# Quick Start Guide

## HP 8133A 3 GHz Pulse Generator

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E1094

# Notice



**Warranty**
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**Safety**
This is a Safety Class 1 instrument (provided with terminal for protective earthing). Before applying power, verify that the correct safety precautions are taken (see the following warnings). In addition, note the external markings on the instrument that are described under **Safety Symbols**.

**Warning**
Before turning on the instrument, you must connect the protective earth terminal of the instrument to the protective earth conductor of the (mains) power cord. The mains plug must only be inserted in a socket outlet with a protective earth contact. Do not negate the protective action by using an extension power cord without a protective grounding conductor. Grounding one conductor of a two-conductor outlet is not sufficient protection.

Service instructions are for trained service personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

If you energize this instrument using an auto-transformer (for voltage reduction) make sure that the common terminal is connected to the earth terminal of the power source.

Whenever it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Do not install substitute parts or perform any unauthorized modification to the instrument.

Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.

**Safety Symbols**

Instruction Manual symbol: The instrument is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the instrument.

Hazardous voltage symbol.

Earth terminal symbol: used to indicate a circuit common connected to grounded chassis.

Protected conductor symbol

**WARNING**
The Warning symbol calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury or loss of life. Do not proceed beyond a Warning symbol until the indicated conditions are fully understood and met.

**CAUTION**
The Caution symbol calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment. Do not proceed beyond a Caution until all the indicated conditions are fully understood and met.

# Notice

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**About this edition**

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## About this book

This book is intended to introduce a new user to the HP 8133A 3 GHz Pulse Generator. The book contains an instrument overview, followed by short examples showing how you might typically use the instrument:

### 1 Introducing the HP 8133A

A summary of the instrument frontpanel, interchannel timing relationships and the VERNIER keys .

### 2 Using the Pulse Output as a Squarewave Clock Source.

*This example applies to all versions of the HP 8133A*

This tutorial shows you how to set up a simple squarewave. You will also learn how to vary the squarewave's phase relative to the HP 8133A Trigger Output and how to vary the duty-cycle (width) of the clock signal.

### 3 Setting up a Repetitive Pattern of Pulses.

*You need an HP 8133A with Option 002 (Second Pulse/Data Channel) for this example.*

This tutorial shows you how to use the optional Pulse/Data output in 32 Bit Data mode, to produce a repetitive pattern of pulses.

### 4 Compensating for Different Signal-path lengths to the Device-under-test.

*You need an HP 8133A with either Option 002 (Second Pulse/Data Channel) or Option 003 (Second Pulse Channel) for this example*

This tutorial shows you how to use the Skew Delay parameter on Channel 1 to adust the Zero-point of the Delay parameter so that zero-delay corresponds to simultaneous arrival of Channel 1 and Channel 2 pulses at your device-under-test.

# Contents


**1. Introducing the HP 8133A**

Summary of HP 8133A Models . . . . . 1-1
Frontpanel Overview . . . . . 1-2
Interchannel Timing relationships . . . . . 1-4
Using the VERNIER keys . . . . . 1-5
Example - Adjusting the Frequency . . . . . 1-5
Summary . . . . . 1-6

**2. Using the Pulse Output as a Squarewave Clock Source.**

Introduction . . . . . 2-1
Overview . . . . . 2-2
Recommended Equipment . . . . . 2-2
Connecting the HP 8133A to an oscilloscope. . . . . 2-3
Recalling the Standard Instrument Setting . . . . . 2-4
Setting the Frequency. . . . . 2-6
Setting up the Trigger Channel Output . . . . . 2-7
Setting the Trigger Output frequency . . . . . 2-7
Setting the Trigger Output levels . . . . . 2-7
Setting up the Pulse Output . . . . . 2-9
Selecting squarewave mode . . . . . 2-9
Setting the Pulse Output levels . . . . . 2-9
Varying the Output Delay/Phase. . . . . 2-11
Varying the Width/Duty-cycle. . . . . 2-13

**3. Setting up a Repetitive Pattern of Pulses**

Introduction . . . . . 3-1
Overview . . . . . 3-2
Recommended Equipment . . . . . 3-2
Connecting the HP 8133A to an oscilloscope. . . . . 3-3
Setting up the Trigger Channel Output . . . . . 3-4
Setting up the Pulse/Data Channel Output . . . . . 3-5
Selecting 32 Bit Data mode . . . . . 3-5

Editing the 32 Bit Data . . . . . 3-6
Setting the Data Output Levels . . . . . 3-6
Varying the Format of the Data . . . . . 3-8
Varying the Phase of the Data . . . . . 3-8
Inverting the Data . . . . . 3-9

**4. Compensating for Different Signal-path Lengths at the Device-under-test.**
Introduction . . . . . 4-1
Overview . . . . . 4-2
Recommended Equipment . . . . . 4-2
Connecting the HP 8133A to an oscilloscope. . . . . 4-3
Setting up the HP 8133A Outputs . . . . . 4-4
Setting up the HP 54121T Oscilloscope . . . . . 4-5
De-skewing the Delay parameter. . . . . 4-6

**Index**

# Figures


1-1. HP 8133A Frontpanel overview . . . . . 1-2
1-2. HP 8133A Interchannel Timing Diagram . . . . . 1-4
2-1. 1 GHz 3 $V_{pp}$ Clock, with divided-by-8 trigger signal . . . . . 2-1
2-2. Connecting the HP 8133A to an HP 54121A Oscilloscope. . . . . 2-3
3-1. Burst of 1 GHz 3 $V_{pp}$ NRZ pulses, with Bit 0 Trigger . . . . . 3-1
3-2. Connecting the HP 8133A Channel 2 to an HP 54121A Oscilloscope. . . . . 3-3
4-1. Channel 1 & 2 1 GHz 3 $V_{pp}$ squarewave output-signals . . . . . 4-1
4-2. Connecting Channels 1 & 2 for de-skewing using an oscilloscope 4-3

# 1

# Introducing the HP 8133A

## Summary of HP 8133A Models

| | |
|---|---|
| **HP 8133A** | Single-channel 3 GHz Pulse Generator.<br>Selectable variable delay OR pulse-width. |
| **HP 8133A Option 001** | Single-channel 3 GHz Pulse Generator.<br>Simultaneously variable delay AND pulse-width. |
| **HP 8133A Option 002** | Dual-channel 3 GHz Pulse Generator.<br>Channel 1 same as HP 8133A Option 001<br>Channel 2 PULSE/DATA Channel:<br>Selectable: Divided Squarewave<br>OR 32-Bit programmable data<br>OR PRBS $2^{23}-1$ |
| **HP 8133A Option 003** | Dual-Channel 3 GHz Pulse Generator.<br>Channel 1 same as HP 8133A Option 001<br>Channel 2 PULSE/DATA Channel:<br>Selectable: Divided Pulse or Squarewave |

