Errata

Title & Document Type: 54118A Trigger Operating and Service Manual

Manual Part Number: 54118-90902

Revision Date: January 1991

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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Operating and Service Manual

HP 54118A Trigger

Serial Numbers:
This manual applies directly to instruments prefixed with serial number:
3051A

With the changes described within, this manual also applies to instruments with serial prefixed:
2808A

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New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition is published.

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The List of Effective Pages gives the date of the current edition and of any pages changed in updates to that edition. Within the manual, any page changed since the last edition is indicated by printing the date the changes were made on the bottom of the page. If an update is incorporated when a new edition of the manual is printed, the change dates are removed from the bottom of the pages and the new edition date is listed in Printing History and on the title page.

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Introducing The HP 54118A

Introduction
The Hewlett-Packard 54118A Trigger is an accessory which extends the trigger range of the HP 54120T Digitizing Oscilloscope to 18 GHz.

Key Features
The HP 54118A's key features include:
- True event triggering
- Continuous wave or pulsed RF input signals
- Input frequency range 500 MHz to 18 GHz
- Outputs a trigger pulse from 5 kHz to 20 kHz
- AC input coupling

Physical Description
The HP 54118A receives its power through an SMB cable which connects from the HP 54118A's rear panel to the four channel test set's rear panel.

There are three front panel controls: ARMING LEVEL, TRIGGER LEVEL, and HOLDOFF.

There are two APC 3.5 front panel connectors: INPUT and OUTPUT. There is one SMB rear panel connector, POWER SUPPLY +15 VDC, which supplies power to the HP 54118A.

Recommended Test Equipment
The test equipment recommended for maintaining the HP 54118A is listed in table 1-1. The three sections requiring test equipment are:
- Performance Tests (Chapter 4)
- Adjustments (Chapter 5)
- Service (Chapter 7, troubleshooting section only)
Table 1-1. Recommended Test Equipment

<table>
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<tr>
<th>Instrument</th>
<th>Critical Specifications</th>
<th>Recommended Model</th>
<th>Use*</th>
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<tbody>
<tr>
<td>Oscilloscope</td>
<td>No Substitute</td>
<td>HP 54120T</td>
<td>P,A,T</td>
</tr>
<tr>
<td>Sweeper</td>
<td>0.5-18 GHz, -22 dBm to +4 dBm (50 mVp-p to 1 Vp-p)</td>
<td>HP 8341B</td>
<td>P</td>
</tr>
<tr>
<td>Oscilloscope Probe</td>
<td>100 MHz, 50 Ω input</td>
<td>HP 54501A</td>
<td>P,T</td>
</tr>
<tr>
<td>Oscilloscope Probe</td>
<td>10:1, 10 M Ω</td>
<td>HP 10432A</td>
<td>T</td>
</tr>
<tr>
<td>Digital Multimeter</td>
<td>3% Accuracy</td>
<td>HP 3478A</td>
<td>A,T</td>
</tr>
<tr>
<td>Pulse Source</td>
<td>0 to 0.5 V positive pulse, 5 μs wide at 4 kHz</td>
<td>HP 8116A</td>
<td>T</td>
</tr>
<tr>
<td>Power Meter</td>
<td>0.5-18 GHz</td>
<td>HP 436A</td>
<td>P</td>
</tr>
<tr>
<td>Power Sensor</td>
<td>-22 dBm to +4 dBm (50 mVp-p to 1 Vp-p)</td>
<td>HP 8485A</td>
<td>P</td>
</tr>
<tr>
<td>Directional Coupler</td>
<td>0.5 GHz-18GHz, directivity &gt; 10 dB</td>
<td>Keytar Model 1851</td>
<td>P</td>
</tr>
<tr>
<td>50 Ω</td>
<td>Termination APC 3.5 connector</td>
<td>HP 909D</td>
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<td>Adapter</td>
<td>SMA (m) to BNC (f)</td>
<td>1250-1200</td>
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<tr>
<td>Adapter</td>
<td>APC 3.5 (m-m)</td>
<td>1250-1864</td>
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<tr>
<td>Adapter</td>
<td>APC 3.5 (f-f)</td>
<td>1250-1865</td>
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<tr>
<td>Coaxial Short</td>
<td>APC 3.5 (f)</td>
<td>1250-2127</td>
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<td>Coaxial Cable</td>
<td>SMA connectors, 18 GHz, Qty 3</td>
<td>8120-4948</td>
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<tr>
<td>Coaxial Cable</td>
<td>SMA connectors, 18 GHz</td>
<td>54118-61607</td>
</tr>
<tr>
<td>BNC Tee</td>
<td>1 (m) end, 2 (f) ends</td>
<td>1250-0781</td>
</tr>
<tr>
<td>BNC Cable</td>
<td></td>
<td>10500A</td>
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<tr>
<td>Resistors</td>
<td>180 Ω, ± 3%, 0.5 watt, Qty 2</td>
<td>N/A</td>
</tr>
<tr>
<td>Alligator Clips</td>
<td>Qty 2</td>
<td>N/A</td>
</tr>
<tr>
<td>Clip Leads</td>
<td>Connect from BNC (f) to wire</td>
<td>N/A</td>
</tr>
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P = Performance Tests    A = Adjustments    T = Troubleshooting

Introduction

1-2
Installation

Accessories Supplied

The following accessories are supplied with the HP 54118A. The quantity is one unless otherwise specified.

- Connector Savers HP 5061-5311 Qty 2
- SMA shorts HP 0960-0055 Qty 2
- External input cable HP 54118-61608
- External output cable HP 54118-61607
- External SMB power cable HP 54111-61609
- Operating and Service Manual HP 54118-90902
- Power splitter HP 11667B *
- 6 dB attenuator HP 33340C opt 006 *
- 3 cm semi-rigid L cable HP 54007-61602 *
- 6 cm semi-rigid L cable HP 54007-61601 *

* Item is deleted if option 090 is ordered.

Figure 2-1. Accessories Supplied

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Installation

2-1
Options Available

The following options are available for the HP 54118A. The quantity is one unless otherwise stated.

- Rack mount kit - Option 908
- Additional copy of Operating and Service Manual - Option 910
- Delete the following items - Option 090
  - Power splitter HP 11667B
  - 6 dB attenuator HP 33340C opt 006
  - 3 cm semi-rigid L cable HP 54007-61602
  - 6 cm semi-rigid L cable HP 54007-61601

Accessories Available

The following accessories are available for the HP 54118A.

- Antistatic mat and wrist strap HP 9300-1346
- Microwave Amplifier 2-20 GHz HP 8149B
- RF Amplifier 0.1-1.3 GHz HP 8447F
- Step Attenuator HP 8494B opt 002
- Step Attenuator HP 8495B opt 002
- Programmable Attenuator HP 33320H
- Programmable Attenuator HP 33321H
- Series Fixed Attenuators HP 33340C
- High Frequency Probe HP 54006A
- Power Splitter HP 11667B
- Accessory Kit HP 54007A
- 22 ns Delay Line HP 54008A
Antistatic Procedures

The HP 54118A is sensitive to electrostatic damage (ESD). When handling the HP 54118A, use an antistatic mat and wrist strap. These are both supplied with the HP 54120T Digitizing Oscilloscope.

The HP 54118A is connected to earth ground through the rear panel external SMB power cable or the front panel trigger cabling, which connects the HP 54118A to the HP 54121A Four Channel Test Set. To avoid possible ESD damage to the instrument when it is not connected to the HP 54121A, connect the HP 54118A's rear panel ground lug to the antistatic mat. Ensure the antistatic mat is connected to earth ground.

Connector Care

APC 3.5 and SMA connectors are precision connectors and wear out with use. The failure to obtain repeatable measurement results or optimum performance may be caused by worn out or damaged connectors. Mechanically and visually check all connectors on a periodic basis. Use the connector savers, APC 3.5 f-f adapters, on all instrument connectors and on expensive hardware. It is less expensive to throw away a damaged or worn out connector saver than to throw away expensive microwave hardware.

Torque all SMA to SMA, or SMA to APC 3.5 connectors to 8 in/lbs.
Torque all APC 3.5 to APC 3.5 connectors to 5 in/lbs.

For a more detailed explanation on connector care refer to the HP 54007A Accessory Kit Operating and Service Manual. The information is also repeated in the HP 54120T Digitizing Oscilloscope Operating Manual appendix B, and Service Manual appendix A.
Connecting the HP 54118A

Use the following steps to connect the HP 54118A to the four channel test set.

**CAUTION**

*Use a properly grounded antistatic wrist strap and mat.*

1. Place HP 54118A either on top or underneath the four channel test set.

2. Connect external SMB power cable from the HP 54118A's rear panel connector POWER SUPPLY +15 VDC to the four channel test set's rear panel connector J2 TRIGGER POWER +15 V. Refer to figure 2-1.

