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User’s Guide

HP 8110A 150 MHz Pulse Generator

HEWLETT PACKARD

HP Part No. 08110-91012
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Notice

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Complete product warranty information is given in the User Guide.

Safety
This is a Safety Class I 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. Do not operate the instrument with its cover removed. Replace fuse only with specified type.

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.

_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 symbol until the indicated conditions are fully understood and met.
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Certification

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States Institute of Standards and Technology, to the extent allowed by the Institute’s calibrating facility, and to the calibration facilities of other International Standards Organization members.

About this edition

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About this book

This book is a guide to operating and programming the HP 8110A with all possible modules installed:

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<td>1</td>
</tr>
<tr>
<td>HP 81107A</td>
<td>Multichannel Deskew</td>
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If your instrument does not have one or more of these modules installed, some of the described features will not be available.

Installing

Line voltage, fuse and other installation information.

Introducing the HP 8110A

An overview of the instrument frontpanel and features, and a Getting Started guide.

Operating Reference

A reference guide for using the frontpanel parameter-screens to operate the instrument.

Programming Reference

A SCPI reference guide for programming the instrument via HP-IB.

Testing the HP 8110A

Performance tests for checking the HP 8110A against its specifications.

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Installing the HP 8110A

Initial Inspection
Inspect the shipping container for damage. If the container or cushioning material is damaged, keep it until the contents of the shipment have been checked for completeness and the instrument has been verified both mechanically and electrically.

Warning
To avoid hazardous electric shock, do not perform electrical tests when there are signs of shipping damage to any part of the instrument’s outer covers or panels.

If the contents are incomplete, or there is mechanical damage, or if the instrument does not pass the Performance Tests in Chapter 5, notify the nearest Hewlett-Packard office. Keep the shipping materials for inspection by the carrier. The HP office will arrange for repair or replacement without awaiting settlement.
Power Requirements

⚠️ Caution

BEFORE APPLYING AC LINE POWER TO THE HP 8110A, ensure that the correct line fuse is installed in the fuse holder and the correct power cable is fitted.

The HP 8110A can operate from any single-phase AC power source supplying 100 – 240 V in the frequency range from 50 to 60 Hz, or 100 – 120 V at 400 Hz. The maximum power consumption is 300 VA with all options installed.

**Table 1-1. Line Voltage and Fuse Selection**

<table>
<thead>
<tr>
<th>Line Voltage</th>
<th>Fuse Type</th>
<th>HP Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 – 240 V~</td>
<td>T 3A, 250 V</td>
<td>2110-0029</td>
</tr>
</tbody>
</table>

**Replacing the Fuse**

1. Remove the power cord.
2. Unscrew the fuse-holder at the rear of the instrument beside the power-inlet socket (See “An Overview of the Rear Panel” in Chapter 2).
3. Replace the fuse with the equivalent part (See Table 1-1).
4. Refit the fuse-holder.

1.2 Installing the HP 8110A
Power Cable

In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate AC power receptacle, this cable grounds the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure 1-1 for the part numbers of the power cables available.

**Warning**  
To avoid the possibility of injury or death, the precautionary Warnings given on the inside front-cover of the manual must be followed before the instrument is switched on.

![Power Cables - Plug Identification](image)

**Figure 1-1. Power Cables - Plug Identification**

The following work should be carried out by a qualified electrician - all local electrical codes being strictly observed. If the plug on the cable does not fit the power outlet, or the cable is to be attached to a terminal block, cut the cable at the plug end and re-wire it.

The color coding used in the cable will depend on the cable supplied. If a new plug is to be connected, it must
meet local safety requirements and include the following features:

- Adequate load-carrying capacity (see table of specifications).
- Ground connection.
- Cable clamp.

**Ventilation Requirements**

The HP 8110A is fitted with two cooling fans. Make sure that there is adequate clearance of 3 inches (75 mm) at the rear and 1/2 inch (12 mm) at the top and bottom to ensure adequate airflow. If the airflow is restricted the internal operating temperature will be higher, reducing the instrument’s reliability or causing the instrument’s thermal-protection circuits to automatically switch off the instrument.

**Thermal Protection**

**Overheating Detection**

The HP 8110A monitors its internal temperature in the region of the power supply. If the temperature exceeds approximately 80°C, the power supply is switched off. The instrument will switch on again if the temperature falls below approximately 77°C.

**Fan Failure**

If either of the fans is prevented from operating by a blockage, or the power supply to the fans is interrupted, the power supply is automatically switched off within 3 to 4 seconds. Note that after the fault condition has been fixed, the instrument must remain switched off for at least 2 minutes to allow the detection circuit to recover.
Battery

Warning

This instrument contains a lithium battery. The battery is not user-replaceable and replacement should only be carried out by qualified service personnel.

There is a danger of explosion if the battery is incorrectly replaced.

The battery must be replaced with the same or equivalent type (HP Part No. 1420-0394). Discard used batteries according to local regulations.

Operating Environment

<table>
<thead>
<tr>
<th>Storage Temperature:</th>
<th>-40°C to -70°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature:</td>
<td>0°C to 55°C</td>
</tr>
<tr>
<td>Humidity:</td>
<td>95% R.H. (0°C to 40°C)</td>
</tr>
</tbody>
</table>

Warning

- The HP 8110A is not designed for outdoor use. Do not expose the HP 8110A to rain or other excessive moisture. Protect the HP 8110A from humidity and temperature changes which could cause condensation within the instrument.
- Do not operate the HP 8110A in the presence of flammable gases, fumes or powders. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
Introducing the HP 8110A

Enhanced Pulse Capability for Digital Design Testing
The HP 8110A 150 MHz Pulse Generator generates all standard pulses, digital patterns and multi-level waveforms needed to test CMOS and other digital designs up to 150 MHz.

Benchtop Testing
The graphic display showing all pulse parameters at a glance, the Cursor keys and the Modify knob allow fast and simple operation.

Automated Testing
The SCPI programming commands, optional rearpanel connectors and 3.5in rack height allow quick and efficient integration into automated test systems.

Reliable Testing
The high pulse integrity with 10 ps timing resolution and down to 20 ps RMS-jitter with the optional PLL/External Clock all ensure consistent, reliable timing.

Upgradeable Testing
The optional second output channel, PLL/External Clock module, and Multichannel Deskew module can be installed at any time, not just at the time of purchase.

<table>
<thead>
<tr>
<th>Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP 81103A</td>
<td>10 V/2 ns Output Channel</td>
</tr>
<tr>
<td>HP 81106A</td>
<td>PLL/External Clock</td>
</tr>
<tr>
<td>HP 81107A</td>
<td>Multichannel Deskew</td>
</tr>
</tbody>
</table>
An Overview of the Frontpanel

Controls

1. **Switch on and off using the Line Switch.**

2. **Move the parameter cursor** ③ **using the CURSOR keys** ⑤. The selected parameter is shown in the Modify Window at the right side of the display. Use the **SHIFT CURSOR** to select a DIGIT or increment/decrement a DIGIT in the Modify Window.

3. **Modify the parameter/menu selection in the Modify Window** ③ **using the MODIFY knob** ⑥.

4. **Select a parameter screen using the Softkeys and MORE.** Use **SHIFT MORE** or press a softkey twice to toggle from the text display to the graphical display, when available.

5. **Use the DATA ENTRY keys to type a value directly into the Modify Window or select a commonly used parameter quickly using the **SHIFT** functions above the keys.

6. **Use a plug-in MEMORY CARD to store and recall instrument settings or update firmware.**
If your HP 8110A has Option UN2 Rear Panel Connectors, these Inputs/Outputs are fitted on the Rear Panel. Refer to "An Overview of the Rearpanel".

7. **EXT INPUT** Connect an external trigger or gate signal here, or use EXT-WIDTH mode to perform pulse recovery.
   
  ⚠️ Maximum External Voltage ±15 V

8. **STROBE OUT**
   - Signal with rising edge marking start of burst in BURST mode.
   - Bitwise programmable in PATTERN mode.
   - Not used in PULSES mode.

  ⚠️ Maximum External Voltage -2 V/+7 V.

9. **TRIGGER OUT** Signal with rising edge marking start of each pulse-period.

   ⚠️ Maximum External Voltage -2 V/+7 V.

10. **OUTPUT 1/2** Pulse outputs, channel 2 optional.

    ⚠️ Maximum External Voltage ±25 V.
Functional Overview

1 TRG-MODE

Use the TRG-MODE screen to:

a. Select the Triggering mode. (CONTINUOUS, TRIGGERED, GATED, EXT WIDTH)
b. Select the Triggered Event. (PULSES, BURST, PATTERN)
c. Select the Pulse type (Single/Double or RZ/NRZ)
d. Select the Pulse-period source.
e. Select the Trigger/Gate source.

2 TRG-LEVEL

Use the TRG-LEVEL screen to:

a. Set the Threshold and Input Impedance of the EXT INPUT and CLK INPUT.
b. Set the Output Levels of the STROBE OUTPUT and TRIGGER OUTPUT.

3 TIMING

Use the TIMING screen to control the pulse timing parameters for both outputs.
4 LEVELS
Use the LEVELS screen to control the pulse level parameters for both outputs.

5 OUTPUT 1/2
Use an OUTPUT screen to control the timing and level parameters for a single output.

6 LIMITS
Use the LIMITS screen to set up voltage and current limits for the pulse level parameters to protect the Device Under Test (DUT).

7 PATTERN
Use the PATTERN screen to set up pattern data for the outputs and the STROBE OUTPUT.

8 CONFIG
Use the CONFIG screen to:

a. *Choose between TIMING/LEVELS or OUTPUT 1/OUTPUT 2 Parameter grouping.
b. Perform selftest.
c. Set the HP-IB address.
d. Select the PLL Reference.
e. Set the output deskew timing.

*Note
On a 2-channel instrument you can choose between displaying
- all parameters for one channel on a single parameter screen (OUTPUT1/OUTPUT2)
- all the Timing parameters for both channels on one screen and all the Level parameters on another screen (TIMING/LEVELS)

using the CONFIG screen.
An Overview of the Rearpanel

Inputs / Outputs

1. **PLL REF IN/CLK IN** If the HP 81106A PLL/External Clock module is fitted, connect an external frequency reference or clock signal here.

   ! Maximum External Voltage ±15 V.

**Note**

If your HP 8110A doesn't have Option UN2 Rear Panel Connectors, the remaining inputs/outputs are fitted on the Frontpanel. Refer to "An Overview of the Frontpanel".

2. **EXT INPUT** Connect an external trigger or gate signal here, or use EXT-WIDTH mode to perform pulse recovery.

   ! Maximum External Voltage ±15 V.

3. **STROBE OUT**
   - Signal with rising edge marking start of burst in BURST mode.
   - Bitwise programmable in PATTERN mode.
   - Not used in PULSES mode.

   ! Maximum External Voltage -2 V/+7 V.
4. **TRIGGER OUT** Signal with rising edge marking start of each pulse period.
   
   ⚠️ Maximum External Voltage -2 V/+7 V.

5. **OUTPUT 1/2** Pulse outputs, channel 2 optional.
   
   ⚠️ Maximum External Voltage ±25 V.

**General**

6. **HP-IB Connector**

7. **Line Voltage Connector**

8. **Serial Number** The HP 8110A mainframe serial number. Note that the Output, PLL/Clock, and Deskew modules have their own serial numbers.

9. **Fuse** 250 V, T 3A, 2110-0029
Getting started

Selftest

A few seconds after switching on the instrument the HP 8110A display switches on and indicates that the instrument selftest is running. This can take several seconds to complete, depending on how many modules are installed.

![Figure 2-1. TIMING Graphics (Dual Channel, Default settings)](image)

Note that Figure 2-1 is from a dual channel instrument with the default timing settings, no selftest errors and the parameter cursor located on pulse-period.

If the selftest fails

If the selftest fails, you see a flashing E at the bottom of the screen. Press HELP to see a list of the selftest error messages. Use the knob or CURSOR keys to scroll through the list if necessary. To return to normal operation press HELP again, or EXIT HELP.

Note that the selftest error messages are removed from the error queue after this.

Recalling the default settings

1. Press SHIFT STORE to select the RECALL function.
2. Press 0 to recall the default settings which are stored in memory 0.
Selecting a parameter

Use the CURSOR keys to move the parameter cursor between the available parameters. The name and value of the selected parameter are displayed in the MODIFY-window at the right of the display.

Select the Width1 (Output 1 pulse-width) parameter:
2 Adjusting the selected parameter value

Use the MODIFY knob to adjust the selected parameter.

![Diagram of the 8110A parameter settings](image)

You can also type a value in directly using the DATA ENTRY keys, for example: \(32.5\text{ nano}\)

(Use CURSOR-left \(\leftarrow\) to backspace during data entry, or \(\text{SHIFT}\text{ ENTER}\) to CANCEL)

You can also use the VERNIER keys to step individual digits:

1. Press \(\text{SHIFT}\) to enter shift mode. The CURSOR keys now function as VERNIER keys.
2. Use \(\leftarrow\) and \(\rightarrow\) to move the digit cursor.
3. Use \(\uparrow\) to increment and \(\downarrow\) to decrement the digit.
4. Press \(\text{SHIFT}\) again to exit shift-mode. The CURSOR keys return to their standard role moving the parameter cursor.

Selecting a parameter screen

- Use the four softkeys directly below the display to move between the parameter screens. (The screen names are displayed above the keys).
- Press \(\text{MORE}\) to display more screen names because there can be up to eight parameter screens available, depending on the channels fitted to your mainframe.

Now press TRG-MODE to select the TRG-MODE screen:
Figure 2-2. TRG-MODE screen (Dual channel)

Note that Figure 2-2 is from a dual channel instrument with the default settings and the parameter cursor located on the triggering mode which is currently set to CONTINUOUS. The available settings are listed in the MODIFY-window at the right of the display. The current setting is also indicated by *.

Changing a setting

Use the MODIFY knob to change the setting of the selected parameter. Set the trigger mode to TRIGGERED:

You can also use the VERNIER keys change the setting:

1. Press **SHIFT** to enter shift mode. The CURSOR keys now function as VERNIER keys.
2. Use **(↑)** and **(↓)** to select a setting from the list in the MODIFY-window.
3. Press **SHIFT** again to exit shift-mode. The CURSOR keys return to their standard role moving the parameter cursor.
Toggling between GRAPHICS and TEXT screens

The TIMING, LEVELS, and PATTERN screens can be displayed in either a text-based or graphics-based mode. To toggle between text and graphics, do one of the following:

- Press (SHIFT)(MORE) (GRAPH)
- Press the softkey for the current screen a second time.

On an OUTPUT screen, the currently selected parameter determines whether the TIMING graphics or LEVELS graphics are displayed in graphics mode.

Parameter Screen summary

All of the parameters and settings which control the HP 8110A are available on one of up to eight parameter screens. The parameter screens group together parameters which are most likely to be used together.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRG-MODE</td>
<td>The overall operating modes of the instrument - triggering, pulse types, period and triggering sources.</td>
</tr>
<tr>
<td>TIMING</td>
<td>All the pulse timing-parameters for Outputs 1 and 2.</td>
</tr>
<tr>
<td>LEVELS</td>
<td>All the pulse voltage or current levels and impedances for Outputs 1 and 2.</td>
</tr>
<tr>
<td>TRG-LEVEL</td>
<td>EXT INPUT, STROBE OUT, TRIGGER OUT and CLK IN levels and impedances.</td>
</tr>
<tr>
<td>LIMITS</td>
<td>Voltage and current limits (for both outputs if fitted).</td>
</tr>
<tr>
<td>PATTERN</td>
<td>4096 bit pattern data (for both outputs, if fitted, and STROBE OUT).</td>
</tr>
<tr>
<td>MEM-CARD</td>
<td>Memory card operations.</td>
</tr>
</tbody>
</table>
CONFIG

General instrument configuration - HP-IB address, deskew (if fitted) and parameter grouping.

OUTPUT 1

All timing, voltage/current and impedance parameters for Output 1 in dual channel instrument.

OUTPUT 2

All timing voltage/current and impedance parameters for Output 2 in dual channel instrument.

OUTPUT

All timing, voltage/current and impedance parameters for Output 1 in a single channel instrument.

Note

The TIMING/LEVELS and OUTPUT 1/OUTPUT 2 screens are alternative pairs of screens. You can select which parameter grouping to use on the CONFIG page.

Use the TIMING/LEVELS grouping if you want to see the timing of both outputs on one screen. Use the OUTPUT 1/2 grouping if you want to see all the parameters for one output on one screen.

A more detailed guide to each parameter screen is given in Chapter 3. “Functional Overview” provides a cross-reference between the parameter screens and the block-diagram of the instrument. The available parameter screens depend on the configuration of the instrument:

Figure 2-3. Parameter Screens: Single Channel

Introducing the HP 8110A 2:13
Figure 2-4.
Parameter Screens: Dual Channel, Group Params by: TIMING/LEVELS

Figure 2-5.
Parameter Screens: Dual Channel, Group Params by: OUTPUT 1/2

Adjusting a parameter or setting

To adjust a parameter/setting on the current screen:

- Use the CURSOR keys to move the parameter cursor onto the parameter/setting you want to adjust.

  The Modify Window at the right hand side of the display shows the value of the selected parameter, or a list of options for the selected setting.

- Use the MODIFY knob to adjust the value of the parameter, or to choose a different setting from the setting-list. The selected setting is indicated by a *.

- Use the DATA ENTRY keys to enter a parameter value directly into the Modify Window without using the knob. Enter the value followed by the appropriate unit and then press ENTER.

  Press CANCEL ((SHIFT ENTER)) to cancel the data entry, or use the cursor-left (←) key to backspace the digit-cursor.

- Press (SHIFT) to enter shift-mode and use the VERNIER (CURSOR)) keys to move the digit-cursor within the
Modify Window. VERNIER a particular digit with the knob or the VERNIER keys.

**Switching the Outputs on and off**

When you switch the HP 8110A on, the outputs are switched off to protect the device under test. The LEDs next to the Output BNC connectors indicate the Output state.

**Output 1**

Press ON/OFF1 (SHIFT 0) to quickly switch Output 1 on or off.

**Output 2**

Press ON/OFF2 (SHIFT 1) to quickly switch Output 2 on or off.

You can also switch either output on or off on the TIMING, LEVELS, OUTPUT 1 or OUTPUT 2 screens by moving the parameter cursor onto the appropriate ON (OFF) field and turning the knob.

**Short-cut for quickly adjusting important parameters**

The most commonly used parameters can be accessed quickly using the short-cut (SHIFT) functions above the DATA ENTRY keys.

1. Press (SHIFT) and the DATA ENTRY key for the parameter you want

2. If necessary, press 1 or 2 to indicate which Output you want.

   The appropriate parameter screen is automatically selected and the parameter cursor is placed on the chosen parameter.

3. Use the DATA ENTRY keys or knob to adjust the parameter.
Operating Reference

Introduction

This chapter is a reference guide for operating the HP 8110A using the frontpanel controls. It contains information on using the (HELP) key and the main frontpanel controls, followed by a reference section for each of the parameter screens selected by the softkeys under the display:

- Using Help
- Frontpanel Controls
- TRG-LEV Screen
- TIMING Screen
- LEVELS Screen
- OUTPUT Screens
- PATTERN Screen
- LIMITS Screen
- TRG-LEV Screen
- MEMCARD Screen
- CONFIG Screen
Using Help

Parameter Help ON FIELD

If there are no Warnings or Errors (See "Warnings and Errors"), press the HELP key at any time to obtain information about the current location of the parameter cursor. The help information gives a short description of the parameter or setting options and the SCPI command(s) syntax for programming the parameter or setting.

Use the MODIFY knob or CURSOR keys to scroll through the help information if there is more than one screen available.

Press EXIT HELP or HELP again to return to normal operation.

Example - Delay parameter

Press HELP with the parameter cursor on the value of the pulse-delay parameter:

Figure 3-1. HELP on pulse-delay parameter
Example - Delay Format

Press HELP with the parameter cursor on the format of the pulse-delay parameter:

![Diagram of delay format settings]

Figure 3-2. HELP on pulse-delay format

Concept Help CONCEPT

If there are no Warnings or Errors (See "Warnings and Errors"), press the HELP key followed by the CONCEPT softkey to view a short description of the HP 8110A.

Operating Reference 3-3
Frontpanel Controls

Serial Numbers and Software Revision SERIAL #
If there are no Warnings or Errors (See “Warnings and Errors”), press the HELP key followed by the SERIAL # softkey to see a list of the installed boards and their serial numbers followed by the software revision code of the instrument’s firmware.

Warning Help WARNINGS
If a Warning condition occurs, indicated by a flashing W, press HELP to see a list of the current warning messages.

Error Queue ERROR QU
If an Error condition occurs, indicated by a flashing E, press HELP to see a list of the current error messages.
Frontpanel Controls

Softkeys ( ) and (MORE)

Use the softkeys to select the parameter screens. The names of the parameter screens are displayed above the softkeys. Press (MORE) to display alternative parameter screens.

SHIFT/LOCAL

Press (SHIFT) to enter SHIFT-mode. A flashing 5 indicates that you are in SHIFT-mode. The extra functions available in SHIFT-mode are shown in blue above the keys.

Note that when using the VERNIER keys (CURSOR keys in SHIFT-mode) you must press (SHIFT) again to exit from SHIFT-mode.

When the instrument is programmed via the HP-IB it enters remote mode and disables the frontpanel controls. Press the (SHIFT) key to return to LOCAL operating mode.

HELP/AUTOSET

Press (HELP) to obtain help on the currently selected parameter/setting.

Press AUTOSET (SHIFT HELP) to set the instrument to a valid setting based on the actual period setting.

STORE/RECALL

Press (STORE) to store the current instrument setting in one of 9 memories.

Press RECALL (SHIFT STORE) to recall a complete instrument setting from one of the 9 memories, or to recall the default instrument settings from memory 0.
Frontpanel Controls

Use the MAN key to generate a manual trigger or gate signal when the HP 8110A is running in TRIGGERED or GATED trigger mode with the MAN key as the selected trigger/gate source.

DATA ENTRY

Use the DATA ENTRY keys to quickly enter a parameter value into the Modify Window. Enter the numeric value followed by the appropriate unit key.

During the data entry you can press CANCEL (SHIFT ENTER) to cancel the entry or use the cursor-left (←) to backspace the digit-cursor.

Use the SHIFT DATA ENTRY functions indicated in blue above the keys to quickly select a particular parameter.

CURSOR/VERNIER

Use the CURSOR keys to move the parameter-cursor on the parameter screen. The parameter-cursor highlights the currently selected parameter or setting. This parameter or setting is then displayed in the Modify Window at the right hand side of the display.

In SHIFT-mode the CURSOR keys move the digit-cursor within the Modify Window and VERNIER the value of the selected digit.

MODIFY knob

Use the knob to modify the selected parameter in the Modify Window, or to select a setting from the list displayed in the Modify window.

On the PATTERN screen when the cursor is located in the Bit-Edit window you can use the knob to scroll through the pattern data. Modify the data with the DATA ENTRY keys.
Connectors

**EXT INPUT**

You can use an external signal connected to the EXT INPUT to trigger the HP 8110A by selecting TRIGGERED mode and Triggered by: EXT-IN on the **TRG-MODE** screen.

You can use an external signal connected to the EXT INPUT to gate (enable/disable) the HP 8110A by selecting GATED mode and Gated by: EXT-IN on the **TRG-MODE** screen.

You can use an external signal connected to the EXT INPUT to generate leading and trailing edges by selecting EXT_WIDTH mode and Width: EXT-IN on the **TRG-MODE** screen.

**TRIGGER OUT**

The TRIGGER OUT signal generates an output pulse for each pulse-period generated by the HP 8110A.

You can set the output levels to TTL or ECL on the **TRG-LEV** screen.

**STROBE OUT**

In **PULSES** mode, the STROBE OUT signal is not used.

In **BURST** mode, the STROBE OUT signal marks the start and end of each burst of pulses generated. The rising edge of the STROBE signal is synchronized to the start of the first pulse-period in a burst, the falling edge is synchronized to the start of the last pulse-period in the burst. Refer to Figure 3-5 for example.

In **PATTERN** mode, the STROBE OUT signal is bit-programmable on the **PATTERN** page. The pulse-width is not programmable, only NRZ pulses are generated. Refer to Figure 3-6 for example.
TRG-MODE Screen

Figure 3-3. Typical TRG-MODE screen

Use the TRG-MODE page to set up the overall operating modes of the HP 8110A. Table 3-1 summarizes the main settings available on this screen.

Table 3-1. TRG-MODE Summary of modes

<table>
<thead>
<tr>
<th>Trigger Mode</th>
<th>CONTINUOUS</th>
<th>TRIGGERED</th>
<th>GATED</th>
<th>EXT WIDTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Pulse Mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Pulse Type</td>
<td>Single/Double</td>
<td>RZ/NI RZ</td>
<td>Single/Double</td>
<td>RZ/NI RZ</td>
</tr>
<tr>
<td>4 Length</td>
<td>2-65536</td>
<td>2-65536</td>
<td>2-65536</td>
<td>2-65536</td>
</tr>
<tr>
<td>5 Period Source</td>
<td>int Osc</td>
<td>int Osc</td>
<td>int Osc</td>
<td>int Osc</td>
</tr>
<tr>
<td></td>
<td>int PLL</td>
<td>int PLL2</td>
<td>int PLL</td>
<td>int PLL</td>
</tr>
<tr>
<td></td>
<td>CLK-IN</td>
<td>CLK-IN</td>
<td>CLK-IN</td>
<td>CLK-IN</td>
</tr>
<tr>
<td>6 Arming Source</td>
<td>MAN Key</td>
<td>MAN Key</td>
<td>MAN Key</td>
<td>MAN Key</td>
</tr>
<tr>
<td></td>
<td>EXT INPUT</td>
<td>EXT INPUT</td>
<td>EXT INPUT</td>
<td>EXT INPUT</td>
</tr>
<tr>
<td>7 STROBE OUT</td>
<td>NOT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 MODIFIED OUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Set Last on PATTERN screen
2 PLL cannot be used as Pulse and Arming source at the same time

To change a setting, move the parameter cursor onto the setting using the CURSOR keys and modify the setting with the MODIFY knob.

3-8 Operating Reference
The following sections explain the mode combinations in more detail.

CONTINUOUS PULSES Mode

**Figure 3-4. Timing Diagram:** CONTINUOUS PULSES

Figure 3-4 does not show the intrinsic fixed delays between the CLK IN and the TRIGGER/STROBE OUT signals, and between the TRIGGER OUT and the main OUTPUT 1/2 signals. Refer to Chapter 6 for the typical values of these delays.

- Pulse-periods are generated continuously
- Select between Single and Double-pulses per pulse-period for each OUTPUT (See 3 in Figure 3-3):
  - **Single-Pulses** Single pulse per period, delay parameter sets delay to leading-edge from start of period.
  - **Double-Pulses** Double pulse per period, double-delay parameter sets delay between leading-edges of pulses.
- If the HP 81106A PLL/External clock is fitted, select the pulse-period source (See 5 in Figure 3-3):
  - [ ] internal Osc
  - [ ] internal PLL (Higher accuracy)

*Operating Reference 3-9*
TRG-MODE CONTINUOUS BURST

- use CLK-IN (External signal), synchronize to rising or falling edge.
- TRIGGER OUT marks each pulse period.
- STROBE OUT not used.

CONTINUOUS BURST Mode

![Timing Diagram]

Figure 3-5. Timing Diagram: CONTINUOUS BURST

Note

Figure 3-5 does not show the intrinsic fixed delays between the CLK IN and the TRIGGER/STROBE OUT signals, and between the TRIGGER OUT and the main OUTPUT 1/2 signals. Refer to Chapter 6 for the typical values of these delays.

- A burst of pulse-periods is repeated continuously. The OUTPUT signal is the same as PULSES mode, but the STROBE OUT now marks the beginning and end of each burst.

- Select the number of pulse-periods per burst in the range 2 - 65536 (See 4 in Figure 3-3).

- Select between Single and Double-pulses per pulse-period for each OUTPUT (See 3 in Figure 3-3):
  
  **Single-Pulses** Single pulse per period, delay parameter sets delay to leading-edge from start of period.

3-10 Operating Reference
Double-Pulses Double pulse per period, double-delay parameter sets delay between leading-edges of pulses.

