

O P E R A T I N G   A N D   S E R V I C E   M A N U A L

# LOGIC PULSER

## 546A



HEWLETT  
PACKARD

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## **CERTIFICATION**

*Hewlett-Packard Company certifies that this instrument met its published specifications at the time of shipment from the factory. Hewlett-Packard Company further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.*

## **WARRANTY AND ASSISTANCE**

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from the date of shipment. Hewlett-Packard will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard, and provided the preventive maintenance procedures in this manual are followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

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

CHANGE DATE: May 5, 1983

# MANUAL CHANGES

## MANUAL DESCRIPTION

This change supersedes all earlier dated changes.

\*\*\* Make all corrections listed under ERRATA before making other changes.

\*\*\* Check following table for your instrument's serial prefix, series number, or date code and make listed change(s) to manual.

```
*****
* INSTRUMENT:      546A
*      Logic Pulser Operating and
*      Service Manual
*
* SERIAL PREFIX:    1644
*
* DATE PRINTED:     MAY 1977
* HP PART NO:       00546-90005
* MICROFICHE NO:    00546-90006
*****
```

# INDICATES NEW OR REVISED ITEM		> INDICATES ACTION TO BE TAKEN	
SERIAL PREFIX, SERIES NUMBER OR DATE CODE	MANUAL CHANGE(S)	SERIAL PREFIX, SERIES NUMBER OR DATE CODE	MANUAL CHANGE(S)
00546-60100 . . . . . 1 Series 1732		00546-60100 . . . . . 1 thru 3 Series 2012	
00546-60100 . . . . . 1,2 Series 2008		01A2132. . . . . 1 thru 4 01A2312. . . . . 1 thru 5 02A2312. . . . . 1 thru 6	

(C5460SX) 1=6809,6812/2=8886E/3=9712E/4=12414,12007/5=14585



Insert this Warning after the Certification/Warranty and Assistance which is on the inside front cover.

### WARNING

This product should be connected to a power source that is sufficiently isolated from the main supply to prevent the risk of electric shock.

To further reduce the risk of electric shock, refer to the service manual for the equipment under test (when applicable) and follow the manufacturer's service and safety precautions particularly when voltages exceeding 30 VRMS or 50 VDC are present.

#ERRATA

Page 30, Figure 14, NOTE\*:

>Change note to read "MP3 NOT USED IN ALL PULSERS. SEE PAGE 33."

Page 33, Table 6, Replaceable Parts:

>Change HP part number for A1R4 to 0686-1325.

Page 36, Figure 16, A1 Schematic Diagram:

>Add two short parallel arrows adjacent to DS1 to indicate a light emitting diode.

>Change NOTE 3 to "U1 PIN 12 MAY BE CONNECTED TO COMMON IN SOME PULSERS".

>Add "+" symbol adjacent to top terminal of C2 to indicate the positive side of the electrolytic capacitor for C2.

Page 32, Table 6, Replaceable Parts:

>Change A1MP1 from 00546-20202 to 0570-0662 in HP Part Number and Mfr. Part Number columns.

CHANGE 1 (00546-60003 Series 1732)

NOTE -- The circuit board is changed mechanically to incorporate an improved push switch. The new 00546-60003 circuit board is electrically identical to the 00546-60002 SERIES 1644 circuit board.



CHANGE 1 (cont'd)

Page 30, Figure 14, Pulser Disassembled:

- >Change MP4 to MP14.
- >Change MP5 to MP15.
- >Change MP8 to MP9.

Page 32, Table 6-1, Replaceable Parts:

- >Change A1 part number from 00546-60002 to 00546-60003 for HP & Mfr. Part No.
- >Change A1 Series number from 1644 to 1732.

Page 33, Table 6, A1 (00546-60100) Replaceable Parts:

- >Change A1S1 from 00546-00001 to 0546-00002 in HP and Mfr. Part Number columns.

Page 33, Table 6, Miscellaneous Parts:

- >Change MP4 to MP14 and Part Number in HP and Mfr. columns from 00546-20201 to 00546-20202.
- >Change MP5 to MP15 and Part Number in HP and Mfr. columns from 00545-20203 to 00545-20205.
- >Change MP8 to MP9 and Part Number in HP and Mfr. columns from 00546-40001 to 00546-40004.
- >Add MP10; 00546-40003; RETAINER-SWITCH, BLK PLASTIC; 28480; 00546-40003.
- >Add MP11; 0624-0340; 2; SCREW-SELF TAPPING 0-42 (MP10 MTG); 28480; 0624-0340.
- >Add MP12; 7120-5268; NAMEPLATE; 28480; 7120-5268 (BOTTOM HALF).
- >Add MP13; 7120-5274; LABEL-OPERATING: 28480; 7120-5274 (TOP HALF).

CHANGE 1 (cont'd)

Page 36, Figure 16, A1 Schematic Diagram:

>Change HP Part Number for A1 from 00546-60002 to 00546-60003 SERIES 1732.

>Add to arrows by DS1 to indicate a LED.

>Change "U1 PIN 2" in NOTE 3 to U1 PIN 12.

CHANGE 2 (00546-60003 Series 2008)

Page 32, Table 6, Replaceable Parts:

>Change A1 from series 1732 to 2008.

>Add A1C8; 0160-0576; CAPACITOR FXD 0.1UF 20% 50VDC CER; 26654; 2130BR050R104M.

Page 36, Figure 16, A1 Schematic Diagram:

>Change A1 series number from 1732 to 2008.

>Add 0.1u capacitor C8 across power supply input between emitter of Q3 and circuit board common.

CHANGE 3 (00546-60003 Series 2012)

Page 32, Table 6, Replaceable Parts:

>Change A1 from series 2008 to 2012.

>Change A1C1 (0160-4422) to 0160-5238; CAPACITOR-FXD .82UF 20% 50VDC DISC CER.

Page 36, Figure 16, A1 Schematic Diagram:

>Change A1 Series from 2008 to 2016.

>Change A1C1 from 1uf to .82uf.

#CHANGE 4

Title Page SERIES NUMBERS NOT LISTED:

>Change to read as follows:

For Logic Pulsers with series numbers higher than 1644, or with condensed Series Numbers provided on the Date Code label, a MANUAL CHANGES sheet is included with this manual. For series numbers below 1644, refer to the Backdating paragraph in this manual.

Page 1 SERIES NUMBER:

>Delete the paragraph under "SERIES NUMBER".

>Replace with the following information:

SERIES/DATE CODE

This product is identified by a SERIES CODE and DATE CODE, located on a vinyl label affixed to the inside of either the top or bottom of the pulser shell. The Series/Date Code format used in all logic probes is as follows:

"01A2132"

The first two digits represent a condensed Series Code. When a change occurs to any model of HP logic probe family which affects the schematic, parts list, or specifications, the condensed SERIES CODE is incremented by one.

The letter "A" designates the country of origin; "A" indicates USA.



CHANGE 4 (cont'd)

The last four digits represent the Date Code. The Date Code identifies the date-of-manufacture for the pulser. The first two digits indicate the year the product was manufactured; the last two digits indicate the week of that year. Datecoding originated in the year 1960, at which time the code "00" was used for the first two digits to represent 1960. Every year after 1960 the code was incremented by one; for example, the Date Code "2012" indicates the product was manufactured in the 12th week of the year 1980 (1960+20).

Your pulser will have either a four-digit Series Number stamped on the printed circuit board or a condensed Series Code, prefixing the Date Code on a vinyl label affixed to the inside of the pulser shell.

WHICH CHANGES APPLY TO YOUR LOGIC PULSER?

There is a SERIES/DATE CODE number listed on the cover of the MANUAL CHANGES sheet. As changes are made, the condensed Series Code is incremented by one. Make all changes to your manual for Series Codes less than or equal to your pulser Series/Date Code.

CHANGE 5

Page 32 and 33, Table 6. A1 (00546-60003) Replaceable Parts:

- >Change C6 from 0160-4343 (.1UF) to 0180-0291 1UF +-10% 35 VDC TA.
- >Change R3 from 0698-7284 (100K) to 0698-7260 10K 1% .05W F TC=0 +- 100.

Page 36, Figure 16. A1 Logic Pulser Assembly Schematic Diagram:

- >Change the value for C6 from .1UF to 1UF.
- >Change the value for R3 from 100K to 10K.

#CHANGE 6

On the Title page, Change the Configuration Code from 01A to 02A.