![Diagram of connections](image)

*Figure 2-2. External SMB Power Connections*

Installation
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3. Ensure all front panel connectors on the HP 54118A and four channel test set have connector savers installed (APC 3.5 f-f adapters).

4. Connect external output cable from the HP 54118A's OUTPUT connector to the four channel test set's TRIG input. Refer to figure 2-2.

*Figure 2-3. Connecting External Output Cable*
Rack Mounting

Figure 2-3 illustrates the recommended rack mounting method for connecting the HP 54118A and four channel test set. The HP 54118A may be placed either on top or underneath the four channel test set. The cables needed are supplied accessories with the HP 54118A. Option 908 (HP part number 5061-9672) supplies the materials needed for rack mounting the two instruments. The semi-rigid cables supplied with the HP 54118A require that the two instruments are spaced 7/16 inch (1.11 cm) apart. This spacing can be achieved by varying the placement of the instruments in the rack.

Figure 2-4. Recommended Rack Mount

Installation
2-6
Figure 2-4 illustrates another rack mount method. The rack mount hardware necessary for this method may be ordered from Hewlett Packard. The semi-rigid cables, which connect the two instruments together, are not supplied.

![Diagram of rack mount setup]

Figure 2-5. Side by Side Rack Mount

Installation

2-7
Operation

Introduction

The HP 54120T 20 GHz Digitizing Oscilloscope triggers on continuous wave signals up to 500 MHz, or higher bandwidth pulses with less than 500 MHz repetition rates. The HP 54118A Trigger extends the HP 54120T's triggering bandwidth by generating low repetition rate pulses which are time correlated to similar positions on the input signal's waveform. Refer to figure 3-1. The HP 54118A's output pulse rate is fairly constant, but it is not an exact subharmonic of the input frequency. This illustrates the HP 54118A Trigger is different from countdown trigger methods.

Figure 3-1. How HP 54118A Triggers the HP 54120T
Functional Description

The HP 54118A Trigger input frequency range is 500 MHz to 18 GHz. The trigger output pulses occur at a much slower rate, 5 kHz to 20 kHz. The output pulse rate is determined by the HP 54118A's front panel HOLDOFF setting. The HP 54118A's simplified operation can be described by the following six step sequence. Refer to figure 3-2.

1. The 180° phase splitter continuously supplies a copy (Vin) and a 180° phase shifted copy (Vin) of the input signal to the trigger assembly.

2. The bias control assembly arms the trigger assembly.

3. The trigger assembly triggers and outputs a pulse.

4. The bias control assembly senses the trigger event and resets the trigger assembly.

5. The trigger assembly is kept in a reset condition until HOLDOFF ends.

6. Repeat steps 2-5.

Figure 3-2. Simplified Block Diagram
Refer to figure 3-3. The input signal is applied to a 180° phase splitter. The phase splitter's output is a copy (Vin) and a 180° phase shifted copy (V̅in) of the input signal. Vin and V̅in are each terminated through 50 Ω into a tunnel diode. Vin produces a signal current (Iin) in the arming tunnel diode. V̅in produces a signal current (I̅in) in the trigger tunnel diode.

The bias control assembly supplies a variable dc trigger bias current to the trigger tunnel diode. After the trigger bias current settles to its final value, the bias control assembly supplies a variable arming bias current to the arming tunnel diode. When the arming bias current is enabled, it increases very slowly with respect to one period of the input trigger signal.

The arming bias current continues to increase until the total current (Iin + arming bias current) reaches the tunnel diode's switching (firing) threshold. When the arming tunnel diode fires, it produces a very fast rising voltage step across the arming tunnel diode.

Figure 3-3. HP 54118A's Internal Functioning

Operation 3-3
This voltage step produces a current step in the trigger tunnel diode. Recall that the arming bias current was increasing very slowly with respect to one period of the input trigger signal. This ensures that the arming tunnel diode always fires on a positive peak of the signal current \( I_{in} \), and a negative peak of the signal current \( I_{in} \). Refer to figure 3-4.

The current step produced in the trigger tunnel diode causes the total current \( (I_{in} + \text{trigger bias current} + \text{current step}) \) to reach the trigger tunnel diode's firing threshold on the next rising edge of \( I_{in} \). The trigger tunnel diode fires producing an output pulse (200 mV, 5 ns wide, with a risetime of approximately 30 ps).

The bias control assembly senses \( V_{sense} \) when either of the tunnel diodes fire. The bias control assembly then resets both tunnel diodes by removing the bias currents.

In addition to disabling the bias currents, the bias control assembly also starts a variable holdoff timer. When the holdoff timer times out, the bias control assembly rearmns the trigger assembly by enabling the bias currents. The period of the holdoff timer directly affects the HP 54118A's output pulse rate.
Continuous wave operation is illustrated in Figure 3-4. \( V_{\text{in}} \) is a copy of the input signal and is applied to the arming tunnel diode. \( V_{\text{in}} \) is a 180° phase shifted copy of the input signal and is applied to the trigger tunnel diode.

**ARMING LEVEL** sets the arming tunnel diode's switching threshold (arming level = switching threshold - arming bias current). For continuous wave signals, it is set to the detent CW position. This ensures that without an input signal applied to the HP 54118A, the arming tunnel diode will switch (fire).

**TRIGGER LEVEL** sets the trigger tunnel diode's switching threshold (trigger level = switching threshold - trigger bias current - current step). Less bias is required for signals with a larger peak-to-peak amplitude. Notice trigger level is brought to a stable operating point before arming level is enabled.

**HOLDOFF** adjusts the period of the holdoff timer. Adjusting holdoff for continuous wave signals changes the HP 54118A's output pulse rate.

![Diagram of Continuous Wave Example](image)

*Figure 3-4. Continuous Wave Example*
Equipment Setup

The following steps describe how to trigger on continuous wave signals.

**CAUTION**

Use a properly grounded antistatic wrist strap and mat to avoid electrostatic damage (ESD) to the instruments.

1. Set HP 54118A's TRIGGER LEVEL, ARMING LEVEL and HOLDOFF fully counterclockwise. ARMING LEVEL should be in the detent CW (continuous wave) position.

2. If the trigger signal is also the signal you wish to view, proceed to the next paragraph Viewing the Trigger Signal. Otherwise, connect trigger source to the HP 54118A INPUT. Example: 10 GHz sine wave, approximately 500 mVp-p (-2 dBm)

3. Connect signal source to HP 54121A channel 4 input. Example: 10 GHz sine wave, approximately 250 mVp-p (-8 dBm)

4. Go to Displaying the Signal paragraph.

Viewing the Trigger Signal

To view the trigger signal, connect the equipment as shown in figure 3-5 and follow steps 1-2. If you are using a delay line to view the trigger event, read the "Delaying the Signal" paragraph in the Pulsed RF portion of this chapter.

Note

The 6 dB attenuator is used to best match the trigger signal to the sensitivity and dynamic range of the displayed channel. If you do not want to use the 6 dB pad, remove the 3 cm semi-rigid L cable and the 6 dB pad. Replace these parts with a 6 cm semi-rigid L cable.

Operation 1-6
1. Connect external trigger source to power splitter's input.  
Example signal: 10 GHz sine wave, approximately 1 Vp-p (4 dBm)

2. The power splitter has an attenuation of 6 dB. When using the power splitter and the 6 dB attenuator, set the HP 54120T's channel attenuation to 3.98. If you are using only the power splitter, set the channel attenuation to 2.000.

**Note**

*The trigger signal was connected to the oscilloscope's channel 4 input because the supplied accessories provide the necessary cabling. You may use other cabling techniques to view a signal on any of the other oscilloscope channel inputs.*

*Figure 3-5. Viewing the Trigger Signal*
Displaying the Signal

1. Change the HP 54120T to the following settings: trigger level 50 mV, positive slope, HF sense and reject off, display persistence 300 ms, Timebase in triggered sweep mode. Set up the sensitivity, offset, Time/div and delay to properly display the signal on the oscilloscope. If you used the example signal, use the following settings: 200 mV/div, offset 0 V, Timebase 100 ps/div, delay 16 ns.

2. Leave ARMING LEVEL in the detent cw position. This ensures the arming diode will fire reliably on continuous wave signals. ARMING LEVEL is only adjusted for pulsed RF operation.

3. Adjust TRIGGER LEVEL for best triggered oscilloscope display.

Note

How stable the displayed signal appears on the HP 54120T can be affected by the HP 54118A’s HOLDOFF setting. By increasing HOLDOFF the HP 54118A’s output pulse rate is decreased. Whenever the oscilloscope’s front panel setup is changed, HOLDOFF should be readjusted for best triggered oscilloscope display.
Pulsed RF Signals

The HP 54118A triggers on the pulsed RF signal's carrier. Pulsed RF operation is illustrated in figure 3-6.

