INSTRUCTION MANUAL

Serial Number ____________

26G1

RATE/RAMP GENERATOR

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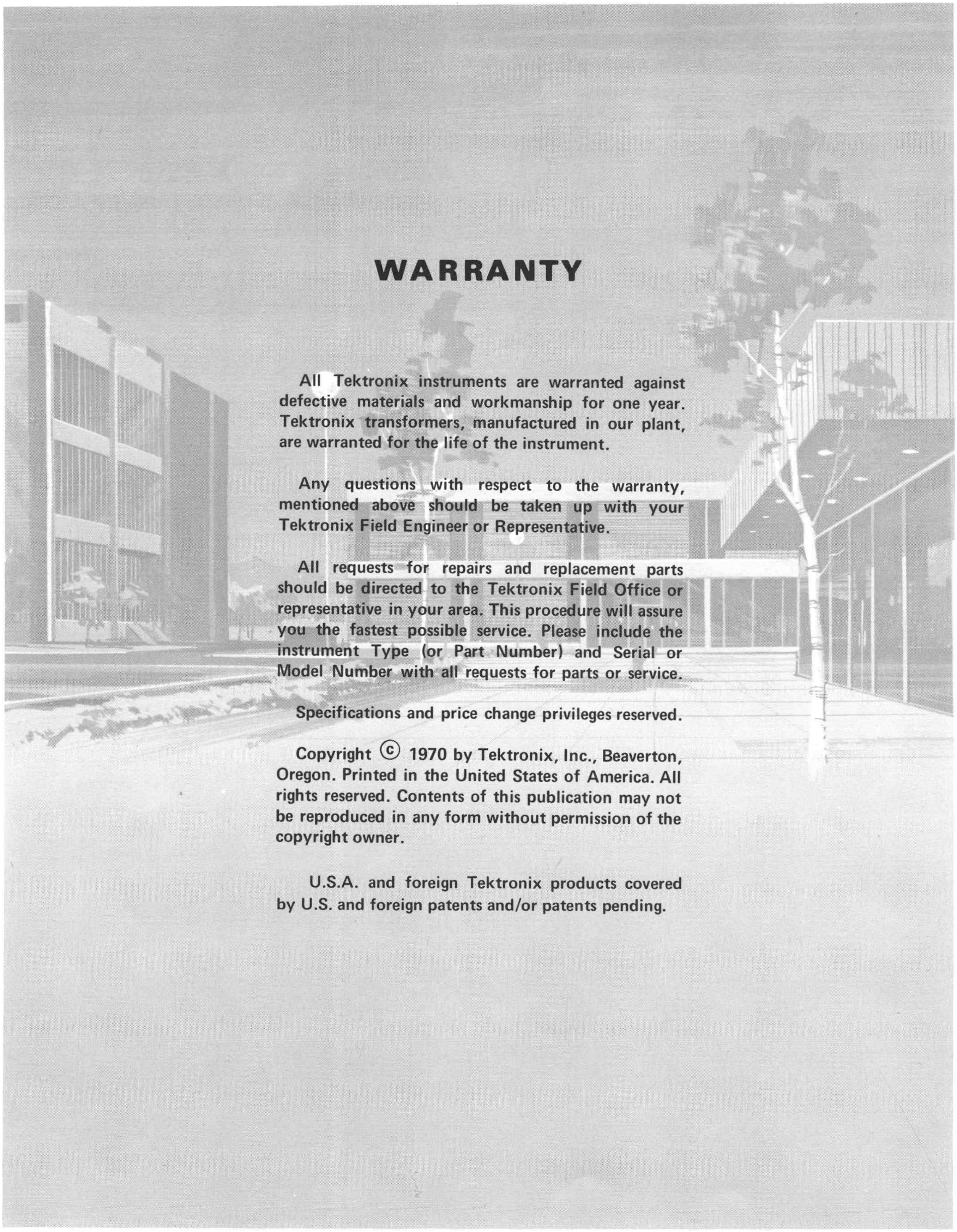

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CHANGE INFORMATION

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

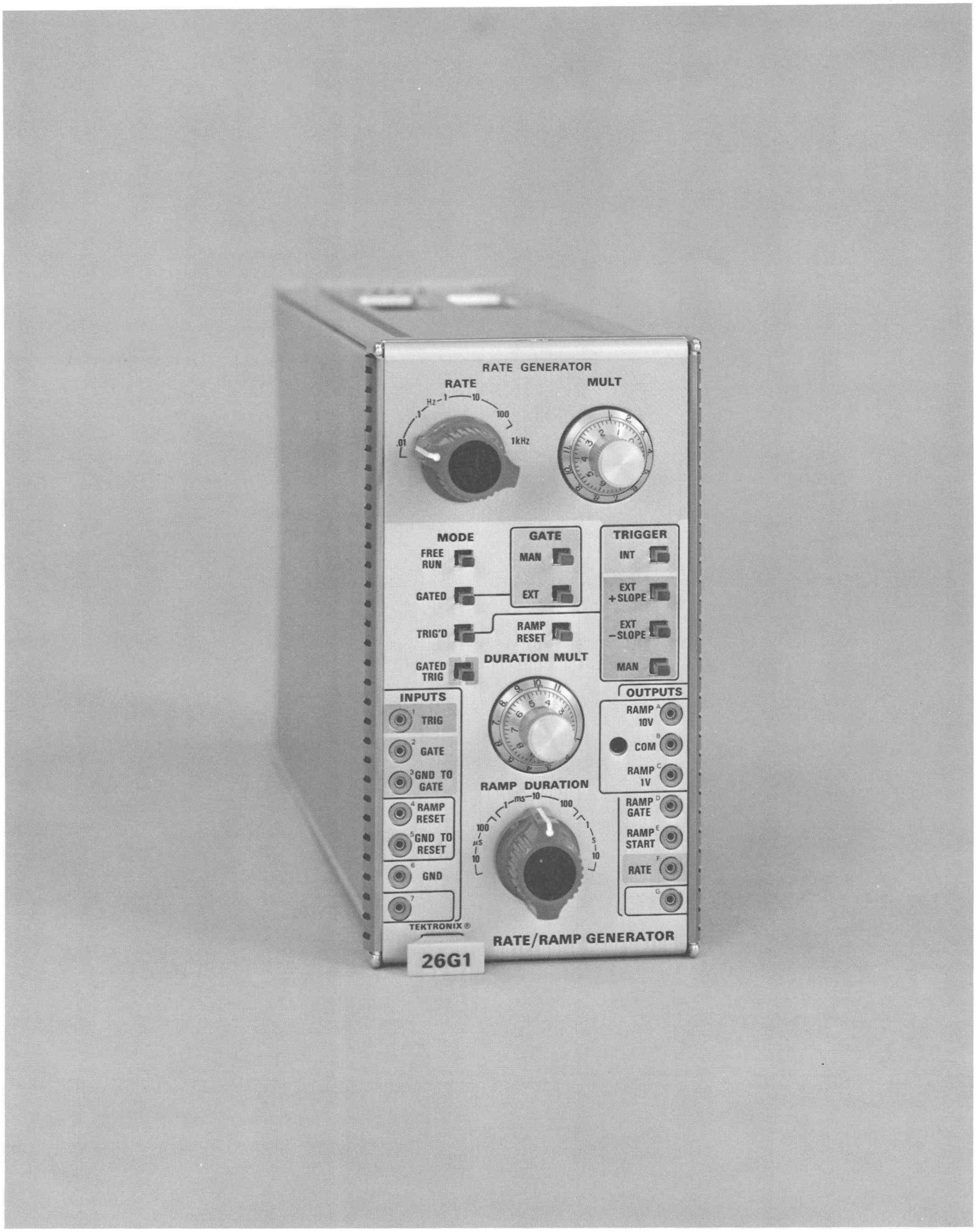

Fig. 1-1. 26G1 RATE/RAMP Generator.

SECTION 1
26G1 SPECIFICATION

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

The 26G1 is a rate and ramp generator plug-in unit designed for use with 2600-Series Mainframes. The major output is a precise voltage ramp. The ramp duration is set by two calibrated front-panel controls (RAMP DURATION and DURATION MULTiplier).

The ramp may be triggered by the calibrated RATE Generator, triggered externally, gated, or triggered during gate.

When used with a 26G3 Pulse Generator, the 26G1 can be used as a time-delay generator.

All front-panel signals are available at the rear-interface connector for patching to other plug-in units.

The 26G1 will perform to the specifications listed in this section within an ambient temperature range between 0°C and +50°C, except as indicated. No warmup time is required. The performance check instructions, Section 5, provide a convenient means of checking the performance of the 26G1.

Electrical Characteristics

RAMP DURATION

Characteristic	Performance Requirement
Ramp Rate Accuracy	
10 µs to 1 s	Within 2% and 20 mV of indicated Amplitude/Time from 0.5 V to 9.9 V for 10 V ramp and 0.05 V to 0.99 V for 1 V ramp.
10 s	Within 4.5% and 20 mV of indicated Amplitude/Time from 0.5 V to 9.9 V for 10 V ramp and 0.05 V to 0.99 V for 1 V ramp.

RATE GENERATOR

Characteristic	Performance Requirement
Accuracy	
1 kHz to .1 Hz	Within 3%
.01 Hz	Within 5%

OUTPUTS

Characteristic	Performance Requirements	Supplemental Information
Ramp, 10 V (A)		
Amplitude		
100 µs to 10 s	+10.0 V, within 0.05 V	
10 µs	+10.0 V, within +0.25 V, −0.05 V	
DC Level between Ramps	0 V, within 20 mV	
Typical Short Circuit current		33 mA
Driving Capability		3 kΩ or greater, and 300 pF or less
Ramp 1 V (C)		
Amplitude		
100 µs to 10 s	+1.0 V, within 0.01 V	
10 µs	+1.0 V, within +0.03 V, −0.01 V	
DC Level between Ramps		0 V, within 5 mV
Source Impedance		50 Ω, within 1%
Ramp Gate (D)		
Amplitude	+3 V, within 20 %	
Off State		0 V, within 100 mV
Source Impedance		150 Ω, within 5%
Risetime, Falltime		100 ns or less, measured at 10% to 90% amplitude points

Characteristic	Performance Requirements	Supplemental Information
Ramp Start (E)		
Amplitude	+3 V, within 20%	
Off State		0 V, within 100 mV
Source Impedance		150 Ω, within 5%
Risetime		100 ns or less, measured at 10% to 90% amplitude points
Width (50% amplitude)		1.5 μs, within 30%
Rate (F)		
Amplitude	+3 V, within 20%	
Off State		0 V, within 100 mV
Source Impedance		150 Ω, within 5%
Risetime		100 ns or less, measured at 10% to 90% amplitude points
Width (50% amplitude)		1.5 μs, within 30%

INPUTS

Characteristic	Performance Requirements	Supplemental Information
Trigger (1)		
Triggering Amplitude V_{on}[1]	At least +1 V (−1 V with internal connector change)	
Non-Function Level V_{off}[1]		+0.4 V or less (−0.4 V with internal connector change)
Maximum Safe Input		15 V (DC + Peak AC)
Minimum On Time		250 ns
Input Resistance		10 kΩ, within 10%

[1] See Fig. 1-2 for Input Ranges.

Characteristic	Performance Requirements	Supplemental Information
Gate (2)		
Gating Amplitude V_{on}[1]	At least +1 V	
Non-Function Level V_{off}[1]		+0.4 V or less
Maximum Safe Input		15 V (DC + Peak AC)
Input Resistance		5 kΩ or greater
Ground to Gate (3)		
Function Range	+0.4 V to 0 V	
Open Circuit Voltage		+5 V or less
Minimum Down Time		250 ns
Current Output		1.25 mA or less
Minimum Sensing Resistance		320 Ω
Maximum Safe Input		15 V (DC + Peak AC)
Ramp Reset (4)		
Function Amplitude V_{on}[1]	At least +1 V	
Non-Function Level V_{off}[1]		+0.4 V or less
Minimum On Time		250 ns
Maximum Safe Input		15 V (DC + Peak AC)
Input Resistance		5 kΩ or greater
Ground to Reset (5)		
Function Range	+0.4 V to 0 V	
Open Circuit Voltage		+3 V or less
Minimum Down Time		250 ns
Current Output		1.25 mA or less
Maximum Sensing Resistance		320 Ω
Maximum Safe Input		15 V (DC + Peak AC)

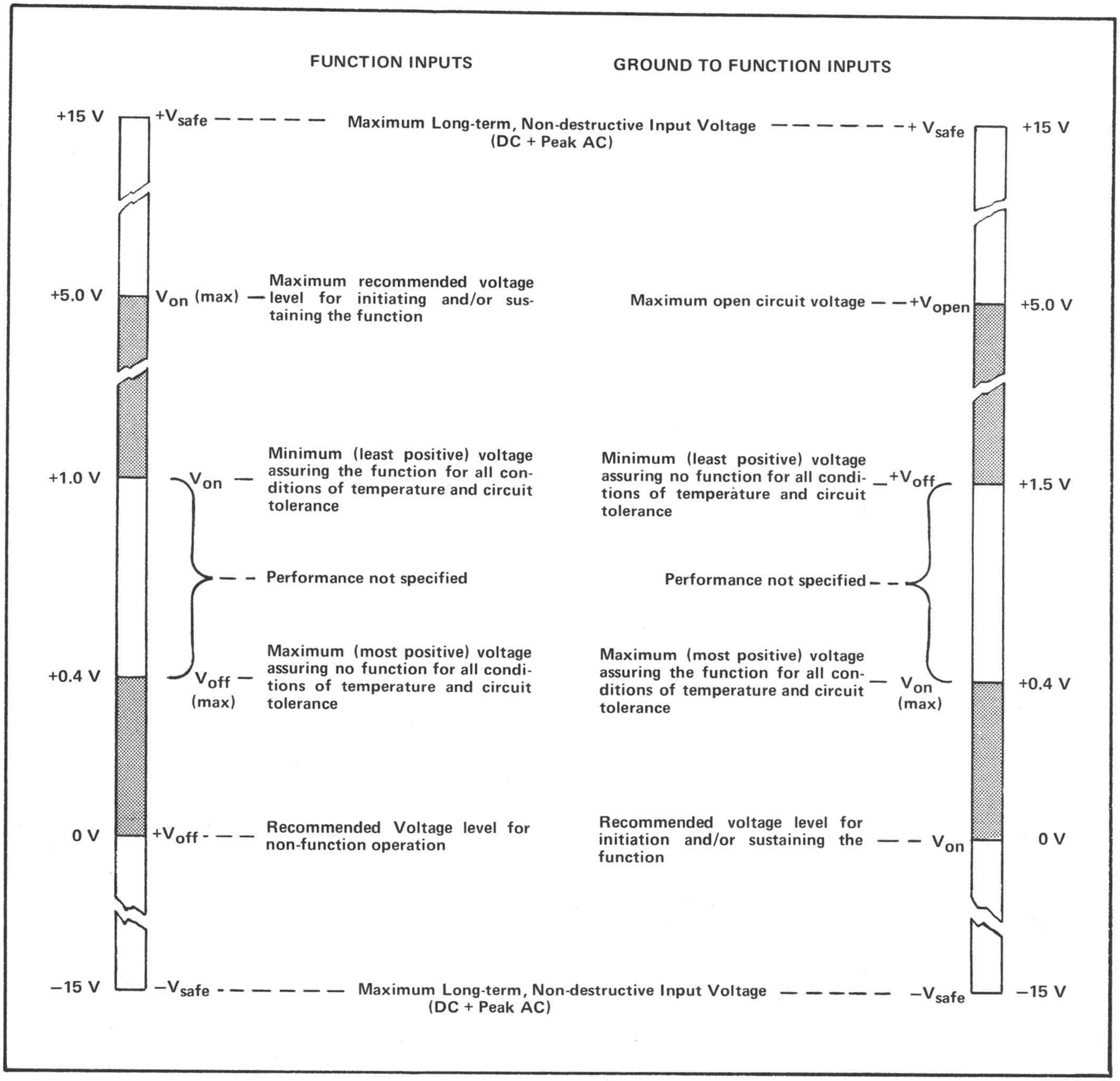

Fig. 1-2. Input Function levels.

Accessories

An illustrated list of Standard and Optional accessories for the 26G1 will be found at the end of the Mechanical Parts List pullout pages.

NOTE

The pins, jacks and cables supplied to interconnect 2600-System modules are based upon a standard 40-mil (0.040 inch or ≈ 1 mm) pin diameter. These items are manufactured by Cambion (Cambridge Thermionic Corp.) and others. Allied Radio Shack catalogs the basic elements of this 40-mil system.

NOTES

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

The 26G1 RATE/RAMP Generator unit is one of a series of plug-in modules and mainframes in the 2600 system. The 26G1 and other units in the series may also be plugged into 7000-Series Oscilloscopes, using an adapter.

To use the 26G1 effectively, the operation and capabilities of the instrument should be understood. This section describes the functions and features of the controls and connectors.

Installation

The 26G1 is designed to operate in any one of the plug-in compartments in the 2600-Series mainframes. To install the 26G1 into the mainframe, align the bottom groove of the 26G1 with the plastic guide bar in the mainframe. Push the 26G1 into the opening until the front panel is flush with the front of the mainframe. To remove the 26G1, pull the release latch to disengage the unit from the mainframe connector. Continue to pull the release latch to remove the unit from the mainframe.

CONTROLS

A description of the function and operation of controls and connectors follows.

The switches used for selecting the various functions are miniature illuminated pushbuttons. The buttons are mechanically interlocked so that only one button may be depressed at one time (except that RAMP RESET is not interlocked to other buttons). Each button is illuminated from behind when the button is pushed in.

MODE Selector

FREE RUN—Provides generation of recurrent ramps at the RAMP 10 V and RAMP 1 V OUTPUTS. Does not depend on external signals or the RATE Generator to initiate the ramps.

GATED—Provides generation of recurrent ramps for the duration of a gate signal.

MAN—Pushing the MAN (manual) button provides one or more ramps for the period the button is held, but always allows completion of the ramp in progress when the button is released.

EXT—Provides recurrent ramps for the duration of at least a +1-volt gating signal applied to GATE INPUT connector. The last ramp completes after gate is removed.

TRIG'D—Pushing the TRIG'D button provides four possible modes of triggering: Internal, Ext +Slope, Ext —Slope, and Manual.

INTernal—A trigger signal from the RATE Generator triggers the ramp generator when the INT button is pushed. In this mode, the RATE generator determines how often the Ramp Generator runs. For example, the RAMP Generator will produce a ramp out each time a trigger arrives from the RATE Generator (provided that the reciprocal of the RATE is equal to or greater than the RAMP duration). If the RAMP DURATION control is set at 100 ms, and the RATE Generator control is set at .1 Hz, a 100 ms ramp will be generated every 10 seconds.

EXT +SLOPE—A positive-going, positive-level (above ground level)[1] trigger signal of 1 volt applied to the TRIG INPUT will initiate ramp generation when this button is pushed.

EXT —SLOPE—A negative-going, positive-level[1] trigger signal of 1 volt applied to the TRIG INPUT will initiate ramp generation when this button is pushed.

MAN—Applies a single trigger to the Ramp Generator each time the MAN button is pushed.

[1]Internal connector (P11-1, 2, 3) permits a negative level (below ground) signal to initiate ramp generation. When connected arrow to arrow, a positive level signal will initiate ramp generation; and when reversed, a negative level signal will initiate ramp generation. See Fig. 2-1.