## Frontpanel Overview

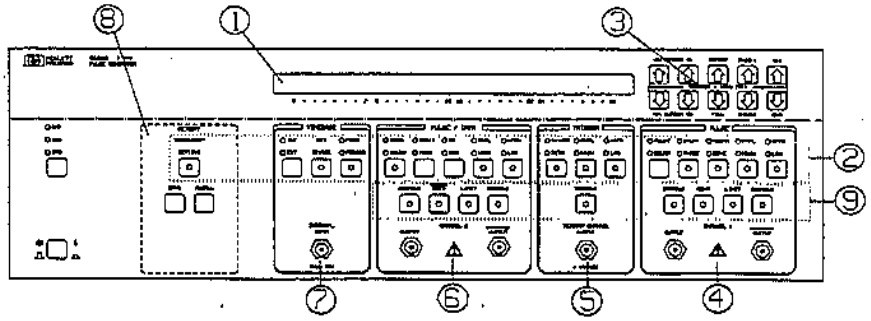



**Figure 1-1. HP 8133A Frontpanel overview**

1. The *Display* shows the **active parameter** and one other parameter.
2. Choose the **active parameter** using the **Mode/Parameter Keys**
3. Edit the **active parameter** using the VERNIER Keys. The 32 BIT DATA editing functions are indicated in blue (Option 002 only).
4. PULSE Channel 1 controls and output connectors.
5. TRIGGER Channel controls and output connector.
6. Optional Channel 2 controls and output connectors. (Option 002 PULSE/DATA, Option 003 PULSE).
7. Use the TIMEBASE keys to control the instrument frequency.
8. Use the MEMORY keys to save and recall instrument settings.
9. Use the **Control keys** to control the output modes.

**Active Parameter** The active parameter is the parameter which can be adjusted using the VERNIER keys. It is the *bright* parameter on the display, and the LED in the **parameter key** is lit.

**Mode keys** Mode keys toggle between different operating modes. They are located in the upper row of keys, see Figure 1-1. The LEDs above the key indicate which mode is selected.

**Parameter keys** Parameter keys activate a parameter on the display. They are located in the upper row of keys, see Figure 1-1. Press once to activate the selected parameter indicated by the LEDs above the key. Press again to select and activate the alternative parameter. The LED in the key indicates that the parameter is active in the display.

**Control keys** Control keys toggle an output mode on or off. They are located in the lower row of keys, see Figure 1-1. The LED in the key is lit when the mode is on.

The maximum external voltage you can apply to the output connectors is ±3V

# Interchannel Timing relationships

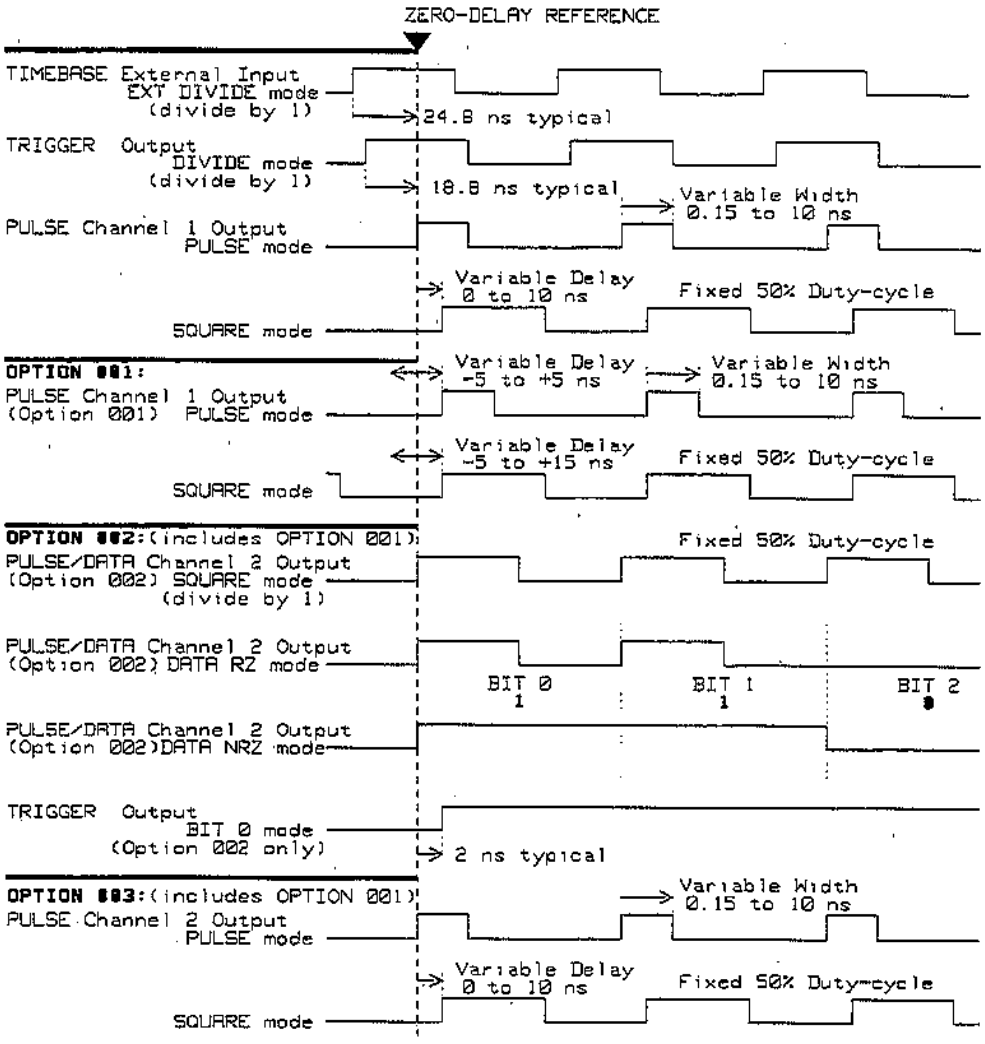
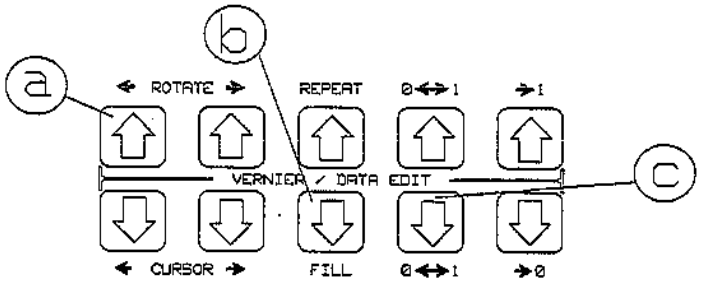



**Figure 1-2. HP 8133A Interchannel Timing Diagram**

## Using the VERNIER keys




### Example - Adjusting the Frequency

After "Recalling the Standard Instrument Setting" in Chapter 2, the display shows the standard Period and Channel 1 Width settings. The Period is the active parameter and appears brighter:

```
Per  30.303 ns 1:Wid  150 ps
```

1. Press TIMEBASE (FREQ/PERIOD) to activate the Frequency parameter.

   The PERIOD LED switches off and the FREQ LED switches on. The LED in the key remains on, indicating that this is still the active parameter. The display now shows the timebase Frequency:

   ```
   Freq  33.0 MHz 1:Wid  150 ps
   ```

2. Use the VERNIER keys to increase the timebase Frequency to 1.0000 GHz:

   a. Press the ↑ ↑ ↑ ↑ ↑ key once:
      `Freq 1.0330 GHz`
   b. Press the ↓ ↓ ↓ ↓ ↓ key three times:
      `Freq 1.0030 GHz`
   c. Press the ↓ ↓ ↓ ↓ ↓ key three times:
      `Freq 1.0000 GHz`

## Summary

Use the VERNIER keys to adjust the value of the active parameter. Only one parameter can be active at a time, although two may be visible on the display. The active parameter is

- the *bright* parameter on the display.
- indicated by LEDs in and above a **mode/parameter key** (See Figure 1-1).