ARMING LEVEL sets the arming tunnel diode's switching threshold (arming level = switching threshold - arming bias current). Arming bias is set low enough to fire the arming tunnel diode near the beginning of the pulse $V_{in}$, but high enough so the arming tunnel diode will not fire on noise between pulse bursts.

TRIGGER LEVEL sets the trigger tunnel diode's switching threshold (trigger level = switching threshold - trigger bias current - current step). It is adjusted so the trigger tunnel diode fires on the next rising edge of $V_{in}$, after the arming tunnel diode has fired.

HOLDOFF is adjusted so the bias control assembly rearms the trigger assembly between pulse bursts rather than during a pulse burst.

Figure 3-6. Pulsed RF Example
Delaying the Signal

There is approximately 20 ns of delay in the signal's trigger path. For most applications, a 22 ns delay line (HP 54008A) placed between the signal source and the oscilloscope's input will allow you to view the trigger point.

When the tunnel diodes fire, they produce a pulse which appears at the HP 54118A's INPUT and OUTPUT connectors. The pulse which appears at the INPUT connector is called kickout. Refer to figure 3-7. The HP 54120T's minimum delay is approximately 16 ns, by which time the kickout pulse should have decayed.

If you are using a delay line, the kickout pulse may be seen on the oscilloscope's display. Splitting the input signal with a directional coupler can minimize the effects of kickout on the displayed signal.

![Figure 3-7. Typical Kickout Pulse](image)

Operation
3-10
1. Connect equipment as shown in figure 3-8 (input signal will be connected in a later step). A directional coupler which meets the following specifications is recommended:
   Frequency range - 500 MHz to 18 GHz
   Nominal Coupling - 10 dB ± 1 dB
   Directivity - 14 dB from 500 MHz to 12.4 GHz
   12 dB from 12.4 GHz to 18 GHz

2. Set HOLDOFF and ARMING LEVEL fully counterclockwise.

3. Set TRIGGER LEVEL fully clockwise.

4. Set oscilloscope's trigger level to 50 mV, positive slope, HF sense and reject off, display persistence 300 ms.

Figure 3-8. Recommended Pulsed RF Connections
5. The oscilloscope should not be triggered. Press the Clear Display key. If the trace does not reappear, the oscilloscope is not triggered.

6. Slowly decrease TRIGGER LEVEL (counterclockwise) until HP 54120T begins to trigger. The oscilloscope's display will begin to update when it is triggered.

7. Slowly increase ARMING LEVEL until triggering stops.

**Displaying the Signal**

1. Connect your available pulsed RF signal to directional coupler
   Example signal: Carrier - 10 GHz sine wave, 500 mVp-p (-2 dBm)
   Modulation - Pulse train, period 10 μs, duty cycle 10%, risetime 10 ns.

2. The oscilloscope's display will begin to update.

3. The oscilloscope's timebase and channel setups will depend on the characteristics of the pulsed RF signal you are using and your preferred view of the signal.

4. Increase TRIGGER LEVEL to obtain display with the least amount of jitter. If the display is a multivalued, increase HOLDOFF to obtain a display with a single valued waveform.

5. Readjust ARMING LEVEL, TRIGGER LEVEL, and HOLDOFF as necessary to obtain the best triggered oscilloscope display.
Performance Tests

Introduction

This chapter describes the performance tests which verify the instrument’s electrical performance using the specifications in chapter 8. All performance tests can be performed without access to the interior of the instrument. Before doing the performance tests, ensure you have adhered to the adjustment cycle listed in chapter 5 (every twelve months or every 2000 hours of operation).

Recommended Test Equipment

In chapter 1, table 1-1 lists the recommended test equipment. Any equipment which satisfies the critical specifications may be used. At the beginning of each performance test, a list of recommended test equipment for that particular test is given.

Test Record

Performance tests results may be tabulated on the performance test record at the end of this chapter. The test record lists all of the tested specifications and their acceptable limits. The results recorded at incoming inspection can be used for comparison during periodic maintenance, troubleshooting, and after repairs or adjustments.

Performance Test Cycle

This instrument requires periodic verification of performance. The instrument should be checked using the following performance tests at least every twelve months or every 2000 hours of operation. If the instrument is used in high humidity conditions (>80%), the performance test interval should be reduced to six months. The amount of use, environmental conditions, and the user’s experience concerning the need for performance checks will contribute in deciding the performance test cycle.
Test Procedures

Note

Allow the instrument to warm up for at least 15 minutes prior to beginning the performance tests.

Note

This test assumes that the HP 54120T Digitizing Oscilloscope is in calibration. If this is not the case, these tests may not work correctly, or some specifications may not be met. It is also assumed that the operator is familiar with power meter operation.

CAUTION

The HP 54118A’s front panel APC 3.5 connectors are very susceptible to physical damage and the HP 54118A to electrostatic damage (ESD). Ensure you are familiar with the Antistatic Procedures and Connector Care sections in chapter 2.
Specifications: Sensitivity and output jitter are system specifications. The system includes the HP 54120T and the HP 54118A. Though not a specified characteristic, error rate can be estimated using this procedure.

Sensitivity:
- 50 mVp-p (-22 dBm) 500 MHz to 2 GHz
- 500 mVp-p (-2 dBm) 2 GHz to 12.4 GHz
- 1 Vp-p (+4 dBm) 12.4 GHz to 18 GHz

Jitter: <3% of input signal period (60 ps at 500 MHz)

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Critical Specifications</th>
<th>Recommended Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscilloscope</td>
<td>No substitute</td>
<td>HP 54120T</td>
</tr>
<tr>
<td>Sweeper</td>
<td>0.5-18 GHz, -22 dBm to +4 dBm (50 mVp-p to &gt;1 Vp-p)</td>
<td>HP 8341B</td>
</tr>
<tr>
<td>Power Meter</td>
<td>0.5-18 GHz</td>
<td>HP 436A</td>
</tr>
<tr>
<td>Power Sensor</td>
<td>-22 dBm to +4 dBm</td>
<td>HP 8485A</td>
</tr>
<tr>
<td>Directional Coupler</td>
<td>0.5-18 GHz, directivity &gt;10 dB</td>
<td>Keysight Model 1851</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessory</th>
<th>Critical Specifications</th>
<th>HP Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adapter</td>
<td>APC 3.5 (m-m)</td>
<td>1250-1964</td>
</tr>
<tr>
<td>Coaxial cable</td>
<td>SMA connectors, 18 GHz, Qty 3</td>
<td>HP 8120-6948</td>
</tr>
<tr>
<td>Coaxial Cable</td>
<td>SMA connectors, 18 GHz</td>
<td>HP 54118-61607</td>
</tr>
</tbody>
</table>

Note

If a directional coupler is not available, a power splitter (such as the HP 11667B 0.5-18 GHz) may be used. However, a signal generator capable of 2 Vp-p at 18 GHz (such as the HP 8340B), must be used.

Procedure

Items shown in parentheses are for the second and third part of this procedure where the steps are repeated, but with different frequencies. i.e. -22 dBm, *(2 dBm), and **(+4 dBm) would be the power settings for 500 MHz *(12.4 GHz), and **(18 GHz) respectively.

Performance Tests

4-3
1. Zero power meter.

2. Connect equipment as shown in figure 4-1. When testing 500 MHz, the
directional coupler connects directly to HP 54121A through an
APC 3.5 (m-m) adapter.

3. Set sweeper output as follows.
   RF output enabled
   CW frequency 500 MHz, *(12.4 GHz), **(18 GHz)
   Power approx. -20 dBm, *(2 dBm), **(+4 dBm)

   ![Diagram](image)

   **Figure 4-1. Initial Equipment Setup**

4. Adjust sweeper power output for -22dBm *(2 dBm) **(+4 dBm) as
   indicated on power meter.

5. Disconnect power meter and connect cable to HP 54118A Input.

6. Set up HP 54120T as follows:
   Channels: Chan 1 to 3 OFF
   Chan 4 ON
   Volts/div (adjust for 6 to 7 divisions of vertical deflection)
   Offset 0.00 V
   Atten 1.0

Performance Tests

4-4
Display:
  Mode       Persistence
  Time       300 ms
  Screen     Single
  Graticule  Grid
  Bandwidth  12.4 GHz

Timebase:
  Time/div   200 ps, *(10 ps), **(10 ps)
  Delay      24 nsec
  Delay Ref at Left
  Sweep      Trig'd

Trigger:
  Level      50 mV
  Slope      Pos
  Atten      1.000

7. Set HP 54118A as follows:
   ARMING LEVEL fully counterclockwise to detent CW position
   HOLDOFF fully clockwise
   TRIGGER LEVEL adjust to obtain most stable display. Check entire range of TRIGGER LEVEL, stable triggering should be possible.