GATED TRIGger—Provides ramp generation at a rate determined by the trigger signal applied to the TRIG INPUT, and for time determined by the duration of the signal applied to the GATE INPUT.

RAMP RESET—Pushing this button terminates the ramp generation cycle in progress and resets the circuit for generation of a new cycle. This can be a convenience when working with long duration ramps.

RAMP DURATION—Selects calibrated ramp durations from 10 μs to 10 s in decade steps.

DURATION MULTiplier—Provides continuously variable calibrated ramp duration from 1.00 to 11.00 times the duration selected by the RAMP DURATION Selector.

RATE GENERATOR

RATE—Selects calibrated rates for .01 Hz to 1 kHz in decade steps.

RATE MULTiplier—Provides calibrated, continously variable rates from 1.00 to 11.00 times the RATE setting.

CONNECTORS

NOTE

The trigger and gate levels of the 26G1, both input and output, are compatible with the logic levels used in most DTL and TTL logic devices.

INPUTS

TRIG (1)—A 1-volt pulse connected to this input (in TRIG'D MODE) initiates a ramp generation cycle.

GATE (2)—External gate signal input connector, requires a positive-going 1-volt signal to start ramp.

GND TO GATE (3)—Ground, a signal of +0.4 V or less, or 320 Ω (to ground) connected to this connector (with MODE switch in GATED or GATED TRIG) produces the same result as a positive-going 1-volt signal applied to GATE INPUT.

NOTE

The GATE and GROUND TO GATE INPUTS can also serve to gate the RATE GENERATOR. Position of the Modification Point Connector, P9 (Fig. 2-1) determines the circuit function. The circuit functions, relative to the positions of the connector, are discussed below.

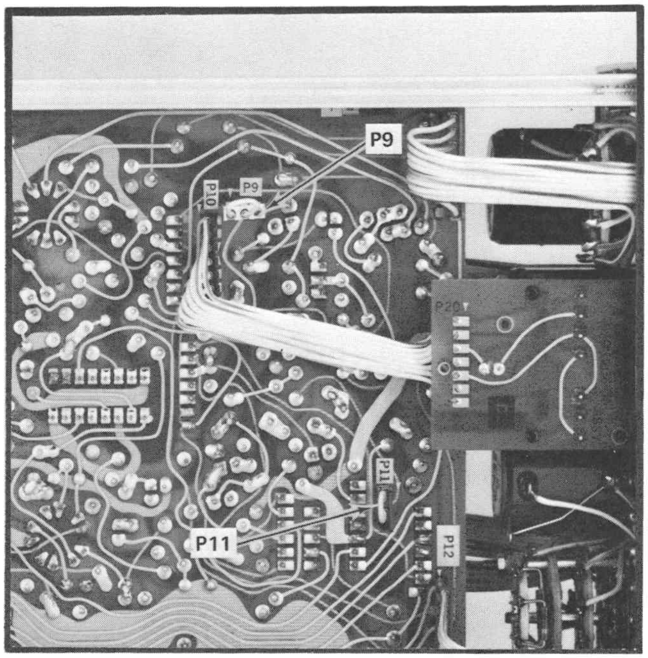

Fig. 2-1. Location of Modification Points, P9 and P11.

Connector Arrows Aligned

RAMP Generator triggered by RATE Generator with MODE switch in TRIG'D INT. RATE Generator free runs at RATE setting and provides a pulse out at RATE (F).

Connector Arrows Not Aligned

GATED Button not pushed

MAN—RATE (only) Generator runs at RATE settings as long as MAN button is pressed. Provides Rate Pulse out at RATE (F).

EXT—RATE (only) Generator runs at RATE setting when gated by an external gating signal applied to GATE or GND TO GATE INPUT.

GATED Button Pushed

MAN—RATE and RAMP Generators run at their respective settings as long as MAN button is pressed. Rate Pulse out at RATE (F) and Ramp Out at RAMP 10 V (A) and RAMP 1 V (C).

EXT—RAMP and RATE Generators run at their respective settings when gated by signal applied to GATE INPUT or GND TO GATE. Rate Pulse out at RATE (F) and Ramp out at RAMP 10 V (A) and RAMP 1 V (C).

RAMP RESET (4)—External positive-going 1-volt signal terminates a ramp at any time during its runup.

GND TO RESET (5)—Ground, a signal of +0.4 V or less, or 320 Ω to ground, connected to this connector terminates a ramp at any time during its runup.

GND (6)—Reference ground for all INPUT connectors.

OUTPUTS

RAMP 10 V (A)—Output of the RAMP Generator. Ramp starts at zero potential, rising linearly to +10 V. Ramp duration is a function of the setting of RAMP DURATION and DURATION MULTiplier control settings.

COM (B)—Reference ground for the RAMP OUTPUT connectors. The ground return for R148 (COM, B) and R136 is connected directly to pin 3, U110, thus assuring a ground return free of any currents other than Ramp current.

RAMP 1 V (C)—Output of the RAMP Generator. Ramp starts at zero potential, rising linearly to +1 V. Ramp duration is a function of the RAMP DURATION and DURATION MULTiplier control settings.

RAMP GATE (D)—Zero to +3-volt step having the same time duration as the output ramp. The positive step is coincident with the start of the ramp, and remains at the high state until the ramp terminates.

RAMP START (E)—Zero to +3-volt, 1.5 μs trigger pulse coincident with the start of the ramp.

RATE (F)—Zero to +3-volt, 1.5 μs trigger pulse from the RATE Generator. This pulse is used internally (Internal Trig Mode) to trigger the RAMP Generator.

Spare (G)—Spare connector is bused through to the rear connector, A8, and appears on a test point, TP150 (see Fig. 2-2).

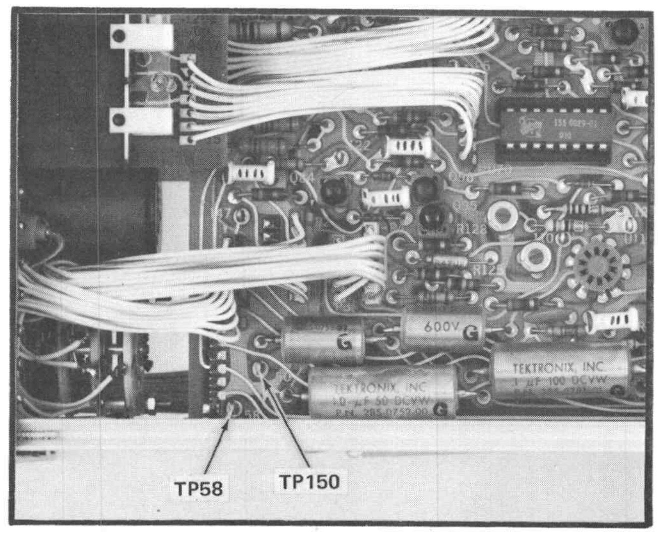

Fig. 2-2. Location of TP 58 and TP 150.

NOTES

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

This section of the manual contains a description of the circuits in the 26G1.

Simplified drawings are provided where necessary for easier circuit understanding. Complete schematic diagrams are included in the Diagram section. These should be referred to throughout the detailed circuit description.

Symbols used on the schematic diagrams are explained on the first foldout diagram in the Schematic Diagram section.

RATE GENERATOR

The Rate Generator in the 26G1 provides an internal trigger for the Master Ramp Generator.

Essentially, the Rate Generator is a free-running ramp generator having a very fast recovery after ramp time (recovery is approximately 1% of the runup time).

The Rate Generator uses the Tektronix Type 155-0028-00 Miller integrator, U10, using the signal from pin 4 as an "end of ramp" termination. When the output ramp reaches the voltage set at pin 6 (by R2), a voltage comparator in U10 causes the level at pin 4 to step positive.

The positive step from pin 4 turns on Q24-Q26, which functions as a Silicon-controlled switch (SCS).

The timing capacitor, C30A through E, switched in between pins 8 and 9, discharges through R23 at a rate determined by R23 and the timing capacitor selected. When the discharge current reaches a low enough level, Q24-Q26 turn off. Immediately following Q24-Q26 turnoff, the ramp runup again starts.

Since the recovery time is so short, the ramp duration is essentially the reciprocal of the ramp rate. The small error due to recovery time may be calibrated out by the two controls, Rate Cal X10 and Rate Cal X1.

Q10 has the ability to lock out the end of ramp information (pin 4) by applying the appropriate logic level to pin 5. Normally, Q10 is turned off and the logic level (current) at pin 4 is up (logic 1). Moving the strap at the modification point, P9, 2-3 (Fig. 3-1) to connect Q10 base to Q55 collector (Q55 is turned off under no-signal conditions), Q10 turns on, which holds pin 4 at a logic 0 and all end of ramp information is locked out. With end of ramp information locked out, the ramp runs up and locks up at the top of its excursion (slightly above 10 volts).

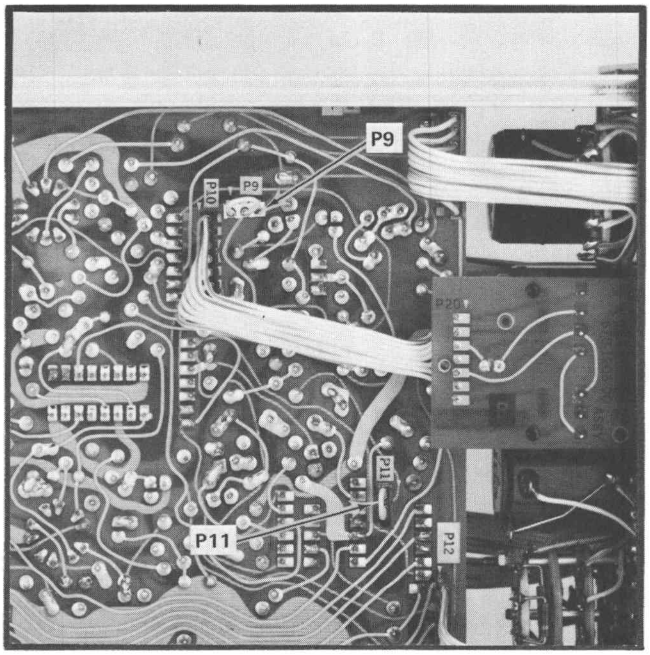

Fig. 3-1. Location of Modification Points, P9 and P11.

When a Gate signal is introduced through the GATE input, whether it be a +GATE, GND TO GATE or MANUAL, Q10 will turn off and the RATE Generator will reset and run up normally. Holding the MANual button depressed will allow the RATE Generator to free run.

Grounding the GND TO GATE connector will also cause the RATE Generator to free run.

Timing

A common timing resistor, R30, is used for five of the timing ranges (0.1 Hz through 1 kHz). The remaining range, 0.01 Hz, changes the value of the timing resistor by a factor of 10 (reduces charging current by a factor of 10).

Five capacitors, C30B through E, are used for the five ranges, .1 Hz through 1 kHz. C30A is used on the ranges 0.01 Hz and 0.1 Hz.

RATE Pulse Out

When Q24-Q26 latches, a negative voltage step is coupled to Q48 base. Q48 turns on and emitter coupling via C42 turns off Q40, holding Q48 on. Q40 emitter voltage then starts to rise toward the +15-volt supply at a rate determined by C42-R42. Q40 again turns on, turning off Q48. The result is a step output signal having an amplitude of +3 volts and a time duration of 1.5 μs. The output resistance is 150 Ω.

The RATE pulse is available on the front panel at connector F, on the 38-pin connector, B10, and at the Trigger Selector switch (S75) on connectors P5-1 and P15-1.

RAMP GENERATOR

General

The Ramp Generator produces three waveforms at the output terminals; a linear sawtooth, a rectangular gate, and a trigger pulse.

The Ramp Generator consists of two integrated circuits; Sweep Logic, U70, and Miller Integrator, U110, and their associated discrete circuit components. The primary functions of these components are Trigger Slope Selection, Trigger Mode Selection, Timing, Holdoff, and Reset.

Table 3-1 discusses each terminal on integrated circuit, U70, and its function. All terminals are digital unless otherwise noted, and positive logic is employed.

TABLE 3-1

Sweep Logic U70

Terminal	Function
1, Reset	Current (logic 1) for at least 20 ns ends ramp, regardless how far the ramp has run up. No input (logic 0) allows U70 to operate.
2, Ext Trig	Gating logic (with pin 10, Lockout). See Table 3-2.
3, Ground	Circuit ground.
4, Trigger Input	Analog input, low impedance. Accepts analog current trigger signal. Trigger threshold: Zero current, ±100 μA.
5, Slope Select	Logic 1 permits trigger to be initiated on the positive slope of a trigger signal. Logic 0 permits trigger to be initiated on the negative slope of a trigger signal.
6, Not used	Held at logic 1.
7, Not used	Held at logic 0.
8, GND, substrate	Reference ground.
9, Not used	Held at logic 0.
10, Lockout	Gating logic 1 (with pin 2 at logic 1) locks out ramp start. See Table 3-2.
11, Holdoff timing	Connects timing components which set trigger lockout period after end of ramp. Holdoff capacitor discharges when ramp starts, and Holdoff timing starts at end of ramp as holdoff capacitor charges. When holdoff capacitor charges to upper threshold, a new ramp can be started.
12, Not used	Held at logic 0.
13, Not used	Held at logic 1.
14, +Gate Out	Provides a +5-volt source through R105 (logic 1) during ramp runup, driving current into pin 1, U110, Logic 0 ends ramp.
15, Not used	Open.
16, Power Supply	+5 volts.

TABLE 3-2

Mode	Logic State Pin 2	Logic State Pin 10	Trig Signal Pin 4	Output of U70 & U110 in combination
Free Run	1	0		Free Running ramp
Gated	1	1		Locked out-No ramp
W/Gate in	1	0		Free runs for duration of gate.
Gated Trig	0	1		No ramp
W/Gate in	0	0		No ramp
W/Gate & Trig in	0	0	Trig in	Single ramp for each Trig with Gate
Trig'd	0	0		No ramp
	0	0	Trig in	Single ramp for each Trigger

Triggering

The trigger circuit, Q84 and associated circuitry, provides current drive to pin 4, U70.

The Trigger Input, Pin 4, has a hysteresis of about 0.2 mV, centered about zero current.

R85, connected to the −15 volt supply, furnishes about 0.6 mA into pin 4 (with no trigger signal), holding the current level away from the trigger threshold.

If a 0.7 volt positive pulse is applied to Q84 base, about 0.7 mA will be diverted (0.7 volt across R84) from pin 4, reducing the current level into the triggered range of U70. U70 will be triggered, therefore, only when the base of Q84, Trigger Signal In, rises to about 0.7 volt positive.

If minus level triggering is desired, the strap at the modification point (Fig. 3-1), P11-1, P11-2, may be moved to the P11-2, P11-3 position.

For minus level triggering, R86 and R87 (to +5 volts) are connected to pin 4, pulling about 1.4 mA out of pin 4, biasing pin 4 at about 0.7 mA positive, and holding the current level away from the 100 μA threshold.

To get into the hysteresis range of pin 4, the 0.7 mA positive bias must be cancelled. A negative-going 0.7 volt signal applied to Trig In diverts current into pin 4, reducing the current level to the trigger threshold.

Voltages in excess of the required 0.7 volt signal level may be tolerated (up to about 15 volts) with no harm to the circuit.

If a large positive voltage is applied to the Trig Input, CR80 turns on, bypassing Q84, increasing the current into pin 4, which can accept up to 15 mA.

In the negative direction, Q84 emitter follows the signal, and will cause no damage up to the dissipation rating limits of R84 (15 volts across R84).

CR83 disconnects Q84 collector from the −15 volt supply if the signal goes too far negative.

Slope Selection

U70 uses only one trigger input, and has the ability to select which slope turns the gate on, a logic 0 or logic 1. Pushing EXT +SLOPE button gives a logic 1 on pin 5, allowing triggering to take place on the positive slope of the triggering signal. Pushing the EXT −SLOPE button gives a logic 0 on pin 5, allowing triggering to take place on the negative slope of the triggering signal.

Reset

If pin 1, U70, is made positive (logic 1) the ramp is terminated, regardless of how far the ramp has run up.

A positive-going signal at RAMP RESET turns Q95 on, which turns Q96 off, applying a logic 1 to pin 1, resetting the output ramp, (U110, pin 8) to zero volts.

Pushing the RAMP RESET button turns Q96 off, applying a logic 1 to pin 1, resetting the output ramp to zero.

A ground (or any source which drops to less than 0.4 volt) at GND TO RESET turns off Q96, applying a logic 1 to pin 1, resetting the output ramp to zero.

Ramp reset initiation may be accomplished very rapidly (typically less than a few hundred nanoseconds) so that the ramp may be accurately terminated through an external logic system.

+GATE Out

The output ramp (pin 8, U110) is initiated by a gate from pin 14, U70, through R104, into pin 1, U110.

Ramp Generator

The Ramp Generator portion of U110 is an operational amplifier using the timing capacitor as the feedback element. Table 3-3 discusses each integrated circuit terminal and its function.

TABLE 3-3

Miller Integrator, U110

Terminal	Function
1, Sweep Gate In	Current into pin 1 results in a linear voltage ramp at pin 8.
2, Oscillation Suppressor	Connects discrete components to prevent oscillation of the integrator.
3, Ground	Provides a reference ground for the RAMP outputs and Power return, +15-volts and −13 mA (from −15 volt supply through R108).
4, Dl'yd Gate Out	Provides reset logic to pin 1, U70, when output level on pin 8 reaches the level set on pin 6 by R101.
5, Not used	Held at logic 1.
6, Ramp Length	Provides the DC reference level for the internal comparator to set up "end of ramp" logic.
7, Power Supply	+15 volts.
8, Output	Produces a linear voltage ramp out when current is gated into pin 1. Ramp is positive-going with an amplitude of approximately 0 to 9 volts.
9, Timing Current Summing node	Connects timing components which determine the ramp rate.
10, Substrate	≈−13 mA from R108.

The ramp start level is set by a logic 0 on U110, pin 1, short circuiting the timing capacitor, pins 8 and 9.

A logic 1 on pin 1 removes the shunt from pins 8 and 9, allowing the timing capacitor to charge through the timing resistor, allowing the output, pin 8 to rise linearly.

When the output ramp reaches the level set at pin 6, U110 by R101, DC comparator in U110 causes the ramp to reset. A gate signal from pin 4, U110, resets U70 via pin 1, removing the clamp from the holdoff timing capacitor (connected to pin 11, U70). When the voltage at pin 11, U70 reaches approximately 3 volts, conditions are set to again accept a signal to restart the ramp.

The timing circuit uses a common resistor, R123, for all but the 10 second ramp, which uses R120 and R121.

Ramp Duration times 1 (X1) calibrates the X1 end of the DURATION MULT and Ramp Duration times 11 (X11) calibrates the X11 end (Calibrate at X10).

R127, R128 and the +15 and −15-volt supplies provide current through the voltage drop across R126 may be adjusted to any value of offset at pin 9 (potential and polarity). Adjusting R128, (Mult Linearity) to set the potential at TP125 equal to that at TP110 (with TP122 shorted to ground) maintains linearity over the full X1 to X11 range of the DURATION MULT, R122. (Before shorting TP122 to ground, the DURATION MULT, R122, must be set to 5.00 to pervent shorting the −15-volt supply).

