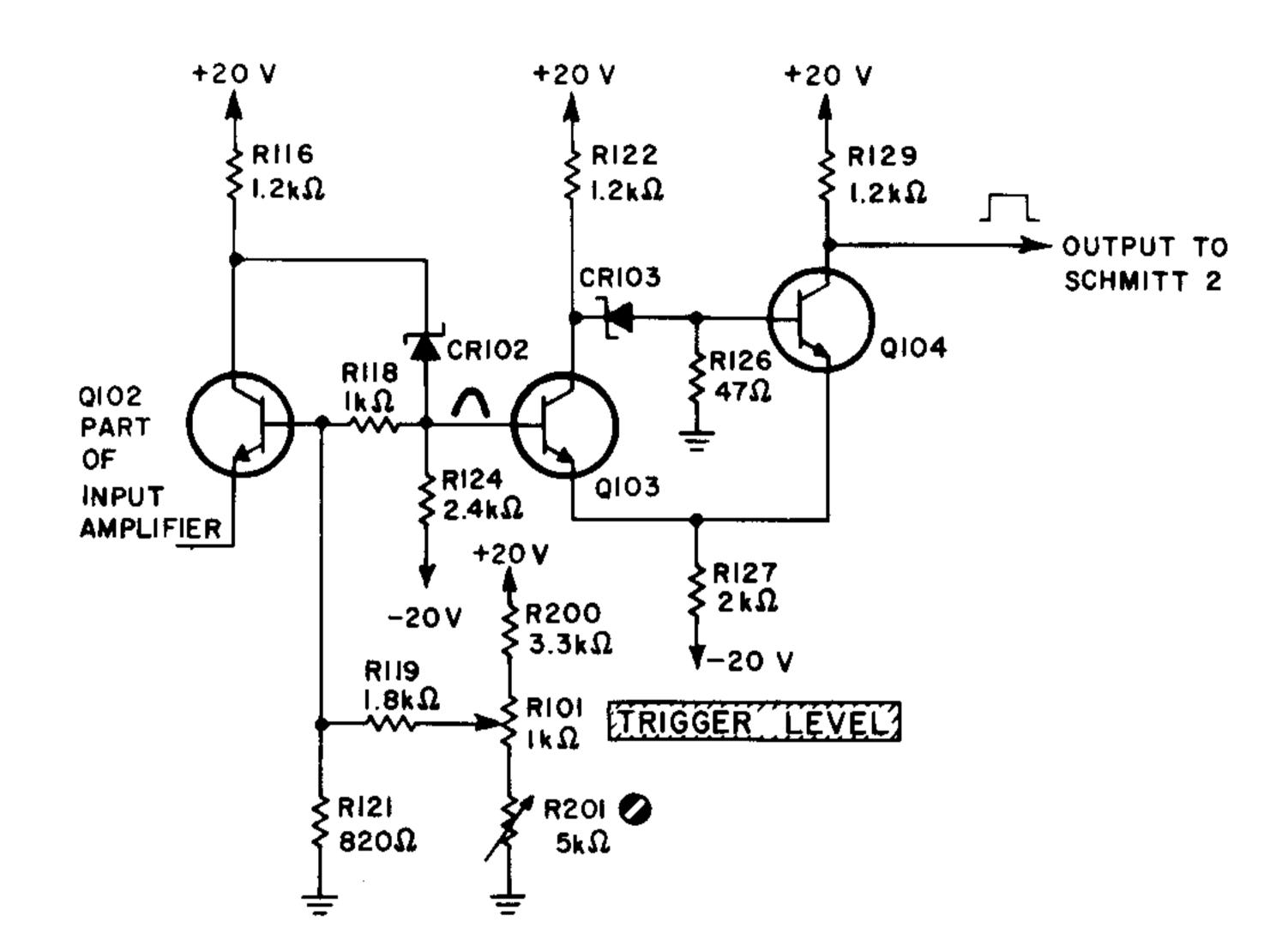
Assume for the moment, that R201 and the TRIG-GER LEVEL control are fixed and have been set so that, with no input signal, the 4 voltage translation from the collector level of Q102 results in a 0-volt level at the base of Q103. Q103 and Q104 form a Schmitt circuit so that when one transistor is off (not conducting), the other is on (conducting); assume Q103 is off.

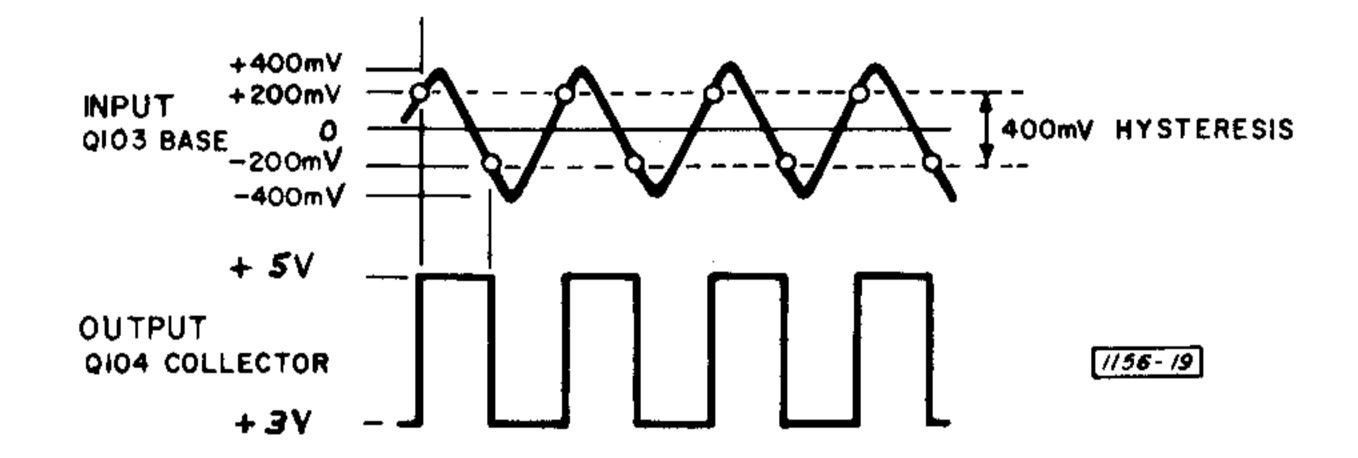
A 200 millivolt signal with a 0-volt base line is applied to the INPUT connector, is amplified by the input amplifier, and appears at Q102 collector as an 800-millivolt signal with a +4-volt base line. CR102 translates the base line 4 volts so that an 800-millivolt signal with a 0-volt base line appears at Q103 base.

A 200-millivolt positive level is necessary to turn on Q103. When the signal at Q103 base reaches +200 millivolts, Q103 turns on; the resulting drop in its collector potential is coupled through CR103 (one of the regenerative paths, the other is the common-emitter connection) and turns off Q104. When Q104 turns off, its collector level changes from about 3 volts to about 5 volts.

The input signal continues up to its peak positive value and then begins to decrease. When it reaches -200 millivolts, Q103 turns off. This difference in the turn-on and turn-off levels is known as hysteresis and amounts to about 400 millivolts for Schmitt 1.

When Q103 turns off, Q104 turns on and its collector level reverts to 3 volts, thus producing a square wave output that follows the input waveform.





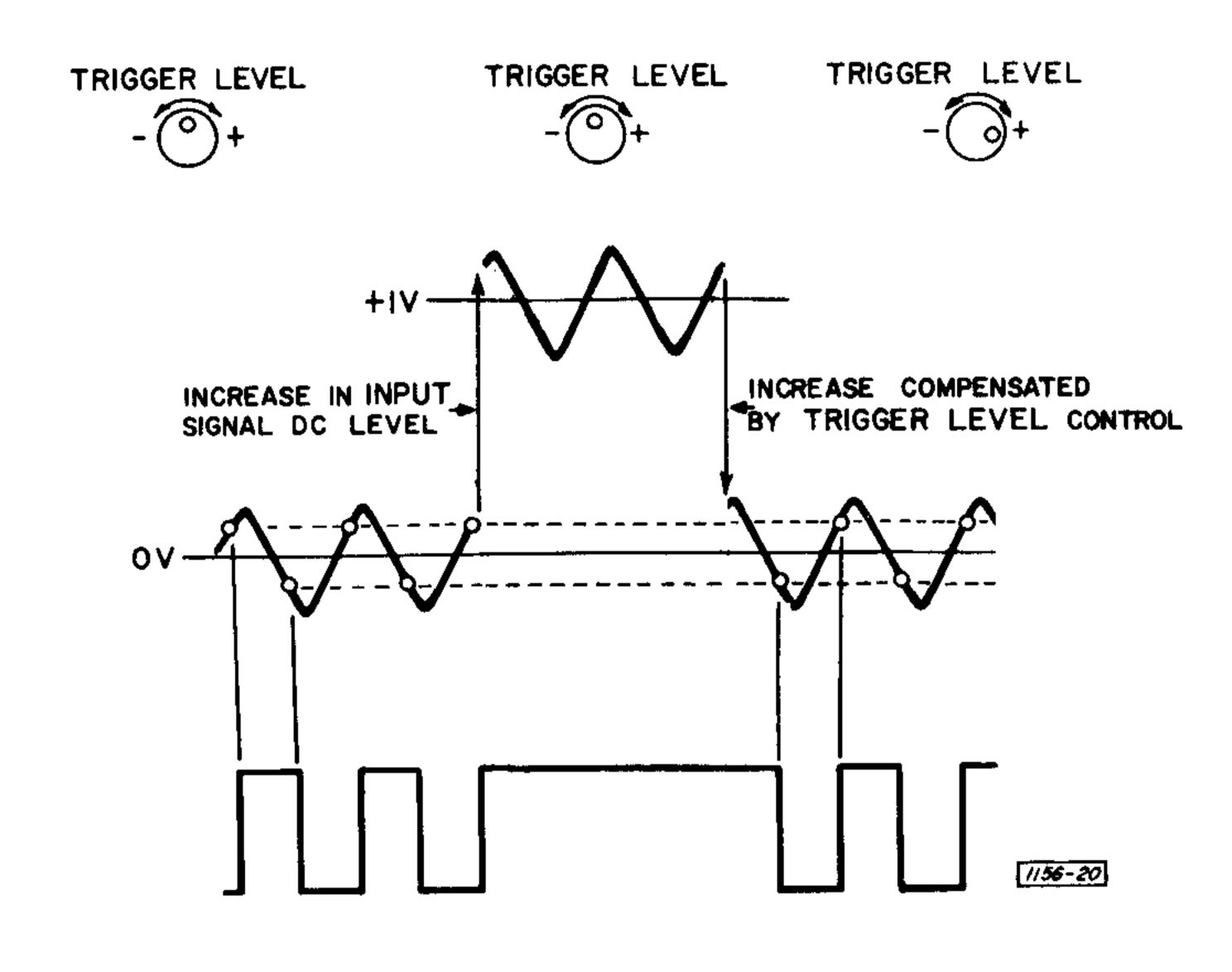
4.4.1 TRIGGER LEVEL CONTROL.