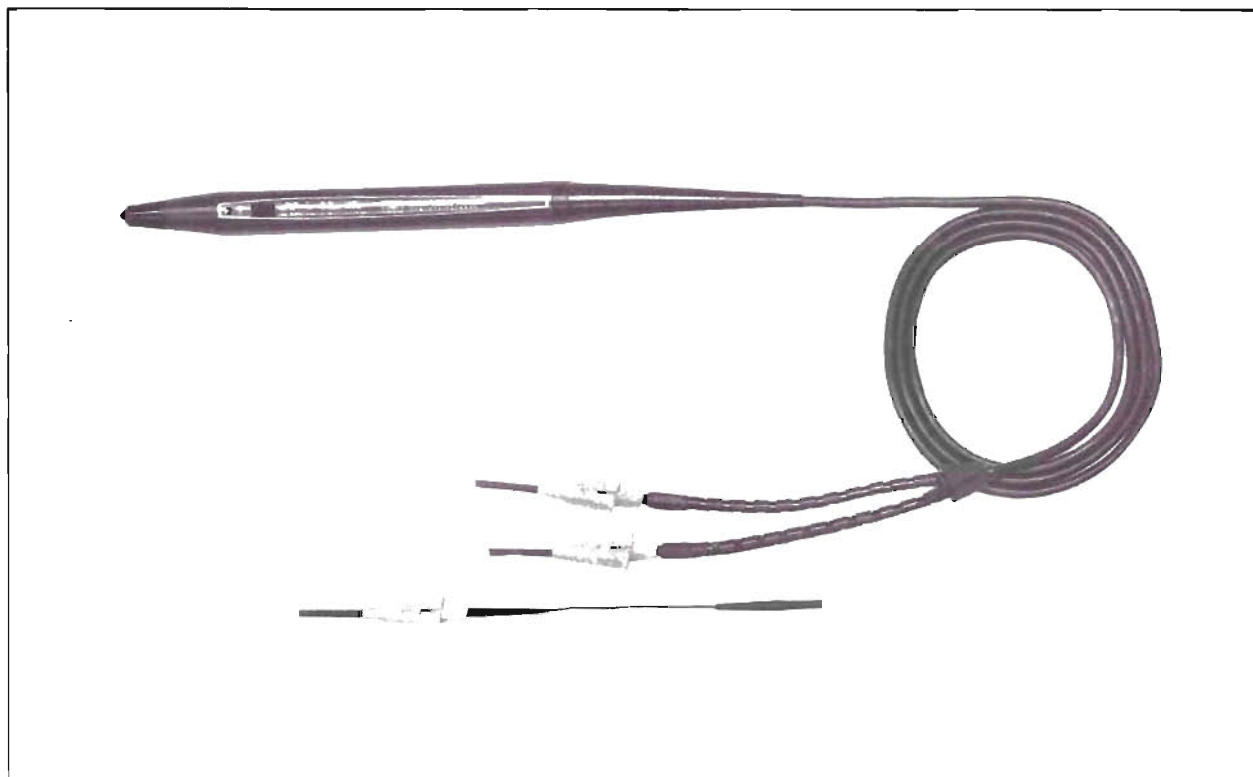


Figure 1. HP 546A Logic Pulser

## SCOPE OF MANUAL

This manual provides operating and service information for the Hewlett-Packard Model 546A Logic Pulser (*Figure 1*). The information includes a description of the Logic Pulser, accessories available, specifications, unpacking, operating characteristics, operating procedures, applications, theory of operation, maintenance, replaceable parts, and a schematic diagram.

## DESCRIPTION

The HP 546A Logic Pulser is a hand-held logic node stimulator used for injecting controlled pulses into digital logic circuits. The electronics are housed in a hand-held probe. Automatic pulse control is provided for TTL, DTL, RTL, HTL, MOS, and CMOS logic. Pulse amplitude depends on the logic supply voltage (3-18V) which is also the supply voltage for the Logic Pulser. Pulse current and pulse width depends on the load being pulsed. The frequency and number of pulses generated by the pulser is controlled by operation of a push-slide switch on the pulser probe. A flashing LED indicator located in the tip indicates the output mode. Refer to *Table 1* for Logic Pulser specifications and to *Figure 2* for accessories available.

## SERIES NUMBER

The Logic Pulser does not have a serial number. It does have a four digit series number, which is stamped on the printed circuit board. Refer to this number and the circuit board part number in any correspondence pertaining to maintenance.

Table 1. Specifications

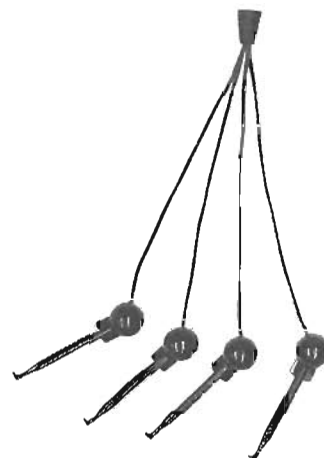
<b>Output<sup>1</sup></b>					
<b>Logic Family</b>	<b>Power Supply Voltage</b>	<b>Output Current</b>	<b>Pulse Width</b>	<b>Typical Output Voltage<sup>2</sup></b>	
				<b>High</b>	<b>Low</b>
TTL	5.0 $\pm$ 10% Vdc	$\leq$ 650 mA	$\geq$ 0.5 $\mu$ s	$\geq$ 3 Vdc	$\leq$ 0.8 Vdc
CMOS	3—18 Vdc	$\leq$ 100 mA	$\geq$ 5 $\mu$ s	$\geq$ V <sub>supply</sub> -1 Vdc 15V maximum	$\leq$ 0.5 Vdc
<p> <i>Tip Output Overload Protection:</i>  <math>\pm</math>25V for one minute  <i>Short Circuit Protection:</i>            Continuous  <i>Impedance:</i> &lt;2 ohms active;            &gt;1 megohm off  <i>Power Supply Requirements:</i>  <i>Operating Voltage Range:</i>              TTL ..... 5 <math>\pm</math> 10% Vdc              CMOS ..... 3—18 Vdc  <i>Operating Current:</i> <math>\leq</math>35 mA         </p> <p> <i>Power Supply Input Protection:</i>  <math>\pm</math>25V for one minute  <i>Time Base Accuracy:</i> <math>\pm</math>10%  <i>Operating Temperature:</i> 0—55°C  <i>Accessory Included:</i> Ground Cable  <i>Assembly, HP Part No. 00545-60105</i>  <i>Accessory Available:</i> Tip Set, HP  <i>Part No. 00545-60104</i> </p>					

<sup>1</sup>Specifications apply over stated operating voltages  
and temperatures for all pulse output modes.

<sup>2</sup>With ground clip attached near load.



**Tip Kit: 00545-60104**



**10526-60002  
Multi-Pin Stimulus Kit**

*Figure 2. 546A Logic Pulser Accessories Available*



## **UNPACKING**

If the shipping package is damaged, ask that the carrier's agent be present when the package is opened. Inspect the Logic Pulser for obvious physical damage (dents, scratches, etc.). If the Logic Pulser is damaged or fails to meet specifications, notify carrier and nearest Hewlett-Packard Sales and Service office immediately. (Sales and Service offices are listed at the back of this manual.) Retain shipping package and packaging material for carrier's inspection. The Sales and Service office will arrange for replacement of your Logic Pulser without waiting for claim against carrier to be settled.

## **POWER SUPPLY**

The power leads are connected to the power supply of the logic being pulsed (3 to 18V). Reverse polarity and excess voltage protection are provided. The red power lead is connected to the positive side of the power supply.

## **OUTPUT GROUND CABLE**

A connector for the ground cable provided is located at the tip of the Logic Pulser. When maximum current output is desired, use the ground cable supplied with the Pulser to make the common return path as short as possible. Current pulses from the Pulser can be more than 650 mA. The ground cable reduces the IR drop and the lead inductance.

## OPERATING CHARACTERISTICS

The HP 546A Logic Pulser generates pulses as programmed by a fingertip push-slide switch. The Pulser is programmed by pushing the switch once for each single pulse output, or a specific number of times for continuous pulse streams or pulse bursts at selected frequencies. The number of times to push the switch to select an output mode is labeled adjacent to the switch and is described in *Table 2*. On the label a dot (●) represents a push; a dash (—) represents a hold. As shown in *Table 2*, the pulses applied to the LED indicators in the tip are slowed down for visibility.

Pressing the switch automatically drives a TTL, DTL, or CMOS logic output or input from LOW to HIGH or from HIGH to LOW. The high source and sink current capability of the Pulser can override integrated circuit output points, originally in either the HIGH or LOW state. The nominal 10  $\mu$ s pulse width is long enough for even slow CMOS circuits to accept, but heavy circuit loads (such as TTL drivers) result in narrower pulses that limit the amount of energy delivered to the device under test.

The Pulser's output is three-state. In the off-state, the probe's high output impedance ensures that circuit operation is unaffected by probing until the Pulser switch is pressed. Pulses can be injected while the circuit is operating and no disconnections are needed. The multi-pin stimulus kit (*Figure 2*) is useful for stimulating up to four inputs of a gate at the same time, or for stimulating four different circuit nodes.

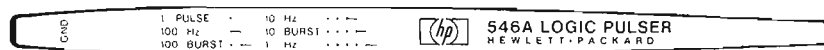
The Pulser's power input and output (tip) circuits are protected against overvoltage and reverse polarity.

Table 2. Output Mode Selection

Switch Action	Output Pulse Rate ( $\pm 10\%$ )	Output Pulse Mode	LED Indication
Push	single	1 Pulse	One short flash
Push-hold	100 Hz	100 Hz (Continuous)	10 Hz rate
Push/push-hold	100 Hz	100 Burst ▲	10 Hz rate during burst
Push/push/push-hold	10 Hz	10 Hz (Continuous)	5 Hz rate
Push/push/push/ push-hold	100 Hz	10 Burst ■	Two short flashes and a 1-second pause
Push/push/push/ push/push-hold	1 Hz	1 Hz (Continuous)	One flash/second

▲ 1 second burst for 100 pulses every two seconds.

■ 0.1 second burst of 10 pulses once each second.



## OPERATING PROCEDURES

To operate the Pulser, observe the following procedures:

### NOTE

In the following step, be sure to connect the red power lead of the Pulser to the positive side of the power supply.

- a. Connect the power leads of the pulser to the power supply of the logic being pulsed (3 to 18V). (The Pulser may be powered from a different source, provided the voltage is the same as that of the circuit under test and a common ground is used.)
- b. Contact the logic node to be stimulated with the tip of the Pulser.
- c. Program the generation of pulses by pushing the switch per adjacent markings (refer to *Table 2* for details). Characteristics of the switch operation are described in the following steps.
  - (1) A push-push action of the switch must occur within less than 1 second to be effective.
  - (2) A hold action of the switch for greater than 1 second begins execution of the programmed output.
  - (3) Any function can be locked on by the push-slide action of the switch.
  - (4) Releasing the switch midway through a burst does not terminate the burst.
  - (5) The single pulses generated when a burst is programmed are subtracted from the first burst, e.g., a 100 burst is output as 1–1–98, 100, 100, etc.
  - (6) Releasing the switch in any output mode other than midburst terminates output and allows a new mode to be programmed immediately. Releasing the switch for longer than 1 second, erases the programming of previous pushes.

- d. The LED's can be used to count the pulses output. Programming bursts of 10 or 100 and counting the lamp flash bursts allows control of a precise number of output pulses.

## APPLICATIONS

Hewlett-Packard makes several instruments which assist the troubleshooter in testing logic circuitry with the Logic Pulser. These instruments are listed in *Table 3* and examples of their applications are given in the following paragraphs.