- If the HP 81106A PLL/External clock is fitted, select the pulse-period source (See 5 in Figure 3-3):
  - internal Osc
  - internal PLL (Higher accuracy)
  - ext CLK-IN (External signal), synchronize to rising or falling edge.

- TRIGGER OUT marks each pulse period.
- STROBE OUT rises at the start of the first pulse-period in a burst and falls at the start of the last pulse-period.

---

**CONTINUOUS PATTERN Mode**

---

**Figure 3-6. CONTINUOUS PATTERN Mode**

Figure 3-6 does not show the intrinsic fixed delays between the CLK IN and the TRIGGER/STROBE OUT signals, and between the TRIGGER OUT and the main OUTPUT 1/2 signals. Refer to Chapter 6 for the typical values of these delays.

- A pattern of pulses is repeated continuously.
- Select between RZ and NRZ data pulses for each OUTPUT (See 3 in Figure 3-3):
  
  **RZ** A single pulse is generated in each pulse-period with data value 1, no pulse is generated for data value 0.
  
  **NRZ** A leading-edge is generated for a 0→1 data transition, a trailing-edge is generated for a 1→0 data transition.

- If the HP 81106A PLL/External clock is fitted, select the pulse-period source (See 5 in Figure 3-3):
  
  - internal Osc
  - internal PLL (Higher accuracy)
  - ext CLK-IN (External signal), synchronize to rising or falling edge.

- Select the **PATTERN** screen to set the pattern length in the range 2 – 4096.

- Select the **PATTERN** screen to program the data values for each OUTPUT.

- TRIGGER OUT marks each pulse period.

- STROBE OUT is bit-programmable, like the OUTPUTS, in NRZ format on the **PATTERN** screen.
**Figure 3-7. Timing Diagram:** TRIGGERED PULSES

Note

Figure 3-7 does not show the intrinsic fixed delays between the EXT INPUT and the TRIGGER/STROBE OUT signals, and between the TRIGGER OUT and the main OUTPUT 1/2 signals. Refer to Chapter 6 for the typical values of these delays.

- Single pulse-periods are triggered by (Trg'd by) an active edge at the selected arming source (See 6 in Figure 3-3):
  - MAN Key (MAN) on frontpanel, triggered by press or release or both.
  - EXT INPUT (External signal) triggered by rising or falling or both edges (See Figure 3-8).

Note

The HP 81106A PLL cannot be selected as the arming source. Select CONTINUOUS PULSES mode with the PLL as Period source to achieve the same result.
Figure 3-8.
Timing Diagram: TRIGGERED PULSES Trg'd by Both

- Select between Single and Double-pulses per pulse-period for each OUTPUT (See 3 in Figure 3-3):
  - Single-Pulses: Single pulse per period, delay parameter sets delay to leading-edge from start of period.
  - Double-Pulses: Double pulse per period, double-delay parameter sets delay between leading-edges of pulses.

- TRIGGER OUT marks each pulse period.
- STROBE OUT not used.
TRIGGERED BURST Mode

Figure 3-9.
Timing Diagram: TRIGGERED BURST Pulse-Period: internal Osc

Note

Figure 3-9 does not show the intrinsic fixed delays between the EXT INPUT and the TRIGGER/STROBE OUT signals, and between the TRIGGER OUT and the main OUTPUT 1/2 signals. Refer to Chapter 6 for the typical values of these delays.

- A burst of pulse-periods is triggered by \( \text{Trg'd by} \) an active edge at the selected arming source (See 6 in Figure 3-3):
  - MAN Key \( \text{MAN} \) on frontpanel, triggered by press or release or both.
  - EXT INPUT (External signal) triggered by rising or falling or both edges.
  - PLL (Internally triggered bursts), select the triggering period.
- Select the number of pulse-periods per burst in the range 2 - 65536 (See 4 in Figure 3-3).
- Select between Single and Double-pulses per pulse-period for each OUTPUT (See 3 in Figure 3-3):
TRG-MODE TRIGGERED BURST

Single-Pulses
Single pulse per period, delay parameter sets delay to leading-edge from start of period.

Double-Pulses
Double pulse per period, double-delay parameter sets delay between leading-edges of pulses.

Figure 3-10.
Timing Diagram: TRIGGERED BURST Pulse-Period:
internal PLL or CLK-IN

- If the HP 81106A PLL/External clock is fitted, select the pulse-period source (See 5 in Figure 3-3):
  - internal Osc (Start of burst synchronized to trigger, see Figure 3-9)
  - internal PLL (Higher accuracy, start of burst not synchronized to trigger, see Figure 3-10)
  - ext CLK-IN (External signal), pulse-period synchronized to rising or falling edge.

Note
You cannot use the PLL as both Pulse-Period source and Trg'd by (arming) source at the same time.

- TRIGGER OUT marks each pulse period.
TRIGGERED PATTERN Mode

- STROBE OUT rises at the start of the first pulse-period in a burst and falls at the start of the last pulse-period.

Figure 3-11.

Timing Diagram: TRIGGERED PATTERN Pulse-Period: internal Osc

Note

Figure 3-11 does not show the intrinsic fixed delays between the EXT INPUT and the TRIGGER/STROBE OUT signals, and between the TRIGGER OUT and the main OUTPUT 1/2 signals. Refer to Chapter 6 for the typical values of these delays.

- A pattern of pulses is triggered by (Trg’d by) an active edge from the selected arming source (See 6 in Figure 3-3):
  - **MAN Key** (MAN) on frontpanel, triggered by press, release or both.
  - EXT INPUT (External signal) triggered by rising, falling or both edges.
  - PLL (internally triggered patterns), select the triggering period.
TRG-MODE TRIGGERED PATTERN

- Select between RZ and NRZ data pulses for each OUTPUT (See 3 in Figure 3-3):

  **RZ**
  A single pulse is generated in each pulse-period with data value 1, no pulse is generated for data value 0.

  **NRZ**
  A leading-edge is generated for a 0→1 data transition, a trailing-edge is generated for a 1→0 data transition.

![Figure 3-12.
Timing Diagram: TRIGGERED PATTERN
Pulse-Period: internal PLL or CLK-IN](image)

- If the HP 81106A PLL/External clock is fitted, select the pulse-period source (See 5 in Figure 3-3):
  - internal Osc (Start of pattern synchronized to trigger, see Figure 3-9)
  - internal PLL (Higher accuracy, start of pattern not synchronized to trigger, see Figure 3-10)
  - ext CLK-IN (External signal), pulse-period synchronized to rising or falling edge.

**Note**
You cannot use the PLL as both Pulse-Period source and Trg'd by (arming) source at the same time.

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- Select the **PATTERN** screen to set the pattern length in the range 2 - 4096.

- Select the **PATTERN** screen to program the data values for each OUTPUT.

- TRIGGER OUT marks each pulse period.

- STROBE OUT is bit-programmable, like the OUTPUTS, in NRZ format on the PATTERN screen.

---

**GATED PULSES Mode**

---

**Note**

Figure 3-13 does not show the intrinsic fixed delays between the EXT INPUT and the TRIGGER/STROBE OUT signals, and between the TRIGGER OUT and the main OUTPUT 1/2 signals. Refer to Chapter 6 for the typical values of these delays.

- Pulse-periods are **Gated by** (enabled by) an active level at the selected arming source (See 6 in Figure 3-3):  
  - **MAN Key** (MAN) on frontpanel, gated while pressed or released or both.  
  - **EXT INPUT** (External signal) gated by high, low or both levels.
- Select between Single and Double-pulses per pulse-period for each OUTPUT (See 3 in Figure 3-3):
  
  **Single-Pulses** Single pulse per period, delay parameter sets delay to leading-edge from start of period.
  
  **Double-Pulses** Double pulse per period, double-delay parameter sets delay between leading-edges of pulses.

![Timing Diagram](image)

**Figure 3-14.**

**Timing Diagram:** GATED PULSES Pulse-Period: PLL or CLK-IN

- If the HP 81106A PLL/External clock is fitted, select the pulse-period source (See 5 in Figure 3-3):
  
  - **internal Osc** (Start of pulse synchronized to trigger, see Figure 3-13)
  - **internal PLL** (Higher accuracy, start of pulse not synchronized to trigger, see Figure 3-14)
  - **ext CLK-IN** (External signal), pulse-period synchronized to rising or falling edge.

- TRIGGER OUT marks each pulse period.
- STROBE OUT not used.
**GATED BURST Mode**

**Figure 3-15.**

**Timing Diagram:**
- **GATED BURST Pulse**
- **Period:** internal Osc

---

**Note**

Figure 3-15 does not show the intrinsic fixed delays between the EXT INPUT and the TRIGGER/STROBE OUT signals, and between the TRIGGER OUT and the main OUTPUT 1/2 signals. Refer to Chapter 6 for the typical values of these delays.

- Bursts of pulse-periods are gated by (enabled by) an active level at the selected arming source (See 6 in Figure 3-3):
  - **MAN Key** (MAN) on front panel, gated while pressed or released or both.
  - **EXT INPUT** (External signal) gated while high or low or both.

- Select the number of pulse-periods per burst in the range 2 - 65536 (See 4 in Figure 3-3).

- Select between Single and Double-pulses per pulse-period for each OUTPUT (See 3 in Figure 3-3):
  - **Single-Pulses**
    - Single pulse per period, delay parameter sets delay to leading-edge from start of period.

---

**Operating Reference** 3-21
Double-Pulses

Double pulse per period, double-delay parameter sets delay between leading-edges of pulses.

Figure 3-16.
Timing Diagram: GATED BURST Pulse-Period: internal PLL or CLK-IN

- If the HP 81106A PLL/External clock is fitted, select the pulse-period source (See 5 in Figure 3-3):
  - internal osc (Start of burst synchronized to trigger, see Figure 3-9)
  - internal PLL (Higher accuracy, start of burst not synchronized to trigger, see Figure 3-10)
  - ext CLK-IN (External signal), pulse-period synchronized to rising or falling edge.

- TRIGGER OUT marks each pulse period.
- STROBE OUT rises at the start of the first pulse-period in a burst and falls at the start of the last pulse-period.
GATED PATTERN Mode

- A pattern of pulses is Gated by (enabled by) an active level at the selected arming source (See 6 in Figure 3-3):
  - MAN Key (MAN) on front panel, gated while pressed, released or both.
  - EXT INPUT (External signal) gated while high or low or both.

- Select between RZ and NRZ data pulses for each OUTPUT (See 3 in Figure 3-3):
  - RZ: A single pulse is generated in each pulse-period with data value 1, no pulse is generated for data value 0.
  - NRZ: A leading-edge is generated for a 0→1 data transition, a trailing-edge is generated for a 1→0 data transition.

- If the HP 81106A PLL/External clock is fitted, select the pulse-period source (See 5 in Figure 3-3):
  - internal Osc (Start of pattern synchronized to gate, see Figure 3-9)
  - internal PLL (Higher accuracy, start of pattern not synchronized to gate, see Figure 3-10)
  - ext CLK-IN (External signal), pulse-period synchronized to rising or falling edge.

- Select the PATTERN screen to set the pattern length in the range 2 – 4096.

- Select the PATTERN screen to program the data values for each OUTPUT.

- TRIGGER OUT marks each pulse period.

- STROBE OUT is bit-programmable, like the OUTPUTS, in NRZ format on the PATTERN screen.
TIMING

**EXT WIDTH Mode**

- The pulse-width is determined by an external signal:
  - **MAN** key: Pressing the **MAN** key generates a leading-edge, releasing the **MAN** key generates a trailing-edge.
  - **EXT-IN**: A rising-edge at the EXT INPUT generates a leading-edge, a falling-edge at the EXT INPUT generates a trailing-edge.

- Set the threshold and impedance of the EXT INPUT on the **TRG-LEV** screen.

- The period, delay, and width of the output pulse are not programmable in this mode as they are determined by the external signal.
TIMING screen

The TIMING screen is only available if you have two channels fitted to your HP 8110A mainframe and you have selected Group Params by: TIMING/LEVELS on the CONFIG screen.

![TIMING screen, text mode](image1)

![TIMING screen, graphics mode](image2)

Figure 3-17. TIMING screen, text mode

Figure 3-18. TIMING screen, graphics mode

Use the TIMING screen to view and control the pulse-timing parameters for both channels on one screen. If you have a single channel instrument both the timing and level parameters are on the OUTPUT screen.

You can toggle between graphics and text mode by pressing the TIMING softkey or [SHIFT]MORE.

Note that in graphics mode you can only adjust the values of each parameter, not the parameter format. If you want to change the format of a parameter, for example Width to DutyCycle, you must be in text mode to select the parameter name with the cursor.
TIMING

Modifying the value of a parameter

You can adjust a parameter value in graphics or text mode. Example screens are shown in the following subsections for graphics mode only.

1. Move the parameter cursor onto the value you want to modify using the CURSOR keys.
2. Modify the value with the knob.

Note that when you use the knob, the parameter range can be restricted to prevent any warnings or errors occurring (See “Warnings and Errors”). If you want to set a value outside this temporary range, use the DATA ENTRY keys or press [SHIFT] and turn the knob. If you try to set a value outside the absolute maximum or minimum limits, the maximum or minimum limit will be set.

Modifying the format of a parameter

Note

You can only modify the format of a parameter in text mode.

Many parameters can be displayed in different formats, for example the pulse-period can be displayed as a period or a frequency. To modify the format of a parameter:

1. If you are in GRAPHics mode, select TEXT mode with [SHIFT] more.
2. Move the cursor onto the parameter name.
3. Use the MODIFY knob to select a parameter format from the list in the MODIFY window.

ON/OFF Parameter

Switch the OUTPUT signal on and off.

Note that you can use the short-cut keys [SHIFT] 0 or [SHIFT] 1 to quickly toggle the OUTPUTS on and off.
Pulse-period Parameter

Set the pulse-period as either Period or Frequency.

You can select the pulse-period source on the TRG-MODE screen.

If you select the HP 81106A CLK IN connector as the pulse-period source, the pulse-period/frequency is determined from the signal applied to CLK IN:

- **Meas Once**: The external signal is measured once. Press ENTER to measure again.
- **Meas Cont**: The external signal is continuously measured.

Output Delay Parameter

![Delay Diagram]

**Figure 3-19.** TIMING/OUTPUT Timing parameter graphics, Delay

Delay the leading-edge of the pulse within the pulse-period. There are three delay formats available, selectable in text mode:

- **Delay**

  Delay is the absolute delay from the start of a pulse-period to the start of the leading-edge of the pulse. The absolute delay is independent of the pulse-period so the leading-edge does not move relative to the start of the period if you change the period.
TIMING

Delay%:

Delay% is the delay from the start of the pulse-period to the start of the leading-edge expressed as a percentage of the pulse-period. In this format if you change the period, the leading-edge moves relative to the start of the period in order to maintain the percentage delay.

Phase:

Phase is the phase delay in degrees from the start of the pulse-period to the start of the leading-edge. (360° = 1 pulse-period). In this format if you change the period, the leading-edge moves relative to the start of the period in order to maintain the phase delay.

Pulse Width Parameter

![Timing parameter graphics, Width]

Figure 3-20.

TIMING/OUTPUT Timing parameter graphics, Width

Set the width of the output pulse. There are three width formats available, selectable in text mode:

Width:

Width is the absolute pulse-width measured from start of the leading-edge to start of the trailing edge. In this format the pulse-width is independent of changes in pulse-period and delay.

DutyCyc:

DutyCycle is the pulse-width measured from start of the leading-edge to start of the trailing edge expressed as a
percentage of the period. In this format if you adjust the period, the absolute width is adjusted to maintain the dutycycle.

Note that you cannot have the width format set to DutyCyc and the leading/trailing-edge format set to percentage of width (LeadEd%/TrailE%) at the same time.

Figure 3-21.

**TIMING/OUTPUT** Timing parameter graphics, Trailing Delay

TrailingDelay is the absolute delay from the start of the pulse-period to the start of the trailing-edge. In this format the trailing-edge remains fixed relative to the start of the pulse-period if you adjust the pulse-delay (leading-edge delay) or the pulse-period.
Pulse Leading-edge Parameter

Figure 3-22.
TIMING/OUTPUT Timing parameter graphics, Leading-edge

Set the leading-edge transition-time of the pulse, measured from 10% to 90% of pulse amplitude. Note that the leading and trailing-edges are independently programmable within certain ranges only, see Figure 6-1. There are two formats available, selectable in text mode:

LeadEdg
The absolute transition-time measured from 10% to 90% of pulse amplitude. In this format the leading-edge is independent of the pulse-width.

LeadEd%
The leading-edge transition-time expressed as a percentage of pulse-width. In this format if you adjust the pulse-width, the transition-time is adjusted to maintain the edge-time as a percentage of the width.

Note that you cannot have the width format set to DutyCyc and the leading/trailing-edge format set to percentage of width (LeadEd%/TrailE%) at the same time.
Pulse Trailing-edge Parameter

Set the trailing-edge transition-time of the pulse, measured from 10% to 90% of pulse amplitude. Note that the leading and trailing-edges are independently programmable within certain ranges only, see Figure 6-1. There are three formats available, selectable in text mode:

=LeadE

The trailing-edge transition-time is coupled directly to the leading edge to maintain a symmetrical pulse.

TrailEd

The absolute transition-time measured from 10% to 90% of pulse amplitude. In this format the trailing-edge is independent of the pulse-width.

TrailE%

The trailing-edge transition-time expressed as a percentage of pulse-width. In this format if you adjust the pulse-width, the transition-time is adjusted to maintain the edge-time as a percentage of the width.

Note that you cannot have the width format set to DutyCyc and the leading/trailing-edge format set to percentage of width (LeadEd%/TrailE%) at the same time.
The LEVELS screen is only available if you have two channels fitted to your HP 8110A mainframe and you have selected Group Params by: TIMING/LEVELS on the CONFIG screen.

![Figure 3-23. LEVELS screen, text mode](image)

Use the LEVELS screen to view and control the pulse-level parameters for both channels on one screen. If you have a single channel instrument both the timing and level parameters are on the OUTPUT screen.

You can toggle between graphics and text mode by pressing the LEVELS softkey or (SHIFT)MORE.

Note that in graphics mode you can only adjust the values of each parameter, not the parameter format. If you want to change the format of a parameter, for example Offset/Amplit to High/Low, you must be in text mode to select the parameter name with the cursor.
Modifying the value of a parameter

You can adjust a parameter value in graphics or text mode. Example screens are shown in the following subsections for graphics mode only.

1. Move the parameter cursor onto the value you want to modify using the CURSOR keys.

2. Modify the value with the knob.

Note that when you use the knob, the parameter range can be restricted to prevent any warnings or errors occurring (See “Warnings and Errors”). If you want to set a value outside this temporary range, use the DATA ENTRY keys or press `SHIFT` and turn the knob. If you try to set a value outside the absolute maximum or minimum limits, the maximum or minimum limit will be set.

Modifying the format of a parameter

Note

You can only modify the format of a parameter in text mode.

Many parameters can be displayed in different formats, for example the pulse-period can be displayed as a period or a frequency. To modify the format of a parameter:

1. If you are in GRAPHics mode, select TEXT mode with `SHIFT` `MORE`.

2. Move the cursor onto the parameter name.

3. Use the MODIFY knob to select a parameter format from the list in the MODIFY window.

ON/OFF Parameter

Switch the OUTPUT signal on and off.

Note that you can use the short-cut keys `SHIFT` `8` or `SHIFT` `9` to quickly toggle the OUTPUTS on and off.
Normal/Compliment Parameter

Note

This parameter is only available in text mode.

Switch the OUTPUT between Normal and Complement modes.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Pulse leading-edge rises from low to high-level, trailing-edge falls from high to low-level.</td>
</tr>
<tr>
<td>Complement</td>
<td>Pulse leading-edge falls from high to low-level, trailing-edge rises from low to high-level.</td>
</tr>
</tbody>
</table>

Separate/Added Outputs Parameter

Note

This parameter is only available in text mode, and if you have two output channels fitted.

Switch Added output mode on and off.

Separate Outputs

OUTPUT 1 and OUTPUT 2 operate as entirely separate output channels.
OUTPUT 1 and OUTPUT 2 signals are added together at the OUTPUT 1 connector. The OUTPUT 2 connector is no longer used. You can use this mode to create complex pulse waveforms as shown in Figure 3-25.

![Figure 3-25. TIMING screen, Added Outputs](image)

Note that by using PATTERN mode you can code 3 or 4-level codes, or place spike pulses from OUTPUT CH2 on particular data pulses on OUTPUT CH1 for example. Since OUTPUT 2 is no longer used, its Impedance parameters are no longer available (See Figure 3-26).

![Figure 3-26. LEVELS screen, Added Outputs text mode](image)
The LEVELS graphic page is also modified to indicate the multiple levels formed by OUTPUT 1 + 2:

![LEVELS screen, Added Outputs graphics mode](image)

**Offset, Amplitude, High, Low Level Parameters**

Set and display the pulse levels in terms of either Offset and Amplitude, or High- and Low-level. You can quickly set TTL or ECL output levels using the **Set TTL** and **Set ECL** formats.

**Set TTL**

Select High and Low-level format and automatically set the levels to the default TTL levels:

\[
\begin{align*}
\text{TTL-HI} & \quad +2.50 \text{ V} \\
\text{TTL-LOW} & \quad +0.0 \text{ mV}
\end{align*}
\]

The default levels are set once and can be adjusted afterwards by moving the cursor onto the values as normal.

**High-Low**

Select High and Low-level format for the pulse levels.

**Offs-Ampl**

Select Offset and Amplitude format for the pulse levels. Offset is measured from 0 V to the middle of the pulse-amplitude. Pulse-amplitude is the difference between the High- and Low-levels of the pulse.
Set ECL

Select High and Low-level format and automatically set
the levels to the default ECL levels:

- ECL-HI: -950 mV
- ECL-LOW: -1.80 V

These default levels are set once and can be adjusted
afterwards by moving the cursor onto the value as
normal.

**Voltage/Current Mode**

<table>
<thead>
<tr>
<th>Note</th>
<th>This parameter is only available in text mode.</th>
</tr>
</thead>
</table>

Move the parameter cursor onto the level Units to
select between setting the pulse-levels in Volts or in
Amperes.

**50Ω into OUTPUT Source Impedance Parameter**

<table>
<thead>
<tr>
<th>Note</th>
<th>This parameter is only available in text mode.</th>
</tr>
</thead>
</table>

Toggle the OUTPUT impedance between 50Ω and 1kΩ. If
you are using Added at Output 1 mode to add OUTPUTS
1 + 2 at OUTPUT 1, the available OUTPUT impedances at
OUTPUT 1 are 48Ω and 500Ω.

**50.0Ω Load Impedance Parameter**

Adjust the load impedance value expected at the
OUTPUT to compensate for non-50Ω loads. The displayed
level-parameters are then calculated using this value and
therefore represent the levels at a non-50Ω static load.
Output Voltage and Power Protection

Note

When an OUTPUT is switched on, the HP 8110A monitors the actual voltage and current levels at the OUTPUT. The OUTPUT is automatically switched off if voltage levels or power dissipation reach levels which could damage the OUTPUT circuits.

The available output levels for an OUTPUT could therefore be limited by external voltages, loads and the level settings of the other OUTPUT if you are using a dual channel instrument with Outputs added at OUTPUT 1. Refer to Specifications chapter 6, Outputs Table 6-1 and Fig. 6-2.
The OUTPUT screen is available if you have only one channel fitted to your HP 8110A mainframe. OUTPUT 1 and OUTPUT 2 screens are available on a two channel instrument if you have selected Group Params by: OUTPUT 1/2 on the CONFIG screen. The OUTPUT screen on a single channel instrument is identical to the OUTPUT 1 screen shown in this section.

![Figure 3-28. OUTPUT 1/OUTPUT screen, text mode](image1)

![Figure 3-29. OUTPUT 2 screen, text mode](image2)

Use an OUTPUT screen to view and control all the pulse parameters for one channel on one screen. If you have a single channel instrument both the timing and level parameters are on the OUTPUT screen.

You can toggle between graphics and text mode by pressing the LEVELS softkey or (SHIFT MORE). You move to the timing graphics if you are currently on a timing parameter, or to the level graphics if you are currently on a level parameter.
Note that in graphics mode you can only adjust the values of each parameter, not the parameter format. If you want to change the format of a parameter, for example Offset/Amp to High/Low, you must be in text mode to select the parameter name with the cursor.

3 Modifying the value of a parameter

You can adjust a parameter value in graphics or text mode. Example screens are shown in the following subsections for graphics mode only.

1. Move the parameter cursor onto the value you want to modify using the CURSOR keys.

2. Modify the value with the knob.

Note that when you use the knob, the parameter range can be restricted to prevent any warnings or errors occurring (See "Warnings and Errors"). If you want to set a value outside this temporary range, use the DATA ENTRY keys or press \texttt{SHIFT} and turn the knob. If you try to set a value outside the absolute maximum or minimum limits, the maximum or minimum limit will be set.

Modifying the format of a parameter

\begin{tabular}{|c|c|}
\hline
\textbf{Note} & You can only modify the format of a parameter in text mode. \\
\hline
\end{tabular}

Many parameters can be displayed in different formats, for example the pulse-period can be displayed as a period or a frequency. To modify the format of a parameter:

1. If you are in GRAPHics mode, select TEXT mode with \texttt{SHIFT} more).

2. Move the cursor onto the parameter name.

3. Use the MODIFY knob to select a parameter format from the list in the MODIFY window.
Pulse-period Parameter

Set the pulse-period as either Period or Frequency.

You can select the pulse-period source on the TRG-MODE screen.

If you select the HP 81106A CLK IN connector as the pulse-period source, the pulse-period/frequency is determined from the signal applied to CLK IN:

- **Meas Once**: The external signal is measured once. Press ENTER to measure again.
- **Meas Cont**: The external signal is continuously measured.

Normal/Complmnt Parameter

Note

This parameter is only available in text mode.

Switch the OUTPUT between Normal and Complement modes.

- **Normal**: Pulse leading-edge rises from low to high-level, trailing-edge falls from high to low-level.
- **Complmnt**: Pulse leading-edge falls from high to low-level, trailing-edge rises from low to high-level.

ON/OFF Parameter

Switch the OUTPUT signal on and off.

Note that you can use the short-cut keys [SHIFT] or [SHIFT] to quickly toggle the OUTPUTS on and off.
Output Delay Parameter

![Figure 3-30. Timing/Output Timing parameter graphics, Delay]

Delay the leading-edge of the pulse within the pulse-period. There are three delay formats available, selectable in text mode:

**Delay**

Delay is the absolute delay from the start of a pulse-period to the start of the leading-edge of the pulse. The absolute delay is independent of the pulse-period so the leading-edge does not move relative to the start of the period if you change the period.

**Delay%**

Delay% is the delay from the start of the pulse-period to the start of the leading-edge expressed as a percentage of the pulse-period. In this format if you change the period, the leading-edge moves relative to the start of the period in order to maintain the percentage delay.

**Phase**

Phase is the phase delay in degrees from the start of the pulse-period to the start of the leading-edge. (360° = 1 pulse-period). In this format if you change the period, the leading-edge moves relative to the start of the period in order to maintain the phase delay.
Pulse Width Parameter

Figure 3-31. TIMING/OUTPUT Timing parameter graphics, Width

Set the width of the output pulse. There are three width formats available, selectable in text mode:

Width

Width is the absolute pulse-width measured from start of the leading-edge to start of the trailing edge. In this format the pulse-width is independent of changes in pulse-period and delay.

DutyCyc

DutyCycle is the pulse-width measured from start of the leading-edge to start of the trailing edge expressed as a percentage of the period. In this format if you adjust the period, the absolute width is adjusted to maintain the dutycycle.

Note that you cannot have the width format set to DutyCyc and the leading/trailing-edge format set to percentage of width (LeadEd%/TrailE%) at the same time.
Trailing Delay is the absolute delay from the start of the pulse-period to the start of the trailing-edge. In this format the trailing-edge remains fixed relative to the start of the pulse-period if you adjust the pulse-delay (leading-edge delay) or the pulse-period.
Pulse Leading-edge Parameter

Figure 3-33.

TIMING/OUTPUT Timing parameter graphics,
Leading-edge

Set the leading-edge transition-time of the pulse,
measured from 10% to 90% of pulse amplitude. Note
that the leading and trailing-edges are independently
programmable within certain ranges only, see Figure 6-1.
There are two formats available, selectable in text mode:

LeadEdg

The absolute transition-time measured from 10% to 90%
of pulse amplitude. In this format the leading-edge is
independent of the pulse-width.