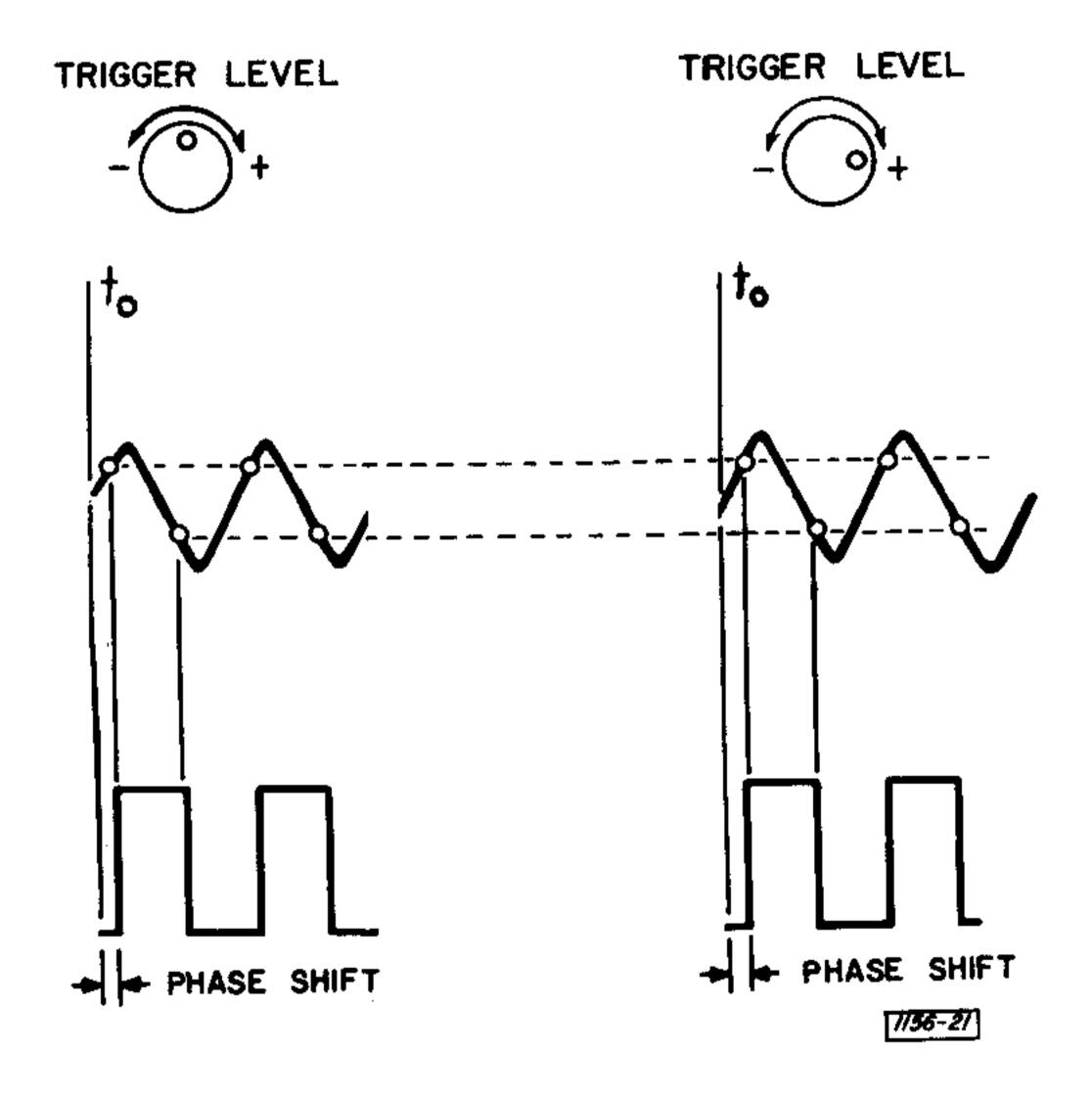
An input signal with other than a 0-volt base line will not operate the Schmitt circuit if the signal's dc component moves it out of the Schmitt's hysteresis spread. For instance, an 800-millivolt signal with a 1-volt base line applied to Q103 base will never move sufficiently negative to turn off Q103. Several methods can be used to prevent this base line shift or dc component from affecting the operation of the schmitt circuit: ac couple the input circuit, move the hysteresis spread to center about the base line, or move the base line to the center of the hysteresis spread.

The latter method is used in the Type 1156-A and is accomplished by the TRIGGER LEVEL control, R101. If the input-signal base line moves positive 1 volt, the TRIGGER LEVEL control is adjusted to move the potential at its center-arm negative 1 volt, and the resultant de potential at Q103 base remains 0 volts. A similar but reverse action occurs with negative dc components.

The total swing of the TRIGGER LEVEL control is ±200 mV, sufficient to handle dc components equal to the SENSITIVITY control setting, i.e., with a SENSI-TIVITY control setting of 0.5 V. The Schmitt circuit will operate properly with INPUT dc components up to ± 0.5 volts.

The TRIGGER LEVEL control can also be used to shift the phase, slightly, of the Schmitt circuit output by shifting the base bias of Q103.





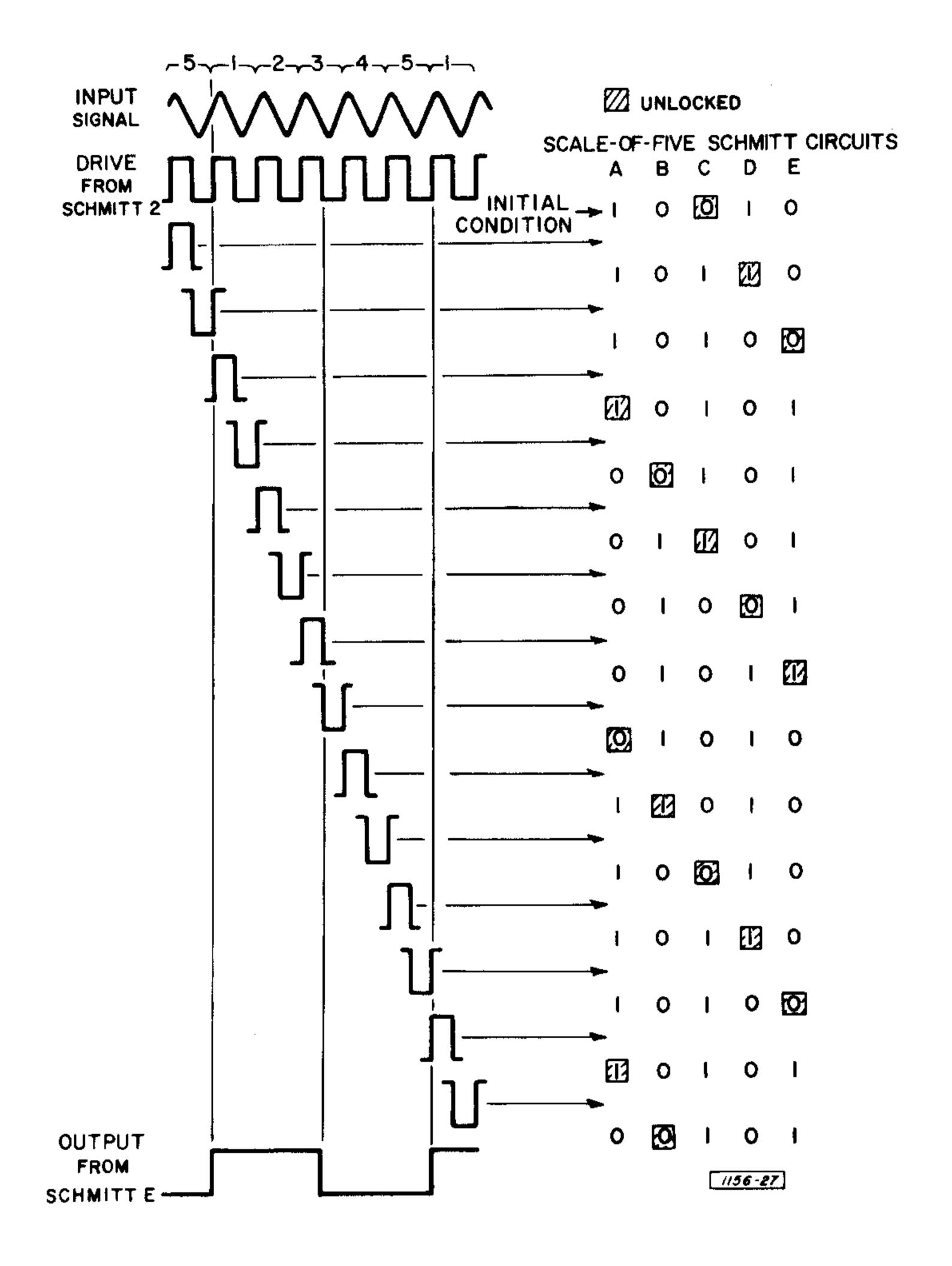
• 4.5 SCALE-OF-FIVE

The scale-of-five circuit performs the first division of the input signal. It consists of five specially biased Schmitt circuits connected in the form of a ring and driven by the output of Schmitt 2. The biasing is arranged so that only one Schmitt is allowed to change state when the drive signal is applied, the other four are locked out.

