MODEL 139 B
PULSE GENERATOR

Serial No. ________________

April 1970

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Shipping instructions, or repair information and parts will be sent to you promptly.

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Fig. 1-1 Model 139B Pulse Generator

SECTION 1
SPECIFICATIONS

1-1 GENERAL

The E-H Model 139B is a solid state pulse generator suitable for applications requiring a pulse generator, a ramp generator, or a delay-and-gate generator. It has a broad range of output pulse parameters. The internal clock repetition rate is continuously variable from 10Hz to 50MHz. It may be externally triggered from zero to 50 MHz. The output may be inhibited or periodically gated by an externally applied gate or dc control voltage. A separate trigger output with an adjustable width pulse is useful in triggering an oscilloscope or another instrument.

The ramp rate feature permits separate adjustment of output pulse leading edge risetime and falling edge falltime, within any one of 12 ramp rate ranges. The baseline offset feature allows the pulse train to be adjusted off the zero reference up to 2v, positive or negative. Output pulse waveforms may be inverted in polarity to accomplish duty factor approaching 100%.

1-2 SPECIFICATIONS (all specifications assume a 50Ω resistive load)

a. Pulse Repetition Frequency. 10 Hz to 50 MHz from an internal clock. Zero to 50 MHz when externally triggered. The internal repetition rate clock is continuously variable through 14 frequency ranges from 10 Hz to 50 MHz in a 1-3-10 sequence, a 3:1 vernier control provides continuous adjustment through each range.

b. Output Pulse Amplitude. The generated pulse amplitude is continuously variable from 3.3v to 10v (either polarity) followed by a step attenuator with ratios of 1:1, 3:1, 10:1, 30:1, 100:1. The pulse amplitude at the output connector is continuously variable from 33 mv to 10v either polarity.

c. Rise and Fall Times (10 to 90%). Continuously adjustable from 6 ns to 3 ms in 12 ranges in a 1-3-10 sequence. Independent 3:1 vernier controls for rise and fall time provide continuous adjustment through each range.

d. Pulse Width. Continuously variable from 10 ns to 10 ms in 12 ranges in a 1-3-10 sequence. A 3:1 vernier control provides continuous adjustment through each range. By use of the inverting feature, pulse widths approaching 100% of the repetition period can be accomplished.

e. Pulse Delay. Continuously variable from 10 ns to 10 ms in 12 ranges in a 1-3-10 sequence. A 3:1 vernier control provides continuous adjustment through each range. A fixed 50 ns of delay exists between an external drive pulse and the trigger pulse.

f. Output Terminating Impedance: 50Ω. The Model 139B is a current source designed to operate into a 50Ω impedance.

The output is short-circuit and open-circuit protected, but is not intended for operation in the open-circuit condition for extended periods.

g. Duty Factor: Greater than 50%. If the pulse-width and pulse-delay settings exceed the duty factor limit, the repetition-rate will automatically scale down in frequency, providing overload protection.

h. Waveform Distortion (into 50Ω resistive load). Pulse top distortion less than 5% peak-to-peak. Baseline distortion less than 5% peak-to-peak, except 100:1 attenuator mode which is less than 8% peak-to-peak. Waveform distortion includes all amplitude departures from an ideal flat waveform including overshoot, undershoot, ringing, and droop.

i. Baseline Offset. Continuously variable from +2v to -2v. The maximum rated peak output amplitude is from +10v to -10v referenced to chassis ground, including any combination of pulse amplitude, pulse polarity, and baseline offset. The output pulses may be inverted. In the inverted mode, the pulse top is adjustable with the offset control from +2v to -2v, and the baseline is adjustable up to +10v or -10v with the pulse amplitude control and the attenuator.

j. Jitter. 0.1% + 50 ps, including repetition-rate, width, and delay jitter.

k. External Drive Input. +1.5v minimum, +15v maximum. The Model 139B may be externally triggered at repetition rates from 0 to 50 MHz. The external triggering signal should have a risetime of 0.1 μs/v or faster. The external drive input impedance is 200Ω.

l. Trigger Output. +1.5v into 50Ω. The trigger pulse width is continuously variable from 10 ns to 50 ns. Risetime of the trigger output pulse is 5 ns/v, source impedance is 50Ω.

m. Double Pulse Operation. A front-panel switch provides double pulse operation. Two identical pulses are generated, one at the beginning of the delay interval, the other at the end of the delay interval. Maximum repetition rate for double pulse operation is 20 MHz. Minimum spacing between the double output pulses is 30% of the pulse width or 15 ns, whichever is greater. Spacing between the double pulses is determined by the delay controls.

n. Single Cycle Operation. A front-panel pushbutton provides single cycle operation when the FREQ. RANGE control is in the EXT position.

o. Gate Input. -2v minimum required to block the pulse train, -15v maximum. The end of the gate waveform initiates the pulse train, synchronizing the output pulses with the gate signal. The gate input impedance is 300Ω.

p. Physical Dimensions.

Cabinet-mount:	6" high, 17" wide, 12" deep
Rack-mount:	7" high, 19" wide, 12" deep
Weight:	20 lbs. net; 28 lbs. commercial packed; 37 lbs. export packed.

q. Power Requirements. 105/125v, 50/60 Hz, 75 volt-amperes. 210/250 volt connection is available as a standard feature.

1-3 ACCESSORIES

a. E-H Model ZL-3 termination. A 50Ω termination with signal pick-off; 3W power dissipation rating.

b. E-H Model CX-5 cable set. Consists of two 5-ft. cables, RG-58A/U with BNC connectors. Characteristic impedance is 50Ω.

c. Additional E-H BNC series accessories are compatible with the Model 139B. For further accessory information, consult your E-H Representative or the factory.

SECTION 2
OPERATING INFORMATION

2-1 GENERAL

The performance specifications require that the Model 139B operate into a 50Ω resistive load. Any other load impedance will cause some distortion of the output waveform. Loads with a capacitive or inductive component will have an appreciable effect on the leading and trailing edges of the output pulses. The E-H Model ZT Pulse Transformer is useful in matching the output of the Model 139B Pulse Generator to impedances other than 50Ω.

2-2 CABLES, CONNECTORS, and ATTENUATORS

The fast risetime output of the Model 139B Pulse Generator contains frequency components in excess of 200 MHz. If any of these high-frequency components are attenuated or distorted by the use of connectors, cables, or attenuators that do not have a flat frequency response materially beyond 200 MHz, degradation of the pulse waveforms will result. Reflections from mismatches will also degrade the pulse waveforms. For optimum results, good high-frequency signal-handling techniques are necessary in coupling the output of the Model 139B to the system or device under test.

Some of the precautions to observe when coupling the output of the Model 139B are:

(1) Always terminate the output of the Model 139B in a 50Ω resistive load. If the impedance of the device or system under test is other than 50Ω, use an impedance matching device so mismatch-effects will not degrade the pulse waveform.

(2) Make sure that all connectors, cables, attenuators, etc. in the signal-handling path have a flat frequency response materially in excess of 200 MHz. Observe the power dissipation ratings of terminations and attenuators.

(3) Use only high-quality 50Ω coaxial cable, such as RG-58A/U or RG-213/U with properly matched connectors. Keep cable lengths as short as possible, since long lengths of even high-quality coaxial cable attenuate high frequencies.

2-3 OPERATING CONTROLS and CONNECTORS

a. FREQ. RANGE. Selects one of 14 internally generated repetition-rate ranges or the external drive function. The repetition-rate range limits are in a 1-3-10 sequence from 10 Hz to 50 MHz.

b. FINE (FREQ. RANGE). A 3:1 vernier control which continuously varies the internally-generated repetition rate within the selected repetition-rate range, with overlap to the two adjacent ranges. In the DOUBLE PULSE mode, the FINE control is disconnected on the highest FREQ. RANGE, and the maximum repetition-rate is limited to 20 MHz.

c. EXT DRIVE INPUT Connector. When the FREQ. RANGE control is in the EXT position, it permits external triggering with repetition rates from 0 to 50 MHz. The external triggering signal must have an amplitude between +1.5v and +15v and a risetime of not longer than 0.1 μs/v. The external drive input impedance is 200Ω.

d. DELAY. Selects one of 12 delay ranges where the delay is the time interval between the leading edge on the trigger pulse and the leading edge of the output pulse. The delay range limits are in a 1-3-10 sequence from 10 ns to 10 ms.

e. FINE (DELAY). A 3:1 vernier control which continuously varies the delay interval within the selected delay range, with overlap to the two adjacent ranges.

f. WIDTH. Selects one of 12 output-pulse width ranges. The pulse width range limits are in a 1-3-10 sequence from 10 ns to 10 ms.

g. FINE (WIDTH). A 3:1 vernier control which continuously varies the output pulse width within the selected range, with overlap to the two adjacent ranges.

h. GATE INPUT Connector. Permits an externally applied voltage between -2v and -15v to inhibit the output of the pulse generator. The GATE INPUT voltage may be a dc control voltage, or a gating pulse. The trailing edge of a gating pulse initiates the output pulse train, synchronizing the output pulses with the gating signal. The gate input impedance is 300Ω.

i. RAMP RATE/10V. Selects one of 16 output pulse rise-time and fall-time ranges. The rise-time and fall-time range limits are in a 1-3-10 sequence from 6 ns to 300 ms. The risetime and falltime of the output pulses have a constant dv/dt slope, independent of amplitude. The ramp-rate ranges state the risetime (falltime) from 10 to 90% of a 10v pulse.

j. RISE (RAMP RATE/10V). A 3:1 vernier control which continuously varies the output pulse risetime within the selected range, with overlap to the two adjacent ranges.

k. FALL (RAMP RATE/10V). A 3:1 vernier control which continuously varies the output pulse falltime within the selected range, with overlap to the two adjacent ranges.

l. POLARITY. Selects one of 4 polarity modes for the output pulse.

(1) +NORMAL. The output pulse is positive-going from a ± baseline set by the offset control to a + pulse top set by the amplitude control.

(2) +INV. The output pulse is negative-going from a + baseline set by the amplitude control to a ± pulse top set by the offset control.

(3) -NORMAL. The output pulse is negative-going from a ± baseline set by the offset control to a - pulse top set by the amplitude control.

(4) -INV. The output pulse is positive-going from a - baseline set by the amplitude control to a ± pulse top set by the offset control.

m. OFFSET. Adds a dc component to the output pulse waveform before the output attenuator. The dc component is continuously variable from -2v to +2v. If an attenuator position other than 1:1 is used, the dc component is attenuated as well as the pulse amplitude. The dc component is otherwise independent of pulse amplitude.

n. ATTENUATOR. Selects one of four resistive attenuation ratios or a straight tnrough connection between the pulse generator and the output connector. The attenuation ratios are: 1:1, 3:1, 10:1, 30:1, and 100:1. In the 1:1 position, the source impedance is determined by the pulse generator output stage. For high frequencies this source impedance is approximately 50Ω. In all other attenuation positions, the output connector is back-terminated by the attenuator. For values on each attenuation range, refer to schematic 5.

o. AMPLITUDE. Continuously varies the pulse amplitude before the attenuator, between the limits of 3.3v and 10v. This control, together with the attenuator, provides continuous adjustment of the pulse amplitude at the output connector from 33 mv to 10v.

p. OUTPUT Connector. The output connector supplies the output pulse train to an external 50Ω load.

q. TRIGGER OUTPUT Connector. Provides a +1.5v trigger output pulse into a 50Ω load. The leading edge of the trigger pulse defines the beginning of the delay interval.

r. TRIGGER WIDTH. Provides continuous adjustment of the TRIGGER OUTPUT pulse width from 10 ns to 50 ns.

s. PULSE MODE

(1) In the SINGLE position, there is one output pulse during the pulse repetition period, occuring at a time interval after the trigger output pulse determined by the delay controls.

(2) In the DOUBLE position, there are 2 identical output pulses during the pulse repetition period, one at the beginning of the delay interval, and the other occuring at a time interval after the trigger pulse determined by the delay controls.

In the DOUBLE pulse mode, the maximum repetition rate for the pulse pairs is 20 MHz. Time separation between the pulses should be not less than 30% of the pulse width or 15 ns, whichever is greater. This time separation limit applies not only to the interval between the first and second pulse, but also to the interval between the second and the first pulse when the second pulse is delayed out near the end of the repetition rate period.

t. SINGLE CYCLE. When the FREQ. RANGE control is in the EXT position, a single cycle can be initiated by manually depressing the SINGLE CYCLE pushbutton.

u. POWER. With the line cord connected to 115 vac, 50/60 Hz power source, and with the POWER switch set to its ON position, power is applied to all internal circuits and the POWER indicator light turns on. With the POWER switch set to its OFF position, all power is removed from the instrument.

2-4 OPERATING NOTES

a. Duty Factor Considerations. For optimum results, the selected pulse width plus the selected delay time should be less than the selected repetition-rate period. When the sum total of the time intervals in the pulse train exceeds the repetition-rate period, the interval-determining multivibrators may not have time to recover to a stable condition before being retriggered. Erratic or unpredictable pulse trains may result.

b. Pulse Widths. The selected pulse width should not significantly exceed 50% of the repetition-rate period. For duty factors greater than 50%, invert the output pulse with the POLARITY control. In the INV position of the POLARITY switch, the WIDTH control determines the interval between pulses. The output pulse width then becomes the repetition-rate period minus the interval selected by the WIDTH control. With the WIDTH controls set to minimum, and the POLARITY control in the INV position, the duty factor is 10 ns less than 100%.

c. DC Offset. The OFFSET control is a variable dc current source which adds from 0 to +100 ma to the output before the attenuator. There is a fixed current source which always supplies -50 ma to the output at the same point. The net result is a variable current source from -50 ma to +50 ma adding current to the output in front of the attenuator. This current source is independent of the pulse output except that the maximum rated peak signal before the attenuator is ± 10v referred to chassis ground. This limit includes pulse amplitude and dc offset.

d. External Gating. The GATE INPUT signal inhibits the internal clock repetition-rate generator. When a dc level is applied to the GATE INPUT connector between -2v and -15v amplitude, the repetition-rate source is stopped as long as the GATE INPUT connector is held below -2v. When the GATE INPUT signal returns to 0v, the pulse train starts again, producing a burst of pulses synchronized with the gating waveform. The GATE INPUT signal inhibits only the repetition-rate generator. Therefore, if a delay interval has started when the GATE INPUT signal is applied, that cycle will continue and generate a pulse output before lockout occurs.

e. Ramp Rate Operation. The ramp rate feature provides control over the risetime and falltime of the output pulses. Linear rise-time and fall-time voltage ramps are provided by charging and discharging a capacitor from constant current sources. In the ramp rate circuit, there are two separate current sources, each variable by a front-panel control. The course RAMP RATE/10V control selects the value of the capacitor, the RISE control determines the amplitude of charging current which forms the leading edge of the output pulse, and the FALL control determines the amplitude of discharging current which forms the trailing edge of the output pulse. Since the resulting voltage ramps are produced by charging and discharging a capacitor from constant current sources, the rise and fall voltage ramps are essentially constant dv/dt, independent of amplitude.

The selected pulse width should be longer than the selected risetime. If the risetime is increased to greater than the pulse width, the output pulse will be a triangle waveform with a notch at the apex. This operation is not harmful to the instrument, but can produce misleading test results in that the pulse never reaches its selected amplitude.

2-5 210-250 VOLT OPERATION

The Model 139B is supplied with internal transformer power supplies. The primary windings are wired for 115v power lines. For use with 220v power lines, the transformer primaries must be rewired. Refer to the power supply schematic in this manual for the proper connections.

2-6 FIRST TIME TURN ON

a. Equipment Required:

(1) Test Oscilloscope, dc to 30 MHz, 0.1v/cm. Tektronix Type 541/L or equivalent.

(2) 2 lengths of coaxial cable, BNC to BNC.

(3) 50Ω termination, BNC to BNC.

b. With one length of 50Ω coax, patch the TRIGGER OUTPUT to the external trigger input on the test oscilloscope. With the other length of 50Ω coax, patch the pulse OUTPUT (beneath the ATTENUATOR switch) to the vertical input of the test oscilloscope. Terminate both cables in 50Ω at the test oscilloscope.

c. Position all of the variable controls on the Model 139B (top row) to the center of their range.

d. Set the remaining controls as follows:

FREQ. RANGE	1-3 kHz
DELAY	1-3 μs
WIDTH	1-3 μs
RAMP RATE/10V	1-3 μs
POLARITY	+NORMAL
ATTENUATOR	10
PULSE MODE	SINGLE
TRIGGER WIDTH	clockwise

e. Set the test oscilloscope to:

Trigger	+EXT
Sweep Speed	1 μs/cm
Vert Sens	0.2 v/cm

f. Turn on the Model 139B and the test oscilloscope, and adjust the scope for a stable display.

g. Change the settings of each of the FINE controls, one at a time, and observe the effect on the displayed waveform. For the FINE (FREQ.) control, switch the test scope to 100 μs/cm. Refer to Paragraph 2-3 for detailed discussion of each control.

h. Switch the POLARITY mode switch through its four positions, observe the effect of the OFFSET control and the AMPLITUDE control on each of the four positions.

i. Switch the test scope to 10 μs/cm, DELAY to 10-30 μs, PULSE MODE to DOUBLE. Change the setting of the FINE (DELAY) control and observe the effect on the pulse pair.

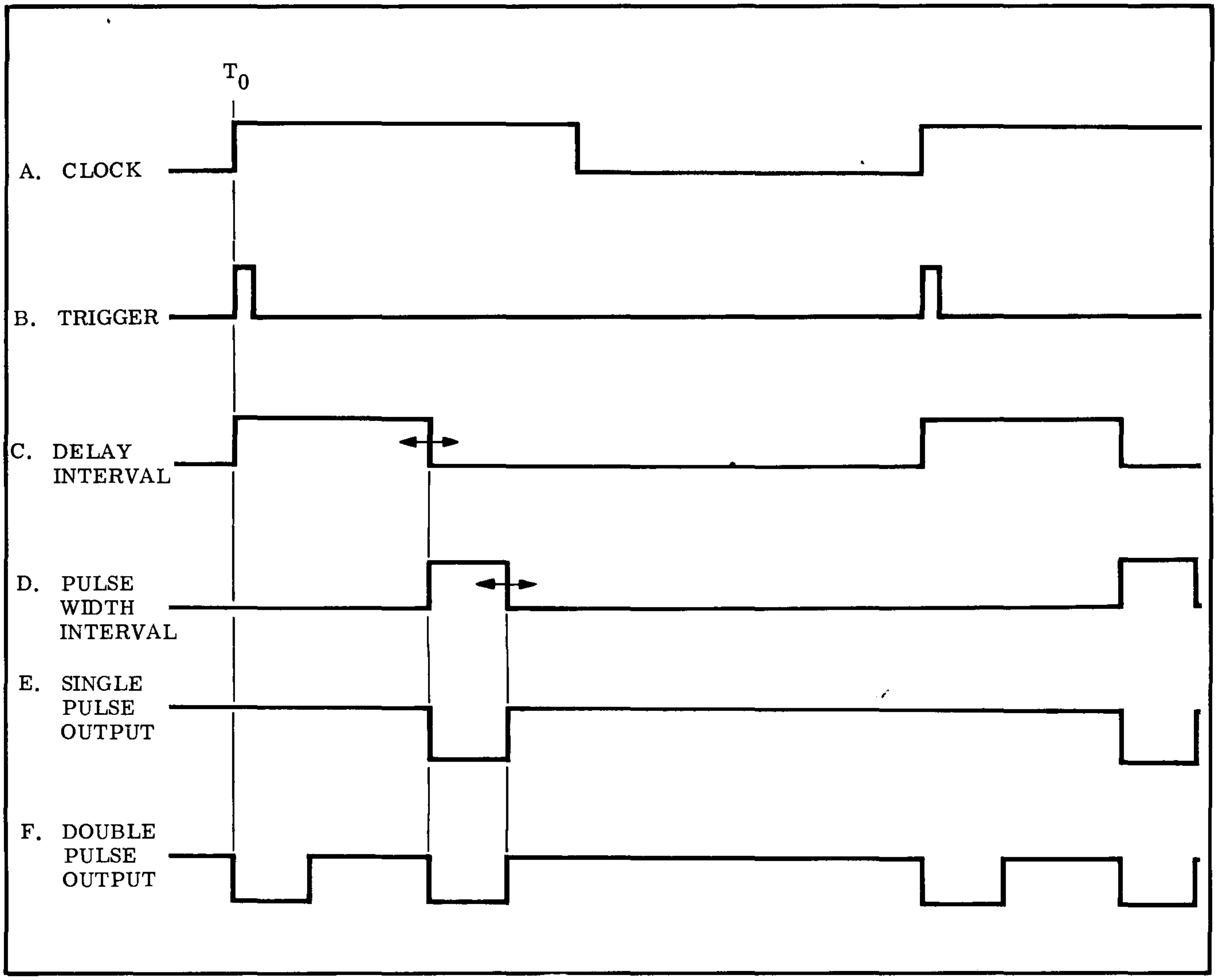

Fig. 3-1 Timing Logic

SECTION 3
THEORY OF OPERATION

3-1 GENERAL

This section of the manual contains an electrical description of each circuit in the Model 139B Pulse Generator. A block diagram is included in the drawings section showing the overall relationship of the various circuits. Schematic circuit numbers are used to identify components in the circuit descriptions. Refer to the specific schematics in the drawing section to supplement the following discussion.