LeadEdg%

The leading-edge transition-time expressed as a
percentage of pulse-width. In this format if you adjust
the pulse-width, the transition-time is adjusted to
maintain the edge-time as a percentage of the width.

Note that you cannot have the width format set to
DutyCyc and the leading/trailing-edge format set to
percentage of width (LeadEdg%/Trailing%) at the same
time.
Pulse Trailing-edge Parameter

Set the trailing-edge transition-time of the pulse, measured from 10% to 90% of pulse amplitude. Note that the leading and trailing-edges are independently programmable within certain ranges only, see Figure 6-1.

There are three formats available, selectable in text mode:

=LeadE

The trailing-edge transition-time is coupled directly to the leading edge to maintain a symmetrical pulse.

Trai1Ed

The absolute transition-time measured from 10% to 90% of pulse amplitude. In this format the trailing-edge is independent of the pulse-width.

Trai1E%

The trailing-edge transition-time expressed as a percentage of pulse-width. In this format if you adjust the pulse-width, the transition-time is adjusted to maintain the edge-time as a percentage of the width.

Note that you cannot have the width format set to DutyCyc and the leading/trailing-edge format set to percentage of width (LeadEd%/Trai1E%) at the same time.
**Separate/Added Outputs Parameter**

This parameter is only available in text mode on the OUTPUT 2 screen (Compare Figure 3-28 and Figure 3-29).

**Note**

Switch Added output mode on and off.

**Seperate Out2**

OUTPUT 1 and OUTPUT 2 operate as entirely separate output channels.

**Added to Out1**

OUTPUT 1 and OUTPUT 2 signals are added together at the OUTPUT 1 connector. The OUTPUT 2 connector is no longer used. You can use this mode to create complex pulse waveforms as shown in Figure 3-34.

![Diagram showing pulse waveforms and timing](image)

**Figure 3-34.**

**TIMING/OUTPUT** Timing parameter graphics, Added Outputs

---

*Operating Reference* 3-47
Note that by using PATTERN mode you can code 3 or 4-level codes, or place spike pulses from OUTPUT CH2 on particular data pulses on OUTPUT CH1 for example. Since OUTPUT 2 is no longer used, its impedance parameters are no longer available (See ***<xref OUTPUT2A>: undefined***).

![Figure 3-35. OUTPUT 2 screen, Added Outputs text mode](image)

The LEVELS graphic page is also modified to indicate the multiple levels formed by OUTPUT 1 + 2:

![Figure 3-36. LEVELS screen, Added Outputs graphics mode](image)
**Offset, Amplit, High, Low Level Parameters**

Set and display the pulse levels in terms of either Offset and Amplitude, or High- and Low-level. You can quickly set TTL or ECL output levels using the Set TTL and Set ECL formats.

**Set TTL**

Select High and Low-level format and automatically set the levels to the default TTL levels:

\[
\begin{align*}
\text{TTL-HI} & \quad +2.5 \text{ V} \\
\text{TTL-LOW} & \quad +0.0 \text{ mV}
\end{align*}
\]

The default levels are set once and can be adjusted afterwards by moving the cursor onto the values as normal.

**High-Low**

Select High and Low-level format for the pulse levels.

**Offs-Ampl**

Select Offset and Amplitude format for the pulse levels. Offset is measured from 0 V to the middle of the pulse-amplitude. Pulse-amplitude is the difference between the High- and Low-levels of the pulse.

**Set ECL**

Select High and Low-level format and automatically set the levels to the default ECL levels:

\[
\begin{align*}
\text{ECL-HI} & \quad -350 \text{ mV} \\
\text{ECL-LOW} & \quad -1.80 \text{ V}
\end{align*}
\]

These default levels are set once and can be adjusted afterwards by moving the cursor onto the value as normal.
Output 1 Output 2

mV, V, mA Voltage/Current Mode

Note This parameter is only available in text mode.

Move the parameter cursor onto the level Units to select between setting the pulse-levels in Volts or in Amperes.

50Ω into Output Source Impedance Parameter

Note This parameter is only available in text mode.

Toggle the OUTPUT impedance between 50Ω and 1kΩ. If you are using Added at Output 1 mode to add OUTPUTS 1 + 2 at OUTPUT 1, the available OUTPUT impedances at OUTPUT 1 are 48Ω and 500Ω.

50.0Ω Load Impedance Parameter

Adjust the load impedance value expected at the OUTPUT to compensate for non-50Ω loads. The displayed level-parameters are then calculated using this value and therefore represent the levels at a non-50Ω static load.
Output Voltage and Power Protection

When an OUTPUT is switched on, the HP 8110A monitors the actual voltage and current levels at the OUTPUT. The OUTPUT is automatically switched off if voltage levels or power dissipation reach levels which could damage the OUTPUT circuits.

The available output levels for an OUTPUT could therefore be limited by external voltages, loads and the level settings of the other OUTPUT if you are using a dual channel instrument with Outputs added at OUTPUT 1. Refer to Specifications chapter 6, Outputs Table 6-1 and Fig. 6-2.
Use the PATTERN screen to edit the pattern data which is generated when you select a PATTERN mode on the TRG-MODE screen.

You can toggle between graphics and text mode by pressing the PATTERN softkey or [SHIFT MORE].

Note that in graphics mode you can see if RZ or NRZ data is selected. In Figure 3-38 the output channels have RZ data selected while the STROBE output shows NRZ data as always. The Normal/Complement state of the outputs is not shown on the PATTERN screen.
**Update Parameter**

The pattern data at the outputs are updated continuously as you edit the data on the screen.

**No Upd (Upd Once)**

The pattern data at the outputs are not updated automatically from the screen. You can therefore modify the data patterns on the screen without affecting the pattern which is currently being generated at the Outputs.

Press \texttt{ENTER} to update the pattern once.

**Addr Parameter**

Adjust the address of the bit-editing window to scroll through the data. Figure 3-37 shows the bit-editing window located at the third bit in the pattern.

**Last Parameter**

Adjust the last bit number to set the length of the pattern in the range 2 to 4096.

**Bit-Editing Window**

Move the parameter cursor into the bit-editing window to edit individual data bits.

![Figure 3-39. PATTERN screen, Bit-editing window](image)

While the parameter cursor is in the bit-edit window you can use the knob to scroll through the data.
**OUTPUTS** (CH1 CH2)

Use the DATA ENTRY keys to edit the data bit at the cursor:

- **0** Set bit to 0, and move the bit-editing window to the next bit.
- **1** Set bit to 1, and move the bit-editing window to the next bit.
- **+/−** Toggle bit without moving the bit-editing window.
- **Q** Toggle the data format between RZ and NRZ. Note that the change is only visible in graphics mode.

You can edit both output channels together in the BOTH pattern. This makes it easy to enter data for 3 or 4-level codes.

---

**Figure 3-40.**

**PATTERN screen, Bit-editing window BOTH**

<table>
<thead>
<tr>
<th>BOTH</th>
<th>DATA ENTRY</th>
<th>CH2</th>
<th>CH1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
**STROBE OUT** *(STRB)*

Use the DATA ENTRY keys to edit the data bit at the cursor:

- **0** Set bit to 0, and move the bit-editing window to the next bit.
- **1** Set bit to 1, and move the bit-editing window to the next bit.
- **+/−** Toggle bit without moving the bit-editing window.

**CH1 CH2 BOTH STRB**  

**Block Editing Functions**

Move the parameter cursor onto the pattern names at the left hand side of the screen to use the block editing functions.

![Block Editing Functions](image.png)

**Figure 3-41. PATTERN screen, Block editing functions**

Select the function using the MODIFY knob. Press ENTER to carry out the edit.

---

**Note**

Most of the block editing functions apply from (or at) the current Addr of the bit-editing window to the Last bit in the pattern.

The data memory is 4096 bits long. Bits beyond the Last bit are not affected by the editing functions except when you insert or delete bits.
Fill 0
Set all bits from Addr to Last inclusive to 0.

Fill 1
Set all bits from Addr to Last inclusive to 1.

Invert
Invert all bits from Addr to Last inclusive.

First Bit
Set the first bit to 1, and bits 2 to Last to 0.

Last Bit
Set the last bit to 1, and all preceding bits to 0.

Ins Bit
Insert a bit at Addr. The bit value is copied from the current bit at Addr, and bits Addr to 4095 are shifted right. Bit 4096 is lost.

Note
The Last parameter is not automatically incremented, so the length of the generated pattern is not increased unless you adjust the Last parameter yourself.

Del Bit
Delete the bit at Addr. Bits (Addr + 1) to 4096 are shifted left and bit 4096 is copied.

Note
The Last parameter is not automatically decremented, so the length of the generated pattern is not decreased unless you adjust the Last parameter yourself.
Clock ÷ N

Fill bits Addr to Last with a divided clock pattern. After pressing \textbf{(ENTER)} you can adjust the dividing factor (≥2) and press \textbf{(ENTER)} again to implement.

Note that the output signal is only a squarewave if you are using NRZ data. You can see this best in graphics mode:

<table>
<thead>
<tr>
<th>UPDATE</th>
<th>Addr 1</th>
<th>Last 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOTH</td>
<td>0000</td>
<td>0000</td>
</tr>
<tr>
<td>STRB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textbf{Figure 3-42. PATTERN Clock ÷4, CH1 = RZ, CH2 = NRZ}

PRBS 2^n-1

Fill bits Addr to Last with a 2^n-1 Pseudo-random Binary Sequence. After pressing \textbf{(ENTER)} you can adjust n in the range 7 to 12 and press \textbf{(ENTER)} again to implement.

\section*{Some Hints on Editing Pattern Data}

The block editing functions, apart from Insert and Delete, do not affect data bits beyond the current Last bit. Therefore you can use the Addr and Last parameters to define the block of bits you want to edit.

Remember, however, that the Last parameter also defines the length of the pattern generated at the outputs.
Example

You are currently generating a 48 bit pattern on OUTPUT 1 and now want to fill bits 10 to 20 with data value 1. On the PATTERN screen:

1. If necessary, move the cursor to UPDATE and select Udp Once to prevent the data edits from affecting the pattern currently being generated at the OUTPUT.

   If NO UPD is already shown, or it isn't important if the pattern is disturbed during the editing you can ignore this step.

2. Adjust Addr to 10.

3. Adjust Last to 20

   If UPDATE is still active, the pattern at the OUTPUT will now be automatically reduced to 20 bits in length.

4. Move the cursor to CH1 to access the block editing functions for OUTPUT 1.

5. Use the MODIFY knob to select Fill 1 from the list of functions.

6. Press [ENTER] to fill bits 10 to 20 with data value 1.

   If UPDATE is still active, the pattern at the OUTPUT will now change automatically.

7. Adjust Last back to 48 to return the pattern length to 48.

   If UPDATE is still active, the pattern at the OUTPUT will now return to 48 bits in length.

8. If necessary, move the cursor to NO UPD and press [ENTER] to update the pattern being generated at the OUTPUT (or select Udp Cont.)
LIMITS screen

<table>
<thead>
<tr>
<th>LIMITS OFF</th>
<th>Limits OFF</th>
<th>MODIFY</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-U +500 mV</td>
<td>High-U +500 mV</td>
<td>*OFF</td>
</tr>
<tr>
<td>Low-U -500 mV</td>
<td>Low-U -500 mV</td>
<td>ON</td>
</tr>
<tr>
<td>High-A +10.0 mA</td>
<td>High-A +10.0 mA</td>
<td></td>
</tr>
<tr>
<td>Low-A -10.0 mA</td>
<td>Low-A -10.0 mA</td>
<td></td>
</tr>
</tbody>
</table>

| LIMITS | TRG-LEV | MEMCARD | CONFIG |

Figure 3-43. LIMITS screen

Use the LIMITS screen to set up voltage and current limits for the pulse level parameters to prevent accidental damage of the device under test.

After you switch on the limits, the pulse level parameters on the LEVELS/OUTPUT screens cannot be adjusted outside the ranges on the LIMITS page if the OUTPUT is switched on. Note that because current and voltage limits apply, the available ranges of the impedance parameters are also affected.

When output limits are on, the limits are indicated on the LEVELS/OUTPUT pages in graphics mode and the level bar is scaled accordingly:

Figure 3-44. Level graphics with Limits ON on OUTPUT 1
Figure 3.45. TRG-LEV screen

Use the TRG-LEV screen to:

- Set the triggering threshold and input impedance for the EXT INPUT connector.
- Set the triggering threshold and input impedance for the HP 81106A CLK IN connector, if fitted.
- Set the output levels for the STROBE OUT and TRIGGER OUT connectors.

**EXT-IN Parameter**

Move the cursor onto EXT-IN to quickly set the triggering threshold of the EXT INPUT to a TTL or ECL compatible level.

**Set TTL**

Set the EXT INPUT threshold to +2.5V.

You can adjust the threshold by moving the cursor onto the value.

**Set ECL**

Set the EXT INPUT threshold to −1.3V.

You can adjust the threshold by moving the cursor onto the value.

**Voltage**

Set any threshold level in the range -10.0 V to +10.0 V.
Move the cursor onto the value to adjust it.
50Ω 10kΩ EXT INPUT Impedance Parameter

Toggle the input impedance of the EXT INPUT connector between 50Ω and 10 kΩ.

CLK-IN Parameter

Note

The CLK-IN parameters are only available if you have the HP 81106A PLL/External Clock module installed.

Move the cursor onto CLK-IN to quickly set the triggering threshold of the CLK IN to a TTL or ECL compatible level.

Set TTL

Set the CLK IN threshold to +2.5V.

You can adjust the threshold by moving the cursor onto the value.

Set ECL

Set the CLK IN threshold to -1.3V.

You can adjust the threshold by moving the cursor onto the value.

Voltage

Set any threshold level in the range -10.0 V to +10.0 V. Move the cursor onto the value to adjust it.

50Ω 10kΩ CLK IN Impedance Parameter

Note

The CLK-IN parameters are only available if you have the HP 81106A PLL/External Clock module installed.

Toggle the input impedance of the EXT INPUT connector between 50Ω and 10 kΩ.
TRG-LEV

TRIGGER-OUT TRIGGER OUT Level Parameter
Set the output levels into 50Ω for the TRIGGER OUT connector.

TTL

<table>
<thead>
<tr>
<th>High-level</th>
<th>+2.50 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-level</td>
<td>0 V</td>
</tr>
</tbody>
</table>

ECL

<table>
<thead>
<tr>
<th>High-level</th>
<th>-0.8 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-level</td>
<td>-1.8 V</td>
</tr>
</tbody>
</table>

STROBE-OUT STROBE OUT Level Parameter
Set the output levels into 50Ω for the STROBE OUT connector.

TTL

<table>
<thead>
<tr>
<th>High-level</th>
<th>+2.50 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-level</td>
<td>0 V</td>
</tr>
</tbody>
</table>

ECL

<table>
<thead>
<tr>
<th>High-level</th>
<th>-0.8 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-level</td>
<td>-1.8 V</td>
</tr>
</tbody>
</table>
Figure 3-46. MEMCARD screen, No card present.

Use the MEMCARD screen to:

- Store instrument settings to the memory-card.
- Recall instrument settings from the memory-card.
- Delete files from the memory-card.
- Format a memory card.

Note that the HP 8110A uses DOS formatted memory-cards and you cannot create or delete directories using the HP 8110A.

Dir Path Current Directory Parameter

Move the cursor onto Dir Path to change directory on the memory-card or to view the subdirectories in the current directory (The current directory name is displayed next to Dir Path).

All the sub-directories in the current directory are listed in the MODIFY window.

Figure 3-47. MEMCARD screen, Dir Path Example
To change directory

1. Use the MODIFY knob to select the directory name from the list of files and directories in the MODIFY window.

2. Press [ENTER].

![Figure 3-48. MEMCARD screen, Subdirectory Example](image)

Note that when you are in a sub-directory you can return to the parent-directory by selecting .. from the directory list in the MODIFY window.

Filename Parameter

Move the cursor onto the Filename parameter to view and select a file from the current directory. Use the MODIFY knob to scroll through the filenames listed in the MODIFY window.

![Figure 3-49. MEMCARD screen, Filename Example](image)
Perform Operation Memory Card Operations

Move the cursor onto Perform Operation and use the knob to select the operation:

ReadCard
Read the DOS file-system information from the memory-card after inserting a new card. Press ENTER to carry out the operation.

Recall
Recall the selected file as the current-instrument setting. Press ENTER to carry out the operation.

Store
Store the current instrument-setting to the memory-card.

![Figure 3-50. MENCARD screen, Store Operation](image)

Press ENTER once to start editing the filename for the setting in the MODIFY window. The currently selected filename is used as default.

If you do not modify the filename, the existing file will be overwritten when you press ENTER.

Press SHIFT ENTER to CANCEL the store operation at any time.
To modify the filename

1. Move the character cursor with the CURSOR keys.
   The filename can be up to 8 characters long.

2. Modify a character using the knob.

3. When you have finished, press \texttt{ENTER} to store the setting.

Note that the DOS filename suffix \texttt{.ST0} is added automatically to the filename when you store the current settings.

\texttt{Store All}

Store the current instrument-setting and the instrument-setting memories 1 to 9 to the memory-card. Each setting is stored in a separate file with the same name but different suffixes:

\begin{table}[h]
\centering
\begin{tabular}{|l|l|}
\hline
\textbf{Setting} & \textbf{Filename Suffix} \\
\hline
Current Setting & \texttt{.ST0} \\
Memory 1 & \texttt{.ST1} \\
Memory 2 & \texttt{.ST2} \\
\cdot & \cdot \\
\cdot & \cdot \\
Memory 9 & \texttt{.ST9} \\
\hline
\end{tabular}
\caption{Filename suffixes}
\end{table}

Press \texttt{ENTER} once to start editing the filename for the setting in the MODIFY window. The currently selected filename is used as default.

\textbf{Caution}

If you do not modify the filename, the existing file will be overwritten when you press \texttt{ENTER}.

Press \texttt{SHIFT ENTER} to CANCEL the store operation at any time.
To modify the filename

1. Move the character cursor with the CURSOR keys.
   The filename can be up to 8 characters long.

2. Modify a character using the knob.

3. When you have finished, press \textbf{ENTER} to store the setting.

Note that the DOS filename suffixes $\text{ST}x$ are added automatically to the filenames when you store the settings.

Delete

Delete the selected file from the memory-card. Press \textbf{ENTER} to carry out the operation.

\textbf{Caution}

Formatting a memory-card destroys any existing files on the card.

Format the memory-card. Press \textbf{ENTER} to carry out the operation.
Use the CONFIG screen to:

- Set the HP-IB address of the HP 8110A.
- Perform a selftest.
- Group the pulse parameters by TIMING/LEVELS or OUTPUT 1/OUTPUT 2 on a two channel instrument.
- Select the frequency reference source and frequency for the PLL if you have the HP 81106A PLL module fitted.
- Set the deskey delays for OUTPUTS 1 and 2 if you have the HP 81107A Multichannel Deskew module fitted.

**HP-IB Address**

Set the HP 8110A HP-IB address in the range 0 to 30.

**Perform Selftest**

Perform a selftest by pressing ENTER. You can choose between testing the microprocessor board (µP Board) and the pulse signal generating boards (Signal).

If the selftest fails, a flashing E is displayed. Press HELP to see the list of error messages.
This option is only available if you have two Output modules fitted to your HP 8110A mainframe.

Configure the grouping of the pulse-parameters on the user interface:

**TIMING/LEVELS**

The pulse-timing parameters for OUTPUTS 1 and 2 are grouped together on the **TIMING** parameter screen.
The pulse-level parameters for OUTPUTS 1 and 2 are grouped together on the **LEVELS** parameter screen.

**OUTPUT 1/2**

All timing and level parameters for OUTPUT 1 are grouped together on the **OUTPUT 1** parameter screen.
All timing and level parameters for OUTPUTS 2 are grouped together on the **OUTPUT 2** parameter screen.
PLL-Ref

This parameter is only available if you have the HP 81106A PLL/External Clock module fitted.

Set the frequency reference source for the PLL:

**Internal**
The internal 5 MHz reference.

**CLK-IN**
An external reference signal at the CLK IN (PLL REF) connector. You can set the expected frequency of the external reference to 5 MHz or 10 MHz:

![Config screen, External PLL Reference frequency](image)

**Note**
The deskew parameters are only available if you have the HP 81107A Multichannel Deskew module fitted.

Set the deskew delays for OUTPUTS 1 and 2. The deskew delays are independent of the standard pulse-delay parameters and provide additional delay range for deskewing in multichannel applications or to compensate for systematic cable delays in the test set-up.
Warnings and Errors

The HP 8110A has two levels of error reporting called warnings and errors. On a single channel instrument, or a two channel instrument with outputs added at Output 1, error and warning checking is always enabled unless you switch it off via the HP-IB using the :SYSTem:CHECK command.

---

Note

On a two channel instrument with Separate Outputs, error and warning checking is automatically disabled for a channel which is switched off. This allows you to ignore the settings of a channel you are not using. You can also switch off error and warning checking via the HP-IB.

---

<table>
<thead>
<tr>
<th>Probably invalid</th>
<th>Probably valid</th>
<th>Maximum programmable range of selected parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERROR</td>
<td>WARNING</td>
<td>--ALL signal parameters in specification--</td>
</tr>
<tr>
<td>Setting not</td>
<td></td>
<td>Setting implemented in hardware</td>
</tr>
<tr>
<td>implemented</td>
<td></td>
<td>Setting not implemented</td>
</tr>
</tbody>
</table>

---

Warnings

A warning is generated when the output signal could be invalid due to a combination of worst case uncertainties at the current settings of all relevant parameters. For example, when adjusting the pulse width, the leading edge, trailing edge, and pulse period settings and their uncertainties have to be considered in order to check if the width setting will fit within the pulse period. Refer to “An Example of Warning and Error Reporting”. Note that the warning limits are therefore not fixed for a particular parameter, but vary with the settings of the related parameters. It is also possible that the error and warning limits are the same, that is, a warning does not occur before the error limit is reached.

If a warning occurs, the settings are still implemented in the hardware since the worst case conditions used to
Warnings and Errors

evaluate the warning limits are very unlikely to occur in practice.
A blinking * indicates that one or more warnings have occurred. Press [HELP] to view the warning list. Multiple warnings can exist together.

Errors

An error is generated when an invalid mode is chosen, or the required parameter settings cannot be implemented in the output hardware. Multiple errors can occur, but only the first error detected is displayed.

An error is indicated by a blinking error message at the bottom of the screen.

Note

If you are using the knob to adjust parameters it is normally not possible to generate warnings or errors. All parameters are automatically limited to settings which guarantee specified operation.

If you do want to use the knob to adjust a parameter beyond its warning limits:
1. Adjust to the limit with the knob
2. Press [SHIFT] and adjust beyond the limit with the knob.

AUTOSET

You can press [SHIFT][HELP] to carry out an AUTOSET. The instrument resets all parameters, based on the current period setting, to remove all warning and error conditions.

An Example of Warning and Error Reporting

1. Switch on instrument and RECALL standard settings with [SHIFT][STORE]. The period is now set to 1 µs.
2. Switch on OUTPUT 1 with [SHIFT][0].
3. On the TIMING or OUTPUT 1 screen, move the parameter cursor onto the value of the Width parameter (100ns).
4. Use the knob to make the Width as large as possible (approximately 940 ns).

This limit is intended to guarantee that the actual output pulse is within specifications, for the actual period.

The limit is calculated taking into account a worst case combination of minimum period from the period setting (1 μs) and maximum width from the width setting (940 ns) together with leading and trailing edge settings (2.00 ns).

Note that if you now try and adjust the Leading Edge from its current setting of 2.00 ns with the knob, it cannot be adjusted. This is because the upper and lower warning limits are currently 2.00 ns. The width is at its maximum value and width + leading edge + trailing edge ≤ period.

5. Press [SHIFT] and adjust the Width above its warning limit. A flashing W appears to indicate that a warning condition has occurred.

Note that as long as no errors occur, the output hardware is set up and attempts to generate the required output.

6. Press [HELP] to see the warning message:

   Trailing edge 1 may cut next pulse

7. Press [HELP] again to return to the Width parameter.

8. Increase the Width further to approximately 980 ns and press [HELP] to see the current warnings:

   Width 1 too close to period
   Trailing edge 1 may cut next pulse


10. Increase the Width further until a flashing error message appears (approximately 1.10 μs):

    OUTPUT 1: Width > Period
You have reached the current upper error-limit of the Width parameter. The setting is not implemented in the output hardware.