Ramp Out (pin 8)

The output ramp (at pin 8, U110) starts at about 0 volts and rises to about 9 volts. The 9-volt ramp is fed into an operational (feedback) amplifier having a gain which is adjustable from 1 to about 1.3. The feedback amplifier, Q132B, Q140, and Q145 with the gain-setting resistor, R137 (adjustable feedback), set the gain at about 1.1 for an output to 10 volts. R130 and R131 provide a current which set the Ramp start to zero potential.

R145, CR143, and Q140 act as a current limit for the output. If the current through Q145 exceeds about 30 mA, CR143 turns on, stealing emitter current from Q140. Since Q145 base current is dependent on Q140 emitter current, any decrease in Q140 emitter current reduces Q145 base current, thus limiting output current.

RAMP 10 V

The RAMP 10 V output provides a 10-volt ramp output which is essentially a zero ohm voltage source. L147 minimizes any tendency to oscillate with reactive loads.

RAMP 1 V

The RAMP 1 V output provides a 1-volt ramp output with an output resistance of 50 ohms.

The common return for R148-R136 is connected directly to pin 3, U110, eliminating any AC or DC current other than output current directly between these points. This assures a zero reference, based on the potential at pin 3.

Other Output Signals

The +Gate from pin 14, U70, provides a Ramp Running indication, a Gate Out and a Trigger Out.

The Ramp Output (Ramp Running) indicator lamp circuit provides switching logic to indicate that a ramp is either running up or has just ended.

The indicator lamp circuit is a monostable multi having a minimum on time of approximately 100 ms. It indicates for even the shortest ramp duration. If the ramp duration is longer than 100 ms, the lamp indicates 100 ms beyond the end of the ramp.

A positive gate from pin 14 (U70) turns on Q162 and Q190, which holds the collector of Q190 negative, quickly discharging C192 (within approximately 1 μs). Q194 turns off, turning off Q196. Q198 turns on, providing operating current for DS198, the indicator lamp.

When the ramp ends, ending the positive gate, Q162 turns off, turning Q190 off. C192 starts to charge toward +15 volts through R192, allowing Q194 gate to rise. Q194 turns on, turning on Q196, turning off Q198, and extinguishing the lamp.

Ramp Gate

When the +Gate occurs at pin 14 (U70), Q170 turns off, allowing Q174 to turn on, providing a positive level gate signal out. The GATE signal has an amplitude of 3 volts and an output resistance of 150 ohms.

Ramp Start

When the +Gate occurs at pin 14 (U70), Q182 turns off and Q184 turns on, and since the signal is AC coupled to Q182, the output is a positive pulse (differentiated step) of 3 volts amplitude, starting at ground and having a duration of 1.5 μs. The output resistance is 150 ohms.

LOW VOLTAGE POWER SUPPLY

General

The regulated DC is supplied to two stages, (1) preregulation of the power transformer primary in the mainframe and (2) regulation in the 26G1 of the three individual voltages supplied by the mainframe power supply (transformer secondary).

Each of the three mainframe supplies (−17 V, +7 V, and +17 V) is rectified and filtered in the mainframe and supplied to the 26G1 unit via the rear connector.

The heart of each regulator is a μA723C Integrated precision voltage regulator, containing a feedback amplifier, reference voltage, current limiter, and output emitter follower. Fig. 3-2 shows the equivalent circuit of the μA723C.

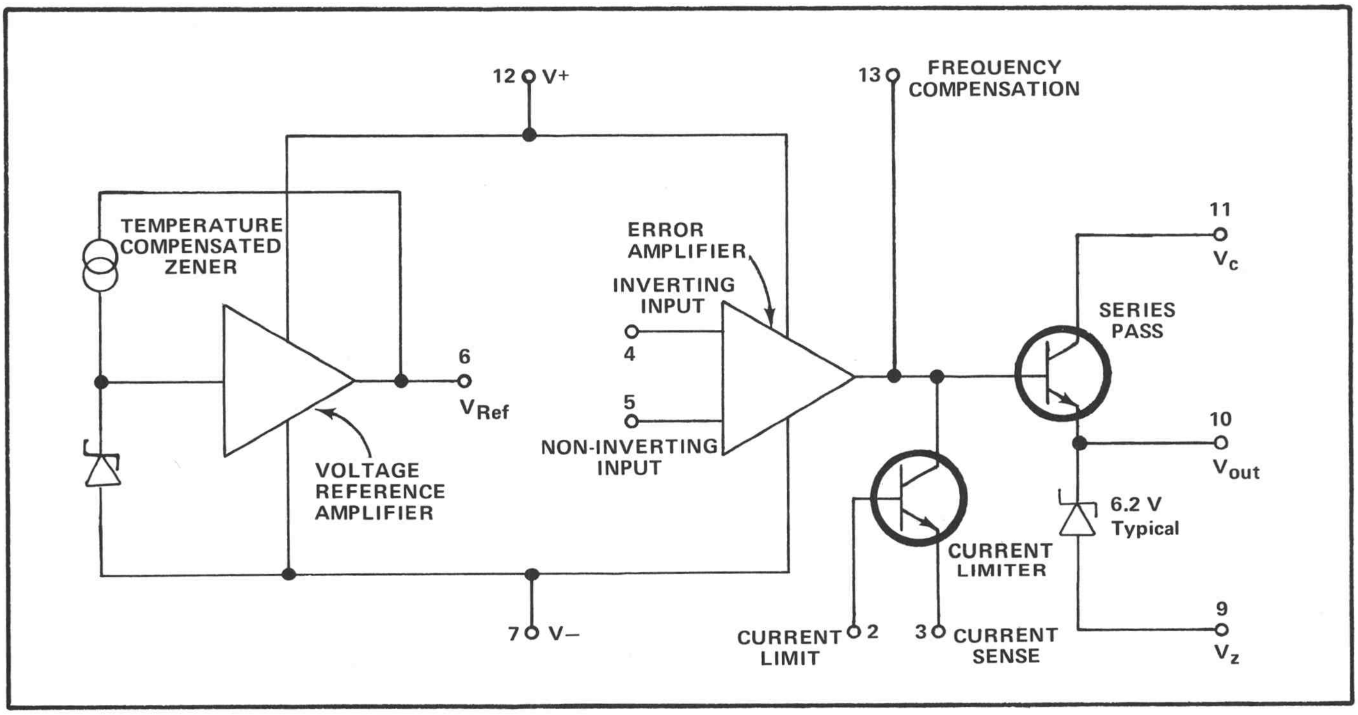

Fig. 3-2. μA723 Integrated Circuit Equivalent.

R340 and R341 (with the temperature compensated Zener in the μA723C) provide the reference voltage for the −15-volt supply. The −15 volt supply is the reference for the +5 and +15-volt supplies.

VR346 provides a negative operating voltage for the +5- and +15-volt supplies.

Q328, Q334, and Q346 are series pass transistors for the +15-, +5- and −15-volt supplies, respectively, and R324, R334, and R349 establish drive current levels for the μA723C output transistors.

R326, R333, and R348 resolve series pass base current as a voltage which will limit current through the series pass transistors during turn-on charging of C328, C336, and C346.

Error voltage is fed back to the −Input from the dividers, R328-R329, R336-R338, and R344-R345-R346 (R345 being the −15-volt adjust).

C321, C331, and C343 prevent oscillations in the feedback loops.

Disable Lines

If the instrument is used in a 7000-Series oscilloscope, which provides the necessary regulated voltages, the −15 V, +5 V, and +15 V regulators are disabled. Plugging the 26G1 into the 7000-Series oscilloscope applies regulated voltage to both input and output of each regulator as well as +15 volts to each disable line. The voltage provided on the disable lines disables the regulators.

SECTION 4 MAINTENANCE

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

This section of the manual contains maintenance information for use in preventive or corrective maintenance and troubleshooting of the 26G1.

Cleaning

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents.

Semiconductor Checks

Periodic checks of the semiconductors in the 26G1 are not recommended. The best check of semiconductor performance is actual operation in the instrument.

Recalibration

A calibration check is recommended after each 1000 hours of operation, or every year if used infrequently. Replacement of components may necessitate recalibration of the affected circuits. Complete calibration instructions are given in the Performance Check/Adjust section.

TROUBLESHOOTING

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in Section 7. The circuit number and electrical value of each component are given on the diagrams. Important voltages are also shown.

Circuit Boards. The circuit boards used in the 26G1 are outlined with a tint band on the Schematic Diagram, and a photograph of each board is shown to the left of the diagram. Each board-mounted electrical component is identified on the photograph by its circuit number.

Voltages and Waveforms. Often the defective components can be located by checking for the correct voltage or waveform in the circuit. Typical voltages are given on the Schematic diagrams. These voltages are not absolute, and may vary slightly from instrument to instrument. To obtain operating conditions similar to those used to take the reading, see the instructions in the Schematic Diagrams section.

Power Supply Voltage and Ripple. Table 4-1 lists the voltage and ripple tolerances of the power supplies in the 26G1. If a power supply voltage and ripple are within the listed tolerance, the supply can be assumed to be working properly. If outside the tolerance, the supply may be misadjusted or operating incorrectly.

TABLE 4-1

Supply	Ripple	Voltage
−15 V	3 mV, p-p	−15 V, ±40 mV
+5 V	2 mV, p-p	+5 V, ±50 mV
+15 V	3 mV, p-p	+15 V, ±150 mV

Troubleshooting Equipment

The following equipment is useful for troubleshooting the 26G1.

1. Semiconductor Tester. Some means of testing the transistors and diodes used in the instrument is helpful. Since most of the semiconductor devices are used in a digital function, probably the most convenient check is that of measuring the junction resistance. For more complete tests, the Tektronix Type 576 is recommended. The most convenient method of integrated circuit check is substitution.

2. DC Voltmeter and Ohmmeter. For most applications, a 20,000 ohms/volt VOM can be used to check voltages and resistance, if allowance is made for the circuit loading when making voltage measurements at high impedance points.

3. Test Oscilloscope. A test oscilloscope is required to check circuit waveforms. An oscilloscope having a DC to 10 MHz frequency response and 1 mV/Div to 10 V/Div vertical deflection factor is suggested. A 10X probe should be used where circuit loading is critical.

REPLACEMENT PARTS

Standard Parts

All electrical and mechanical parts replacements for the 26G1 can be obtained through your local Tektronix Field Office or Representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before buying or ordering replacement parts, check the parts lists for value, tolerance, rating and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in the instrument. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect the instrument performance.

CAUTION

Multi-layer circuit boards require extra care when replacing soldered components. Excess heat can cause the board laminations to separate and conductors to release. Many components have clinched leads which should be straightened before removal, so as not to damage the plated through holes. Such damage may result in irreparable loss of connection to an inner layer conductor.

Special Parts

Some parts are manufactured or selected by Tektronix, Inc. to satisfy particular requirements, or are manufactured for Tektronix, Inc. to our specifications. These special parts are indicated in the parts lists by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., refer to the Parts Ordering Information and Special Notes and Symbols on the page immediately preceding the Electrical Parts List section. Include the following information:

1. Instrument Type (26G1)

2. Instrument Serial Number

3. A description of the part (if electrical, include the circuit number).

4. Tektronix Part Number.

COMPONENT REPLACEMENT

General

The exploded-view drawings associated with the Mechanical Parts Lists (Fig. 1, pullout page) may be helpful when disassembling or reassembling individual components or subassemblies.

Circuit Board Replacement

Most of the circuit boards in this instrument are easily removed for maintenance. However, some of the circuit boards are permanent parts of switch assemblies and are not intended for removal. For these boards, see the instructions given under Pushbutton Switch Assembly Replacement.

The following general instructions apply to the removable main boards:

1. Disconnect all of the multiple-pin connectors.

2. Remove the four screws at the rear of the instrument that secure the plastic guide to the side rails.

3. Pull the circuit board straight out to the rear. The four plastic clips that position the board will slide out with the board.

To replace the board, proceed as follows:

1. Place two plastic clips as shown in Fig. 4-1.

2. Position the circuit board between the two clips.

3. Slide the circuit board toward the front of the instrument until the notch about half-way back on the board edge is about 1/2 inch from the rear of the cutout side panel. Place the clip on the board edge, slide the board and clip forward, guiding the clip into the channel.

4. Slide the circuit board forward until the board notch at the opposite side is in position to mount the plastic clip. Position the clip over the board notch, and again push the assembly forward until the rear plastic guide seats against the ends of the side panels.

5. Replace the screws.

6. Reconnect the multiple-pin connectors.

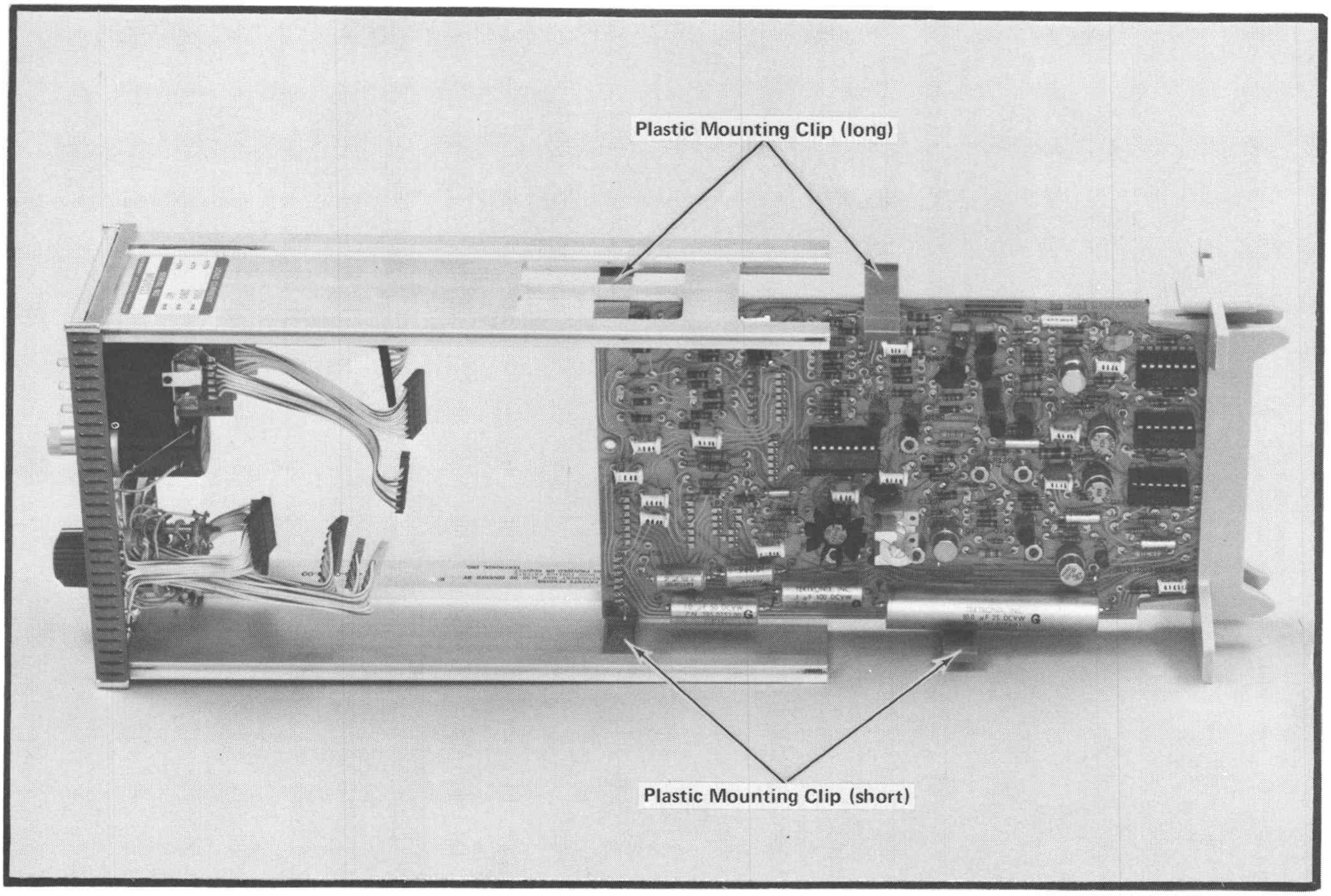

Fig. 4-1. Circuit Board Replacement.

Semiconductor Replacement

Replacement semiconductors should be of the original type or a direct replacement. Fig. 4-2 shows the lead configuration of the semiconductors used in this instrument. Some plastic case transistors may have lead configurations which do not agree with those shown here. If a replacement transistor is made by a manufacturer other than the original, check the manufacturer's basing diagram for correct basing. All transistor sockets in this instrument are wired for the standard basing as used for metal-cased transistors.

An extracting tool should be used to remove the 14-pin integrated circuits to prevent damage to the pins. A removing tool is available from Tektronix, Inc., as Part No. 003-0619-00. If an extracting tool is not available for removal of integrated circuits, pull evenly on both ends of the device. Avoid having one end of the package disengage from the socket ahead of the other.

Lead-end Pin Connectors

The pin connectors are grouped together and mounted in a plastic holder to serve as a multi-pin connector. To provide correct orientation of this multi-pin connector an arrow is stamped on the circuit board, and a matching arrow is molded into the plastic connector body. Replace the connector with the arrows aligned. If individual lead-end pin connectors are removed from the plastic body, note the individual wire color.

Pushbuttons

The pushbutton switches are not repairable and should be replaced as a unit. The pushbutton-illuminating lamp is the only replacable component on some of the pushbutton assembly circuit boards (see the information under Lamp Replacement).

To remove the pushbutton switches, use the following procedure:

1. Remove the RATE and RAMP DURATION switch knobs (front panel).

2. Insert a screwdriver blade between the bottom of the front-panel casting and the indentation at the bottom cen-

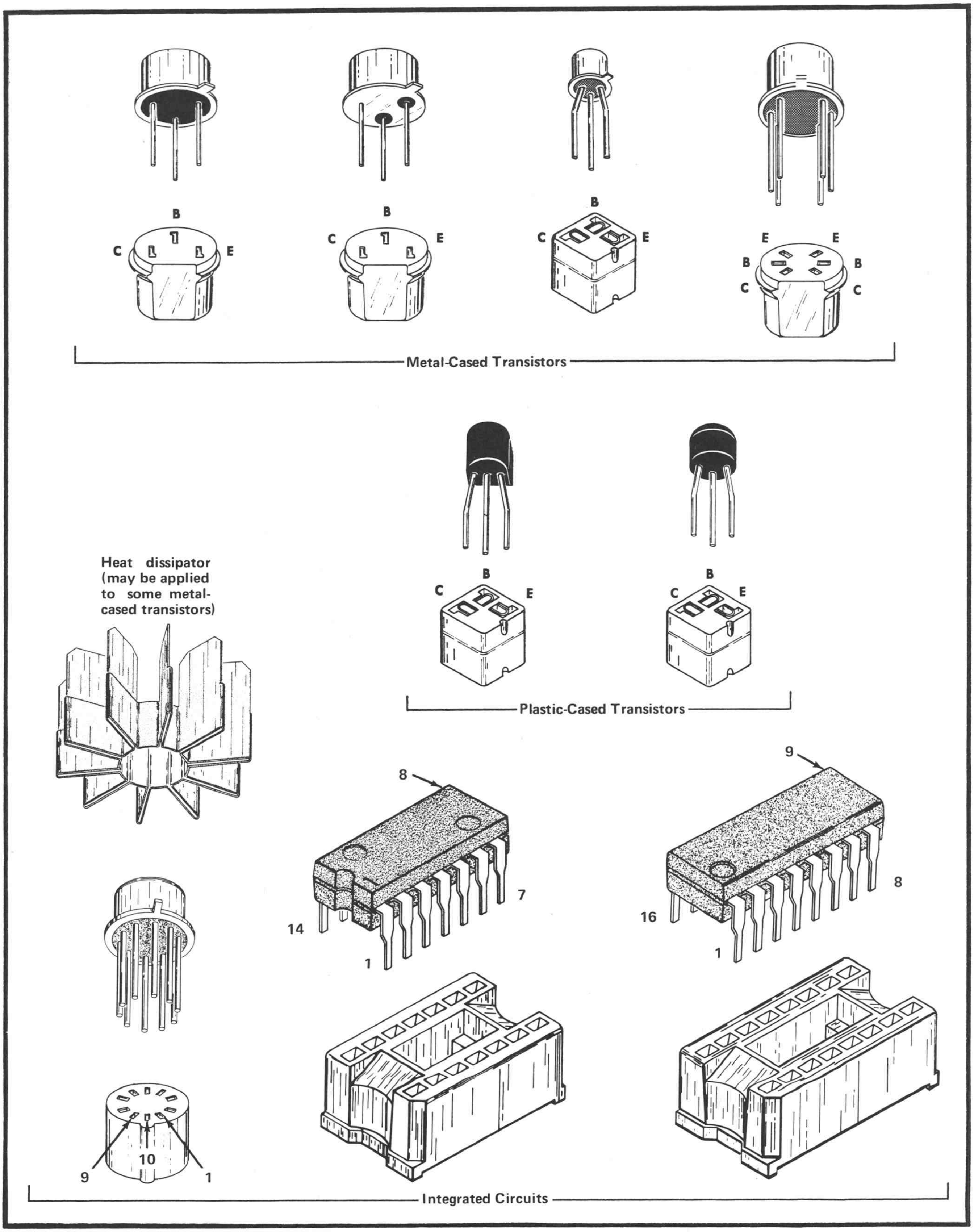

Fig. 4-2. Semiconductor Lead configuration.

ter of the front-panel overlay. Carefully twist the screwdriver to move the overlay away from the subpanel. Remove the overlay.