3-2 CIRCUIT LOGIC

a. The timing logic in the Model 139B is determined by three multivibrators; the clock multivibrator, the delay multivibrator, and the width multivibrator. Each of the three multivibrators have independently variable periods determined by panel-mounted controls. The relationship of the three multivibrators is illustrated by waveforms A, C, and D of Fig. 3-1.

b. The clock multivibrator can operate free-running, triggered, or gated. The operation of the clock multivibrator is dependent on the position of the FREQ. RANGE switch, and the waveforms applied to the EXT DRIVE INPUT and the GATE INPUT.

When the FREQ. RANGE switch is in the EXT position, the clock multivibrator produces one output for each positive input at the EXT DRIVE INPUT connector or each time the SINGLE CYCLE button is depressed.

When the FREQ. RANGE switch is in any position other than EXT, the clock multivibrator free-runs at a repetition rate determined by its panel-mounted controls. The pulse train may be interrupted by a gating signal of -2 to -15 volts applied to the GATE INPUT connector.

In any of its modes of operation, the output from the clock multivibrator keys the trigger circuit and the delay multivibrator.

c. The delay multivibrator determines the time interval between the trigger output and the pulse width interval. The delay interval is keyed by the output from the clock multivibrator. The output from the delay multivibrator in turn keys the pulse width multivibrator.

d. The pulse width multivibrator defines a time interval in the pulse train beginning at the end of the delay interval. Depending on the POLARITY and OFFSET controls, the pulse width interval can define the OUTPUT pulse width, or the interval between the OUTPUT pulses.

When the PULSE MODE switch is in the DOUBLE position, the pulse width multivibrator is keyed at the beginning of the delay interval as well as at the end of the delay interval. See waveform F of Fig. 3-1.

e. The amplitude logic of the Model 139B is determined by summing the currents from a pulsed current amplifier, a negative constant current source, and a manually adjustable positive constant current source. Fig 3-2 is a simplified representation of the relationship of these current sources.

A constant -50 ma is always supplied to the current summing point from a fixed negative constant current source. One component of the positive constant current source is adjustable from 0 to +100 ma by the panel-mounted OFFSET control. These two current sources make it possible for the OFFSET control to add from -50 to +50 ma of dc current to the current summing point in all modes of operation. This -50 to +50 ma of OFFSET current is independent of other currents supplied to the current summing point.

In addition to the OFFSET current, there is also a negative current source that is adjustable from -60 to -200 ma, and a positive current source that is adjustable from +60 to +200 ma. The panel-mounted AMPLITUDE control adjusts the amplitude of each of these two current sources simultaneously. Regardless of the amplitude selected, these two currents of opposite polarity are always equal.

The -60 to -200 ma is switched by the pulse width interval. In the +INV and -NORMAL positions of the POLARITY mode switch, this negative current source is turned on for the pulse width interval and turned off at all other times. In the +NORMAL and -INV positions of the POLARITY mode switch, this negative current source is turned on at all times except the pulse width interval during which it is turned off. In all modes of operation the amplitude of the -60 to -200 ma current source is controlled by the panel-mounted AMPLITUDE control.

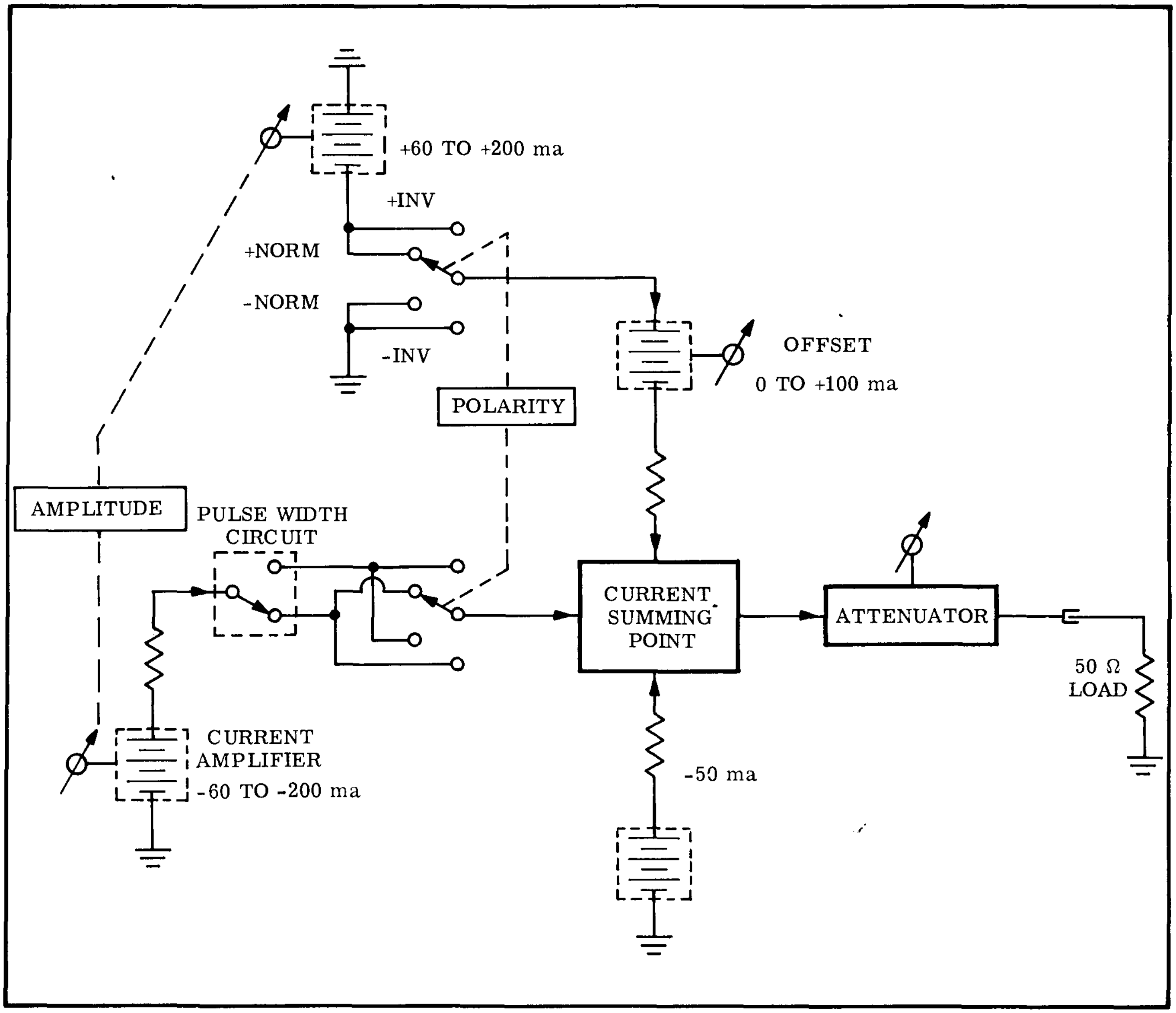

Fig. 3-2 Amplitude Logic

The +60 to +200 ma current source is selected by the POLARITY mode switch in the +NORMAL and +INV positions. When it is selected, it is a dc current source and is not switched by the pulse train. The amplitude of the positive current source is also controlled by the panel-mounted AMPLITUDE control. If selected, the positive dc current source is equal in amplitude to the switched negative current source for all settings of the AMPLITUDE control.

Refer to Fig 3-3 for various combinations of current summing and the outputs they produce.

3-3 BLOCK DIAGRAM

a. Clock Multivibrator. The clock multivibrator initiates each cycle of the output pulse train in all modes of operation. The operation of the clock is dependent on the position of the FREQ. RANGE selector, and the voltage waveforms applied to the DRIVE INPUT and the GATE INPUT. The three modes of operation for the clock are:

(1) Free Running. When the FREQ. RANGE control is in any position except EXT, and the voltage at the GATE INPUT is 0v, the clock is a free-running emitter-coupled multivibrator. The FREQ. RANGE control selects a 3:1 frequency range between 10 Hz and 50 MHz, by selecting the value of the emitter coupling capacitor. The FINE (FREQ.) control provides continuous adjustment over the selected frequency range and overlap into the two adjacent ranges. When the double pulse mode of operation is selected, the upper frequency limit is restricted to 25 MHz by substituting a fixed resistor for the FINE (FREQ.) control on the top frequency range. All other ranges operate normally in either single or double pulse modes.

(2) Gated Operation. The clock can be inhibited by an externally applied voltage at the GATE INPUT

OUTPUT PULSE MODE	OUTPUT CONDITION	SOURCE CURRENT (ma) PULSE CURRENT	POSITIVE CURRENT dc	NEGATIVE CURRENT dc	CURRENT SUM (ma)	OUTPUT WAVEFORM ACROSS 50Ω
1 +NORMAL	QUIESCENT	-200	+250	-50	0	+10V 0V
	PULSE +10V	0	+250	-50	+200	
2 +INV	QUIESCENT	0	+250	-50	+200	+10V 0
	PULSE +10V	-200	+250	-50	0	
3 -NORMAL	QUIESCENT	0	+50	-50	0	0 -10V
	PULSE -10V	-200	+50	-50	-200	
4 -INV	QUIESCENT	-200	+50	-50	-200	0 -10V
	PULSE -10V	0	+50	-50	0	
5 +NORMAL	QUIESCENT	-100	+150	-50	0	+5V 0
	PULSE +5V	0	+150	-50	+100	
6 +NORMAL	QUIESCENT +2V OFFSET	-100	+190	-50	+40	+5V +2V 0
	PULSE +5V	0	+190	-50	+140	

Fig. 3-3 Combinations of Current Summing

connector between -2 and -15v. This mode of operation produces pulse bursts synchronized with the gating waveform. When the input gate waveform is 0v, the clock free-runs at the frequency determined by the FREQ. RANGE control and the FINE (FREQ.) control.

(3) External Drive Operation. When the FREQ. RANGE control is in the EXT position, the clock multivibrator is changed to a trigger circuit. It initiates a pulse train for each positive-going input applied to the EXT DRIVE INPUT connector, or each time the SINGLE CYCLE button is manually depressed.

b. Trigger Multivibrator. The trigger multivibrator is a variable-width one-shot. The trigger multivibrator is keyed by the output of the clock multivibrator in all modes of operation. The output from the trigger multivibrator is a positive pulse, 1.5v into 50Ω, occurring at the beginning of each pulse train. The emitter-follower isolated trigger pulse is available at the TRIGGER OUTPUT connector on the front panel.

c. Delay Multivibrator. The delay multivibrator is also a variable-width one-shot which is keyed by the output pulse from the clock multivibrator in all modes of operation. The DELAY control selects the value of the common emitter capacitor, and the FINE (DELAY) control varies the charging time-constant of the common emitter capacitor.

The delay multivibrator has two outputs, each a positive-going differentiated voltage spike. One output occurs at the beginning of the delay interval, and the other at the end of the delay interval. The output at the end of the delay interval keys the width multivibrator in all modes of operation. The output at the beginning of the delay interval keys the width multivibrator only in the double pulse mode of operation.

d. Width Multivibrator. The width multivibrator is a variable-width one-shot which determines the pulse width of the output pulses. The width multivibrator is keyed by one or both of the outputs from the delay multivibrator, depending on whether or not double pulse operation has been selected. The period of the width multivibrator is effected by both the WIDTH control and the FINE (WIDTH) control. The WIDTH control selects the value of the emitter-coupling capacitor, and the FINE (WIDTH) control varies the charging time-constant of the emitter coupling capacitor.

e. Inverter. The inverter provides the pulse polarity selected by the POLARITY mode switch. Positive-going output pulses are provided in the +NORMAL and -INV modes, and negative-going output pulses are provided in the +INV and -NORMAL modes.

f. Ramp Generator. The ramp generator is made up of a positive ramp current source, a negative ramp current source, a current-steering diode bridge, and a charging capacitor. The current-steering diode bridge is switched during the pulse-width interval by the output of the inverter. The current-steering bridge permits either the positive ramp current source or the negative ramp current source to provide current to the charging capacitor, but not both simultaneously.

At the beginning of the pulse-width interval, the ramp current source selected by the POLARITY mode switch provides a constant amplitude charging current to the charging capacitor. The amplitude of the charging current during risetime is determined by the front-panel mounted RISE control. The voltage across the charging capacitor increases at a constant dv/dt rate until it reaches a limit-level set by one of the clamp diodes. The voltage across the charging capacitor remains at that limit-level for the remainder of the pulse-width interval.

At the end of the pulse-width interval, the current-steering diode bridge is switched, and the other ramp current source provides a constant-amplitude charging current of the opposite polarity to the charging capacitor. The amplitude of the fall-time constant-current is determined by the panel-mounted FALL control. The voltage across the charging capacitor increases in the opposite direction at a constant dv/dt rate until it reaches the limit-level set by the other clamp diode. The voltage across the charging capacitor remains at this limit-level until the current-steering diode bridge switches for the next pulse.

g. Amplitude Control. The amplitude control circuit determines the amplitude of the output pulse before the attenuator, and also determines the amplitude of one component of the positive constant current supply in the two + positions of the POLARITY mode switch.

In the ramp generator circuit, there are two clamp diodes. One of the clamp diodes limits the positive excursion of the ramp generator output to -15v. The other clamp diode limits the negative excursion of the ramp generator output to a voltage level set by the amplitude control circuit. Therefore, the amplitude control circuit can control the amplitude of the output pulse, before the attenuator, between the limits of 3 and 10v peak pulse amplitude.

In the +NORMAL and +INV positions of the POLARITY mode switch, the amplitude control circuit also provides an input to the positive constant-current supply which makes a positive dc current available to the current-summing point equal in amplitude to the pulse amplitude. This positive current is independent of the dc component controlled by the OFFSET control, even though they are provided by the same positive current supply.

h. Current Amplifier. The current amplifier is the output stage for the pulse portion of the output waveform. The output of the current amplifier is summed at the current-summing point with the outputs from the dc offset current supplies to drive either the OUTPUT connector or the attenuator, depending on the position of the ATTENUATOR selector switch. The output of the current amplifier is always a negative current. Positive outputs are accomplished by adding positive dc current at the current-summing point.

i. Negative Constant Current Supply. The negative current supply is a fixed constant-current source which always supplies -50 ma to the output current-summing point. If not cancelled by a positive current it will add a -2v dc offset component to the output in front of the attenuator.

j. Positive Current Supply. The positive current supply provides positive dc current to the current-summing point. A positive current of +60 to +200 ma is selected by the POLARITY mode switch in the +NORMAL and +INV positions. The amplitude of this +60 to +200 ma of dc current is determined by the AMPLITUDE control. A variable 0 to +100 ma is controlled by the OFFSET control.

For 0 offset, the OFFSET control provides +50 ma to cancel the -50 ma from the fixed negative current supply. The 0 to +100 ma of variable current, plus the fixed -50 ma from the negative supply provides an effective offset current that is variable from -50 to +50 ma.

In the +NORMAL and +INV positions of the POLARITY mode switch, the positive current source supplies a current equal in amplitude to the negative pulse current supplied by the current amplifier. The pulse output is 0 when the current amplifier is conducting, and positive when the current amplifier is not conducting. In the -NORMAL and -INV positions, the fixed positive current is not supplied to the current-summing point, therefore, the pulse output is 0 when the current amplifier is not conducting, and negative when the current amplifier is conducting.

k. Attenuator. The ATTENUATOR switch selects a straight through position (1:1), or a resistive attenuator network of 3:1, 10:1, 30:1, or 100:1 between the current-summing point and the OUTPUT connector. In the straight-through position, the current amplifier defines the source impedance (approximately 50Ω at high frequencies), in any of the other ATTENUATOR positions, the internal attenuator networks back-terminate the OUTPUT connector.

3-4 CIRCUIT DESCRIPTION

a. Clock Multivibrator. The clock multivibrator is the internal repetition rate generator. It determines the repetition rate at which pulse trains are initiated in both the free-running mode and the gated mode of operation. In the external drive mode, the multi is converted to a trigger circuit and initiates a pulse train each time a positive input is applied to the EXT DRIVE INPUT connector or each time the SINGLE CYCLE button is manually depressed.

In the free-running mode, the clock multivibrator has no inputs. It generates the repetition-rate interval in accordance with the value of the emitter-coupling capacitor selected by the FREQ. RANGE switch, and the clamp voltage set by the FINE (FREQ.) control. In the gated mode of operation, a voltage controlled switch, Q4, in series with half of the multivibrator stops the clock when an input of -2 to -15v is applied to the GATE INPUT connector. In the external drive mode of operation, the input to the clock multivibrator is the positive going drive signal applied to the EXT DRIVE INPUT connector. In all modes of operation, the output of the clock multivibrator keys the delay multivibrator and the trigger multivibrator.

The clock is an astable emitter-coupled multivibrator made up of Q2 and Q3. Its free-running frequency is determined by the value of the emitter-coupling capacitor and the voltage switching amplitude of the two collectors. The FREQ. RANGE switch selects the value of the emitter-coupling capacitor. The FINE (FREQ.) control varies the frequency over the selected frequency range by controlling the collector clamp voltage through the emitter follower, Q1, and the collector clamp diodes, CR1 and CR2.

The voltage controlled switch, Q4, interrupts current to one half of the multivibrator in the gated mode and the external drive mode of operation. In the external drive mode of operation, the emitter of Q3 is held positive by the emitter follower, Q7, and the multivibrator can not free-run. Also, in the external drive mode, a positive current source is removed from the voltage controlled switch, Q4, such that it is normally turned off. It requires a positive signal input from the EXT DRIVE INPUT connector before it will conduct.

Q2 and Q3 are cross connected such that each base-current path is through the collector load of the other. The two emitters are coupled by C5, paralleled by C201 through C218 as selected by the FREQ. RANGE control. The result is that either Q2 or Q3 conducts, the other is turned off. Whichever transistor conducts, pulls its emitter up. The voltage at the emitter of the off transistor decays towards ground with a time-constant set by the emitter-coupling capacitor and either R6 or R52. When the voltage at the emitter of the off transistor has decayed to one junction drop below its base voltage, the off transistor will turn on and (1) pull its emitter up, and (2) drop the base voltage of the other transistor. The emitter-coupling capacitor must then discharge in the other direction through the other emitter resistor.

The FREQ. RANGE control influences the free-running frequency by selecting the value of the emitter-coupling capacitor, C201 through C218. The FINE (FREQ.) control sets the clamp voltage that limits the negative excursion of the collectors. Since each base is referred to the other collector through a zener diode, the FINE (FREQ.) control indirectly determines the voltage level at the base of the off transistor. It therefore determines how far the emitter-coupling capacitor must discharge before the off transistor will turn on.

The current-commutating pair, Q5 and Q6, alternately conduct the constant current provided by their common emitter resistor, R9. The voltage across R9 is set by either CR3 or CR4 depending on which state the clock multivibrator is in. Since CR3 and CR4 are a matched pair, R9 has a constant voltage across it and is therefore a constant current source. Q5 conducts all the current provided by R9 during one half cycle of the clock, and Q6 conducts all the current provided during the other half cycle of the clock.

The voltage-controlled switch, Q4, provides the ground return for the emitter resistor for half of the clock multivibrator. When the clock is in the free-running mode of operation, Q4 is saturated holding the bottom of R52 at essentially ground potential. In the quiescent condition, the tunnel diode, CR25, is held in its high voltage state by current through CR24 and R49 to the +15v supply. When CR25 is in its high voltage state, the base-emitter junction of Q4 is forward biased and Q4 conducts at saturation.