*Table 3. Logic Test Instruments*

Typical Digital IC Troubleshooting	HP Instruments	
	Stimulus	Response
Shorted IC Input	546A Pulser	547A Current Tracer and 545A Logic Probe
Stuck Data Bus	546A Pulser	545A Logic Probe and 547A Current Tracer
Internal Open in IC	546A Pulser	545A Logic Probe
Solder Bridge	546A Pulser	547A Current Tracer
Sequential Logic Fault	546A Pulser	548A Logic Clip
Shorts to $V_{CC}$ or Ground	546A Pulser	545A Logic Probe
Multi-Pin Testing	546A Pulser	10529A Logic Comparator



## Logic Gate Testing

A logic gate may be tested by pulsing the gate's input, while monitoring the output with a Logic Probe (see Figure 3). The Logic Pulser generates a pulse opposite to the state of the input line and can change the gate output's state. This assumes the output of the gate is not clamped in its state by another input, e.g., a HIGH on the other input of an OR gate.

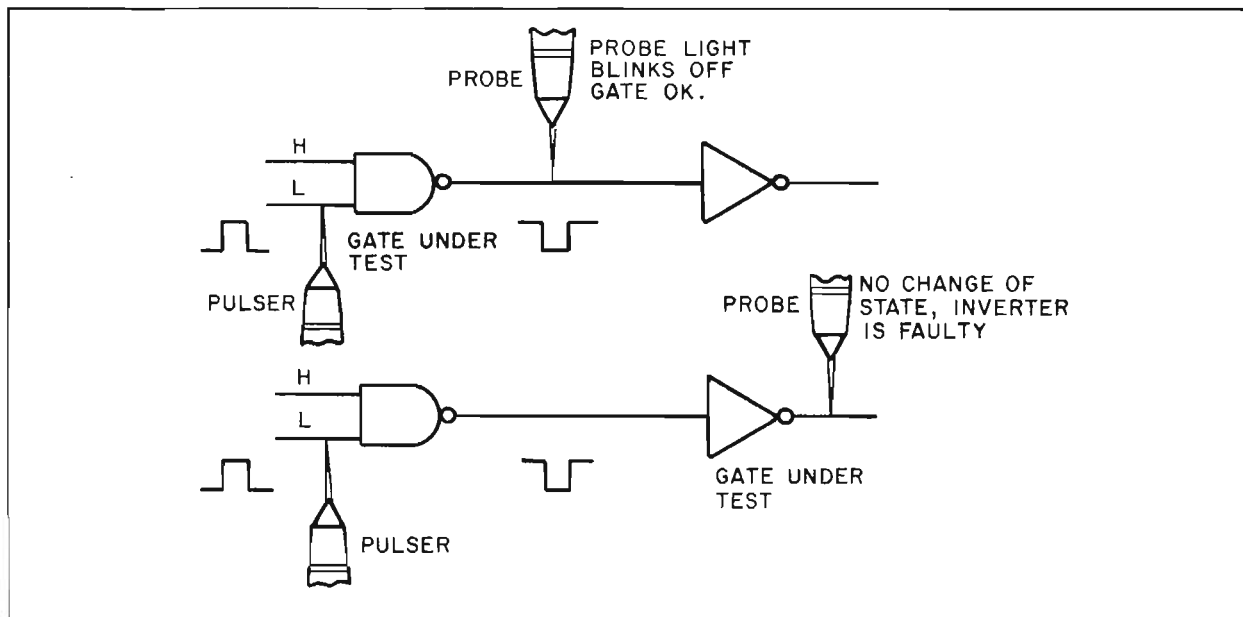


Figure 3. Logic Gate Testing

If the pulse is not detected at the output, pulse the output line (see *Figure 4*). If the output is not shorted to  $V_{CC}$  or common return, the Logic Probe should indicate a pulse opposite to its original indication. If not, check for external shorts (solder bridges, etc.) before removing the integrated circuit. Refer also to Gate-to-Gate Faults paragraph.

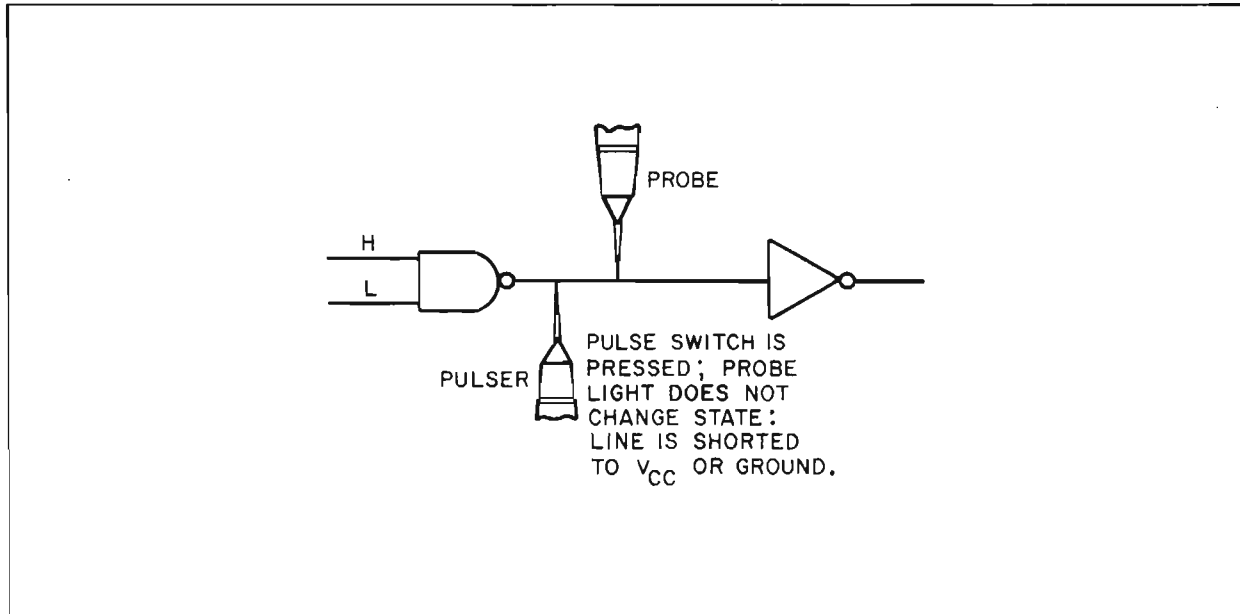
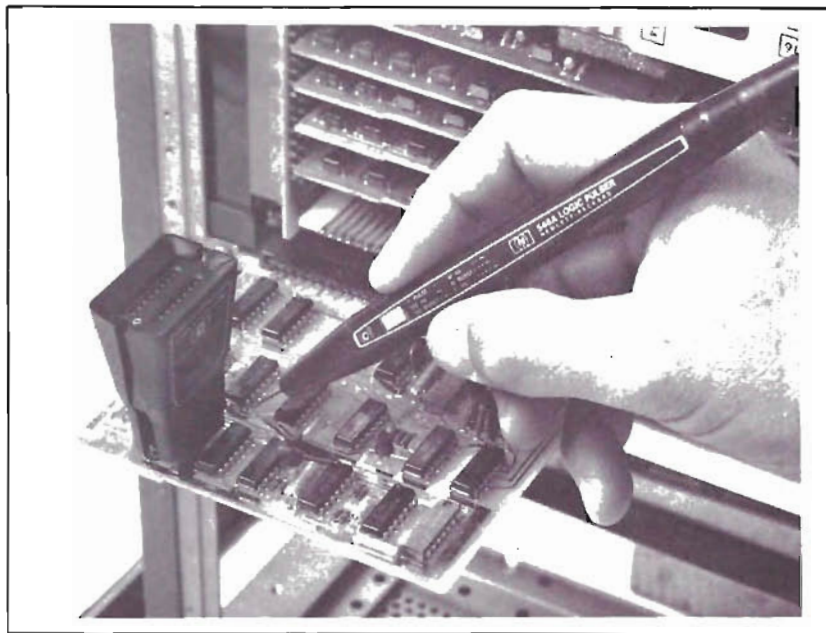


Figure 4. Testing for Shorts

### Counter, Shift Register, and Flip-Flop Testing

MSI IC's, such as shift registers and counters, typically have several output pins where data must be monitored when testing. The Logic Pulser, used as a manually controlled clock, allows the Logic Clip to simultaneously examine all output data at rates convenient for viewing.

When the Logic Clip is placed on an IC, the LED's on the clip indicate the logic state of each pin (see *Figure 5*). As the Pulser clocks the input, the indications on the Clip can be compared to a truth table.



*Figure 5. Multi-pin Testing with Logic Clip*

## Logic Comparator

The 10529A Logic Comparator (*Figure 6*) is an IC troubleshooting tool that electrically compares a reference IC to an IC under test. The reference IC shares the power and input signals with the test IC. When comparing the outputs of the two IC's, any level difference existing for  $0.2 \mu\text{s}$  or more will light an LED on the comparator, thereby indicating a fault.

The Logic Pulser allows in-circuit stimulation, so test pulses may be introduced at circuit nodes. Thus, reset or synchronizing pulses may be injected to reset the comparator's IC to the same initial state as the test IC. This allows the reference IC and the test IC to begin operation from the same reference point.