Each pair of keys controls the corresponding digit of the parameter:

⇧ Press once to increment digit by 1

⇩ Press once to decrement digit by 1

Hold a key down to auto-repeat and smoothly change a parameter. If you hold two neighbouring keys down, the auto-increment (or decrement) steps at a rate of one-third of the higher digit.

A decimal-carry operates when you change a digit from 9 to 0 or from 0 to 9. Leading zeroes are not displayed, but the vernier keys can still be used to increase/decrease the "digit". If you try to adust a parameter outside its valid range, you will see an error message telling you the parameter limit.

# 2

# Using the Pulse Output as a Squarewave Clock Source.

## Introduction

This tutorial shows you how to set up a simple squarewave. You will also learn how to vary the squarewave's phase relative to the HP 8133A Trigger Output and how to vary the duty-cycle (width) of the clock signal.

**Note**

The tutorial assumes you will be observing the output waveforms on an HP 54121T oscilloscope. Due to differences between instruments, you may need to adjust your oscilloscope after using [AUTOSCALE] in order to obtain the waveforms shown.

If you want to quickly familiarize yourself with the HP 8133A controls, you can work through the tutorial without connecting a 'scope.

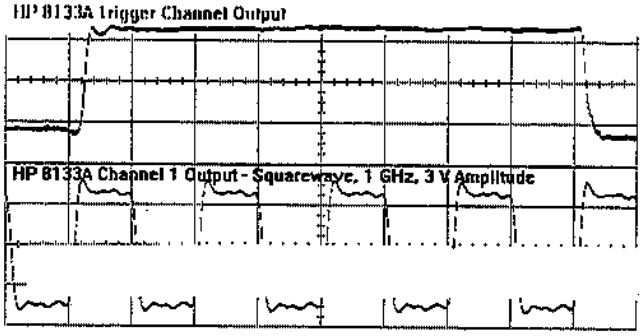



**Figure 2-1. 1 GHz 3 $V_{pp}$ Clock, with divided-by-8 trigger signal**

2 **Overview**

Work through the tutorial in order:

1. Connect the HP 8133A to an oscilloscope.
2. Recall the Standard Instrument Setting.
3. Set the frequency.
4. Set up the Trigger Channel to trigger the oscilloscope.
5. Set up the Pulse output mode and levels.
6. Vary the output phase (delay).
7. Vary the output duty-cycle (pulse width).

## Recommended Equipment

- Oscilloscope HP 54121T (HP 54120B & HP 54121A)
- 3 SMA Cables
- 3 20 dB Attenuators 33340C
- 1 Power Splitter 11667B
- 1 SMA Adaptor (m-m) 1250-1159

## Connecting the HP 8133A to an oscilloscope. 2

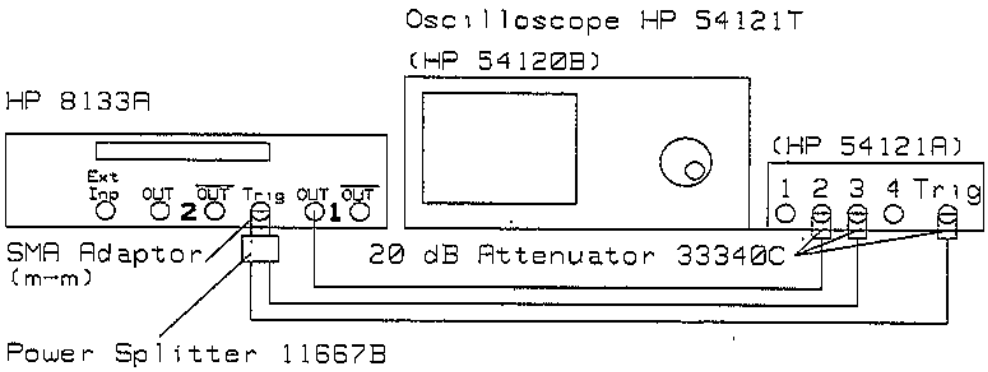



**Figure 2-2. Connecting the HP 8133A to an HP 54121A Oscilloscope.**

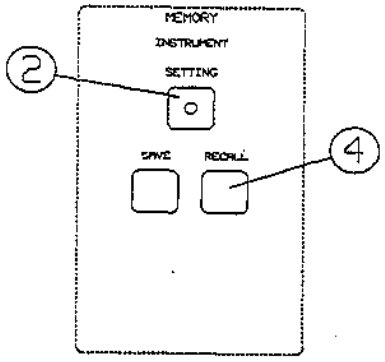
1. Connect the HP 8133A Channel 1 Output to the Channel 2 input on the 'scope via a 20 dB attenuator.
2. Connect the HP 8133A Trigger Channel Output to the Power Splitter input using a male-male SMA adaptor.
3. Connect one of the Power Splitter outputs to the Channel 3 input on the 'scope via a 20 dB attenuator.
4. Connect the other Power Splitter output to the Trigger input on the 'scope via a 20 dB attenuator.
5. Set the Channel Attenuation factor for 'scope channels 2 and 4 to 10 to account for the 20 dB attenuators.
6. Set the Channel Attenuation factor for 'scope channel 3 to 20 to account for the 20 dB attenuator and Power Splitter.

## 2 Recalling the Standard Instrument Setting

1. Switch on the HP 8133A.

   After carrying out a self-test, the HP 8133A recalls its last setting.

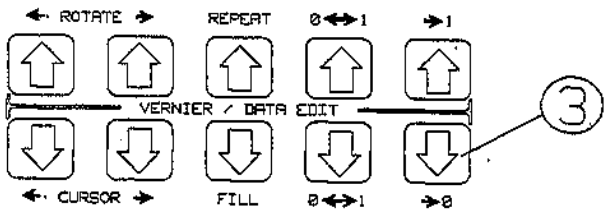
2. Press MEMORY (INSTRUMENT SETTING).




The LED in the key lights, and the number of the last Memory used is displayed, for example:

```
Memory No. 1
```

3. Press the ⇩⇩⇩⇩⇩ VERNIER key (right-most vernier-down key),




until the following message appears:

```
Standard Setting
```

4. Press MEMORY (RECALL) to recall the standard setting.

   The display now shows the standard Period and Channel 1 Width:

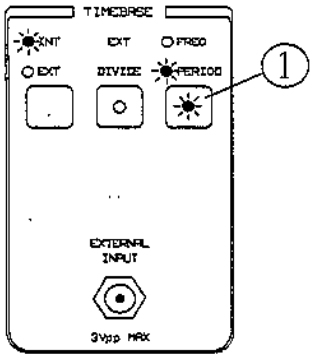
   ```
   Per  80.308 ns 1:Wid  150 ps
   ```

**Note**

a. The Period parameter appears brighter, because it is the **active parameter** currently controlled by the **vernier keys**. The LED in the Timebase (FREQ/PERIOD) key also indicates that this is the active parameter.

b. The `1:` next to the Width parameter means that this is the Width parameter for Channel 1.