State terminology: The terms 0 and 1 are used to describe the state of a Schmitt and are defined here as the state of the output potential; 0 state if the potential is minimum and 1 state if the potential is maximum.

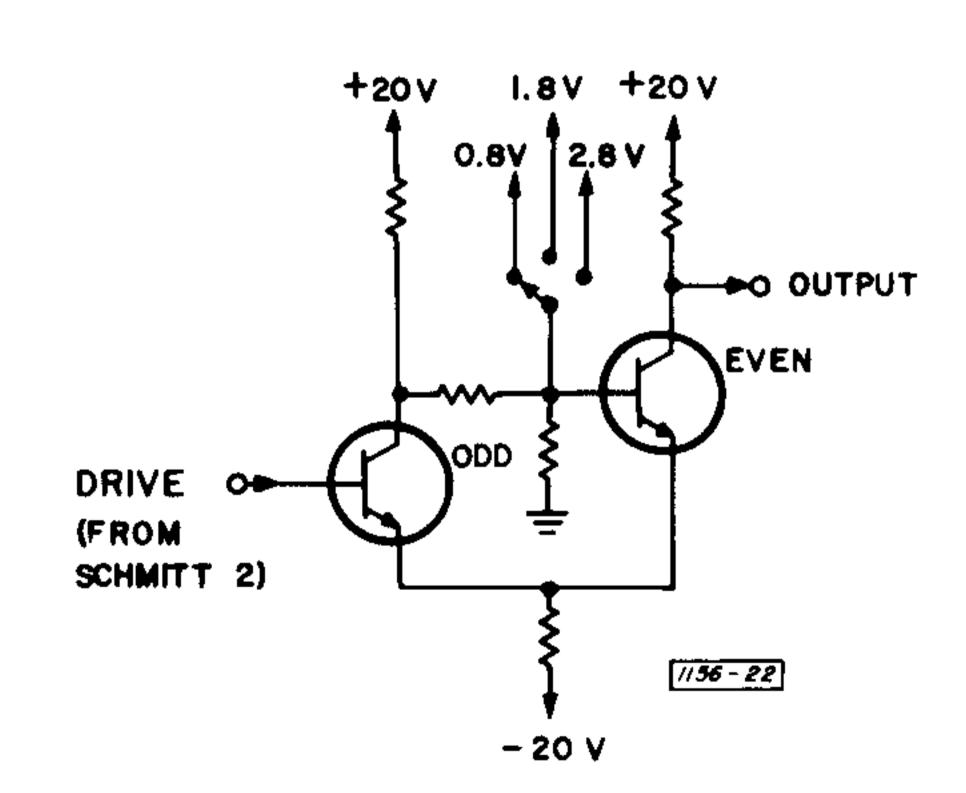
Assume the initial condition is as shown in the diagram. The output is taken from Schmitt E and since Schmitt E is in the 0 state, the output is minimum. Although the drive signal is applied to each Schmitt, it only affects the state of the unlocked Schmitt. A Schmitt is unlocked when the preceding Schmitt is in the same state.

In the initial condition, Schmitt C is unlocked and in the 0 state. A positive drive pulse changes it to the 1 state which unlocks Schmitt D. The next drive pulse changes Schmitt D to the 0 state and unlocks Schmitt E. The action is such that each time a Schmitt changes state it locks itself, unlocks the next Schmitt, and produces an output at Schmitt E which is one-fifth of the input frequency.



4.5.1 LOCKING

A special bias arrangement permits the Schmitts in the scale-of-five circuit to be locked or unlocked. Each even transistor has three bias levels: 0.8, 1.8, and 2.8 volts. When 0.8 volt is applied, the eventransistor is turned off and cannot be turned on. Since it is held off, the odd side is held on and a drive pulse has no effect on the Schmitt (the Schmitt is locked in the 1 state). When 1.8 volts is applied the Schmitt is free to change states when a drive signal is applied (unlocked). When 2.8 volts is applied the Schmitt is locked in the 0 state.



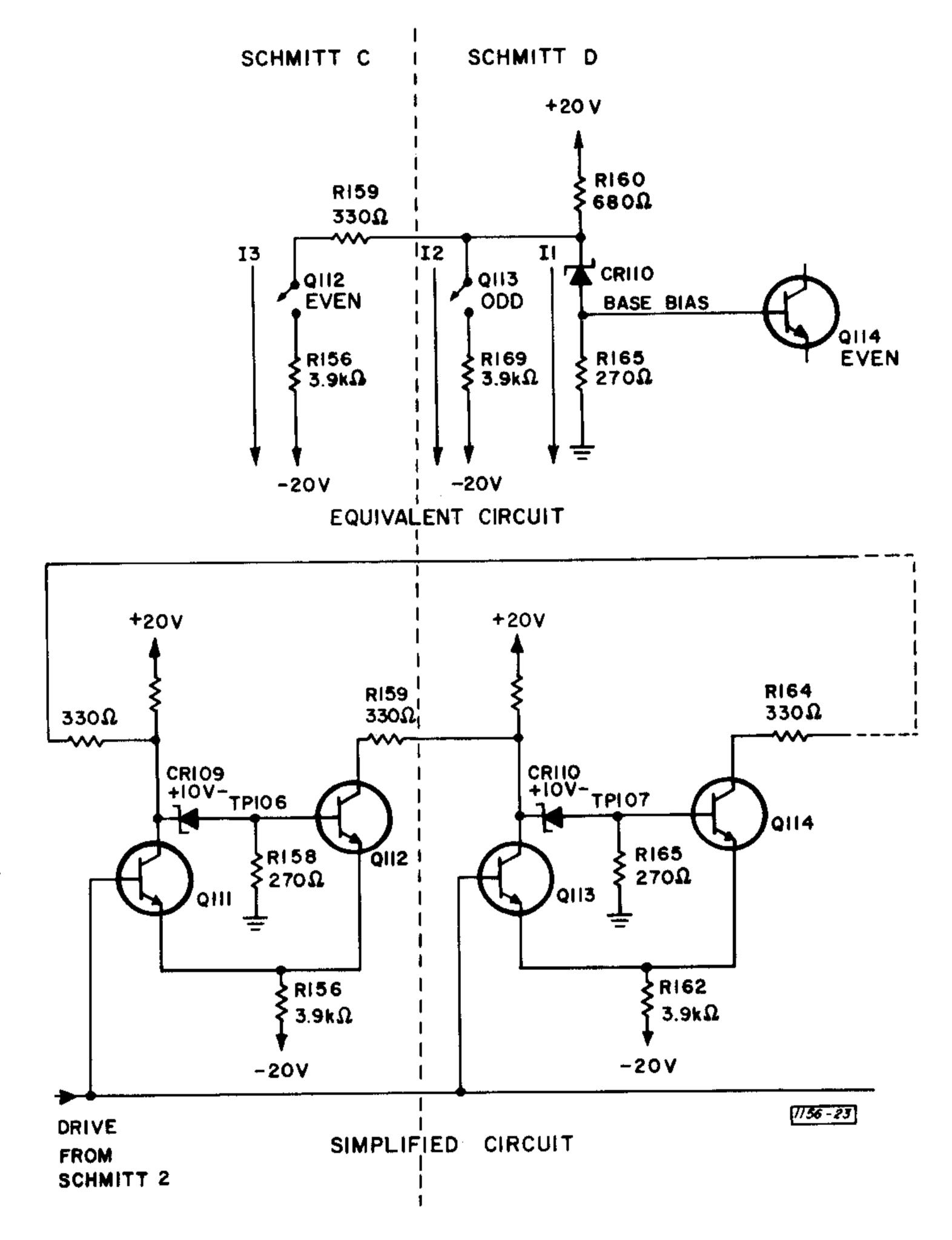
4.5.2 BIASING

The even transistor of each Schmitt is biased by its odd transistor and by the even transistor of the preceding Schmitt. For example:

When Schmitt D is in the 0 state, the even transistor, Q114, is on and the odd transistor, Q113, is off. With Q113 off, current path I2 is open. When Schmitt C is in the 1 state, its even 2.8 V transistor, Q112, is off and current path 13 is open. The bias for Q114 is then determined solely by current path I1 which sets the base bias of Q114 to 2.8 volts and locks Schmitt D in the 0 state.