11. Press \texttt{SHIFT HELP} to carry out an AUTOSET.
## HP 8110A Programming Reference

Common Command Summary IEEE 488.2

### Table 4-1.
**HP 8110A IEEE 488.2 Common Command Summary**

<table>
<thead>
<tr>
<th>Command</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>*CLS</td>
<td>—</td>
<td>Clear the status structure</td>
</tr>
<tr>
<td>*ESE</td>
<td>&lt;0-255&gt;</td>
<td>Set the Event Status Register Mask</td>
</tr>
<tr>
<td>*ESR?</td>
<td>—</td>
<td>Read the Event Status Register</td>
</tr>
<tr>
<td>*IDN?</td>
<td>—</td>
<td>Read the instrument's Identification string</td>
</tr>
<tr>
<td>*LIN?</td>
<td>—</td>
<td>Read the complete Instrument Setting</td>
</tr>
<tr>
<td>*OPC</td>
<td>—</td>
<td>Set the Operation Complete bit when all pending actions are complete</td>
</tr>
<tr>
<td>*OPT?</td>
<td>—</td>
<td>Read the installed options</td>
</tr>
<tr>
<td>*RCL</td>
<td>&lt;0-9&gt;</td>
<td>Recall a complete Instrument Setting from memory</td>
</tr>
<tr>
<td>*RST†</td>
<td>—</td>
<td>Reset the instrument to standard settings</td>
</tr>
<tr>
<td>*SAY</td>
<td>&lt;1-9&gt;</td>
<td>Save the complete Instrument Setting to memory</td>
</tr>
<tr>
<td>*SER</td>
<td>&lt;0-255&gt;</td>
<td>Set the Service Request Enable Mask</td>
</tr>
<tr>
<td>*SMB?</td>
<td>—</td>
<td>Read the Status Byte</td>
</tr>
<tr>
<td>*TRG</td>
<td>—</td>
<td>Trigger</td>
</tr>
<tr>
<td>*TST?</td>
<td>—</td>
<td>Execute instrument's self-test</td>
</tr>
<tr>
<td>*WAI</td>
<td>—</td>
<td>Wait until all pending actions are complete</td>
</tr>
</tbody>
</table>

1 See the default settings in Table 4-13, at the end of this section.
### Table 4-2. HP 8110A SCPI Command Summary

<table>
<thead>
<tr>
<th>Command</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[:ARM]</td>
<td></td>
<td>(Trigger mode and source)</td>
</tr>
<tr>
<td>[:SEQuence [1]]:STARt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:LAyer [1]]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:EWIDTH]</td>
<td>&lt;value&gt;</td>
<td>Set/read External Width mode</td>
</tr>
<tr>
<td>[:FREquency]</td>
<td>&lt;value&gt;</td>
<td>Set/read trigger frequency, when PLL (INT2) used as source</td>
</tr>
<tr>
<td>[:IMPedance]</td>
<td>&lt;value&gt;</td>
<td>Set/read impedance at EXT INPUT(^1)</td>
</tr>
<tr>
<td>[:LEVel]</td>
<td>&lt;value&gt;</td>
<td>Set/read threshold level at EXT INPUT</td>
</tr>
<tr>
<td>[:PERiod]</td>
<td>&lt;value&gt;</td>
<td>Set/read trigger period, when PLL (INT2) used as source</td>
</tr>
<tr>
<td>[:SENSe]</td>
<td>EDGE[LEVEL]</td>
<td>Set/read trigger on edge or gate on level</td>
</tr>
<tr>
<td>[:SLOPe]</td>
<td>POS[NEG][ETH]</td>
<td>Set/read trigger slope at EXT INPUT</td>
</tr>
<tr>
<td>[:SOURCe]</td>
<td>IMM[INT2][EXT][MAN]</td>
<td>Set/read trigger source (VFO[PLL][EXT INPUT][MAN key])</td>
</tr>
<tr>
<td>[:CHANnel]</td>
<td>OFF[PLUS]</td>
<td>Set/read addition of channels 1 &amp; 2 at Output 1</td>
</tr>
<tr>
<td>[:MATH]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:DIgital]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:STIMulus]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:PATTERN]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:DATA[1][2][3]]</td>
<td>[.start] [.data]</td>
<td>Set/read pattern data [from Bit .start]</td>
</tr>
<tr>
<td>[:PRBS[1][2][3]]</td>
<td>.n .length</td>
<td>Set PRBS 2(^n) data</td>
</tr>
<tr>
<td>[:PRESet[1][2][3]]</td>
<td>.n .length</td>
<td>Set preset pattern with frequency CLOCK(÷)n</td>
</tr>
<tr>
<td>[:STATE]</td>
<td>OFF[ON][1]</td>
<td>Switch PATTERN pulse-mode on or off</td>
</tr>
<tr>
<td>[:UPDATE]</td>
<td>OFF[ON][ONCE]</td>
<td>Update the hardware with pattern data</td>
</tr>
<tr>
<td>[:SIGNal[1][2]]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:DIRMat]</td>
<td>.Z[,N]</td>
<td>Set/read data format of Output channel</td>
</tr>
</tbody>
</table>

\(^1\) Value will be rounded to 50 Ω or 1 kΩ

---

4-2  HP 8110A Programming Reference
### Table 4-2.
HP 8110A SCPI Command Summary (continued)

<table>
<thead>
<tr>
<th>Command</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>:MMEMory</td>
<td>[A:]</td>
<td>Read directory of memory card</td>
</tr>
<tr>
<td>:CDIRectory</td>
<td>[&lt;name&gt;]</td>
<td>Change directory on memory card</td>
</tr>
<tr>
<td>:COPY</td>
<td>&lt;source&gt;,[A:],&lt;dest&gt;[A:]</td>
<td>Copy a file on memory card</td>
</tr>
<tr>
<td>:DELETE</td>
<td>&lt;name&gt;[A:]</td>
<td>Delete a file from memory card</td>
</tr>
<tr>
<td>:INITialize</td>
<td>[A:],[DOS]</td>
<td>Initialize memory card to DOS format</td>
</tr>
<tr>
<td>:LOAD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>:STATE</td>
<td>&lt;n&gt;,&lt;name&gt;</td>
<td>Load file from memory card to memory n</td>
</tr>
<tr>
<td>:STORE</td>
<td>&lt;n&gt;,&lt;name&gt;</td>
<td>Store memory n to memory card</td>
</tr>
<tr>
<td>:OUTPut[1/2]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:STATE]</td>
<td>ON[OFF]10</td>
<td>Set/read channel output state</td>
</tr>
<tr>
<td>:IMPedance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:INTERNAL]</td>
<td>&lt;value&gt;</td>
<td>Set/read internal source impedance of output</td>
</tr>
<tr>
<td>:EXTERNAL</td>
<td>&lt;value&gt;</td>
<td>Set/read expected external load impedance at output</td>
</tr>
<tr>
<td>:POLarity</td>
<td>NORM(INV)</td>
<td>Set/read output polarity</td>
</tr>
<tr>
<td>[:SOURce]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>:CORRection[1/2]</td>
<td></td>
<td>(Only if HP 81107A Deskew fitted)</td>
</tr>
<tr>
<td>:EDELay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:TIME]</td>
<td>&lt;value&gt;</td>
<td>Set/read channel deskew</td>
</tr>
<tr>
<td>:CURRENT[1/2]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:LEVEL]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:IMMediate]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:AMPLitude]</td>
<td>&lt;value&gt;</td>
<td>Set/read channel amplitude current</td>
</tr>
<tr>
<td>:OFFSet</td>
<td>&lt;value&gt;</td>
<td>Set/read channel offset current</td>
</tr>
<tr>
<td>:HIGH</td>
<td>&lt;value&gt;</td>
<td>Set/read channel high-level current</td>
</tr>
<tr>
<td>:LOW</td>
<td>&lt;value&gt;</td>
<td>Set/read channel low-level current</td>
</tr>
<tr>
<td>:LDMIt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:HIGH]</td>
<td></td>
<td>Set/read maximum current limit</td>
</tr>
<tr>
<td>:LOW</td>
<td></td>
<td>Set/read minimum current limit</td>
</tr>
<tr>
<td>:STATE</td>
<td>ON[OFF]10</td>
<td>Enable/Disable the current limits.</td>
</tr>
<tr>
<td>:FREQuency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:CW:FIXed]</td>
<td>&lt;value&gt;</td>
<td>Set/read frequency of pulses</td>
</tr>
<tr>
<td>:AUTO</td>
<td>ONCE</td>
<td>Measure frequency at CLK IN</td>
</tr>
<tr>
<td>:HOLD[1/2]</td>
<td>VOLT</td>
<td>CURR</td>
</tr>
</tbody>
</table>

1 The CURRENT and VOLTage subsystems cannot be used at the same time. Use the :HOLD command to select between them.
### HP 8110A SCPI Command Summary (continued)

<table>
<thead>
<tr>
<th>Command</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[:SOURCE]</td>
<td></td>
<td>(Continued from previous page)</td>
</tr>
<tr>
<td>:PHASE[1][2]</td>
<td>&lt;value&gt;</td>
<td>Set/read channel phase</td>
</tr>
<tr>
<td>:ADJus[1][2]</td>
<td>&lt;value&gt;</td>
<td>Set/read channel phase</td>
</tr>
<tr>
<td>:PULse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>:DCYcle[1][2]</td>
<td>&lt;value&gt;</td>
<td>Set/read channel duty cycle</td>
</tr>
<tr>
<td>:DELay[1][2]</td>
<td>&lt;value&gt;</td>
<td>Set/read channel delay (to leading edge)</td>
</tr>
<tr>
<td>:HOLD</td>
<td>TIME</td>
<td>FRATio</td>
</tr>
<tr>
<td>:UNIT</td>
<td>SEC</td>
<td>PCT</td>
</tr>
<tr>
<td>:DoubLe[1][2]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>:STATe</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>:DELay</td>
<td>&lt;value&gt;</td>
<td>Set/read delay between double pulses</td>
</tr>
<tr>
<td>:HOLD</td>
<td>TIME</td>
<td>FRATio</td>
</tr>
<tr>
<td>:UNIT</td>
<td>SEC</td>
<td>PCT</td>
</tr>
<tr>
<td>:HOLD[1][2]</td>
<td>WIDTH</td>
<td>DCYcle</td>
</tr>
<tr>
<td>:PERiod</td>
<td>&lt;value&gt;</td>
<td>Set/read pulse-period</td>
</tr>
<tr>
<td>:AUTO</td>
<td>ONCE</td>
<td>Measure pulse-period at CLK IN</td>
</tr>
<tr>
<td>:TrailingDELay[1][2]</td>
<td>&lt;value&gt;</td>
<td>Set/read trailing edge delay</td>
</tr>
<tr>
<td>:TRANSition[1][2]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>:HOLD</td>
<td>TIME</td>
<td>WRATio</td>
</tr>
<tr>
<td>:UNIT</td>
<td>SEC</td>
<td>PCT</td>
</tr>
<tr>
<td>:LEADing</td>
<td>&lt;value&gt;</td>
<td>Set/read leading-edge transition</td>
</tr>
<tr>
<td>:TRailing</td>
<td>&lt;value&gt;</td>
<td>Set/read trailing-edge transition</td>
</tr>
<tr>
<td>:AUTO</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>:TRiger[1][2]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>:VOLTage</td>
<td>TTL</td>
<td>ECL</td>
</tr>
<tr>
<td>:WIDTH[1][2]</td>
<td>&lt;value&gt;</td>
<td>Set/read channel pulse-width</td>
</tr>
</tbody>
</table>
### Table 4-2. HP 8110A SCPI Command Summary (continued)

<table>
<thead>
<tr>
<th>Command</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[:SOURce]</td>
<td>INternal/EXternal</td>
<td>(Continued from previous page)</td>
</tr>
<tr>
<td>:ROScillator</td>
<td></td>
<td>Set/read PLL reference source</td>
</tr>
<tr>
<td>:SOURce</td>
<td></td>
<td>Set/read PLL reference source</td>
</tr>
<tr>
<td>:EXternal</td>
<td></td>
<td>Set/read frequency of external PLL reference</td>
</tr>
<tr>
<td>:FREQuency</td>
<td>&lt;value&gt;</td>
<td>Set/read frequency of external PLL reference</td>
</tr>
<tr>
<td>:VOLtag(e)[1][2]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:LEVEL]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:IMMediate]</td>
<td>&lt;value&gt;</td>
<td>Set/read channel amplitude voltage</td>
</tr>
<tr>
<td>[:AMPlitude]</td>
<td>&lt;value&gt;</td>
<td>Set/read channel offset voltage</td>
</tr>
<tr>
<td>:OFFSet</td>
<td>&lt;value&gt;</td>
<td>Set/read channel high-level voltage</td>
</tr>
<tr>
<td>:HIGH</td>
<td>&lt;value&gt;</td>
<td>Set/read channel low-level voltage</td>
</tr>
<tr>
<td>:LOW</td>
<td>&lt;value&gt;</td>
<td></td>
</tr>
<tr>
<td>:LIMit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[:HIGH]</td>
<td></td>
<td>Set/read maximum voltage limit</td>
</tr>
<tr>
<td>:LOW</td>
<td></td>
<td>Set/read minimum voltage limit</td>
</tr>
<tr>
<td>:STATe</td>
<td>ON[OFF]1[0]</td>
<td>Enable/Disable the voltage limits</td>
</tr>
</tbody>
</table>

**Note:** Value will be rounded to 5 MHz or 10 MHz.
### Table 4.2.
#### HP 8110A SCPI Command Summary (continued)

<table>
<thead>
<tr>
<th>Command</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>:SYSTem</td>
<td>:CHECK [:ALL]</td>
<td>ON</td>
</tr>
<tr>
<td>:STATe</td>
<td>ERRor?</td>
<td>Numeric</td>
</tr>
<tr>
<td>:KEY</td>
<td>SECURITY</td>
<td>Block data</td>
</tr>
<tr>
<td>:PRESet</td>
<td>:STATE</td>
<td>ON</td>
</tr>
<tr>
<td>:SECURITY</td>
<td>:STATE</td>
<td>Block data</td>
</tr>
<tr>
<td>:SET</td>
<td>:STATE</td>
<td>Block data</td>
</tr>
<tr>
<td>:VERSion?</td>
<td>WARNING</td>
<td>Read SCPI compliance version</td>
</tr>
<tr>
<td>:COUNT?</td>
<td>:STRING?</td>
<td>Read number of active warnings</td>
</tr>
<tr>
<td>:BUFFer?</td>
<td>:STATE</td>
<td>Read active warnings as concatenated string</td>
</tr>
<tr>
<td>:TRIGger [:SEQUence] [:START]</td>
<td></td>
<td>Read maximum possible length of concatenated string</td>
</tr>
<tr>
<td></td>
<td>:COUNT</td>
<td>&lt;value&gt;</td>
</tr>
<tr>
<td></td>
<td>:IMPedance</td>
<td>&lt;value&gt;</td>
</tr>
<tr>
<td></td>
<td>:LEVEL</td>
<td>&lt;value&gt;</td>
</tr>
<tr>
<td></td>
<td>:SLOPe</td>
<td>POS</td>
</tr>
<tr>
<td></td>
<td>:SOURCE</td>
<td>IMM</td>
</tr>
</tbody>
</table>

1 BURST or PATTERN length
2 Value will be rounded to 50 Ω or 1kΩ
1. Condition: PLL as period source, period >999 ms
   Anomaly: When period source is switched from PLL to internal oscillator, the frequency is not reset on the display but the frequency changes to 1 Hz. No error signal or warning is generated.
   Solution: Set the required frequency before or after switching away from the PLL.

2. Condition: Channel 1 off, Channel 2 on, amplitude = max
   Anomaly: Channel 2 amplitude display can be set above max, e.g.:
   >10.2 Vpp (50 Ω into 50 Ω)
   >19.4 Vpp (1 kΩ into 50 Ω)
   Solution: Switch Channel 1 on, Channel 2 then operates correctly and it is no longer feasible to set excessive voltages in the display.

3. Condition: Remote control, external clock
   Anomaly: Conflict between measurement of ext frequency and HP-IB process.
   Solution: Select “measure once” mode. The command sequence is:
   ":SOUR:FREQ:AUTO ONCE"  !This stops continuous measurement
   ":DIG:PATT ON"            !Selects mode, in this case, pattern mode
   ":TRIG:SOUR EXT2"          !Selects external clock as period source
   ":ARM:SOUR IMM"           !Selects continuous operation
SCPI Command Summary

"SOUR:FREQ:AUTO ONCE"  This command initiates a single measurement. It should therefore be repeated whenever it is necessary to measure the ext frequency.

4. Condition: Programming trailing delay via HP-IB

Anomaly: No reaction to the command
"SOUR:PULS:TDEL <value>"

Solution: First send the command
"SOUR:PULS:HOLD TDEL"
The HP 8110A has a status reporting system conforming to IEEE 488.2 and SCPI. Figure 4-1 shows the status groups available in the HP 8110A. Each status group is made up of component registers, as shown in Figure 4-2.
Status Model

Figure 4-2. Component registers in a Status Group

Condition Register

A condition register contains the current status of the hardware and firmware. It is continuously updated and is not latched or buffered. You can only read condition registers. If there is no command to read the condition register of a particular status group, then it is simply invisible to you.

Transition Filters

Transition filters are used to detect changes of state in the condition register and set the corresponding bit in the event register. You can set transition filter bits to detect positive transitions (PTR), negative transitions (NTR) or both. Transition filters are therefore read-write registers. They are unaffected by *CLS.

Event Register

An event register latches transition events from the condition register as specified by the transition filters or records status events. Querying (reading) the event register clears it, as does the *CLS command. There is no buffering, so while a bit is set, subsequent transition events are not recorded. Event registers are read-only.

Enable register

The enable register defines which bits in an event register are included in the logical OR into the summary bit. The enable register is logically ANDed with the event register and the resulting bits ORed into the summary bit. Enable
registers are read-write, and are not affected by *CLS or querying.

Although all status groups have all of these registers, not all status groups actually use all of the registers. Table 4-3 summarizes the registers used in the HP 8110A status groups.

<table>
<thead>
<tr>
<th>Status Group</th>
<th>Registers in Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CONDITION  NTR  PTR  EVENT  ENABLE</td>
</tr>
<tr>
<td>QUESTIONable</td>
<td>✓            ✓    ✓    ✓    ✓</td>
</tr>
<tr>
<td>OPERATION†</td>
<td>×            ×    ×    ×    ×</td>
</tr>
<tr>
<td>Standard Event Status</td>
<td>×            ×    ×    ✓    ✓</td>
</tr>
<tr>
<td>Status Byte</td>
<td>×            ×    ×    ✓    ✓</td>
</tr>
</tbody>
</table>

1 Present, but not used. COND and EVENT always 0.
2 Use *ESR? to query.
3 Use *ESE to set, *ESE? to query
4 Use *STE? to query
5 Use *SRE to set, *SRE? to query

**Status Byte**
The status byte summarizes the information from all other status groups. The summary bit for the status byte actually appears in bit 6 (RQS) of the status byte. When RQS is set it generates an SRQ interrupt to the controller indicating that at least one instrument on the bus requires attention. You can read the status byte using a serial poll or *STB?.
### Status Model

#### Table 4-4. Status Byte bits

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>1</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>2</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>3</td>
<td>QUESTIONable Status Summary Bit</td>
</tr>
<tr>
<td>4</td>
<td>MAV - Message Available in output buffer</td>
</tr>
<tr>
<td>5</td>
<td>Standard Event Status summary bit</td>
</tr>
<tr>
<td>6</td>
<td>RQS - ReQuest Service</td>
</tr>
<tr>
<td>7</td>
<td>OPERation Status summary Bit, unused</td>
</tr>
</tbody>
</table>

#### Standard Event Status Group

#### Table 4-5. Standard Event Status Group bits

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Operation Complete, set by *OPC</td>
</tr>
<tr>
<td>1</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>2</td>
<td>Query Error</td>
</tr>
<tr>
<td>3</td>
<td>Device Dependant Error</td>
</tr>
<tr>
<td>4</td>
<td>Execution Error</td>
</tr>
<tr>
<td>5</td>
<td>Command Error</td>
</tr>
<tr>
<td>6</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>7</td>
<td>Power On</td>
</tr>
</tbody>
</table>
## OPERation Status Group

This Status Group is not used in the HP 8110A.

### Table 4-6. OPERation Status Group bits

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>1</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>2</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>3</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>4</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>5</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>6</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>7</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>8</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>9</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>10</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>11</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>12</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>13</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>14</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>15</td>
<td>Always 0</td>
</tr>
</tbody>
</table>
Programming Trigger Modes

QUESTionable Status Group

<table>
<thead>
<tr>
<th>Bit</th>
<th>QUESTionable</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Voltage warning</td>
</tr>
<tr>
<td>1</td>
<td>Current warning</td>
</tr>
<tr>
<td>2</td>
<td>Time warning</td>
</tr>
<tr>
<td>3</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>4</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>5</td>
<td>Frequency warning</td>
</tr>
<tr>
<td>6</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>7</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>8</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>9</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>10</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>11</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>12</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>13</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>14</td>
<td>Unused, always 0</td>
</tr>
<tr>
<td>15</td>
<td>Always 0</td>
</tr>
</tbody>
</table>

Table 4-7. QUESTionable Status Group bits

The QUESTionable Status group is used to report warning conditions amongst the voltage, current, pulse timing and frequency parameters. For more information on warning conditions refer to “Warnings and Errors” in Chapter 3. Warnings occur when a parameter, although not outside its maximum limits, could be causing an invalid signal at the output because of the actual settings and uncertainties of related parameters.
Programming the HP 8110A Trigger Modes

Figure 4-3. HP 8110A ARM-TRIGGER model

You program the comprehensive triggering capabilities of the HP 8110A using the SCPI :ARM and :TRIGger subsystems. Using these two command subsystems you can program the operating modes of the instrument which are set up using the TRG-MODE screen on the frontpanel.

Use the :ARM subsystem to select the overall triggering mode of the instrument (CONTINUOUS, TRIGGERED, GATED, EXT WIDTH), and the :TRIGger subsystem to select the pulse-period source, triggering and number of pulse-periods per :ARM event (BURST or PATTERN length).
Programming Trigger Modes

CONTINUOUS

Set CONTINUOUS mode by ARMing the HP 8110A from its internal oscillator:

:ARM:SOURce IMMEDIATE

Arm from internal osc.

TRIGGERED

Set TRIGGERED mode by ARMing the HP 8110A on edges from the EXT INPUT:

:ARM:SOURce EXTERNAL
:ARM:SENSe EDGE
:ARM:SLOPe POSitive
:ARM:LEVel 1V

Arm from EXT INPUT
Arm on edge
Arm on positive edge
Set EXT INPUT threshold

If you have the HP 81106A PLL/External Clock fitted, you can also ARM the HP 8110A from the PLL and set the frequency (or period) of the PLL to the required triggering rate:

:ARM:SOURce INTERNAL2
:ARM:SENSe EDGE
:ARM:SLOPe POSitive
:ARM:FREQuency <value>

Arm from HP 81106A PLL
Arm on edge
Arm on positive edge
Set PLL frequency

Note

The HP 81106A PLL (INTERNAL2) cannot be used as :ARM:SOURce (triggering rate) if it is already being used as :TRIGger:SOURce (pulse-period source).

GATED

Set GATED mode by ARMing the HP 8110A on levels from the EXT INPUT:

:ARM:SOURce EXTERNAL
:ARM:SENSe LEVEL
:ARM:SLOPe POSitive

Arm from EXT INPUT
Arm on signal level
Arm on positive level

EXT WIDTH

Set EXT WIDTH mode using the :EVIDth:[STATE] command:

:ARM:EVIDth ON

Switch on EXT WIDTH mode

This command disables the ARM-TRIGger system. The ARM-TRIGger system is re-enabled by switching OFF EVIDth mode.
Programming Trigger Modes

PULSES
Set PULSES mode by setting the :TRIGger:COUNt to 1 so that a single triggered pulse-period is generated for every ARM event. The trigger source sets the pulse-period:

:TRIGger:COUNt 1 Single pulse-period per ARM event
:TRIGger:SOURce INTernal1 Pulse-period from internal osc.
:DIGital:PATTern OFF Disable pattern data

Table 4-8.
Pulse-period sources set by :TRIG:SOUR

<table>
<thead>
<tr>
<th>Pulse-period source</th>
<th>:TRIGger:SOURce</th>
</tr>
</thead>
<tbody>
<tr>
<td>internal osc.</td>
<td>INTernal1</td>
</tr>
<tr>
<td>HP 81106A PLL</td>
<td>INTernal2</td>
</tr>
<tr>
<td>HP 81106A CLK IN</td>
<td>EXternal2</td>
</tr>
</tbody>
</table>

Note
The HP 81106A PLL (INTernal2) cannot be used as :TRIGger:SOURce (pulse-period source) if it is already being used as :ARM:SOURce (triggering rate).

Note that in TRIGGERED PULSES mode the pulse-period source is not relevant because a single pulse is generated for each ARM event.

BURST of
Set BURST of mode by setting the :TRIGger:COUNt to the burst count required. The trigger source sets the pulse-period for the pulses within the burst (See Table 4-8):

:TRIGger:COUNt 16 Burst of 16 pulse-periods
:TRIGger:SOURce INTernal1 Pulse-period from internal osc.
:DIGital:PATTern OFF Disable pattern data

PATTERN
Set PATTERN mode by setting the :TRIGger:COUNt to the pattern length required, and switching on digital pattern data. The trigger source sets the pulse-period for the data pulses (See Table 4-8):

:TRIGger:COUNt 512 Pattern length 512
:TRIGger:SOURce INTernal1 Pulse-period from internal osc.
:DIGital:PATTern ON Enable pattern data
:DIGital:SIGNal1:FORMat NRZ Set OUTPUT 1 data to NRZ
Programming Trigger Modes

Command Dictionary

The following reference sections list the HP 8110A commands in alphabetical order. In addition to a command description, the attributes of each command are described under the following headings. Not all of these attributes are applicable to all commands.

<table>
<thead>
<tr>
<th>Form</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set</td>
<td>The command can be used to program the instrument</td>
</tr>
<tr>
<td>Query</td>
<td>The command can be used to interrogate the instrument. Add a ? to the command if necessary.</td>
</tr>
<tr>
<td>Event</td>
<td>The command performs a one-off action.</td>
</tr>
</tbody>
</table>

Parameter

The type of parameter, if any, accepted by the command.

Parameter Suffix

The suffixes which may follow the parameter.

Functional Coupling

Any other commands which are implicitly executed by the command.

Value Coupling

Any other parameter which is also changed by the command.

Range Coupling

Any other parameters whose valid ranges may be changed by the command.

*RST value

The value/state following a *RST command.

Specified Limits

The specified limits of a parameter.
Absolute Limits

Some parameters can be programmed beyond their specified limits.

Example

Example programming statements which assume:

- HP BASIC 5.0/5.1/6.1
- HP-IB Interface Select Code = 7
- HP 8110A HP-IB Address = 10
:ARM:EWIDth:STATe

Form  Set & Query

Parameter  ON|OFF|1|0

*RST value  OFF

Description  This command enables the EXT WIDTH trigger mode available on the TRG-MODE screen using the frontpanel. When EXT WIDTH mode is switched on, the rest of the :ARM and :TRIG system is disabled.

In EXT WIDTH mode a signal applied to the EXT INPUT determines the width and period of the output signal(s) from the HP 8110A. You can still control the edge transition-times and levels of the output signal(s).
:ARM:FREQuency

**Form** Set & Query

**Parameter** Numeric

**Parameter Suffix** HZ with engineering prefixes, or MHz is Megahertz.

**RST value** 100 kHz

**Specified Limits** See ":ARM:PERiod"

**Description** Use this command to program the frequency of the HP 81106A PLL (INTernal12) when it is used as the :ARM:SOURce for internal triggering of pulses, bursts or patterns.

If you are using the PLL as :TRIGger:SOURce to set the pulse frequency, use the [:SOURce]:FREQuency[:CW]:FIXed command.

**Example** To set up bursts of four 100 MHz pulses occurring at a burst-rate of 10 MHz:

```
OUTPUT 710;"::TRIG::SOUR INT"
OUTPUT 710;"::FREQ 100MHZ"
OUTPUT 710;"::ARM::SOUR INT2"
OUTPUT 710;"::ARM::SENS EDGE"
OUTPUT 710;"::ARM::FREQ 10MHZ"
OUTPUT 710;"::TRIG::COUNT 4"
```

Select internal osc. as pulse-period source
Set pulse frequency to 100 MHz
Select PLL as triggering source
Sense edge of PLL signal
Set triggering frequency to 10 MHz
Set burst length to 4
:ARM:IMPedance

Form Set & Query

Parameter Numeric

Parameter Suffix 0HM with engineering prefixes, or M0HM is Megaohms.

*RST value 50 Ω

Specified Limits 50 Ω or 10 kΩ

Description Use this command to program the input impedance of the EXT INPUT connector. Note that only two settings are available. If you try to program any other value, it will be rounded to one of the specified values.

Example

OUTPUT 710;"::ARM:IMP 500HM" Set EXT INPUT impedance to 50 Ω

OUTPUT 710;"::ARM:LEV 2.5V" Set EXT INPUT threshold to 2.5 V
:ARM:LEVEL

Form  Set & Query
Parameter Numeric
Parameter Suffix V with engineering prefixes.
*RST value +1.0 V
Specified Limits -10 V to +10 V
Description Use this command to program the triggering threshold of the EXT INPUT connector.
Example

```
OUTPUT 710;"::ARM:IMP 500ΩM"
Set EXT INPUT impedance to 50 Ω

OUTPUT 710;"::ARM:LEV 2.5V"
Set EXT INPUT threshold to 2.5 V
```
:ARM:PERiod

Form  Set & Query
Parameter  Numeric
Parameter Suffix  S with engineering prefixes.
*RST value  10.00 μs
Specified Limits  6.65 ns to 999 s

Description  Use this command to program the period of the HP 81106A PLL (INTERNAL2) when it is used as the :ARM:SOURce for internal triggering of pulses, bursts or patterns.

If you are using the PLL as :TRIGger:SOURce use the [:SOURce]:PULSe:PERiod command to set the pulse period,

Example  To set up bursts of four 10 ns pulses occurring every 100 ns:

```
OUTPUT 710;"; :TRIG:SOUR INT"  Select internal osc. as pulse-period source
OUTPUT 710;"; :PER 10NS"  Set pulse period to 10 ns
OUTPUT 710;"; :ARM:SOUR INT2"  Select PLL as triggering source
OUTPUT 710;"; :ARM:SENS EDGE"  Sense edge of PLL signal
OUTPUT 710;"; :ARM:PER 100ns"  Set triggering period to 100 ns
OUTPUT 710;"; :TRIG:COUNT 4"  Set burst length to 4
```
:ARM:SENSe

**Form**  Set & Query

**Parameter**  EDGE|LEVEL

**RST value**  EDGE

**Description**  Use this command to select TRIGGERED or GATED mode by choosing whether the HP 8110A arms on the edge(s) or level of the arming signal.

When sensing edges, the HP 8110A triggers when the arming signal crosses the selected threshold level (:ARM:LEV) in the selected direction (:ARM:SLOP). This corresponds to the TRIGGERED mode selected on the TRG-MODE screen when using the frontpanel.

When sensing levels, the HP 8110A triggers as long as the arming signal is above (:ARM:SLOP POS), or below (:ARM:SLOP NEG) the selected threshold level (:ARM:LEV). This corresponds to the GATED mode selected on the TRG-MODE screen when using the frontpanel.
:ARM:SLOPe

Form  Set & Query

Parameter  POSitive|NEGative|EITHER

*RST value  POS

Description  Use this command to select the trigger slope for the arming signal when triggering on edges. Use EITHER to trigger on both the positive and negative edges of the arming signal. This allows you to trigger at twice the frequency of the arming signal.