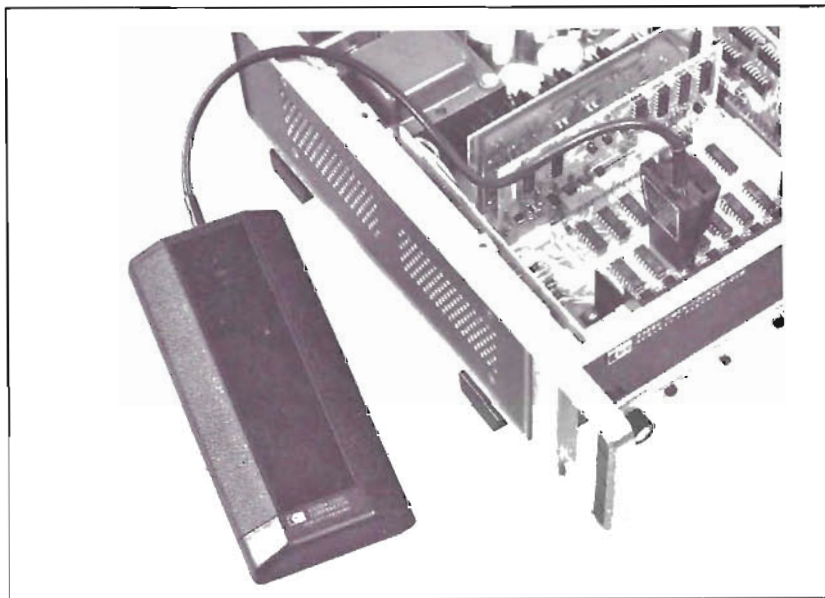


Figure 6. Multi-pin Testing with Logic Comparator

## Wire-AND Node

One of the most difficult problems encountered in troubleshooting integrated circuits is a stuck wire-AND node. Typically, one of the open-collector gates may still continue sinking current after it has been turned off. The Logic Pulser and Current Tracer provides an easy method of identifying the fault gate.

Referring to *Figure 7* place the Current Tracer on the gate side of the pull-up resistor. Align the mark on the probe tip along the length of the printed-circuit trace and adjust the probe's sensitivity control until the indicator is just fully lighted. If the indicator will not light — use a Logic Pulser programmed to the 100 Hz continuous mode to excite the line. Place the tracer tip on the output pin of each gate; only the faulty gate will cause the indicator to light.

## Gate-to-Gate Faults

When a low-impedance fault exists between two gates, the Current Tracer and Logic Pulser combine to quickly pinpoint the defect. In *Figure 8* gate A's output is shorted to ground. Place the pulse midway between the two gates and place the Current Tracer's tip on the Pulser's pin. Pulse the line in the 100 Hz continuous mode and adjust the Current Tracer's sensitivity control until the indicator just lights. First place the Current Tracer tip next to gate A and then gate B while continuing to excite the trace. The tracer will light only on the gate A side, since gate A, (the defect in this example), is sinking the majority of the current.



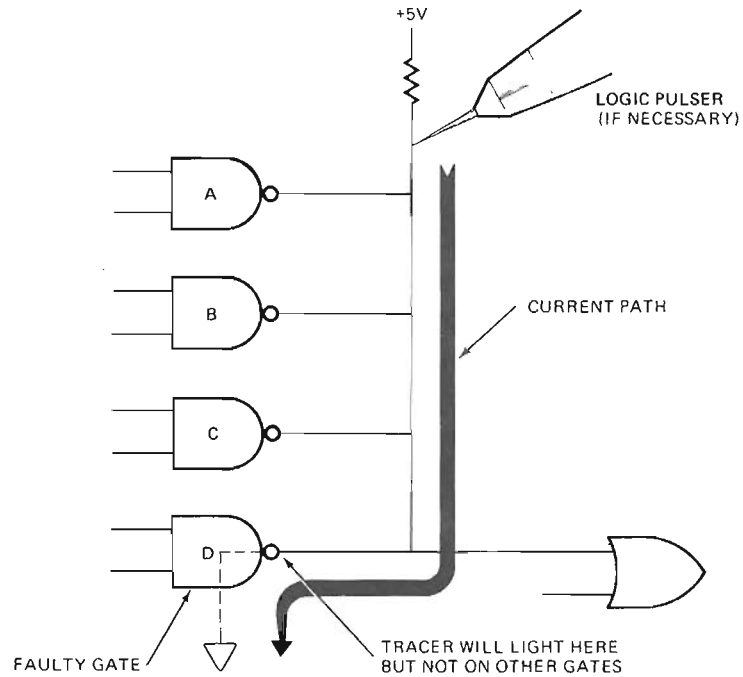


Figure 7. Wire-AND Node Fault

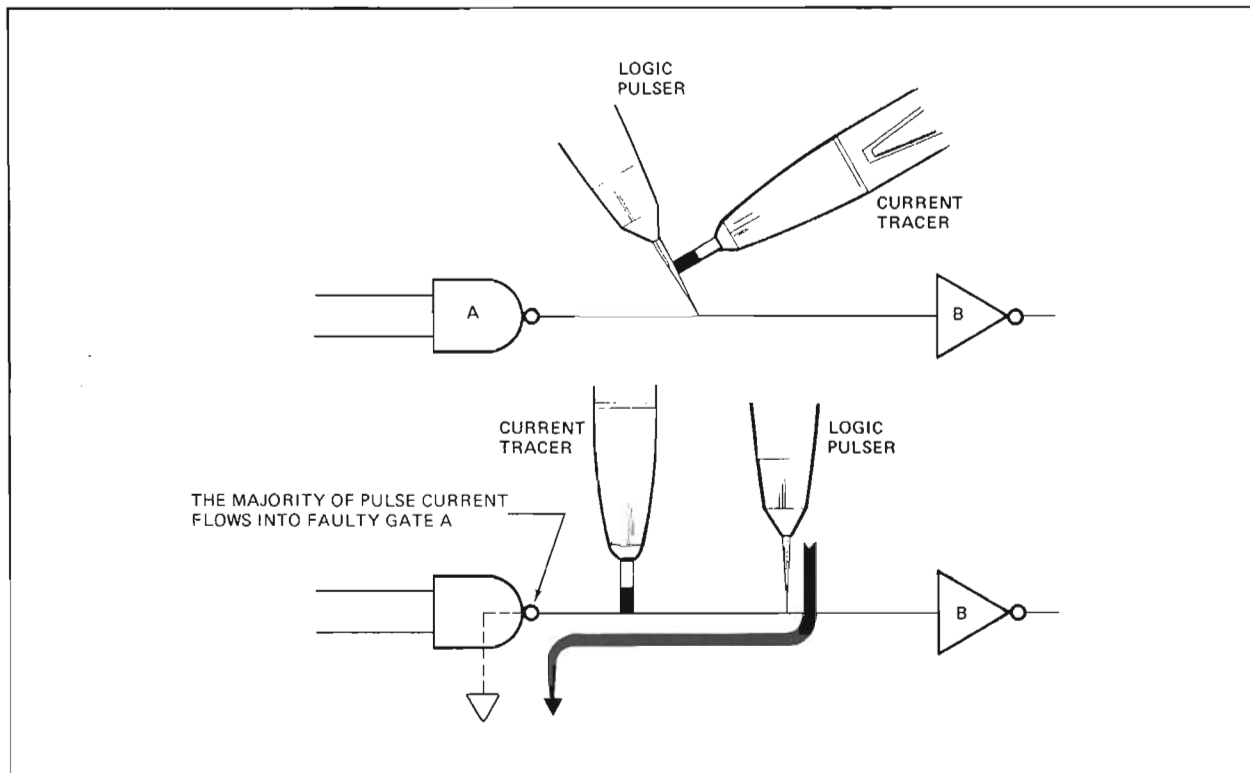


Figure 8. Gate-to-Gate Faults

## THEORY OF OPERATION

The major circuits of the Pulser are contained in integrated circuit U1 as shown in *Figure 9*. Operating voltage is supplied by a power supply and outputs are sent to the output drive circuits and to the display LED's.

### Power Supply

The power supply converts the dc input voltage to a regulated voltage for low power logic. The circuit provides reverse voltage and overvoltage protection.

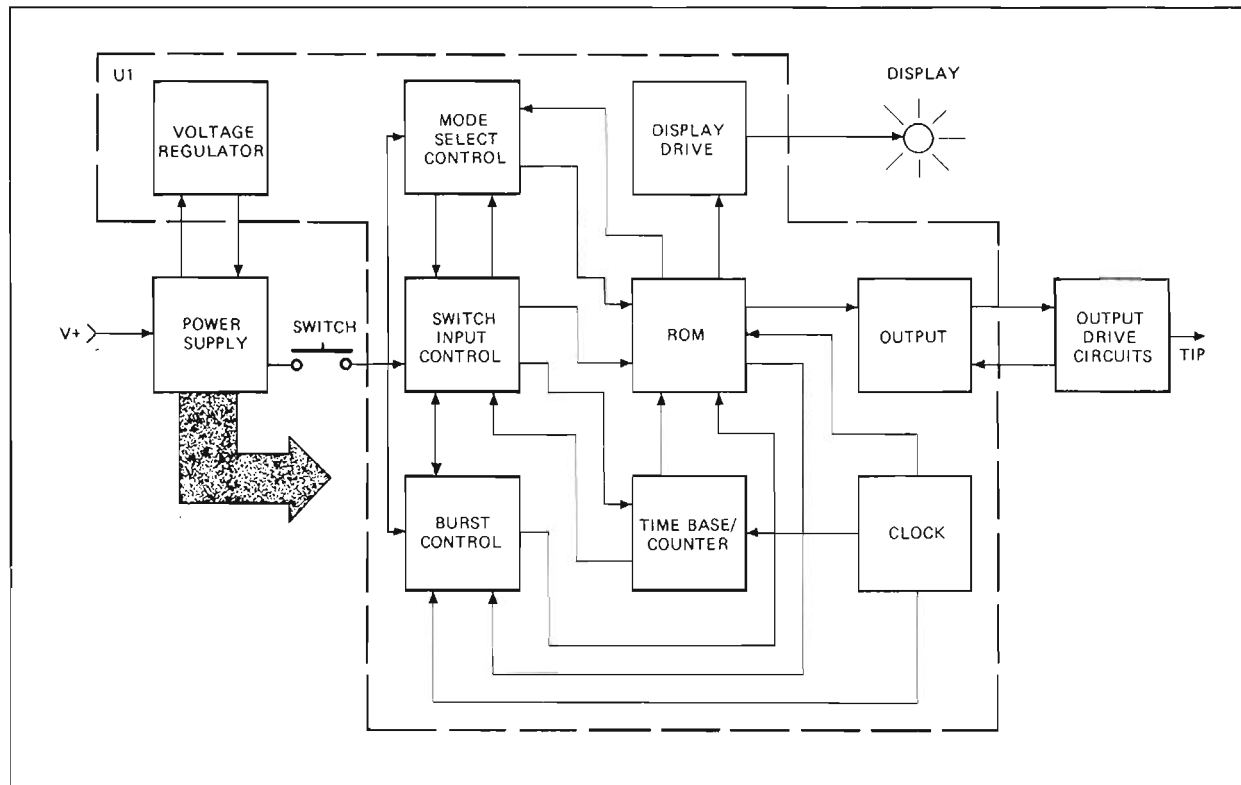
### Integrated Circuit U1

Several functions are provided by U1 as described in the following paragraphs.