When a negative gate signal is applied to the GATE INPUT connector, the resulting gate current through R48, CR23, and CR22 robs current from the tunnel diode, CR25. When the GATE INPUT signal has reached -2v, enough current has been diverted from the tunnel diode for it to snap to its low voltage state, remove the forward bias from the base-emitter junction of Q4, and Q4 turns off. With Q4 turned off, Q2 in the clock multivibrator can not conduct, and the repetition-rate generator is disabled as long as the negative voltage is maintained at the GATE INPUT connector.

When the voltage at the GATE INPUT connector goes more positive than -2v, the tunnel diode snaps to its high voltage state, forward biases the base-emitter junction of Q4, current is again provided to the clock multivibrator, and the clock free-runs at the rate determined by its frequency controls.

In the EXT position of the FREQ. RANGE control, R44 is disconnected from the +15v supply. The current through R45 from the -15v supply must then flow through CR21, robbing current from the tunnel diode, CR25, and turning off Q4. Also, another contact on S201 connects the clamp diode, CR5, to the emitter of Q3.

This prevents the emitter of Q3 from going more negative than one junction drop below the voltage level set by the emitter follower, Q7. In this configuration the clock multivibrator can not free-run. When a positive voltage is applied to the EXT DRIVE INPUT connector, the junction of R45 and CR21 is pulled positive, restoring current to the tunnel diode, CR25. CR25 snaps to its high voltage state and turns on Q4. In the external drive mode of operation, the clock produces a single output pulse each time current is initiated in Q4. Wide inputs at the **EXT DRIVE INPUT** connector do not produce multiple outputs since the clock is prevented from free-running by the emitter follower, Q7.

The current-commutating pair, Q8 and CR8, are switched by the collector waveform of Q5. The cathode of CR8 is held at +5v by the zener diode, CR9. The base of Q8 is driven more positive than +5v for one half of the clock cycle, and more negative than +5v for the other half cycle by the collector waveform of Q5 through CR6. R19 provides a constant current of about 30 ma from the +15v supply. Q8 conducts the current from R19 on alternate half cycles of the clock multivibrator. The collector waveform of Q8 is differentiated by the inductor, L3, producing a sharp positive voltage spike when Q8 goes into conduction, and a sharp negative spike when Q8 turns off. The positive voltage spike is coupled through CR10 to key the delay multivibrator, and through CR27 to key the trigger multivibrator.

b. Trigger Generator. The trigger generator provides a +1.5v output pulse at the TRIGGER OUTPUT connector at the beginning of the pulse train in all modes of operation. The trigger multivibrator is a variable-width emitter-coupled one-shot, made up of Q17 and Q18. The emitter follower, Q19, couples the trigger pulse to the TRIGGER OUTPUT connector through a 28 ns delay line. The purpose of the delay line is to make the delay between the leading edge of the trigger pulse and the leading edge of the output pulse less than 10 μs when the minimum delay is selected.

The trigger multivibrator is keyed at the beginning of the delay interval in all modes of operation by the output of the clock. The trigger pulse-width is variable by the front-panel mounted TRIGGER WIDTH control.

The voltages at the bases of Q17 and Q18 are set in the quiescent condition by a pair of matched zener diodes, CR28 and CR33. Current from the -15v supply through R53 forward biases the clamp diode, CR29. This sets the reference for CR28 at one junction drop below ground. Conduction of Q17 forward biases CR31 and CR32, setting the voltage reference for CR33 at two junction drops above ground. Since the zeners, CR28 and CR33, have the same voltage drops, the voltage at the base of Q18 is three junction drops more positive than the voltage at the base of Q17. In the quiescent condition, Q17 conducts the current provided through R208 and R57 from the +15v supply. Q17 also conducts the current provided through R58 and CR30, holding the emitter of Q18 more negative than its base. Q18 does not conduct in the quiescent condition.

The positive voltage spike from the collector of Q8 at the beginning of the delay interval is coupled through CR27 and CR28 to the base of Q17, turning off Q17. The resulting negative-going waveform at the collector of Q17 is coupled through CR33 to the base of Q18, turning on Q18. When Q18 turns on, the negative-going step at the emitter of Q18 coupled through C16 pulls the emitter of Q17 negative. Q17 will remain turned off until C16 charges through R57 and R208 far enough for the emitter of Q17 to go one junction drop more positive than its base. When C16 has charged enough to forward bias the base-emitter junction of Q17, Q17 goes back into conduction, the collector of Q17 turns off Q18, and the multivibrator regenerates into its quiescent condition.

The positive trigger pulse at the collector of Q18 is coupled through the emitter follower, Q19 to the TRIGGER OUTPUT connector.

c. Delay Multivibrator. The delay multivibrator is a variable width emitter-coupled one-shot made up of Q9 and Q10. Q11 and Q12 are a current-commutating pair which provides the outputs from the delay circuit.

The delay multivibrator is keyed by the differentiated output from the clock multivibrator. The front-panel DELAY control selects the value of the emitter-coupling capacitor, C219 through C230, and the FINE (DELAY) control determines the charge time-constant of the emitter-coupling capacitor. The output of the delay circuit keys the width multivibrator, and determines the time interval between the trigger output and the pulse output. In the double pulse mode, the delay circuit keys the width multivibrator at the beginning of the delay interval and at the end of the delay interval.

In the quiescent condition, Q9 is conducting and Q10 is turned off. The matched pair of zener diode, CR12 and CR14, set the voltages at the bases of Q9 and Q10. Current through R65 from the -15v supply forward biases the clamp diode, CR11, and sets the reference for CR12 at one junction drop below ground. Collector current from Q9 forward biases CR34 and CR35, setting the reference for CR14 at two junction drops above ground. The quiescent voltage at the base of Q10 is three junction drops more positive than the voltage at the base of Q9. Q9 conducts the current provided through R206 and R25 from the +15v supply. Q9 also conducts the current provided through R27 and CR13 from the +15v supply holding the emitter of Q10 more negative than its base.

The sharp positive voltage spike from the collector of Q8 is coupled through CR10 and CR12 to the base of Q9, turning off Q9. The resulting negative-going-waveform at the collector of Q9, coupled through CR14, turns on Q10. When Q10 turns on, the negative-going waveform at the emitter of Q10, coupled through the emitter-coupling capacitor, holds Q9 turned off for a period determined by the charging time-constant of the emitter-coupling capacitor. After the emitter coupling capacitor has charged through R26 and R206 far enough for the emitter of Q9 to go one junction drop more positive than its base, Q9 turns back on. The collector waveform of Q9 turns off Q10, and the delay multivibrator regenerates into its quiescent condition.

Q11 and Q12 make up a current-commutating output pair for the delay multivibrator. In the quiescent condition, Q12 conducts the current provided through the common emitter resistor, R30, from the +15v supply, and Q11 is turned off. During the astable period of the delay multivibrator, Q11 conducts the common emitter current, and Q12 is turned off. L5 in the collector circuit of Q11 differentiates the positive-going collector waveform of Q11 and produces a sharp positive voltage spike at the beginning of the delay interval. L4 in the collector circuit of Q12 differentiates the collector waveform of Q12 and produces a sharp positive voltage spike at the end of the delay interval. The positive voltage spike from L4 at the end of the delay interval is coupled through CR38 to the width multivibrator in all modes of operation. The positive voltage spike from L5 at the beginning of the delay interval is coupled through CR40 only if the hold-off bias is removed from CR40 by the PULSE MODE switch in the DOUBLE position.

d. Width Multivibrator. The width multivibrator is a variable width emitter-coupled one-shot made up of Q13 and Q14. Q15 and Q16 are a current-commutating pair which provide the outputs from the width multivibrator.

The width multivibrator is keyed by the differentiated output of the delay multivibrator at the end of the delay interval in all modes of operation. The width multivibrator is keyed at both the beginning and the end of the delay interval in the double pulse mode of operation. The front-panel WIDTH control selects the value of the emitter coupling capacitor. C231 through C243, and the FINE (WIDTH) control determines the charging time-constant of the emitter-coupling capacitor. The outputs of the width multivibrator drives the inverter stage.

In the quiescent condition, Q13 is conducting and Q14 is turned off. The matched pair of zener diodes, CR16 and CR18, set the voltages at the bases of Q13 and Q14. Current through R73 from the -15v supply forward biases the clamp diode, CR39, and sets the reference for CR16 at one junction drop below ground. Collector current from Q13 forward biases CR41 and CR42, setting the reference for CR18 at two junction drops above ground. The quiescent voltage at the base of Q14 is three junction drops more positive than the voltage at the base of Q13. Q13 conducts the current provided through R35 and R211 from the +15v supply. Q13 also conducts the current provided through R36 and CR17 from the +15v supply, holding the emitter of Q14 more negative than its base.

The sharp positive voltage spikes from the delay multivibrator output stage are coupled through CR16 to the base of Q13, turning off Q13. The resulting negative-going waveform at the collector of Q13 coupled through CR18, turns on Q14. When Q14 turns on, the negative-going waveform at the emitter of Q14, coupled through the emitter-coupling capacitor, holds Q13 off for a period determined by the charging time-constant of the emitter-coupling capacitor. After the emitter-coupling capacitor has charged through R35 and R211 far enough for the emitter of Q13 to go one junction drop more positive than its base, Q13 turns backon, the collector waveform of Q13 turns off Q14, and the width multivibrator regenerates into its quiescent condition.

Q15 and Q16 make up a current-commutating output pair for the width multivibrator. In the quiescent condition, Q16 conducts the current provided through the common emitter resistor, R39, from the +15v supply, and Q15 is turned off. During the astable period of the width multivibrator, Q15 conducts the common emitter current and Q16 is turned off. The outputs from Q15 and Q16 drive the inverter through the current-steering diodes.

e. Inverter. The inverter is a current-commutating pair made up of Q1 and Q2. The input to the inverter is the output from the width multivibrator output stage. The diode current-steering network at the input to the inverter is essentially a double-pole-double-throw switch.

The output of the inverter switches between -12v and -20v. When the POLARITY mode switch is in the +NORMAL and -INV positions, the output of the inverter is quiescently at -20v, switching to -12v during the astable period of the width multivibrator. When the POLARITY mode switch is in the +INV and -NORMAL positions, the output of the inverter is quiescently at -12v, switching to -20v during the astable period of the width multivibrator.

The inverter determines whether the pulse output stage will conduct during the astable period of the width multivibrator or whether the pulse output stage will conduct at all times except the astable period of the width multivibrator.

The voltage across R4 at the input to the diode current-steering network in the quiescent condition is 0v, switching to +2v during the astable period of the width multivibrator. The voltage across R3 in the quiescent condition is +2v, switching to 0v during the astable period of the width multivibrator.

In the +NORMAL and +INV positions of the POLARITY mode switch; CR1, CR4, CR6, and CR8 are forward biased by current through R2 and R6 from the +15v supply. CR6, CR8, CR1, and CR4 are back biased and do not contribute to the operation of the circuit. In these two positions of the POLARITY mode switch, Q2 conducts in the quiescent condition and Q1 is turned off. During the astable period of the width multivibrator, current is switched from Q2 to Q1, producing a negative-going pulse at the collector of Q2.

The output of the inverter is coupled to the ramp rate generator through the complimentary emitter followers, Q3 and Q4.

f. Ramp Rate Generator. The ramp rate generator controls the slope of the leading and trailing edges of the output waveform. The ramp rate generator charges (or discharges) a capacitor from a constant-current source to produce the desired ramp rate. The RAMP RATE/10V control selects the value of the capacitor, and the RISE and FALL control determines the amplitudes of the charging and discharging constant-current sources. The ramp-rate generator is switched at the beginning and the end of the pulse width by the output of the inverter. The charging capacitor charges between two limits, one set by the -15v supply, and the other set by the amplitude control circuit. The output of the ramp-rate generator drives the current amplifier.

The ramp-rate generator is made up of (1) a positive ramp-current source, Q12; (2) a negative ramp-current source, Q8; (3) a diode current-steering bridge, CR12 through CR15; and (4) a charging capacitor, C244 through C254.

The positive excursion of the charging capacitor is clamped to the -15v supply by the clamp diode, CR17. The negative excursion of the charging capacitor is clamped to the amplitude clamp bus by the clamp diode, CR16. The voltage level of the amplitude clamp bus is variable by the AMPLITUDE control from -17v to -19.5v.

In all modes of operation, the output of the complimentary emitter followers, Q3 and Q4, switch the input to the current-steering bridge between -12v and -20v. When the output of the complimentary emitter followers is at -12v, current from the negative ramp-current source, Q8, is conducted through CR14, L4, and Q3 to ground. CR12 and CR15 are back biased, and the positive ramp-current source charges the ramp-rate capacitor through CR13 to one junction drop more positive than the -15v supply. When the ramp-rate capacitor reaches a voltage positive enough to forward bias CR17, CR17 provides the current for the positive ramp-current source, and the voltage across the ramp-rate capacitor remains constant until the complimentary emitter followers switch the current-steering bridge in the other direction.

When the output of the complimentary emitter followers is at -20v, current to the positive ramp-current source is conducted from the -25v supply through Q4, L4, and CR12. CR13 and CR14 are back-biased, and the negative ramp-current source charges the ramp-rate capacitor through CR15 to one junction drop more negative than the amplitude clamp bus. When the ramp-rate capacitor reaches a voltage negative enough to forward bias CR16, CR16 provides the current for the negative ramp-current source and the voltage across the ramp-rate capacitor remains constant until the complimentary emitter followers again switches the current-steering bridge. See Fig. 3-4.

Since the ramp-rate capacitor is charged in either direction by a constant-current supply, both voltage slopes will be essentially constant dv/dt. The specific dv/dt slope will be a function of the value of the ramp-rate capacitor, and the amplitude of the constant-current source charging it. The voltage across the ramp-rate capacitor will slew back and forth between the voltage limits established by the clamp diodes, CR16 and CR17 at times determined by the output of the complimentary emitter followers, Q3 and Q4, and at slewing rates determined by the value of the ramp-rate capacitor and the positive and negative constant-current supplies.

g. Amplitude Control Circuit. The amplitude control circuit sets the negative clamp voltage level for the ramp generator in all modes of operation. It also provides one of the inputs to the positive constant-current supply when the POLARITY mode switch is in

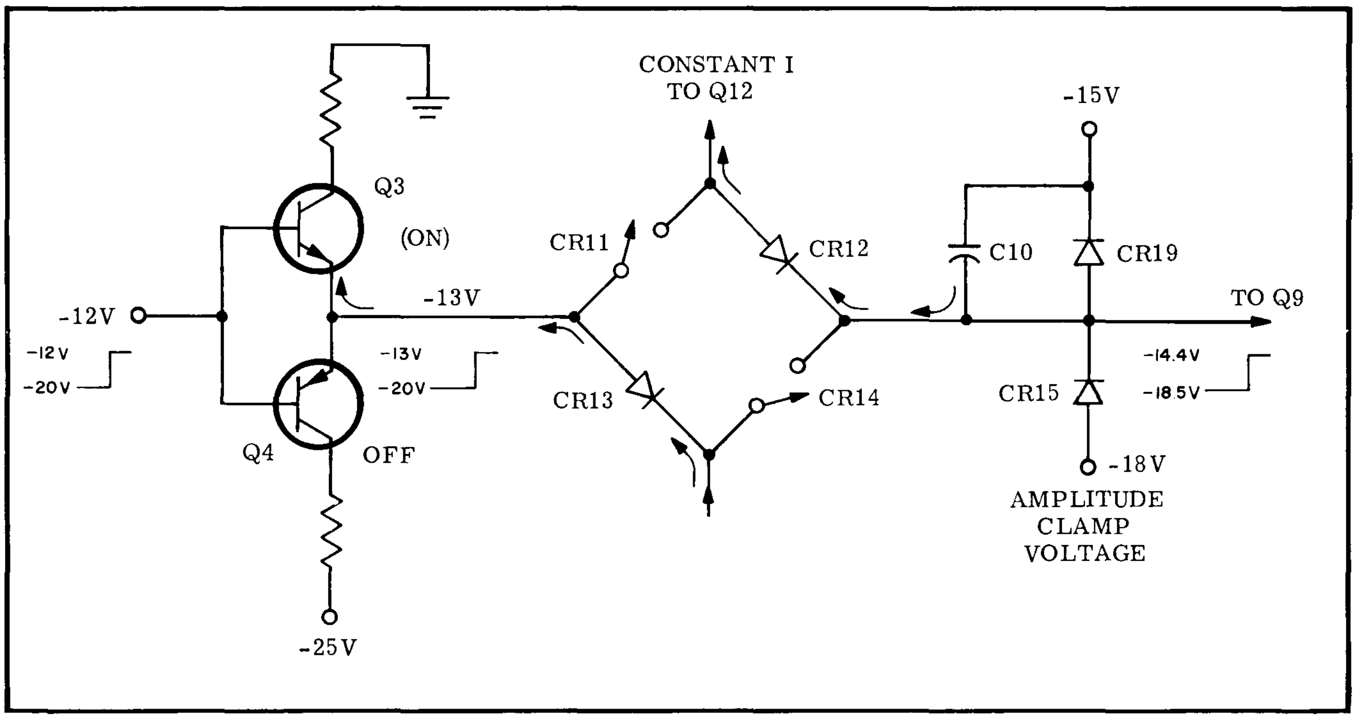

Fig. 3-4 (A) Ramp Rate Generator/Positive-Going Ramp

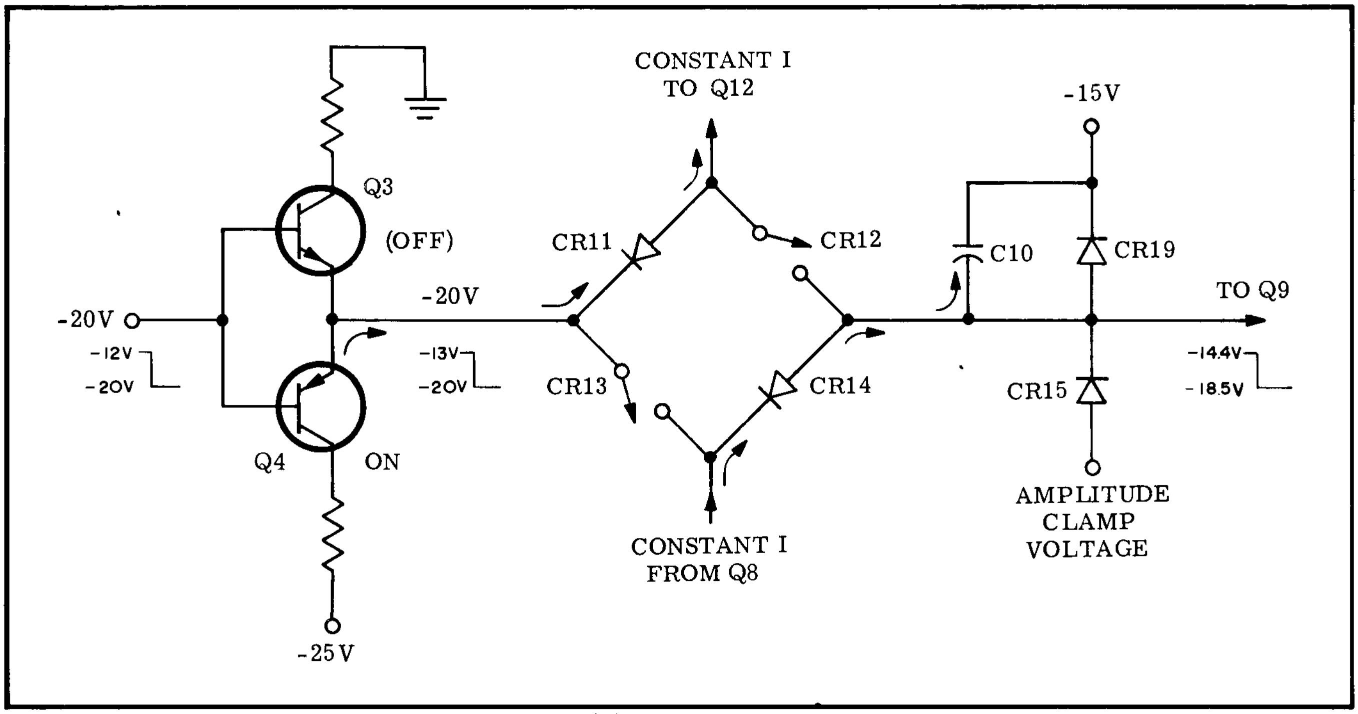

Fig. 3-4 (B) Negative-Going Ramp

either the +NORMAL or +INV positions.