8. Re-adjust HP 54120T Timebase Delay to center waveform valley to center graticule. Refer to figure 4-2.

Figure 4-2. Timebase and Delay Settings

Performance Tests 4-5
9. Change HP 54120A to
   Delta V: V markers ON
   Preset Levels 0 to 100%

10. Press Auto Level Set and note Delta V reading ________

11. On HP 54120T, press MORE, then HISTOGRAM. Set
    Window/Acquire/Results  Window
    Source is  Chan 4
    Time/Voltage/Histogram  Time

12. Use data entry keys to set window marker 1 to + 0.5% of step 10's
    reading and window marker 2 to - 0.5% of step 10's reading

13. On HP 54120T set
    Window/Acquire/Results  Acquire
    number of samples  4000, *(4000), **(8000)

14. Press Stop and Clear Display on HP 54120T system control keys, then
    Start Acquiring histogram key. Wait for Number of Samples to be
    100%.

15. Change HP 54120T to
    Window/Acquire/Results  Results
    Upper distr limit  set upper distribution limit with RPG knob
    to the right side of the distribution on the POS slope
    of signal as shown in figure 4-3.


17. Adjust lower distribution marker to right edge of the left distribution as
    shown in figure 4-3.

18. Press 0-100% Set at Limit.


Performance Tests
4-6
20. Observe the Upper % = 100.0% of reading in the lower left corner of display, while turning the RPG knob counterclockwise. Turn counterclockwise until Upper % changes from 100%, then turn slowly clockwise until it just returns back to 100%.

21. Note Upper Marker Value (time). Start = _________.

22. Note Lower Marker Value (time). Stop = _________.

23. Press Lower distr limit. Adjust Lower % distribution limit as close to 50% as possible, using either RPG or ENTRY arrows.

24. Note Lower Marker Value (time) Stop = _________. (Median)
   This value will be used later and referred to as the "median".

25. Note Delta t reading _________.

26. Now move lower distribution marker back until Delta t reading equals TWICE the value noted in step 25.

27. Press 0–100% Set at Limits.
28. Press Sigma. Sigma value displayed in lower right portion of display is estimated jitter. Note value.

29. Reset Lower Distribution Limit Marker to Stop value noted in step 22 using data entry keys.

30. Press Upper Distr Limit and set to Start value noted in step 21 using data entry keys.

31. Press 0-100% Set at Limits.

32. Press Lower Distr Limit and set lower limit marker, using data entry keys, to median value from step 24, minus 4 times the estimated jitter noted in step 28.
   Median _____
   minus
   4 times step 28’s value _____
   Result _____

33. Note Lower % value as estimated % of error. This is not a specified value, but has been included for information purposes.

34. Press 0-100% Set at Limits.

35. Press Sigma. The value of Sigma is jitter. Specifications are:
   < 60 ps at 500 MHz, < 2.5 ps at 12.4 GHz, and < 1.7 ps at 18 GHz.

36. Reverse the directional coupler’s outputs. Connect the -10 dB output to the HP 54121A channel 4 input, and connect the straight-thru output to the HP 54118A input.

37. Repeat procedure at 12.4 GHz using power values shown with *(__).

38. Repeat procedure at 18 GHz using power values shown with **(__).
Input Reflection

Specification: <5% for 30 ps risetime

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Critical Specifications</th>
<th>Recommended Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscilloscope</td>
<td>No Substitute</td>
<td>HP 54120T</td>
</tr>
<tr>
<td>50 Ω termination</td>
<td>APC 3.5 (m)</td>
<td>HP 909D opt 011</td>
</tr>
<tr>
<td>Accessory</td>
<td></td>
<td>HP Part Number</td>
</tr>
<tr>
<td>Adapter</td>
<td>APC 3.5 (i-f)</td>
<td>1250-1865</td>
</tr>
<tr>
<td>Coaxial Short</td>
<td>APC 3.5 (f)</td>
<td>1250-2127</td>
</tr>
<tr>
<td>Coaxial Cable</td>
<td>SMA connectors, 18 GHz</td>
<td>54118-61606</td>
</tr>
</tbody>
</table>

Note

This test is made on the HP 54118A WITHOUT power. Be sure that the rear panel external SMB power cable is disconnected. To ensure the HP 54118A is grounded, connect a cable between the rear panel ground lug from the HP 54118A to the four channel test set.

Procedure

1. Perform a one-keydown power up. Hold down any key and cycle oscilloscope power off and on. Continue to hold key down until graticules are displayed on screen.

2. Set up HP 54120T as follows:

   Channels: Chan 1 ON
              Chan 2-4 OFF
              Volts/div 5 mV/div
              Offset 200 mV

   Display: Mode Average
            Averages 16
            Screen Single

Performance Tests
4-9
Timebase: Time/div 350 ps/div
         Delay 19 ns

Network: Reflect/Trans/CAL Reflect
         Step & chan 1 On

3. Press Network menu, then Reflect/Trans/CAL until CAL is highlighted.

4. Press Reflect/Cal key. Connect semi-rigid cable to HP 54121A TDR
   Output. Connect a coaxial short connector (APC 3.5 ft) to end of cable.
   Press Reflect/Cal again.

5. Remove coaxial short from cable and connect a 50 Ω termination
   through an APC 3.5 (f-f) adapter in its place. Press Reflect/Cal again.

6. Remove 50 Ω termination. Connect cable to HP 54118A INPUT.
   Press Clear Display key and wait for 16 averages to occur.

7. Press Network menu key, then Reflect/Trans/CAL key until Reflect is
   highlighted.

8. Set Normalized risetime to 30 ps. Press Normalize to Mem 1 key.
   Wait for normalization.

9. Press Stop key, then Clear Display key.

10. Press Cursor Chan 1 until Cursor Mem 1 is highlighted.

11. Press Min & Max Reflect key.

12. Minimum and Maximum RHO values are displayed in upper left
    corner of display. They should be ≤ 5%.

Performance Tests
4-10
## Holdoff Time

**Specification:** 50 μsec to 200 μsec

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Critical Specifications</th>
<th>Recommended Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscilloscope</td>
<td>No Substitute</td>
<td>HP 54120T</td>
</tr>
<tr>
<td>Oscilloscope</td>
<td>100 MHz</td>
<td>HP 54201A</td>
</tr>
<tr>
<td>50 Ω Termination</td>
<td>APC 3.5 (m)</td>
<td>HP 909D opt 011</td>
</tr>
<tr>
<td>Accessory</td>
<td>Critical Specifications</td>
<td>HP Part Number</td>
</tr>
<tr>
<td>Adapter</td>
<td>SMA (m) to BNC (f)</td>
<td>1250-1200</td>
</tr>
<tr>
<td>Coaxial Cable</td>
<td>BNC (m-m)</td>
<td>10503A</td>
</tr>
</tbody>
</table>

### Procedure

1. Connect external SMB power cable from HP 54118A to the four channel test set.

2. Set up HP 54118A as follows:
   - Arming Level: Fully counterclockwise to detent CW position
   - Trigger Level: Fully counterclockwise
   - Holdoff: Fully clockwise

3. Connect oscilloscope to HP 54118A OUTPUT using the SMA to BNC adapter. Connect 50 Ω termination to HP 54118A INPUT.

### Note

_A monitor digitizing oscilloscope may need to be in the infinite persistence mode to observe the extremely narrow holdoff pulses._

4. Observe output signal. Pulse period should be greater than 200 μsec.

5. Change Holdoff setting to fully counterclockwise.

6. Observe output signal. Pulse period should be less than 50 μsec.
Performance Test Record

Input Sensitivity and Output Jitter

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triggers at 500 MHz 50 mVp-p (-22 dBm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jitter at 500 MHz 50 mVp-p (-22 dBm)</td>
<td>Limit &lt; 60 ps</td>
<td></td>
</tr>
<tr>
<td>Triggers at 12.4 GHz 500 mVp-p (-2 dBm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jitter at 12.4 GHz 500 mVp-p (-2 dBm)</td>
<td>Limit &lt; 2.5 ps</td>
<td></td>
</tr>
<tr>
<td>Triggers at 18 GHz 1 Vp-p (+4 dBm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jitter at 18 GHz 1 Vp-p (+4 dBm)</td>
<td>Limit &lt; 1.7 ps</td>
<td></td>
</tr>
</tbody>
</table>

Input Reflection

< 5% with 30 ps incident pulse | Limit < 5% |

Holdoff

Minimum HOLDOFF setting | Limit ≤ 50 μs |

Maximum HOLDOFF setting | Limit ≥ 200 μs |
Adjustments

Introduction

This chapter describes the adjustments for returning the instrument to optimum operating capabilities after repairs have been made or during routine preventive maintenance.

Adjustment Interval

To maintain proper calibration, these adjustments should be made at approximately one year or after 2000 hours of operation, whichever is less. Amount of use, environmental conditions, and the user’s experience concerning the need for adjustment verification will contribute in deciding the adjustment interval.

Recommended Test Equipment

The following list of equipment is recommended for the adjustment procedure. Any equipment which satisfies the critical specifications may be used.