If you are arming on levels, use this command to select whether the HP 8110A triggers during the positive or negative cycle of the arming signal.
:ARM:SOURce

Form Set & Query


*RST value IMM

Description Use this command to select the triggering mode of the HP 8110A by selecting the source of the arming signal:

Table 4-9. Triggering sources and modes set by :ARM:SOUR

<table>
<thead>
<tr>
<th>Triggering source</th>
<th>:ARM:SOURce</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERNAL OSC.</td>
<td>IMMEDIATE</td>
<td>CONTINUOUS</td>
</tr>
<tr>
<td>HP 8110A PLL</td>
<td>INTERNAL2</td>
<td>1TRIGGERED</td>
</tr>
<tr>
<td>EXT INPUT</td>
<td>EXTERNAL</td>
<td>1TRIGGERED</td>
</tr>
<tr>
<td>MAN key</td>
<td>MANual</td>
<td>1TRIGGERED</td>
</tr>
</tbody>
</table>

1 Use :ARM:SENSe EDGE|LEVEL to choose between TRIGGERED and GATED
:CHANnel:MATH

Form Set & Query

Parameter OFF|PLUS

*RST value OFF

Description Use this command to enable or disable channel addition in an instrument with two HP 81103A Output channels installed. With :CHAN:MATH ON the signals from both channels are added at OUTPUT 1. OUTPUT 2 is not used. This allows you to for example

- Generate 3 and 4 level waveforms
- Simulate single or repeated glitches
- Generate pulse transitions with a step-change in slew-rate
- Simulate overshoot and undershoot

For levels and amplitude values which can be added in the channel addition mode, refer to Chapter 6 Specifications, Outputs Table 6-1 and Figure 6-2.
:DIGital[:STIMulus][:PATTern]:DATA[1|2|3]

Form
Set & Query

Parameter
[<start>,] <data>

*RST value

Table 4-10. *RST PATTERN data

<table>
<thead>
<tr>
<th>Channel</th>
<th>Description</th>
<th>Bit 1</th>
<th>Bit 2</th>
<th>Bits 3 to 4096</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CH1 (OUTPUT 1)</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>CH2 (OUTPUT 2)</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>STRB (STROBE OUT)</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Description
Use this command to set or read the pattern data of one or all channels starting from Bit 1. (Note that the optional <start> parameter is ignored by the HP 8110A if you use it). The <data> is an arbitrary block of program data as defined in IEEE 488.2 7.7.6.2, for example:

#1541213
# Start of block
1 Length of the length of the data
5 Length of the data
41213 5 bytes of data

#2161000100010001000
# Start of block
2 Length of the length of the data
16 Length of the data
10...00 16 bytes of data
Examples

:DIG:PATT:DATA #1541213

The HP 8110A uses each byte of data set one Bit in the pattern memory. If you don’t specify a particular channel, the lowest three bits of each byte are used to set all three channels, and the top five bits are ignored. Note that you can therefore use the ASCII characters ‘0’, ‘1’, ‘2’ and ‘3’ to program Outputs 1 and 2 in binary with STROBE = 0 (or ‘4’, ‘5’, ‘6’, and ‘7’ for STROBE = 1):

<table>
<thead>
<tr>
<th>ASCII</th>
<th>D7 D6 D5 D4 D3 D2 D1 D0</th>
<th>STROBE</th>
<th>CH2 OUTPUT</th>
<th>CH1 OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0 1 1 1 0 1 0 0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0 1 1 1 0 0 0 1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>0 1 1 1 0 0 1 0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0 1 1 1 0 0 0 1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>0 1 1 1 0 0 1 1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Programming Example:

```
OUTPUT 710;":ARM:SOUR IMM"
OUTPUT 710;" :DIG:PATT:DATA #1541213"
OUTPUT 710;" :TRIG:COUN 5"
OUTPUT 710;" :DIG:PATT ON"
```

Set CONTINUOUS mode
Set up pattern data for all channels
Set pattern length (last bit) to 5
Switch on PATTERN mode
DIGITAL[>:STIMulus]:PATTern:DATA[1|2][3]

DIG:PATT:DATA2 #1501011

If you specify a particular channel, the least significant bit of each byte is used to set the selected channel, and the top seven bits are ignored. Note that you can therefore use the ASCII characters '1' and '0' to set individual bits to 1 and 0:

<table>
<thead>
<tr>
<th>ASCII</th>
<th>IGNORED</th>
<th>LSB</th>
<th>STROBE OUT</th>
<th>CH2 OUTPUT 2</th>
<th>CH1 OUTPUT 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 0 1 1 1 0 0 0 0</td>
<td>X</td>
<td>0</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 0 1 1 1 0 0 0 0 1</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 0 1 1 1 0 0 0 0</td>
<td>X</td>
<td>0</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 0 1 1 1 0 0 0 1</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 0 1 1 1 0 0 0 1</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 X indicates that the bit remains unchanged

Programming Example:

OUTPUT 710;"::ARM:SOUR IMM" Set CONTINUOUS mode
OUTPUT 710;"::DIG:PATT:DATA3 #1501011" Set up pattern data for STROBE channel
OUTPUT 710;"::TRIG:COUN 5" Set pattern length (last bit) to 5
OUTPUT 710;"::DIG:PATT ON" Switch on PATTERN mode
:DIGital[:STIMulus]:PATTern:PRBS[1|2|3]

Form Set

Parameter <n>, <length>

*RST value Not applicable

Specified Limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;n&gt;</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>&lt;length&gt;</td>
<td>1</td>
<td>4096</td>
</tr>
</tbody>
</table>

Description Use this command to set up PRBS data starting from bit 1. The parameter <n> is used as the basis to generate a $2^n - 1$ PRBS. The parameter <length> determines how many bits of the PRBS sequence are used. If <length> is longer than the PRBS, the PRBS is repeated as necessary to achieve the required length.

Example To set up a repeating $2^{10} - 1$ PRBS on OUTPUT 1:

```
OUTPUT 710;":ARM:SOUR IMM"
OUTPUT 710;":TRIG:COUN 1023
OUTPUT 710;":DIG:PATT:PRBS1 10,1023"
OUTPUT 710;":DIG:PATT ON"
```

Set CONTINUOUS mode
Set pattern length (last bit) to 1023
Set up PRBS on OUTPUT 1
Switch on PATTERN mode
:DIGital[:STIMulus]:PATTer:n:PRESet[1|2|3]

Form  Set

Parameter  \(<n>,<\text{length}>\)

*RST value  Not applicable

Specified Limits  
\(<n>\)  1 to 2048 (integer)
\(<\text{length}>\)  1 to 4096 (integer)

Description  Use this command to set up clock data starting from bit 1 with value 1. The parameter \(<n>\) is used as the divider to generate a CLOCK÷\(n\) sequence (squarewave if NRZ data is selected). The parameter \(<\text{length}>\) determines the length of the sequence.

\(n=2\)  Sequence = 101010101010101....
\(n=4\)  Sequence = 110011001100110....
\(n=6\)  Sequence = 111000111000111....
\(n=8\)  Sequence = 111100001111000....
and so on.

Example  To set up a CLOCK÷4 squarewave on STROBE OUT:

```
OUTPUT 710;":TRIG:COUN 4096  Set pattern length (last bit) to 4096
OUTPUT 710;":DIG:PATT:PRES3 4,4096"  Set up CLOCK÷4 on STRB
OUTPUT 710;":DIG:PATT ON"  Switch on PATTERN mode
```

Note  To produce a CONTINUOUS squarewave the pattern length must be a multiple of twice the selected divider, in this case a multiple of 8.
:DIGital[:STIMulus]:PATTern[:STATE]

**Form**  Set & query

**Parameter**  ON|OFF

**RST**  OFF

**Description**  Use this command to enable and disable PATTERN mode. Use :TRIG:COUN to program the length of the pattern.
DIGital[:STIMulus]:PATTern:UPDate

**Form** Set & query

**Parameter** ON|OFF|ONCE

**RST** ON

**Description** Use this command to enable and disable the automatic updating of the pattern generating hardware following a :DIG:PATT:DATA command. Disable the automatic updating if you want to set up new pattern data in the HP 8110A without affecting the pattern which is currently being generated. You can then update the hardware with the new pattern data by sending a :DIG:PATT:UPD ONCE command.
:DIGital[:STIMulus]:SIGNal[1|2]:FORMat

**Format**  Set & Query

**Parameter**  RZ|NRZ

**Range Coupling**  Period, Frequency

**RST value**  RZ

**Description**  Use this command to set and read the data format of channels 1 and 2 when using PATTERN mode. If you don't specify a channel number in the command, channel 1 is assumed.

- **RZ**  Return to Zero. An RZ pulse is generated for each '1' in the data. You can vary the width, edges and levels of the pulse.
- **NRZ**  Non Return to Zero. A pulse of 100% duty cycle is generated for each '1' in the data. You can vary the edges and levels of the pulse.

**Example**

```
OUTPUT 710;"":DIG:SIGN:FORM NRZ"  Set channel 1 data format to NRZ
```
:DISPlay[:WINDow][:STATE]

Form Set & Query

Parameter ON|OFF|1|0

*RST value ON

Description This command is used to turn the frontpanel display on and off. Switching off the display improves the programming speed of the instrument.

Note *RST switches the display back on. Use :SYSTem:PRESet to perform an *RST without switching the display back on.

Example

OUTPUT 710;":DISP OFF"  Switch off the frontpanel display
:MEMory:CATalog?

Form  Query

Parameter  ["A:"

*RST value  Not applicable

Description  Use this command to get a listing of the contents of the currently selected directory on the memory card. As there is only one memory card slot, the parameter A: is optional. The information returned is:

<bytes_used>,<bytes_free>{,<file_entry>}

<bytes_used>  The total number of bytes used on the memory card.

<bytes_free>  The total number of bytes still available on the memory card.

<file_entry>  String containing the name, type and size of one file:

"<file_name>,<file_type>,<file_size>"

Note  
- The <file_type> is always blank.
- A directory name has <file_size> = 0
:MEMORY:CDIREctory

Form      Event

Parameter  ["directory_name"]

*RST value  Not applicable

Description  Use this command to change the current directory on
the memory card. If you don’t specify a directory name
parameter, the root directory is selected.

Note that you cannot use DOS pathnames as directory
names, you can only select a directory name within the
current directory.

Use the directory name "." to move back to the parent
directory of the current directory, unless you are already
in the root directory "\".

Examples

OUTPUT 710;":@MEM:CDIR"    Select root directory
OUTPUT 710;":@MEM:CDIR ""PERFORM""
OUTPUT 710;":@MEM:CDIR ""..""    Select parent directory
:MMEMory:COPY

Form  Event

Parameter  "filename", "A:.", "copyname", "A:"

*RST  Not applicable

Description  Use this command to copy an existing file filename in the current directory to a new file copyname. If copyname is the name of a sub-directory in the current directory, a copy of the file filename is made in the sub-directory. Use ".." as copyname to copy a file into the parent directory of the current directory.

Examples

```
OUTPUT 710; ":MMEM:COPY ""test1"", "test2"
Copy test1 to test2
OUTPUT 710; ":MMEM:COPY ""test1"", ".."
Copy test1 into parent directory
```
:MMEMory:DELeTe

Form  Event

Parameter  "filename"

*RST  Not applicable

Description  Use this command to delete file filename from the currently selected directory.
:MMEMory:INITialize

Form  Event

Parameter  ["A:"", "DOS"]

*RST  Not applicable

Description

Caution  Initializing a memory card destroys any existing data on the card.

Use this command to initialize a memory card to DOS format.
:MMEMory:LOAD:STATe

Form Event

Parameter <n>, "filename"[,"A:"

*RST Not applicable

Specified Limits <n> = 0 to 9 (integer)

Description Use this command to load a complete instrument setting from file filename in the current directory into memory <n> in the HP 8110A.

Memories 1 to 9 are the internal memories. Use memory 0 to load a setting as the current instrument setting.

Examples

OUTPUT 710;":MMEM:LOAD:STAT 1,""FREQPERF""
Load FREQPERF into memory 1

OUTPUT 710;":MMEM:LOAD:STAT 0,""AMPTEST""
Load AMPTEST as current setting

OUTPUT 710;"*SAV 2"
Save current setting in memory 2

OUTPUT 710;"*RCL 3"
Recall memory 3 as current setting
:MMEMory:STORe:STATe

Form  Event

Parameter  <n>, "filename"[","A:"]

*RST  Not applicable

Specified Limits  <n> = 0 to 9 (integer)

Description  Use this command to store a complete instrument setting from memory <n> to file filename in the current directory on the memory card.

Memories 1 to 9 are the internal memories. Use memory 0 to store the current instrument setting to a file.

Examples

OUTPUT 710;":MMEM:STOR:STAT 1,""FREQPERF""

Store memory 1 to file FREQPERF

OUTPUT 710;":MMEM:STOR:STAT 0,""AMPTEST""

Store current setting to file AMPTEST

OUTPUT 710;"*SAV 2"

Save current setting in memory 2

OUTPUT 710;"*RCL 3"

Recall memory 3 as current setting
:OUTPut[1|2][:STATe]

**Form**  
Set & Query

**Parameter**  
ON|OFF|1|0

**RST value**  
OFF

**Description**  
Use this command to switch the OUTPUTs on or off

**Example**

```plaintext
OUTPUT 710;"OUTP1 ON"  Switch on OUTPUT 1
OUTPUT 710;"OUTP2 OFF"  Switch off OUTPUT 2
```
:OUTPut[1|2]:IMPedance[:INTernal]

Form Set & Query

Parameter Numeric

Parameter Suffix OHM with engineering prefixes, or MOHM is Megaohms.

*RST value 50 Ω

Specified Limits 50 Ω or 1 kΩ

Description Use this command to program the source impedance of the OUTPUT connectors. Note that only two settings are available. If you try to program any other value, it will be rounded to one of the specified values.

Example

```
OUTPUT 710;":OUTP1:IMP 500OHM"  Set OUTPUT 1 impedance to 50 Ω
OUTPUT 710;":OUTP2:IMP 10000OHM" Set OUTPUT 2 impedance to 1 kΩ
```
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Set &amp; Query</td>
</tr>
<tr>
<td>Parameter</td>
<td>Numeric</td>
</tr>
<tr>
<td>Parameter Suffix</td>
<td>OHM with engineering prefixes, or MΩHM is Megohms.</td>
</tr>
<tr>
<td>*RST value</td>
<td>50.0 Ω</td>
</tr>
<tr>
<td>Specified Limits</td>
<td>2.5 Ω to 999 kΩ</td>
</tr>
<tr>
<td>Description</td>
<td>Use this command to set the expected load impedance of the device-under-test at the OUTPUT connectors. If you have a non-50 Ω load, the output levels at the device-under-test will not be the levels you program or set via the frontpanel unless you set the expected load using this command.</td>
</tr>
</tbody>
</table>

**Example**

```
OUTPUT 710;"::OUTP1:IMP:EXT 47.6OHM"  Set load impedance at OUTPUT 1 impedance to 47.6 Ω
OUTPUT 710;"::OUTP2:IMP:EXT 999KOHM" Set load impedance at OUTPUT 2 impedance to 999 kΩ
```
:OUTPut[1|2]:POLarity

Form        Set & Query
Parameter   NORMal|INVerted
*RST value  NORM
Description Use this command to invert the signal at the OUTPUTs.

Example

```
OUTPUT 710;"':OUTP1:POL INV"
OUTPUT 710;"':OUTP2:POL NORM"
```

Inverted signal at OUTPUT 1
Normal signal at OUTPUT 1
[:SOURce]:CORRection[1|2]:EDELay[:TIME]

**Form**  Set & Query

**Parameter**  Numeric

**Parameter Suffix**  $S$ with engineering prefixes.

**RST value**  0

**Specified Limits**  0 to 28.0 ns

**Description**  Use this command to program the OUTPUT Deskew delay of the HP 81107A Multichannel Deskew module (if fitted). This allows you to deskew the OUTPUTS so that the zero-delay points of both OUTPUT signals are the same at the device-under-test.

**Example**

```
OUTPUT 710;":CORR1:EDEL 0NS"
OUTPUT 710;":CORR1:EDEL 5.18NS"
```

Set OUTPUT 1 DESKEW to 0
Set OUTPUT 1 DESKEW to 5.18 ns
[:SOURce]:CURRent[1|2][:LEVel][:IMMediate][:AMPLitude]

Form Set & Query

Parameter Numeric

Parameter suffix A with engineering prefixes.

*RST value 20 mA (50 Ω into 50 Ω)

Specified Limits 4 mA to 400 mA typical

Value coupling

\[ Amplitude = \text{High} - \text{Low} \]
\[ Offset = \frac{\text{High} - \text{Low}}{2} \]

Range coupling Offset

Description This command programs the amplitude current of the OUTPUT signal. Note that to set the OUTPUT levels in terms of current, you first have to execute the [:SOURce]:HOLD CURRent command to enable the [:SOURce]:CURRent subsystem.

The available current range is limited by the combination of:

- Specified Voltage limits
- Actual OUTPUT Impedance setting :OUTPut:IMPedance
- Actual Expected Load impedance setting :OUTPut:IMPedance:EXTernal

Example

OUTPUT 710;"::HOLD CURR"
OUTPUT 710;"::CURR1 75MA" Enable CURRent subsystem
Set OUTPUT 1 amplitude to 75 mA
**:SOURce**:CURRent[1|2][:LEVel][:IMMediate]:OFFSet

**Form**  
Set & Query

**Parameter**  
Numeric

**Parameter suffix**  
*A* with engineering prefixes.

**RST value**  
0.0 µA (50 Ω into 50 Ω)

**Value coupling**  
\[
\text{Amplitude} = \text{High} - \text{Low} \\
\text{Offset} = \frac{\text{High} - \text{Low}}{2}
\]

**Range coupling**  
Amplitude

**Description**  
This command programs the offset current of the OUTPUT signal. Note that to set the OUTPUT levels in terms of current, you first have to execute the [:SOURce]:HOLD CURRent command to enable the [:SOURce]:CURRent subsystem.

The available current range is limited by the combination of:

- Specified Voltage limits
- Actual OUTPUT Impedance setting :OUTPut:IMPedance
- Actual Expected Load impedance setting :OUTPut:IMPedance:EXTernal

**Example**  
OUTPUT 710;":HOLD CURR"

Enable CURRENT subsystem

OUTPUT 710;":CURR1:OFF 50MA"

Set OUTPUT 1 offset to 50 mA
[::SOURce]:CURRent[1|2][::LEVel][::IMMediate]:HIGH

Form  Set & Query

Parameter  Numeric

Parameter suffix  A with engineering prefixes.

Value coupling  

\[
\text{Amplitude} = \text{High} - \text{Low} \\
\text{Offset} = \frac{\text{High} - \text{Low}}{2}
\]

Range coupling  Low-level

*RST value  +10 mA (50 Ω into 50 Ω)

Specified Limits  -396 mA to 400 mA typical

Description  This command programs the High-level current of the OUTPUT signal. Note that to set the OUTPUT levels in terms of current, you first have to execute the [::SOURce]:HOLD CURRent command to enable the [::SOURce]:CURRent subsystem.

The available current range is limited by the combination of:

- Specified Voltage limits
- Actual OUTPUT Impedance setting :OUTPut:IMPedance
- Actual Expected Load impedance setting :OUTPut:IMPedance:EXTernal
Example

```
OUTPUT 710;"':HOLD CURR"
OUTPUT 710;"':CURR1:HIGH 150MA"
```

Enable CURRENT subsystem
Set OUTPUT 1 High-level to 150 mA
[::SOURce]:CURRent[1|2][::LEVEL][::IMMediate]:LOW

Form  Set & Query

Parameter Numeric

Parameter suffix A with engineering prefixes.

Value coupling

\[
Amplitude = High - Low \\
Offset = \frac{High - Low}{2}
\]

Range coupling High-level

*RST value -10 mA (50 Ω into 50 Ω)

Specified Limits -400 mA to 300 mA typical

Description This command programs the Low-level current of the OUTPUT signal. Note that to set the OUTPUT levels in terms of current, you first have to execute the [:SOURce]:HOLD CURRent command to enable the [:SOURce]:CURRent subsystem.

The available current range is limited by the combination of:

- Specified Voltage limits
- Actual OUTPUT Impedance setting :OUTPut::IMPedance
- Actual Expected Load impedance setting :OUTPut::IMPedance:EXTernal
Example

OUTPUT 710;"::HOLD CURR"
OUTPUT 710;"::CURRI:LOW 50MA"  
Enable CURRENT subsystem
Set OUTPUT 1 Low-level to 50 mA
[:SOURce]:CURRent[1|2]:LIMit[:HIGH]

Form  Set & Query

*RST value  +10.0 mA

Description  Use this command to set/read the High-level current limit. If you switch on current limiting, the High-level current cannot be set above the programmed limit.
Note that the current is NOT limited by the OUTPUT hardware, this is a software limit.

Example

OUTPUT 710;"":HDLD CURR"
OUTPUT 710;"":CURR1:LIM 50MA"
OUTPUT 710;"":CURR1:LIM:STAT ON"

Enable CURRENT subsystem
Set OUTPUT 1 High-level current limit
to 50 mA
Switch on OUTPUT 1 limits
[SOURce]:CURRent[1|2]:LIMit:LOW

**Form** Set & Query

*RST value* -10.0 mA

**Description** Use this command to set/read the Low-level current limit. If you switch on current limiting, the Low-level current cannot be set below the programmed limit. Note that the current is *NOT* limited by the OUTPUT hardware, this is a software limit.

**Example**

```
OUTPUT 710;"::HOLD CURR"
OUTPUT 710;"::CURR1:LIM:LOW -50MA"
OUTPUT 710;"::CURR1:LIM:STAT ON"
```

Enable CURRENT subsystem
Set OUTPUT 1 Low-level current limit to -50 mA
Switch on OUTPUT 1 limits
[:SOURce]:CURRent[1|2]:LIMit:STATe

**Form**  Set & Query

**Parameter**  ON|OFF|1|0

**RST value**  OFF

**Description**  This command switches the output limits on or off. When you switch on the output limits cannot program the output-levels beyond the programmed limits, until you switch off the output-limits. The limits apply whether you program High/Low levels or Amplitude/Offset levels.

**Note**  You can switch the limits on and off in both the [:SOURce]:CURRent and the [:SOURce]:VOLTage subsystems but the current and voltage limits are not enabled/disabled independently. The voltage and current limits are always enabled/disabled together.

**Example**

```
OUTPUT 710;":\n\nHD\n\nLD CURR"
OUTPUT 710;":\n\nCURR1:LIM 50MA"

OUTPUT 710;":\n\nCURR1:LIM:LOW -50MA"

OUTPUT 710;":\n\nCURR1:LIM:STAT ON"
```

Enable CURRENT subsystem
Set OUTPUT 1 High-level current limit to 50 mA
Set OUTPUT 1 Low-level current limit to -50 mA
Switch on OUTPUT 1 limits
[:SOURce]:FREQuency[:CW]:FIXed

**Form**  Set & Query

**Parameter**  Numeric

**Parameter Suffix**  Hz with engineering prefixes, or MHz for Megahertz.

**Value coupling**  
\[ Period = \frac{1}{Frequency} \]

**RST value**  1.00 MHz

**Specified limits**  See [:SOURce]:PULSe:PERiod

**Description**  Use this command to set/read the pulse frequency. Select the frequency source for the pulse frequency using :TRIGger:SOURce. The currently selected source is programmed by this command. Note that the specified limits and available resolution depend on the selected source.

You cannot set the pulse frequency if you have selected the HP 81106A CLK IN connector as the frequency source (:TRIG:SOUR EXT).

**Example**

```
OUTPUT 710;":TRIG:SOUR INT"  Select internal osc. as pulse trigger
OUTPUT 710;":FREQ 75MHz"  Set pulse frequency to 75 MHz
```
[:SOURce]:FREQuency[:CW]:FIXed]:AUTO

Form  Event

Parameter  ONCE

*RST value  Not applicable

Description  Use this command to measure the frequency at the HP 81106A CLK IN connector. If the CLK IN connector is the selected pulse frequency source, you can then read the measured value with :FREQ?

Example  

```
OUTPUT 710;"":TRIG:SOUR EXT"
OUTPUT 710;"":FREQ:AUTO ONCE"
OUTPUT 710;"":FREQ?"
ENTER 710;P$
```

Select ext CLK IN as pulse trigger
Measure frequency at CLK IN
Query pulse frequency
[:SOURce]:HOLD

Form
Set & Query

Parameter
VOLTage|CURRent

*RST value
VOLT

Description
Use this command to enable either of the [:SOURce]:VOLTage or [:SOURce]:CURRent subsystems.

You can control the signal levels of the HP 8110A OUTPUTs in terms of voltage or current.
[::SOURce]:PHASE[:1|2][::ADJus]t

**Form**  
Set & Query

**Parameter**  
Numeric

**Parameter suffix**  
DEG or RAD. A parameter without a suffix is interpreted as RAD.

**Functional coupling**  
Programming the pulse phase also executes [:SOURce]:PULSE:HOLD PHASE so that the pulse phase is held constant when the signal frequency is changed.

**Value coupling**  
\[ \text{Delay} = \frac{\text{Phase}}{360} \times \text{Period} \]

**RST value**  
0.0

**Specified limits**  
0 to 360°, constrained by delay and period limits.

**Description**  
Use this command to set/read the relative phase-delay of the output signal. This is equivalent to setting an absolute or percentage pulse-delay with [:SOURce]:PULSE:DELa.

If you want the phase delay to remain constant when the pulse-period is varied (rather than the absolute pulse delay) use [:SOURce]:PULSE:DELa[:1|2]:HOLD PRATio.

**Example**

```
OUTPUT 710;"::PULS:DEL1 500NS"
OUTPUT 710;"::PHAS2 180DEG"
OUTPUT 710;"::PULS:DEL1:HOLD TIM"
```

Set OUTPUT 1 delay to 500 ns  
Set OUTPUT 2 phase to 180°  
Hold OUTPUT 1 delay constant with varying period
[:SOURce]:PHASE[1|2][:ADJJust]

OUTPUT 710;"[:PULS:DEL2:HOLD PRAT]"

Hold OUTPUT 2 phase constant with varying period.
[:SOURce]:PULSe:DCYCle[1|2]

**Form**  Set & Query

**Parameter**  Numeric

**Value coupling**  
\[ Width = \frac{Dutycycle}{100} \times Period \]

**RST value**  10.0% (derived from Width and Period)

**Specified limits**  0.1 - 99.9%, constrained by Width & Period limits.

**Description**  Use this command to program the dutycycle of the pulse signal. If you want to set an absolute pulse-width use [:SOURce]:PULSe:WIDTh[1|2].

If you want the pulse dutycycle to remain constant when the pulse-period is varied (rather than the absolute pulse width) use [:SOURce]:PULSe:HOLD[1|2] DCYCle

**Example**

```
OUTPUT 710;""::PULS:DCYC1 25PCT"
OUTPUT 710;""::PULS:HOLD1 DCYC"
```

* Set OUTPUT 1 dutycycle to 25%  
* Hold dutycycle constant with varying period
Form  Set & Query

Parameter  Numeric

Parameter suffix  S with engineering prefixes. You can change the default unit using [:SOURce]:PULSe:DELay[1|2]:UNIT.

Value coupling  

\[
\text{Phase} = \frac{\text{Delay}}{\text{Period}} \times 360
\]

\[
\text{Delay}\% = \frac{\text{Delay}}{\text{Period}} \times 100
\]

*RST value  0.0

Specified limits  0.00 ns to 999 ms (limited by period–6.6 ns)

Description  Use this command to set/read the pulse-delay. Delay is the time between the start of the pulse-period and the start of the leading-edge of the pulse.

If you want the pulse-delay to remain constant when the pulse-period is varied (rather than the phase-delay) use [:SOURce]:PULSe:DELay[1|2]:HOLD TIME.

Example

```
OUTPUT 710;".PULS:DEL1 500NS"
OUTPUT 710;".PHAS2 180DEG"
OUTPUT 710;".PULS:DEL1:HOLD TIM"
OUTPUT 710;".PULS:DEL2:HOLD PRAT"
```

Set OUTPUT 1 delay to 500 ns
Set OUTPUT 2 phase to 180\(^\circ\)
Hold OUTPUT 1 delay constant with varying period
Hold OUTPUT 2 phase constant with varying period
[::SOURce::PULSe:DELay[1|2]:HOLD]

**Form**  Set & Query

**Parameter**  TIMe|PeriodRATio

**RST value**  TIM

**Description**  Use this command to set/read the coupling between the pulse-period and the pulse-delay:

- **TIMe**  The absolute pulse-delay is held fixed when the pulse-period is varied (Pulse phase varies).
- **PeriodRATio**  The pulse phase-delay (delay as ratio of period) is held fixed when the pulse-period is varied (Pulse-delay varies).