**VOLTAGE REGULATOR.** Provides voltage and temperature compensated reference and control circuitry for the low voltage logic on the IC.

**MODE SELECT CONTROL.** Determines whether the instrument is programming a mode or executing a mode and when to reset.

**SWITCH INPUT CONTROL.** Presets the time base/counter and burst control circuit; generates a single-shot pulse to the output and debounces the switch.

*Figure 9. Pulser Block Diagram*

**BURST CONTROL.** Controls the start, stop, and count of a burst.

**DISPLAY DRIVE.** Controls the LED display to indicate Pulser activity.

**ROM.** A 256-bit special purpose read-only-memory that controls the operation of the Pulser.

**TIME BASE/COUNTER.** Used as time base for the ROM to generate the 1, 10, and 100 Hz continuous stream pulses, as a counter for the burst counts and for overall system timing.

**CLOCK.** Free-running 100 Hz RC controlled clock acts as a time base for operation of the Pulser.

**OUTPUT.** Provides single positive and negative pulses at controlled rates, widths, and levels to the output drive circuits. Senses the charge delivered to the external load and will automatically terminate (shutdown), an output that exceeds a predetermined limit.

### Detailed Circuit Analysis

As shown in *Figure 16*, transistor Q3 is a series pass element for a voltage regulator in U1 which generates a 2.7 volt reference voltage. Resistor R4 acts as a series pass helper resistor, diverting some of the heat normally generated in Q3, especially at high voltage. Capacitors C5 and C7 act as low impedance filter capacitors to the 2.7 volt supply. The LED for DS1 is driven by a switchable constant current driver on U1 to indicate the output mode. A difference exists between the light output of the LED and the tip output of the probe. Since the human eye cannot see a 100 Hz, 10  $\mu$ s blink, the LED pulses are actually slowed down and stretched, driving the LED at a slower rate, indicating the particular activity at the tip. Switch S1 is used to program the mode of U1. Resistor R3 and capacitor C6 are the timing elements that control the accuracy and frequency of the voltage and temperature compensated 100 Hz clock in U1.

**OUTPUT STAGE.** (Pins 2,1,16,15.) Capacitor C2 is a charge storage capacitor that is charged through an internal resistor to the supply voltage (V+), the “1” output level. This capacitor allows the Pulser to delivery high output current without causing heavy surges on the power lead. Breakdown diode CR1 protects U1(1) from high voltages. Transistor Q1 is the drive transistor for the logic “1” pulse and Q2 is the drive transistor for the logic “0” pulse. Capacitor C1 and resistor R1 are coupling elements to the tip of the probe. Capacitor C1 decouples high dc levels from the tip of the probe to the output circuitry and also acts as an overload sensing element, activating the shutdown circuitry in U1 (pin 16). Between output cycles resistor R1 discharges any residual charge on capacitor C1. Resistor R2 limits the current into U1 on this sense line, and capacitor C3 is a speedup capacitor. Capacitor C4 on pin 14 controls the normal output pulse width of both the “1” and “0” through a one-shot in U1, typically 10  $\mu$ s (may vary between 5–15  $\mu$ s). Resistor R5 stabilizes the output stage.

## Overcurrent Output Shutdown

If the circuit under test presents an overload to the Pulser’s output, a sensing circuit within U1 causes the overcurrent shutdown cycle to occur and turn off the output transistor. If the overload presents a low impedance to V+, the “0” overcurrent cycle occurs. If the load presents a low impedance to ground, the “1” overcurrent cycle occurs. These cycles are described in the following paragraphs. Waveforms of the overcurrent conditions are shown under test procedure paragraphs.

Immediately prior to any output pulse cycle, capacitor C2 is charged to V+, capacitor C1 is discharged by resistor R1 to 0 volts, transistors Q1 and Q2 are off and U1 pin 16 is at the tip voltage.

**“0” OVERCURRENT CYCLE.** When output occurs, transistor Q2 saturates and the sense circuit in U1 (pin 16) begins measuring voltage on the tip through resistor R2 and capacitor C3. With transistor Q2 conducting heavy current from the load through the tip, capacitor C2 develops a voltage charge. When this voltage reaches approximately 0.8 volts (relative to ground) pulse shutdown occurs in the U1 sensing circuit and transistor Q2 turns off.

**“1” OVERCURRENT CYCLE.** The “1” cycle is similar to the “0” cycle except that transistor Q1 saturates, the direction of current flow is reversed and the shutdown threshold voltage is referenced to V+ (set to approximately V+ minus 1.5 volts). In addition, capacitor C2 supplies most of the output current through transistor Q1 thus reducing current surges on the V+ line.

In either overcurrent cycle the fast turn on and turn off of transistors Q1 and Q2 provides sharp pulse edge transitions through logic threshold transition regions. The “1” or “0” overcurrent output cycle is repeated each time a high current pulse is outputted.

## MAINTENANCE

The following paragraphs provide test procedures, probe disassembly and assembly and parts replacement information.

### Test Procedures

The following performance tests ensure that the Pulser is operating properly. Test equipment required is listed in *Table 4*. Test equipment having equivalent characteristics may be substituted.

**NOTE**

The HP 180C oscilloscope listed in Table 4 is recommended as a usually available type. However, a storage scope such as the HP 181A is preferable to use for the performance tests.

*Table 4. Test Equipment Required*

<b>Instrument</b>	<b>Required Characteristics</b>	<b>Recommended HP Type</b>
Oscilloscope	35 MHz, 10 mV/div, 0.1 $\mu$ s/div	180C/1807A/1821A
Power Supply	0—20V, 0—1A	6201B
Counter	0—10 MHz	5300B/5301A
Resistor	TRMR, 200, 10%	2100-2413
Resistor	6.2 $\Omega$ , 5%, .25W	0683-0625
Resistor	3.6 $\Omega$ , 5%, .25W	0683-0365
Resistor (2)	1K, 5%, .25W	0683-1025
Capacitor	10 $\mu$ F, $\pm$ 10%, 20V	0180-0374



## Functional Output Test

Using the test setup shown in *Figure 10*, proceed as follows:

- a. Set power supply to +5V.
- b. Press Pulser pushbutton and latch (100 Hz mode) while observing oscilloscope for the waveform shown in *Figure 10*.
- c. The Pulser LED's should flash once when the pushbutton is pressed and continuously when the switch is latched.
- d. Repeat step (b) while varying the power supply output over the range of 3 to 18 volts and check waveform. Change the scope vertical scale factor as required. The output pulse width will normally decrease in the 15 to 18 volt range.

## “0” Output Pulse at 5V Test

Connect the equipment as shown in *Figure 11* and proceed as follows:

- a. Set the power supply to +5V.
- b. Press Pulser pushbutton and latch while observing oscilloscope for the waveform shown in *Figure 11*.