Table 5-I. Recommended Test Equipment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Critical Specifications</th>
<th>Recommended Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Multimeter</td>
<td>3% Accuracy</td>
<td>HP 3478A</td>
</tr>
<tr>
<td>Oscilloscope</td>
<td>Trigger on 20 KHz</td>
<td>HP 5412T</td>
</tr>
<tr>
<td>50 Ω Termination</td>
<td>APC 3.5 Connectors</td>
<td>HP 909D</td>
</tr>
<tr>
<td>Coaxial Cable</td>
<td>SMA connectors, 1 GHz</td>
<td>HP 54118-61607</td>
</tr>
</tbody>
</table>
Equipment Setup

CAUTION

Use a properly grounded antistatic wrist strap and mat.

1. Remove top cover from HP 54118A.

2. Place HP 54118A on top of four channel test set.

3. Connect 50 Ω termination to HP 54118A’s INPUT.

4. Disconnect any cables from the four channel test set.

5. Connect external power cable from the HP 54118A’s rear panel connector POWER SUPPLY +15 VDC to the four channel test set’s rear panel connector J2 TRIGGER POWER +15 V.

6. Ensure connector savers, APC 3.5 (f-f), are installed on the HP 54118A’s OUTPUT and on the four channel test set’s TRIG input.

7. Connect external output cable from the HP 54118A’s OUTPUT to the four channel test set’s TRIG input.

8. On the HP 54118A set the front panel TRIGGER LEVEL, ARMING LEVEL, and HOLD OFF controls fully counterclockwise.

9. Setup HP 54120T as follows:

- Display - Persistence mode, 300 ms
- Channels - Channel 1 on, vertical sensitivity 20 mV/div, offset 0 V, channels 2-4 off.
- Timebase - 1 μs/div, delay 16 ns, sweep trg’d
- Trigger - Level 50 mV, positive slope, HF sense and reject off

Adjustments
5-2
The following adjustments are performed on the HP 54118A's Bias Control Assembly, (A1).

1. Set R28, MIN. TRIG. LEVEL, and R29, MIN. ARM. LEVEL, full clockwise.

2. There should be a trace on the oscilloscope's display that is continuously being updated. If you press the Clear Display key and the trace reappears on the oscilloscope's display, the trace is being updated.

3. Slowly adjust R28, MIN. TRIG. LEVEL, counterclockwise until the displayed trace is not being updated.

4. Press the Clear Display key. The trace will disappear from the oscilloscope's display and not reappear.

5. Slowly increase R28 until oscilloscope just starts to trigger.

6. Connect digital multimeter's positive lead to TP2 and negative lead to TP4, ground.

7. Note the multimeter's reading, _______ V

8. Subtract 200 mV from step 7's measurement

   _______ V - 200 mV = _______ V

9. Slowly adjust R28 clockwise until the multimeter reading equals the result in step 8 ± 10 mV.

1: Using 200 mV is the preferred method to ensure proper operation over the instrument's complete temperature range and best front panel control adjustment. During the instrument's life, the aging of the trigger assembly may cause the adjustment to not have enough range to achieve 200 mV. It is permissible to use a value as low as 100 mV to avoid purchasing a new trigger assembly at this time.
10. There should be a trace on the oscilloscope’s display that is continuously being updated.

11. Move digital multimeter’s positive lead to TP1.

12. Slowly adjust R29, MIN. ARM. LEVEL, counterclockwise until the displayed trace is not being updated.

13. Press the Clear Display key. The trace will disappear from the oscilloscope’s display and not reappear.

14. Slowly increase R29 until oscilloscope just starts to trigger.

15. Note the multimeter’s reading, _____ V.

16. Subtract 200 mV from step 15’s measurement.¹
   _____ V - 200 mV = _____ V

17. Slowly adjust R29 clockwise until the multimeter reading equals the result in step 16 ± 10 mV.

18. There should be a trace on the oscilloscope’s display that is being updated.

Adjustments
5-4
Disassembly

Introduction
This chapter contains removal and replacement procedures for the chassis and assembly parts in the HP 54118A Trigger.

Safety Considerations
The following warnings and cautions must be followed for your protection and to avoid damage to the instrument.

**WARNING**

Remove instrument power before replacing any modules to avoid damaging the instrument.

**CAUTION**

The HP 54118A is very sensitive to static discharge. Failure to observe proper antistatic methods may result in damage to the instrument. All maintenance or operation should be performed while using a grounded antistatic mat and wrist strap.

Tools Required
The following tools are used for disassembly of the HP 54118A.

- 3/32 allen wrench (180° phase splitter)
- 0.050 allen wrench (front panel knobs)
- 1/4 inch nut driver (trigger power cable)
- 1/2 inch nut driver (front panel controls)
- 9/16 inch thin wrench HP part number 8710-1770 (APC Connectors)
- 5 in/lb torque driver with TORX #10 (used for most procedures)
- 5 in/lb torque with 5/16 inch wrench (semi-rigid cable)
- 18 in/lb torque driver with TORX #15 (frame hardware)
- Medium posi drive (cover screws)
Rear Panel

Removal

1. Disconnect power cable, and remove top and bottom covers.
2. Remove four screws from top and bottom of rear casting. Refer to figure 6-1.
3. Disconnect external power cable from J1 on the bias control assembly.
4. Pull rear panel away from instrument.

Replacement

1. Reverse removal procedure to install rear panel.

Disassembly
6-2
**Trigger Power Cable**

**Removal**

1. Disconnect power cable, and remove top and bottom covers.

2. Remove rear panel. Refer to removal procedure for "Rear Panel" in this chapter.

3. Use a 1/4 inch nut driver or wrench to remove hex nut and washer which attach the trigger power cable to the rear panel. Refer to figure 6-2.

**Replacement**

1. Reverse removal procedure to install trigger power cable.

*Figure 6-2. Trigger Power Cable Removal*
Trigger Assembly

Removal

1. Disconnect power cable, and remove top and bottom covers.

**CAUTION**

The exposed trigger assembly's pins are very sensitive to electrostatic damage (ESD). Ensure you are wearing a properly grounded antistatic wrist strap before continuing.

2. Disconnect red, black, and blue wires from trigger assembly. Refer to figure 6-3

3. Use a 5/16 inch wrench to disconnect arming, trigger, and output semi-rigid cables from trigger assembly. Avoid bending or stressing the semi-rigid cables.

4. Loosen two screws holding trigger assembly to main deck.

Replacement

1. Attach trigger assembly to main deck with two screws and tighten with a 5 in/lb torque driver.

2. Install semi-rigid cables into trigger assembly. When pushing semi-rigid cables into connectors, a definite slight snap sound will be heard as the cable and connector are seated together. Tighten semi-rigid cable connectors with a 5 in/lb torque wrench

5. Connect red, black, and blue wires to trigger assembly. Refer to figure 6-3.

6. Install top and bottom covers.

Disassembly
6-4
Figure 6-3. Trigger Assembly Removal

Disassembly
6-5
Bias Control Assembly

Removal

1. Disconnect power cable, and remove top and bottom covers.
2. Disconnect trigger power cable from J1, trigger control cable from J2, holdoff cable from J3, trigger level cable from J4, and arming level cable from J5.
3. Remove two screws holding Q3 and Q7 to heat sinks on main deck.
4. Remove five screws holding bias control assembly to main deck. Refer to figure 6-4.

Replacement

1. Reverse removal procedure to install bias control assembly. Tighten all seven screws to 5 in/lbs with a torque driver.

Disassembly
6-6
Front Panel Controls

Removal

1. Disconnect power cable, and remove top and bottom covers.

2. Remove main deck. Refer to removal procedure for "Main Deck" in this chapter.

3. Use a 0.050 Allen wrench to remove knob from front panel control.

4. Use a 1/2 inch wrench to remove nut from front panel control.
   Refer to figure 6-5.

5. Disconnect front panel control's wire lead assembly from bias control assembly.

Replacement

1. Reverse removal procedure to install front panel control. H12 is a flat nylon washer used only on the ARMING LEVEL and TRIGGER LEVEL controls.

Figure 6-5. Front Panel Controls Removal
180° Phase Splitter

Removal

1. Disconnect power cable, and remove top and bottom covers.

2. Remove bias control assembly. Refer to removal procedure for "Bias Control Assembly" in this chapter.

3. Use a 5/16 inch wrench to disconnect, input, arming, and trigger semi-rigid cables from 180° phase splitter. Avoid bending or stressing the semi-rigid cables.

4. Use a 3/32 inch allen wrench to remove four screws which hold 180° phase splitter to main deck. Refer to figure 6-6.

5. Remove 50 Ω SMA termination from 180° phase splitter.

Replacement

1. Attach 50 Ω SMA termination to 180° phase splitter.

2. Attach 180° phase splitter to main deck with four socket-headed cap screws and tighten with a 3/32 inch allen wrench.

3. Install semi-rigid cables into 180° phase splitter. When pushing semi-rigid cables into connectors, a definite slight snap sound will be heard as the cable and connector are seated together. Tighten semi-rigid cable connectors with a 5 in/lb torque wrench.