3. Remove the two flat-head, No. 0, POZ-I-DRIV R screws and remove the switch from the rear.

To replace the switch, reverse the above procedure.

Lamp Replacement (Series 70 Switches)

The following procedure describes lamp replacement in the pushbutton assembly.

1. Remove the pushbutton switch as described previously.

2. Note the position of the lamp on the circuit board. Unsolder the lamp leads from the circuit board.

3. Move the lamp out through the light manifold.

4. Install the new lamp in the same position as the original and solder the leads to the circuit board. Use a heat sink to protect the lamp during soldering.

Lamp Replacement (Output Indicator)

This lamp is mounted in a plastic cap that snaps into a holder mounted behind the front panel.

INSTRUMENT REPACKAGING

If the 26G1 is to be shipped over long distances by commercial transportation, it is recommended that the instrument be repackaged in the original manner for maximum protection. Repackaging information and/or new shipping cartons may be obtained from Tektronix, Inc. Contact the nearest Tektronix Field Office or representative.

NOTES

SECTION 5
PERFORMANCE CHECK/ADJUSTMENT

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

A calibration check is recommended every 1000 hours of operation, or every year if used infrequently. Before complete calibration, the instrument should be cleaned and inspected as outlined in the Maintenance section.

As an aid to checking the performance of the 26G1, a Short-Form Procedure is given prior to the complete procedure. To facilitate instrument checkout, the Short-Form Procedure lists the check and applicable tolerances. This Procedure also includes the step number and title as listed in the complete Performance Check, and the page number on which each step begins. The Short-Form Procedure also provides spaces to record performance data or to check off steps as they are completed.

The Performance Check can be used to check instrument performance without making any internal adjustments.

Following the Performance Check is a complete ADJUST Procedure. Completion of the Adjust Procedure insures that the instrument meets the electrical specifications given in Section 1.

NOTE

Limits, tolerances and waveforms in the ADJUST procedure are given as calibration guides, and should not be interpreted as instrument specifications except as specified in Section 1. All waveforms shown in this procedure were taken with a Tektronix Oscilloscope Camera system.

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or equivalent, are required for complete check or adjustment of the 26G1. Specifications given are the minimum necessary for accurate check or adjustment. Some of the recommended equipment may have specifications that exceed those given. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

see copy 1
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Special Tektronix calibration fixtures are used in this procedure only where they facilitate calibration. These special fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Test Equipment

1. Test Oscilloscope, consisting of indicator, Dual Trace Amplifier, Differential Comparator, and Time Base.

Dual Trace Amplifier: Deflection Factor, 100 mV to 5 V; Bandwidth, 10 MHz, Single, Alternate and Chopped display modes; Trigger Source selection.

Differential Comparator: Comparison Voltage range from zero volts to +15.00 volts; Deflection Factor from 2 V/Div to 1 mV/Div.

Time Base: Time/Div from 1 μs to 1 s with 10X magnification.

The oscilloscope recommended is the Tektronix 7504 with the following plug-ins:

7A12 Dual Trace Amplifier.

7A13 Differential Comparator

7B50 Time Base

2. Time-Mark Generator. Marker Range, .1 μs to 1 s; Trigger Range, 1 μs to 1 s. Type 184 or 2901 Time Mark Generator is recommended.

3. Pulse Generator. Output Pulse and Duration Variable; Output level 0-1 V, within 1% of indicated; DC Output level, 0-1 V, within 1% of indicated. The 26G3 is recommended.

4. 2600-Series Mainframe. To provide operating power for the 26G1 and 26G3 generators.

5. Plug-in extender. To provide access to the adjustments and test points in the 26G1. Tektronix Part Number 067-0630-00.

6. Coaxial Cable assembly (2 required); 50 Ω with BNC connectors. Tektronix Part Number 012-0057-01.

7. BNC to 40-Mil Pin adapter cable. Tektronix Part Number 175-1178-00 (2 required).

8. BNC "T" Connector. Tektronix Part Number, 103-0030-00.

9. 1X Probe with BNC connectors (2 required). Tektronix Type P6011 is recommended. Tektronix Part Number 010-0192-00.

SHORT-FORM PERFORMANCE CHECK AND INDEX

26G1 Serial No.

Date

By

1. Check Output 10 V Ramp DC Level — Page 5-3

   0 volt, within 20 mV

2. Check Output Ramp 10 V Amplitude (100 μs through 10 s) — Page 5-4

   Peaks of the ramps are 10 volts, within 50 mV

3. Check Output Ramp 10 V Amplitude (10 μs) — Page 5-4

   Peaks of the ramps are 10 volts, within +250 mV, −50 mV

4. Check Output Ramp 1 V Amplitude — Page 5-4

   Peaks of the ramps are 1 volt, within 10 mV (1 ms)

   Peaks of the ramps are 1 volt, within +30 mV, −10 mV (10 μs)

5. Check Ramp Gate Amplitude — Page 5-5

   Gate Amplitude is 3 volts, within 20%

6. Check Ramp Start Amplitude — Page 5-5

   Ramp Start Amplitude is 3 volts, within 20%

7. Check Rate Amplitude — Page 5-5

   Rate Amplitude is 3 volts, within 20%

8. Check Input Trig Level — Page 5-5

   Ramp is triggered on by the time the Trig Input level reaches +1 volt

9. Check Input Gate Level — Page 5-5

   Ramp is gated on by the time the gate level reaches +1 volt

10. Check Input Gnd to Gate Level — Page 5-6

    Ramp is gated on when DC level is between 0 and +0.4 volt

    Ramp stops at some voltage more positive than +0.4 volt

11. Check Input Ramp Reset Level — Page 5-6

    Ramp circuit resets at +1 volt or less

12. Check Input Gnd To Reset — Page 5-6

    Ramp circuit resets (ramp does not run) between 0 and +0.4 volt

13. Check 1 ms, X1, Ramp Duration — Page 5-6

    Ramp terminates within 20 μs (2%) of leading edge of the 10th time mark

14. Check 1 ms, X10, Ramp Duration — Page 5-7

    Ramp terminates within 200 μs (2%) of leading edge of the 10th time mark

15. Check Duration Mult Linearity — Page 5-7

    Ramp terminates within 180 μs (2%) of leading edge of the 9th time mark.

16. Check Ramp Rate Accuracy — Page 5-8

    The point at which the ramp crosses the 10-volt reference is within 9.8 to 10.2 μs of the 10th time mark

17. Check Rate Generator Accuracy Page 5-9

Rate Pulse is within 30 μs of the time mark

SHORT FORM ADJUSTMENT PROCEDURE AND INDEX

1. Adjust −15-volt Supply Page 5-9

ADJUST R345 for exactly −15 volts

2. Adjust Output Ramp DC Level Page 5-10

ADJUST R130 to set the output DC level to zero volt

3. Adjust Ramp 10 V Output Amplitude Page 5-11

ADJUST R137 to set the ramp peaks at exactly 10 volts

4. Adjust 1 ms, X1 Ramp Duration Page 5-11

ADJUST R101 to terminate the ramp on the leading edge of the 10th time mark

5. Adjust Multiplier Linearity Page 5-12

ADJUST R128 to bring the potential difference between TP110 and TP125 to zero (TP122 shorted to ground and DURATION MULT set to 5.00)

6. Adjust 1 ms, X10 Ramp Duration Page 5-12

ADJUST R125 to terminate the ramp on the leading edge of the 10th time mark

7. Adjust 10 μs Ramp Duration Page 5-12

ADJUST C120A to terminate the ramp on the leading edge of the 10th time mark

8. Adjust Rate Mult Timing Page 5-13

ADJUST R2 for 1 pulse for each time mark

ADJUST R34 to set the leading edge of the pulse to the leading edge of the time mark

PERFORMANCE CHECK PROCEDURE

General

The following procedure is arranged to check the 26G1 with the least reconnection of equipment. The control settings throughout this procedure continue from the preceding step(s) unless otherwise noted. The control settings can be checked at the points listed as Preliminary Control Settings.

NOTE

Control titles which are printed on the front panel of the 26G1 are capitalized in this procedure (e.g., RAMP DURATION). Associated equipment controls are initial capitalized only (e.g., Marker Output).

The following procedure uses the equipment listed under Test Equipment Required. If other equipment is substituted, control settings or checking setup may need to be altered to meet the requirements of the equipment used. Operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is required.

NOTE

The performance of this instrument may be checked at any temperature from 0°C to +50°C provided that the instrument was adjusted within an ambient range of +20°C to +30°C.

PRELIMINARY CONTROL SETTINGS

26G1

MODE	GATED
RAMP DURATION	1 ms
DURATION MULT	1.00
Internal Modification Points	P9-2 connected to P9-3
	CHECK THAT CONNECTOR ARROWS ARE ALIGNED ON P9 & P11

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Differential Comparator

Volts/Div	5 mV
+Input	Gnd
−Input	Gnd

Time Base

Triggering	
Mode	Auto
Coupling	AC
Source	Int
Display Mode	Time Base
Time/Div	1 ms
Magnifier	X1

1. Check Output Ramp 10 V DC Level

a. Connect the Differential Comparator +Input to RAMP 10 V OUTPUT (A) and COM (B).

b. Vertically position the trace (test scope) to graticule center.

c. Switch +Input to DC.

d. CHECK—That the trace is within 4 divisions (20 mV) of graticule center.

Reset the following controls:

26G1

MODE	TRIG'D
TRIGGER	INT
RATE GENERATOR	
RATE	1 kHz
MULT	1.00
RAMP DURATION	100 μs

Differential Comparator

Volts/Div	20 mV
Variable	Pulled Out
Comparison Voltage	10.00 V
+Input	Gnd

2. Check Output Ramp 10 V Amplitude (100 μs through 10 s)

a. Vertically position the trace to graticule center.

b. Switch +Input to DC.

c. Switch −Input to V_C.

d. CHECK—That peaks of the ramps are within 50 mV (2.5 divisions) of graticule center.

e. CHECK—Remaining ranges (not including 10 μs) through 10 s for +10 V, ±50 mV.

Reset the following controls:

26G1

RAMP DURATION	10 μs

Differential Comparator

Volts/Div	.1 V
Comparison Voltage	10.00
Variable	Pushed in
+Input	Gnd
−Input	Gnd

3. Check Output Ramp 10 V Amplitude (10 μs)

a. Vertically position the trace to graticule center.

b. Switch +Input to DC.

c. Switch −Input to V_C.

d. CHECK—That the ramp peaks are within 2.5 divisions (250 mV) above or 0.5 division below graticule center.

Reset the following controls:

26G1

RAMP DURATION	1 ms

Time Base

Time/Div	1 ms

Differential Comparator

Volts/Div	10 mV
Comparison Voltage	1.000 V
+Input	Gnd
−Input	Gnd

4. Check Output Ramp 1 V Amplitude

a. Connect the OUTPUT RAMP 1 V (C) to Differential Comparator +Input.

b. Position the trace to graticule center.

c. Switch +Input to DC.

d. Switch −Input to V_C.

e. CHECK—That the ramp peaks measure 1.00 volt, within 1 division (10 mV) of graticule center.

f. Switch 26G1 RAMP DURATION to 10 μs.

g. CHECK—That the ramp peaks are within +3 divisions (30 mV), −1 division (10 mV) at 10 μs.

Reset the following controls:

Differential Comparator

−Input	Gnd
+Input	DC
Volts/Div	1 V

5. Check Ramp Gate Amplitude

a. Connect RAMP GATE (D) and Gnd to Differential Comparator +Input.

b. Display output of RAMP GATE on test scope.

c. CHECK—That gate amplitude is 3 divisions (3 volts), within 0.6 division (20%).

6. Check Ramp Start Amplitude

a. Connect RAMP START (E) and Gnd to Differential Comparator +Input.

b. Display output of RAMP START on test scope.

c. CHECK—That the RAMP START amplitude is 3 divisions (3 volts), within 0.6 division (20%).

7. Check Rate Amplitude

a. Connect RATE (F) and Gnd to Differential Comparator +Input.

b. Display output of RATE (F) on test scope.

c. CHECK—That RATE Amplitude is 3 divisions (3 volts), within 0.6 division (20%).

Set controls as follows:

26G1

RAMP DURATION	1 ms
DURATION MULT	1.0
MODE	TRIG'D
TRIGGER	+SLOPE
RATE	100 Hz
MULT	1.00

26G3

Pulse Duration	1 ms
Triggering	Preset Level
Amplitude Range	1 V
Pulse Amplitude	0.00

8. Check Input Trig Level

a. Connect 26G1 RATE OUTPUT to 26G3 Trig (1) Input.

b. Connect 26G3 +Pulse Output to 26G1 INPUT TRIG.

c. Monitor 26G1 OUTPUT RAMP 10 V with test scope.

d. Increase 26G3 Pulse Amplitude until ramp is displayed on the test scope.

e. CHECK—Ramp is triggered on by the time the TRIG INPUT level reaches +1 volt.

Reset the following controls:

26G1

MODE	GATED
GATE	EXT
RATE	1 kHz

26G3

Pulse Duration	DC
Pulse Amplitude	0.00

9. Check Input Gate Level

a. Connect 26G3 +Pulse Out to 26G1 INPUT GATE.

b. Monitor RAMP OUT 10 V with test scope.

c. Increase DC level from 26G3 (Pulse Amplitude) until ramp is displayed on test scope.

d. CHECK—That ramp is gated on by the time the gate level reaches +1 volt.

Reset the following controls:

26G3

Pulse Amplitude	0.00

Dual Trace Amplifier

Volts/Div	2
Input CH 1	DC
Display Mode	CH 1
Trigger Source	CH 1

Differential Comparator

Volts/Div	50 mV
+Input	Gnd
−Input	Gnd
Comparison voltage	+0.4 V

10. Check Input Gnd to Gate Level

a. Connect 26G3 +Pulse Out to 26G1 GND TO GATE.

b. Monitor 26G1 RAMP OUT (1) with test scope (Dual Trace Amplifier). Ramp should be running.

c. Connect Differential Comparator +Input to 26G3 +Pulse Output.

d. Increase DC Level from 26G3 (Pulse Amplitude) until ramp stops.

e. CHECK—That ramp is gated on when DC level is between 0 and +0.4 volt, and that ramp stops at some voltage more positive than +0.4 volt (measure with differential comparator).

Reset the following controls:

26G1

MODE	FREE RUN

11. Check Input Ramp Reset Level

a. Connect 26G3 +Pulse Out to 26G1 RAMP RESET.

b. Monitor RAMP 10 V OUTPUT (A) with test scope (ramp should be running).

c. Increase DC Level from 26G3 (Pulse Amplitude) until ramp display on test scope terminates.

d. CHECK—That ramp circuit resets (output ramp stops) at +1 volt or less.

12. Check Input Ground To Reset Level

a. Connect 26G3 +Pulse Output to 26G1 GND TO RESET.

b. Monitor RAMP 10 V OUTPUT with test scope.

c. Increase DC level from 26G3 (Pulse Amplitude) until ramp is displayed on test scope.

d. CHECK—That ramp circuit resets (output ramp does not run) between 0 and +0.4 volt (measure with differential comparator).

Set the following controls:

Time Mark Generator

Marker Selector	.1 ms
Trigger Selector	1 ms

26G1

RAMP DURATION	1 ms
DURATION MULT	1.00
MODE	TRIG'D
TRIGGER	EXT +SLOPE

Dual Trace Amplifier

CH 1	
Input	DC
Volts/Div	.5 V
CH 2	
Input	DC
Volts/Div	2 V
Display Mode	Add
Trigger Source	CH 1

Time Base

Time/Div	.1 ms
Magnifier	X1
Triggering	
Mode	Auto
Coupling	AC
Source	Ext

13. Check 1 ms, X1, Ramp Duration

a. Connect Time Marker Output to Dual Trace Amplifier CH 1 Input.

b. Connect Trigger Output to Time Base Ext Trig In and 26G1 TRIG INPUT.

c. Connect 26G1 RAMP 10 V OUTPUT to Dual Trace Amplifier CH 2 Input.

d. Display Ramp and Marker outputs as shown in Fig. 5-1.

e. Switch Magnifier to X10.

f. CHECK—That the ramp terminates within 2 divisions (20 μs) of the leading edge of the 10th time mark.

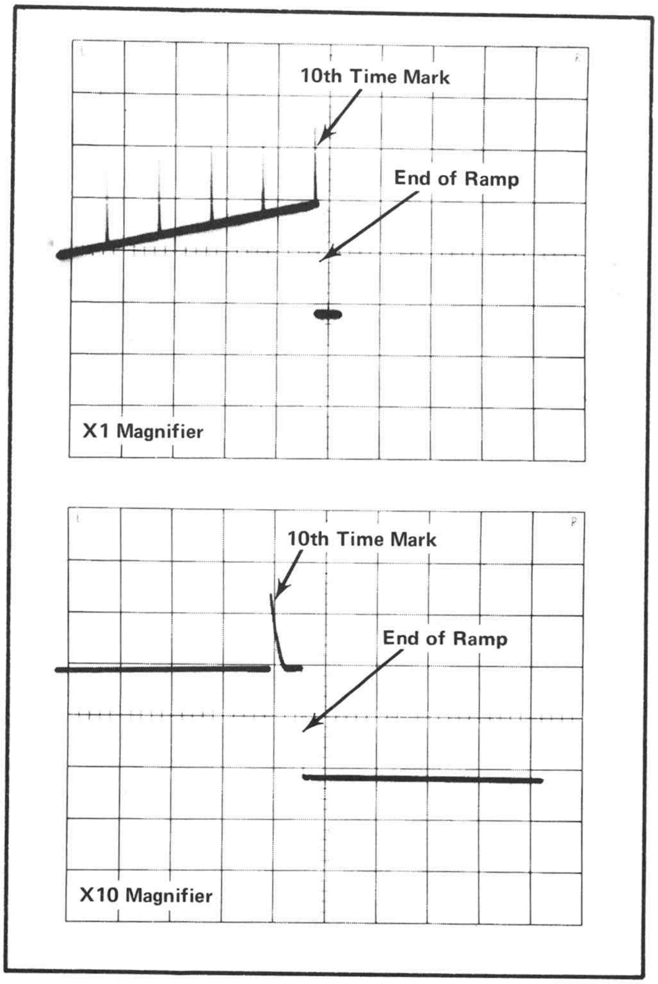


Fig. 5-1. Typical display of ramp and time marks for steps 13 and 14.