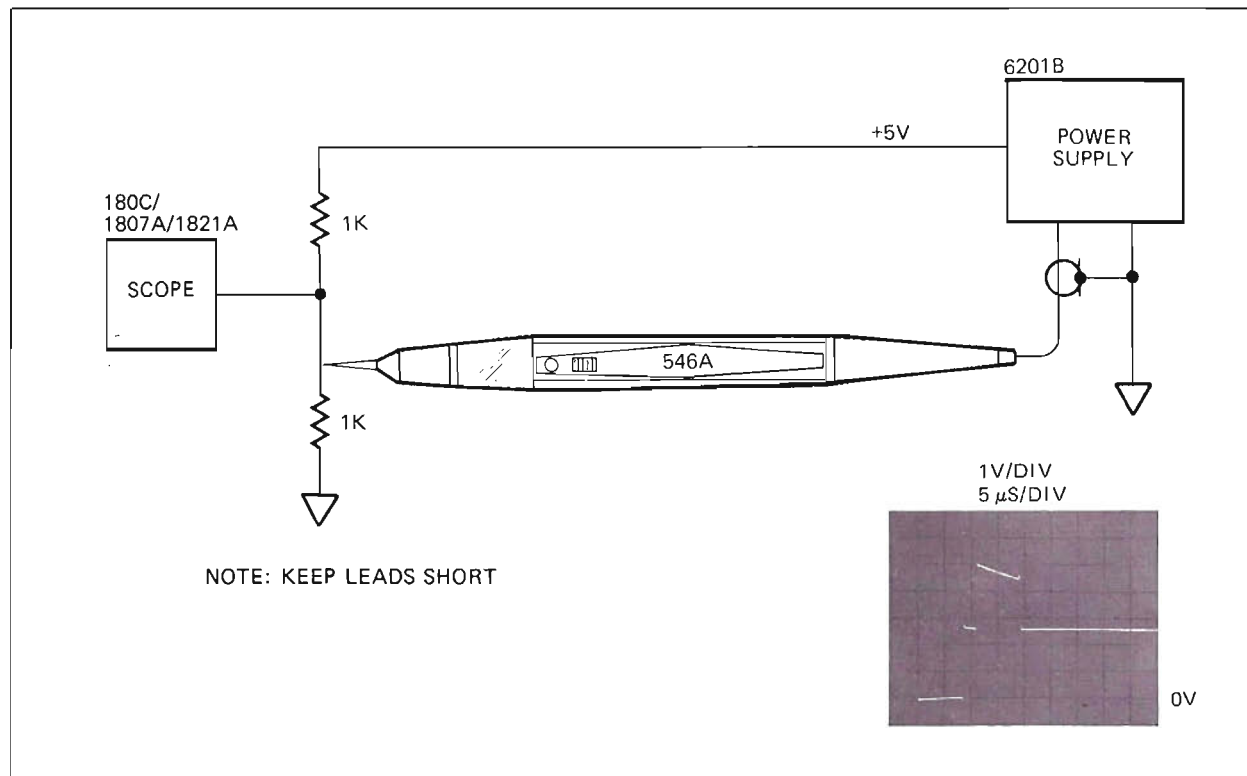


Figure 10. Functional Output Test

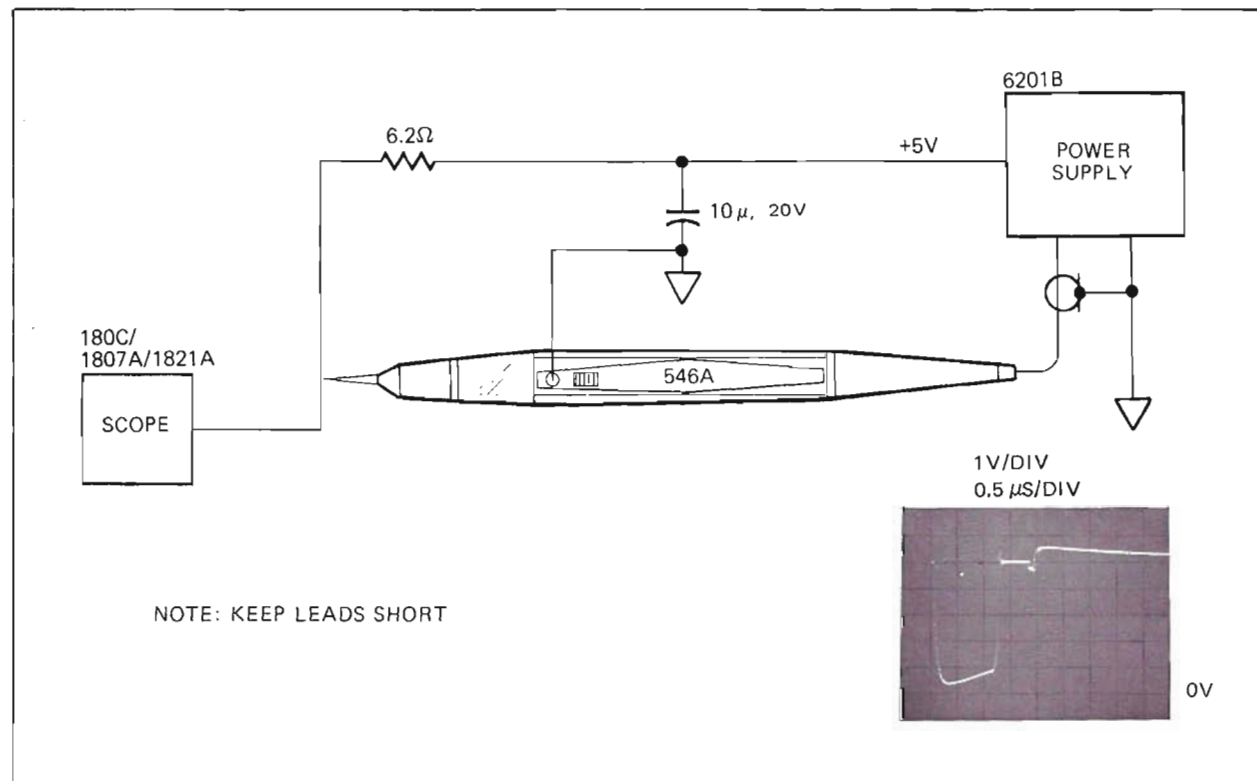


Figure 11. "0" Output Pulse at 5V Test Setup

### **“0” Output Pulse at 12V Test**

Connect the equipment as shown in *Figure 12* and proceed as follows:

- a. Set the power supply to +12V and set the variable resistor to 200 ohms.
- b. Press Pulser pushbutton and latch while observing oscilloscope for waveform A, *Figure 12*.

### **“0” Output Pulse at 12V and Variable Load Test**

Connect the equipment as shown in *Figure 12* and proceed as follows:

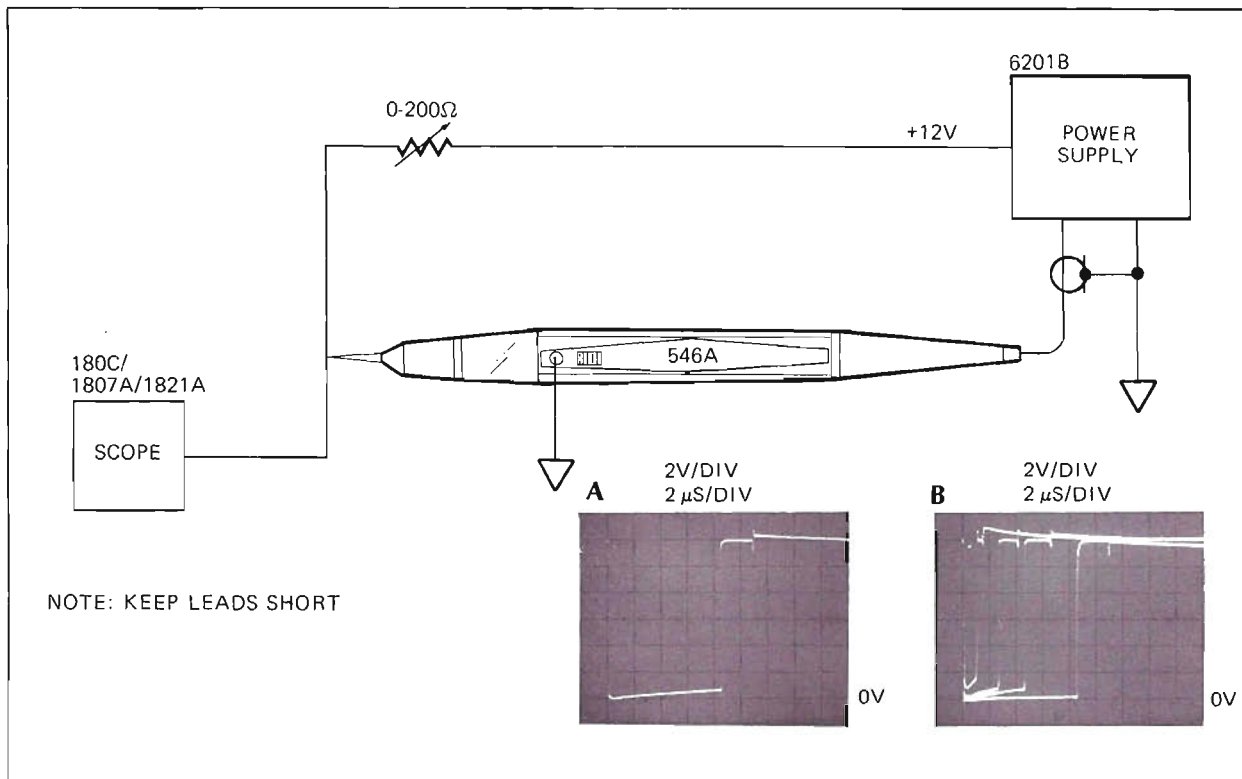
- a. Set the power supply to +12V.
- b. Press Pulser pushbutton and latch.
- c. Set the variable resistor to the values listed below while observing the oscilloscope for the outputs shown in waveform B from left to right in order of the values listed below:

10 ohms

50 ohms

100 ohms

200 ohms



### **“1” Output Pulse Test**

Connect the equipment as shown in *Figure 13* (except omit the counter) and proceed as follows:

- a. Set the power supply to +5V.
- b. Set the variable resistor to 0 ohms.
- c. Press Pulser pushbutton and latch while observing oscilloscope for waveform A, *Figure 13*.
- d. Set power supply to +12V and variable resistor to 200 ohms while observing oscilloscope for waveform B, *Figure 13*.
- e. Set the variable resistor to the values listed below and observe the oscilloscope for the outputs shown in waveform C from left to right in order of the values listed below:
  - 10 ohms
  - 50 ohms
  - 100 ohms
  - 200 ohms

### **Frequency and Mode Test**

Connect the counter in the test setup shown in *Figure 13* and proceed as follows:

- a. Set the power supply to +5V.
- b. Set the variable resistor to 200 ohms.
- c. Set counter in Totalize mode.
- d. Press Pulser pushbutton and release while observing counter. The counter should totalize each repeated action.
- e. Program the Pulser per the switch action column in *Table 2*. The counter should indicate the frequency and burst action shown in the table.