4. Install top and bottom covers.

Disassembly
6-8
Figure 6-6. 180° Phase Splitter Removal
APC 3.5 Connectors

Removal

1. Disconnect power cable, and remove top and bottom covers.
2. Remove main deck. Refer to removal procedure for "Main Deck" in this chapter.
3. Use a 5/16 inch wrench to disconnect semi-rigid cable from defective APC 3.5 connector.
4. Use a thin 9/16 inch wrench (HP part number 8710-1770) to remove damaged APC 3.5 connector.
   Refer to figure 6-9.

Replacement

1. Reverse removal procedure in install APC 3.5 connector. When pushing semi-rigid cables into connectors, a definite slight snap sound will be heard as the cable and connector are seated together. Tighten semi-rigid cable connector with a 5 in/lb torque wrench.

Figure 6-9. APC 3.5 Connector Removal

Disassembly
6-12
Front Panel

Removal

1. Remove power cable, and remove top and bottom covers.
2. Remove main deck. Refer to removal procedure for "Main Deck" in this chapter.
3. Remove arming level, trigger level, and holdoff assemblies. Refer to removal procedure for "Front Panel Controls" in this chapter.
4. Remove APC 3.5 connectors. Refer to removal procedure for "APC 3.5 Connectors" in this chapter.
5. Remove two screws from each side of front panel. Refer to figure 6-10.

Replacement

1. Reverse removal procedure to install front panel.

Figure 6-10. Front Panel Removal

Disassembly
6-13
The HP 54118A Trigger input frequency range is 500 MHz to 18 GHz. The trigger output pulses occur at a much slower rate, 5 kHz to 20 kHz. The output pulse rate is determined by the HP 54118A's front panel HOLDOFF setting. The HP 54118A's simplified theory of operation can be described by the following five step sequence. Refer to figure 7-1.

1. The 180° phase splitter continuously supplies a copy (Vin) and a 180° phase shifted copy (Vin) of the input signal to the trigger assembly.

2. The bias control assembly arms the trigger assembly.

3. The trigger assembly triggers and outputs a pulse.

4. The bias control assembly senses the trigger event and resets the trigger assembly.


Figure 7-1. Simplified Block Diagram
The following theory refers to figure 7-2. A trigger signal is applied to the 180° phase splitter assembly, A3. The phase splitter's output is a copy (Vin) and a 180° phase shifted copy (Vin) of the input signal. Vin and Vin are each terminated through 50 Ω into a tunnel diode. Vin produces a signal current (Lin) in the arming diode. Vin produces a signal current (Lin) in the trigger diode.

The bias control assembly, A1, supplies a variable dc bias current to the trigger diode. Increasing the front panel TRIGGER LEVEL decreases the trigger bias current.

After a fixed 15 μs delay, produced by U4 and U5, the bias control assembly supplies a variable dc bias current to the arming tunnel diode. Increasing the front panel ARMING LEVEL decreases the arming bias current. When the arming bias current is enabled, it increases very slowly with respect to one period of the input signal current, Lin.

The arming bias current continues to increase until the total current (Lin + arming bias current) reaches the arming tunnel diode's switching (firing) threshold. At the firing threshold, the tunnel diode fires and produces a very fast rising voltage step across the arming tunnel diode. The voltage step generates a current step in the trigger tunnel diode.

Remember that the arming bias current increases very slowly with respect to one period of the input signal current, Lin. This ensures that the arming tunnel diode always fires on a positive peak of its signal current, Lin, and a negative peak of the trigger tunnel diode's signal current, Lin. The current step produced by the arming tunnel diode causes the total trigger tunnel diode's current (Lin + trigger bias current + current step) to reach the trigger tunnel diode's firing threshold during the next rising edge of Lin. The trigger tunnel diode fires and generates a 200 mV, 5 ns wide pulse at the trigger assembly's output.

The bias control assembly senses when either of the tunnel diodes fire. Within 2 μs both bias currents are disabled by shunting the currents to ground through Q2 and Q6. This removes the bias currents and resets both tunnel diodes.
In addition to disabling the bias currents, the bias control assembly also starts a variable holdoff timer. The front panel HOLDOFF control varies the period of the holdoff timer. When holdoff times out, the bias currents are enabled again and the cycle restarts.

Figure 7-2. Detailed Block Diagram
Troubleshooting

Troubleshooting the HP 54118A consists of making several checks to determine whether the faulty assembly is the bias control assembly, trigger assembly, or cables. Faulty assemblies are a throw away item (there are no exchange assemblies).

Recommended Test Equipment

The following equipment is used for troubleshooting the HP 54118A. Any instrument which satisfies the critical specifications may be used.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Critical Specifications</th>
<th>Recommended Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscilloscope</td>
<td>100 MHz, 50 Ω input</td>
<td>HP 54201A</td>
</tr>
<tr>
<td>Oscilloscope Probe</td>
<td>10:1, 10 M Ω</td>
<td>HP 10432A</td>
</tr>
<tr>
<td>Pulse Source</td>
<td>0 to 0.5 V positive pulse 5 μs wide at 4 kHz</td>
<td>HP 8116A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessory</th>
<th>Critical Specifications</th>
<th>HP Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNC Tee</td>
<td>1 (m) end, 2 (f) ends</td>
<td>1250-0781</td>
</tr>
<tr>
<td>BNC Cable</td>
<td></td>
<td>10503A</td>
</tr>
<tr>
<td>Resistors</td>
<td>180 Ω, ± 3%, 0.5 watt, Qty 2</td>
<td>N/A</td>
</tr>
<tr>
<td>Alligator Clips</td>
<td>Qty 2</td>
<td>N/A</td>
</tr>
<tr>
<td>Clip Leads</td>
<td>Connect from BNC (f) to wire</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Incorrect Output or No Output

1. Set ARMING LEVEL fully counterclockwise to detent CW position. Set TRIGGER LEVEL and HOLDOFF fully counterclockwise. On the bias control assembly, set both R28 (MIN TRIG LEVEL) and R29 (MIN ARM LEVEL) fully clockwise.

2. Set monitor oscilloscope to 50 Ω. Connect HP 54118A OUTPUT to monitor oscilloscope. Set up monitor oscilloscope to observe pulses. Pulses should be approximately +225 mV and approximately 5 ns wide. Refer to figure 7-3.

Note

Presence of an output does not verify correct performance since the oscilloscope will not display the actual risetime or jitter. This check is just a troubleshooting aid.

Figure 7-3. HP 54118A Trigger Output Pulses

3. If output is absent or obviously incorrect, first check for obvious problems: damaged connectors, burned components, or loose wires (especially the red, blue, and black wires connecting to the trigger assembly).

4. Check the operating voltage, +15 Vdc at J1 on the bias control assembly. If +15 Vdc is not present at J1, check the HP 54121A rear panel J2 TRIGGER POWER for +15 Vdc. If there is +15 Vdc at the four channel test set, than check W8 trigger power cable and the external SMB power cable for continuity.

5. Disconnect external SMA power cable from HP 54118A's rear panel.
6. Connect a monitor oscilloscope with a 10:1 high impedance probe to U3 pin1.

7. Reconnect power cord. Observe monitor oscilloscope display. Approximately 1/2 second after power-up, the dc level at U3 pin 1 should rise from 0 Vdc to about +5 Vdc. If this does not occur, replace the bias control assembly A1.

8. Disconnect external SMB power cable from HP 54118A’s rear panel.

9. Disconnect the three wires connected to top of trigger assembly.

10. Connect a 180 Ω ±3%, 0.5 watt resistor to the black wire, and another to the blue wire. Connect other end of resistors to chassis ground. Refer to figure 7-4.

Note

These resistors are simulating the current load for the trigger assembly. Keeping these resistors within the ±3% of 180 Ω is very critical. The circuitry may not work properly if this is not adhered to. Hewlett-Packard part number 0698-3334, 178 Ω ±1%, 0.5 watt resistors may be used. DO NOT use resistors with less than a 0.5 watt rating.

11. Set up equipment as shown in figure 7-4. Notice the red wire connects to a pulse source through a BNC tee. Set monitor oscilloscope channel B to 50 Ω.

12. Set pulse source for a 0 V to 0.5 Vdc positive pulse, approximately 5 μs wide at 4 kHz.
CAUTION

Ensure the resistor and test leads do not short together.

13. Reconnect power cord.

Figure 7-4. Troubleshooting Equipment Setup
14. Using a 10:1 high impedance probe from monitor oscilloscope, check outputs from the blue wire and black wire. Figures 7-5 and 7-6 show the correct waveforms.