In the +NORMAL position of the POLARITY mode switch, the current amplifier, Q10 and Q11, is turned on in the quiescent condition. This provides a negative current to the current summing point whose amplitude is determined by the AMPLITUDE control. The positive constant-current supply provides a positive current to the current-summing point of equal amplitude to the negative current from the current amplifier. The output pulse is produced by turning off the current amplifier during the desired pulse width, leaving only the positive current from the positive constant-current supply.

In the +INV position of the POLARITY mode switch, the current amplifier is turned off in the quiescent condition. The positive constant-current supply provides a positive current to the current-summing point equal to the pulse amplitude. The output pulse is produced by turning on the current amplifier during the desired pulse width, cancelling the current from the positive constant-current supply.

The currents discussed above are independent of the offset current provided by the positive constant-current supply.

The amplitude control circuit is made up of a voltage-selecting potentiometer, R214; an emitter follower, Q5; and a boot-strapped emitter follower, Q6 and Q7.

The panel-mounted AMPLITUDE control, R214, sets the voltage level at the base of the emitter follower, Q5. Q5 provides base drive current for the current amplifier, Q11 through R37, R38, and L6. This base current is proportional to the output pulse amplitude.

Q5 also provides the input voltage level for the boot-strapped emitter follower, Q6 and Q7, through the voltage divider, R36, R103, R39, and R34.

Collector current from Q6 provides base current to Q7. Collector current from Q7 in turn robs emitter current from Q6. The result is a low-impedance source of voltage at the collector of Q7 whose amplitude is determined by the voltage level at the base of Q6. Because of the combined current gains of Q6 and Q7, current demands on the collector of Q7 have very little loading effect on the voltage level at the base of Q6. The clamp diode, CR16, is referenced to the voltage at the collector of Q7, and determines the maximum negative excursion of the ramp generator output voltage. Since the positive excursion of the ramp generator output voltage is always clamped to the -15v supply, the voltage level at the collector of Q7 effectively controls pulse amplitude.

The voltage level at the collector of Q7 also provides an input current to the positive constant current supply's operational amplifier through L3 and R14 in the two + positions of the POLARITY mode switch. This causes one component of the positive constant-current supply to be equal to the negative current supplied by the current amplifier.

h. Current Amplifier. The current amplifier is the pulse output stage made up of Q9, Q10, and Q11. The current amplifier is driven by the voltage across the ramp-rate capacitor. The output of the current amplifier is a current pulse between 60 ma and 200 ma determined by the AMPLITUDE control. The output of the current amplifier when the two output transistors are conducting, is always a negative current. The output pulse flexibility of amplitude, polarity, and offset are accomplished by adding dc current to the output of the current amplifier.

The output transistor, Q10, is a grounded base amplifier with its base held at -15v. The voltage across the ramp-rate capacitor is coupled to the emitter of Q10 through the emitter followers, Q9 and Q11, and the current metering resistors, R48 and R49. When the voltage across the ramp-rate capacitor is one junction drop above the -15v supply (positive excursion), the base-emitter drop of Q9 places the base of Q11 at -15v. With the base of both Q10 and Q11 at -15v, there is no voltage across the metering resistors, R48 and R49, and no current output from the collector of Q10. When the voltage across the ramp-rate capacitor is at its negative extreme (maximum amplitude), there is 2v across the metering resistors, R48 and R49, providing 200 ma to the emitter of Q10 and to the current-summing point in the collector circuit of Q10.

i. Negative Constant Current Supply. The negative current supply, Q16, provides a constant -50 ma to the output current-summing point.

j. Positive Current Supply. The positive constant-current source serves two separate purposes: (1) it provides a manually adjustable constant-current from 0 to +100 ma, determined by the panel-mounted OFFSET control. This 0 to +100 ma, together with the fixed -50 ma from the negative constant-current source, permits the OFFSET control to effectively furnish -50 to +50 ma of dc current to the current-summing point in all modes of operation, and (2) the positive constant-current source also makes available a + dc current equal in amplitude to the pulse output of the current amplifier stage. The amplitude of this portion of the positive constant-current source is controlled by the AMPLITUDE control. It is switched in or out by the POLARITY mode switch.

In the +NORMAL mode, the current amplifier is turned on in the quiescent condition. Its output is cancelled at the current-summing point by an equal + current from the positive constant-current source. During the pulse width, the current amplifier stage is turned off, and the constant + current produces the output pulse.

In the +INV mode, the current amplifier is turned off in the quiescent condition. The positive constant-current source provides a +baseline. During the pulse width, the current amplifier is turned on, furnishing a - current to the current-summing point equal in amplitude to the + dc current from the positive constant-current source.

The positive constant-current source is an operational amplifier with three current-summing inputs. The operational amplifier is made up of Q13 and Q14 which produces a voltage drop across R19 proportional to the sum of the three input currents. Q15 is a constant-current generator which provides collector current to the current-summing point proportional to the voltage drop across R19.

The input to the operational amplifier is at the base of Q14. The input currents are, (1) through R12 from the OFFSET control, (2) through R9 from the zero set adjustment, and (3) through R14 from the amplitude bus and the "0" set adjustment. The feedback resistors are R13 and R15. The emitter follower, Q13, pulls a current through the feedback resistors, R13 and R15, which equals the sum of the input currents through R12, R9, and R14. The resulting voltage level at the emitter of Q13 together with the value of the emitter resistor, R18, sets the amplitude of the collector current from Q13 and hence the voltage drop across the collector load resistor, R19.

The voltage drop across R19 sets the voltage level at the base of Q15. This voltage level together with the value of the emitter resistor, R22, determines the amplitude of the collector current from Q15. Collector current from Q15 adds + current to the current-summing point proportional to the sum of the input currents to the operational amplifier. The three input currents to the operational amplifier independently influence collector current in Q15. The input current to the operational amplifier through R14 from the amplitude bus is selected by contacts on S205, the POLARITY mode switch, in the +NORMAL and +INV modes only. The other inputs to the operational amplifier are present in all modes of operation.

SECTION 4
MAINTENANCE

4-1 GENERAL

The E-H Model 139B Pulse Generator requires a minimum amount of maintenance; however, normal aging of electronic components may eventually cause abnormal operation. Therefore, general maintenance and trouble shooting information is included in this section as a guide to restoring the instrument to normal operation.

4-2 ROUTINE MAINTENANCE

A regular program for maintenance and inspection every four to six months is recommended to effectively minimize equipment down time. As part of the regular maintenance and inspection procedure, the instrument should be carefully checked in the following manner:

a. Remove the Model 139B cover panels.

b. Make a thorough inspection of all wiring and cables. Check for frayed, loose, or burned wires.

c. Check the physical integrity of all components. Look for evidence of burning or cracking, loose solder connections, leakage of insulation compounds, and general physical damage.

d. Check all switches and controls for loose or broken terminals, tight or sticking shafts, etc.

e. If the internal panel surfaces and components have an excessive amount of dust or lint deposited on them, use a low pressure stream of air to remove the foreign material.

CAUTION

> Do not clean the circuit boards or small internal components with a wiping cloth or solvents, since damage to the circuits may result.

f. Wipe the external surfaces of the instrument with a soft, damp cloth to remove dirt, fingerprints, and other foreign materials.

g. If repairs are made to the instrument, or if a performance verification indicates that it is not operating within the tolerances stated in Section 1, a complete calibration procedure as outlined in this section should be performed. Before attempting the calibration procedure, read Section 3 of this instruction manual. A working knowledge of the circuitry is necessary to insure optimum performance of the instrument.

4-3 PERFORMANCE VERIFICATION

The performance verification procedure is provided to assure that the instrument operates within its required-specifications. The test equipment listed was selected on the basis of the test equipment most probably available at a majority of the facilities having need for a formal performance verification procedure. Substitutions may be made for the recommended test equipment provided the alternates can accurately evaluate the specific performance specifications being tested.

Regular periodic performance verification is recommended as an effective part of the preventative maintenance procedure. In many cases, component failure is preceeded by a period of "out of spec" performance.

No specific environmental conditions are required for a meaningful performance verification. The operating characteristics of the instrument are only slightly effected by an extremely wide range of environmental circumstances. Before testing, the instrument should be inspected for obvious physical damage, absence of condensation inside the instrument, unrestricted air flow through the air filter and cooling fan, all printed circuit boards firmly in place, etc.

The verification of the instrument's operating characteristics should be performed with the dust covers in place, and without access to the internal adjustments. Failure of the instrument to perform within the limits of any one of its required specifications indicates the need for repair and/or recalibration.

a. Equipment required:

(1) A fast rise-time oscilloscope having an effective pass band sufficient for accurate observation of 5 ns rise-time pulses. An oscilloscope with a rise-time of 1 ns (350 MHz) will add approximately 0.1 ns to a 5 ns rise-time pulse. If the oscilloscope rise-time is 3.5 ns (100 MHz), a 5 ns rise-time pulse will be displayed as over 6 ns. Regardless of the pass band, the test oscilloscope must be free of blow-by,

overshoot, and ringing.

(2) A general purpose oscilloscope of dc to 25 MHz pass band, with a high-impedance low-capacitance probe, and vertical sensitivity of 0.5v/cm (at the input to the probe).

(3) A pulse generator having repetition rates to 50 MHz, variable width to 10 μs, and variable output amplitude to at least 4v into 50Ω.

(4) An accurate multimeter.

(5) A 50Ω termination having no more than 1% deviation from nominal resistance, capable of dissipating 2W, and with good RF characteristics beyond 200 MHz.

b. Connect the Trigger OUTPUT of the Model 139B to the external trigger input of the general purpose test scope with a length of 50Ω coax terminated in 50Ω at the test scope. Connect the pulse OUTPUT of the Model 139B to the vertical input of the test scope with a length of 50Ω coax terminated in 50Ω at the test scope.

CAUTION

The full unattenuated output of the Model 139B is capable of permanently damaging the input to a sampling oscilloscope. In the 1 and 3 positions of the ATTENUATOR, the Model 139B can deliver an output pulse amplitude in excess of 1v. When using these ATTENUATOR positions, be sure there is enough attenuation in the signal-handling patch to protect the test oscilloscope.

c. Check internal clock repetition rate generator. Requirement: Continuously adjustable from 10 Hz to 50 MHz, the FINE (FREQ. RANGE) control must smoothly vary the internally generated repetition-rate frequency over the interval determined by the FREQ. RANGE selector with overlap into the two adjacent ranges.

(1) Set the OFFSET and AMPLITUDE controls to the center of their range, set all other FINE controls (top row) counter-clockwise. Set the remaining controls as follows:

FREQ. RANGE	10 - 30 Hz
DELAY	10 - 30 ns
RAMP RATE/10V	6 - 10 ns
POLARITY	+NORMAL
ATTENUATOR	10
PULSE MODE	SINGLE
TRIGGER WIDTH	clockwise

(2) Check that the FINE (FREQ. RANGE) control smoothly varies the time interval between output pulses per Fig. 4-1.

d. Check WIDTH and FINE (WIDTH) controls. Requirement: Output pulse width must be continuously adjustable from 10 ns to 10 ms. FINE control must smoothly vary the output pulse width over the interval determined by the WIDTH control with overlap into the two adjacent ranges.

(1) With the same setup as used in c. above, check clockwise and counter-clockwise limits of the FINE (WIDTH) control on each of the WIDTH ranges. Measure the pulse width at 50% of the pulse height. For pulse widths shorter than 300 ns, use the sampling oscilloscope.

e. Check DELAY and FINE (DELAY) controls. Requirement: The delay interval between the trigger pulse and the output pulse must be continuously variable from 10 ns to 10 ms. The FINE (DELAY) control must smoothly vary the delay over the interval determined by the DELAY control with overlap into the two adjacent ranges.

(1) Use the setup described in c., set DELAY to 3 ms, WIDTH to 300 μs, and PULSE MODE to DOUBLE. Check the interval between the leading edges of the double pulses with the FINE (DELAY) control at both extremes. The pulse width must be reduced as the DELAY interval decreases, such that the pulse width is always less than 50% of the minimum DELAY on any particular DELAY range. Increase the FREQ. RANGE only as necessary to maintain a practical writing-rate on the test oscilloscope. In any case, keep the FREQ. RANGE slow enough that the maximum DELAY on any particular range is not more than 50% of the repetition-rate period. Delays of less than 100 ns should be checked on a dual-trace sampling oscilloscope. For delays of less than 100 ns, operate the Model 139B in the SINGLE PULSE MODE, and display the trigger output on the channel and the pulse output on the other channel. Be sure the cable lengths are the same for the trigger pulse and the output pulse.

f. Check output amplitude. Requirement: the pulse output amplitude must be continuously variable from less than 30 mv to more than 10v into 50Ω.

(1) Display a 1 μs wide pulse, 1 μs delay, at 10 kHz repetition rate. Set RAMP RATE/10V to 6 - 10 ns, RISE and FALL counter-clockwise, POLARITY to +NORMAL, OFFSET to 0, and ATTENUATOR to 1. Check that the AMPLITUDE control varies the output pulse amplitude between the limits shown below in all four positions of the POLARITY mode switch.

ATTENUATOR	AMPLITUDE	
	CCW	CW
1	3 v	10.0 v
3	1 v	3.3 v
10	300 mv	1.0 v
30	100 mv	333.0 mv
100	30 mv	100.0 mv

g. Check OFFSET control. Requirement: The OFFSET control must provide a dc offset component to the output pulse which is continuously variable from -2 volts to +2 volts, in the unattenuated output mode.

(1) Using the set-up described in f(1), set the AMPLITUDE control counter-clockwise. Check the range of the OFFSET control from at least -2 volts to at least +2 volts on each of the four positions of the POLARITY mode switch.

h. Output pulse shape. Requirement: The peak-to-peak amplitude departures from a flat pulse top must be more than 5% of the pulse amplitude. The peak-to-peak amplitude departures from a flat baseline must not be more than 5% of the pulse amplitude. Except on the 100:1 attenuator position, in which case the pulse top distortion and/or the baseline distortion must be less than 8% of the pulse amplitude. Waveform distortion includes all amplitude departures from an ideal flat waveform including overshoot, undershoot, droop, and ringing.

(1) Display a 300 ns wide pulse, delayed 300 ns, on a test oscilloscope with a 1 ns risetime capability. Examine the pulse top and baseline for amplitude departures from an ideal flat waveform. Pay particular attention to the portion of the pulse top immediately following the risetime, and the portion of the baseline immediately following the falltime. Check the output waveform on all positions of the ATTENUATOR, and all positions of the POLARITY mode switch.

CAUTION

> Many oscilloscopes with sub-nanosecond rise-time capability contribute a significant amount of overshoot and ringing when displaying a fast rise-time waveform. Effective evaluation of the output pulse waveform from the Model 139B requires the use of an oscilloscope that is reasonably free from these typical vertical amplifier perterbations. Also, pay particular attention to the signal-handling plumbing between the OUTPUT connector of the Model 139B and the input to the test oscilloscope.

i. Check pulse output risetime and falltime. Requirement: At full amplitude (+ and -10 volts) the risetime and falltime of the output pulse must be continuously adjustable from less than 6 ns to more than 3 ms (10 to 90% amplitude points).

(1) With the RAMP RATE/10V switch in the 6 to 10 ns position and the RISE and FALL controls full counter-clockwise, display a 50 ns wide pulse at full amplitude. Include enough attenuation in the signal path to prevent damage to the test scope. Measure the risetime and the falltime in each of the four positions of the POLARITY mode switch.

(2) Check the range of adjustment of the RISE and the FALL controls on each of the RAMP RATE/10V ranges. Adjust the WIDTH controls as necessary so the pulse width is wide enough to have a definite flat pulse top. As necessary, select slower repetition rates so the output duty cycle is not more than 50%.

j. Gate input. Requirement: The output pulse train must start and stop in accordance with a -2 volt gate waveform applied to the GATE INPUT connector.

(1) Drive the GATE INPUT connector with a -2 volt, 10 μs pulse at a repetition rate of 10 kHz. Set FREQ. RANGE to a high repetition rate; DELAY, WIDTH, and RAMP RATE/10V to minimum. Observe the output pulse train and check for clean positive pulse bursts with no spurious or erratic effects.

k. External drive. Requirement: With the FREQ. RANGE switch in the EXT position, a +1.5 volt pulse with a risetime of 100 ns/volt or faster must initiate an output pulse train.

(1) Set FREQ. RANGE to EXT; DELAY, WIDTH, and RAMP RATE/10V to minimum, and PULSE MODE to SINGLE. Apply a pulse to the EXT DRIVE INPUT that is +1.5 volts in amplitude, 10μs wide, 150 ns rise and fall time, and a repetition rate of 10 kHz. Observe the output pulse train and check for clean triggering with no multiple pulsing.

(2) Apply a 10 ns, fast risetime, +1.5 volt pulse to the EXT DRIVE INPUT. Check for clean triggering to 50 MHz.

l. Trigger output waveform. Requirement: The TRIGGER OUTPUT waveform must be a positive pulse, not less than +1.5 volts amplitude into 50Ω, with an adjustable pulse width from less than 10 ns to greater than 50 ns. The risetime must be 5 ns/volt or faster.

(1) Display the trigger output waveform on a 1 ns risetime sampling scope and check for the stated requirements.

4-4 CALIBRATION PROCEDURE

a. Equipment required.

(1) Test oscilloscope, <1 ns risetime, Tektronix Type 661/5T3 or equal.
(2) Volt-ohmmeter.
(3) E-H Model 139B Pulse Generator, or equal.
(4) 10X T-pad, cables, etc.
(5) Line-voltage variac.

CAUTION

> The full unattenuated output of the Model 139B is capable of permanently damaging the input to a sampling oscilloscope. In the 1 and 3 positions of the ATTENUATOR the Model 139B can deliver an output pulse amplitude in excess of 1 volt. When using these two positions of the ATTENUATOR switch, be sure there is enough attenuation in the signal path to avoid damage to the test oscilloscope.

b. Set the controls on the Model 139B as follows:

FREQ. RANGE	3 - 10 kHz	Fine - CW
WIDTH	10 - 30 ns	Fine - CCW
DELAY	10 - 30 ns	Fine - Center
RAMP RATE/10V	6 - 10 ns	Rise - CCW
		Fall - CCW
POLARITY	+NORMAL	Offset - Center
ATTENUATOR	10	Amplitude - CCW
PULSE MODE	SINGLE	
TRIGGER WIDTH	CCW	

Terminate the output in 50Ω.

c. Regulated supplies.

(1) Monitor the voltage at pin 1 of the power supply board socket, and adjust R102 (+15V ADJ.) for +15 volts.