## 2 Setting the Frequency.




After "Recalling the Standard Instrument Setting", the TIMEBASE controls are as shown above. The display shows the standard Period and Channel 1 Width settings, and the Period is the active parameter:

```
Per  30.303 ns 1:Wid  150 ps
```

1. Press TIMEBASE, FREQ/PERIOD to activate the Frequency parameter.

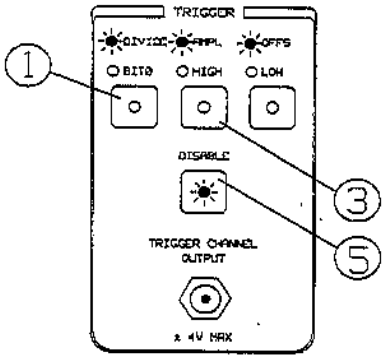
   The PERIOD LED switches off and the FREQ LED switches on. The LED in the key remains on, indicating that this is still the active parameter. The display now shows the timebase Frequency:

   ```
   Freq  33.0 MHz 1:Wid  150 ps
   ```

2. Use the VERNIER keys to increase the timebase Frequency to 1.0000 GHz. Refer to "Using the VERNIER keys" in Chapter 1 if necessary.

## Setting up the Trigger Channel Output






After "Recalling the Standard Instrument Setting", the TRIGGER controls are as shown above. You are going to set up a divided-by-8 trigger-signal to trigger the oscilloscope. The Trigger Channel Output signal is always a squarewave.

### Setting the Trigger Output frequency

1. Press TRIGGER DIVIDE to activate the Trigger Divider parameter.

   ```
   Freq 1.0000 GHz  Tr:divide ÷ 1
   ```

2. Press the ↑↑↑↑ ↑ key three times to set the Trigger Divider to 8.

   ```
   Freq 1.0000 GHz  Tr:divide ÷ 8
   ```

### Setting the Trigger Output levels

**Caution**

The output levels used in this example are suitable for an HP 54121A Trigger input with 20 dB attenuator and power-splitter as shown in Figure 2-2.

If you are using a different 'scope, refer to its manual for suitable levels.

2

3. Press TRIGGER (AMPL/HIGH) to activate the Trigger Amplitude parameter:

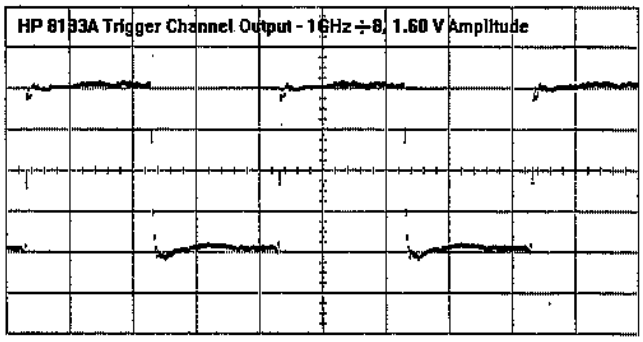
   Tr:Ampl 0.20 V Tr:Offs 0.00 V

4. Use the VERNIER keys to set the Trigger Amplitude to 1.6 V. Refer to "Using the VERNIER keys" in Chapter 1 if necessary.

5. Press TRIGGER (DISABLE) to enable the Trigger Output.

   The LED in the (DISABLE) key switches off, indicating that the output is now enabled.

6. On the oscilloscope, press (AUTOSCALE) to view the Trigger Output signal.



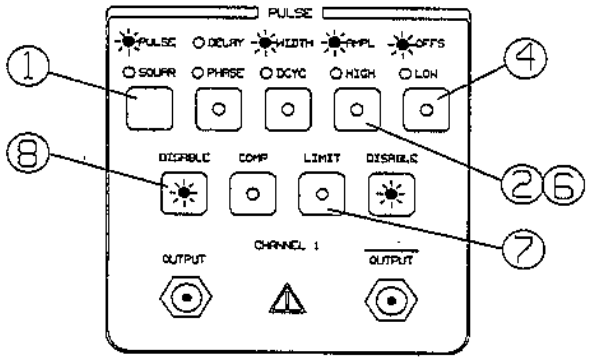

**400 mV/div 2.00 ns/div**

**Note**

Don't forget to set the Channel 3 attenuation factor on the oscilloscope to 20, to account for the 20 dB attenuator and Power Splitter.

Due to differences between 'scopes you may need to adjust the Timebase Time/Div and/or Delay to obtain the waveform shown.

## Setting up the Pulse Output




After "Recalling the Standard Instrument Setting", the PULSE controls are as shown above. You are going to set up a 3 $V_{pp}$ squarewave (0.4 V – 3.4 V).

### Selecting squarewave mode

1. Press PULSE (PULSE/SQUAR) to select squarewave mode.

   The PULSE LED switches off and the SQUAR LED switches on.

### Setting the Pulse Output levels

2. Press PULSE (AMPL/HIGH) to activate the Amplitude parameter.

   `1:Ampl  0.10 V 1:Offs  0.00 V`

3. Use the VERNIER keys to set the Amplitude to 3.00 V:

   `1:Ampl  3.00 V 1:Offs  0.00 V`

4. Press PULSE (OFFS/LOW) to activate the Offset parameter.

5. Use the VERNIER keys to set the Offset parameter to 1.90 V:

   `1:Ampl  3.00 V 1:Offs  1.90 V`

2

6. Press PULSE (AMPL/HIGH) *twice* to activate the High parameter. The output-levels are now displayed as High- and Low-levels:

   1:High 3.40 V 1:Low 0.40 V

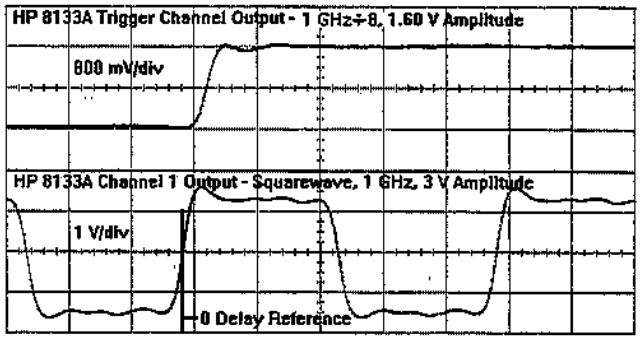
7. Press PULSE (LIMIT) to activate limited-output mode and prevent the output-levels from moving outside their current voltage-window.

   The current High- and Low-level parameters are taken as limit values. You cannot move the output-levels beyond these temporary limits, until you switch off limited-output mode by pressing (LIMIT) again. The limits apply whether you set High/Low levels or Amplitude/Offset levels.

8. Press PULSE (DISABLE) above the OUTPUT connector to enable the output signal.

   The LED in the (DISABLE) key switches off, indicating that the output is now enabled. A seperate (DISABLE) key above the $\overline{\text{OUTPUT}}$ connector controls the inverted output ($\overline{\text{OUTPUT}}$).

9. On the oscilloscope, press (AUTOSCALE) and adjust the Timebase Delay to position the rising trigger-edge as shown:

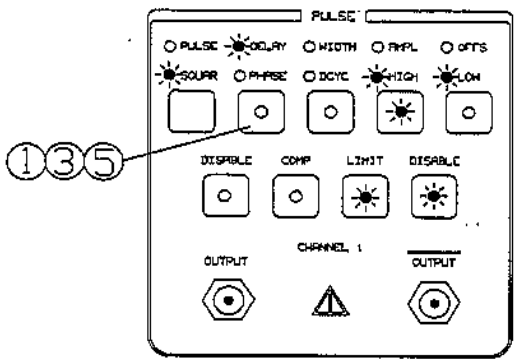



**200 ps/div**

Note that the fixed delay between the Trigger and Channel 1 Outputs can vary between instruments.