When the preceding Schmitt, Schmitt C, changes states from 1 to 0, Q112 turns on and switches in current path 13. Current path 13 brings 1.8 V the bias of Q114 more negative to 1.8 volts and unlocks Schmitt D.

With Schmitt D unlocked, a positive drive pulse will turn on Q113 and change Schmitt D to the 1 state. With Q113 on, current path I2 is switched in which brings the bias of Q114 further 0.8 V negative to 0.8 volts and locks Schmitt D in the 1 state.



• 4.6 SCHMITT 3

Schmitt E consists of Q117 and Q118 and acts as a buffer-amplifier and pulse shaper for the scale-of-two circuit. The input from TP108 of the scale-of-five circuit is applied to Q117 base. The output is taken from Q118 collector and coupled through a dc-translation diode, CR113, to the input of the scale-of-two circuit.

• 4.7 SCALE-OF-TWO

The scale-of-two circuit consists of Q119 and Q120 and is a conventional, emitter-coupled, bistable multivibrator which is triggered by positive pulses from the output of Schmitt 3.

• 4.8 SCHMITT 4

Schmitt 4 consists of Q121 and Q122 and provides the necessary high-current drive (20 milliamperes) to the OUTPUT connector.

4.9 POWER SUPPLY

The power supply contains two regulators which provide two outputs, +20 volts and -20 volts.

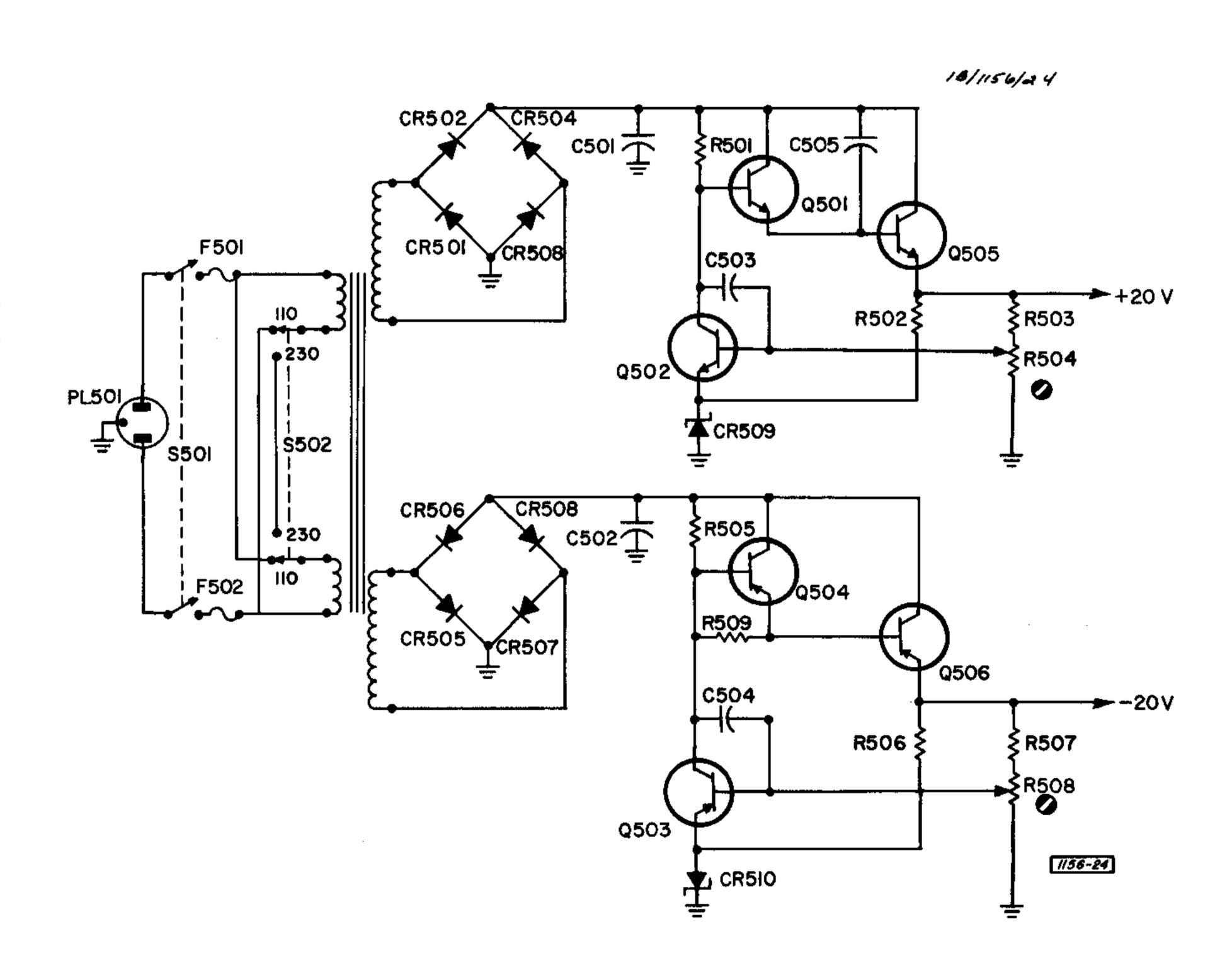
4.9.1 + 20-VOLT REGULATOR

The +20-volt supply consists of a full-wave bridge rectifier (CR501 through CR504), a series regulator (Q505), a comparator (Q502), and an error-voltage emitter follower (Q501).

The +20-volt output is taken from the emitter of Q505. Error voltage from the center arm of R504 is applied to the base of the comparator, Q502, whose bias is set by a zener diode, CR509. The comparator amplifies and inverts the error voltage and applies it to the base of the error-voltage emitter follower, Q501, which drives the series regulator to maintain a constant +20-volt output.

4.9.2 -20-YOLT REGULATOR

The -20-volt supply is identical to the +20-volt supply except the rectifiers are reversed and PNP transistors are used instead of NPN transistors.



SECTION 5 SERVICE AND MAINTENANCE

5.1	WARRANTY	.25
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5.3	ROUTINE MAINTENANCE	.25
5.4	SCALE-OF-FIVE DC VOLTAGES	. 25
5.5	CALIBRATION PROCEDURE	26

• 5.1 WARRANTY

We warrant that each new instrument manufactured and sold by us is free from defects in material and work-manship, 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 or 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 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 numbers 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 ROUTINE MAINTENANCE

None required.

• 5.4 SCALE-OF-FIVE DC VOLTAGES

The scale-of-five circuit can be checked by means of dc-voltage measurements:

- 1. Remove any input signal, set the TRIGGER LEVEL control fully cw, and connect a 1-k Ω resistor between AT508 (+20 V) and CR106 anode (scale-of-five input). The dc voltages at the bases of the even tran-
- sistors in the circuit (Q108, Q110, Q112, Q114, and Q116) should be about 2 V.
- 2. Move the 1-k Ω resistor to AT507 (-20 V) and set the TRIGGER LEVEL control fully ccw. The dc voltages at the bases of the even transistors should again be about 2 V.

• 5.5 CALIBRATION PROCEDURE

5.5.1 INTRODUCTION

Each step in the calibration procedure should be performed in sequence since one step serves as a foundation for the next. A complete calibration insures that all circuits are operating properly and within spec-

ifications. The Type 1156-A Decade Scaler incorporates the high reliability one expects of conservatively designed, semiconductor circuits and routine calibrations are unnecessary.

5.5.2 TEST SETUP AND EQUIPMENT REQUIRED

The following equipment is required for a complete calibration of the Type 1156-A Decade Scaler. The specifications given for the equipment are those necessary for the calibration of the Type 1156-A and are not necessarily those of the suggested equipment.

Metered, adjustable autotransformer

Output: 115 V, 15 W. Meter: Ac, ±3% accuracy

The Type W5MT3W Metered Variac® Autotransformer

can be used.

Oscilloscope

Bandwidth: dc to $\approx 30 \,\mathrm{Mc/s}$ (-3 dB points)

Sensitivity: 1 to 5 V, p-to-p Impedance: 50Ω or greater

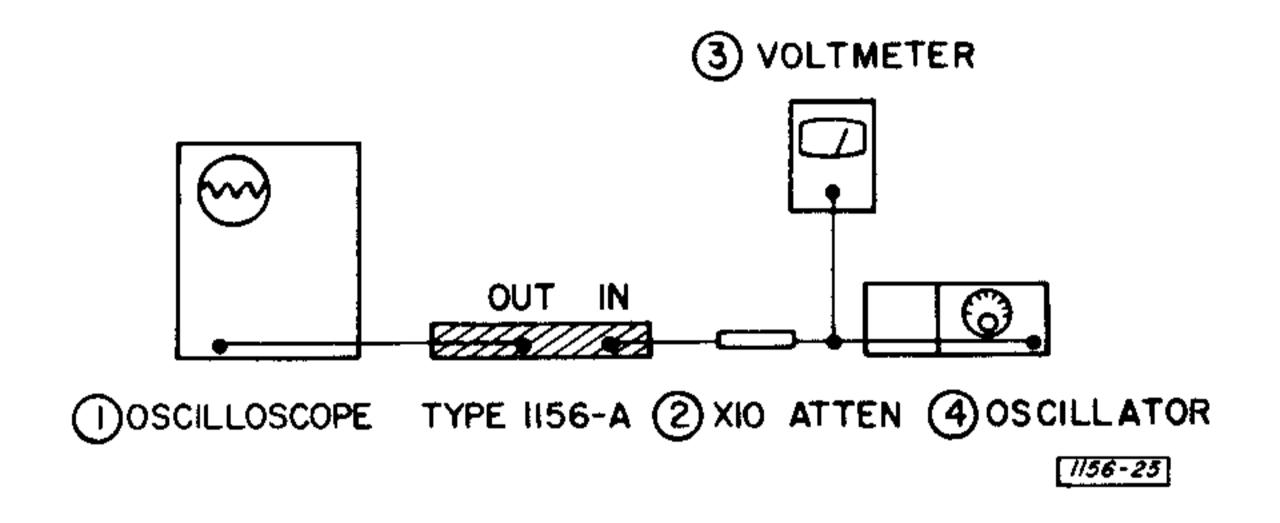
X10 attenuator

Attenuator: X10, ±1.5% accuracy

Impedance: 50 Ω

The Type 874-G20 or Type 874-G20L (locking con-

nectors) Fixed Attenuator can be used.