Reset the following controls:

Time Mark Generator

Marker Selector	1 ms
Trigger Selector	10 ms

26G1

DURATION MULT	10.00

Time Base

Time/Div	1 ms
Magnifier	X1

14. Check 1 ms, X10, Ramp Duration

a. Display ramp and markers as shown in Fig. 5-1.

b. Switch Magnifier to X10.

c. CHECK—That the ramp terminates within 2 divisions (200 μs) of the leading edge of the 10th time mark.

15. Check Duration Mult Linearity

a. Switch Magnifier to X1.

b. Set DURATION MULT to 9.00.

c. Display ramp and markers as shown in Fig. 5-2.

d. Position the 9th marker horizontally to graticule center.

e. Switch Magnifier to X10.

f. CHECK—That the ramp terminates within 1.8 divisions (2%) of the 9th time mark.

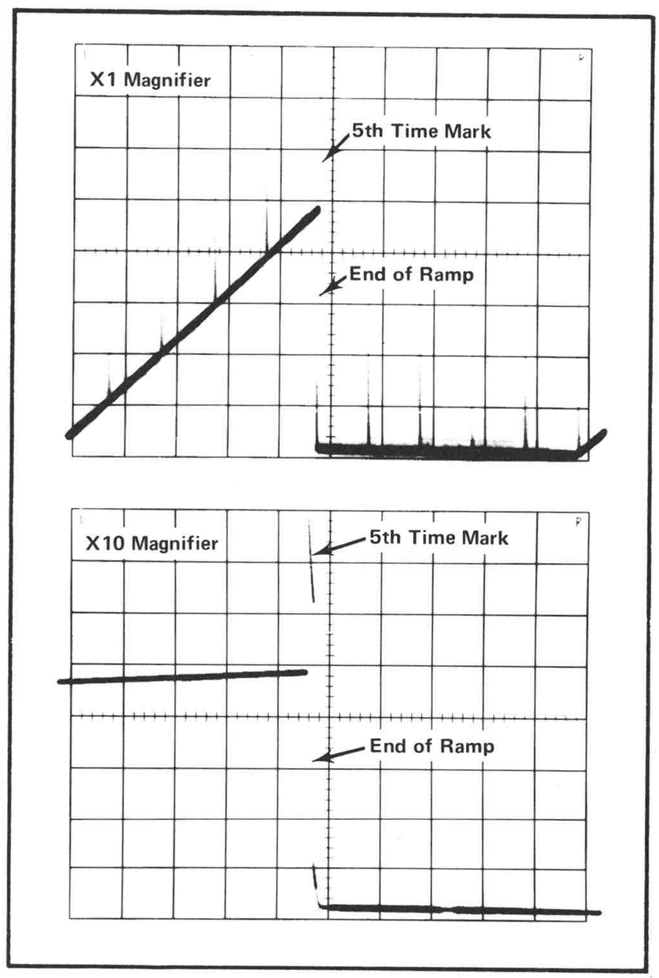


Fig. 5-2. Typical display of ramp and time marks for step 15.

g. CHECK—DURATION MULT linearity at 8.00, 7.00, etc., as outlined above.

Set the following controls:

Time Mark Generator

Marker Selector	1 µs
Trigger Selector	.1 ms

26G1

RAMP DURATION	10 µs
DURATION MULT	1.00
MODE	TRIG'D
TRIGGER	EXT +SLOPE

Time Base

Time/Div	1 µs
Magnifier	X1
Trigger	
Mode	Auto
Coupling	AC
Source	Ext

Differential Comparator

+Input	Gnd
−Input	Gnd
Volts/Div	10 mV
Variable	Pulled Out
Comparison Voltage	10.00 V

Test Scope Mainframe

Vertical Mode	Alt

Dual Trace Amplifier

CH 1	
Volts/Div	.5 V
Input	DC
Display Mode	Alt
Trigger Source	CH 1

16. Check Ramp Rate Accuracy

a. Connect the 26G1 RAMP 10 V OUTPUT to Differential Comparator +Input.

b. Connect Time Mark Generator Marker Output to Dual Trace Amplifier CH 1 Input.

c. Connect Time Mark Generator Trigger Output to 26G1 TRIG INPUT and to Time Base Ext Trig In.

d. Position the trace (Differential Comparator) vertically to graticule center (10-volt reference).

e. Switch Differential Comparator +Input to DC.

f. Switch Differential Comparator −Input to V_C.

g. Display ramp and time marks as shown in Fig. 5-3.

h. Switch Magnifier to X10.

i. CHECK—That the point at which the ramp crosses the 10-volt reference (center graticule line) is within 2 divisions (9.8 to 10.2 µs) of the 10th time mark.

Set the following controls:

Time Mark Generator

Marker Selector	1 ms

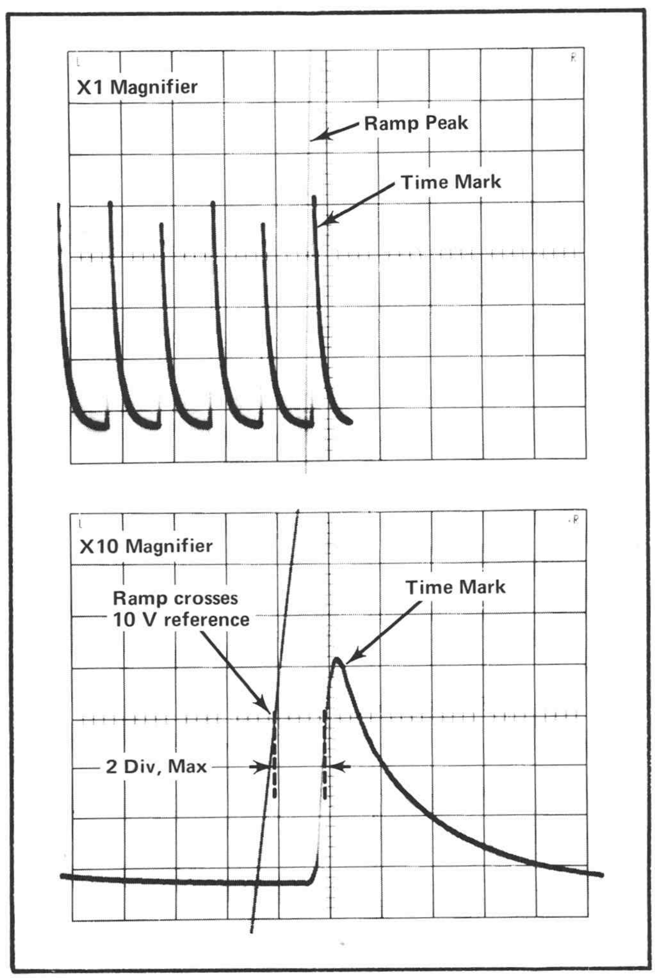


Fig. 5-3. Typical display of ramp and time marks for step 16.

26G1

RATE GENERATOR	
RATE	1 kHz
MULT	1.00

Dual Trace Amplifier

Display Mode	Alt
Trigger Source	CH 1 – CH 2
Volts/Div	
CH 1	.5 V
CH 2	1 V
Input	
CH 1	DC
CH 2	DC
Time Base	
Time/Div	.1 ms
Magnifier	X1

17. Check Rate Generator Accuracy

a. Connect 26G1 RATE (F) and Gnd to Dual Trace Amplifier CH 2 Input.

b. Connect Time Mark Generator Marker Output to CH 1.

c. Display RATE Pulse and Markers as shown in Fig. 5-4.

d. Switch Time Base Magnifier to X10.

e. CHECK—That RATE Pulse is within 3 divisions (30 μs) of the time mark.

f. CHECK—The remaining RATE settings using the procedure outlined above.

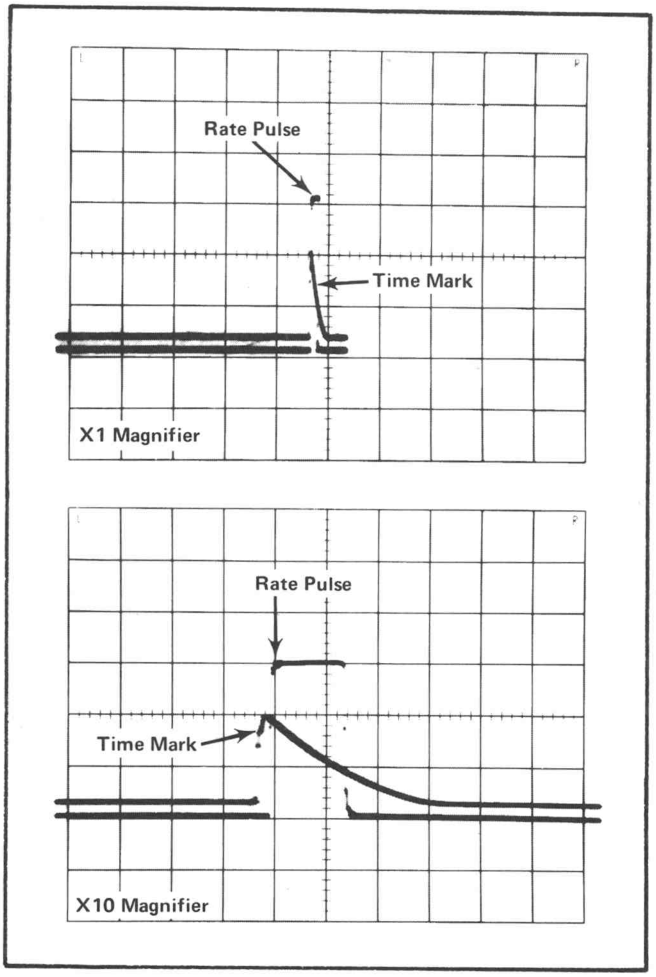


Fig. 5-4. Typical display of Rate Generator Accuracy Check, step 17.

ADJUSTMENT PROCEDURE

Preliminary Control Settings

26G1

MODE	GATED

Differential Comparator

+Input	Gnd
–Input	Gnd
Comparison Voltage	–15 volts
Volts/Div	10 mV

Time Base

Time/Div	1 ms
Triggering	
Mode	Auto
Coupling	AC
Source	Int
Display Mode	Time Base

1. Adjust –15-Volt Supply

a. Connect a 1X probe from Differential Comparator +Input to –15-volt Test Point (location shown in Fig. 5-5).

b. Vertically position the trace to graticule center (Differential Comparator Position control).

c. Switch +Input to DC.

d. Switch –Input to V_C.

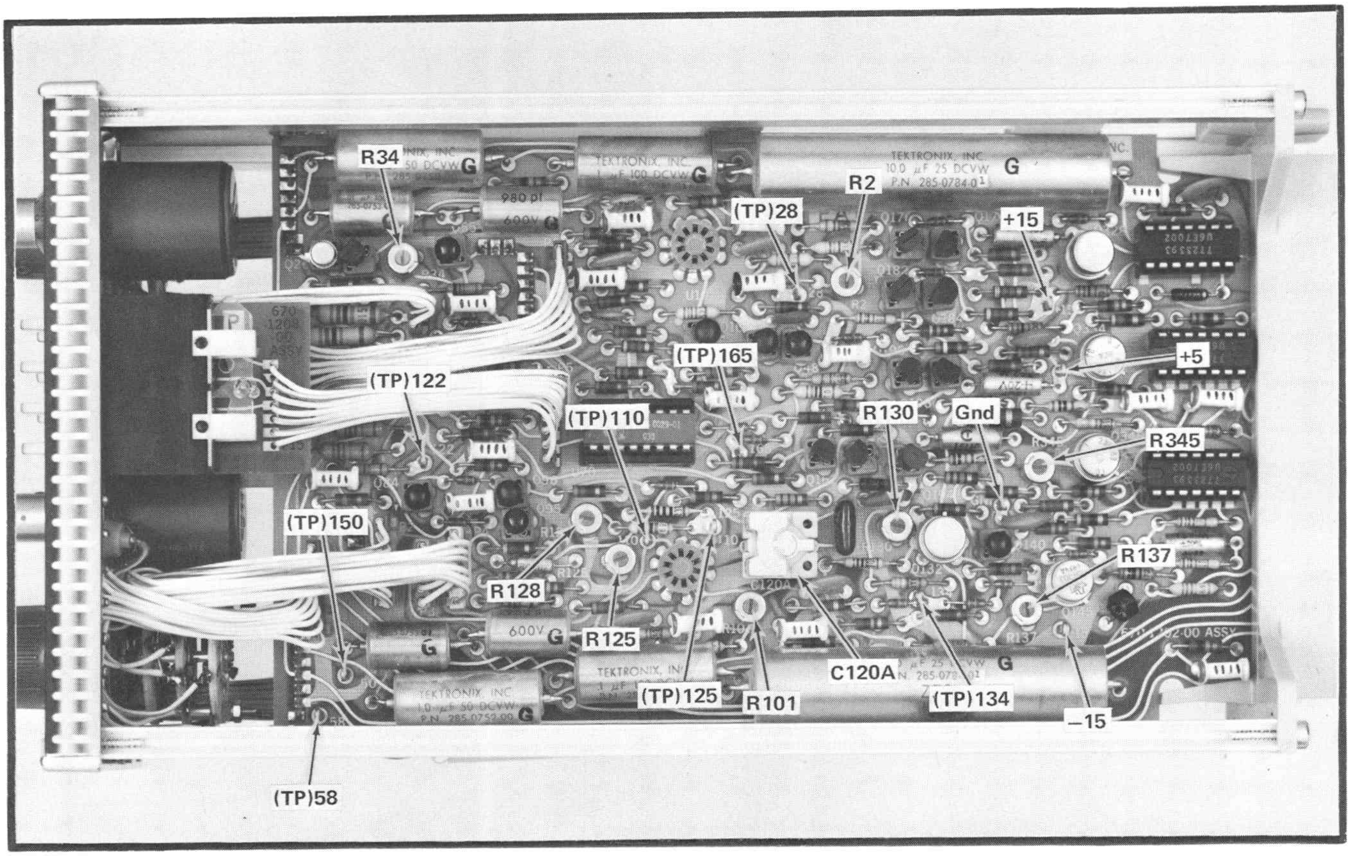


Fig. 5-5. Location of internal adjustments.

e. ADJUST—R345 to position the trace to graticule center.

f. Check the +5-volt and +15-volt supplies in the manner detailed above.

Set the following controls:

26G1

MODE	GATED
RAMP DURATION	1 ms
DURATION MULT	1.00

Differential Comparator

Volts/Div	5 mV
+Input	Gnd
−Input	Gnd

Time Base

Time/Div	1 ms
Magnifier	X1
Display Mode	Time Base
Triggering	
Mode	Auto
Coupling	AC
Source	Int

2. Adjust Output Ramp DC Level (R130)

a. Connect the Differential Comparator +Input to RAMP 10 V OUTPUT (A) and COM (B).

b. Vertically position the trace (test scope) to graticule center.

c. Switch +Input to DC.

d. ADJUST—R130 to set the trace to graticule center.

Reset the following controls:

26G1

MODE	TRIG'D
TRIGGER	INT

RAMP DURATION	1 ms
RATE GENERATOR	
RATE	1 kHz
MULT	1.00

Differential Comparator

Volts/Div	20 mV
Variable	Pulled out
Comparison voltage	10.00 V
+Input	Gnd

3. Adjust Ramp 10 V Amplitude (R137)

a. Vertically position the trace to graticule center.

b. Switch +Input to DC.

c. Switch −Input to V_C.

d. ADJUST—R137 to set ramp peaks to graticule center.

Set the following controls:

26G1

RAMP DURATION	1 ms
DURATION MULT	1.00
MODE	TRIG'D
TRIGGER	EXT +SLOPE

Dual Trace Amplifier

CH 1	
Input	DC
Volts/Div	2 V
CH 2	
Input	DC
Volts/Div	.5 V
Display Mode	Add
Trigger Source	CH 1

Time Base

Time/Div	.1 ms
Magnifier	X1
Triggering	
Mode	Auto
Coupling	AC
Source	Ext

Time Mark Generator

Marker Selector	.1 ms
Trigger Selector	1 ms

4. Adjust 1 ms, X1 Ramp Duration (R101)

a. Connect 26G1 RAMP 10 V OUTPUT to Dual Trace Amplifier CH 1 Input.

b. Connect Time Mark Generator Marker Output to Dual Trace Amplifier CH 2 Input.

c. Connect Time Mark Generator Trigger Output to 26G1 TRIG INPUT.

d. Adjust Time Base Trigger/Level and Position controls to give a stable display similar to that in Fig. 5-6.

e. Switch Time Base Magnifier to X10.

f. ADJUST—R101 (see Fig. 5-5 for location of internal adjustments) to terminate the ramp on the leading edge of the 10th time mark.

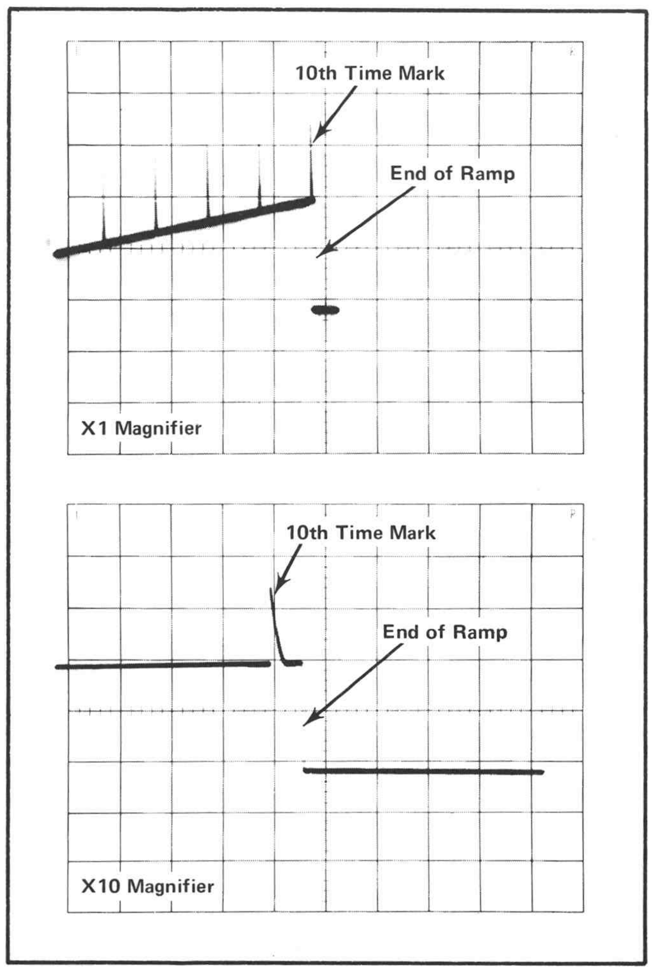


Fig. 5-6. Typical display of ramp and time marks for ADJUST steps 4 and 6.