## Varying the Output Delay/Phase.






After "Setting up the Pulse Output", the PULSE controls are as shown above.

1. Press PULSE (DELAY/PHASE) to activate the absolute Delay parameter.

   ```
   1:Skew   0 ps 1:Del    0 ps
   ```

2. Press the (↑)(↑)(↑)(↑)(↑) key three times to increase the Delay to 300 ps.

   ```
   1:Skew   0 ps 1:Del   300 ps
   ```

3. Press PULSE (DELAY/PHASE) *twice* to activate the relative Phase-delay parameter. (Pressing once activates the Skew parameter)

   ```
   1:Skew   0 ps 1:Pha   108.0°
   ```

   The 300 ps Delay is now expressed as a phase-shift of 108.0° relative to the current Period of 1 ns. You can check the current Period by pressing TIMEBASE (FREQ/PERIOD) twice. Press PULSE (DELAY/PHASE) again to re-activate the Phase parameter.

4. Using the VERNIER keys, increase the phase to 180.0°.

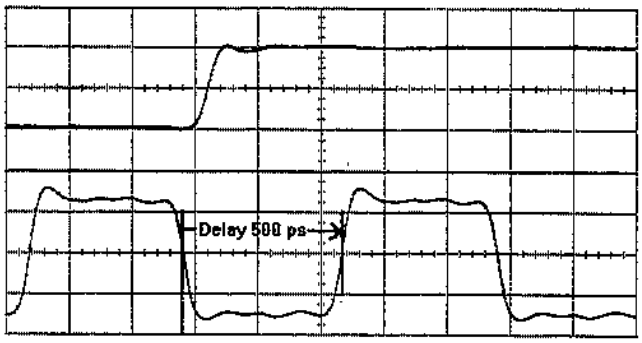
   ```
   1:Skew   0 ps 1:Pha   180.0°
   ```

2

5. Press PULSE DELAY/PHASE TWICE to activate the absolute Delay parameter again.

```
1:Skew    0 ps 1:Del   500 ps
```

The Phase-shift of 180.0° is now expressed as an absolute delay of 500 ps (half of the current period).



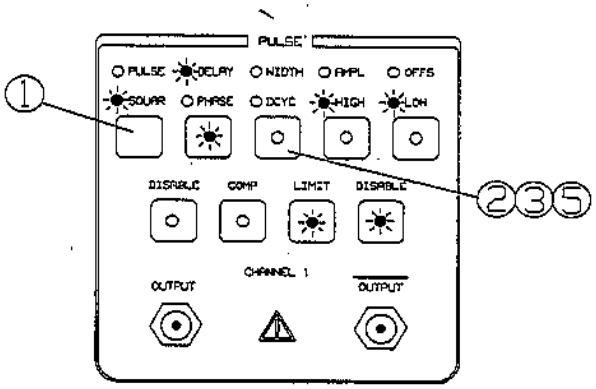

**200 ps/div**

**Note**

- There is always a fixed delay of 18.8 ns (typical) between the TRIGGER Channel OUTPUT and a PULSE Channel OUTPUT.
- In SQUARewave mode, you can use the DELAY/PHASE parameter to vary the phase of the output signal from a PULSE channel relative to the TRIGGER OUTPUT.
- If you have Option 001,002 or 003, the DELAY/PHASE parameter can also be used in PULSE mode.
- A PULSE/DATA channnel (Option 002 only) has no DELAY/PHASE parameter.
- You can use the Skew parameter to set the zero-point of your Delay parameter. The sum of the Skew and Delay parameters will be the final delay at the output connectors. The delay-range specified for your instrument applies to the sum of the Skew and Delay parameters. Refer to Chapter 4.

## Varying the Width/Duty-cycle.

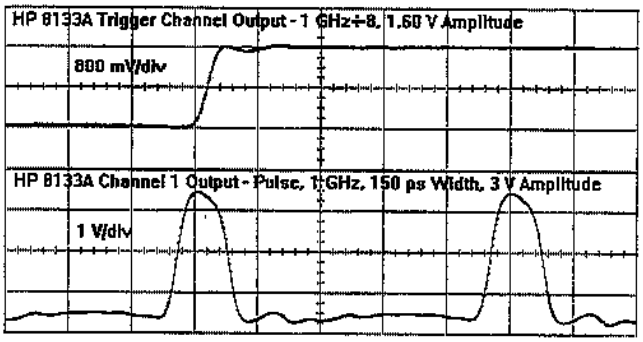





After "Varying the Output Delay/Phase.", the PULSE controls are as shown above.

1. Press PULSE (PULSE/SQUAR) to activate PULSE mode.

   The SQUAR LED switches off and the PULSE LED switches on. On a standard instrument the DELAY LED switches off and the WIDTH LED switches on.(It is not possible to vary both DELAY and pulse WIDTH simultaneously on a standard instrument.) The Output signal is no longer a squarewave, but a pulse-stream with a pulse Width of 150 ps:




**200 ps/div**

2 Note that the Channel 1 Delay remains 500 ps if you have Option 001, 002 or 003.

2. If you have a non-standard instrument, press PULSE (WIDTH/DCYC) to activate the Width parameter:

   ```
   Freq 1.0000 GHz 1:Wid   150 ps
   ```

3. Press PULSE (WIDTH/DCYC) to activate the relative Duty-cycle parameter:

   ```
   Freq 1.0000 GHz 1:Dcyc  15.0%
   ```

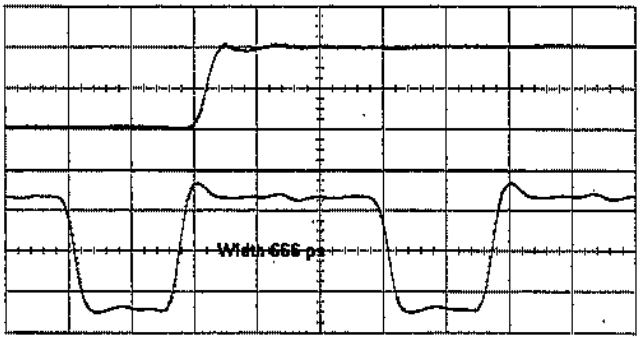
   The fixed pulse Width of 150 ps is now expressed as a Duty-cycle of 15.0% relative to the current Period of 1 ns.

4. Use the VERNIER keys to increase the Duty-cycle to 66.6%.

5. Press PULSE (WIDTH/DCYC) to activate the fixed Width parameter:

   ```
   Freq 1.0000 GHz 1:Wid   666 ps
   ```

   The Duty-cycle of 66.6% is now expressed as a fixed Width of 666 ps (two-thirds of the current Period).




**200 ps/div**

# 3

# Setting up a Repetitive Pattern of Pulses



## Introduction

This tutorial shows you how to set up a repetitive pattern of NRZ or RZ pulses using the second PULSE/DATA channel (Option 002) in 32 BIT Data mode.

**Note**

The tutorial assumes you will be observing the output waveforms on an HP 54121T oscilloscope. Due to differences between instruments, you may need to adjust your oscilloscope after using (AUTOSCALE) in order to obtain the waveforms shown.

If you want to quickly familiarize yourself with the HP 8133A controls, you can work through the tutorial without connecting a 'scope.