**Note**

*These waveforms show voltage levels with the front panel knobs and internal pots in several positions. Make all combinations of checks.*

The critical parameter is the current provided to the trigger assembly. A more accurate check is to measure the current through the 180 Ω resistors. Current measurements should be made with the pulse source disconnected. Figures 7-5 and 7-6 contain a listing of the correct currents for each control setting.

15. If signals are correct, replace trigger assembly, A2.

16. If signals are incorrect or absent, replace bias control assembly, A1.

17. Perform adjustment procedure and performance tests to verify correct instrument operation.

**Excessive Jitter**

Excessive jitter problems can be caused either by the HP 54120T system or the trigger assembly, A2.

1. Verify jitter and trigger specifications of the HP 54120T system. If adjustments are made to the HP 54120T system, retest the HP 54118A for proper operation.

2. If excessive jitter remains, replace the HP 54118A trigger assembly, A2.

**Schematic Diagrams**

Figure 7-11 is the component locator for the Bias Control Assembly. Figures 7-12 and 7-13 are the schematic diagrams for the Bias Control Assembly, A1. These three figures are at the end of this chapter and are included as additional information only.
**Figure 7-5. Trigger Diode Waveforms on the Blue Wire**

**BLUE LEAD (TRIGGER DIODE)**

211.5V
≤3.8V
OV

20-50 usec wide
HOLDOFF MINIMUM

With internal minimum trigger level adjusted set to fully CCW, maximum voltage excursions change to ≤7.4V to ≤3.8V.

<table>
<thead>
<tr>
<th>TRIGGER LEVEL Control</th>
<th>MIN TRIG LEVEL R28</th>
<th>Trigger Diode Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully counter clockwise</td>
<td>Fully clockwise</td>
<td>≥64mA</td>
</tr>
<tr>
<td>Fully counter clockwise</td>
<td>Fully counter clockwise</td>
<td>≤41mA</td>
</tr>
<tr>
<td>Fully clockwise</td>
<td>Fully counter clockwise</td>
<td>≤21mA</td>
</tr>
</tbody>
</table>

**Figure 7-6. Arming Diode Waveforms on the Black Wire**

**BLACK LEAD (ARMING DIODE)**

≥11.5V
≤5.6V
OV

HOLDOFF MINIMUM

With internal minimum arming level adjusted set to fully CCW, voltage excursions change to ≤7.4V to ≤5.6V.

<table>
<thead>
<tr>
<th>ARMING LEVEL Control</th>
<th>MIN ARM LEVEL R26</th>
<th>Trigger Diode Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detent CW position</td>
<td>Fully clockwise</td>
<td>≥64mA</td>
</tr>
<tr>
<td>Detent CW position</td>
<td>Fully counter clockwise</td>
<td>≤41mA</td>
</tr>
<tr>
<td>Fully clockwise</td>
<td>Fully counter clockwise</td>
<td>≤31mA</td>
</tr>
</tbody>
</table>

Service 7-9
Replaceable Parts

The following replaceable parts tables are included in this section.

- Table 7-1 - List of Manufacturers' Codes
- Table 7-2 - Chassis mounted parts
- Table 7-3 - Bias Control Assembly, A1

Tagging for Service

If the instrument is to be shipped to a Hewlett-Packard office for service or repair, attach a tag showing the following:

- Owners name and address
- Entire instrument serial number
- Complete description of service required
- Use original packing material if possible. Otherwise, wrap instrument in heavy paper or plastic, and package in strong shipping container.
- Seal the shipping container securely
- Mark the container FRAGILE

In any correspondence, refer to the instrument by model number and entire serial number.

Direct Mail Order System

Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using this system are as follows:

- Direct ordering and shipment form HP Parts Center in Mountain View, California.
- No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through local HP offices when orders require billing and invoicing).
- Prepaid transportation (there is a small handling charge for each order).
- No invoices

To provide these advantages, check or money order must accompany each order. Mail order forms are available through your local HP offices.
<table>
<thead>
<tr>
<th>Mfr No.</th>
<th>Manufacturer Name</th>
<th>Address</th>
<th>Zip Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>C0633</td>
<td>Rifa Bromm</td>
<td>SE</td>
<td></td>
</tr>
<tr>
<td>S0167</td>
<td>Fujitsu Ltd Tokyo</td>
<td>JP</td>
<td></td>
</tr>
<tr>
<td>00000</td>
<td>Any Satisfactory Supplier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01121</td>
<td>Allen-Bradley Co</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01281</td>
<td>TRW Inc Semiconductor Div</td>
<td>Milwaukee WI</td>
<td>53204</td>
</tr>
<tr>
<td>01295</td>
<td>Texas Instr Inc Semicond Cmpnt Div</td>
<td>Lawndale CA</td>
<td>90260</td>
</tr>
<tr>
<td>02111</td>
<td>Spectrol Electronics Corp</td>
<td>City of Ind CA</td>
<td>91745</td>
</tr>
<tr>
<td>02114</td>
<td>Ferroxcube Corp</td>
<td>Saugerties NY</td>
<td>12477</td>
</tr>
<tr>
<td>03888</td>
<td>K D I Pyrofilm Corp</td>
<td>Whippany NJ</td>
<td>07981</td>
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<tr>
<td>04672</td>
<td>TRW Inc Philadelphia Div</td>
<td>Philadelphia PA</td>
<td>19108</td>
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<td>04713</td>
<td>Motorola Semiconductor Products</td>
<td>Phoenix AZ</td>
<td>85008</td>
</tr>
<tr>
<td>06665</td>
<td>Precision Monolithics Inc</td>
<td>Santa Clara CA</td>
<td>95050</td>
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<td>07263</td>
<td>Fairchild Semiconductor Div</td>
<td>Mountain View CA</td>
<td>94042</td>
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<tr>
<td>1B546</td>
<td>Varo Semiconductor Inc</td>
<td>Garland TX</td>
<td>75040</td>
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<td>11236</td>
<td>CTS of Berne Inc</td>
<td>Berne IN</td>
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<td>15454</td>
<td>Ametek/Rodan Div</td>
<td>Anaheim CA</td>
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<td>18324</td>
<td>Signetics Corp</td>
<td>Sunnyvale CA</td>
<td>94086</td>
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<td>19701</td>
<td>Mepco/Electra Corp</td>
<td>Mineral Wells TX</td>
<td>76067</td>
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<td>24546</td>
<td>Corning Glass Works (Bradford)</td>
<td>Bradford PA</td>
<td>16701</td>
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<td>25403</td>
<td>N.V. Philips-Elcoma Department</td>
<td>Eindhoven NL</td>
<td>02876</td>
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<td>27014</td>
<td>National Semiconductor Corp</td>
<td>Santa Clara CA</td>
<td>95050</td>
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<td>Corning Glass Works (Wilmington)</td>
<td>Wilmington NC</td>
<td>28401</td>
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<td>28480</td>
<td>Hewlett-Packard Co Corporate HQ</td>
<td>Palo Alto CA</td>
<td>94304</td>
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<tr>
<td>34335</td>
<td>Advanced Micro Devices Inc</td>
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<td>34649</td>
<td>Intel Corp</td>
<td>Mountain View CA</td>
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<td>75915</td>
<td>Littelfuse Inc</td>
<td>Des Plaines IL</td>
<td>60016</td>
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<td>80031</td>
<td>Mepco/Electra Corp</td>
<td>Morristown NJ</td>
<td>07960</td>
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</table>
Figure 7-7. View with Covers and Feet Installed

Figure 7-8. View of Semi-rigid Cables and Assemblies
Figure 7-9. Top View with Covers Removed