Electronic voltmeter

Voltage: 20 V dc and 0.35V to 1V, rms, ac; $\pm 2\%$ accuracy

Impedance: $100 \,\mathrm{k}\Omega$ or greater Frequency: Dc to 100 Mc/s

The Type 1806 Electronic Voltmeter can be used

Oscillator

Frequency: 1 Mc/s and 100 Mc/s Output: 0.035 to 1 V, rms, into 50Ω

For 1Mc/s the Type 1211 Unit Oscillator can be used For 100 and 125 Mc/s the Type 1208 or 1215 Unit

Oscillator can be used

5.5.3 POWER SUPPLY

+20 volts. Set the line voltage to 115 volts and connect a meter and an oscilloscope to AT508. Adjust R504 R504 for +20 volts, dc, and check ripple; must be 120 c/s and less than 60 mV, p-to-p.

Vary the line voltage from 105 to 125 volts and check, (1) dc voltage, must remain within 0.5 volt of +20 volts; (2) ripple, must not increase.

-20 volts. Set the line voltage to 115 volts and connect a meter and an oscilloscope to AT507. Adjust R508 R508 for -20 volts, dc and check ripple; must be 120 c/s and less than 30 mV, p-to-p.

Vary the line voltage from 105 to 125 volts and check, (1) dc voltage, must remain within 0.5 volt of -20 volts; (2) ripple, must not increase.

5.5.4 SENSITIVITY

Adjustment. Check the mechanical position of the TRIGGER LEVEL knob on the shaft: the dot must be straight up at the center of the potentiometers' range.

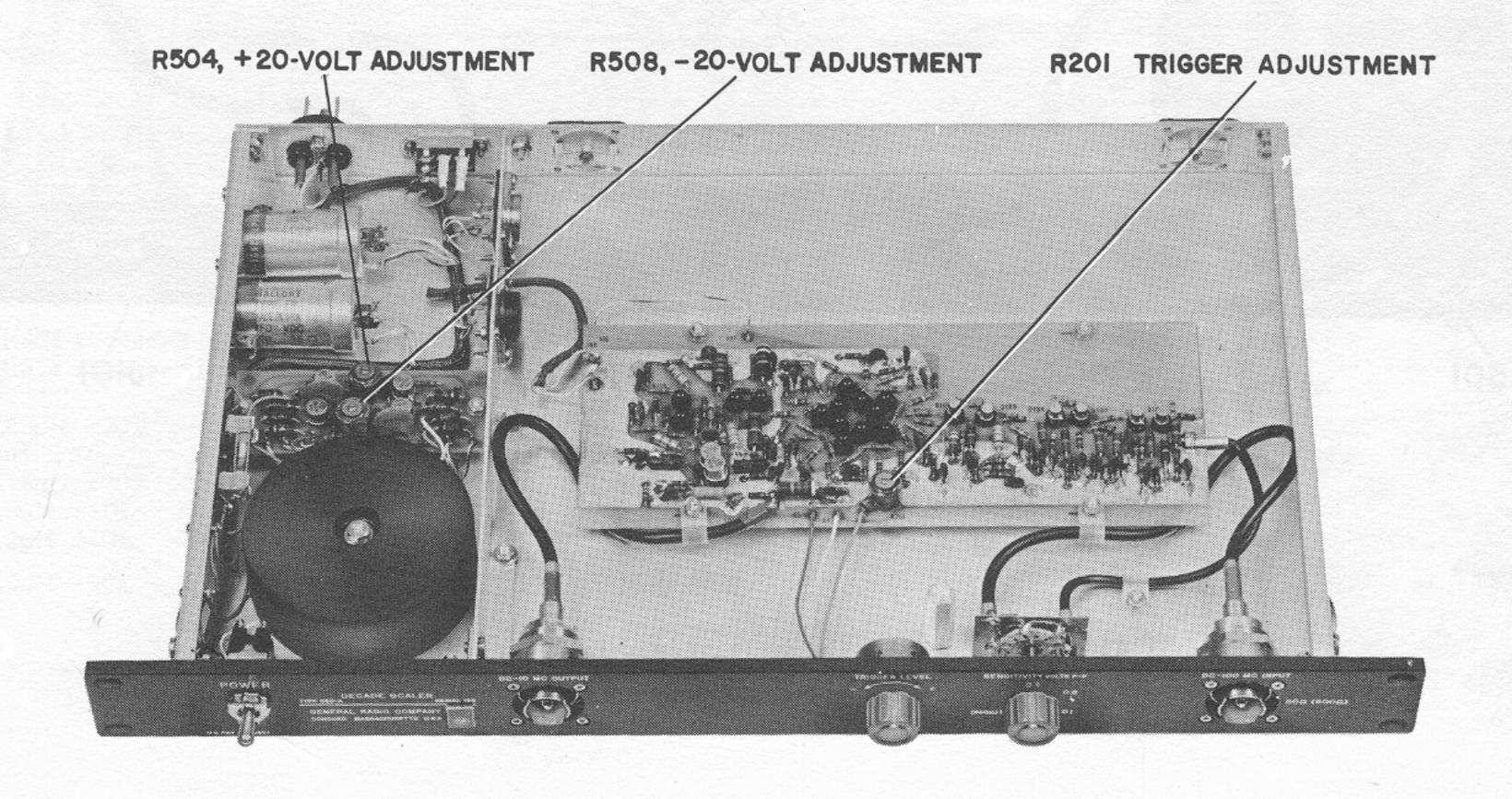
Set the dot on the TRIGGER LEVEL control straight up and set the SENSITIVITY control to 1 (1 V, p-to-p). Set the oscillator output for 1 V, rms (10 V on meter) at 1 Mc/s and adjust R201 for the proper OUTPUT R201 as displayed on the oscilloscope. Reduce the oscillator output amplitude and adjust R201 so that proper triggering is obtained with the input as low as 0.35 V, rms (3.5 V on meter).

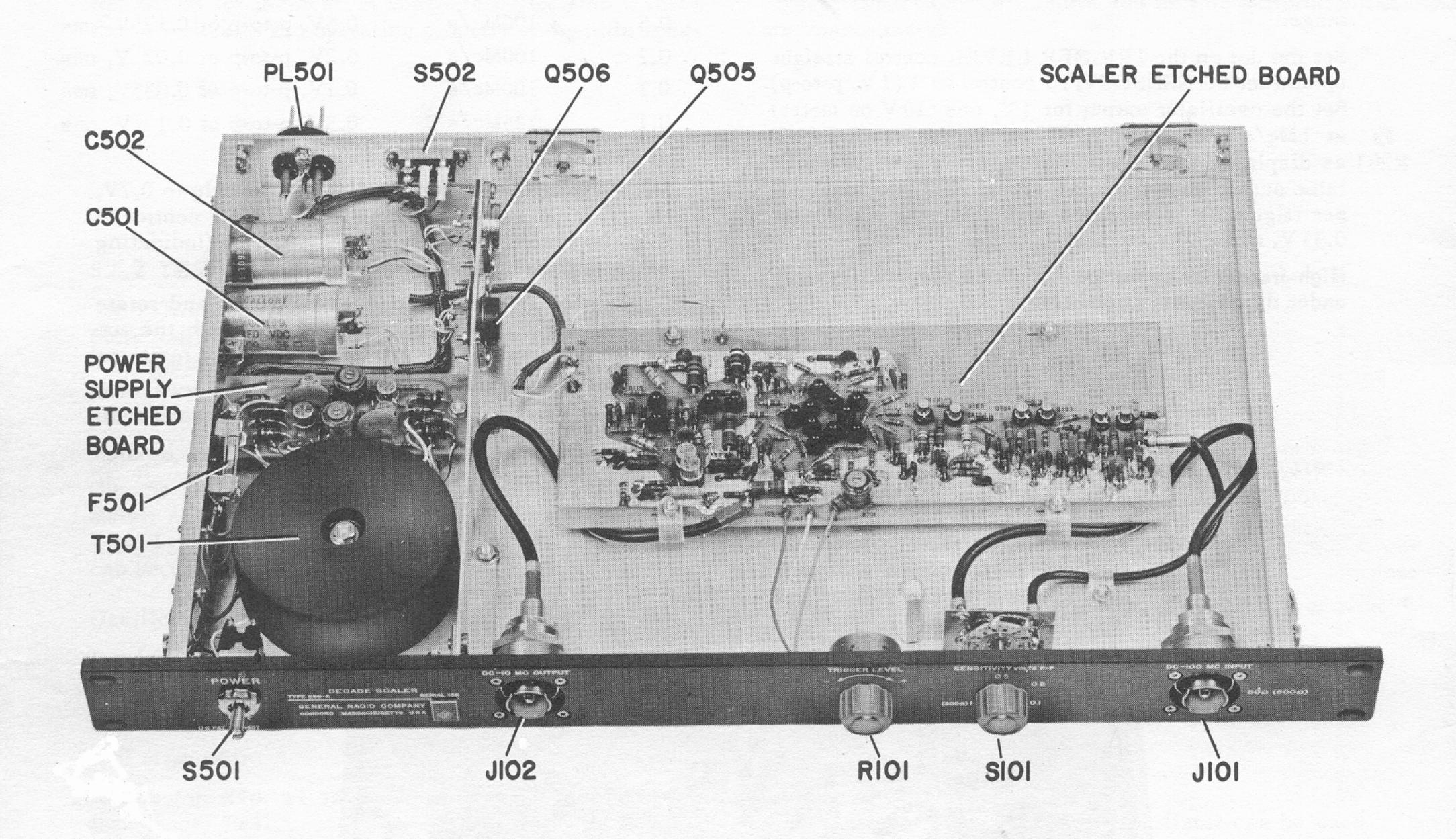
High-frequency operation. Check for proper triggering under the following conditions:

SENSITIVITY	Oscil	lator
control	frequency	amplitude at INPUT connector
1	100Mc/s	1 V, p-to-p or 0.35 V, rms
0.5	100Mc/s	0.5V, p-to-p or 0.175V, rms
0.2	100Mc/s	0.2V, p-to-p or 0.07 V, rms
0.1	100Mc/s	0.1V, p-to-p or 0.035V, rms
0.1	125Mc/s	0.3V, p-to-p or 0.1 V, rms

Maximum input. Set the oscillator amplitude to 0.7V, rms, (7 V on meter) and the SENSITIVITY control to 0.1: the instrument must trigger properly (indicating an input dynamic range of 20:1).

Dc operation. Disconnect the oscillator and rotate the TRIGGER LEVEL control back and forth: the output must complete one cycle for every 10 rotations of the TRIGGER LEVEL control.





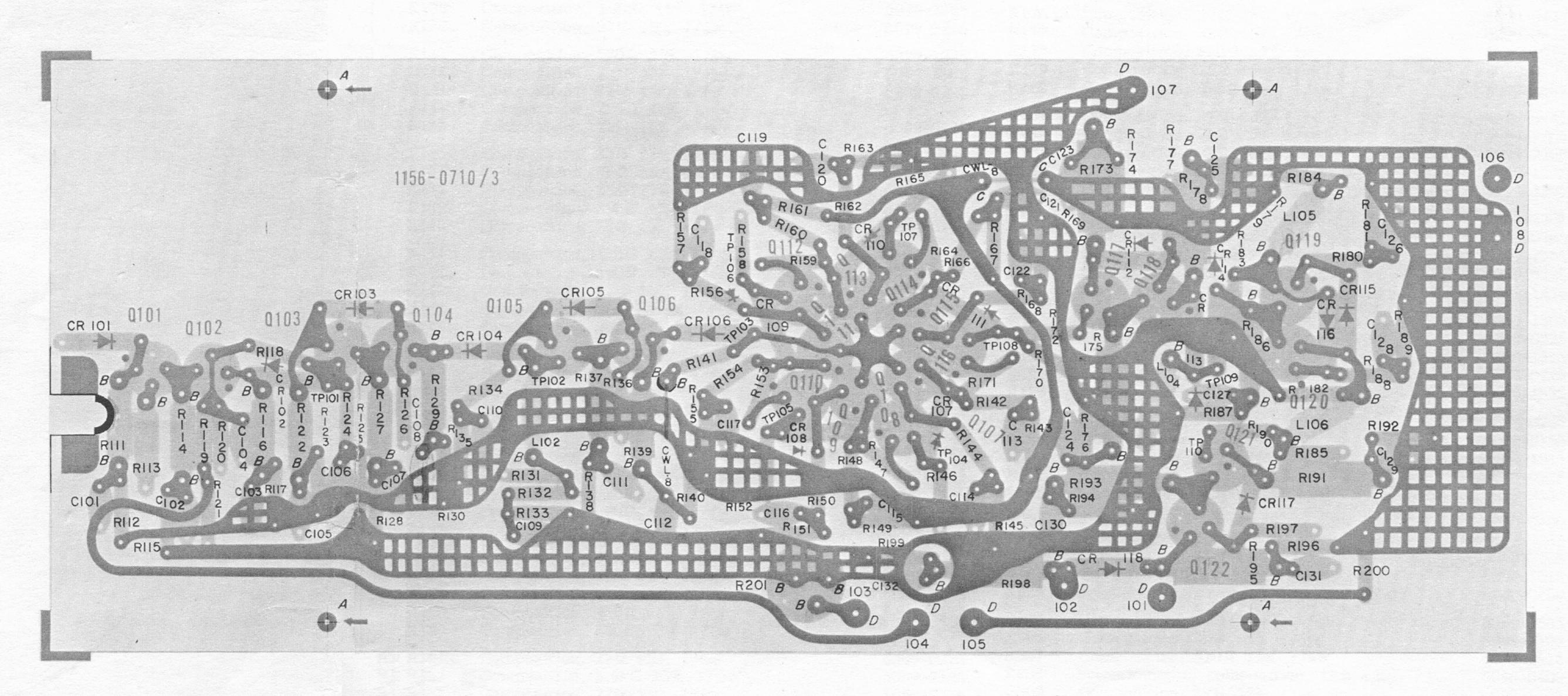
SCALER etched-board circuit assembly 1156-2710 POWER SUPPLY etched-board circuit assembly 1156-2750