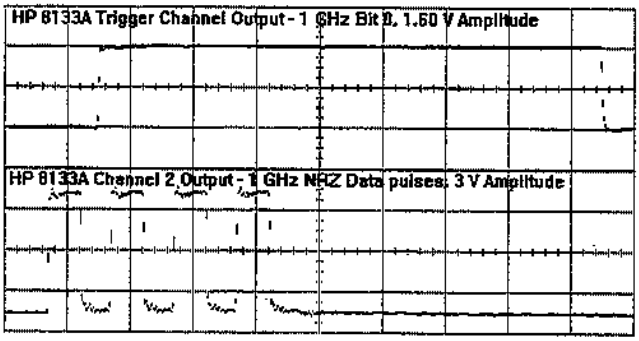



**Figure 3-1. Burst of 1 GHz 3 $V_{pp}$ NRZ pulses, with Bit 0 Trigger**

## Overview

Work through the tutorial in order:

1. Connect the HP 8133A to an oscilloscope.
2. Recall the Standard Instrument Setting. (Refer to "Recalling the Standard Instrument Setting" in Chapter 2.)
3. Set the frequency. (Refer to "Setting the Frequency." in Chapter 2.)
4. Set up the Trigger Channel to trigger the oscilloscope.
5. Set up the Pulse/Data output.
6. Vary the output phase.
7. Vary the data format.

## Recommended Equipment

- Oscilloscope HP 54121T (HP 54120B & HP 54121A)
- 3 SMA Cables
- 3 20 dB Attenuators 33340C
- 1 Power Splitter 11667B
- 1 SMA Adaptor 1250-1159

## Connecting the HP 8133A to an oscilloscope.

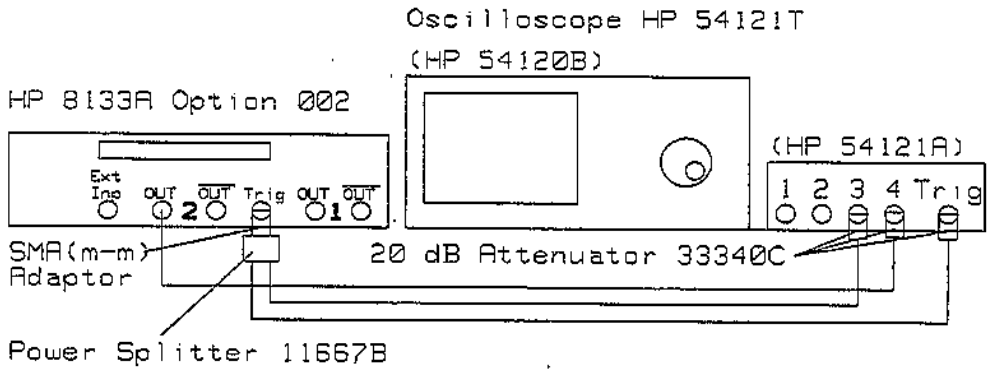



**Figure 3-2.**
**Connecting the HP 8133A Channel 2 to an HP 54121A Oscilloscope.**

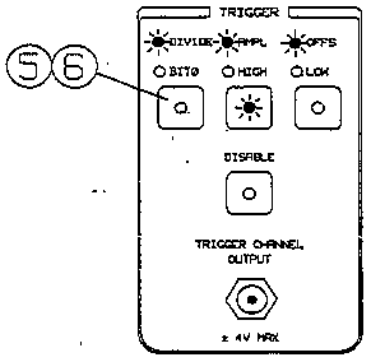
1. If you have the equipment set up for Chapter 2, connect the Channel 4 input on the 'scope to the Channel 2 PULSE/DATA output of the HP 8133A, as shown in Figure 3-2. Either DISABLE the Channel 1 output, or disconnect it from Channel 2 of the 'scope.

   Otherwise:

   a. Connect the HP 8133A Channel 2 Output to the Channel 4 input on the 'scope via a 20 dB attenuator.
   b. Connect the HP 8133A Trigger Channel Output to the Power Splitter input.
   c. Connect one of the Power Splitter outputs to the Channel 3 input on the 'scope via a 20 dB attenuator.
   d. Connect the other Power Splitter output to the Trigger input on the 'scope via a 20 dB attenuator.
   e. Set the Channel Attenuation factor for 'scope channel 4 to 10 to account for the 20 dB attenuator.
   f. Set the Channel Attenuation factor for 'scope channel 3 to 20 to account for the 20 dB attenuator and Power Splitter.

## Setting up the Trigger Channel Output

1. If you have just worked through Chapter 2, skip straight to list item 5.
2. Recall the standard instrument setting, see "Recalling the Standard Instrument Setting" in Chapter 2.
3. Set the Frequency to 1 GHz, see "Setting the Frequency." in Chapter 2.
4. Set up the Trigger Channel as described in "Setting up the Trigger Channel Output" in Chapter 2. The TRIGGER controls are now as shown:




5. Press TRIGGER (DIVIDE/BIT 0) to activate the Divider parameter.

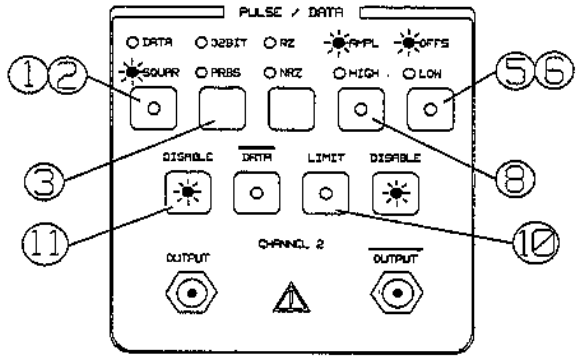
   ```
   Freq 1.0000 GHz Tr:Divide ÷ 8
   ```

6. Press TRIGGER (DIVIDE/BIT 0) to synchronize the trigger signal to Bit 0 of the PULSE/DATA channel.

   ```
   Freq 1.0000 GHz Tr:Bitstream
   ```

   In Bitstream mode the Trigger Output signal is always a divided-by-32 squarewave synchronized to Bit 0 of the 32 Bit data. The rising edge of the Trigger signal lags the start of Bit 0 by 1.8 ns (typical).Refer to Figure 1-2.

## Setting up the Pulse/Data Channel Output




After "Recalling the Standard Instrument Setting" in Chapter 2, the PULSE/DATA controls are as shown above.

### Selecting 32 Bit Data mode

1. Press PULSE/DATA (DATA/SQUAR) to activate the Squarewave divider parameter:

   ```
   Freq 1.0000 GHz  2:Squarewave÷ 1
   ```

2. Press PULSE/DATA (DATA/SQUAR) again to switch to Data mode:

   ```
   Freq 1.0000 GHz  2:PRBS mode
   ```

3. Press PULSE/DATA (32 BIT/PRBS) to change the Data mode from PRBS to 32 Bit:

   ```
   ___┌___┐___┌___┐___┌___┐___┌___┐___┌
   ```

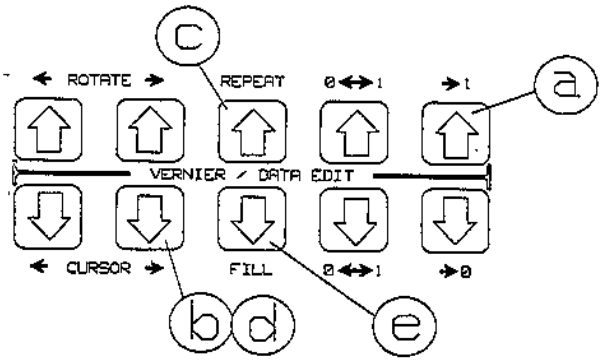
   The display now shows the standard 32 Bit data pattern. Bit 0 blinks to indicate the current cursor position. The VERNIER keys now act as DATA EDIT keys indicated by the blue lettering.