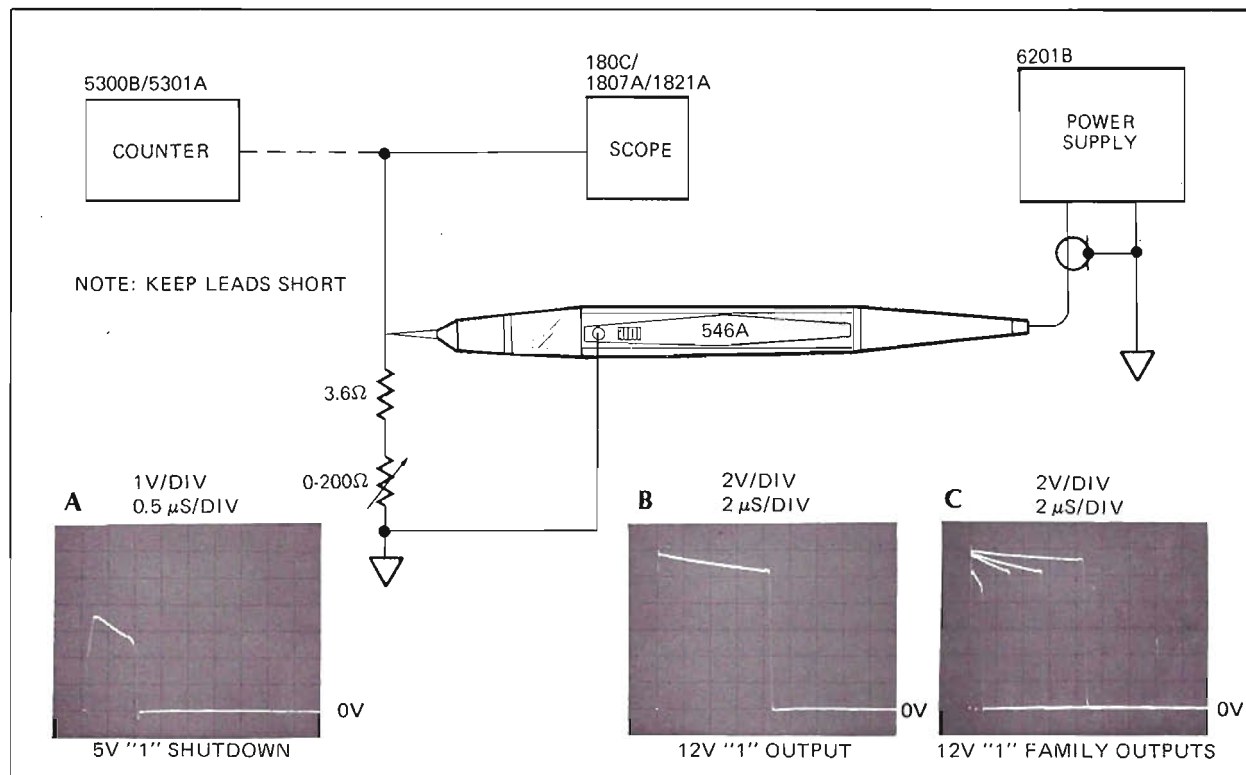


Figure 13. "1" Output Pulse Test Setup

## PULSER DISASSEMBLY

To disassemble the Pulser refer to *Figure 14* and proceed as follows:

- a. With fingers, unscrew (ccw) the Pulser tip (MP1).
- b. Remove indicator window (MP2). Note position of slots inside window for reference when pulser is to be reassembled. If window has a protruding rear stud, skip to step d.
- c. With Pulser tip, carefully remove retainer ring (MP3).
- d. Slide bottom shell (MP5) off the Pulser.
- e. Lift top shell (MP4) off the Pulser.

## PULSER ASSEMBLY

Pulser assembly is essentially the reverse of the above disassembly procedure.

### CAUTION

**BE CAREFUL WHEN REPLACING PARTS ON THE FRAGILE PRINTED-CIRCUIT BOARD. EXCESS HEAT CAN RUIN THE BOARD. USE A LOW WATTAGE ( $\leq 25$  WATTS) IRON AND APPLY THE MINIMUM HEAT NECESSARY TO UNSOLDER THE LEADS.**



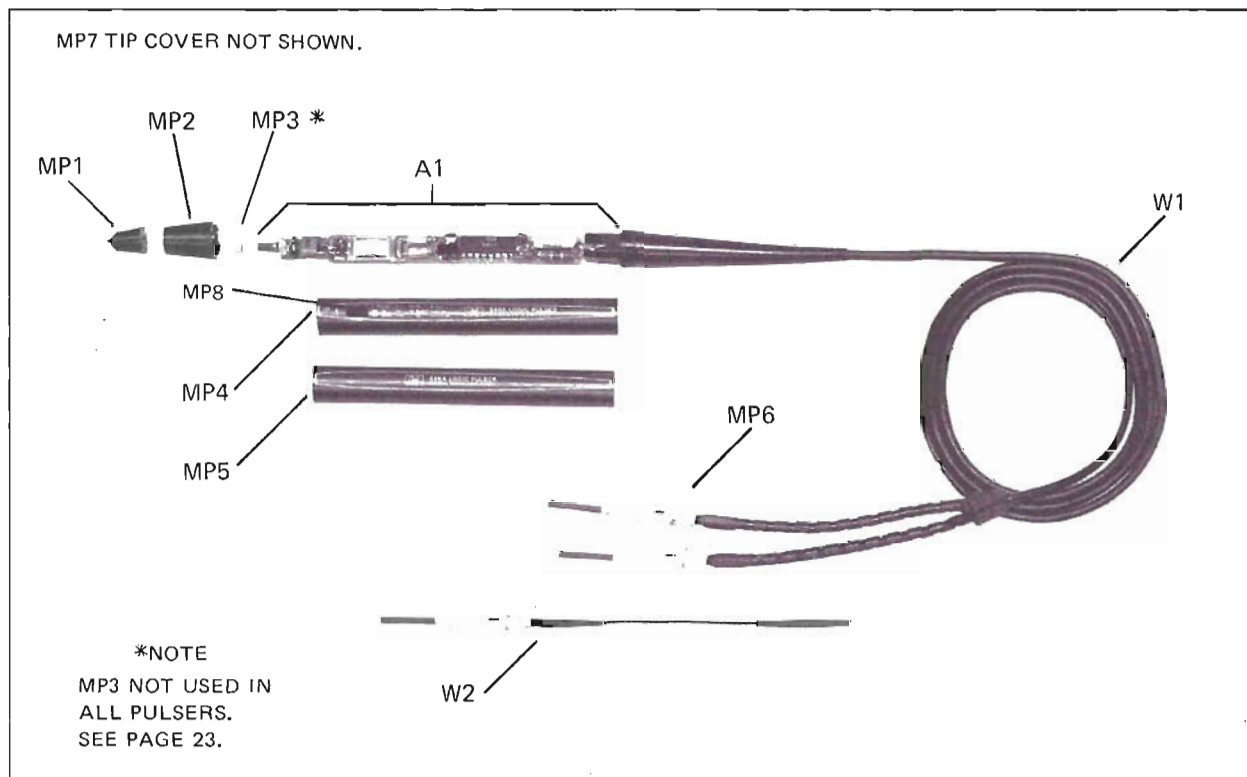


Figure 14. Pulser Disassembled

## TROUBLESHOOTING

To troubleshoot a malfunction in the Pulser's operation, conduct the performance tests to determine specific symptoms then refer to *Table 5* for the most likely cause of the problem.

### NOTE

To check integrated circuit U1, measure the voltage at pin 5 for 2.7 ( $\pm 0.3$ ) volts. Check pin 7 with a scope for the clock waveform shown on the schematic diagram.

*Table 5. Troubleshooting Isolation*

Symptom	Check (in order listed)
No output-no LED indication	Power cable W2, U1, Q3, S1, C6, C5, R3, and C7
No "1" or "0" output	U1, C1, Q2, Q1, and C4
No "1" output	Q1, U1, CR1, C2, and R5
No "0" output	Q2 and U1
Overcurrent shutdown fails to operate	U1, C1, and R2
Program mode failure	U1, Q3, and S1

Table 6. Replaceable Parts List

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	00546-60002	1	Logic Pulser Assembly (Series 1644)	28480	00546-60002
A1C1	0160-4422	1	Capacitor Fxd, 1 UF, $\pm 20\%$ , 50V	28480	0160-4422
A1C2	0180-0690	1	Capacitor Fxd, 2.2 UF, $\pm 20\%$ , 20V	28480	0180-0690
A1C3	0160-4545	1	Capacitor Fxd, 220 PF, $\pm 20\%$ , 50V	28480	0160-4545
A1C4	0160-3879	1	Capacitor Fxd, .01 UF, $\pm 20\%$ , 100V	28480	0160-3879
A1C5	0180-2623	1	Capacitor Fxd, 12 UF, $\pm 10\%$ , 6V	28480	0180-2623
A1C6	0160-4343	1	Capacitor Fxd, 0.1 UF, $\pm 5\%$ , 100V	28480	0160-4343
A1C7	0160-0576	1	Capacitor Fxd, 0.1 UF, $\pm 20\%$ , 50V	26654	2130BR050R104M
A1CR1	1902-3205	1	Diode, Zener, 15.0V, 5%, 400MW	04713	SZ10939-233
A1DS1	1990-0582	1	LED, Red	28480	1990-0582
A1J1	1251-4259	1	Connector, Sgl Contact	71279	460-2983-01-03
A1MP1	00545-20202	1	Stud, Tip	28480	00545-20202
A1Q1	1853-0271	1	Transistor, PNP, SI	04713	2N4403
A1Q2	1854-0568	1	Transistor, NPN, SI	28480	2N5845A
A1Q3	1853-0389	1	Transistor, PNP, SI	28480	1853-0389

Table 6. Replaceable Parts List (Continued)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R1	0698-5999	1	Resistor, 470-Ω, 5%, 1/8W	01121	BB4725
A1R2	0698-5426	1	Resistor, 10KΩ, 10%, 1/8W	01121	BB1031
A1R3	0698-7284	1	Resistor, 100KΩ, 2%, .05W	24545	C3-1/8-TO-1003-G
A1R4	0698-1325	1	Resistor, 1300Ω, 5%, 1/2W	01121	EB1325
A1R5	0698-3111	1	Resistor, 30Ω, 5%, 1/8W	01121	BB3005
A1S1	00546-00001	1	Switch, Push/Slide	28480	00546-00001
A1U1	1820-1487	1	IC, Bipolar	28480	1820-1487
<b>MISCELLANEOUS PARTS</b>					
MP1	5060-0418	1	Tip Assembly	28480	5060-0418
MP2	00546-40002	1	Window	28480	00546-40002
MP3 ▲	00545-20204	1	Ring, Retainer	28480	00545-20204
MP4	00546-20201	1	Body, Top Half	28480	00546-20201
MP5	00545-20203	1	Body, Bottom Half	28480	00545-20203
MP6	10230-62101	2	Grabber	28480	10230-62101
MP7	00547-40005	1	Cover, Tip	28480	00547-40005
MP8	00546-40001	1	Switch, Slider	28480	00546-40001
W1	00547-60100	1	Cable Assembly, Probe	28480	00547-60100
W2	00545-60105	1	Cable Assembly with Grabber	28480	00545-60105

▲ NOT NEEDED WITH 00546-40002 WINDOW WHICH HAS PROTRUDING STUD ON REAR.  
 IF 00545-40001 WINDOW (LESS REAR STUD) IS USED, MP3 IS REQUIRED.