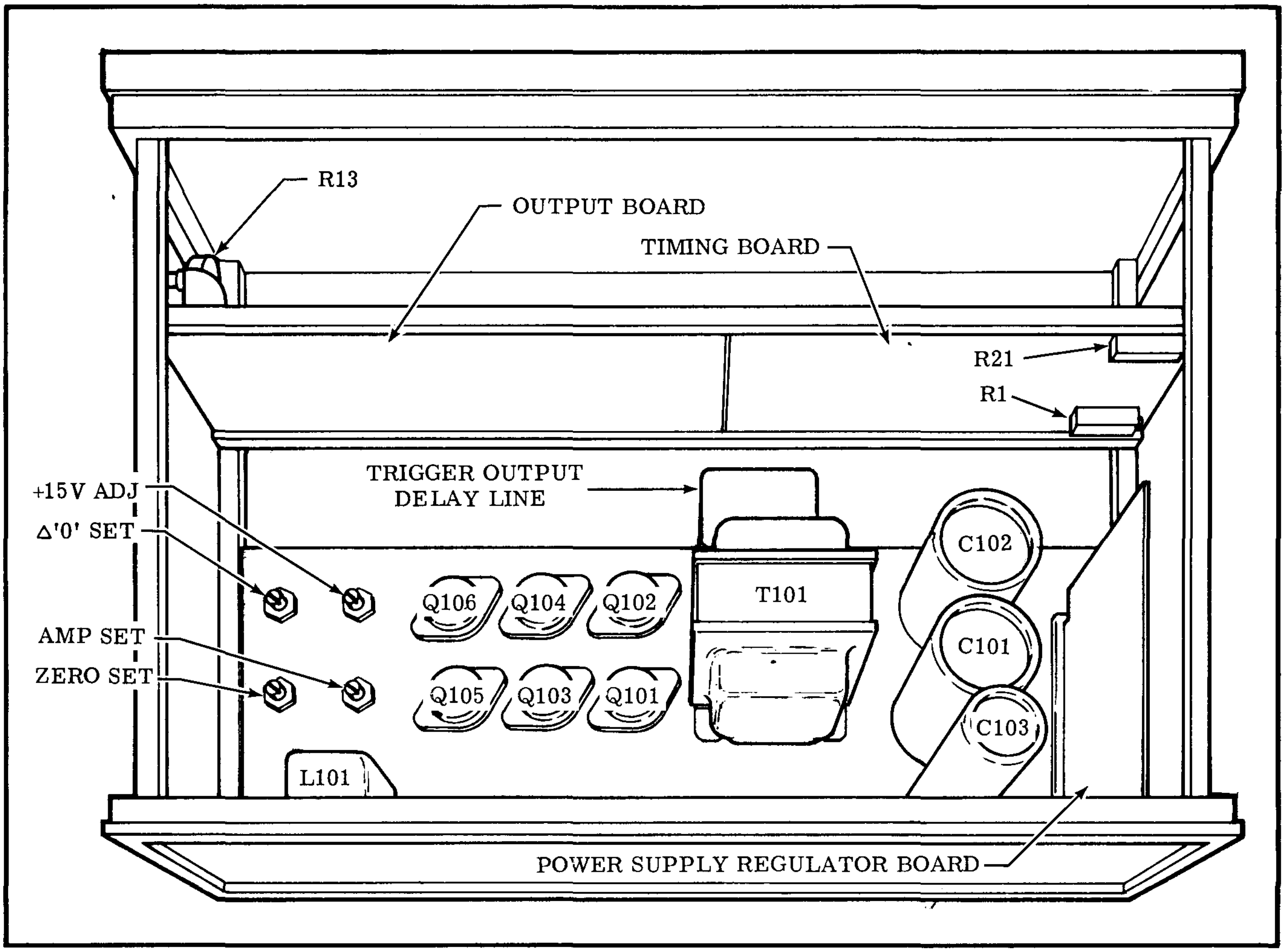

Fig. 4-1 Location of Calibration Adjustment

(2) Monitor the difference between the -15 volt supply, pin 7 (+), and the -25 volt supply, pin 13 (-). Select R16 for 10 volts difference ± 0.1 volt.

(3) The -15 volt supply, pin 7, should be between -15 volts and -16 volts.

(4) The -25 volt supply, pin 13, should be between -25 volts and -26 volts.

(5) The -30 volt supply, pin 8, is typically -31 volts.

(6) Check the power supply regulation range by monitoring the -25 volt supply, pin 13, with the test oscilloscope (5 mv/cm) and varying the line voltage. The power supplies should not go out of regulation at more than 105 volts on the low end, or less than 125 on the high end.

d. Connect the TRIGGER OUTPUT pulse to the vertical input of the test oscilloscope through a 50-ohm coaxial cable, terminated in 50 ohms at the test scope. The trigger output pulse should be not less than +1.5 volts in amplitude, and its width should be adjustable by the TRIGGER WIDTH control from less than 10 ns to greater than 50 ns. The risetime should be not more than 5 ns/volt.

e. Freq Range.

(1) Set TRIGGER WIDTH counter-clockwise, and increase FREQ. RANGE to 3-10 MHz. Adjust R1 on the timing board for 10.5 MHz (~~0.95 µs~~ per rep rate period). 95 ns

(2) Switch the FREQ. RANGE to 25-50 MHz, set FINE (FREQ.) CW, and select R202 for 52.5 to 55 MHz (between 18 and 19 ns per rep rate period). Larger values increases repetition frequency. R202 is physically located between the FREQ. RANGE switch and the FINE (FREQ. RANGE) control. Typical value is 3 k-ohms. D.F. MIN

(3) Check all positions of the FREQ. RANGE switch and both extremes of the FINE (FREQ. RANGE) control. The FINE control should smoothly cover the full range selected by the FREQ. RANGE switch with overlap into the two adjacent ranges. See Performance Verification. Change Q6 if there is pulse-top oscillations at 50 MHz rep rate.

(4) Check GATE INPUT. Set FREQ. RANGE and FINE (FREQ.) to maximum; DELAY and FINE (DELAY) to minimum; WIDTH and FINE (WIDTH) to minimum. Drive the GATE INPUT with a negative pulse 1 µs wide at 1 kHz repetition rate. Check for clean positive gating of the output pulse train with a GATE INPUT signal from less than -2 volts to more than -15 volts. Check internal repetition rates down to 1 kHz and pulse

widths up to 50% duty factor.

(5) Check EXT DRIVE. See paragraph k. of performance verification. Adjust R21, on the timing board, to stop double triggering. Check particularly that a pulse train is not initiated by the negative going slope of the EXT DRIVE signal.

(6) Check the operation of the SINGLE CYCLE pushbutton with the FREQ. RANGE switch on EXT. Only one pulse train should be initiated each time the SINGLE CYCLE pushbutton is depressed.

f. Check DELAY and FINE (DELAY). See paragraph e. of the Performance Verification.

g. Check WIDTH and FINE (WIDTH). See paragraph d. of the Performance Verification. If the two shortest DELAY ranges oscillate, exchange or replace Q13 and Q14. Display an 8 volt, 20 ns pulse in the +NORMAL mode. Switch to -NORMAL and adjust only the AMPLITUDE control for 8 volts. The -NORMAL pulse must be less than 25 ns and greater than 15 ns. If not, suspect the balance of the zener diodes, CR9 and CR10, in the inverter; or the level set by the zener diode, CR11, in the inverter. If changes are made to the inverter, recheck paragraph e(2) at 50 MHz.

h. Check RAMP RATE/10V ranges according to paragraph i. of the performance verification. If ramp readings are incorrect suspect the bridge diodes, CR12 through CR15, in the ramp generator.

i. Set output amplitude.

(1) Set controls as in paragraph b. With a 10X T-pad between the output of the Model 139B and the test sampling scope, set the ATTENUATOR to 1 and the AMPLITUDE control full clockwise. Set POLARITY mode switch to +INV. Adjust R103, "Amp Set", for a 10.2 volt output pulse. If the output is low, check R35 on the output board for not more than 200 ohms, replace Q11 on the output board, and/or reduce R36 on the output board to 430 ohms.

(2) Set POLARITY mode switch to +NORMAL and recheck fastest rise and fall time at full amplitude per paragraph i. of the Performance Verification. If rise and fall times are slow at all amplitudes suspect Q10 on the output board. If rise and fall times meet specs at low amplitudes but not at full amplitude, suspect Q11. If transistors are replaced, repeat steps i(1) and i(2).

(3) Switch to +NORMAL and minimum AMPLITUDE. Select R213 for 3.1 to 3.2 output pulse amplitude. R213 is physically located on the terminals of the AMPLITUDE potentiometer. Typical value is 3 k-ohms.

(4) Switch to -NORMAL, minimum AMPLITUDE, 300 ns pulse WIDTH, 10 kHz repetition rate. Check for pulse-top distortion of less than 5%. Select C25 on the output board to hold overshoot to less than 5% without degrading risetime. Typical value is 400 pf. Q10 and/or CR18 on the output board can cause excessive overshoot.

j. Baseline shift.

(1) Switch to +NORMAL and adjust R13 on the output board for minimum baseline shift while varying the AMPLITUDE control from minimum to maximum.

(2) With the OFFSET control centered, adjust R104, "Zero Set", so the baseline of the output pulse is 0 volts.

(3) Switch to -NORMAL and adjust R105, "Δ0 Set", so the baseline of the output pulse is 0 volts.

k. Do the entire Performance Verification.

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SECTION 5
PARTS LIST

5-1. ORDERING INFORMATION

Replacement parts may be ordered through an E-H Representative or directly from the factory. To be certain of receiving the proper parts, always include the following information with the order:

a. Model number and serial number of the instrument on which the parts will be installed.

b. Circuit reference number and subassembly name, if applicable, for which the part is intended. If the part does not have a circuit reference, the description from the parts list should be used.

c. E-H part number.

The warranty is given on page ii of this manual, opposite the Table of Contents. For factory repair, contact the Customer Service Department of E-H Research Laboratories, Inc., at the address given on the title page of this manual. Include the following information:

a. Model number and serial number of the instrument on which the work is to be performed.

b. Details concerning the nature of the malfunction; or, type of repair desired.

Shipping instructions will be sent to you promptly.

5-2. HOW TO USE THIS PARTS LIST

The parts list is divided into subsections corresponding to the physical subsections of the instrument (printed circuit boards, chassis and subassemblies, miscellaneous hardware). Component locations can be determined from the schematic diagrams; each component appears only once in the parts list. At the beginning of each subsection are listed part numbers for any complete subassemblies in that category that are available as replacement parts. These subassemblies may include individually-listed components; care should be taken to locate malfunctions to the lowest possible level of replacement part and thus avoid the time and cost involved in "over-repair".

In the component descriptions, capacitor dielectrics are abbreviated as follows: polyethylene (poly.), ceramic (cer.), printed circuit (P.C.), electrolytic (elect.) and tantalum (tant.). Resistor and potentiometer values are given in ohms; the symbol for "ohm" (Ω) has been omitted. If no material is listed, resistors may be assumed to be carbon composition; other resistor types are metal film (MF) and wire-wound (WW). An asterisk following a component value indicates that the actual value is factory-selected at time of manufacture; the listed value is nominal.

5-2. Timing Board

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
C1	Cap., 2.2 μF, 25 V, cer	311-00019
C2	Cap., 0.001 μF, 1 Hi-Q, cer	311-00067
C3	Cap., 0.001 μF, 1 kV, cer	311-00010
C4	Same as C3	
C5	Cap., 10pF, 1 kV, cer	311-00001
C6	Same as C2	
C7	Cap., 0.1 μF, 75 V, cer	311-00014
C8	Cap., 0.1 μF, 50 V, cer	311-00034
C9	Cap., 50pF, 1 kV, cer	311-00006
C10	Same as C3	
C11	Cap., 25 μF, 25 V, elect	312-00028
C12	Same as C9	
C13	Cap., 0.005 μF, Hi-Q, cer	311-00069
C14	Cap., 400pF, 1 kV, cer	311-00026
C15	Cap., 0.01 μF, 600 V, cer	311-00012
C16	Cap., 68pF, 1 kV	311-00044
C17	Same as C3	
C18	Same as C3	
C19	Same as C3	
C20	Same as C13	
C21	Same as C13	
C22	Same as C13	
C23	Cap., 25 μF, 25 V, elect	376-00022
C24	Same as C13	
C25	Same as C13	
CR1	Diode	376-11764
CR2	Same as CR1	
CR3, CR4	Diode, Zener, matched pair	374-11731
CR4	See CR3	
CR5	Diode	374-11742

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
CR6	Diode, Zener	374-11731
CR7	Same as CR5	
CR8	Diode	376-11764
CR9	Same as CR6	
CR10	Same as CR5	
CR11	Same as CR5	
CR12, CR14	Diode, Zener, matched pair	374-11730
CR13	Same as CR5	
CR14	See CR12	
CR15	Diode, 1N751A, Zener	374-00022
CR16, CR18	Diode, Zener, matched pair	374-11730
CR17	Same as CR5	
CR18	See CR16	
CR19	Same as CR15	
CR20	Diode, 1N914B	376-00022
CR21	Same as CR20	
CR22	Same as CR20	
CR23	Same as CR20	
CR24	Same as CR20	
CR25	Diode, tunnel	376-00044
CR26	Diode, 1N270	376-00031
CR27	Same as CR5	
CR28, CR33	Diode, Zener, matched pair	374-11730
CR29	Same as CR5	
CR30	Same as CR5	
CR31	Same as CR5	
CR32	Same as CR5	
CR33	See CR28	
CR34	Same as CR5	
CR35	Same as CR5	
CR36	Same as CR5	
CR37	Same as CR5	
CR38	Same as CR5	
CR39	Same as CR5	
CR40	Same as CR5	
CR41	Same as CR5	
CR42	Same as CR5	
CR43	Same as CR1	
L1	Choke, 0.22 μH, 20%	335-00014
L2	Same as L1	
L3	Choke, 0.33 μH, 10%	335-00010
L4	Choke, 0.47 μH, 20%	335-00019
L5	Same as L4	
Q1	Transistor	663-11749
Q2	Transistor, 2N2369	663-00089
Q3	Same as Q2	
Q4	Transistor	663-11722
Q5	Transistor	663-11757
Q6	Same as Q5	
Q7	Transistor	663-11701
Q8	Same as Q5	
Q9	Same as Q5	
Q10	Same as Q5	
Q11	Same as Q5	
Q12	Same as Q5	
Q13	Same as Q5	
Q14	Same as Q5	
Q15	Same as Q5	
Q16	Same as Q5	
Q17	Same as Q5	
Q18	Same as Q5	
Q19	Transistor,	663-00009
R1	Potentiometer, 100	551-00024
R2	Res., 1k, 1/4W, 5%	595-00102
R3	Res., 200, 1/4W, 5%	595-00201
R4	Res., 5.1, 1/4W, 5%	595-00051
R5	Res., 1.5k, 1/4W, 5%	595-00152
R6	Res., 560, 1/4W, 5%	595-00561
R7	Res., 220, 1/4W, 5%	595-00221
R8	RSame as R4	
R9	Res., 160, 1/4W, 5%	595-00161
R10	Same as R7	
R11	Same as R5	
R12	Res., 100, 1/4W, 5%	595-00101
R13	Same as R12	
R14	Res., 2k, 1/4W, 5%	595-00202
R15	Res., 750, 1/2W, 5%	596-00751
R16	Same as R11	
R17	Res., 150, 1/4W, 5%	595-00151
R18	Same as R12	
R19	Res., 330, 1/2W, 5%	596-00331
R20	Res., 2.2k, 1/4W, 5%	595-00222
R21	Potentiometer, 2k	551-00023
R22	Same as R15	
R23	Same as R14	
R24	Res., 3k, 1/4W, 5%	595-00302
R25	Res., 51, 1/4W, 5%	595-00510
R26	Same as R2	
R27	Same as R6	
R28	Res., 51, 1/4W, 5%	595-00510
R29	Same as R11	
R30	Res., 390, 1/2W, 5%	596-00391
R31	Same as R12	
R32	Res., 3k, 1/4W, 5%	595-00302
R33	Same as R32	
R34	Same as R28	
R35	Same as R2	
R36	Same as R6	
R37	Same as R28	
R38	Same as R11	
R39	Same as R19	
R40	Same as R32	
R41	Same as R12	
R42	Res., 10k, 1/4W, 5%	595-00103
R43	Res., 22M, 1/4W, 5%	595-00226
R44	1.2k, 1/2W, 5%	596-00122
R45	Res., 1.4k, 1/2W, 1%	618-00004
R46	Same as R28	

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
R47	Res., 100k, 1/4W, 5%	595-00104
R48	Same as R7	
R49	Same as R45	
R50	Res., 5.1k, 1/4W, 5%	595-00512
R51	Res., 510, 1W, 5%	597-00511
R52	Same as R6	
R53	Same as R14	
R54	Same as R24	
R55	Same as R28	
R56	Same as R7	
R57	Res., 560, 1/2W, 5%	596-00561
R58	Same as R57	
R59	Same as R24	
R60	Same as R28	
R61	Same as R7	
R62	Same as R3	
R63	Res., 1.2k, 1/4W, 5%	595-00122
R64	Same as R24	
R65	Same as R14	
R66	Same as R25	
R67	Res., 1.1k, 1/4W, 5%	595-00112
R68	Same as R3	
R69	Res., 300, 1/4W, 5%	595-00301
R70	Same as R69	
R71	Same as R23	
R72	Same as R26	
R73	Same as R23	
R74	Res., 1.1k, 1/4W, 5%	595-00112
R75	Same as R3	
R76	Same as R42	
R77	Not Used	
R78	Same as R25	
R79	Same as R25	

5-3 Output Board Assembly

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
C1	Cap., .01 μF, 600 V, cer	311-00012
C2	Same as C1	
C3	Cap., .05 μF, 75 V, cer	311-00021
C4	Cap., 0.1 μF, 75 V, cer	311-00014
C5	Cap., 25 μF, 25 V, elect	316-00028
C6	Same as C4	
C7	Cap., .001 μF, cer	311-00010
C8	Same as C7	
C9	Same as C7	
C10	Same as C7	
C11	Cap., 2.2 μF, 25 V	311-00019
C12	Same as C4	
C13	Same as C4	
C14	Same as C4	
C15	Cap., 13pF	312-11371
C16	Same as C11	
C17	Cap., .001	312-00001
C18	Cap., .01 μF	312-00003
C19	Cap., 300pF	312-10952
C20	Cap., 0.1 μF, 50 V	311-00034
C21	Same as C7	
C22	Same as C11	
C23	Cap., 100 μF, 25 V	316-00035
C24	Same as C23	
C25	See Calibration Procedure	
C26	Same as C21	
CR1	Diode, 1N270	376-00031
CR2	Same as CR1	
CR3	Same as CR1	
CR4	Same as CR1	
CR5	Same as CR1	
CR6	Same as CR1	
CR7	Same as CR1	
CR8	Same as CR1	
CR9, 10	Diode, Zener, matched pair	374-11733
CR10	See CR9	
CR11	Diode, Zener, 1N750	374-00066
CR12	Diode	376-11764
CR13	Same as CR12	
CR14	Same as CR12	
CR15	Same as CR12	
CR16	Diode	376-11742
CR17	Same as CR12	
CR18	Diode	376-11794
CR19	Diode, Zener, 1N3789A	374-00027
CR20	Diode, 1N914B	376-00022
L1	Inductor	335-10956
L2	Inductor	335-12121
L3	Choke, 2.2 μH	335-00016
L4	Choke, 0.33 μH	335-00010
L5	Same as L3	
L6	Inductor	335-10995
L7	Inductor	335-10956
L8	Inductor	335-12122
Q1	Transistor,	663-11757
Q2	Same as Q1	
Q3	Transistor, 2N834	663-00028
Q4	Same as Q1	
Q5	Transistor, 2N1132	663-00024
Q6	Transistor	663-11701
Q7	Same as Q5	
Q8	Same as Q3	
Q9	Transistor	663-11722
Q10	Transistor, 2N2950	663-00039
Q11	Transistor	663-11716
Q12	Transistor	663-11725
Q13	Same as Q6	
Q14	Same as Q6	
Q15	Transistor	663-11705
Q16	Same as Q6	
R1	Res., 1.3k, 1/4W, 5%	595-00132
R2	Same as R1	
R3	Res., 62, 1/2W, 5%	596-00620
R4	Same as R3	
R5	Same as R1	

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
R6	Res., 1.3k, 1/4W, 5%	596-00132
R7	Res., 220, 1/4W, 5%	696-00221
R8	Res., 200, 1/4W, 5%	595-00201
R9	Res., 18k, 1/2W, 5%	596-00183
R10	Res., 3.3k, 1/2W, 5%	596-00332
R11	Res., 5.1k, 1/2W, 5%	596-00512
R12	Res., 4.3k, 1/2W, 5%	596-00432
R13	Potentiometer, 1k	550-00031
R14	Res., 2k, 1/2W, 5%	596-00202
R15	Same as R10	
R16	Res., 6.2k, 1/2W, 5%	596-00622
R17	Res., 430, 1W, 5%	597-00431
R18	Res., 180, 1W, 5%	597-00181
R19	Res., 91, 1/2W, 5%	596-00910
R20	Res., 3.6k, 1/2W, 5%	596-00362
R21	Res., 3k, 1/2W, 5%	596-00302
R22	Res., 10, 1W, 5%	597-00100
R23	Res., 180, 1W, 5%	597-00181
R24	Res., 1.8k, 1/2W, 5%	596-00182
R25	Res., 2.2k, 1/2W, 5%	596-00222
R26	Res., 220, 1W, 5%	597-00221
R27	Res., 160, 1/2W, 5%	596-00161
R28	Same as R18	
R29	Res., 2.k, 1/2W, 5%	596-00222
R30	Res., 51, 1/2W, 5%	596-00510
R31	Res., 270, 1/2W, 5%	596-00271
R32	Same as R6	
R33	Same as R14	
R34	Res., 1k, 1/2W, 5%	596-00102
R35	Res., 200, 1/2W, 5%	596-00201
R36	Res., 470, 1/2W, 5%	596-00471
R37	Res., 100, 1/4W, 5%	595-00101
R38	Res., 330, 1W, 5%	597-00331
R39	Res., 510, 1/2W, 5%	596-00511
R40	Same as R14	
R41	Same as R34	
R42	Res., 200, 1/4W, 5%	595-00201
R43	Same as R7	
R44	Res., 33, 1/4W, 5%	595-00330
R45	Res., 2.7, 1/2W, 5%	596-00027
R46	Same as R37	
R47	Res., 10, 1/4W, 5%	595-00100
R48	Res., 20, 1/2W, 5%	696-00200
R49	Same as R48	
R50	Res., 30, 1/4W, 5%	595-00300
R51	Res., 1.6k, 1/2W, 5%	596-00162
R52	Same as R47	