PARTS LIST

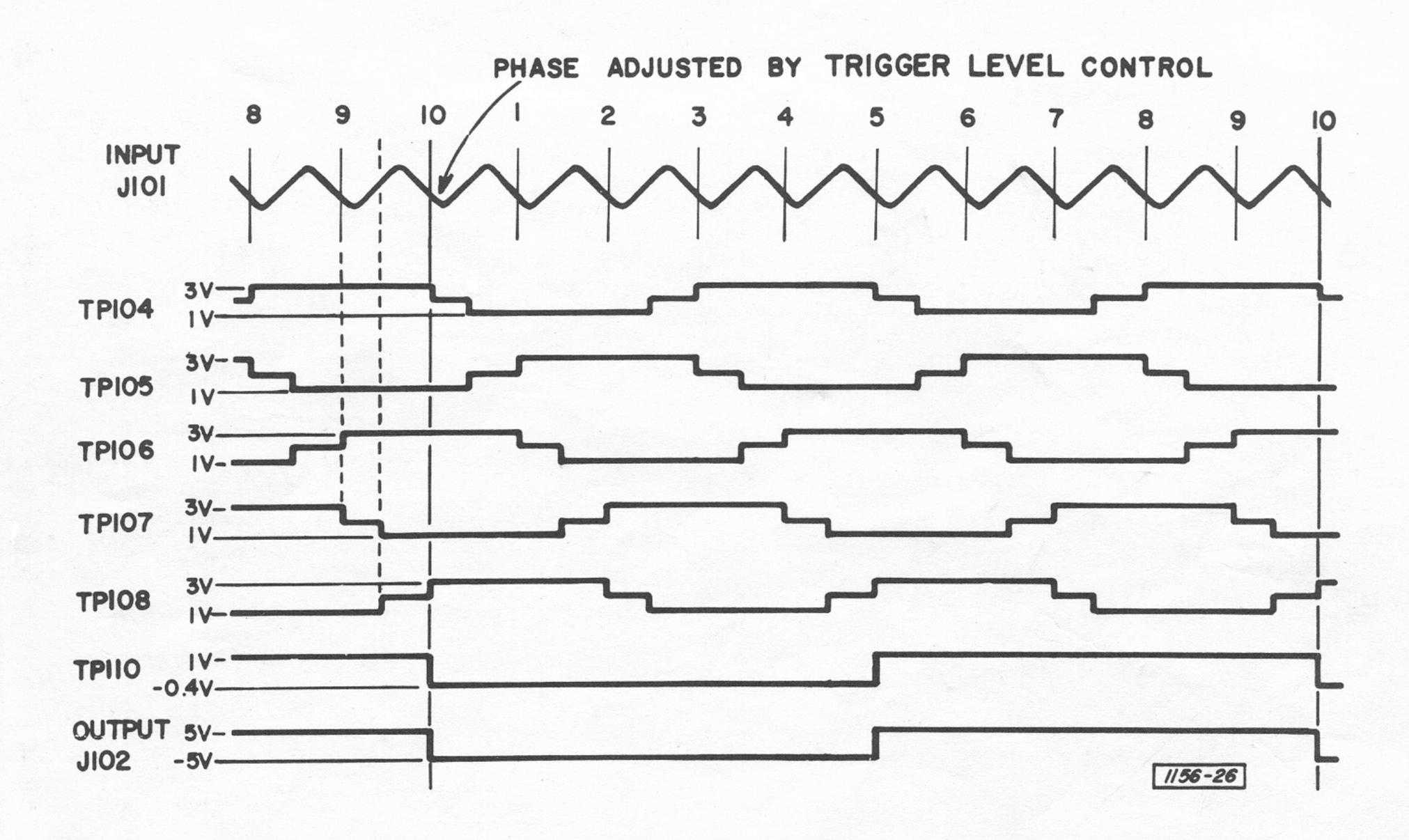
REF NO.	DESCRIPTION	PART NO.	REF NO.	DESCRIPTION	PART NO.
CAPACITORS			PLUG	•	
C101 C102 C103 C104	Ceramic, $0.001\mu F$ $+80-20\%$ 500V Ceramic, $0.001\mu F$ $+80-20\%$ 500V Ceramic, $0.001\mu F$ $+80-20\%$ 500V Ceramic, $47pF$ $\pm 5\%$ 500V	4404 -2109 4404 -2109 4404 -2109 4404 -0475	PL501	3-terminal power plug; power connector consists of; 2-terminal power plug ground pin	4240-0600 4240-0800
C105			TRANSISTOR:		
thru C132	Ceramic, 0.001µF +80-20% 500V	4404-2109	Q101 thru Q106	Type K2037	8210-1088
C501 C502 C503 C504	Electrolytic, $600\mu F$ +100-10% 35V Electrolytic, $600\mu F$ +100-10% 35V Ceramic, $0.022\mu F$ ±20% 500V Ceramic, $0.022\mu F$ ±20% 500V	4450-2400 4450-2400 4407-3220 4407-3220	Q107 thru Q120	Type 2N3563	8210-1066
C505 DIODES	Ceramic, $0.01\mu F +80-20\% 50V$	4401-3100	Q121 Q122	Type 2N2218 Type 2N2218	8210-1028 8210-1028
CR 101 thru CR 104	Type 1N748A	6083-1002	Q501 Q502 Q503	Type 2N1304 Type 2N1304 Type 2N1304	8210-1304 8210-1304 8210-1305
CR105 thru CR111	Type 1N758A	6083-1012	Q504 Q505 Q506	Type 2N1305 Type 2N1702 Type 2N1544	8210-1305 8210-1065 8210-1014
CR112 CR113 CR114	Type 1N752 Type 1N752 Type 1N995	6083 - 1004 6083 - 1004 6082 - 1002	RESISTORS R101	Potentiometer, composition, TRIGGER LEVEL $1k\Omega$ $\pm 10\%$ uses 5540-3000 gray knob	
CR115 CR116	Type 1N957B Type 1N957B	6083 - 1009 6083 - 1009	R102 R103 R104	Composition, $75\Omega \pm 5\% = 1/2w$ Composition, $75\Omega \pm 5\% = 1/4w$ Composition, $130\Omega \pm 5\% = 1/4w$	6100-0755 6099-0755 6099-1135
CR117	Type 1N752	6083-1004	R105	Composition, $120\Omega \pm 5\% 1/4w$	6099-1125
CR118	Type 1N752	6083 - 1004	R106	Composition, $130\Omega \pm 5\% 1/4$ w	6099-1135
CR501 thru CR508	Type 1N3254	6081-1002	R107 R108 R109 R110	Composition, 75Ω $\pm 5\%$ $1/4w$ Composition, 820Ω $\pm 5\%$ $1/4w$ Composition, 150Ω $\pm 5\%$ $1/4w$ Composition, 300Ω $\pm 5\%$ $1/4w$	6099-0755 6099-1825 6099-1155 6099-1305
CR509	Type 1N758A	6083 - 1012			
CR510 Fuse	Type 1N758A	6083 - 1012	R111 R112	Composition, $1.2k\Omega \pm 5\% = 1/4w$ Composition, $22\Omega \pm 5\% = 1/4w$	6099 - 2125 6099 <i>-</i> 0225
F501 JACKS	0.25A	5330-1400	R113 R114	Composition, $75\Omega \pm 5\% = 1/2w$ Composition, $2k\Omega \pm 5\% = 1/2w$	6100-0755 6100-2205
J101	GR874 recessed locking connector	INPUT 0874-4622	R115	Composition, $22\Omega \pm 5\% 1/4$ w	6099-0225
J102 INDUCTORS	GR874 recessed locking connector	OUTPUT 0874-4622	R116	Composition, $1.2k\Omega$ ±5% 1/4w	6099-2125
L101	$0.68 \mu H \pm 20\%$	4300-0500	R117	Composition, $22\Omega \pm 5\% 1/4$ w	6099-0225
L101	$1 \mu H \pm 10\%$	4300-0300	R118	Composition, $1k\Omega \pm 5\% = 1/4w$	6099-2105
L103	$0.15 \mu H \pm 20\%$	4300-0100	R119	Composition, $1.8k\Omega \pm 5\% = 1/4w$	6099 - 2185
L104	$1.8 \mu H \pm 10\%$	4300-1100	R120	Composition, $200\Omega \pm 5\% 1/4$ w	6099-1205
L105	$2.2 \mu H \pm 10\%$	4300-1200	R121	Composition, $820\Omega \pm 5\% 1/4$ w	6099-1825
L106	$2.2 \mu H \pm 10\%$	4300-1200	R122 R123	Composition, $1.2k\Omega$ $\pm 5\%$ $1/4w$ Composition, 22Ω $\pm 5\%$ $1/4w$	6099-2125 6099-0225