**Example**

```
OUTPUT 710;"::PULS:DELI 500NS"
OUTPUT 710;"::PHAS2 180DEG"
OUTPUT 710;"::PULS:DELI::HOLD TIM"
OUTPUT 710;"::PULS:DEL2::HOLD PRAT"
```

*Set OUTPUT 1 delay to 500 ns*
*Set OUTPUT 2 phase to 180°*
*Hold OUTPUT 1 delay constant with varying period*
*Hold OUTPUT 2 phase constant with varying period*
 [:SOURce]:PULSe:DELa y[1|2]:UNIT

Form  Set & Query

Parameter  S|SEC|PCT|DEG|RAD

*RST value  S

Description  Use this command to set/read the default units for the pulse-delay parameter. The default unit of a parameter is the unit used when the parameter is programmed to a value without a unit suffix.

Example

OUTPUT 710;":PULS:DEL1:UNIT PCT"

Set OUTPUT 1 delay unit to %

OUTPUT 710;":PULS:DEL1 50"

Set OUTPUT 1 delay to 50% of period
[::SOURce]:PULSe:DOUBle[1|2][::STATe]

Form: Set & Query

Parameter: OFF|ON

*RST value: OFF

Description: Use this command to switch double-pulse mode on or off. In double-pulse mode two pulses are generated per pulse-period and the delay between the leading edges of the first and second pulse can be adjusted.
[:SOURce]:PULSe:DOUBLE[1|2]:DElay

**Form**  Set & Query

**Parameter**  Numeric

**Parameter suffix**  S with engineering prefixes. You can change the default unit using [:SOURce]:PULSe:DOUBLE:DElay[1|2]:UNIT.

**Value coupling**  \[ DblDel\% = \frac{DblDel}{Period} \times 100 \]

**RST value**  0.0

**Specified limits**  0.00 ns to 999 ms (limited by period–6.6 ns)

**Description**  Use this command to set/read the delay between the leading edges of the two pulses in double-pulse mode. The first pulse always starts at the start of the pulse-period.

If you want the double-delay to remain constant when the pulse-period is varied (rather than the double-delay as percentage of period) use [:SOURce]:PULSe:DOUBLE[1|2]:DElay:HOLD TIME.

**Example**

```
OUTPUT 710;"':PULS:DOUB1 ON"
OUTPUT 710;"':PULS:DOUB1:DEL 500NS"
OUTPUT 710;"':PULS:DOUB1:DEL:HOLD TIM"
```

Switch on Double-pulses on OUTPUT 1
Set inter-pulse delay to 500 ns
Hold inter-pulse delay fixed with varying pulse-period

HP 8110A Programming Reference   4-69
[:SOURce]:PULSe:DOUBlе[1|2]:DELaу:HO LD

**Form** Set & Query

**Parameter** TIme|PeriodRATio

**RST value** TIM

**Description** Use this command to set/read the coupling between the pulse-period and the Double-pulse delay:

**TIme** The absolute double-pulse delay is held fixed when the pulse-period is varied.

**PeriodRATio** The double-pulse delay as percentage of period is held fixed when the pulse-period is varied.

**Example**

```
OUTPUT 710;"*:PULS:DOUB1 ON"
OUTPUT 710;"*:PULS:DOUB1:DEL 50PCT"
OUTPUT 710;"*:PULS:DOUB1:DEL:HOLD PRAT"
```

Switch on Double-pulses on OUTPUT 1
Set inter-pulse delay to 50% of pulse-period
Hold inter-pulse delay as fixed percentage of pulse-period
[:SOURce]:PULSe:DOUBlE[1|2]:DELay:UNIT

Form
Set & Query

Parameter
S|SEC|PCT

*RST value
S

Description
Use this command to set/read the default units for the double-delay parameter. The default unit of a parameter is the unit used when the parameter is programmed to a value without a unit suffix.

Example

OUTPUT 710;"::PULS:DOUB1:DEL:UNIT PCT"
Set OUTPUT 1 double-delay unit to %

OUTPUT 710;"::PULS:DOUB1:DEL 50"
Set OUTPUT 1 interpulse delay to 50% of period
[:SOURce]:PULSe:HOLD[1|2]

Form  Set & Query

Parameter  WIDTH|DCYCl|TrailingDELAY

*RST value  WIDTH

Description  Use this command to set whether the pulse-width, the pulse-duty cycle or the pulse trailing-edge delay is held constant when the pulse-period is changed.

Example

OUTPUT 710;":PULS:DEL:HOLD1 TIM"  Hold OUTPUT 1 delay fixed when frequency varies
OUTPUT 710;":PULS:DEL 20NS"  Set OUTPUT 1 delay to 20 ns
OUTPUT 710;":PULS:HOLD1 DCYC"  Hold OUTPUT 1 Duty cycle fixed when frequency varies
OUTPUT 710;":PULS:DCYC 25PCT"  Set OUTPUT 1 Duty cycle to 25%
[:SOURce]:PULSe:PERiod

**Form**  Set & Query

**Parameter**  Numeric

**Parameter Suffix**  S with engineering prefixes.

**Value coupling**  \[ Frequency = \frac{1}{\text{Period}} \]

**"RST value**  1 \(\mu\)s

**Specified limits**
- 6.65 ns to 999 ms  Internal Oscillator (INT1)
- 6.650 ns to 999.0 s  HP 81106A PLL (INT2)

**Description**
Use this command to set/read the pulse-period. Select the pulse-period source using :TRIGger:SOURce. The currently selected source is programmed by this command. Note that the specified limits and available resolution depend on the selected source.

You cannot set the pulse-period if you have selected the HP 81106A CLK IN connector as the frequency source (:TRIG:SOUR EXT).

**Example**

```
OUTPUT 710;"::TRIG:SOUR INT"  Select internal osc. as pulse trigger
OUTPUT 710;"::PULS:PER 25NS"  Set pulse frequency to 25 ns
```
[SOURce]:PULS:PERiod:AUTO

Form  Event
Parameter  ONCE
*RST value  Not applicable

Description  Use this command to measure the period at the HP 81106A CLK IN connector. If the CLK IN connector is the selected pulse-period source, you can then read the measured value with :PULS:PER?

Example

```
OUTPUT 710;"*:TRIG:SOUR EXT"
OUTPUT 710;"*:PULS:PER:AUTO ONCE"
OUTPUT 710;"*:PULS:PER?"
ENTER 710;P$
```

`Select ext CLK IN as pulse trigger`

`Measure period at CLK IN`

`Query pulse period`
[::SOURce]:PULSe:TrailingDElay[1|2]

Form  Set & Query

Parameter  Numeric

Parameter Suffix  S with engineering prefixes.

*RST value  100 ns

Specified Limits  3.30 ns to 999 ms (Maximum = Period - 3.3 ns)

Description  Use this command to program the delay of the trailing-edge of the pulse relative to the start of the pulse-period. This is an alternative method of programming the pulse-width.

Example

OUTPUT 710;"::PULS:DEL1 500NS"

OUTPUT 710;"::PULS:DEL1:HO LD TIM"

OUTPUT 710;"::PULS:TDEL1 750NS"

Set OUTPUT 1 delay to 500 ns
Hold OUTPUT 1 delay constant with varying period
Set OUTPUT 1 trailing delay to 750 ns
[:SOURce]:PULSe:TRANsition[1|2]:HOLD

**Form**  Set & Query

**Parameter**  TIme|WRATio

**RST value**  TIM

**Description**  Use this command to set the coupling between transition-times and the pulse-width:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIme</td>
<td>The absolute transition-times are held when the pulse-width is varied.</td>
</tr>
<tr>
<td>WRATio</td>
<td>The ratio of transition-time to pulse-width is held when the pulse-width is varied.</td>
</tr>
</tbody>
</table>

**Example**

```
OUTPUT 710;":PULS:TRAN1: HOLD TIM"
```

Hold OUTPUT 1 transitions fixed when pulse-width varies

```
OUTPUT 710;":PULS:TRAN2: HOLD WRAT"
```

Hold OUTPUT 2 transition:width ratio when pulse-width varies
Form    Set & Query

Parameter  S|SEC|PCT

*RST value  S

Description  Use this command to set the default units for the pulse transition-times. The default unit is used when the parameter is programmed to a value without a unit suffix.
[:SOURce]:PULSe:TRANsition[1|2][:LEADing]

Form
Set & Query

Parameter
Numeric

Parameter suffix
S with engineering prefixes, or PCT

*RST value
2.00 ns

Specified limits
2.00 ns to 200 ms

Parameter coupling
Trailing-edge = Leading-edge with
:PULS:TRAN:TRA:AUTO ON. This is the default condition.
Use :PULS:TRAN:TRA:AUTO OFF to enable independent
programming of the trailing-edge within a 1:20 ratio for
the ranges shown in Figure 6-1.

Description
Use this command to set/read the transition-time of
the pulse leading-edge. Note that the leading and
trailing edges of the pulse have to fit within the defined
pulse-width.

Example

```
OUTPUT 710;"":PULS:TRAN1 3NS"
OUTPUT 710;"":PULS:TRAN1:TRA:AUTO OFF"
OUTPUT 710;"":PULS:TRAN1:TRA 15NS"
```

Set OUTPUT 1 leading edge to 3 ns
Enable independent setting of trailing-edge
Set OUTPUT 1 trailing edge to 15 ns
[:SOURce]:PULSe:TRANsition[1|2]:TRAilng

Form
Set & Query

Parameter
Numeric

Parameter suffix
S with engineering prefixes, or PCT

*RST value
2.00 ns

Specified limits
2.00 ns to 200 ms

Parameter coupling
Trailing-edge = Leading-edge with
:PULS:TRAN:TRA:AUto ON. This is the default condition.
Use :PULS:TRAN:TRA:AUto OFF to enable independent programming of the trailing-edge within a 1:20 ratio for the ranges shown in Figure 6-1.

Description
Use this command to set/read the transition-time of the pulse trailing-edge. Note that the leading and trailing edges of the pulse have to fit within the defined pulse-width.

Example

```
OUTPUT 710;".:PULS:TRAN1 3NS"
Set OUTPUT 1 leading edge to 3 ns

OUTPUT 710;".:PULS:TRAN1:TRA:AUto OFF"
Enable independent setting of trailing-edge

OUTPUT 710;".:PULS:TRAN1:TRA 15NS"
Set OUTPUT 1 trailing edge to 15 ns
```
[:SOURce]:PULSe:TRANsition[1|2]:TRAiling:AUTO

Form  Set & Query

Parameter  ON|OFF|ONCE

*RST value  ON

Description  Use this command to set/read the automatic coupling of the pulse trailing-edge transition-time to the leading-edge transition-time.

ON  The trailing-edge transition time is automatically set to the same value as the leading-edge, and is updated automatically each time the leading-edge transition-time changes.

OFF  The trailing-edge transition time is independently programmable.

ONCE  The trailing-edge transition time is set ONCE to the same value as the leading-edge.

Example

OUTPUT 710;"::PULS:TRAN1 3NS"  Set OUTPUT1 leading-edge to 3 ns

OUTPUT 710;"::PULS:TRAN1:TRA:AUTO OFF"  Enable independent setting of trailing-edge

OUTPUT 710;"::PULS:TRAN1:TRA 15NS"  Set OUTPUT1 trailing-edge to 15 ns
[:SOURce]:PULSe:TRIGger[1|2]:VOLTage

**Form**: Set & Query

**Parameter**: TTL|ECL

**RST value**: TTL

**Description**: Use this command to set/read the output levels at the TRIGGER OUT connector.
[:SOURce]:PULSe:WIDTh[1|2]

Form  Set & Query

Parameter  Numeric

Parameter suffix  S with engineering prefixes

*RST value  100 ns

Specified limits  3.30 ns to 999 ms (Maximum = Period – 3.3 ns)

Description  Use this command to program the width of the pulse signal. If you want to set width as dutycycle use [:SOURce]:PULSe:DCYCLE[1|2].

If you want the pulse-width to remain constant when the pulse-period is varied (rather than the dutycycle) use [:SOURce]:PULSe:HOLD[1|2] WIDTh.

Example

```
OUTPUT 710;".PULS:WIDT1 50NS"
OUTPUT 710;".PULS:HOLD1 WIDT"  Set OUTPUT1 pulse-width to 50 ns
                                Hold pulse-width constant with varying period
```
[:SOURce]:ROSCillator:SOURce

Form  Set & Query

Parameter  INTernal|EXTernal

*RST Value  INT

Description  Use this command to set/read the reference source for the HP 81106A PLL. If you select the external reference (CLK IN connector) you can choose to use a 5 MHz or 10 MHz reference signal using :ROSC:EXT:FREQ.

INTernal  Lock the PLL to its internal reference

EXTernal  Lock the PLL to a reference signal at the CLK IN connector. The external reference signal can be 5 or 10 MHz.

Example

```
OUTPUT 710;"::ROSC:SOUR EXT"
```

Set external PLL reference (CLK IN)

```
OUTPUT 710;"::ROSC:EXT:FREQ 10MHZ"
```

Set expected PLL reference frequency to 10 MHz
[:SOURce]:ROSCillator:EXTernal:FREQuency

**Form**  
Set & Query

**Parameter**  
Numeric

**RST value**  
5 MHz

**Specified limits**  
5 MHz or 10 MHz

**Description**  
Use this command to set/read the expected reference frequency for the HP 81106A PLL at the CLK IN connector. The external reference can be a 5 or 10 MHz signal. Note that if you program any value other than the two specified values, the value will be set to the nearest of the two specified values.

**Example**

```
OUTPUT 710;";ROSC:SOUR EXT"
Set external PLL reference (CLK IN)

OUTPUT 710;";ROSC:EXT:FREQ 10MHZ"
Set expected PLL reference frequency to 10 MHz
```
[:SOURce]:VOLTage[1|2][:LEVEL][:IMMediate][:AMPLitude]

Form  Set & Query
Parameter Numeric
Parameter suffix V with engineering prefixes.
Value coupling \[ \text{High} = \text{Offset} + \frac{\text{Amplitude}}{2} \]
\[ \text{Low} = \text{Offset} - \frac{\text{Amplitude}}{2} \]
Range coupling Offset
*RST value 1.00 V
Specified limits 100 mV to 10.0 V (50Ω into 50Ω)

Description
This command programs the amplitude voltage of the OUTPUT signal. Note that to set the OUTPUT levels in terms of voltage, you first have to execute the [:SOURce]:HOLD VOLTage command to enable the [:SOURce]:VOLTage subsystem.

The available voltage range is limited by the combination of:
- Specified Current limits
- Actual OUTPUT Impedance setting :OUTPut:IMPedance
- Actual Expected Load impedance setting :OUTPut:IMPedance:EXTernal

Example
```
OUTPUT 710;"::HOLD VOLT"
OUTPUT 710;"::VOLT 5V"
```

Enable VOLTAGE subsystem
Set OUTPUT 1 amplitude to 5 V

HP 8110A Programming Reference  4-85
[:SOURce]:VOLTag[e][1|2][:LEVel][:IMMediate]:OFFSet

Form  Set & Query

Parameter  Numeric

Parameter suffix  V with engineering prefixes.

Value coupling
\[
\begin{align*}
High &= Offset + \frac{Amplitude}{2} \\
Low &= Offset - \frac{Amplitude}{2}
\end{align*}
\]

Range coupling  Amplitude

"RST value  0.0 mV

Description  This command programs the offset voltage of the OUTPUT signal. Note that to set the OUTPUT levels in terms of voltage, you first have to execute the [:SOURce]:HOLD VOLTag[e] command to enable the [:SOURce]:VOLTag[e] subsystem.

The available voltage range is limited by the combination of:

- Specified current limits
- Actual OUTPUT Impedance setting :OUTPut:IMPedance
- Actual Expected Load impedance setting :OUTPut:IMPedance:EXTernal

Example

\[
\begin{align*}
&\text{OUTPUT 710;"":HOLD VOLT"} \\
&\text{OUTPUT 710;"":VOLT:OFF -800MV"} \\
&\text{Enable VOLTag[e] subsystem} \\
&\text{Set OUTPUT 1 offset to -800 mV}
\end{align*}
\]
[:SOURce]:VOLTage[1|2][:LEVel][:IMMediate]:HIGH

Form Set & Query

Parameter Numeric

Parameter suffix V with engineering prefixes.

Value coupling

\[
\text{Amplitude} = \text{High} - \text{Low} \\
\text{Offset} = \frac{\text{High} - \text{Low}}{2}
\]

Range coupling Low-level

*RST value 500 mV

Specified limits -9.90 V to 10.0 V (500 into 500)

Description

This command programs the High-level voltage of the OUTPUT signal. Note that to set the OUTPUT levels in terms of voltage, you first have to execute the [:SOURce]:HOLD VOLTage command to enable the [:SOURce]:VOLTage subsystem.

The available voltage range is limited by the combination of:

- Specified current limits
- Actual OUTPUT Impedance setting :OUTPut:IMPedance
- Actual Expected Load impedance setting :OUTPut:IMPedance:EXTernal
Example

```
OUTPUT 710;";HOLD VOLT"
OUTPUT 710;";VOLT1:HIGH 4.8V"
```

Enable VOLTAGE subsystem
Set OUTPUT 1 High-level to 4.8 V
[[:SOURce]:VOLTage[1|2]][:LEVel][:IMMediate]:LOW

Form Set & Query

Parameter Numeric

Parameter suffix V with engineering prefixes.

Value coupling

\[
Amplitude = \text{High} - \text{Low} \\
Offset = \frac{\text{High} - \text{Low}}{2}
\]

Range coupling High-level

*RST value -500 mV

Specified limits -10.0 V to 9.90 V (50Ω into 50Ω)

Description This command programs the Low-level voltage of the OUTPUT signal. Note that to set the OUTPUT levels in terms of voltage, you first have to execute the [:SOURce]:HOLD VOLTage command to enable the [:SOURce]:VOLTage subsystem.

The available voltage range is limited by the combination of:

- Specified current limits
- Actual OUTPUT Impedance setting :OUTPut:IMPedance
- Actual Expected Load impedance setting :OUTPut:IMPedance:EXTernal

Example

```
OUTPUT 710;"::HOLD VOLT"
OUTPUT 710;"::VOLT1:LOW 500MV"
```

Enable VOLTAGE subsystem
Set OUTPUT 1 Low-level to 500 mV

HP 8110A Programming Reference 4-89
[:SOURce]:VOLTage[1|2]:LIMit[:HIGH]

**Form**  Set & Query

**RST value**  +500 mV

**Description**  Use this command to set/read the High-level voltage limit. If you switch on voltage limiting, the High-level voltage cannot be set above the programmed limit. Note that the voltage is *NOT* limited by the OUTPUT hardware, this is a software limit.

**Example**

```plaintext
OUTPUT 710;"::HOLD VOLT"
OUTPUT 710;"::VOLT1:LIM 3V"
OUTPUT 710;"::VOLT1:LIM:STAT ON"
```

Enable VOLTAGE subsystem
Set OUTPUT 1 High-level voltage limit to 3 V
Switch on OUTPUT 1 limits
[:SOURce]:VOLTage[1|2]:LIMit:LOW

Form  Set & Query

*RST value  -500 mV

Description  Use this command to set/read the Low-level voltage limit. If you switch on voltage limiting, the Low-level voltage cannot be set below the programmed limit. Note that the voltage is NOT limited by the OUTPUT hardware, this is a software limit.

Example

```
OUTPUT 710;"::HOLD VOLT"
OUTPUT 710;"::VOLT1:LIM:LOW 0V"
OUTPUT 710;"::VOLT1:LIM:STAT ON"
```

Enable VOLTAGE subsystem
Set OUTPUT 1 Low-level voltage limit to 0 V
Switch on OUTPUT 1 limits
[:SOURce]:VOLTage[1|2]:LIMit:STATe

Form  Set & Query

Parameter  ON|OFF|1|0

*RST value  OFF

Description  This command switches the output limits on or off. When you switch on the output limits cannot program the output-levels beyond the programmed limits, until you switch off the voltage-limits. The limits apply whether you program High/Low levels or Amplitude/Offset levels.

Note  You can switch the limits on and off in both the [:SOURce]:CURRent and the [:SOURce]:VOLTage subsystems but the current and voltage limits are not enabled/disabled independently. The voltage and current limits are always enabled/disabled together.

Example

```
OUTPUT 710;"HOLD VOLT"
OUTPUT 710;"VOLT1:LIM 3V"
OUTPUT 710;"VOLT1:LIM:LOW 0V"
OUTPUT 710;"VOLT1:LIM:STAT ON"
```

Enable VOLTAGE subsystem
Set OUTPUT 1 High-level voltage limit to 3 V
Set OUTPUT 1 Low-level voltage limit to 0 V
Switch on OUTPUT 1 limits

4-92  HP 8110A Programming Reference
:STATus:OPERation

This command tree accesses the OPERation status group. The OPERation status group is not used by the HP 8110A, therefore this command tree is redundant.

:STATus:OPERation[:EVENT]?

:STATus:OPERation:CONDition?

:STATus:OPERation:ENABle

:STATus:OPERation:NTRANSition

:STATus:OPERation:PTRANSition
:STATus:PRESet

**Form**  
Event

**RST value**  
Not Applicable

**Description**  
This command
- Clears all status group event-registers
- Clears the error queue
- Presets the status group enable-, PTR-, and NTR-registers as follows:

<table>
<thead>
<tr>
<th>Status Group</th>
<th>Register</th>
<th>Preset value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPERation</td>
<td>ENABie</td>
<td>0000000000000000</td>
</tr>
<tr>
<td></td>
<td>PTR</td>
<td>0111111111111111</td>
</tr>
<tr>
<td></td>
<td>NTR</td>
<td>0000000000000000</td>
</tr>
<tr>
<td>QUESTIONable</td>
<td>ENABie</td>
<td>0000000000000000</td>
</tr>
<tr>
<td></td>
<td>PTR</td>
<td>0111111111111111</td>
</tr>
<tr>
<td></td>
<td>NTR</td>
<td>0000000000000000</td>
</tr>
</tbody>
</table>
:STATus:QUESTionable

This command tree accesses the QUESTionable status group. The QUESTionable status group contains warning bits for voltage, current, time and frequency parameters. A warning occurs when the output signal *could* be out of specification due to the combined specification uncertainties of many parameters, although all parameters are set within their individually specified limits. If a parameter is set outside its specified limits an error is generated.

The following commands are used to access the registers within the status group:

:STATus:QUESTionable[:EVENt]?

Form | Query
---|---
*RST value | Not Applicable
Description | This command reads the event register in the QUESTionable status group.

:STATus:QUESTionable:CONDition?

Form | Query
---|---
*RST value | Not Applicable
Description | This command reads the condition register in the QUESTionable status group.

:STATus:QUESTionable:ENABLe

Form | Set & Query
Parameter | Numeric
*RST value | Not affected by *RST
Specified limits | 0 – 32767
:STATus:QUEStionable

**Description**

This command sets or queries the enable register in the QUEStionable status group.

:STATus:QUEStionable:NTRansition

<table>
<thead>
<tr>
<th><strong>Form</strong></th>
<th>Set &amp; Query</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter</strong></td>
<td>Numeric</td>
</tr>
<tr>
<td><strong>RST value</strong></td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>Specified limits</strong></td>
<td>0–32767</td>
</tr>
</tbody>
</table>

**Description**

This command sets or queries the negative-transition register in the QUEStionable status group.

:STATus:QUEStionable:PTRansition

<table>
<thead>
<tr>
<th><strong>Form</strong></th>
<th>Set &amp; Query</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter</strong></td>
<td>Numeric</td>
</tr>
<tr>
<td><strong>RST value</strong></td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>Specified limits</strong></td>
<td>0–32767</td>
</tr>
</tbody>
</table>

**Description**

This command sets or queries the positive-transition register in the QUEStionable status group.
:SYSTem:CHECK[:ALL][:STATE]

Form  Set & Query

Parameter  ON|OFF

*RST value  Not Applicable

Description  Use this command to switch the instrument's error checking on or off. Switch off the error checking if you want to improve the programming speed of the instrument, but remember that no invalid parameter or mode settings will be detected and reported.

Caution  Error checking cannot be switched on or off from the frontpanel. Error checking is not automatically re-enabled if you switch the instrument off and on again. Therefore your test programs should switch error checking on again before ending.
:SYSTem:ERRor?

**Form**  Query

**RST value**  Not Applicable

**Description**  Use this command to read the HP 8110A error queue. The HP 8110A error queue can store up to 30 error codes on a first-in-first-out basis. When you read the error queue, the error number and associated message are put into the instrument’s output buffer.

If the queue is empty, the value 0 is returned, meaning **No Error**. If the queue overflows at any time, the last error code is discarded and replaced with -350 meaning **Queue overflow**.
:SYSTem:KEY

**Form**  Set & Query

**Parameter**  Numeric

**Parameter suffix**  No suffix allowed

**RST value**  -1

**Specified limits**  See Table 4-11

**Description**  In query form, this command reads the last key pressed. The buffer is emptied by *RST and returns the value -1 when empty.

In set form, the command simulates pressing a key on the frontpanel. Simulated key-press are also recorded as the last key pressed.

**Note**  
1. **:SYST:KEY 19** sets the instrument to LOCAL mode.

2. In remote mode *only* the softkeys under the display and the (SHIFT) (LOCAL) key are active. Since the instrument normally switches to remote mode when any command is received, including :SYSTem:KEY, simulating one of the other disabled keys has no effect.

3. If you want to simulate full frontpanel operation, you must prevent the instrument from entering remote mode by using the REN line of the HP-IB to maintain local mode (LOCAL 7 in BASIC).

If you do this, the :SYSTem:KEY command is the only command which works. Any other commands will be buffered in the HP 8110A, blocking any further :SYSTem:KEY commands, until remote mode is enabled.
### Table 4-11. [:SYStem:KEY] parameter reference

<table>
<thead>
<tr>
<th>No.</th>
<th>Key Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>No key pressed (query only)</td>
</tr>
<tr>
<td>0</td>
<td>DATA ENTRY 0</td>
</tr>
<tr>
<td>1</td>
<td>DATA ENTRY 1</td>
</tr>
<tr>
<td>2</td>
<td>DATA ENTRY 2</td>
</tr>
<tr>
<td>3</td>
<td>DATA ENTRY 3</td>
</tr>
<tr>
<td>4</td>
<td>DATA ENTRY 4</td>
</tr>
<tr>
<td>5</td>
<td>DATA ENTRY 5</td>
</tr>
<tr>
<td>6</td>
<td>DATA ENTRY 6</td>
</tr>
<tr>
<td>7</td>
<td>DATA ENTRY 7</td>
</tr>
<tr>
<td>8</td>
<td>DATA ENTRY 8</td>
</tr>
<tr>
<td>9</td>
<td>DATA ENTRY 9</td>
</tr>
<tr>
<td>10</td>
<td>DATA ENTRY 10</td>
</tr>
<tr>
<td>11</td>
<td>DATA ENTRY 11</td>
</tr>
<tr>
<td>12</td>
<td>CURSOR ←</td>
</tr>
<tr>
<td>13</td>
<td>CURSOR →</td>
</tr>
<tr>
<td>14</td>
<td>CURSOR ‡</td>
</tr>
<tr>
<td>15</td>
<td>CURSOR ↓</td>
</tr>
<tr>
<td>16</td>
<td>MAN</td>
</tr>
<tr>
<td>17</td>
<td>STORE</td>
</tr>
<tr>
<td>18</td>
<td>HELP</td>
</tr>
<tr>
<td>19</td>
<td>SHIFT</td>
</tr>
<tr>
<td>20</td>
<td>MORE</td>
</tr>
<tr>
<td>21</td>
<td>Softkey 1 (LEFT)</td>
</tr>
<tr>
<td>22</td>
<td>Softkey 2</td>
</tr>
<tr>
<td>23</td>
<td>Softkey 3</td>
</tr>
<tr>
<td>24</td>
<td>Softkey 4 (RIGHT)</td>
</tr>
<tr>
<td>25</td>
<td>DATA ENTRY nano</td>
</tr>
<tr>
<td>26</td>
<td>DATA ENTRY [micro\Mega]</td>
</tr>
<tr>
<td>27</td>
<td>DATA ENTRY [milli\Kilo]</td>
</tr>
<tr>
<td>28</td>
<td>DATA ENTRY ENTER</td>
</tr>
<tr>
<td>29</td>
<td>MODIFY Knob left (anticlockwise)</td>
</tr>
<tr>
<td>30</td>
<td>MODIFY Knob right (clockwise)</td>
</tr>
</tbody>
</table>
No function.
**:SYSTem:SECurity[:STATE]**

**Form**  
Set & Query

**Parameter**  
ON|OFF

**RST value**  
OFF

**Description**

Do not switch on system security unless you are willing to erase the instrument settings stored in the instrument. All instrument memories, including the current setting, will be overwritten with the default settings if you

- Switch off system security
- Switch the instrument off and on again

If you accidentally switch on system security, and want to rescue the settings stored in the instrument, store the settings on a memory card. You can then recall them from the memory card later.