## Editing the 32 Bit Data

4. Use the DATA EDIT keys to set up the following 32 Bit data:

   ⊓_⊓_⊓_⊓_⊓_____

3




   a. Press DATA EDIT (⇒1) to set Bit 0 to 1 (⊓), the cursor moves on to Bit 1.
      ⊓_⊓_____⊓_____⊓_____⊓_____⊓_____⊓_____⊓_____⊓_____⊓
   b. Press DATA EDIT (CURSOR⇒) to move the cursor right to Bit 2.
   c. Press DATA EDIT (REPEAT) to repeat the data before the cursor up to Bit 31.
      ⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_⊓_
   d. Press DATA EDIT (CURSOR⇒) five times to move the cursor right to Bit 7.
   e. Press DATA EDIT (FILL) to fill the data pattern from the cursor to Bit 31.
      ⊓_⊓_⊓_⊓_____

## Setting the Data Output Levels

5. Press PULSE/DATA (AMPL/HIGH) to activate the Amplitude parameter.

   2:Ampl 0.10 V 2:Offs 0.00 V

6. Use the VERNIER keys to set the Amplitude to 3.00 V:

   2:Ampl 3.00 V 2:Offs 0.00 V

7. Press PULSE/DATA (OFFS/LOW) to activate the Offset parameter.

8. Use the VERNIER keys to set the Offset parameter to 1.90 V:

   2:Ampl 3.00 V 2:Offs 1.90 V

9. Press PULSE DATA (AMPL/HIGH) *twice* to activate the High-level parameter. The output-levels are now displayed as High- and Low-levels:

   2:High 3.40 V 2:Low 0.40 V

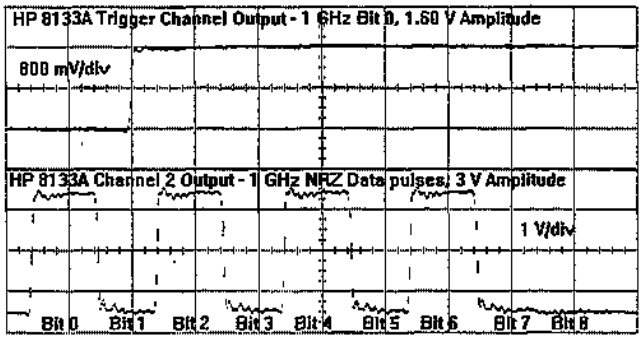
10. Press PULSE/DATA (LIMIT) to activate limited-output mode and prevent the output-levels from moving outside their current voltage-window.

    The current High- and Low-level parameters are taken as limit values. You cannot move the output-levels beyond these temporary limits, until you switch off limited-output mode by pressing (LIMIT) again. The limits apply whether you set High/Low levels or Amplitude/Offset levels.

11. Press PULSE/DATA (DISABLE) above the OUTPUT connector to enable the output signal.

    The LED in the (DISABLE) key switches off, indicating that the output is enabled. A seperate (DISABLE) key above the $\overline{\text{OUTPUT}}$ connector controls the inverted output ($\overline{\text{OUTPUT}}$).

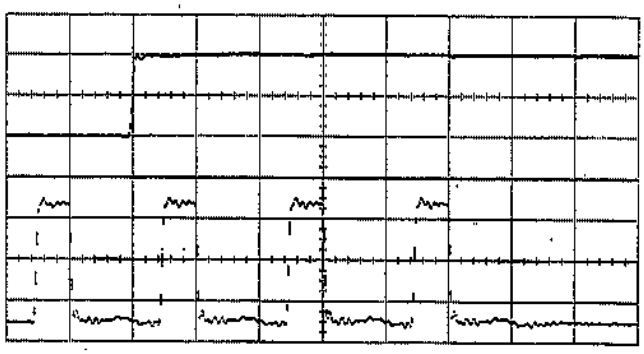
12. On the oscilloscope, press (AUTOSCALE) and adjust the Timebase Sweep-time and Delay until the Trigger rising-edge and pulses are as shown:




**1 ns/div**

## Varying the Format of the Data

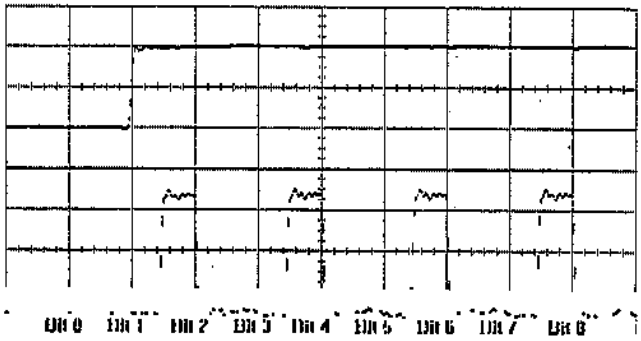
13. Press PULSE/DATA (RZ/NRZ) to select RZ Data mode:



1 ns/div

## Varying the Phase of the Data

14. Press DATA EDIT (ROTATE⇒) twice to rotate the 32 Bit data 2 periods to the right:



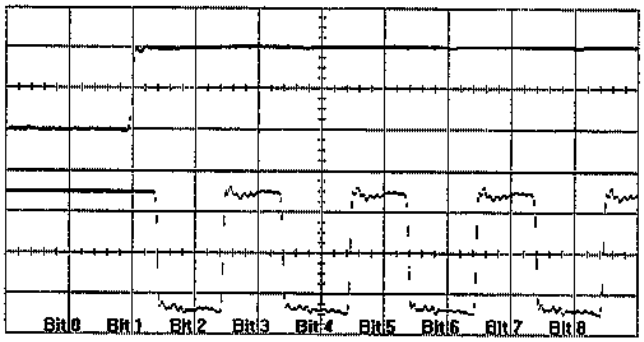
1 ns/div

## Inverting the Data

15. Press PULSE/DATA (DATA) to logically invert the 32 Bit Data.

16. Press PULSE/DATA (RZ/NRZ) to return to NRZ data format:






**1 ns/div**

# 4

# Compensating for Different Signal-path Lengths at the Device-under-test.

## Introduction

This tutorial shows you how to use the Skew Delay parameter on Channel 1 to adjust the Zero-point of the Delay parameter so that zero-delay corresponds to simultaneous arrival of Channel 1 and Channel 2 pulses at your device-under-test.



**Note**

The tutorial assumes you will be observing the output waveforms on an HP 54121T oscilloscope. Due to differences between instruments, you may need to adjust your oscilloscope after using AUTOSCALE in order to obtain the waveforms shown.