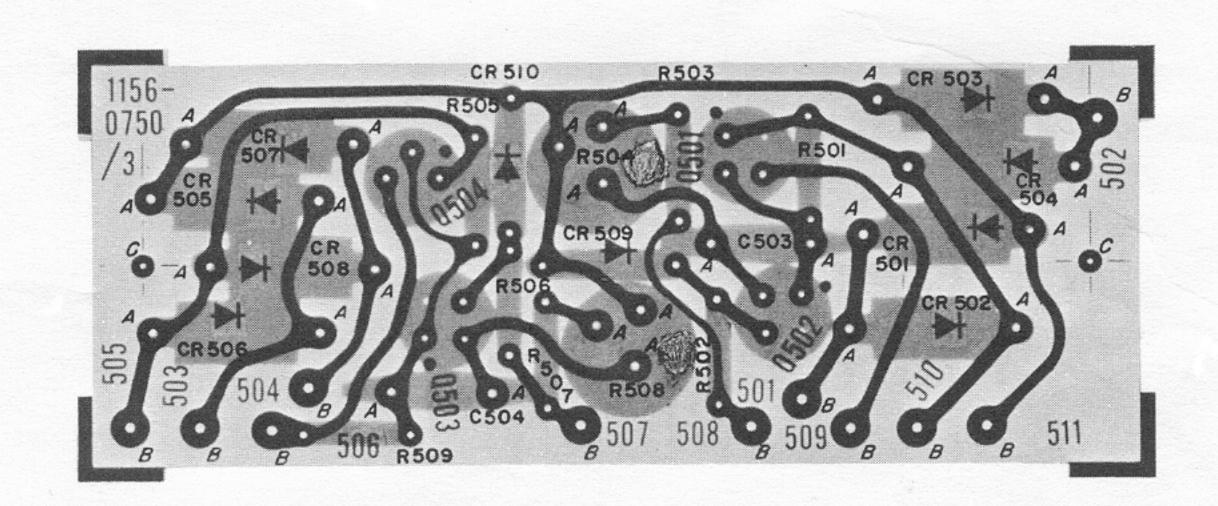
PARTS LIST

REF NO.	DESCRIPTION	₹	PART NO.	REF NO.	DESCRIPTION	PART NO.
RESISTOR				RESISTOR		
R124	Composition.	$2.4k\Omega \pm 5\% 1/4w$	6099-2245	R171	Composition, $330\Omega \pm 5\% 1/4w$	6099-1335
R125	•	$22\Omega \pm 5\% 1/4w$	6099-0225	R172	Composition, $470\Omega \pm 5\% = 1/4w$,
	•			R173	Composition, $370\% \pm 5\% = 174$ w Composition, $390\% \pm 5\% = 1$ w	6099-1475
R126		±5% 1/4w value chosen in final c	alibration	R174		6110-1395
R127	Composition,	$2k\Omega \pm 5\% $ 1/2w	6100-2205	R17 3 R175	Composition, $22\Omega \pm 5\% = 1/4w$	6099-0225
R128	Composition,	$22\Omega \pm 5\% $ 1/4w	6099-0225	K1/3	Compostiion, $1k\Omega \pm 5\%$ 1w	6110-2105
R129	Composition,	$1.2k\Omega \pm 5\% 1/4w$	6099-2125	R176	Composition, $22\Omega \pm 5\% = 1/4w$	6099-0225
R130	Composition,	$22\Omega \pm 5\% $ 1/4w	6099-0225	R177	Composition, $82\Omega \pm 5\% 1/4w$	6099-0825
R131	Composition	220Ω ±5% 1/4w	6000 1225	R178	Composition, $510\Omega \pm 5\%$ 1w	6110-1515
R132	<u>-</u>	$3k\Omega \pm 5\% 1/4w$	6099-1225	R179	Composition, $22\Omega \pm 5\% 1/4$ w	6099-0225
R133		$22\Omega \pm 5\% = 1/4w$	6099-2305 6099-0225	R180	Composition, $680\Omega \pm 5\% \cdot 1/4w$	6099-0225
R134		$820\Omega \pm 5\% = 1/4w$				0077-1003
R135		$22\Omega \pm 5\% = 1/4w$	6099-1825	R181	Composition, $22\Omega \pm 5\% = 1/4$ w	6099-0225
1(100	Composition,	2230 1370 1/4W.	6099-0225	R182	Composition, $2k\Omega \pm 5\% = 1/4w$	6099-2205
R136	Composition,	$33\Omega \pm 5\% 1/4w$	6099-0335	R183	Composition, $2k\Omega \pm 5\% = 1/4w$	6099-2205
R137	Composition,	$2k\Omega \pm 5\% 1/2w$	6100 - 2205	R184	Composition, $270\Omega \pm 5\% = 1/4$ w	6099-1275
R138	Composition,	$22\Omega \pm 5\% 1/4w$	6099-0225	R185	Composition, $270\Omega \pm 5\% = 1/4w$	6099-1275
R139	Composition,	$390 \Omega \pm 5\% 1/2w$	6100-1395	R186	Composition, $2k\Omega \pm 5\% = 1/2w$	6100 2205
R140	Composition,	$22\Omega \pm 5\% $ 1/4w	6099-0225	R187	2 , , , , , , , , , , , , , , , , , , ,	6100 - 2205
R141	Composition	120Ω ±5% 1/4w	6000 1105	R188	Composition, $22\Omega \pm 5\% = 1/4w$	6099-0225
R142	•	, ,	6099-1125		Composition, $680\Omega \pm 5\% = 1/4$ w	6099-1685
	-	$680\Omega \pm 5\% = 1/4w$	6099-1685	R189	Composition, $22\Omega \pm 5\% = 1/4$ w	6099-0225
R143	•	$22\Omega \pm 5\% = 1/4$ w	6099-0225	R190	Composition, $470\Omega \pm 5\% 1/4$ w	6099-1475
R144		$3.9k\Omega \pm 5\% 1/4w$	6099-2395	R191	Wire-wound, $300\Omega \pm 5\% 3w$	6680 - 1305
R145	Composition,	$22\Omega \pm 5\% $ 1/4w	6099-0225	R192	Composition, $22\Omega \pm 5\%$ 1/4w	6099-0225
R146	Composition,	$270 \Omega \pm 5\% 1/4w$	6099-1275	R193	Wire-wound, $510\Omega \pm 5\%$ 3w	6680-1515
R147	Composition.	$330\Omega \pm 5\% 1/4w$	6099-1335	R194	Composition, $22\Omega \pm 5\% 1/4w$	6099-0225
R148	Composition,	$680\Omega \pm 5\% 1/4w$	6099-1685	R195	Wire-wound, $330\Omega \pm 5\%$ 3w	6680-1335
R149	•	$22\Omega \pm 5\% 1/4w$	6099-0225		,	
R150	-	$3.9k\Omega \pm 5\% 1/4w$	6099-2395	R196	Composition, $22\Omega \pm 5\% = 1/4$ w	6099-0225
D151	-			R197	Composition, $15\Omega \pm 5\% = 1/4$ w	6099-0155
R151	_ ·	$22\Omega \pm 5\% 1/4$ w	6099-0225	R198	Composition, $910\Omega \pm 5\% 1/2w$	6100-1915
R152	•	$270\Omega \pm 5\% = 1/4$ w	6099-1275	R199	Composition, $22\Omega \pm 5\% = 1/4$ w	6099-0225
R153	•	$330\Omega \pm 5\% = 1/4$ w	6099-1335	R200	Composition, $3.3k\Omega \pm 5\% 1/4w$	6099-2335
R154	-	$680\Omega \pm 5\% 1/4$ w	6099-1685	R201	Potentiometer, composition, $5k\Omega \pm 20\%$	6040 -0600
R155	Composition,	$22\Omega \pm 5\% $ 1/4w	6099-0225	R501	Composition, $5.6k\Omega \pm 5\% 1/4w$	6099-2565
R156	Composition.	$3.9k\Omega \pm 5\% 1/4w$	6099-2395	R502	Composition, $1k\Omega \pm 5\%$ 1/4w	6099-2105
R157	•	$22\Omega \pm 5\% 1/4w$	6099-0225	R503	Composition, $510\Omega \pm 5\% 1/4w$	6099-1515
R158		$270\Omega \pm 5\% 1/4w$	6099-1275	R504	Potentiometer, composition, $1k\Omega \pm 20\%$	6040 -0400
	<u> </u>	$330\Omega \pm 5\% 1/4w$	6099-1335	DEOE		
R160		$680\Omega \pm 5\% 1/4w$	6099-1685	R505	Composition, $5.6k\Omega \pm 5\% 1/4w$	6099-2565
	-			R506	Composition, $1k\Omega \pm 5\% = 1/4w$	6099-2105
R161	•	$22\Omega \pm 5\% 1/4$ w	6099-0225	R507	Composition, $510\Omega \pm 5\% 1/4$ w	6099-1515
R162	•	$3.9k\Omega \pm 5\% 1/4w$	6099-2395		Potentiometer, composition, $1k\Omega \pm 20\%$	6040 -0400
	<u>-</u>	$22\Omega \pm 5\% 1/4$ w	6099-0225	R509	Composition, $1k\Omega \pm 5\% 1/4w$	6099-2105
R164	-	$330\Omega \pm 5\% 1/4$ w	6099-1335	SWITCHES	Dot	T1T# - T4
R165	Composition,	$270\Omega \pm 5\% 1/4w$	6099-1275		Rotary, uses 5540-3000 gray knob SENSI	-
R166	Composition.	$680\Omega \pm 5\% 1/4w$	6099-1685			POWER 7910-1300
	_	$22\Omega \pm 5\%$ $1/4w$	6099-0225	S502	Slide	LINE 7910-0831
_	_	$3.9k\Omega \pm 5\% 1/4w$	6099-2395	TRANSFORM		— - ·
R169	•	$22\Omega \pm 5\% 1/4w$	6099-0225	T501	Power transformer	1156 - 2020
R170	.	$270\Omega \pm 5\% 1/4w$	6099-1275			
		· - -	· · · · · · · · · · · · · · ·			

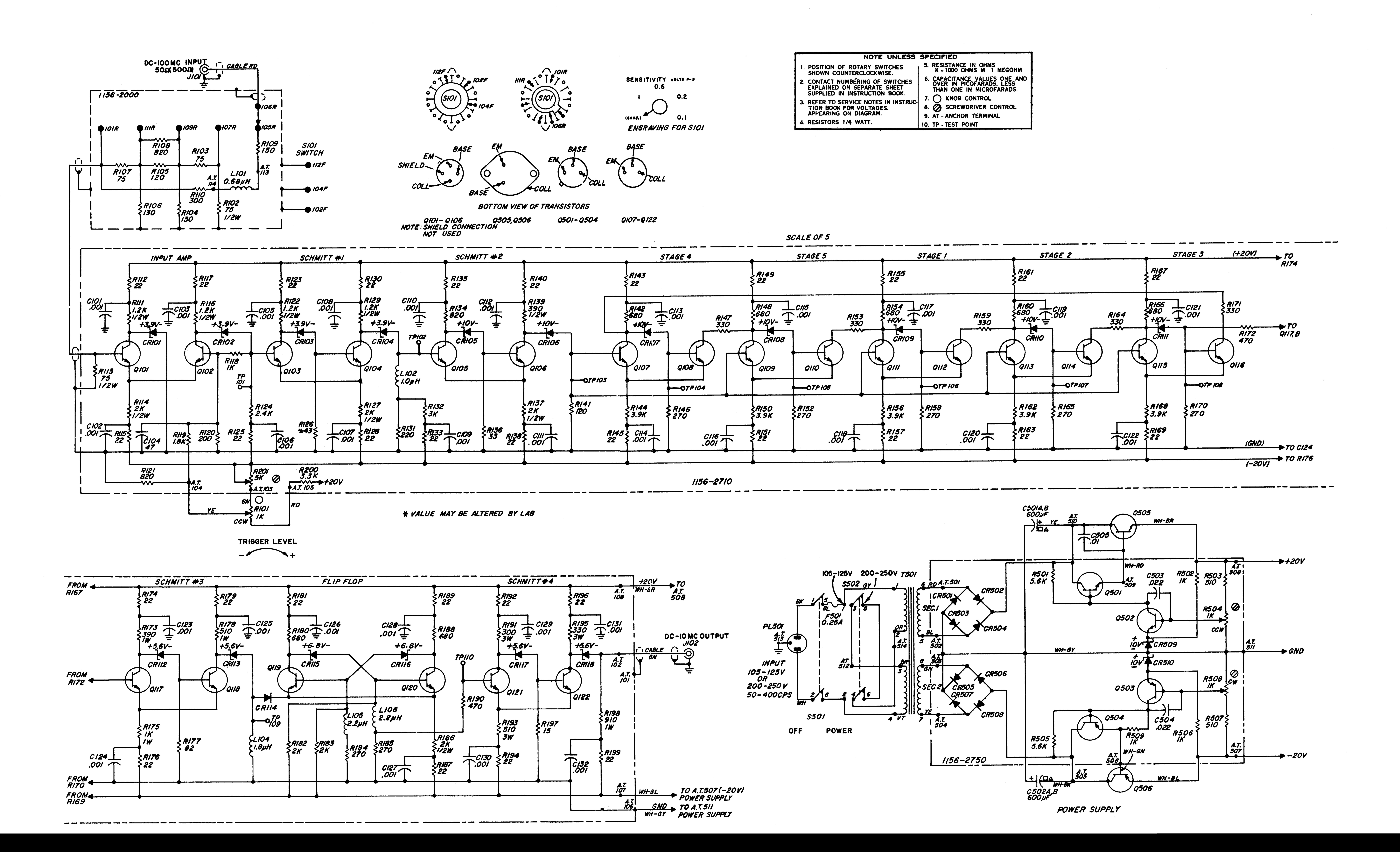


Scaler etched-board circuit assembly of Type 1156-A Decade Scaler





Power Supply etched-board circuit assembly of Type 1156-A Decade Scaler



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^{*} Repair services are available at these offices.