Figure 7-10. APC 3.5 Connector Exploded View
<table>
<thead>
<tr>
<th>Reference Designator</th>
<th>HP Part Number</th>
<th>CD Qty</th>
<th>Description</th>
<th>Mfr Code</th>
<th>Mfr Part Number</th>
</tr>
</thead>
<tbody>
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<td>A1</td>
<td>54118-66501</td>
<td>4</td>
<td>1Bias Control Assembly</td>
<td>28480</td>
<td>54118-66501</td>
</tr>
<tr>
<td>A2</td>
<td>5180-2725</td>
<td>3</td>
<td>1Trigger Assembly</td>
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</tr>
<tr>
<td>A3</td>
<td>0557-0445</td>
<td>6</td>
<td>1180° Phase Splitter</td>
<td>28480</td>
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<tr>
<td>A4</td>
<td>5062-1247</td>
<td>6</td>
<td>2APC 3.5 Connector Assembly</td>
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<tr>
<td>E1</td>
<td>1250-2153</td>
<td>1</td>
<td>250 Ω SMA (m) Termination</td>
<td>28480</td>
<td>1250-2153</td>
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<tr>
<td>J1</td>
<td>08513-20017</td>
<td>3</td>
<td>2APC 3.5 Bulk Head Connector P/O A4</td>
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<td>08513-20017</td>
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<tr>
<td>H1</td>
<td>0515-0372</td>
<td>2</td>
<td>17Screw M3 X 10</td>
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<tr>
<td>H2</td>
<td>0515-1403</td>
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<td>16Screw M4 X 7</td>
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<td>H3</td>
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<td>3Washer</td>
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<td>2Lock Washer</td>
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<td>H5</td>
<td>2950-0043</td>
<td>8</td>
<td>3Nut 3/8 X 32</td>
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<td>2950-0043</td>
</tr>
<tr>
<td>H6</td>
<td>2950-0132</td>
<td>6</td>
<td>2Hex Nut 7/16</td>
<td>28480</td>
<td>2950-0132</td>
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<tr>
<td>H7</td>
<td>3030-0253</td>
<td>3</td>
<td>4CS 4-40</td>
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<td>H8</td>
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<td>7</td>
<td>2Screw 3 X .5 MM</td>
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<td>H9</td>
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<td>4Flathead Screw M3</td>
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<td>H14</td>
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<td>2Cover Screw</td>
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<td>H15</td>
<td>0510-1253</td>
<td>8</td>
<td>2Retainer Ring For Cover Screw</td>
<td>28480</td>
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<tr>
<td>MP1</td>
<td>0340-1074</td>
<td>2</td>
<td>2Insulator</td>
<td>28480</td>
<td>0340-1074</td>
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<tr>
<td>MP2</td>
<td>0370-1091</td>
<td>6</td>
<td>1Knob Base 1/2 Holdoff</td>
<td>28480</td>
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<tr>
<td>MP3</td>
<td>0370-1099</td>
<td>4</td>
<td>2Knob Jade Gray Arming and Trigger</td>
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<td>0370-1099</td>
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<tr>
<td>MP4</td>
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<td>5</td>
<td>2Tilt Stand</td>
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<tr>
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<td>1510-0038</td>
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<td>2APC 3.5 Center Conductor P/O A4</td>
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<td>5062-1243</td>
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</table>

Service

7-14
Table 7-2. Chassis Mounted Replaceable Parts

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<td>28480</td>
<td>0698-6975</td>
</tr>
<tr>
<td>R42</td>
<td>0698-4002</td>
<td>9</td>
<td>1</td>
<td>Resistor 5 K 1% .125 W TF TC=0 ± 100</td>
<td>24546</td>
<td>CT418TO502F</td>
</tr>
<tr>
<td>R43</td>
<td>0757-0442</td>
<td>9</td>
<td>0</td>
<td>Resistor 10 K 1% .125 W TF TC=0 ± 100</td>
<td>24546</td>
<td>CT418TO1002F</td>
</tr>
<tr>
<td>R44</td>
<td>0757-0280</td>
<td>3</td>
<td>0</td>
<td>Resistor 1 K 1% .125 W TF TC=0 ± 100</td>
<td>24546</td>
<td>CT418TO1001F</td>
</tr>
</tbody>
</table>

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Table 7-3. Bias Assembly (A1) Replaceable Parts (Continued)

<table>
<thead>
<tr>
<th>Reference Designator</th>
<th>HP Part Number</th>
<th>CD</th>
<th>Qty</th>
<th>Description</th>
<th>Mfr Code</th>
<th>Mfr Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP1</td>
<td>0360-1971</td>
<td>0</td>
<td>4</td>
<td>Terminal Test Point 0.563 in Long; 0.118</td>
<td>28480</td>
<td>0360-1971</td>
</tr>
<tr>
<td>TP2</td>
<td>0360-1971</td>
<td>0</td>
<td>0</td>
<td>Terminal Test Point 0.563 in Long; 0.118</td>
<td>28480</td>
<td>0360-1971</td>
</tr>
<tr>
<td>TP3</td>
<td>0360-1971</td>
<td>0</td>
<td>0</td>
<td>Terminal Test Point 0.563 in Long; 0.118</td>
<td>28480</td>
<td>0360-1971</td>
</tr>
<tr>
<td>TP4</td>
<td>0360-1971</td>
<td>0</td>
<td>0</td>
<td>Terminal Test Point 0.563 in Long; 0.118</td>
<td>28480</td>
<td>0360-1971</td>
</tr>
<tr>
<td>U1</td>
<td>1826-6708</td>
<td>8</td>
<td>1</td>
<td>IC V Rgtr V-Ref-Fad 9.9/10.1 V 8 Pin Dip</td>
<td>06665</td>
<td>Ref-01CP</td>
</tr>
<tr>
<td>U2</td>
<td>1826-6524</td>
<td>6</td>
<td>1</td>
<td>IC Op Amp GP Quad 14 Pin Dip Pkg</td>
<td>27014</td>
<td>LM324AN</td>
</tr>
<tr>
<td>U3</td>
<td>1826-4641</td>
<td>1</td>
<td>1</td>
<td>IC Comparator FPCN Dual 8 Pin Dip Pkg</td>
<td>27014</td>
<td>LM353N</td>
</tr>
<tr>
<td>U4</td>
<td>1820-3203</td>
<td>2</td>
<td>1</td>
<td>IC CMOS/4HC Monostable Retrig/Reset</td>
<td>04713</td>
<td>MC74HC4528N</td>
</tr>
<tr>
<td>U5</td>
<td>1820-4653</td>
<td>7</td>
<td>1</td>
<td>IC FF CMOS D Type Pos Edge Trig Dual</td>
<td>04713</td>
<td>MC14013BCP</td>
</tr>
<tr>
<td>XQ3</td>
<td>1200-0690</td>
<td>1</td>
<td>2</td>
<td>3 Pin Transistor Socket Dip Sdr</td>
<td>28480</td>
<td>1200-0690</td>
</tr>
<tr>
<td>XQ7</td>
<td>1200-0690</td>
<td>1</td>
<td>0</td>
<td>3 Pin Transistor Socket Dip Sdr</td>
<td>28480</td>
<td>1200-0690</td>
</tr>
</tbody>
</table>
Figure 7-11. Bias Control Assembly Component Locator
Figure 7-12. Bias Control Schematic 1.

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Figure 7-13. Bias Control Schematic 2.

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Specifications and Characteristics

Introduction

This chapter contains a list of specifications for your reference and performance verification reference. Also included are supplemental characteristics which are typical parameters that are included in this manual as additional information.

Specifications

The following specifications are divided into two groups: input and output.

**Input**

- **Sensitivity**
  - 50 mVp-p (−22 dBm) from 500 MHz to 2 GHz
  - 500 mVp-p (−2 dBm) from 2 GHz to 12.4 GHz
  - 1 Vp-p (+4 dBm) from 12.4 GHz to 18 GHz
% Reflection <5% with 30 ps step

Frequency Coverage 0.5 GHz to 18 GHz

Connector 3.5 mm (male)

Nominal Impedance 50 Ω

Coupling ac

Maximum Safe Input 25 Vdc, 4Vp-p ac (+16 dBm)

Trigger Level range 0 V to 2 Vp-p (+10 dBm)

Arming Level Range 0 V to 2 Vp-p (+10 dBm)

**Output**

Jitter (one sigma) specified for the system HP 54120T plus HP54118A <3% of input signal period

i.e. <2.5 ps @ 12.4 GHz
<1.7 ps @ 18 GHz

Connector 3.5 mm (male)

Nominal Impedance 50 Ω

Coupling ac

Maximum Safe External Voltage 25 Vdc, 4Vp-p ac (+16 dBm)

Holdoff Range 50 μs to 200 μs
Characteristics

The following characteristics are divided into four groups: output, power, environmental, and weight.

Input
Kickout (at signal input) 300 mV kickout (single pulse)

\[ \begin{align*}
275 \text{mV} \\
1.5 \text{ns} \\
2.0 \text{ns} \\
\text{input} \\
-150 \text{mV}
\end{align*} \]

*Figure 8-1. Typical Kickout Pulse*

Output
Signal (into 50 Ω) 200 mV positive pulse 5 ns wide

Delay From Trigger Edge: 4 ns (approximate)

Error Rate (trigger misfire rate) ≤ 1% of all trigger events

Power
Connector SMB snap on coaxial

Voltage: +15 Vdc ± 5%

Current: 150 mA maximum, 130 mA typical

Power: 2.4 Watts maximum
Environmental

Temperature Operating: +15°C to +35°C (+59°F to +95°F)
Temperature Non-operating: -40°C to +70°C (-40°F to +150°F)

Humidity Operating: 90% @ 35°C (+95°F)
Humidity Non-operating: 90% @ 35°C (+95°F)

Altitude Operating: 4600 metres (15,000 feet)
Altitude Non-operating: 15300 metres (50,000 feet)

Vibration Operating: 0.3 g random 5 to 500 Hz, 10 min/axis
Vibration Non-operating: 2.41 g RMS random 5 to 500 Hz, 10 min/axis
0.75 g RMS sine 5-500 Hz, 5 min/resonance

Weight

Net Weight: 1.8 kg (4 lbs) approximate

Figure 8-2. HP 5411A's Dimensions