Reset the following controls:

Dual Trace Amplifier

CH 1	
Volts/Div	50 mV
Input	Gnd
CH 2	
Volts/Div	50 mV
Input	Gnd
Display Mode	Alt

5. Adjust Multiplier Linearity (R128)

a. Connect a 1X probe from Dual Trace Amplifier, CH 1, to TP110. See Fig. 5-5 for test point location.

b. Connect a 1X probe from Dual Trace Amplifier, CH 2, to TP125.

c. Vertically position both traces to graticule center.

d. Set the 26G1 DURATION MULT to 5.00 (failure to set DURATION MULT to 5.00 will short circuit the −15-volt supply).

e. Connect TP122 to ground.

f. Switch Dual Trace Amplifier CH 1 and CH 2 to DC.

g. ADJUST—R128 to bring the two traces together.

h. Remove shorting strap and probes.

Set the following controls:

Time Mark Generator

Marker Selector	1 ms
Trigger Selector	10 ms

Time Base

Time/Div	1 ms
Magnifier	X1
Trigger	
Source	Ext

Dual Trace Amplifier

CH 1	
Input	DC
Volts/Div	2 V
CH 2	
Input	DC
Volts/Div	.5 V
Display Mode	Add

26G1

DURATION MULT	10.00

6. Adjust 1 ms, X10 Ramp Duration (R125)

a. Connect 26G1 RAMP 10 V OUTPUT to Dual Trace Amplifier, CH 1.

b. Connect Time Mark Generator Marker Output to Dual Trace Amplifier, CH 2.

c. Connect Time Mark Generator Trigger Output to 26G1 TRIG INPUT and Time Base Ext Trig In.

d. Display ramp and time marks as shown in Fig. 5-6.

e. Switch time Base Magnifier to X10.

f. ADJUST—R125 to terminate the ramp on the leading edge of the 10th time mark.

Reset the following controls:

Time Mark Generator

Marker Selector	10 μs
Trigger Selector	.1 ms

26G1

RAMP DURATION	10 μs
DURATION MULT	10.00

Time Base

Time/Div	10 μs
Magnifier	X1

7. Adjust 10 μs Ramp Duration (C120A)

a. Display ramp and time marks as shown in Fig. 5-7.

b. Switch Magnifier to X10.

c. ADJUST—C120A to terminate the ramp on the leading edge of the 10th time mark.

Reset the following controls:

Time Mark Generator

Marker Selector	.1 ms

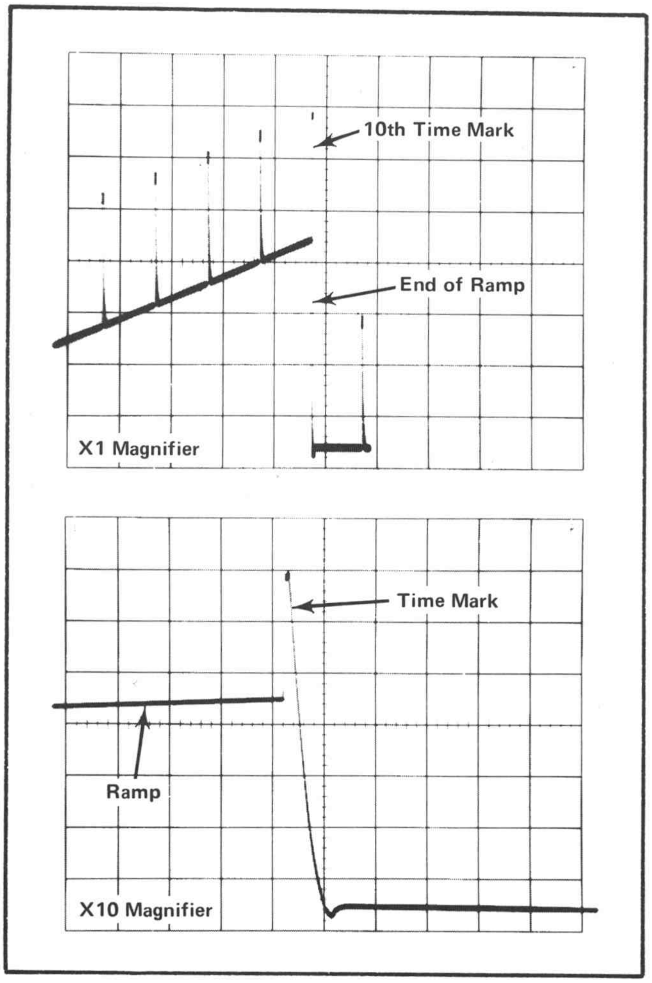


Fig. 5-7. Typical display of 10 μs Ramp Duration Adjust, step 7.

26G1

RATE	1 kHz
MULT	10.00

Dual Trace Amplifier

CH 1	
Volts/Div	1 V
Input	DC
CH 2	
Volts/Div	.5 V
Input	DC
Display Mode	Alt
Trigger Source	CH 1 – CH 2

Time Base

Time/Div	.1 ms
Magnifier	X1
Triggering	
Source	Int

8. Adjust Rate Mult Timing (R2-R34)

a. Connect RATE (F) OUTPUT and Gnd to Dual Trace Amplifier, CH 1.

b. Connect the Time Mark Generator Marker Output to Dual Trace Amplifier, CH 2.

c. If components have been replaced, set R2 and R34 to midrange.

d. Check for one output pulse for each time mark. Set R2 for one pulse for each time mark as in Fig. 5-8.

e. Set Time Base Time/Div to 10 μs.

f. Position the 2nd time mark horizontally to graticule center.

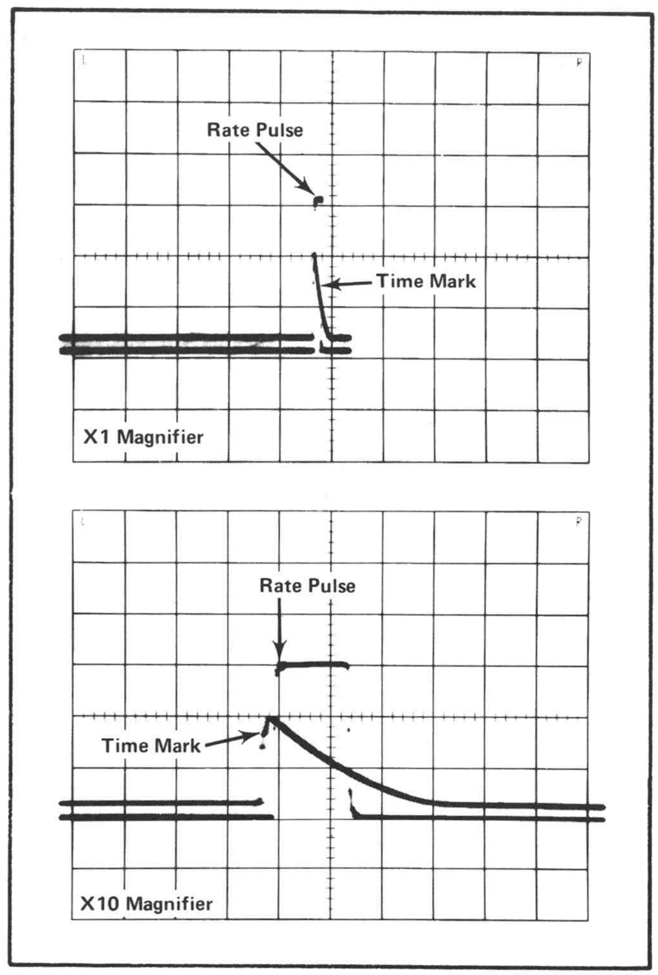


Fig. 5-8. Typical display for Rate Mult Timing Adjust, step 8.

g. Switch Magnifier to X10.

h. Adjust R2 to set the leading edge of the pulse to the leading edge of the time mark.

i. Switch Magnifier to X1 and Time/Div to 1 ms.

j. Turn RATE MULT to 1.00.

k. Set Time Mark Generator Marker Selector to 1 ms.

l. Set R34 for one pulse for each time mark.

m. Set Time Base Time/Div to .1 ms.

n. Position 2nd time mark horizontally to graticule center.

o. Switch Magnifier to X10.

p. ADJUST—R34 to set the leading edge of the pulse to the leading edge of the time mark.

PARTS LIST ABBREVIATIONS

BHB	binding head brass	int	internal
BHS	binding head steel	lg	length or long
cap.	capacitor	met.	metal
cer	ceramic	mtg hdw	mounting hardware
comp	composition	OD	outside diameter
conn	connector	OHB	oval head brass
CRT	cathode-ray tube	OHS	oval head steel
csk	countersunk	P/O	part of
DE	double end	PHB	pan head brass
dia	diameter	PHS	pan head steel
div	division	plstc	plastic
elect.	electrolytic	PMC	paper, metal cased
EMC	electrolytic, metal cased	poly	polystyrene
EMT	electrolytic, metal tubular	prec	precision
ext	external	PT	paper, tubular
F & I	focus and intensity	PTM	paper or plastic, tubular, molded
FHB	flat head brass	RHB	round head brass
FHS	flat head steel	RHS	round head steel
Fil HB	fillister head brass	SE	single end
Fil HS	fillister head steel	SN or S/N	serial number
h	height or high	S or SW	switch
hex.	hexagonal	TC	temperature compensated
HHB	hex head brass	THB	truss head brass
HHS	hex head steel	thk	thick
HSB	hex socket brass	THS	truss head steel
HSS	hex socket steel	tub.	tubular
ID	inside diameter	var	variable
inc	incandescent	w	wide or width
		WW	wire-wound

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.

INDEX OF ELECTRICAL PARTS LIST

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		

CHASSIS

Bulb

DS178	*150-0048-01			Incandescent, #683, selected		

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R36	311-1057-00			5 kΩ, Var		
R61	315-0105-00			1 MΩ	1/4 W	5%
R62	315-0104-00			100 kΩ	1/4 W	5%
R122	311-0946-00			50 kΩ, Var		

Switches

	Wired or Unwired					
S30	260-1155-00			Rotary	RATE	
S60	260-1154-00			Rotary	RAMP DURATION	

A1 MAIN Circuit Board Assembly

	*670-1202-00			Complete Board		

Capacitors

Tolerance ±20% unless otherwise indicated.

C3	283-0003-00			0.01 μF	Cer	150 V	
C4	283-0003-00			0.01 μF	Cer	150 V	
C20	281-0518-00			47 pF	Cer	500 V	
C21	281-0523-00			100 pF	Cer	350 V	
C24	283-0000-00			0.001 μF	Cer	500 V	
C28	281-0504-00			10 pF	Cer	500 V	10%

A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Capacitors (cont)			
C30A [1]	*295-0139-00			10 μF	Timing Series		
C30B				1 μF			
C30C				0.1 μF			
C30D				0.01 μF			
C30E				980 pF			
C42	283-0114-00			0.0015 μF	Cer	200 V	5%
C52	281-0518-00			47 pF	Cer	500 V	
C54	281-0523-00			100 pF	Cer	350 V	
C55	281-0523-00			100 pF	Cer	350 V	
C62	290-0244-00			0.47 μF	Elect.	35 V	5%
C64	281-0525-00			470 pF	Cer	500 V	
C72	283-0000-00			0.001 μF	Cer	500 V	
C73	281-0525-00			470 pF	Cer	500 V	
C77	281-0523-00			100 pF	Cer	350 V	
C91	281-0523-00			100 pF	Cer	350 V	
C92	281-0523-00			100 pF	Cer	350 V	
C102	283-0003-00			0.01 μF	Cer	150 V	
C104	281-0504-00			10 pF	Cer	500 V	10%
C108	283-0003-00			0.01 μF	Cer	150 V	
C111	281-0518-00			47 pF	Cer	500 V	
C112	281-0523-00			100 pF	Cer	350 V	
C120A	281-0111-00			2-27 pF, Var	Air		
C120B	283-0633-00			77 pF	Mica	100 V	1%
C120C [1]	*295-0139-00			980 pF	Timing Series		
C120D				0.01 μF			
C120E				0.1 μF			
C120F				1 μF			
C120G				10 μF			
C180	281-0543-00			270 pF	Cer	500 V	10%
C192	283-0001-00			0.005 μF	Cer	500 V	
C321	281-0523-00			100 pF	Cer	350 V	
C328	290-0135-00			15 μF	Elect.	20 V	
C331	281-0523-00			100 pF	Cer	350 V	
C336	290-0135-00			15 μF	Elect.	20 V	
C341	290-0135-00			15 μF	Elect.	20 V	
C343	281-0523-00			100 pF	Cer	350 V	
C346	290-0135-00			15 μF	Elect.	20 V	
C350	283-0003-00			0.01 μF	Cer	150 V	
C352	283-0003-00			0.01 μF	Cer	150 V	
C354	283-0003-00			0.01 μF	Cer	150 V	

[1]**Individual timing capacitors in this assembly must be ordered by the 9 digit part number, letter suffix and tolerance printed on the timing capacitor to be replaced.**

Example: **F—**

285-XXXX-XX

The letter suffix and the tolerance should be the same for all of the timing capacitors in the assembly.

MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Semiconductor Device, Diodes		
CR3	*152-0185-00			Silicon		Replaceable by 1N4152
CR46	*152-0185-00			Silicon		Replaceable by 1N4152
CR55	*152-0185-00			Silicon		Replaceable by 1N4152
CR58	*152-0185-00			Silicon		Replaceable by 1N4152
CR80	*152-0185-00			Silicon		Replaceable by 1N4152
CR83	*152-0185-00			Silicon		Replaceable by 1N4152
CR85	*152-0185-00			Silicon		Replaceable by 1N4152
CR92	*152-0185-00			Silicon		Replaceable by 1N4152
CR98	*152-0185-00			Silicon		Replaceable by 1N4152
CR134	*152-0185-00			Silicon		Replaceable by 1N4152
CR136	*152-0185-00			Silicon		Replaceable by 1N4152
CR137	*152-0185-00			Silicon		Replaceable by 1N4152
CR143	*152-0185-00			Silicon		Replaceable by 1N4152
CR160	*152-0185-00			Silicon		Replaceable by 1N4152
CR173	*152-0185-00			Silicon		Replaceable by 1N4152
CR186	*152-0185-00			Silicon		Replaceable by 1N4152
CR190	152-0246-00			Silicon		Low leakage, 250 mW, 40 V
CR324	*152-0185-00			Silicon		Replaceable by 1N4152
VR346	152-0217-00			Zener		1N756A 400 mW, 8.2 V, 5%
				Inductor		
L147	*120-0407-00			Toroid, 5 turns, single		
				Transistors		
Q10	151-0223-00			Silicon	NPN	TO-18 2N4275
Q24	151-0221-00			Silicon	PNP	TO-18 2N4258
Q26	*151-0277-00			Silicon	NPN	Low leakage Tek Spec
Q40	151-0220-00			Silicon	PNP	TO-18 2N4122
Q48	151-0220-00			Silicon	PNP	TO-18 2N4122
Q55	151-0190-00			Silicon	NPN	TO-92 2N3904
Q84	*151-0219-00			Silicon	PNP	TO-18 Replaceable by 2N4250
Q95	151-0190-00			Silicon	NPN	TO-92 2N3904
Q96	151-0223-00			Silicon	NPN	TO-18 2N4275
Q132	151-0232-00			Silicon	NPN	TO-77 Dual
Q140	151-0220-00			Silicon	PNP	TO-18 2N4122
Q145	*151-0103-00			Silicon	NPN	TO-5 Replaceable by 2N2219
Q162	151-0188-00			Silicon	PNP	TO-92 2N3906
Q170	*151-0216-00	B010100	B019999	Silicon	PNP	TO-92 Replaceable by MOT MPS 6523
Q170	151-0188-00	B020000		Silicon	PNP	TO-92 2N3906
Q174	151-0164-00			Silicon	PNP	TO-5 2N3702

A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			

Transistors (cont)

Ckt. No.	Tektronix Part No.	Eff	Disc	Description		
Q182	*151-0216-00	B010100	B019999	Silicon	PNP	TO-92 Replaceable by MOT MPS 6523
Q182	151-0188-00	B020000		Silicon	PNP	TO-92 2N3906
Q184	151-0164-00			Silicon	PNP	TO-5 2N3702
Q190	*151-0195-00			Silicon	NPN	TO-92 Replaceable by MPS 6515
Q194	151-1025-00			FET		N channel, junction type, X55
Q196	151-0188-00			Silicon	PNP	TO-92 2N3906
Q198	151-0164-00			Silicon	PNP	TO-5 2N3702
Q328	*151-0134-00			Silicon	PNP	TO-5 Replaceable by 2N2905
Q334	151-0260-00			Silicon	NPN	TO-39 2N5189
Q346	151-0260-00			Silicon	NPN	TO-39 2N5189

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Value	Power	Type	Tolerance
R1	321-0250-00	3.92 kΩ	1/8 W	Prec	1%
R2	311-0609-00	2 kΩ, Var			
R3	321-0265-00	5.62 kΩ	1/8 W	Prec	1%
R4	321-0352-00	45.3 kΩ	1/8 W	Prec	1%
R6	316-0682-00	6.8 kΩ	1/4 W		
R8	315-0621-00	620 Ω	1/4 W		5%
R10	316-0682-00	6.8 kΩ	1/4 W		
R14	316-0682-00	6.8 kΩ	1/4 W		
R21	316-0101-00	100 Ω	1/4 W		
R23	316-0101-00	100 Ω	1/4 W		
R24	316-0102-00	1 kΩ	1/4 W		5%
R25	316-0822-00	8.2 kΩ	1/4 W		
R26	316-0472-00	4.7 kΩ	1/4 W		
R30	321-0402-01	150 kΩ	1/8 W	Prec	1/2%
R31	322-0469-01	750 kΩ	1/4 W	Prec	1/2%
R32	322-0469-01	750 kΩ	1/4 W	Prec	1/2%
R34	311-0978-00	250 Ω, Var			
R35	321-0155-00	402 Ω	1/8 W	Prec	1%
R40	316-0680-00	68 Ω	1/4 W		
R42	321-0265-00	5.62 kΩ	1/8 W	Prec	1%
R44	321-0239-00	3.01 kΩ	1/8 W	Prec	1%
R46	321-0090-00	84.5 Ω	1/8 W	Prec	1%
R48	321-0114-00	150 Ω	1/8 W	Prec	1%
R53	315-0103-00	10 kΩ	1/4 W		5%
R55	315-0103-00	10 kΩ	1/4 W		5%
R57	316-0472-00	4.7 kΩ	1/4 W		
R58	316-0222-00	2.2 kΩ	1/4 W		
R59	316-0102-00	1 kΩ	1/4 W		
R64	315-0303-00	30 kΩ	1/4 W		5%
R66	316-0682-00	6.8 kΩ	1/4 W		
R68	316-0682-00	6.8 kΩ	1/4 W		