5-4 Regulator Supply Board

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
C1	Cap., 25 μF, 25 V	316-00028
C2	Cap., 100 μF, 25 V	316-00035
C3	Same as C2	
C4	Same as C1	
C5	Same as C1	
C6	Same as C2	
C7	Cap., 50 μF, 25 V	316-00037
C8	Same as C1	
C9	Same as C2	
CR1	Diode, Zener, 1N3785A	374-00028
Q1	Transistor	663-11701
Q2	Same as Q1	
Q3	Transistor, 2N1303	663-00011
Q4	Same as Q3	
Q5	Same as Q3	
R1	Res., 1k, 1/2W, 5%	596-00102
R2	Res., 330, 1/2W, 5%	596-00331
R3	Res., 10k, 1/2W, 5%	596-00103
R4	Res., 2k, 1/2W, 5%	596-00202
R5	Res., 470, 1/2W, 5%	596-00471
R6	Res., 680, 1/2W, 5%	596-00681
R7	Res., 620, 1/2W, 5%	596-00621
R8	Res., 1k, 1/2W, 5%	596-00102
R9	Same as R4	
R10	Res., 3.3k, 1/2W, 5%	596-00332
R11	Same as R1	
R12	Same as R1	
R13	Res., 220, 1/2W, 5%	596-00221
R14	Res., 3.01k, 1/2W, 1%, MF	618-00018
R15	Res., 5.11k, 1/2W, 1%, MF	618-00020
R16	See Calibration Procedure	
R17	Same as R1	
R18	Res., 18k, 1/2W, 5%	596-00183
R19	Res., 2k, 1/2W, 1%	618-00005
R20	Same as R19	
R21	Res., 1.5k, 1/2W, 5%	596-00152
R22	Same as R1	
R23	Same as R19	
R24	Same as R19	
R25	Res., 75k, 1/2W, 5%	596-00753
R26	Res., 5.1, 1/2W, 5%	596-00051

5-5 Attenuator

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
R1a	Res., 200, 1W, 5%	597-00201
R1b	Res., 200, 1W, 5%	597-00201
R1c	Res., 200, 1W, 5%	597-00201
R2a	Res., 33, 1W, 5%	597-00300
R2b	Res., 68, 2W, 5%	598-00680
R3	Res., 100, 1/2W, 5%	596-00101
R4	Res., 75, 1/2W, 5%	596-00750
R5	Res., 91, 1/4W, 5%	595-00910
R6	Same as R5	
R7	Same as R2b	
R8	Res., 100, 1/4W, 5%	595-00101
R9	Same as R8	
R10	Same as R4	
R11	Same as R5	
R12	Same as R5	

5-6 Miscellaneous

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
C101	Cap., 1500 μF, 50 V	316-00045
C102	Same as C101	

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
C103	Cap., 250 µF, 50 V	316-00025
C104	Cap., 0.1 µF, 75 V	311-00014
C105	Cap., .01 µF, 600 V	311-00012
C201	Cap., 0.015 µF	320-00031
C202	Cap., 0.047 µ	320-00032
C203	Cap., 0.15 µF	320-00036
C204	Cap., 0.47 µF	320-00035
C205	Cap., 1.5 µF, 20 V	320-00037
C206	Cap., 4.7 µF, 20 V	318-00002
C207	Cap., 15 µF, 20 V	318-00009
C208	Cap., 47 µF, 20 V	318-00001
C209	Same as C208	
C210	Same as C208	
C211	Same as C208	
C212	Cap., 20pF	311-00002
C213	Same as C212	
C214	Cap., 75pF	311-00025
C215	Cap., 10pF	311-00001
C216	Cap., 400pF	311-00026
C217	Cap., 0.0015 µF	311-00033
C218	Cap., 4300pF	326-00017
C219	Cap., 0.025 µF	320-00017
C220	Cap., 7000pF	326-00008
C221	Cap., 2500pF	326-00011
C222	Cap., 620pF	326-00013
C223	Cap., 200pF, 10%	311-00028
C224	Same as C215	
C225	Cap., 22 µF	318-00013
C226	Cap., 6.8 µF	318-00012
C227	Cap., 2.7 µF	318-00011
C228	Cap., 0.68 µF	318-00010
C229	Cap., 0.25 µF	320-00021
C230	Cap., 0.07 µF	320-00020
C231	Same as C219	
C232	Same as C220	
C233	Same as C221	
C234	Cap., 250pF	311-00004
C235	Same as C216	
C236	Cap., 200pF	311-00028
C237	Cap., 22 µF	318-00013
C238	Same as C226	
C239	Cap., 1.8 µF	318-00008
C240	Same as C228	
C241	Same as C228	
C242	Cap., 0.25 µF	320-00021
C243	Cap., 0.07 µF	320-00020
C244	Cap., 50pF	311-00006
C245	Cap., 250pF	311-C0004
C246	Cap., 820pF	311-00027
C247	Same as C221	
C248	Same as C220	
C249	Cap., .025 µF	320-00017
C250	Cap., .07 µF	320-00020
C251	Cap., 25 µF	320-00021
C252	Cap., .82 µF, 20 V	318-00014
C253	Cap., 2.7 µF, 20 V	318-00011
C254	Cap., 8.2 µF, 20 V	318-00015
CR101	Diode, 1N4005	376-00034
CR102	Same as CR101	
CR103	Same as CR101	
CR104	Same as CR101	
CR105	Same as CR101	
CR106	Same as CR101	
CR107	Same as CR101	
CR108	Same as CR101	
L101	Inductor	655-10563
Q101	Transistor	663-11705
Q102	Same as Q101	
Q103	Same as Q101	
Q104	Same as Q101	
Q105	Same as Q101	
Q106	Same as Q101	
R101	Res., 5, 3W, WW	610-00003
R102	Potentiometer, 1k	545-00003
R103	Potentiometer, 500	545-000034
R104	Potentiometer, 10k	545-00006
R105	Potentiometer, 24k	545-00007
R106	Res., 7.5k, 1/2W, 5%	596-00752
R107	Res., 2k, 1/2W, 5%	596-00202
R201	Potentiometer, 5k	550-00003
R202	See Calibration Procedure	
R203	Res., 1k, 1/4W, 5%	595-00102
R204	Res., 2.7k, 1/4W, 5%	595-00272
R205	Res., 1.2k, 1/4W, 5%	595-00122
R206	Same as R201	
R207	Res., 470, 1/4W, 5%	595-00471
R208	Same as R201	
R209	Same as R204	
R210	Same as R205	
R211	Same as R201	
R212	Potentiometer, 1k	550-00002
R213	See Calibration Procedure	
R214	Same as R212	
R215	Res., 2.2k, 1/2W, 5%	596-00222
R216	Same as R212	
R217	Res., 390, 1/2W, 5%	596-00391
R218	Same as R215	
R219	Same as R212	
R220	Res., 330, 1/2W, 5%	596-00331
R221	Res., 5.1k, 1/2W, 5%	596-00512
R222	Res., 10k, 1/2W, 5%	596-00103
R223	Res., 100k, 1/2W, 5%	596-00104
S201	FREQ RANGE	624-000048
S202	DELAY	624-00007
S203	WIDTH	624-00007
S204	RAMP RATE/10V	
S205	POLARITY	624-00041
S206	ATTENUATOR	626-12086
S207	PULSE MODE	630-00006

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
S208	SINGLE CYCLE	635-00003
S209	POWER	630-00006
T101	Transformer	650-11170

SECTION 6
DRAWINGS

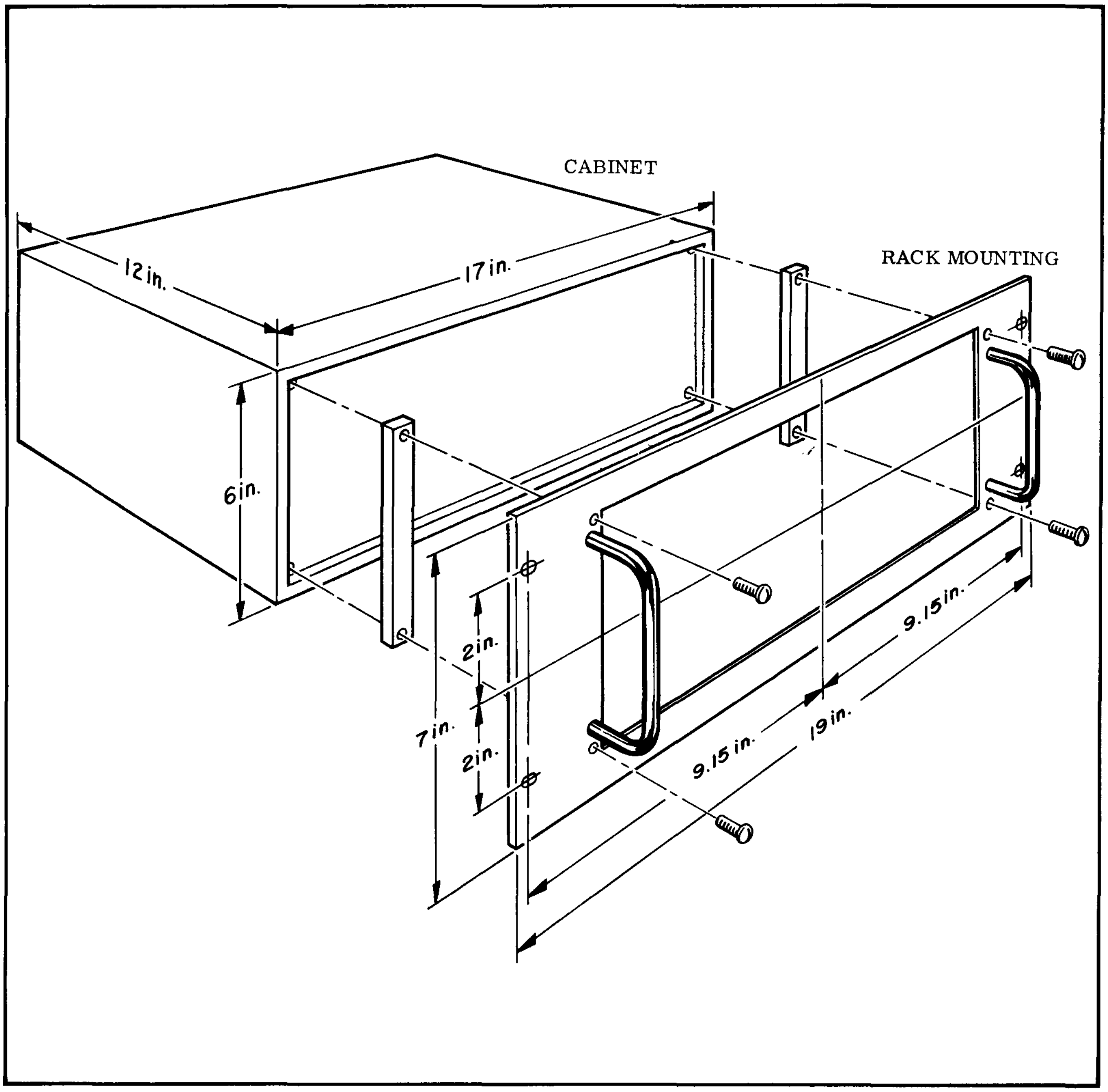


Fig. 6-1 Outline Dimensions

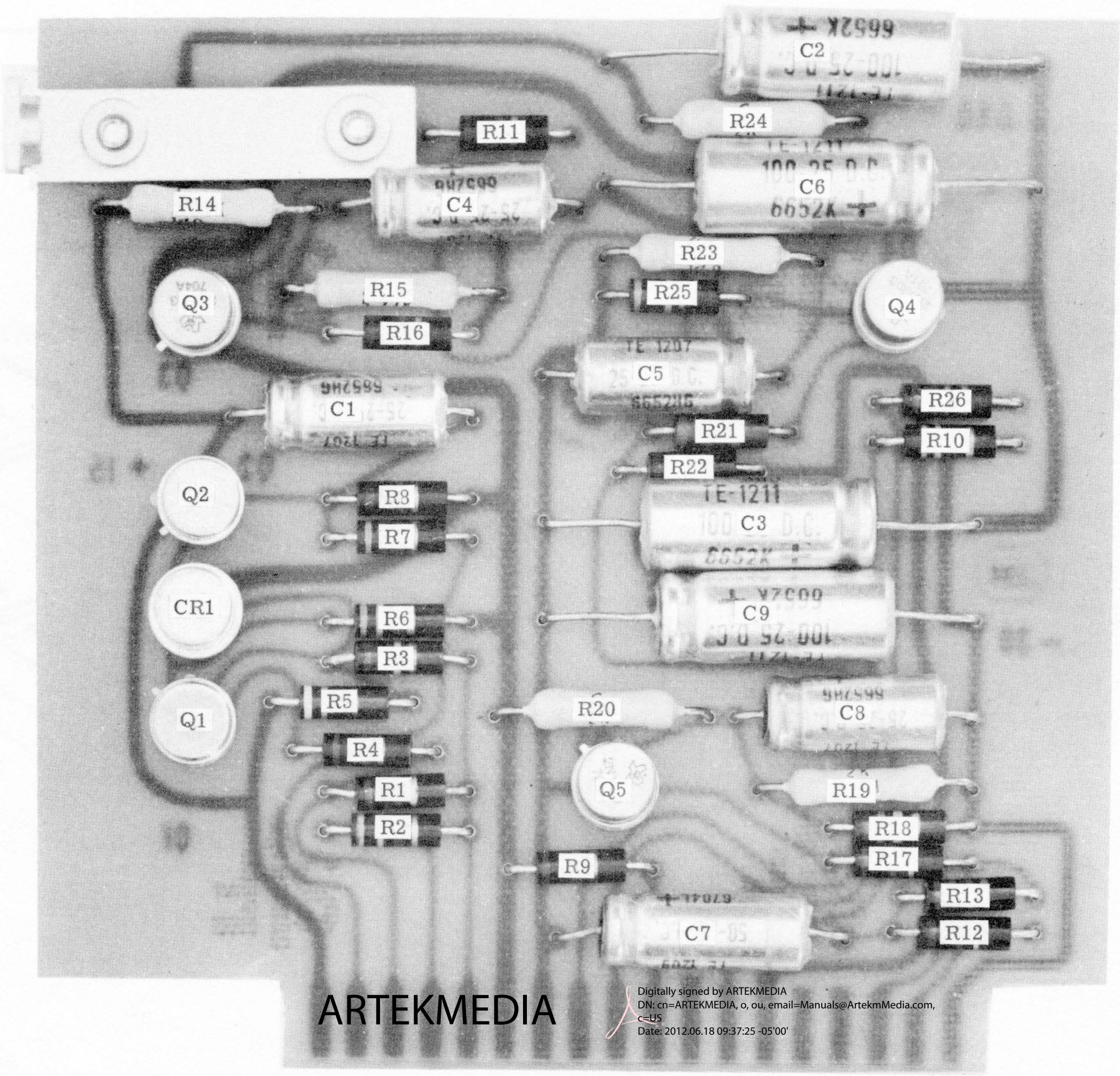


Fig. 6-2 Regulator Supply Board

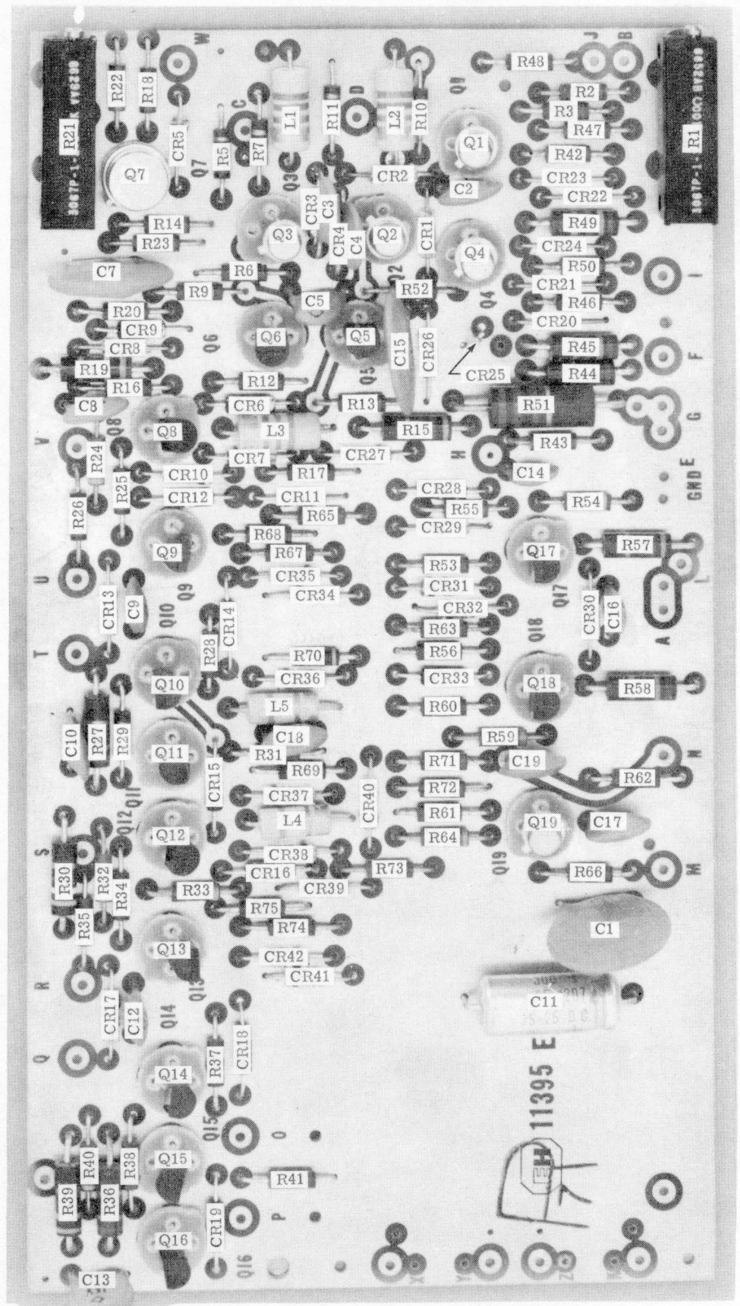


Fig. 6-3 Timing Board

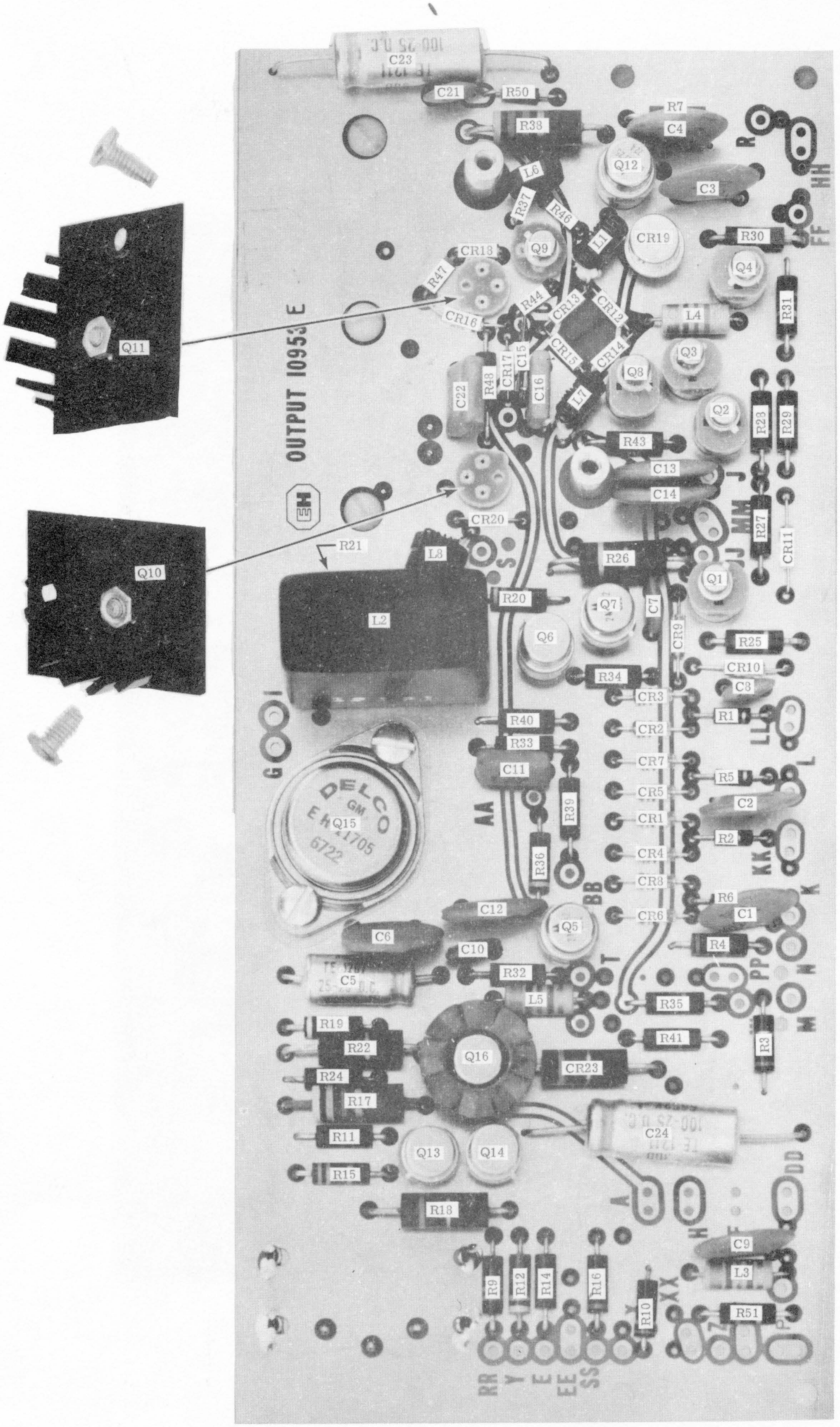


Fig. 6-4 Output Board (Front)