Use this command to switch on system security mode. Switch on system security if you need to make sure that all instrument settings stored in the instrument are erased automatically when the instrument is switched off, or when security mode is switched off.

The instrument settings are erased by overwriting them with the default settings.

System security mode is not available via the frontpanel. If you want to erase all settings by hand:

1. **SHIFT STORE 0** to RECALL the default settings from memory 0.

2. **STORE 1, STORE 2, ... STORE 9** to store the defaults in memories 1 to 9.
Form: Set & Query

Parameter: Block data

*RST value: Not applicable

Description: In query form, the command reads a block of data containing the instrument's complete set-up. The set-up information includes all parameter and mode settings, but does not include the contents of the instrument setting memories, the status group registers or the :DISPlay[:WINDow][:STATe]. The data is in a binary format, not ASCII, and cannot be edited.

In set form, the block data must be a complete instrument set-up read using the query form of the command.
:SYSTem:VERSion?

**Form**  Query

**RST value**  “1992.0”

**Description**  This command reads the SCPI revision to which the instrument complies.
**Form**  Query

**RST value**  Not applicable

**Description**  Use this command to read the number of warnings which are currently active. Note that the warning status of voltage, current, time and frequency are also summarised by bits in the QUESTionable Status register.
:SYSTem:WARNing:STRing?

Form Query

*RST value Not applicable

Description Use this command to read all the currently active warning messages. The warning messages are concatenated to form a single string with a ; as separator between the messages.
:SYSTem:WARNing:BUFFer?

Form  Query  

*RST value  Not applicable  

Description  Use this command to read the maximum possible number of characters which could be returned by :SYST:WARN:STR? if all warnings were active.
**:TRIGger:COUNt**

**Form**  Set & Query

**Parameter**  Numeric

*RST value*  2

**Specified limits**  
- *DIG:PATT OFF*: 1 to 65536
- *DIG:PATT ON*: 2 to 4096

**Description**  
Use this command to set/read the number of trigger events (pulse-periods) to be generated for each arming event. This corresponds to selecting the event mode on the TRG-MODE screen:

- **PULSES**: Set a trigger count of 1 so that a single pulse-period is generated for each arming event.

- **BURST of**: Set a trigger count of 2 to 65536 so that a burst of 2 to 65536 pulse-periods is generated for each arming event. Switch off pattern mode so that a pulse (or double-pulse) is generated in each pulse-period. (*DIG:PATT OFF*)

- **PATTERN of**: Set a trigger count of 2 to 4096 so that a burst of 2 to 4096 pulse-periods is generated for each arming event. Switch on pattern mode so that the pattern memory is used to generate the pulses. (*DIG:PATT ON*)
Examples

To set CONTINUOUS PATTERN of NRZ--Pulses at Out1, with a 512 bit pattern length:

OUTPUT 710;":ARM:SOUR IMM"
OUTPUT 710;":TRIG:COUN 512"
OUTPUT 710;":TRIG:SOUR INT1
OUTPUT 710;":DIG:PATT ON
OUTPUT 710;":DIG:SIGN1:FORM NRZ

Set CONTINUOUS arming
Pattern length 512
Pulse-period trigger from internal osc.
Enable pattern data
Set OUTPUT 1 data to NRZ

To set TRIGGERED BURST of 16 Single-Pulses at Out1, each burst triggered by a positive edge at the EXT INPUT:

OUTPUT 710;":ARM:SOUR EXT1"
OUTPUT 710;":ARM:SENS EDGE"
OUTPUT 710;":ARM:SLOP POS"
OUTPUT 710;":TRIG:COUN 16"
OUTPUT 710;":TRIG:SOUR INT1
OUTPUT 710;":DIG:PATT OFF
OUTPUT 710;":FULS:DOUB1 OFF

Set arming from EXT INPUT
Set arming on edges
Set arming on positive edges
Burst length 16
Pulse-period trigger from internal osc.
Disable pattern data
Ensure single pulses at OUTPUT 1

To set GATED PULSES Single-Pulses at Out1, gated by a positive level at the EXT INPUT:

OUTPUT 710;":ARM:SOUR EXT1"
OUTPUT 710;":ARM:SENS LEVEL"
OUTPUT 710;":ARM:SLOP POS"
OUTPUT 710;":TRIG:COUN 1"
OUTPUT 710;":TRIG:SOUR INT1
OUTPUT 710;":DIG:PATT OFF
OUTPUT 710;":FULS:DOUB1 OFF

Set arming from EXT INPUT
Set arming on levels
Set arming on positive level
1 pulse-period
Pulse-period trigger from internal osc.
Disable pattern data
Ensure single pulses at OUTPUT 1
:TRIGger:IMPedance

Form  Set & Query

Parameter  Numeric

Parameter Suffix  ΩHM with engineering prefixes, or MHzM is Megaohms.

*RST value  50 Ω

Specified Limits  50 Ω or 1 kΩ

Description  Use this command to program the input impedance of the HP 81106A CLK IN connector. Note that only two settings are available. If you try to program any other value, it will be rounded to one of the specified values.

Example  OUTPUT 710; "TRIG:IMP 50ΩHM"  Set CLK IN impedance to 50 Ω
OUTPUT 710; "TRIG:LEV 2.5V"  Set CLK IN threshold to 2.5 V
OUTPUT 710; "TRIG:SOUR EXT2"  Pulse-period trigger from CLK IN
<table>
<thead>
<tr>
<th><strong>Form</strong></th>
<th>Set &amp; Query</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter</strong></td>
<td>Numeric</td>
</tr>
<tr>
<td><strong>Parameter Suffix</strong></td>
<td>V with engineering prefixes.</td>
</tr>
<tr>
<td><strong>RST value</strong></td>
<td>1.0 V</td>
</tr>
<tr>
<td><strong>Specified Limits</strong></td>
<td>-10 V to +10 V</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Use this command to program the triggering threshold of the CLK IN connector.</td>
</tr>
</tbody>
</table>
| **Example** | OUTPUT 710; ":TRIG:IMP 500HM"  Set CLK IN impedance to 50 Ω  
OUTPUT 710; "":TRIG:LEV 2.5V"  Set CLK IN threshold to 2.5 V |
<table>
<thead>
<tr>
<th><strong>Form</strong></th>
<th>Set &amp; Query</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter</strong></td>
<td>POSitive</td>
</tr>
<tr>
<td><strong>RST value</strong></td>
<td>POS</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Use this command to select the trigger slope for the pulse-period triggering signal applied to the CLK IN connector.</td>
</tr>
</tbody>
</table>
:TRIGger:SOURCE

**Form**  Set & Query

**Parameter**  IMMediate|INTernal[1]|INTernal2|EXTernal2

**RST value**  IMM

**Description**  Use this command to select the pulse-period source of the HP 8110A by selecting the source of the pulse-period trigger signal:

<table>
<thead>
<tr>
<th>Pulse-period source</th>
<th>:TRIG:SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal osc.</td>
<td>IMMediate</td>
</tr>
<tr>
<td>HP 81106A PLL</td>
<td>INTernal[1]</td>
</tr>
<tr>
<td>HP 81106A CLK IN</td>
<td>INTernal2</td>
</tr>
</tbody>
</table>

Table 4-12.  Pulse-period sources set by :TRIG:SOUR
Default Values

Default Values, standard settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>*RST, Default Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>:ARM</td>
<td>:EWIt/dh :STATE</td>
</tr>
<tr>
<td></td>
<td>:FREquency</td>
</tr>
<tr>
<td></td>
<td>:IMPedance</td>
</tr>
<tr>
<td></td>
<td>:LVel</td>
</tr>
<tr>
<td></td>
<td>:PERiod</td>
</tr>
<tr>
<td></td>
<td>:SENSe</td>
</tr>
<tr>
<td></td>
<td>:SLOPe</td>
</tr>
<tr>
<td></td>
<td>:SOURCE</td>
</tr>
<tr>
<td>:CHANnel</td>
<td>:MATH</td>
</tr>
<tr>
<td>:DIG</td>
<td>[:STIMulus] :PATtern :DATA[1][2][8]</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>:PRES[1][2][8]</td>
</tr>
<tr>
<td></td>
<td>:PRESet[1][2][3]</td>
</tr>
<tr>
<td></td>
<td>[:STATE]</td>
</tr>
<tr>
<td></td>
<td>:UPDate</td>
</tr>
<tr>
<td></td>
<td>:SIGNal[1][2] :FORMat</td>
</tr>
<tr>
<td>:DISPlay</td>
<td>[:WINDow] [:STATE]</td>
</tr>
<tr>
<td>:MEMory</td>
<td>:CATalog?</td>
</tr>
<tr>
<td></td>
<td>:CDItectory</td>
</tr>
<tr>
<td></td>
<td>:COPY</td>
</tr>
<tr>
<td></td>
<td>:DELeRe</td>
</tr>
<tr>
<td></td>
<td>:INITialize</td>
</tr>
<tr>
<td></td>
<td>:LOAD :STATE</td>
</tr>
<tr>
<td></td>
<td>:STORE :STATE</td>
</tr>
<tr>
<td>Parameter</td>
<td>*RST, Default Values</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>:OUTPUT[1][2] [:STATE]</td>
<td>OFF</td>
</tr>
<tr>
<td>:IMPedance</td>
<td>500</td>
</tr>
<tr>
<td>:EXternal</td>
<td>50.00</td>
</tr>
<tr>
<td>:POLarity</td>
<td>NORMAL</td>
</tr>
<tr>
<td>[:SOURCE]</td>
<td></td>
</tr>
<tr>
<td>:CORRelation[1][2] [:EDELay [:TIME]]</td>
<td>0</td>
</tr>
<tr>
<td>:CURRENT[1][2] [:LEVEL]</td>
<td>20.0mA (from 500 into 600)</td>
</tr>
<tr>
<td>:DMM [:AMPL]</td>
<td>0.0mA (from 500 into 500)</td>
</tr>
<tr>
<td>:HIGH</td>
<td>+ 10.0mA (from 500 into 500)</td>
</tr>
<tr>
<td>:LOW</td>
<td>-10.0mA (from 500 into 500)</td>
</tr>
<tr>
<td>:LIMit [:HIGH]</td>
<td>+ 10.0mA</td>
</tr>
<tr>
<td>:LOW</td>
<td>-10.0mA</td>
</tr>
<tr>
<td>:STATE</td>
<td>OFF</td>
</tr>
<tr>
<td>:FREQ [:CW[:FIXed]]</td>
<td>1.00MHz</td>
</tr>
<tr>
<td>:AUTO</td>
<td>not applicable</td>
</tr>
<tr>
<td>:HOLD</td>
<td>VOLT</td>
</tr>
<tr>
<td>:PHASE[1][2] [:ADJJust]</td>
<td>0.0</td>
</tr>
<tr>
<td>:PULSe [:DCYcle[1][2]]</td>
<td>10.0% (derived from Width and Period)</td>
</tr>
<tr>
<td>:DELay[1][2]</td>
<td>0.0</td>
</tr>
<tr>
<td>:HOLD [:UNIT]</td>
<td>TIME</td>
</tr>
<tr>
<td>:DELay</td>
<td>S</td>
</tr>
<tr>
<td>:HOLD [:UNIT]</td>
<td>TIME</td>
</tr>
<tr>
<td>:STATE</td>
<td>S</td>
</tr>
<tr>
<td>:HOLD</td>
<td>WIDTh</td>
</tr>
</tbody>
</table>
### Table 4-13. HP 8110A Default Values (continued)

<table>
<thead>
<tr>
<th>Parameter</th>
<th><strong>RST, Default Values</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>[:SOURce] :PULSed :PERiod :AUTO</td>
<td>1μs not applicable</td>
</tr>
<tr>
<td>.:Trailing DELay[1][2]</td>
<td>100ns</td>
</tr>
<tr>
<td>.:TRANSition[1][2] :HOLD :UNIT</td>
<td>TIME s</td>
</tr>
<tr>
<td>.[:LEADing]</td>
<td>2.0ns</td>
</tr>
<tr>
<td>.:TRAIling</td>
<td>2.0ns</td>
</tr>
<tr>
<td>.:AUTO</td>
<td>ON</td>
</tr>
<tr>
<td>.:TRIGger[1][2] :VOLDage</td>
<td>TTL</td>
</tr>
<tr>
<td>.:WIDTh[1][2]</td>
<td>100ns</td>
</tr>
<tr>
<td>.:ROSCillator :SOURce :EXternal :FREQ</td>
<td>INTERNAL</td>
</tr>
<tr>
<td></td>
<td>[:OFFset] 0.0mV</td>
</tr>
<tr>
<td></td>
<td>.:HIGH 500mV</td>
</tr>
<tr>
<td></td>
<td>.:LOW −500mV</td>
</tr>
<tr>
<td></td>
<td>.:HIGH +500mV</td>
</tr>
<tr>
<td></td>
<td>.:LOW −500mV</td>
</tr>
<tr>
<td></td>
<td>.:STATe OFF</td>
</tr>
<tr>
<td>Parameter</td>
<td>*RST, Default Values</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>:STATus :OPERation</td>
<td>not applicable</td>
</tr>
<tr>
<td>:PRESet</td>
<td>not applicable</td>
</tr>
<tr>
<td>:QUESTIONable [:EVENT]</td>
<td>not applicable</td>
</tr>
<tr>
<td>:CONDITION?</td>
<td>not applicable</td>
</tr>
<tr>
<td>:ENABLE</td>
<td>not affected</td>
</tr>
<tr>
<td>:NTRanition</td>
<td>not applicable</td>
</tr>
<tr>
<td>:PTRanition</td>
<td>not applicable</td>
</tr>
<tr>
<td>:SYStem :CHECK [::ALL] [:STATE]</td>
<td>not applicable</td>
</tr>
<tr>
<td>:ERROR?</td>
<td>not applicable</td>
</tr>
<tr>
<td>:KEY</td>
<td>– 1</td>
</tr>
<tr>
<td>:PRESet</td>
<td>not applicable</td>
</tr>
<tr>
<td>:SECurity [:STATE]</td>
<td>OFF</td>
</tr>
<tr>
<td>:SET</td>
<td>not applicable</td>
</tr>
<tr>
<td>:VERSion</td>
<td>“1992.0”</td>
</tr>
<tr>
<td>:WARNING [:COUNT] [:STRING] [:BUFFER]</td>
<td>not applicable</td>
</tr>
<tr>
<td>:TRIGger :COUNT</td>
<td>2</td>
</tr>
<tr>
<td>:IMPedance</td>
<td>500</td>
</tr>
<tr>
<td>:LEVEL</td>
<td>1.0V</td>
</tr>
<tr>
<td>:SLOPe</td>
<td>POSitive</td>
</tr>
<tr>
<td>:SOURce</td>
<td>IMMEDIATE</td>
</tr>
</tbody>
</table>
Testing the HP 8110A

**Introduction**

Use the tests in this chapter if you want to check that the HP 8110A 150MHz Pulse Generator is working correctly. Before starting any testing allow all test equipment to warm up for at least 30 minutes.

**Conventions Used**

When referring to actions that you perform during the tests, the following conventions are used:

- ![FUNCTION](image) This indicates that a labelled button must be pressed
- ![TRG MODE](image) This shows that a soft-key must be pressed. A soft-key is an unlabelled button whose label is shown on the display, and which can vary according to the job that the button is doing
- ![CONTINUOUS PULSES](image) This is an option shown on the display, and is selected by use of the vernier keys. It is shown in upper or lower case to match the case displayed.

**Test Results Tables**

Tables for entering the results of the tests are included at the end of this chapter. The tests are numbered and reference numbers for each Test Result (TR) are given in a small table at the end of each test. The reference number shows you where the actual results should be entered in the Test Results Tables.

The Test Results tables at the end of the chapter should be photocopied, and the Test Results entered on the copies. Then, if the tests need to be repeated, the tables can be copied again.
If Channel 2 has been fitted to your instrument, make an extra copy of the Test Results tables for entry of the results of tests on that channel. In this case, however, it is not necessary to repeat the Period tests, as these are common to both channels.

Recommended Test Equipment and Accessories

The following tables list the recommended test equipment you need to perform all the tests in this chapter. You can use alternative instruments if they meet the critical specifications given. The test set-ups and procedures assume you are using the recommended equipment.

Table 5-1. Recommended Test Equipment List

<table>
<thead>
<tr>
<th>Test Equipment</th>
<th>Model</th>
<th>Critical Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscilloscope</td>
<td>HP 54121T</td>
<td>20 GHz, 10 bit vertical resolution, Histogram capability</td>
</tr>
<tr>
<td>Counter</td>
<td>HP 5834B</td>
<td>Period and Time Interval measurements</td>
</tr>
<tr>
<td>Counter</td>
<td>HP 5305A</td>
<td>Frequency measurements &gt; 150 MHz</td>
</tr>
<tr>
<td>Digital Voltmeter</td>
<td>HP 3458A</td>
<td>DCV up to 20 V</td>
</tr>
<tr>
<td>Pulse Generator</td>
<td>HP 8112A</td>
<td>50 MHz</td>
</tr>
<tr>
<td>Delay line</td>
<td>HP 54008A</td>
<td>22 ns</td>
</tr>
</tbody>
</table>
### Table 5-2. Recommended Accessories

<table>
<thead>
<tr>
<th>Accessories</th>
<th>Model</th>
<th>Critical Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digitizing Oscilloscopes Accessories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attenuators</td>
<td>HP 33340C/020</td>
<td>20 dB</td>
</tr>
<tr>
<td></td>
<td>HP 33340C/006</td>
<td>6 dB</td>
</tr>
<tr>
<td>Power Splitter</td>
<td>HP 11667B</td>
<td></td>
</tr>
<tr>
<td>SMA/SMA (m-m) adaptor</td>
<td>1250-1159</td>
<td></td>
</tr>
<tr>
<td>SMA/BNC Adaptor</td>
<td>1250-1700</td>
<td></td>
</tr>
<tr>
<td>SMA Cable</td>
<td>8120-4048</td>
<td></td>
</tr>
<tr>
<td>50 Ω Feedthrough Termination</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HP 10100C</td>
<td>2 W, 1%</td>
</tr>
<tr>
<td></td>
<td>See Figure 5-1</td>
<td>10 W, 0.1%</td>
</tr>
<tr>
<td>Adapter</td>
<td>1261-2277</td>
<td>BNC to Banana</td>
</tr>
<tr>
<td>Cable Assemblies, BNC</td>
<td>8120-1830</td>
<td></td>
</tr>
<tr>
<td>Torque Wrench</td>
<td>8710-1582</td>
<td>5/16 in, 5 lb-in (56 Ncm)</td>
</tr>
</tbody>
</table>

**Note**

When you connect the test equipment for the first time, and whenever you change the setup during the course of these tests, use the 8710-1582 torque wrench to tighten and loosen SMA connectors. This will ensure that the connectors are at the correct tightness and give the best signal transfer.
50 Ohm, 0.1%, 10 W Feedthrough Termination

The following figure provides a schematic and a parts list except for the case. The case must provide shielding and maintain grounding integrity.

Figure 5-1.
50 Ohm, 0.1%, 10 W Feedthrough Termination

The following parts are required:
1. R1 = 53.6Ω, 1%, 10 W; HP Part Number: 0699-0146.
2. R2 = 200 Ω, 10%, 0.5 W, Variable trimmer; HP Part Number: 2100-3350.
3. R3 = 681 Ω, 1%, 0.5 W; HP Part Number: 0757-0816.
4. BNC (M); HP Part Number: 1250-0045.
5. BNC (F); HP Part Number: 1250-0083.
Getting Started

The HP 8110A is controlled by selecting options in a series of pages that are displayed on the instrument's screen. These options vary with the boards that are fitted in the instrument. When the HP 8110A is being tested, therefore, different situations can arise, depending on whether you have a standard instrument or one that has had additional boards fitted. The following examples illustrate this.

Typical Examples of Displayed Screens

Figure 5-2 shows the TRG MODE (Trigger Mode) screen of an instrument that has a full complement of PC boards, including a PLL Board and an Output 2 Board.

![Figure 5-2. The TRG MODE Screen Display in a Fully Fitted HP 8110A](image)

Figure 5-3 shows the TRG MODE screen of a standard instrument.

![Figure 5-3. The TRG MODE Screen Display in a Standard HP 8110A](image)
Figure 5-4 shows the TRG MODE screen of a fully-fitted instrument where manual triggering has been selected.

![TRG MODE Screen](image)

**Figure 5-4.**
The TRG MODE Screen With Manual Triggering in a Fully-Fitted HP 8110A

Figure 5-5 shows the TRG MODE screen of a standard instrument where manual triggering has been selected.

![TRG MODE Screen](image)

**Figure 5-5.**
The TRG MODE Screen With Manual Triggering in a Standard HP 8110A

Figure 5-6 shows the OUTPUT screen of a standard instrument.

![OUTPUT Screen](image)

**Figure 5-6.**
The Output Screen in a Standard HP 8110A
Instrument Serial Numbers

You will need to write the serial numbers of the instrument and its boards at the top of the Test Reports. These can be found as follows:

Press HELP, MORE, SERIAL #

The HP 8110A display lists the instrument’s product and serial numbers.

The display on your instrument should look similar to this:

Prod.Nr. Serial Nr.
FRAME  8110A  3236G00153
CH1-Bd.  81103A  3233G00135
CH2-Bd.  81103A  3304G00216
PLL-Bd.  81106A  3237G00184
DSK-Bd.  81107A  3308G00173

The number given for the FRAME applies to the Mainframe, the Power Supply, the Microprocessor Board, and the Period Board. The serial number is available on the Period Board.

Initial Setup of the HP 8110A

In the majority of these tests the initial setting up of the instrument is identical. Therefore, it is described once here, and then referred to where appropriate. In cases where the initial setup differs, an illustration of the settings is shown.

Set up the HP 8110A as follows:

1. Select TRG-MODE:
   - CONTINUOUS PULSES
   - Single-Pulses at Out 1 (plus Single-Pulses at Out 2, if second channel is installed)

If PLL (HP 81106A) is fitted, set:
   - Pulse-Period: internal Osc
2. If a second output channel is installed, select the CONFIG screen and set up as follows:

<table>
<thead>
<tr>
<th>Group/Params: OUT/2/1</th>
<th>PLL Ref: Internal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deskew 1: 0.00ns</td>
<td>Deskew 2: 0.00ns</td>
</tr>
</tbody>
</table>

**Figure 5-7.**

**CONFIG Screen, Parameters grouped by OUTPUT**

**Note**

Set-ups are given in all the tests for OUTPUT 1 and OUTPUT 2. If you are testing a single channel instrument set up the OUTPUT screen with the settings given for OUTPUT 1.
Test 1: Period

Test Specifications

Range 6.65 ns to 999 ms
Resolution 3 digits, best case 10 ps
Accuracy ±5% ±100 ps
RMS-Jitter 0.03% + 25 ps (0.05% + 25 ps in the range 50 ns to 100 ns)

Equipment Needed
Digitizing Oscilloscope with Accessories
Counter
Cable, 50 Ω, coaxial, BNC