A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R69	316-0682-00			6.8 kΩ	¼ W		
R71	316-0106-00			10 MΩ	¼ W		
R72	316-0471-00			470 Ω	¼ W		
R74	316-0682-00			6.8 kΩ	¼ W		
R75	316-0682-00			6.8 kΩ	¼ W		
R80	315-0103-00			10 kΩ	¼ W		5%
R82	316-0682-00			6.8 kΩ	¼ W		
R84	316-0102-00			1 kΩ	¼ W		
R85	315-0303-00			30 kΩ	¼ W		5%
R86	315-0242-00			2.4 kΩ	¼ W		5%
R87	315-0162-00			1.6 kΩ	¼ W		5%
R89	316-0682-00			6.8 kΩ	¼ W		
R91	315-0103-00			10 kΩ	¼ W		5%
R92	315-0103-00			10 kΩ	¼ W		5%
R94	316-0472-00			4.7 kΩ	¼ W		
R95	316-0332-00			3.3 kΩ	¼ W		
R98	316-0682-00			6 8 kΩ	¼ W		
R100	321-0262-00			5.23 kΩ	⅛ W	Prec	1%
R101	311-0609-00			2 kΩ, Var			
R102	321-0282-00			8.45 kΩ	⅛ W	Prec	1%
R104	315-0682-00			6.8 kΩ	¼ W		5%
R106	316-0682-00			6.8 kΩ	¼ W		
R108	315-0621-00			620 Ω	¼ W		5%
R112	316-0101-00			100 Ω	¼ W		
R113	316-0153-00			15 kΩ	¼ W		
R120	322-0473-02			825 kΩ	¼ W	Prec	½%
R121	322-0473-02			825 kΩ	¼ W	Prec	½%
R123	321-0406-02			165 kΩ	⅛ W	Prec	½%
R124	321-0253-00			4.22 kΩ	⅛ W	Prec	1%
R125	311-0609-00			2 kΩ, Var			
R126	321-0126-00			200 Ω	⅛ W	Prec	1%
R127	321-0306-00			15 kΩ	⅛ W	Prec	1%
R128	311-1035-00			50 kΩ, Var			
R130	311-1035-00			50 kΩ, Var			
R131	321-0356-00			49.9 kΩ	⅛ W	Prec	1%
R132	321-0193-00			1 kΩ	⅛ W	Prec	1%
R134	315-0752-00			7.5 kΩ	¼ W		5%
R136	321-0251-00			4.02 kΩ	⅛ W	Prec	¼%
R137	311-0635-00			1 kΩ, Var			
R138	315-0153-00			15 kΩ	¼ W		5%

A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Resistors (cont)			
R140	315-0302-00			3 kΩ	¼ W		5%
R141	315-0123-00			12 kΩ	¼ W		5%
R143	315-0222-00			2.2 kΩ	¼ W		5%
R145	315-0101-00			100 Ω	¼ W		5%
R147	321-0612-03			500 Ω	⅛ W	Prec	¼%
R148	321-0750-06			55.5 Ω	⅛ W	Prec	1%
R161	315-0332-00			3.3 kΩ	¼ W		5%
R163	316-0152-00			1.5 kΩ	¼ W		
R165	315-0102-00			1 kΩ	¼ W		5%
R166	315-0392-00			3.9 kΩ	¼ W		5%
R171	315-0471-00			470 Ω	¼ W		5%
R173	315-0151-00			150 Ω	¼ W		5%
R180	316-0101-00			100 Ω	¼ W		
R181	315-0243-00			24 kΩ	¼ W		5%
R182	315-0752-00			7.5 kΩ	¼ W		5%
R184	315-0471-00			470 Ω	¼ W		5%
R186	315-0151-00			150 Ω	¼ W		5%
R190	316-0333-00			33 kΩ	¼ W		
R192	316-0336-00			33 MΩ	¼ W		
R196	316-0103-00			10 kΩ	¼ W		
R198	316-0332-00			3.3 kΩ	¼ W		
R320	316-0103-00			10 kΩ	¼ W		
R324	316-0681-00			680 Ω	¼ W		
R326	316-0470-00			47 Ω	¼ W		
R328	321-0603-07			15 kΩ	⅛ W	Prec	1/10%
R329	321-0603-07			15 kΩ	⅛ W	Prec	1/10%
R330	316-0103-00			10 kΩ	¼ W		
R333	316-0330-00			33 Ω	¼ W		
R334	316-0681-00			680 Ω	¼ W		
R335	302-0330-00			33 Ω	½ W		
R336	321-0816-07			5 kΩ	⅛ W	Prec	1/10%
R338	321-0603-07			15 kΩ	⅛ W	Prec	1/10%
R340	321-0239-00			3.01 kΩ	⅛ W	Prec	1%
R341	321-0239-00			3.01 kΩ	⅛ W	Prec	1%
R343	316-0103-00			10 kΩ	¼ W		
R344	321-0274-00			6.98 kΩ	⅛ W	Prec	1%
R345	311-0634-00			500 Ω, Var			
R346	321-0223-00			2.05 kΩ	⅛ W	Prec	1%
R348	316-0470-00			47 Ω	¼ W		
R349	316-0681-00			680 Ω	¼ W		

A1 MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
				Integrated Circuits
U10	*155-0028-00			Miller integrator
U70	*155-0029-01	B010100	B019999	Sweep control, 16-pin DIP
U70	*155-0056-00	B020000		Sweep control
U110	*155-0028-00			Miller integrator
U320	156-0071-00			Volt reg. Replaceable by Fairchild μA723C
U330	156-0071-00			Volt reg. Replaceable by Fairchild μA723C
U340	156-0071-00			Volt reg. Replaceable by Fairchild μA723C

A2 MODE SWITCH Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
	*670-1206-00			Complete Board
				Bulb
DS65	*150-0048-01			Incandescent, #683, selected
				Switch
	Wired or Unwired			
S65[2]	*670-1206-00			Pushbutton MODE

A3 GATE SWITCH Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
	*670-1207-00			Complete Board
				Bulb
DS55	*150-0048-01			Incandescent, #683, selected
				Switch
	Wired or Unwired			
S55[2]	*670-1207-00			Pushbutton GATE

A4 TRIGGER SWITCH Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
	*670-1208-00			Complete Board
				Bulb
DS75	*150-0048-01			Incandescent, #683, selected
				Switch
	Wired or Unwired			
S75[2]	*670-1208-00			Pushbutton TRIGGER

[2]See Mechanical Parts List for replacement parts.

SECTION 7

DIAGRAMS, CIRCUIT BOARDS, MECHANICAL AND REPACKAGING PARTS ILLUSTRATIONS

Symbols and Reference Designators

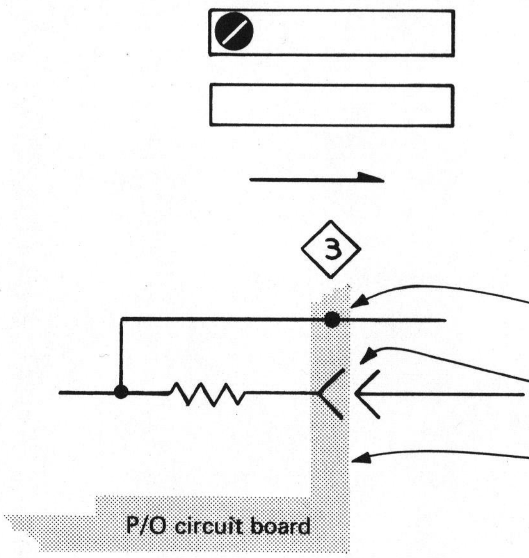
Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors =	Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors =	Ohms (Ω)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



External screwdriver adjustment.

External control or connector.

Clockwise control rotation in direction of arrow.

Refer to diagram number indicated in diamond.

Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)
AT	Attenuator, fixed or variable
B	Motor
BT	Battery
C	Capacitor, fixed or variable
CR	Diode, signal or rectifier
DL	Delay line
DS	Indicating device (lamp)
F	Fuse
FL	Filter
H	Heat dissipating device (heat sink, heat radiator, etc.)
HR	Heater
J	Connector, stationary portion
K	Relay
L	Inductor, fixed or variable
LR	Inductor/resistor combination
M	Meter
Q	Transistor or silicon-controlled rectifier
P	Connector, movable portion
R	Resistor, fixed or variable
RT	Thermistor
S	Switch
T	Transformer
TP	Test point
U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
V	Electron tube
VR	Voltage regulator (zener diode, etc.)
Y	Crystal

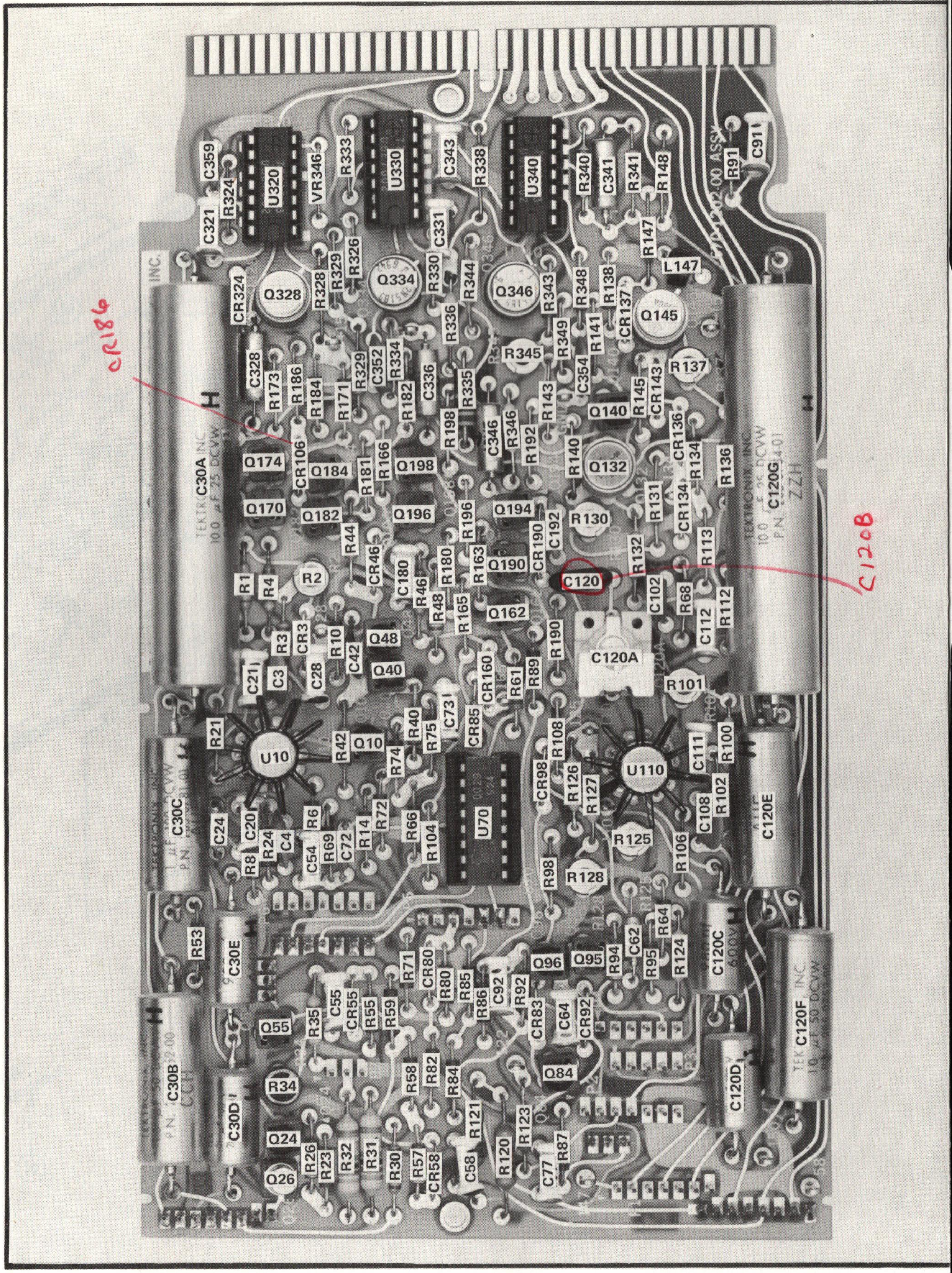
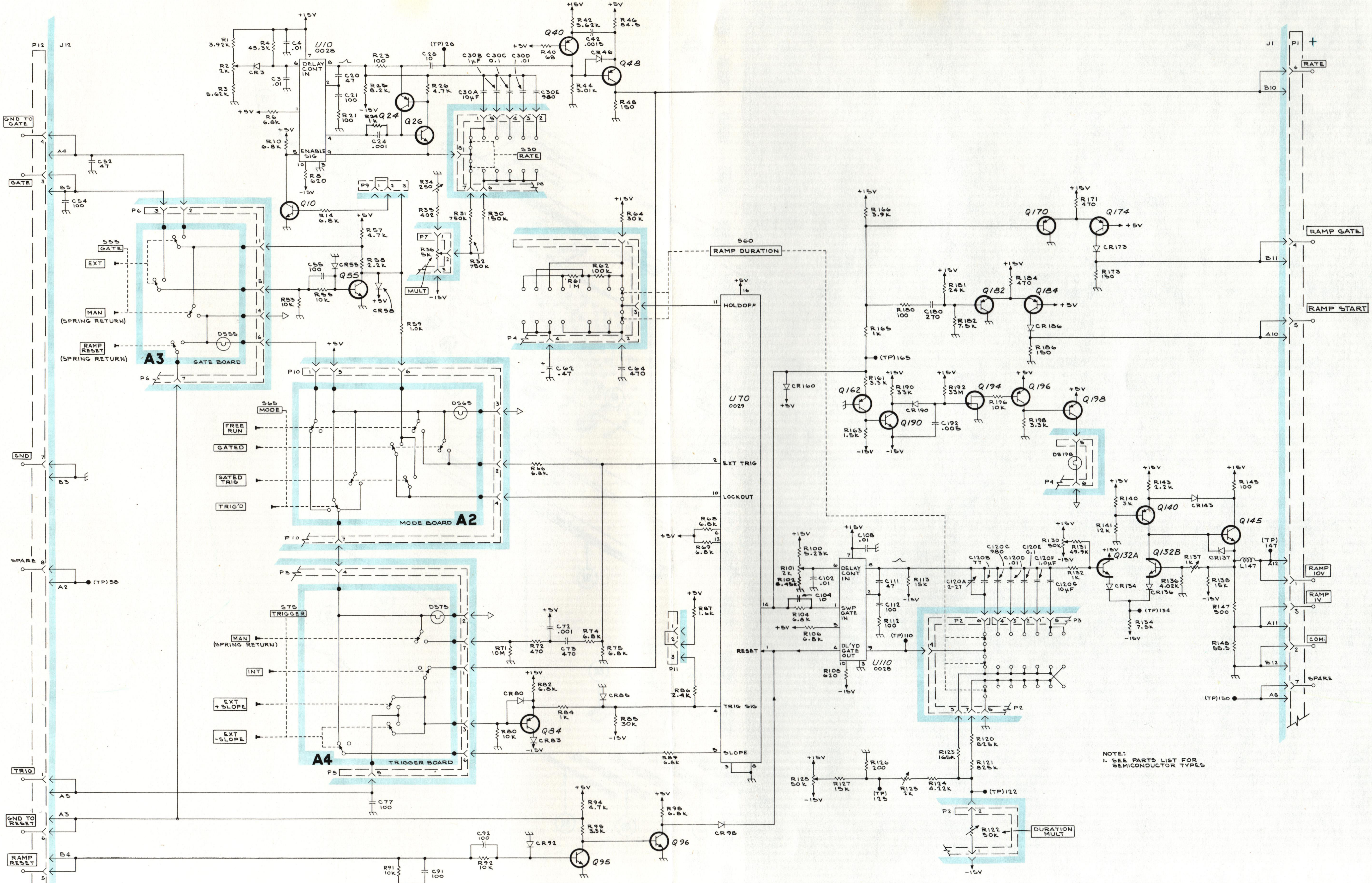


FIG 7-1 A1 MAIN CIRCUIT BOARD ASSEMBLY



A1 RAMP/RATE GENERATOR

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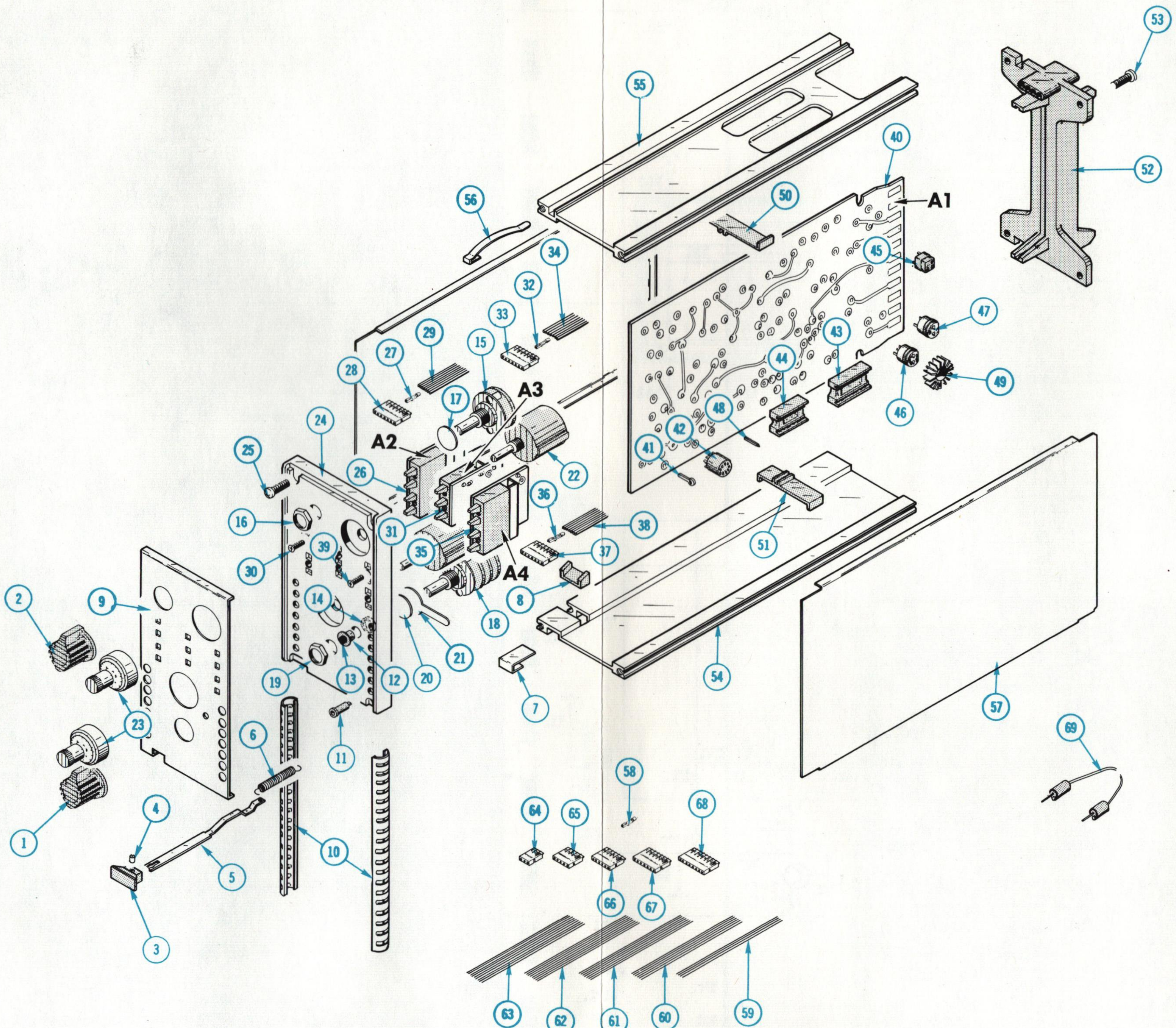
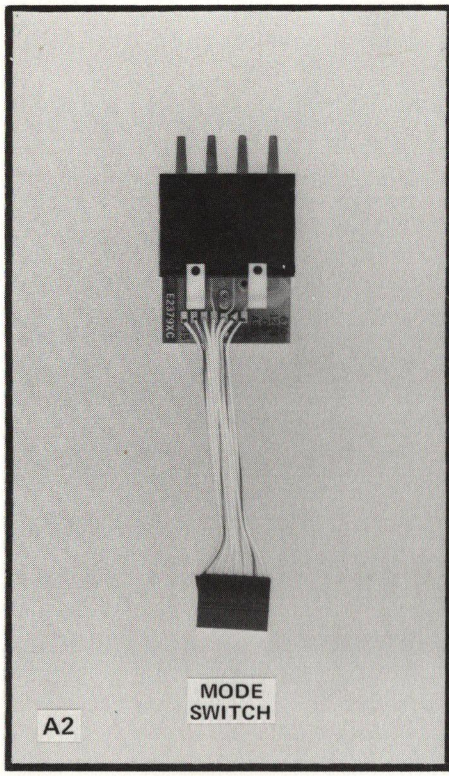
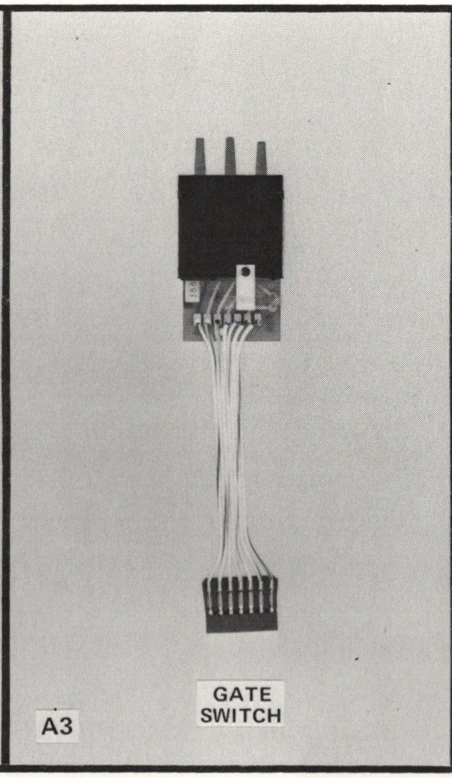
FIG. 1 EXPLODED & STANDARD ACCESSORIES