*Table 7. Manufacturers Code List*

<b>Mfr No.</b>	<b>Manufacturer Name</b>	<b>Address</b>	<b>Zip Code</b>
01121	Allen-Bradley Co., Milwaukee, WI		53212
24546	Corning Glass Works (Bradford), Bradford, PA		16701
26654	Varadyne Inc., Capacitor Division, Santa Monica, CA		90404
28480	Hewlett-Packard Co. Corporate Hq., Palo Alto, CA		94304
71279	Cambridge Thermionic Corp., Cambridge, MA		02138
04713	Motorola Semiconductor Products, Phoenix, AZ		85008



PART NO. 00546-60002 CIRCUIT BOARD SERIES 1624 AND 1644.  
(LIGHT EMITTING DIODE DS2 ONLY IN SERIES 1624)



PART NO. 00546-60001 CIRCUIT BOARD SERIES 1608, 1616, AND 1624.  
(BREAKDOWN DIODE CR1 ONLY IN SERIES 1624)

Figure 15. Pulser Component Locators

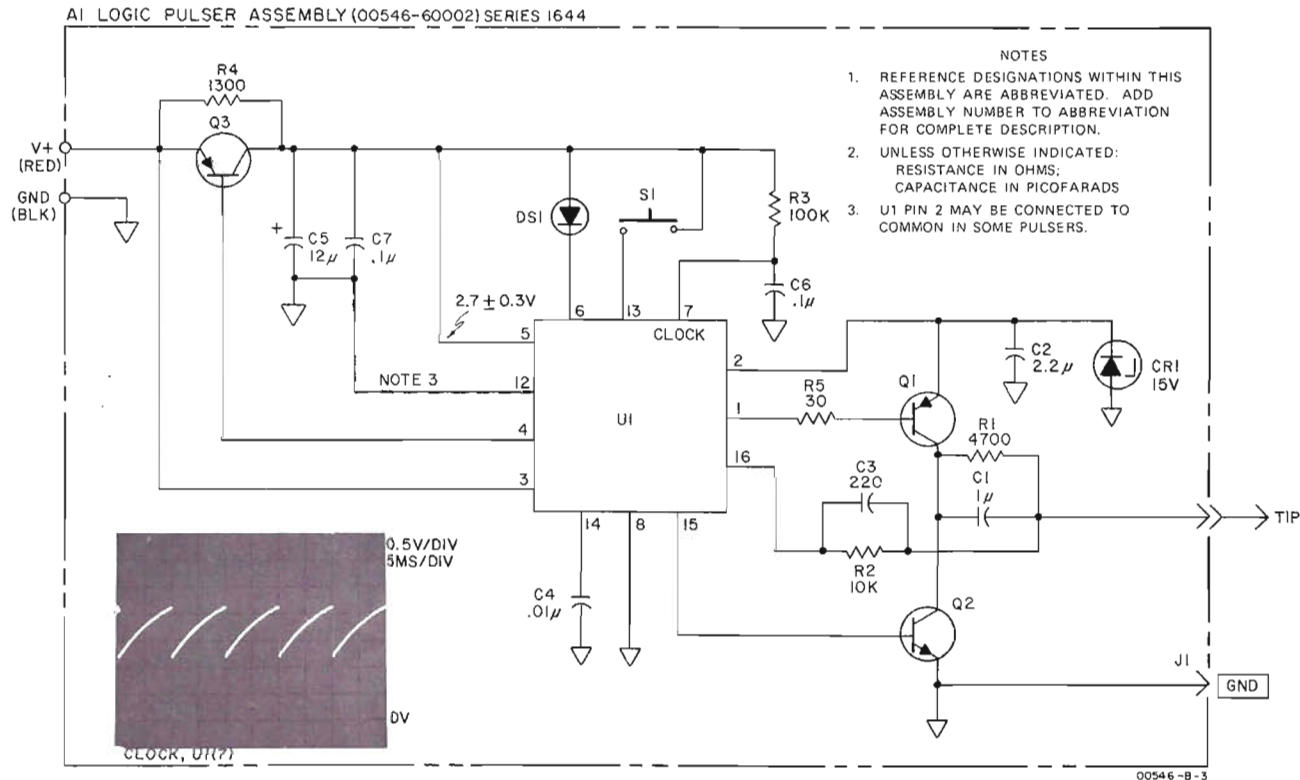


Figure 16. A1 Logic Pulser Assembly (00546-60002) Series 1644, Schematic Diagram

**BACKDATING (OLDER PULSERS)**

Backdating applies to Logic Pulser circuit boards with the **SERIES** and **HP** part numbers in Table 8. To adapt this manual to the circuit boards in Table 8, perform the backdating changes that apply to the circuit board in your Pulser.

*Table 8. Manual Backdating*

<b>Ckt Bd Part No.</b>	<b>Series No.</b>	<b>Manual Backdating Changes</b>
00546-60001	1608 or 1616	1, 2, 3
00546-60001	1624	1, 2
00546-60002	1624	1

**CHANGE 1 (00546-60002 Series 1624)**

Page 32, Table 6, Replaceable Parts:

Change A1 series number to 1624.

Add A1DS2; 1990-0582; 1; LED, Red.

Page 36, Figure 16, A1 Schematic Diagram:

Change A1 series number to 1624.

Add DS2 LED in parallel with DS1.



**CHANGE 2 (00546-60001 Series 1624)**

Page 32, Table 6, Replaceable Parts:

Change A1 part numbers to 00546-60001 (Series 1624) in HP and Mfr Part Number columns.

Change A1C3 to 0160-3878; Capacitor, Fxd, .001 UF, 20%, 100V; 28480; 0160-3878.

Change A1C4 quantity to two.

Change A1C7 to 0160-3879; Capacitor, Fxd, .01 UF, 20%, 100V; 28480; 0160-3879.

Change A1CR1 to 1920-3234; Diode, Zener, 19.6V 5%; 04713; SZ10939-266.

Change A1Q1 to 1853-0390; Transistor, PNP, SI, 2N6067; 28480; 1853-0390.

Delete A1R5 resistor HP Part Number 0698-3111 (30 ohms).

Page 36, Figure 16, A1 Schematic Diagram:

Change A1 Part Number, at top of diagram, to 00546-60001 (Series 1624).

Change A1C3 to .001  $\mu$ F and A1C7 to .01  $\mu$ F.

Change A1CR1 to 19.6V.

Delete A1R5 and connect A1Q1 base directly to A1U1 pin 1.

**CHANGE 3 (00546-60001 Series 1608 and 1616)**

Page 32, Table 6, Replaceable Parts:

Change A1 series number to Series 1608 and 1616.

Delete A1CR1 breakdown diode HP Part No. 1902-3234.

Page 36, Figure 16, A1 Schematic Diagram:

Change A1 series number to Series 1608 and 1616.

Delete A1CR1 breakdown diode.

# 546A

## LOGIC PULSER

### OPERATING AND SERVICE MANUAL

**SERIES NUMBER: 1644**

This manual applies directly to Hewlett-Packard Model 546A Logic Pulsers having the above series number.

#### **SERIES NUMBERS NOT LISTED**

For series numbers higher than 1644, a "Manual Change" sheet is included with this manual. For series numbers below 1644, refer to Backdating paragraph in this manual.

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**MANUAL PART NO. 00546-90005**  
**MICROFICHE PART NO. 00546-90006**

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PACKARD**

**TABLE OF CONTENTS**

<b>Title</b>	<b>Page</b>
Scope of Manual .....	1
Description .....	1
Series Number .....	1
Unpacking .....	4
Power Supply .....	4
Output Ground Table .....	4
Operating Characteristics .....	5
Operating Procedures .....	7
Applications .....	8
Logic Gate Testing .....	9
Counter, Shift Register, and Flip-Flop Testing .....	11
Logic Comparator .....	12
Wire-AND Node .....	13
Gate-to-Gate Faults .....	13
Theory of Operation .....	16
Power Supply .....	16
Integrated Circuit U1 .....	16
Detailed Circuit Analysis .....	18
Overcurrent Output Shutdown .....	19

**TABLE OF CONTENTS (Continued)**

<b>Title</b>	<b>Page</b>
Maintenance .....	20
Test Procedures .....	20
Functional Output Test .....	22
"0" Output Pulse at 5V Test .....	22
"0" Output Pulse at 12V Test .....	25
"0" Output Pulse at 12V and Variable Load Test .....	25
"1" Output Pulse Test .....	27
Frequency and Mode Test .....	27
Pulser Disassembly .....	29
Pulser Assembly .....	29
Troubleshooting .....	31
Backdating (Older Pulsers) .....	37

**LIST OF TABLES**

<b>Table</b>		<b>Page</b>
1.	Specifications .....	2
2.	Output Mode Selection .....	6
3.	Logic Test Instruments .....	8
4.	Test Equipment Required .....	21
5.	Troubleshooting Isolation .....	31
6.	Replaceable Parts List .....	32
7.	Manufacturers Code List .....	34
8.	Manual Backdating .....	37

## LIST OF FIGURES

Figure		Page
1.	HP 546A Logic Pulser .....	0
2.	546A Logic Pulser Accessories Available .....	3
3.	Logic Gate Testing .....	9
4.	Testing for Shorts .....	10
5.	Multi-pin Testing with Logic Clip .....	11
6.	Multi-pin Testing with Logic Comparator .....	12
7.	Wire-AND Node Fault .....	14
8.	Gate-to-Gate Faults .....	15
9.	Pulser Block Diagram .....	17
10.	Functional Output Test .....	23
11.	"0" Output Pulse at 5V Test Setup .....	24
12.	"0" Output Pulse at 12V Test Setup .....	26
13.	"1" Output Pulse Test Setup .....	28
14.	Pulser Disassembled .....	30
15.	Pulser Component Locators .....	35
16.	A1 Logic Pulser Assembly (00546-60002) Series 1644 .....	36



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