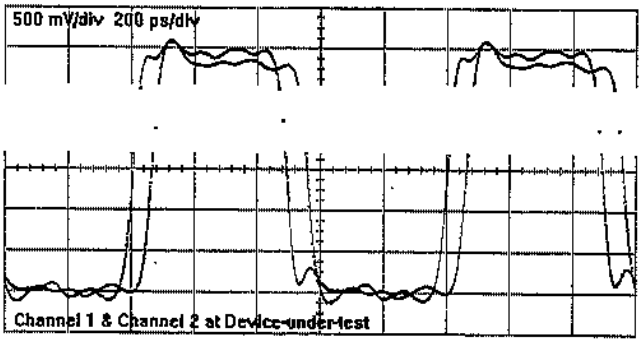



**Figure 4-1. Channel 1 & 2 1 GHz 3 $V_{pp}$ squarewave output-signals**

## Overview

Work through the tutorial in order:

1. Connect the HP 8133A to the oscilloscope.
2. Recall the Standard Instrument Setting. (Refer to "Recalling the Standard Instrument Setting" in Chapter 2.)
3. Set the frequency to 1 GHz. (Refer to "Setting the Frequency." in Chapter 2.)
4. Set up the Trigger Channel to trigger the oscilloscope. (Refer to "Setting up the Trigger Channel Output" in Chapter 2.)
5. Set up the Pulse Channel 1 ouput.
6. Set up the Channel 2 output.
7. De-skew Channel 1 relative to Channel 2.

## Recommended Equipment

- Oscilloscope HP 54121T (HP 54120B & HP 54121A)
- 3 SMA Cables
- 3 20 dB Attenuators 33340C

## Connecting the HP 8133A to an oscilloscope.

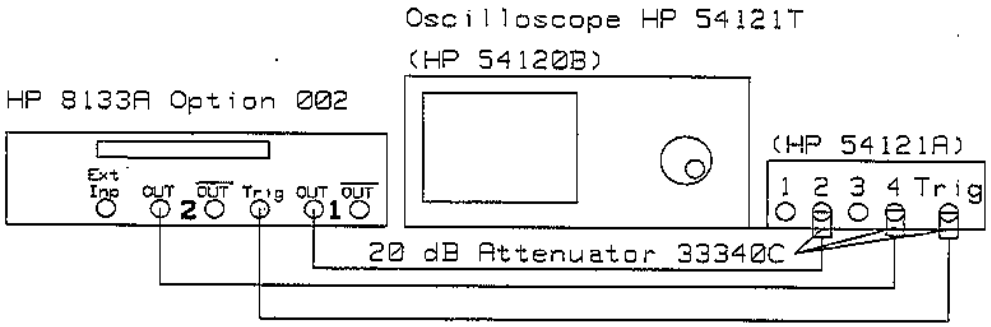



**Figure 4-2. Connecting Channels 1 & 2 for de-skewing using an oscilloscope**

1. If you have the equipment set up for Chapter 3, re-connect the Channel 2 input on the 'scope to the Channel 1 PULSE output of the HP 8133A and connect the 'scope Trigger Input *directly* to the Trigger Channel Output of the HP 8133A. See Figure 4-2.

   Otherwise:

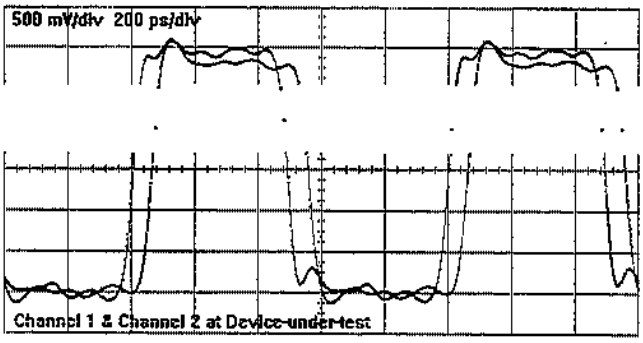
   a. Connect the HP 8133A Channel 1 Output to the Channel 2 input on the 'scope via a 20 dB attenuator.
   b. Connect the HP 8133A Channel 2 Output to the Channel 4 input on the 'scope via a 20 dB attenuator.
   c. Connect the HP 8133A Trigger Channel Output to the Trigger input on the 'scope vi a 20 dB attenuator.
   d. Set the Channel Attenuation factor for each 'scope channel to 10 to account for the 20 dB attenuators.

## Setting up the HP 8133A Outputs

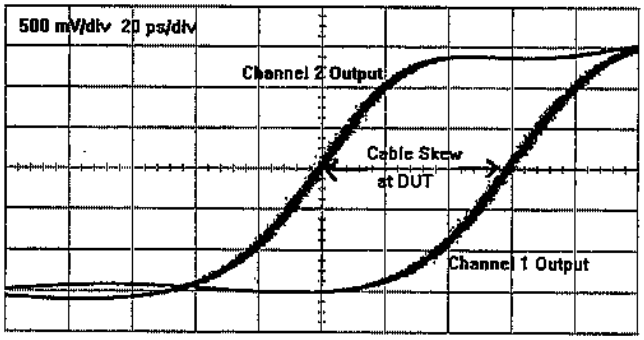
1. If you have just worked through Chapter 2 and Chapter 3, skip straight to "Setting up the HP 54121T Oscilloscope".
2. Recall the standard instrument setting, see "Recalling the Standard Instrument Setting" in Chapter 2.
3. Set the Frequency to 1 GHz, see "Setting the Frequency." in Chapter 2.
4. Set up the Trigger Channel as described in "Setting up the Trigger Channel Output" in Chapter 2.
5. Set up PULSE Channel 1 as described in "Setting up the Pulse Output" in Chapter 2, but don't bother viewing the signals on the 'scope.
6. Set up PULSE/DATA or PULSE Channel 2 as described in "Setting up the Pulse Output" in Chapter 2 (i.e. SQUARewave mode with output-levels as given), but don't bother viewing the signals on the 'scope.
7. On Channel 1, press DELAY/PHASE to activate the Delay parameter. If necessary use the VERNIER keys to set the delay to 0 ps.

## Setting up the HP 54121T Oscilloscope

1. Press AUTOSCALE to display both Output signals.
2. Change the display to Display Screen Single to show the two output signals superimposed:

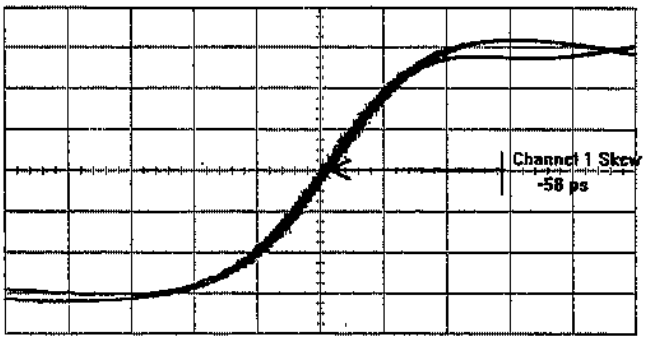



3. Adjust the Timebase sweep-time to 20.0 ps/div.
4. Adjust the Timebase delay until a rising edge from the Channel 2 output (Channel 4 Input) is centered on the screen:



## De-skewing the Delay parameter.

1. On Channel 1, press (DELAY/PHASE) to activate the Skew parameter.
2. Use the VERNIER keys to adjust the Skew parameter until the Channel 1 rising-edge (Channel 2 Input) and the Channel 2 rising-edge reach 50% amplitude at the same time:




**500 mV/div 20.0 ps/div**

**Note**

- The two channels are now de-skewed for their current operating settings (Squarewave mode). If you change the mode of either channel, you may need to de-skew the signals again in their new modes.
- Always allow the HP 8133A to warm up for at least 30 minutes to attain its specified performance.