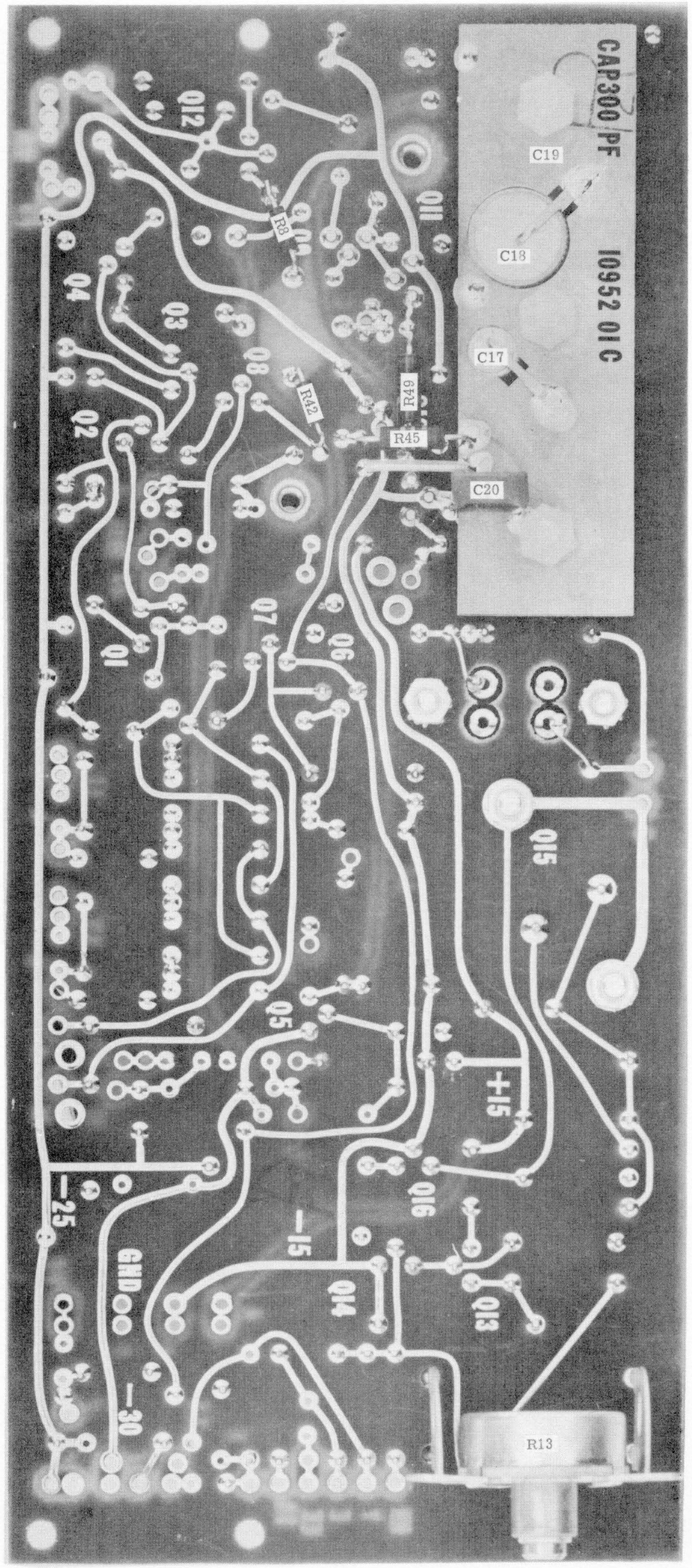
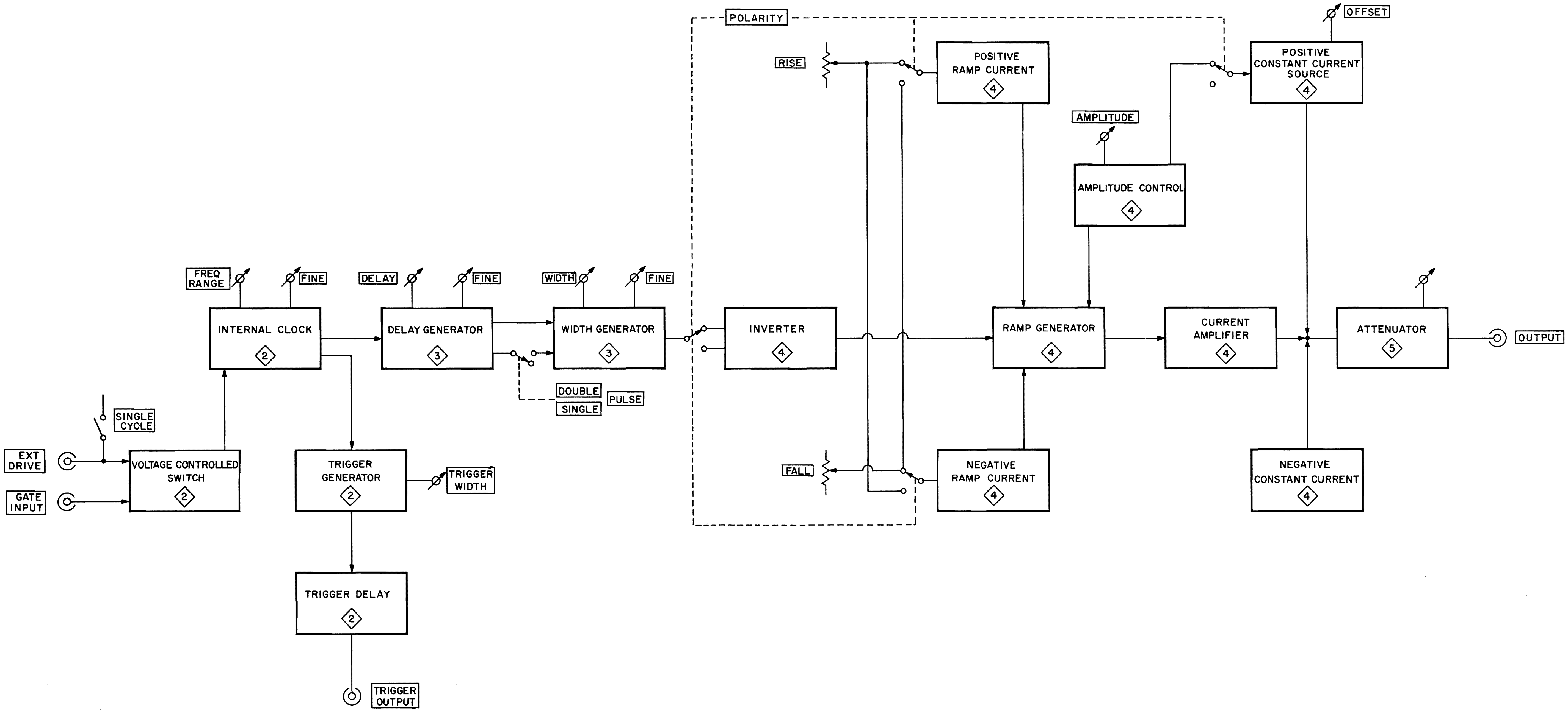
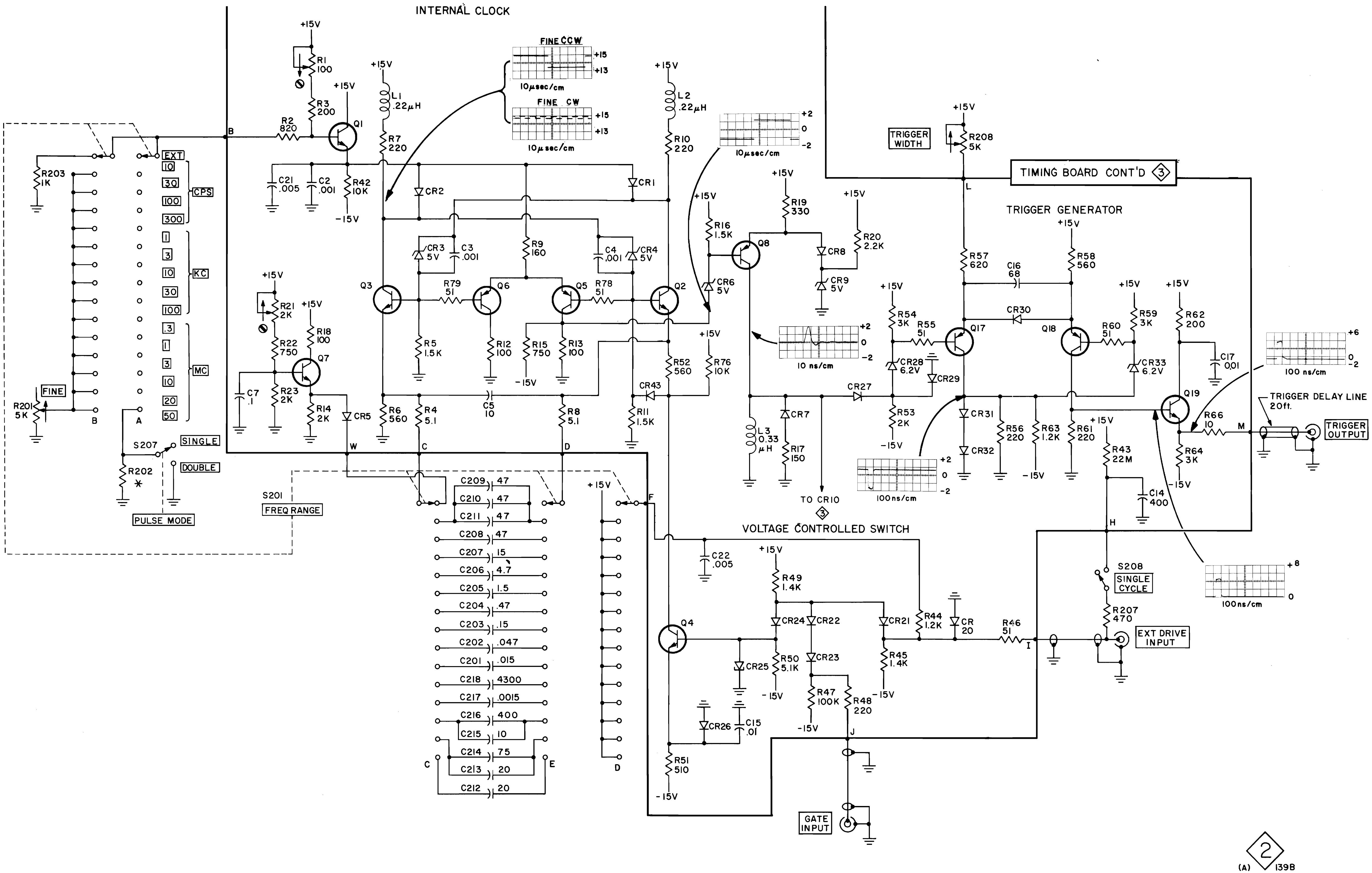


Fig. 6-5 Output Board (Reverse)