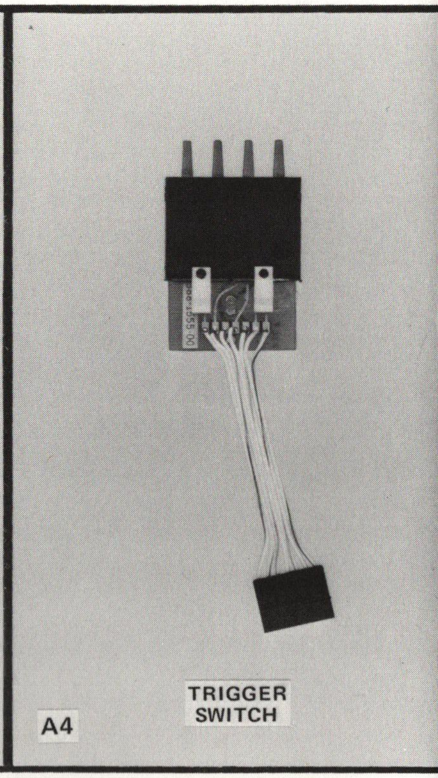
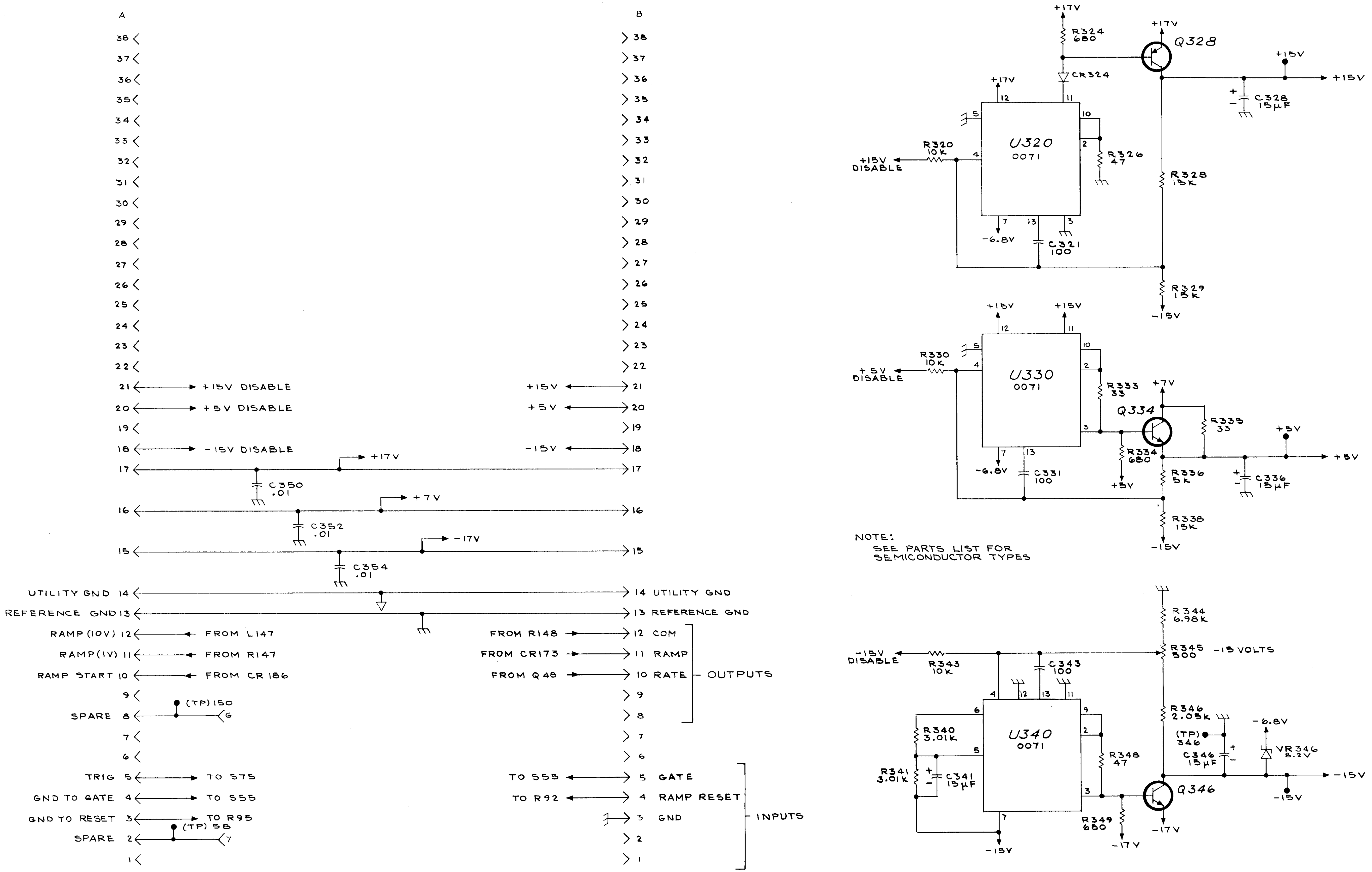


FIG 7-2 MODE SWITCH

FIG 7-3 GATE SWITCH

FIG 7-4 TRIGGER SWITCH



A1 PLUG-IN CONNECTOR & REGULATORS

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CARTON ASSEMBLY
(Part No. 065-0138-00)

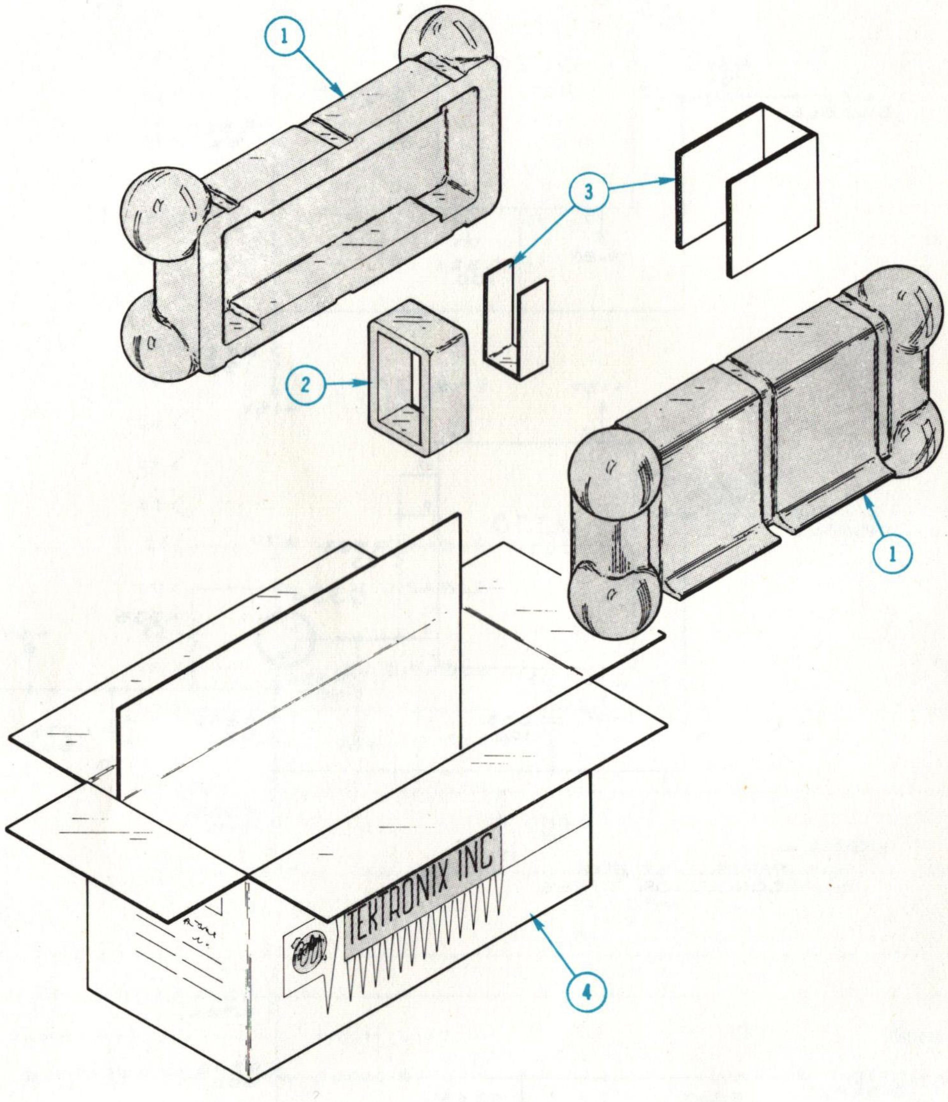

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-	065-0138-00			1	CARTON ASSEMBLY
	- - - - - -			-	carton assembly includes:
-1	004-0241-00			2	CASE HALF
-2	004-0243-00			1	END CAP, front
-3	004-1079-00			1	PAD SET, 2 piece
-4	004-0748-00			1	CARTON

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear either on the back of the diagrams or on pullout pages immediately following the diagrams of the instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicated item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
  Detail Part of Assembly and/or Component
  mounting hardware for Detail Part
    Parts of Detail Part
    mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL AND REPACKAGING PARTS ILLUSTRATIONS

SECTION 8
MECHANICAL PARTS LIST

FIGURE 1 EXPLODED & STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-1	366-1028-00			1	KNOB, gray—RAMP DURATION
	- - - - - -			-	knob includes:
	213-0153-00			2	SETSCREW, 5-40 x 0.125 inch, HSS
-2	366-1028-00			1	KNOB, gray—RATE
	- - - - - -			-	knob includes:
	213-0153-00			2	SETSCREW, 5-40 x 0.125 inch, HSS
-3	366-1058-16			1	KNOB, latch
	- - - - - -			-	mounting hardware: *(not included w/knob)*
-4	214-1095-00			1	PIN, spring, split
-5	105-0075-00			1	RELEASE BAR, latch
-6	214-1280-00			1	SPRING, helical compression
-7	214-1054-00			1	SPRING, flat, latch detent
-8	105-0076-00			1	BOLT, latch, plastic
-9	333-1295-00			1	PANEL, front
-10	348-0235-00			2	SHIELDING GASKET, electrical
-11	136-0387-00			14	SOCKET, 1 pin
-12	352-0157-00			1	HOLDER, lamp
-13	378-0602-00			1	LENS, indicator light
-14	200-0935-00			1	CAP, lamp holder
-15	260-1155-00			1	SWITCH, rotary—RATE, unwired
	- - - - - -			-	mounting hardware: *(not included w/switch)*
-16	210-0590-00			1	NUT, hex., 0.375-32 x 0.438 inch
-17	210-0012-00			1	WASHER, lock, internal, 0.375 ID x 0.50 inch OD
-18	260-1154-00			1	SWITCH, rotary—RAMP DURATION, unwired
	- - - - - -			-	mounting hardware: *(not included w/switch)*
-19	210-0590-00			1	NUT, hex., 0.375-32 x 0.438 inch
-20	210-0012-00			1	WASHER, lock, internal, 0.375 ID x 0.50 inch OD
-21	210-0207-00			1	LUG, solder, 0.375 ID x 0.625 inch OD, SE
-22	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: *(not included w/resistor)*
-23	331-0268-00			1	DIAL, control, 10 turn
-24	386-1447-33			1	SUBPANEL, front
	- - - - - -			-	mounting hardware: *(not included w/subpanel)*
-25	213-0192-00			4	SCREW, thread forming, 6-32 x 0.50 inch, Fil HS

FIGURE 1 EXPLODED & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
-26	670-1206-00			1	CIRCUIT BOARD ASSEMBLY—MODE A2
	- - - - - -			-	circuit board assembly includes:
-27	131-0707-00			7	CONNECTOR, terminal
-28	352-0165-00			1	HOLDER, terminal connector, 7 wire *(black)*
-29	175-0830-00			ft	WIRE, electrical, 7 wire ribbon, 0.271 foot long
	380-0155-00			1	HOUSING, light, 4 button
	- - - - - -			-	mounting hardware: *(not included w/housing)*
	213-0181-00			1	SCREW, thread forming, #2 x 0.375 inch, PHS
	- - - - - -			-	mounting hardware: *(not included w/circuit board assembly)*
-30	211-0156-00			2	SCREW, 1-72 x 0.25 inch, 82° csk, FHS
-31	670-1207-00			1	CIRCUIT BOARD ASSEMBLY—GATE & RAMP RESET A3
	- - - - - -			-	circuit board assembly includes:
-32	131-0707-00			7	CONNECTOR, terminal
-33	352-0165-06			1	HOLDER, terminal connector, 7 wire *(blue)*
-34	175-0830-00			ft	WIRE, electrical, 7 wire ribbon, 0.271 foot long
	380-0154-00			1	HOUSING, light, 3 button
	- - - - - -			-	mounting hardware: *(not included w/housing)*
	213-0181-00			1	SCREW, thread forming, #2 x 0.375 inch, PHS
	- - - - - -			-	mounting hardware: *(not included w/housing)*
	211-0156-00			2	SCREW, 1-72 x 0.25 inch, 82° csk, FHS
-35	670-1208-00			1	CIRCUIT BOARD ASSEMBLY—TRIGGER A4
	- - - - - -			-	circuit board assembly includes:
-36	131-0707-00			7	CONNECTOR, terminal
-37	352-0165-05			1	HOLDER, terminal connector, 7 wire *(green)*
-38	175-0830-00			ft	WIRE, electrical, 7 wire ribbon, 0.271 foot long
	380-0155-00			1	HOUSING, light, 4 button
	- - - - - -			-	mounting hardware: *(not included w/housing)*
	213-0181-00			1	SCREW, thread forming, #2 x 0.375 inch, PHS
	- - - - - -			-	mounting hardware: *(not included w/circuit board assembly)*
-39	211-0156-00			2	SCREW, 1-72 x 0.25 inch, 82° csk, FHS
-40	670-1202-00			1	CIRCUIT BOARD ASSEMBLY—MAIN A1
	- - - - - -			-	circuit board assembly includes:
	388-1551-00			1	CIRCUIT BOARD
-41	214-0579-00			13	PIN, test point
-42	136-0241-00			2	SOCKET, integrated circuit, 10 pin
-43	136-0260-01			1	SOCKET, integrated circuit, 16 pin
-44	136-0269-00			3	SOCKET, integrated circuit, 14 pin
-45	136-0220-00			19	SOCKET, transistor, 3 pin, square
-46	136-0235-00			1	SOCKET, transistor, 6 pin
-47	136-0183-00			4	SOCKET, transistor, 3 pin
-48	131-0608-00			71	TERMINAL, pin, 0.365 inch long
-49	214-1291-00			2	HEAT SINK, transistor
	- - - - - -			-	mounting hardware: *(not included w/circuit board assembly)*
-50	344-0210-00			2	CLIP, spring tension, plastic, top
-51	344-0211-00			2	CLIP, spring tension, plastic, bottom

FIGURE 1 EXPLODED & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
-52	386-1402-00			1	PANEL, rear
	- - - - - -			-	mounting hardware: *(not included w/panel)*
-53	213-0192-00			4	SCREW, thread forming, 6-32 x 0.50 inch, Fil HS
-54	426-0628-00			1	FRAME SECTION, bottom
-55	426-0629-00			1	FRAME SECTION, top
-56	214-1061-00			1	SPRING, flat, sliding ground
-57	337-1316-00			2	SHIELD, electrical
-58	131-0707-00			50	CONNECTOR, terminal
-59	175-0826-00			ft	WIRE, electrical, 3 wire, ribbon, 0.448 foot long
-60	175-0828-00			ft	WIRE, electrical, 5 wire ribbon, 0.448 foot long
-61	175-0829-00			ft	WIRE, electrical 6 wire ribbon, 0.448 foot long
-62	175-0830-00			ft	WIRE, electrical, 7 wire ribbon, 0.75 foot long
-63	175-0831-00			ft	WIRE, electrical, 8 wire ribbon, 0.667 foot long
-64	352-0161-01			1	HOLDER, terminal connector, 3 wire *(brown)*
	352-0161-07			1	HOLDER, terminal connector, 3 wire *(violet)*
	352-0161-09			1	HOLDER, terminal connector, 3 wire *(white)*
-65	352-0163-03			1	HOLDER, terminal connector, 5 wire *(orange)*
-66	352-0164-04			1	HOLDER, terminal connector, 6 wire *(yellow)*
-67	352-0165-01			1	HOLDER, terminal connector, 7 wire *(brown)*
	352-0165-02			1	HOLDER, terminal connector, 7 wire *(red)*
-68	352-0166-02			1	HOLDER, terminal connector, 8 wire *(red)*
	352-0166-08			1	HOLDER, terminal connector, 8 wire *(gray)*

STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description
-69	012-0200-00			2	PATCH CORD, pinjack to pinjack *(red)*
	012-0201-00			2	PATCH CORD, pinjack to pinjack *(blue)*
	012-0202-00			1	PATCH CORD, pinjack to pinjack *(black)*
	070-1065-00			1	MANUAL, instruction *(not shown)*