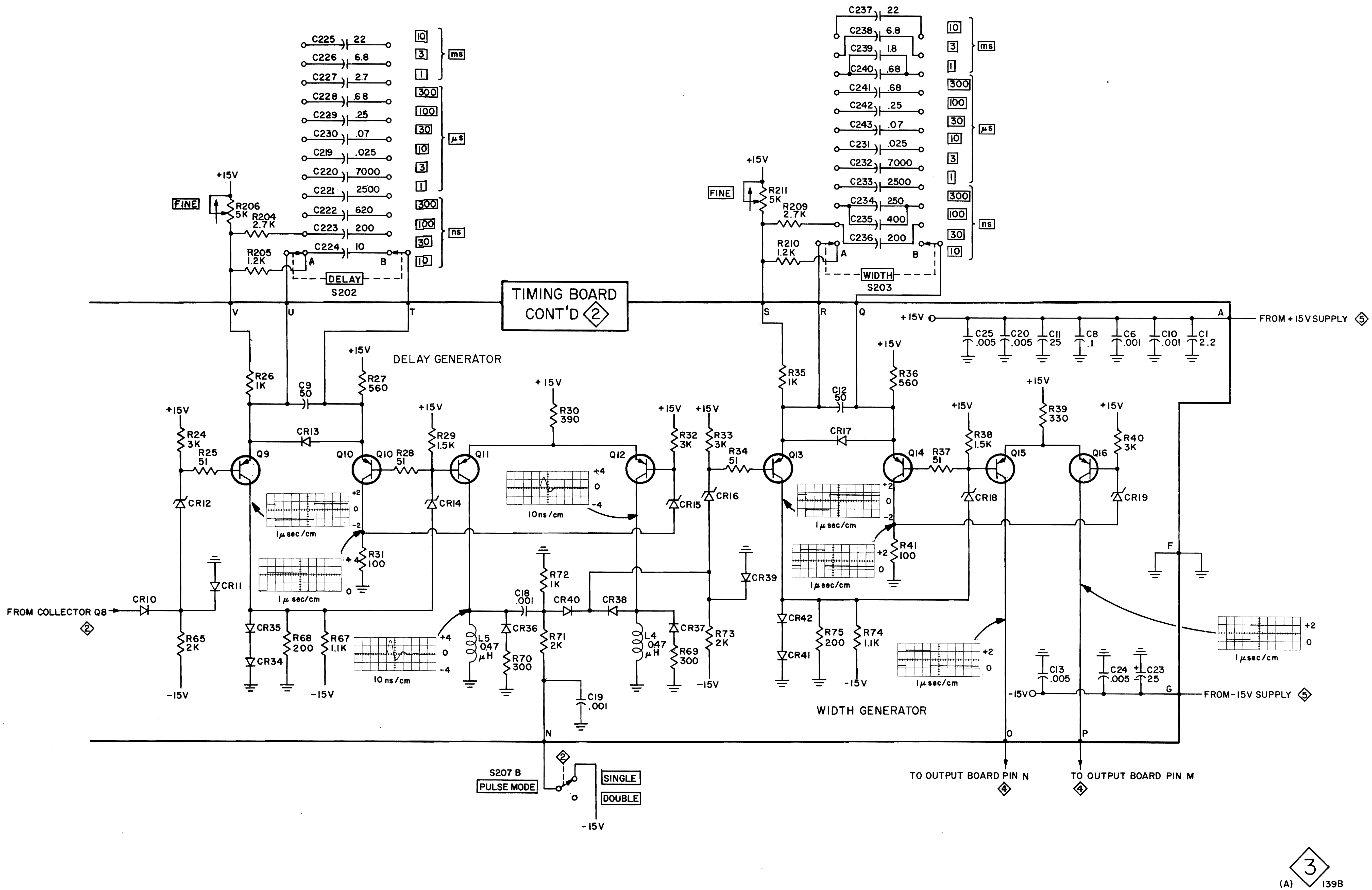


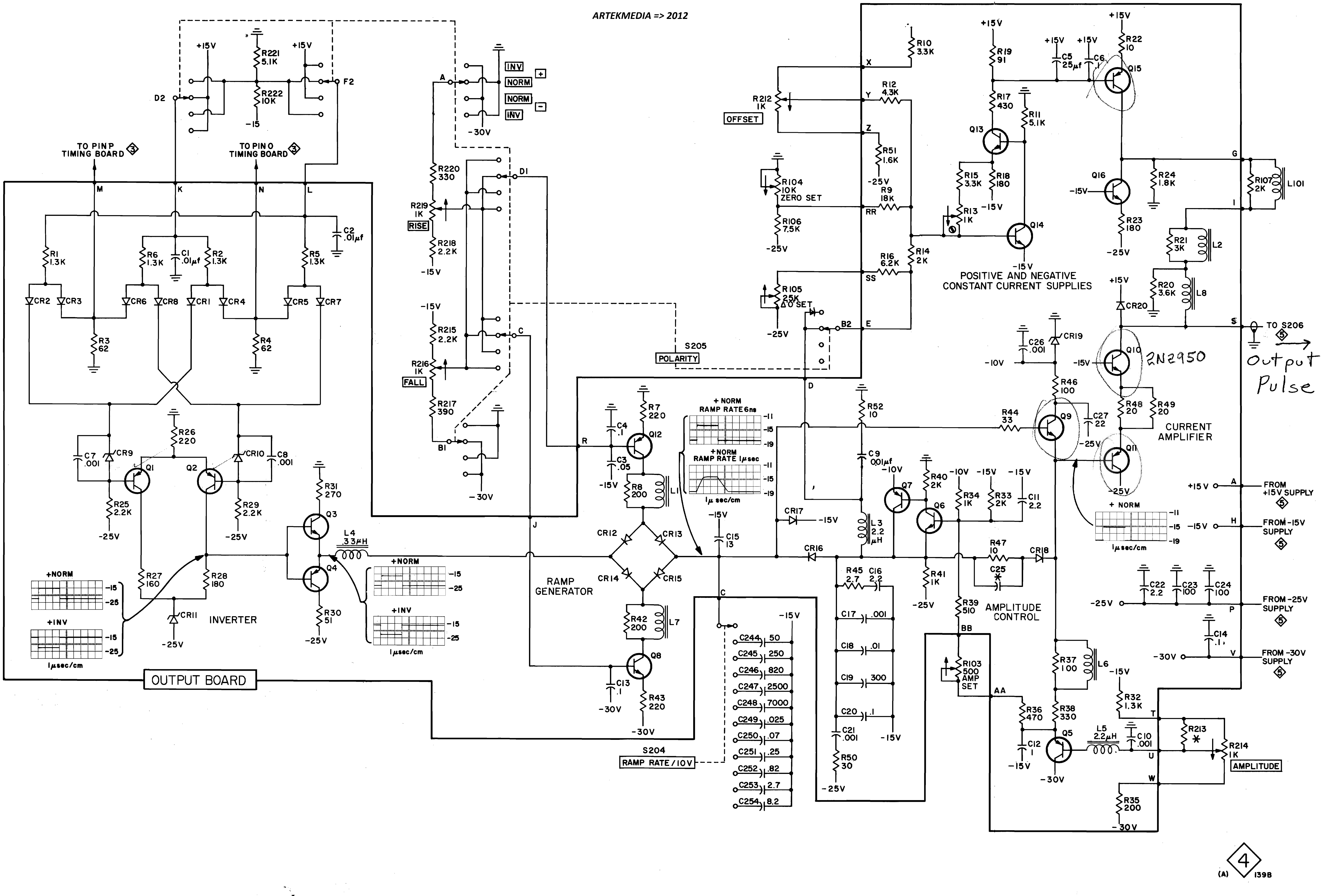
BLOCK DIAGRAM

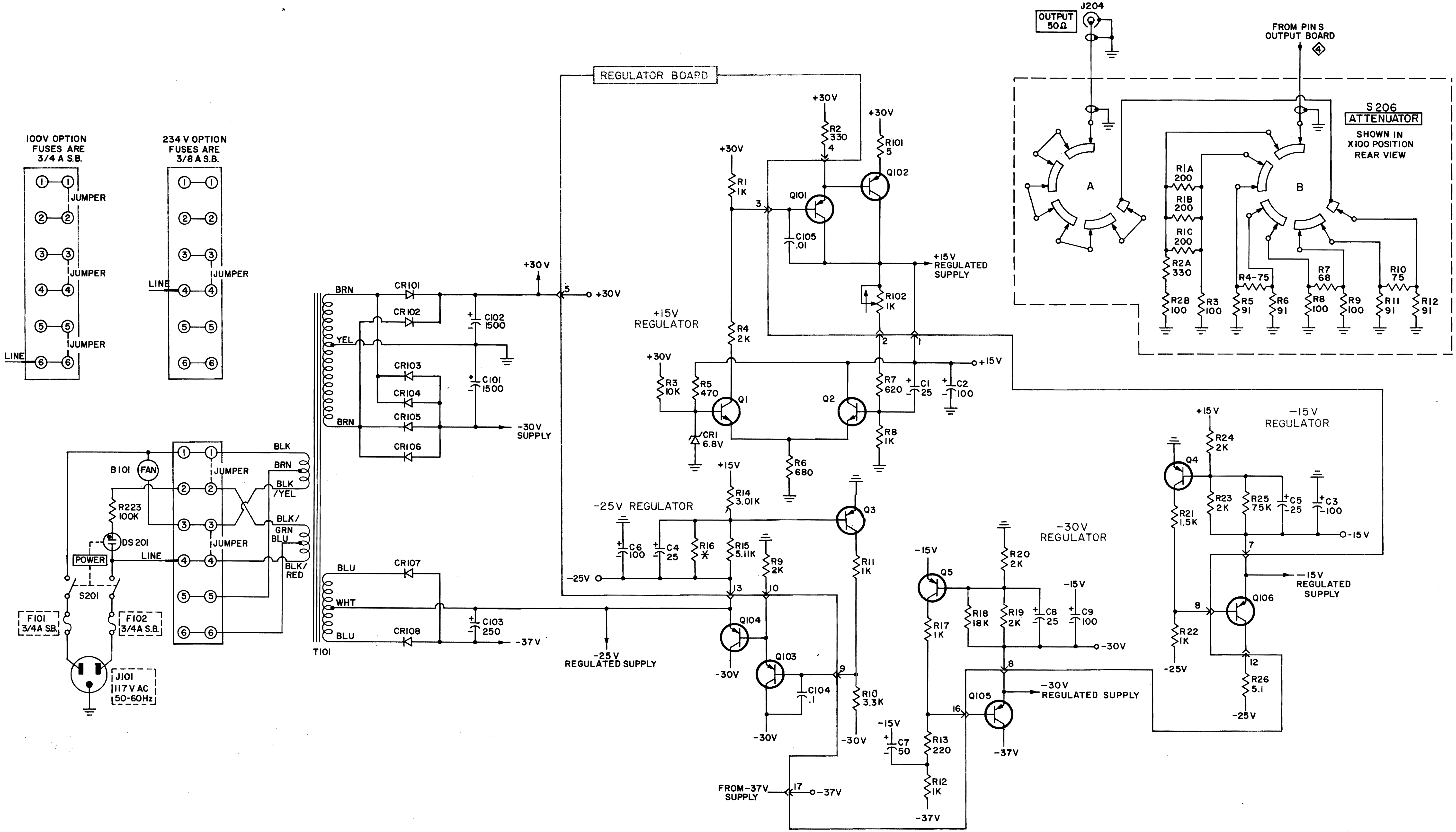
(A) 1 1398



INTERNAL CLOCK
TIMING BOARD CONT'D 3
TRIGGER GENERATOR
VOLTAGE CONTROLLED SWITCH
TRIGGER WIDTH
R208 5K
FINE CCW
FINE CW
10μsec/cm
10 ns/cm
100ns/cm
EXT
CPS
KC
MC
FINE
R201 5K
R203 1K
S207
SINGLE
DOUBLE
R202 *
PULSE MODE
S201
FREQ RANGE
S208
SINGLE CYCLE
EXT DRIVE INPUT
GATE INPUT
TRIGGER DELAY LINE 20ft.
TRIGGER OUTPUT
TO CR10 3
R1 100
R2 820
R3 200
R7 220
R10 220
L1 .22μH
L2 .22μH
L3 0.33 μH
C21 .005
C2 .001
R42 10K
R9 160
C3 .001
C4 .001
CR3 5V
CR4 5V
R79 51
R78 51
R5 1.5K
R12 100
R15 750
R13 100
R6 560
R4 5.1
C5 10
R8 5.1
R11 1.5K
R52 560
R76 10K
R16 1.5K
CR6 5V
R19 330
R20 2.2K
CR9 5V
R17 150
R21 2K
R18 100
R22 750
R23 2K
R14 2K
C7 .1
R57 620
R58 560
C16 68
R54 3K
R55 51
R60 51
R59 3K
R62 200
C17 0.01
CR28 6.2V
CR33 6.2V
R53 2K
R56 220
R63 1.2K
R61 220
R43 22M
C14 400
R66 10
R64 3K
R207 470
R49 1.4K
R50 5.1K
R47 100K
R48 220
R45 1.4K
R44 1.2K
R46 51
CR 20
C22 .005
C15 .01
R51 510
C209 47
C210 47
C211 47
C208 47
C207 15
C206 4.7
C205 1.5
C204 .47
C203 .15
C202 .047
C201 .015
C218 4300
C217 .0015
C216 400
C215 10
C214 75
C213 20
C212 20
(A) 2 1398


TIMING BOARD CONT'D 2
DELAY GENERATOR
WIDTH GENERATOR
FINE
DELAY
S202
WIDTH
S203
FROM COLLECTOR Q8
FROM +15V SUPPLY 5
FROM -15V SUPPLY 5
TO OUTPUT BOARD PIN N
TO OUTPUT BOARD PIN M
S207 B
PULSE MODE
SINGLE
DOUBLE
1 μ sec/cm
10 ns/cm
(A) 139B


TO PIN P TIMING BOARD
TO PIN O TIMING BOARD
OUTPUT BOARD
INVERTER
+NORM
+INV
1μsec/cm
RAMP GENERATOR
+NORM RAMP RATE 6ns
+NORM RAMP RATE 1μsec
1μsec/cm
INV
NORM
NORM
INV
RISE
FALL
S205
POLARITY
S204
RAMP RATE/10V
OFFSET
R104 10K ZERO SET
R105 25K ΔO SET
POSITIVE AND NEGATIVE CONSTANT CURRENT SUPPLIES
CURRENT AMPLIFIER
AMPLITUDE CONTROL
R103 500 AMP SET
AMPLITUDE
2N2950
TO S206
Output Pulse
FROM +15V SUPPLY
FROM -15V SUPPLY
FROM -25V SUPPLY
FROM -30V SUPPLY
4
(A)
1398



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(A) 5 1398

CHANGE INFORMATION

The following types of changes are found in this Section:

Corrections–
changes due to errors in text or illustrations

Additions–
new text or new illustrations to supplement original manual

Revisions–
new text or new illustrations to up-date original manual

Options–
information on non-standard accessories or options available for this instrument

Modifications–
information on special features of a custom-designed instrument

CORRECTION Sections 1-4

Insert the attached change pages into the back of your E-H Model 139B Pulse Generator Manual.

CORRECTION Section 5

Remove the Section 5 in the Model 139B manual and replace with the attached Section 5.

CORRECTION Section 6

Remove the schematic drawings from Section 6 and replace with those attached.

CORRECTION-Section 1
Page Number 1-1

Section 1-2l should read:

l. Trigger Output. +1.5 V into 50 Ω. The trigger pulse width is continuously variable from 10 ns to 50 ns. Risetime of the trigger output pulse is 5 ns/v.

Page Number 1-2

Section 1-2m should read:

m. Double pulse Operation. A front-panel switch provides double pulse operation. Two identical pulses are generated, one at the beginning of the delay interval, the other at the end of the delay interval. Maximum repetition frequency for the double pulse operation is 20 MHz. Minimum spacing between the double output pulses is 50% of range width minimum or 15 ns, whichever is greater. Spacing between first and second pulse in the double pulse mode is determined by the setting of the delay controls.

CORRECTION-Section 2
Page Number 2-1

Section 2-3i should read:

i. RAMP RATE/10 V. Selects one of 12 output pulse risetime and falltime ranges. The risetime and falltime range limits are in a 1-2-10 sequence from 6 ns to 3 ms. The risetime and falltime of the output pulses have a constant dv/dt slope, independent of amplitude. The ramp-rate ranges state the risetime (falltime) from 10 to 90% of a 10 V pulse.

Page Number 2-2

Section 2-9s(2) second paragraph should read:
In the DOUBLE pulse mode, the maximum repetition frequency for the pulse pairs is 20 MHz. Time separation between the pulses should not be less than 50% of the pulse width or 15 ns, whichever is greater. This time separation limit applies not only to the interval between the first and second pulse, but also to the interval between the second and the first pulse when the second pulse is delayed out near the end of the repetition frequency period.

Page Number 2-3

Section 2-6a (3) should read:

(3) Two 50 Ω terminations, BNC to BNC.

CORRECTION-Section 3
Page Number 3-1

Section 3-2d should read:

d. The pulse width multivibrator defines a time interval in the pulse train beginning at the end of the delay interval. Depending on the POLARITY, the pulse width interval can define the OUTPUT pulse width, or the interval between the OUTPUT pulses.

Page Number 3-6

Section 3-4b should read:

b. Trigger Generator. The trigger generator provides a +1.5 V output pulse at the TRIGGER OUTPUT connector at the beginning of the pulse train in all modes of operation. The trigger multivibrator is a variable-width emitter-coupled one-shot, made up of Q17 and Q18. The emitter follower, Q19, couples the trigger pulse to the TRIGGER OUTPUT connector through a 28 ns delay line. The purpose of the delay line is to make the delay between the leading edge of the trigger pulse and the leading edge of the output pulse less than 10 ns when the minimum delay is selected.

Page Number 3-7

Section 3-4f fourth paragraph should read:

The voltage across R4 at the input to the diode current-steering network in the quiescent condition is 0 V, switching to +1.5 V during the astable period of the width multivibrator, the voltage across R3 in the quiescent condition is +1.5 V, switching to 0 V during the astable period of the width multivibrator.

Page Number 3-8

Section 3-4f fourth paragraph should read:

In all modes of operation, the output of the complementary emitter followers, Q3 and Q4, switch the input to the current-steering bridge between -12 V and -20 V. When the output of the complementary emitter followers is at -13 V, current from the negative ramp-current source, Q8, is conducted through CR14, L4, and Q3 to ground. CR12 and CR15 are back-biased, and the positive ramp current source charges the ramp-rate capacitor through CR13 to one junction drop more positive than the -15 V supply. When the ramp-rate capacitor reaches a voltage positive enough to forward bias CR17, CR17 provides the current for the positive ramp-current source, and the voltage across the ramp-rate capacitor remains constant until the complimentary emitter followers switch the current-steering bridge in the other direction.

When the output of the complementary emitter followers is at -19 V, current to the positive ramp-current source is conducted from the -25 V supply through Q4, L4, and CR12. CR13 and CR14 are back-biased, and the negative ramp-current source charges the ramp-rate capacitor through CR15 to one junction drop more negative than the amplitude clamp bus. When the ramp-rate capacitor reaches a voltage negative enough to forward bias CR16, CR16 provides the current for the negative ramp-current source and the voltage across the ramp-rate capacitor remains constant until the complementary emitter followers again switch the current-steering bridge. See Figure 3-4.

CORRECTION-Section 4
Page Number 4-3

Section 4-3k(2) should read:

(2) Apply a 10 ns, fast risetime, +1.5 V pulse to the EXT DRIVE INPUT. Check for clean triggering to 50 MHz. (The 139B Trigger output width should be reduced to the minimum)..

Page Number 4-4

Section 4-4d (3) should read:

(3) Check all positions of the FREQ. RANGE switch and both extremes of the FINE (FREQ. RANGE) control. The FINE control should smoothly cover the full range selected by the FREQ. RANGE switch with overlap into the two adjacent ranges. See Performance Verification. Change Q6 (on the output board) if there are pulse-top oscillations at 50 MHz repetition frequency.

Page Number 4-5

Section 4-4g should read:

g. Check WIDTH and FINE (WIDTH). See paragraph d. of the Performance Verification. If the two shortest DELAY ranges oscillate, exchange or replace Q13 and Q14.

modifications

E-H MODIFICATION KIT 350-18666

file code: 6-18666-A

February 1971

APPLIES TO: Model 139B Pulse Generators serial number 782432 and below

PURPOSE: Original output transistor type is no longer available. If output transistor Q11 is replaced, a substitute type is used and minor circuit changes are required.

COMPONENTS REQUIRED: E-H Modification Kit 350-18666

MODIFICATION PROCEDURE:

1. Turn off instrument power switch and disconnect power cable.

2. Remove top and bottom covers.

3. On the component side of the output board, remove and discard Q9 and Q11. See Figure 1.

4. Remove and discard L6 and R37. Replace R37 with a short jumper, insulated with sleeving.

5. Replace CR11 with 1N749A supplied in modification kit.

6. Replace CR18 with diode, part number 376-11764, supplied in kit. Last five digits of part number are marked on the glass body of the diode.

7. Replace CR17 with diode, part number 376-11742, supplied in kit. Part number is marked on diode.

8. Unsolder cathode end of CR16 and raise at an angle from the board. Connect diode, part number 376-11764, in series "tepee" fashion. Cathode lead of added diode is soldered to circuit board and anode lead is soldered to cathode lead of CR16. Use shortest leads possible.

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9. Replace R26 with 240 ohm, 1 watt resistor supplied in kit.

10. Replace Q9 with transistor, MPS 2369, supplied in kit.

11. Replace Q11 with transistor, MM 4019, supplied in kit. Using diagonal cutting pliers, clip off a corner of the heat sink to clear the case of Q8.

12. On the circuit side of the output board connect 12 ohm, 1/4 watt resistor and 150 pF capacitor (supplied in kit) in series from the base of Q10 to the −25 V bus. See Figure 2. Cut leads as short as possible.

13. On the Power Supply Regulator Board, replace R21 with 1.3 K, 1/2 watt resistor supplied in kit. Refer to Figure 6-2 of the Model 139B instruction manual. This completes the modification.

ADJUSTMENT PROCEDURE:

Perform the calibration procedure given in paragraph 4-4 of the Model 139B instruction manual.

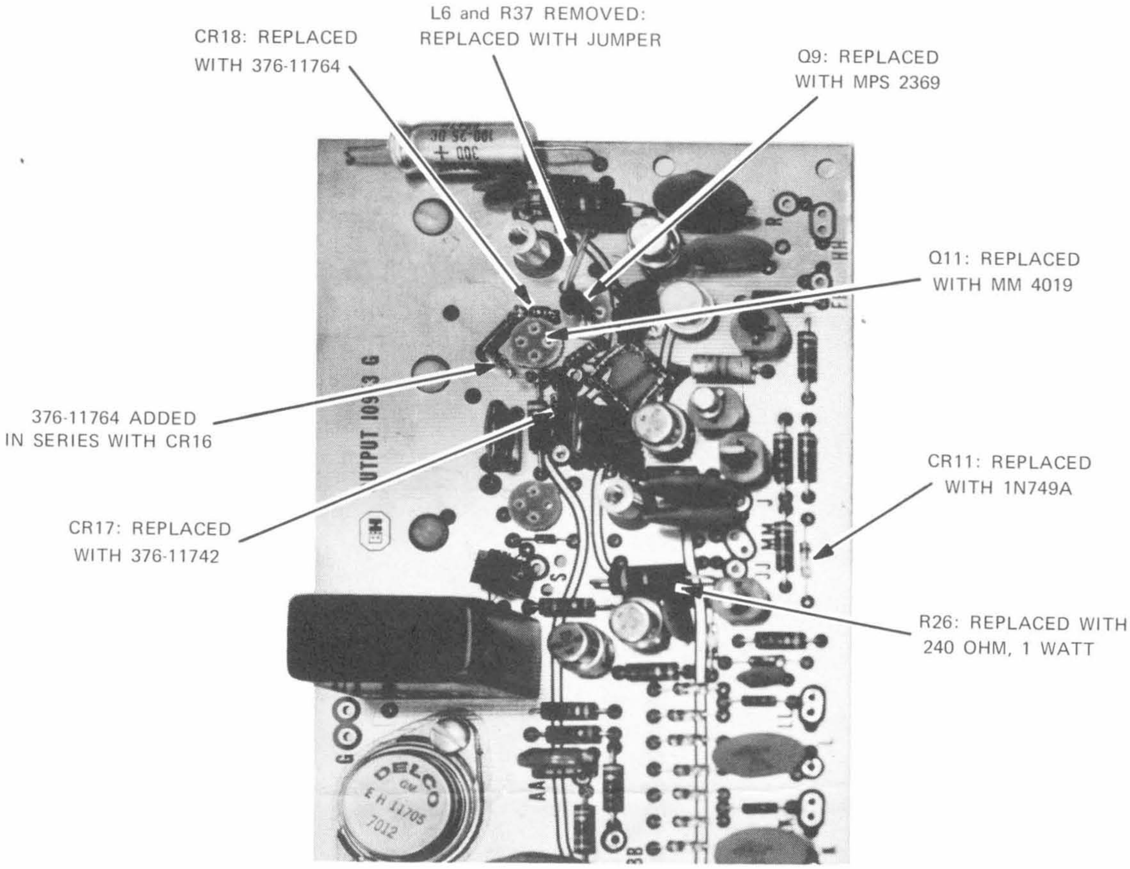

Figure 1. Output Board, Component Side (After Modification)

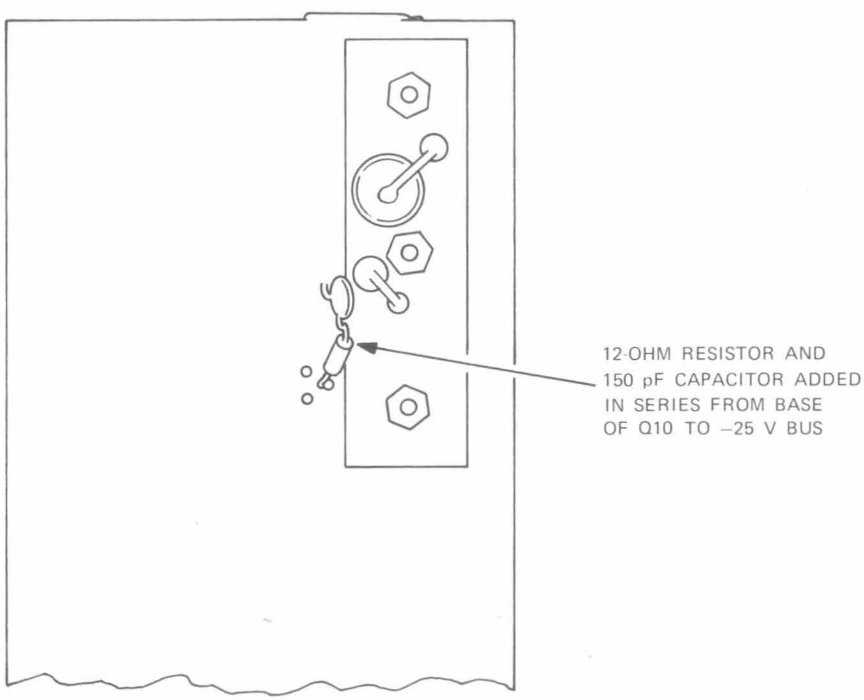

Figure 2. Output Board, Circuit Side