Procedure

1. Connect the HP 8110A to the digitizing oscilloscope as shown:

```
HP 8110A UNDER TEST
--- INPUT OUT ---
--- INPUT OUT ---
--- INPUT OUT ---
--- INPUT OUT ---
--- INPUT OUT ---
--- INPUT OUT ---

HP 5411ET FRONTEND
--- INPUT OUT ---
--- INPUT OUT ---
--- INPUT OUT ---
--- INPUT OUT ---
--- INPUT OUT ---
--- INPUT OUT ---

Connecting the HP 8110A to the Scope

2. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”

Testing the HP 8110A 5-9
3. On the HP 8110A press [MORE] and set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

![Configuring Output 1]

![Configuring Output 2]

**Note**

When you are testing instruments with 2 output channels it is necessary to:

a. Configure *both* channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

4. Set the Digitizing Oscilloscope HP 54121T:

- Press [AUTOSCALE]
- Select the Display menu and set the Number of Averages to 32
- Press [MORE] key
- Press [MEASURE] key
- Press [PERIOD] key
5. Check the HP 8110A pulse period at the following settings:

<table>
<thead>
<tr>
<th>Oscilloscope Timebase</th>
<th>Period</th>
<th>Acceptable Range</th>
<th>TR entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ns/div</td>
<td>6.65 ns</td>
<td>6.2175 ns to 7.0825 ns</td>
<td>1 - 1</td>
</tr>
<tr>
<td>2 ns/div</td>
<td>9.90 ns</td>
<td>9.300 ns to 10.380 ns</td>
<td>1 - 2</td>
</tr>
<tr>
<td>2 ns/div</td>
<td>10.0 ns</td>
<td>9.4 ns to 10.6 ns</td>
<td>1 - 3</td>
</tr>
<tr>
<td>10 ns/div</td>
<td>50.0 ns</td>
<td>47.4 ns to 52.6 ns</td>
<td>1 - 4</td>
</tr>
<tr>
<td>20 ns/div</td>
<td>99.9 ns</td>
<td>94.805 ns to 104.965 ns</td>
<td>1 - 5</td>
</tr>
</tbody>
</table>

6. Connect the HP 8110A to the Counter as follows:

7. Set the Counter to:
   - FUNCTION: Period A
   - INPUT A: 50 Ω
   - SENSE: On
8. Check the HP 8110A period at the following settings:

<table>
<thead>
<tr>
<th>Period</th>
<th>Acceptable Range</th>
<th>TR entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ns</td>
<td>94.9 ns to 106.1 ns</td>
<td>1 - 6</td>
</tr>
<tr>
<td>500 ns</td>
<td>474.9 ns to 525.1 ns</td>
<td>1 - 7</td>
</tr>
<tr>
<td>1 μs</td>
<td>940.9 ns to 1050.1 ns</td>
<td>1 - 8</td>
</tr>
<tr>
<td>5 μs</td>
<td>4.75 μs to 5.25 μs</td>
<td>1 - 9</td>
</tr>
<tr>
<td>50 μs</td>
<td>47.5 μs to 52.5 μs</td>
<td>1 - 10</td>
</tr>
<tr>
<td>500 μs</td>
<td>475 μs to 525 μs</td>
<td>1 - 11</td>
</tr>
<tr>
<td>5 ms</td>
<td>4.75 ms to 5.35 ms</td>
<td>1 - 12</td>
</tr>
<tr>
<td>50 ms</td>
<td>47.5 ms to 52.5 ms</td>
<td>1 - 13</td>
</tr>
<tr>
<td>500 ms</td>
<td>475 ms to 525 ms</td>
<td>1 - 14</td>
</tr>
</tbody>
</table>
Test 2: PLL Period

Note

This test is only performed if HP 81106A is installed.

Test Specifications

Range: 6.65 ns to 999 second
Resolution: 4 digits, best case 10 ps
Accuracy: ± 0.1%
RMS-Jitter: 0.003% + 20 ps

Equipment Needed

Counter HP 5335A
Cable, 50 Ω, coaxial, BNC

Note

The HP 5335A counter is used in frequency mode to meet the MIL CAL A uncertainty requirements for TAR (Test Accuracy Ratio) > 4:1.

Procedure

1. Connect the HP 8110A to the counter as follows:

   ![Diagram of HP 8110A and HP 5335A connection]

   Connecting HP 8110A to the Counter

2. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”
3. Select the TRG-MODE screen on the HP 8110A and set up as follows:

The TRG MODE Screen Setup

4. On the HP 8110A set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

Configuring Output Screen 1

Configuring Output Screen 2
When you are testing instruments with 2 output channels it is necessary to:

a. Configure both channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you want to test, and switch Off the other channel.

5. Set the Counter to:

FUNCTION Frequency A
INPUT A 50 Ω
SENSE On

6. Check the HP 8110A PLL pulse period at the following settings:

<table>
<thead>
<tr>
<th>Period</th>
<th>Frequency</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.650 ns</td>
<td>150.3766 MHz</td>
<td>150.2257 MHz to 150.5264 MHz</td>
<td>2 - 1</td>
</tr>
<tr>
<td>9.066 ns</td>
<td>100.010 MHz</td>
<td>99.910 MHz to 100.110 MHz</td>
<td>2 - 2</td>
</tr>
<tr>
<td>10.00 ns</td>
<td>100 MHz</td>
<td>99.900 MHz to 100.100 MHz</td>
<td>2 - 3</td>
</tr>
<tr>
<td>50.00 ns</td>
<td>20 MHz</td>
<td>19.980 MHz to 20.020 MHz</td>
<td>2 - 4</td>
</tr>
<tr>
<td>66.66 ns</td>
<td>10.0010 MHz</td>
<td>9.991 MHz to 10.001 MHz</td>
<td>2 - 5</td>
</tr>
<tr>
<td>100 ns</td>
<td>10 MHz</td>
<td>9.990 MHz to 10.010 MHz</td>
<td>2 - 6</td>
</tr>
<tr>
<td>500 ns</td>
<td>2 MHz</td>
<td>1.998 MHz to 2.002 MHz</td>
<td>2 - 7</td>
</tr>
<tr>
<td>1 μs</td>
<td>1 MHz</td>
<td>999 kHz to 1.001 MHzsec</td>
<td>2 - 8</td>
</tr>
<tr>
<td>5 μs</td>
<td>200 kHz</td>
<td>199.800 kHz to 200.200 kHz</td>
<td>2 - 9</td>
</tr>
<tr>
<td>50 μs</td>
<td>20 kHz</td>
<td>19.980 kHz to 20.020 kHz</td>
<td>2 - 10</td>
</tr>
<tr>
<td>500 μs</td>
<td>2 kHz</td>
<td>1.998 kHz to 2.002 kHz</td>
<td>2 - 11</td>
</tr>
<tr>
<td>5 ms</td>
<td>200 Hz</td>
<td>199.800 Hz to 200.200 Hz</td>
<td>2 - 12</td>
</tr>
<tr>
<td>50 ms</td>
<td>20 Hz</td>
<td>19.980 Hz to 20.020 Hz</td>
<td>2 - 13</td>
</tr>
<tr>
<td>500 ms</td>
<td>2 Hz</td>
<td>1.998 Hz to 2.002 Hz</td>
<td>2 - 14</td>
</tr>
<tr>
<td>5 s</td>
<td>0.2 Hz</td>
<td>0.1998 Hz to 0.2002 Hz</td>
<td>2 - 15</td>
</tr>
</tbody>
</table>
Test 3: Width

Test Specifications

- Range: 3.30 ns to 999 ms
- Resolution: 3 digits, best case 10 ps
- Accuracy: ± 5% ± 250 ps
- RMS-Jitter: 0.03% + 25 ps (0.05% + 25 ps in the range 50 ns to 100 ns)

Equipment Needed

- Digitizing Oscilloscope with Accessories
- Counter
- Cable, 50 Ω, coaxial, BNC

Procedure

1. Connect HP 8110A to the Scope as shown:

   ![Diagram of connection setup]

   Connecting HP 8110A to the Scope

2. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”
3. On the HP 8110A press [MORE] and set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

![Configuring Output Screen 1]

![Configuring Output Screen 2]

**Note**

When you are testing instruments with 2 output channels it is necessary to:

a. Configure *both* channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

4. Set the Digitizing Oscilloscope HP 54121T:

- Press [AUTOSCALE]
- Select the Display menu and set the Number of Averages to 32
- Select the delta V menu and turn the voltage markers On
- Set the preset levels to 50% -50% and press [AUTO LEVEL SET]
- Select the delta t menu and turn the time markers ON
- Set START ON EDGE = POS 1 and STOP ON EDGE = NEG1

5. Change the oscilloscope timebase to 1 ns/div
6. Change the HP 8110A width to 3.3 ns
7. Center the pulse in the Scope display
8. Press the (PRECISE EDGE FIND) key for each new Width setting
9. Check the HP 8110A pulse width at the following settings:

<table>
<thead>
<tr>
<th>Oscilloscope Timebase</th>
<th>Period</th>
<th>Width</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ns/div</td>
<td>200 ns</td>
<td>3.30 ns</td>
<td>2.885 ns to 3.715 ns</td>
<td>3 - 1</td>
</tr>
<tr>
<td>1 ns/div</td>
<td>200 ns</td>
<td>6.60 ns</td>
<td>6.020 ns to 7.180 ns</td>
<td>3 - 2</td>
</tr>
<tr>
<td>2 ns/div</td>
<td>200 ns</td>
<td>9.90 ns</td>
<td>9.240 ns to 10.760 ns</td>
<td>3 - 3</td>
</tr>
<tr>
<td>2 ns/div</td>
<td>200 ns</td>
<td>10.0 ns</td>
<td>9.250 ns to 10.750 ns</td>
<td>3 - 4</td>
</tr>
<tr>
<td>10 ns/div</td>
<td>200 ns</td>
<td>50.0 ns</td>
<td>47.25 ns to 52.75 ns</td>
<td>3 - 5</td>
</tr>
<tr>
<td>20 ns/div</td>
<td>200 ns</td>
<td>99.9 ns</td>
<td>94.655 ns to 105.345 ns</td>
<td>3 - 6</td>
</tr>
<tr>
<td>20 ns/div</td>
<td>1 µs</td>
<td>100 ns</td>
<td>94.75 ns to 105.25 ns</td>
<td>3 - 7</td>
</tr>
<tr>
<td>100 ns/div</td>
<td>1 µs</td>
<td>500 ns</td>
<td>474.75 ns to 525.25 ns</td>
<td>3 - 8</td>
</tr>
</tbody>
</table>
10. Connect the HP 8110A to the Counter as shown:

Connecting HP 8110A to the Counter

11. Set the Counter to:

- **FUNCTION**: TI A → B
- **SENSE**: On
- **INPUT A**: 50 Ω
- **COM A**: On
- **INPUT B**: 50 Ω, negative slope

12. Check the HP 8110A width at the following settings:

<table>
<thead>
<tr>
<th>Period</th>
<th>Width</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 µs</td>
<td>1 µs</td>
<td>949.75 ns to 1050.25 µs</td>
<td>3 - 9</td>
</tr>
<tr>
<td>100 µs</td>
<td>5 µs</td>
<td>4.75 µs to 6.25 µs</td>
<td>3 - 10</td>
</tr>
<tr>
<td>100 µs</td>
<td>50 µs</td>
<td>47.5 µs to 52.5 µs</td>
<td>3 - 11</td>
</tr>
<tr>
<td>10 ms</td>
<td>500 µs</td>
<td>475 µs to 525 µs</td>
<td>3 - 12</td>
</tr>
<tr>
<td>10 ms</td>
<td>5 ms</td>
<td>4.75 ms to 5.25 ms</td>
<td>3 - 13</td>
</tr>
<tr>
<td>999 ms</td>
<td>50 ms</td>
<td>47.5 ms to 52.5 ms</td>
<td>3 - 14</td>
</tr>
<tr>
<td>999 ms</td>
<td>500 ms</td>
<td>475 ms to 525 ms</td>
<td>3 - 15</td>
</tr>
</tbody>
</table>

**Note**

Repeat the entire test for the second channel, if it is installed.
Test 4: Delay

Test Specifications

Range
Fixed: typical 34.0 ns
Variable: 0.00 ns to 999 ms

Resolution
3 digits, best case 10 ps

Accuracy
± 5% ± 1 ns

RMS-Jitter
0.03% + 25 ps (0.05% + 25 ps in the range 50 ns to 100 ns)

Equipment Needed

Digitizing Oscilloscope with Accessories
Pulse Generator
Counter
Cable, 50 Ω, coaxial, BNC

Procedure

1. Connect HP 8110A to the Scope as shown:

   ![Connecting HP 8110A to the Scope](image)

2. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”

3. Set the Pulse Generator to:

   Period 1 μs
   Width 100 ns
   Amplitude 1 V
   Offset 0 V
   Output Enable

5-20 Testing the HP 8110A
4. Select the TRG-MODE screen on the HP 8110A and set up as follows:

The TRG MODE Screen Setup

5. On the HP 8110A set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

Configuring Output Screen 1

Configuring Output Screen 2
When you are testing instruments with 2 output channels it is necessary to:

a. Configure both channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

6. Set the Digitizing Oscilloscope HP 54121T:

- Press [AUTOSCALE]
- Set timebase to TIME/DIV = 10 ns/div
- Center the positive-going edges of the two signals
- Select the Display menu and set the screen function to single; set the number of averages to 32
- Select the Delta V menu and turn the voltage markers ON and assign marker 1 to channel 3 and marker 2 to channel 4
- Set Preset levels to 50% - 50% and press [AUTO LEVEL SET]
- Select the Delta t menu and turn the time markers ON
- Set START ON EDGE = POS1 and STOP ON EDGE = POS 1
- Press the [PRECISE EDGE FIND] key
7. Check the HP 8110A delay at the following settings:

<table>
<thead>
<tr>
<th>Oscilloscope Timebase</th>
<th>Delay</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 ns/div</td>
<td>0.00 ns</td>
<td>fixed Delay</td>
<td>4 - 1</td>
</tr>
<tr>
<td>10 ns/div</td>
<td>5.00 ns</td>
<td>3.75 ns to 6.25 ns</td>
<td>4 - 2</td>
</tr>
<tr>
<td>20 ns/div</td>
<td>9.99 ns</td>
<td>8.49 ns to 11.49 ns</td>
<td>4 - 3</td>
</tr>
<tr>
<td>50 ns/div</td>
<td>49.9 ns</td>
<td>46.5 ns to 53.5 ns</td>
<td>4 - 4</td>
</tr>
<tr>
<td>50 ns/div</td>
<td>99.9 ns</td>
<td>93,006 ns to 105,806 ns</td>
<td>4 - 5</td>
</tr>
<tr>
<td>50 ns/div</td>
<td>999 ns</td>
<td>94 ns to 106 ns</td>
<td>4 - 6</td>
</tr>
<tr>
<td>200 ns/div</td>
<td>500 ns</td>
<td>474 ns to 526 ns</td>
<td>4 - 7</td>
</tr>
</tbody>
</table>

Record the value of the fixed delay and subtract it from the other readings.

8. Connect the HP 8110A to the Counter as follows:

Connecting HP 8110A to the Counter

9. Set HP 8110A to Continuous-Pulses on the TRG MODE screen
10. Set the Counter to:

FUNCTION  TI A — B
SENSE        On
INPUT A     50 Ω
INPUT B     50 Ω

11. Check the HP 8110A delay at the following settings:

Note
Subtract the fixed delay from the other readings

Table 5-9.
Delay Settings and TR Reference

<table>
<thead>
<tr>
<th>Period</th>
<th>Delay</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 μs</td>
<td>1 μs</td>
<td>949 ns to 1051 ns</td>
<td>4 - 8</td>
</tr>
<tr>
<td>100 μs</td>
<td>5 μs</td>
<td>4.740 μs to 5.251 μs</td>
<td>4 - 9</td>
</tr>
<tr>
<td>100 μs</td>
<td>50 μs</td>
<td>47.5 μs to 52.5 μs</td>
<td>4 - 10</td>
</tr>
<tr>
<td>10 ms</td>
<td>500 μs</td>
<td>475 μs to 525 μs</td>
<td>4 - 11</td>
</tr>
<tr>
<td>10 ms</td>
<td>5 ms</td>
<td>4.75 ms to 5.25 ms</td>
<td>4 - 12</td>
</tr>
<tr>
<td>990 ms</td>
<td>50 ms</td>
<td>47.5 ms to 52.5 ms</td>
<td>4 - 13</td>
</tr>
<tr>
<td>990 ms</td>
<td>500ms</td>
<td>475 ms to 525 ms</td>
<td>4 - 14</td>
</tr>
</tbody>
</table>

Note
Repeat the entire test for the second channel, if it is installed.
Test 5: Double Pulse Delay

Test Specifications
- Range: 6.65 ns to 999 ms
- Resolution: 3 digits, best case 10 ps
- Accuracy: ± 5% ± 250 ps

Equipment Needed
- Digitizing Oscilloscope with Accessories
- Counter
- Cable, 50 Ω, coaxial, BNC

Procedure
1. Connect HP 8110A to the Scope as shown:

   ![Diagram](image)

   Connecting HP 8110A to the Scope

   2. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”
3. Select the TRG-MODE screen on the HP 8110A and set up as follows:

![TRG-MODE Screen Setup]

The TRG MODE Screen Setup

4. On the HP 8110A set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

![Configuring Output Screen 1]

Configuring Output Screen 1

![Configuring Output Screen 2]

Configuring Output Screen 2
When you are testing instruments with 2 output channels it is necessary to:

a. Configure both channels.
b. Switch OFF the channel that is not being tested

If you then test the other channel:
c. Switch ON the channel you are testing, and switch OFF the other channel.

5. Set the Digitizing Oscilloscope HP 54121T:
   - Press **[AUTOSCALE]**
   - Center the double pulse signal
   - Select the Display menu and set the Number of Averages to 32
   - Select the Delta V menu and turn the Voltage markers On
   - Set Preset Levels = 50% -50% and press **[AUTO LEVEL SET]**
   - Select the Delta t menu and turn the Time markers On
   - Set START ON EDGE = POS1 and STOP ON EDGE = POS2

6. Press the **[PRECISE EDGE FIND]** key for each new Double Delay setting

7. Check the HP 8110A double delay at the following settings:

<table>
<thead>
<tr>
<th>Oscilloscope Timebase</th>
<th>Double Delay</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 ns/div</td>
<td>6.65 ns</td>
<td>6.6075 ns to 7.3325 ns</td>
<td>5 - 1</td>
</tr>
<tr>
<td>2 ns/div</td>
<td>9.90 ns</td>
<td>9.241 ns to 10.74 ns</td>
<td>5 - 2</td>
</tr>
<tr>
<td>10 ns/div</td>
<td>50.0 ns</td>
<td>47.25 ns to 62.75 ns</td>
<td>5 - 3</td>
</tr>
<tr>
<td>20 ns/div</td>
<td>99.9 ns</td>
<td>94.655 ns to 105.145 ns</td>
<td>5 - 4</td>
</tr>
</tbody>
</table>

**Table 5-10. Double Delay Settings and TR Reference**
8. Connect the HP 8110A to the Counter as shown:

![Diagram of HP 8110A and HP 5334B Counter connection]

**Connecting HP 8110A to the Counter**

9. Set the Counter to:
   - FUNCTION: Period A
   - INPUT A: 50 Ω
   - SENSE: On
   - EXT ARM SELECT:
     a. Start (ST): leading edge
     b. Stop (SP): trailing edge

10. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”

11. Select the TRG-MODE screen on the HP 8110A and set up as follows:

   ![TRG-MODE Screen Setup]

   The TRG MODE Screen Setup
12. On the HP 8110A set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

**Configuring Output Screen 1**

**Configuring Output Screen 2**

**Note**

When you are testing instruments with 2 output channels it is necessary to:

a. Configure both channels.
b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.
13. Check the HP 8110A double pulse delay at the following settings:

Table 5-11.
Double Delay Settings and TR Reference

<table>
<thead>
<tr>
<th>Double Delay</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ns</td>
<td>94.75 ns to 105.25 ns</td>
<td>5 - 5</td>
</tr>
<tr>
<td>500 ns</td>
<td>474.75 ns to 525.25 ns</td>
<td>5 - 6</td>
</tr>
<tr>
<td>1 μs</td>
<td>940.75 ns to 1050.25 μs</td>
<td>5 - 7</td>
</tr>
<tr>
<td>5 μs</td>
<td>47.5 μs to 5.25 μs</td>
<td>5 - 8</td>
</tr>
<tr>
<td>50 μs</td>
<td>47.5 μs to 52.5 μs</td>
<td>5 - 9</td>
</tr>
<tr>
<td>500 μs</td>
<td>475 μs to 525 μs</td>
<td>5 - 10</td>
</tr>
<tr>
<td>5 ms</td>
<td>4.76 ms to 5.25 ms</td>
<td>5 - 11</td>
</tr>
<tr>
<td>50 ms</td>
<td>47.5 ms to 52.5 ms</td>
<td>5 - 12</td>
</tr>
<tr>
<td>500 ms</td>
<td>475 ms to 525 ms</td>
<td>5 - 13</td>
</tr>
</tbody>
</table>

**Note**: Repeat the entire test for the second channel, if it is installed.
**Test 6: Jitter**

The following tests are required:

1. Period Jitter
   a. Internal Oscillator
   b. Internal PLL (if HP 81106A is installed)
2. Width Jitter
3. Delay Jitter

**Test 6.1a: Period Jitter, Internal Oscillator**

**Test Specifications**

- RMS-Jitter: 0.03% + 25 ps (0.05% + 25 ps in the range 50 ns to 100 ns)

**Equipment Needed**

- Digitizing Oscilloscope with Accessories
- Delay Line (22 ns)
- Power Splitter
- Cable, 50 Ω, coaxial, BNC

**Procedure**

1. Connect HP 8110A to the Scope as shown:

   ![Diagram](image)

   **Equipment Set-up for Jitter Test**

2. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”
3. On the HP 8110A set up OUTPUT 1 and OUTPUT 2 as shown in the following illustrations:

Configuring Output Screen 1

Configuring Output Screen 2

When you are testing instruments with 2 output channels it is necessary to:

a. Configure both channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

4. Set the Digitizing Oscilloscope HP 54121T:

- Press (AUTOSCALE)
- Select the Display menu and set the Number of Averages to 64
- Select the Channel menu and set the Attenuation factor of channel 4 to 2
- Set the VOLTS/DIV of channel 4 to 10 mV/div
- Set OFFSET to 250 mV
- Select the Timebase menu and set the TIME/DIV to 100 ps/div
- Center the first positive-going edge of the signal (approximate Delay = 32.4 ns)
- Select the Delta V menu and turn the V markers On
- Set the Marker 1 Position to 245 mV and the Marker 2 Position to 250 mV
- Select the Delta t menu and turn the T Markers On
- Set START ON EDGE = POS1 and STOP ON EDGE = POS1
- Press the [PRECISE EDGE FIND] key

5. RECORD the delta t reading. This is the rise time of the reference signal within a 1% amplitude window of the signal connected to Input 4. This value is needed later to calculate the correct jitter (delta.t.up)

6. Select the Timebase menu and center the second positive-going edge of the signal (approximate Delay = 82.35 ns)

7. Press [MORE] and [HISTOGRAM]
   - Select the Window submenu and set:
   - Source is channel 4
   - Choose the Time Histogram
   - Press [WINDOW MARKER 1] and set it to 245 mV
   - Press [WINDOW MARKER 2] and set it to 250 mV

8. Select the Acquire submenu, set the Number of Samples to 1000 and press [START ACQUIRING]

9. After the data for the time histogram has been acquired (# Samples = 100%), select the Result submenu.

10. Press [MEAN] and [SIGMA]. RECORD the values of sigma

11. The RMS-jitter is calculated as follows:

\[
RMS - jitter = \frac{6\text{sigma} - \text{delta.t.up}}{6}
\]
12. The RMS-jitter for period of 50 ns is 50 ps. Enter the result in the Test Report as TR entry 6.1a - 1

13. Set the HP 8110A period to 500 ns

14. Repeat steps 6 to 11

Note

TIME/DIV = 200 ps/div; approximate Delay = 532 ns

15. The RMS-jitter for period of 500 ns is 175 ps. Enter the result in the Test Report as TR entry 6.1a - 2

Test 6.1b: Period Jitter, Internal PLL (If HP 81106A is installed)

Test Specifications

RMS-Jitter 0.003% ± 20 ps

Equipment Needed

Digitizing Oscilloscope with Accessories
Delay Line (22 ns)
Power Splitter
Cable, 50 Ω, coaxial, BNC

Procedure

1. Connect HP 8110A to the Scope as shown:

2. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”
3. Select the TRG-MODE screen on the HP 8110A and set up as follows:

The TRG MODE Screen Setup

4. On the HP 8110A set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

Configuring Output Screen 1

Configuring Output Screen 2
When you are testing instruments with 2 output channels it is necessary to:

a. Configure both channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

5. Set the Digitizing Oscilloscope HP 54121T:
   - Press **[AUTOSCALE]**
   - Select the Display menu and set the Number of Averages to 64
   - Select the Channel menu and set the Attenuation factor of channel 4 to 2
   - Set the **VOLTS/DIV** of channel 4 to 10 mV/div
   - Set **OFFSET** to 250 mV
   - Select the Timebase menu and set the **TIME/DIV** to 100 ps/div
   - Center the first positive-going edge of the signal (approximate Delay = 32.4 ns)
   - Select the Delta V menu and turn the V markers On
   - Set the Marker 1 Position to 245 mV and the Marker 2 Position to 250 mV
   - Select the Delta t menu and turn the T Markers On
   - Set **START ON EDGE** = POS1 and **STOP ON EDGE** = POS1
   - Press the **[PRECISE EDGE FIND]** key

6. RECORD the delta t reading. This is the rise time of the reference signal within a 1% amplitude window of the signal connected to Input 4. This value is needed later to calculate the correct jitter (delta.t.up)

7. Select the Timebase menu and center the second positive-going edge of the signal (approximate Delay = 52 ns)
8. Press MORE and HISTOGRAM
   - Select the Window submenu and set:
   - Source is channel 4
   - Choose the Time Histogram
   - Press WINDOW MARKER 1 and set it to 245 mV
   - Press WINDOW MARKER 2 and set it to 250 mV

9. Select the Acquire submenu, set the Number of Samples to 1000 and press START ACQUIRING

10. After the data for the time histogram has been acquired (# Samples = 100%), select the Result submenu.

11. Press MEAN and SIGMA. RECORD the values of sigma

12. The RMS-jitter is calculated as follows:

\[ RMS - jitter = \frac{6\text{sigma} - \text{delta.t.up}}{6} \]

13. The RMS-jitter for period of 20 ns is 20.6 ps. Enter the result in the Test Report as TR entry 6.1b - 1
Test 6.2: Width Jitter

**Test Specifications**  
RMS-Jitter  
0.03% + 25 ps (0.05% + 25 ps in the range 50 ns to 100 ns)

**Equipment Needed**  
Digitizing Oscilloscope with Accessories  
Delay Line (22 ns)  
Power Splitter  
Cable, 50 Ω, coaxial, BNC

**Procedure**  
1. Connect HP 8110A to the Scope as shown:

2. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”
3. On the HP 8110A set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

**Configuring Output Screen 1**

**Configuring Output Screen 2**

*Note*

When you are testing instruments with 2 output channels it is necessary to:

a. Configure *both* channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

4. Set the Digitizing Oscilloscope HP 54121T:

   - Press (AUTOSCALE)
   - Select the Display menu and set the Number of Averages to 128
   - Select the Channel menu and set the Attenuation factor of channel 4 to 2
   - Set the VOLTS/DIV of channel 4 to 10 mV/div
   - Set OFFSET to 250 mV
Select the Timebase menu and set the TIME/DIV to 10 ps/div
Center the first negative-going edge of the signal (approximate Delay = 35.5 ns)
Select the Delta V menu and turn the V markers On
Set the Marker 1 Position to 255 mV and the Marker 2 Position to 250 mV
Select the Delta t menu and turn the T Markers On
Set START ON EDGE = NEG1 and STOP ON EDGE = NEG1
Press the [PRECISE EDGE FIND] key

5. RECORD the delta t reading. This is the fall time of the reference signal within a 1% amplitude window of the signal connected to Input 4. This value is needed later to calculate the correct jitter. (delta.t.dn)

6. Set the HP 8110A Pulse Width to 50 ns

7. Select the Timebase menu and center the first negative-going edge of the signal (approximate Delay = 82.5 ns)

8. Press [MORE] and [HISTOGRAM]

9. Select the Window submenu and set:
   - Source is channel 4
   - Choose the Time Histogram
   - Press [WINDOW MARKER 1] and set it to 255 mV
   - Press [WINDOW MARKER 2] and set it to 250 mV

10. Select the Acquire submenu, set the Number of Samples to 1000 and press [START ACQUIRING]

11. After the data for the time histogram has been acquired (# Samples = 100%), select the Result submenu.

12. Press [MEAN] and [SIGMA]. RECORD the value of sigma

13. The RMS-jitter is calculated as follows:

\[
RMS - \text{jitter} = \frac{6\text{sigma} - \text{delta.t.dn}}{6}
\]
14. The RMS-jitter for pulse width of 50 ns is 50 ps.  
Enter the result in the Test Report as TR entry 6.2-1

15. Set the HP 8110A for pulse width of 500ns

16. Repeat steps 7 to 13

Note

TIME/DIV = 200ps/div. Approximate delay = 533 ns

17. The RMS-jitter for pulse width of 500 ns is 175 ps.  
Enter the result in the Test Report as TR entry 6.2-2
Test 6.3: Delay Jitter

Test Specifications
RMS-Jitter
0.03\% + 25 ps (0.05\% + 25 ps in the range 50 ns to 100 ns)

Equipment Needed
Digitizing Oscilloscope with Accessories

Procedure
1. Connect HP 8110A to the Scope as shown:

![Diagram](image)

Equipment Set-up for Delay Jitter Test

2. For calculating the RMS-jitter, the rise time of the reference signal within a 1\% amplitude window is required. If this value is not already measured in the Period Jitter test, then perform the first 6 steps of the Period Jitter test.

3. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”
4. On the HP 8110A press \textit{MORE} and set up \textit{OUTPUT 1} and \textit{OUTPUT 2} pages as shown in the following illustrations:

\textbf{Configuring Output Screen 1}

\textbf{Configuring Output Screen 2}

\textbf{Note}\hspace{1cm}

When you are testing instruments with 2 output channels it is necessary to:

a. Configure \textit{both} channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

5. Set the Digitizing Oscilloscope HP 54121T:

- Press \textit{AUTOSCALE}
- Select the Display menu and set the Number of Averages to 64
- Set the VOLTS/DIV = 10 mV/div
- Set OFFSET to 500 mV
- Select the Timebase menu and set the TIME/DIV to 100 ps/div
Center the first positive-going edge of the signal (approximate Delay = 78.3 ns)

6. Press **MORE** and **HISTOGRAM**

7. Select the Window submenu and press **WINDOW MARKER 1** and set it to 490 mV

8. Press **WINDOW MARKER 2** and set it to 500 mV

9. Select the Acquire submenu, set the Number of Samples to 1000 and press **START ACQUIRING**

10. After the delta for the time histogram has been acquired (# Samples = 100%), select the Result submenu.

11. Press **MEAN** and **SIGMA**. RECORD the values of sigma!

12. The RMS-jitter is calculated as follows:

\[
RMS - jitter = \frac{6 \sigma - \Delta t_{up}}{6}
\]

13. The RMS-jitter for delay of 50 ns is 50 ps. Enter the result in the Test Report as TR entry 6.3 - 1

14. Set HP 8110A for delay of 500 ns

15. Repeat steps 9 to 12

---

**Note**

TIME/DIV = 200 ps/div. Approximate delay = 528.7 ns

---

16. The RMS-jitter for delay of 500 ns is 175 ps. Enter the result in the Test Report as TR entry 6.3 - 2
Test 7: High and Low Levels

The following tests are required:
1. High level from 50Ω into 50Ω
2. Low level from 50Ω into 50Ω
3. High level from 1KΩ into 50Ω
4. Low level from 1KΩ into 50Ω

Test Specifications

<table>
<thead>
<tr>
<th>Load Impedance:50 Ω</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Impedance</td>
<td>50 Ω</td>
</tr>
<tr>
<td>High Level</td>
<td>-9.80 V to -10.0 V</td>
</tr>
<tr>
<td>Low Level</td>
<td>-10.0 V to -9.8 V</td>
</tr>
<tr>
<td>Amplitude</td>
<td>0.10 V to 10.0 V</td>
</tr>
<tr>
<td>Level Resolution</td>
<td>10 mV</td>
</tr>
<tr>
<td>Level Accuracy</td>
<td>±1% of ampl ±50 mV</td>
</tr>
</tbody>
</table>

Equipment Needed

1. Digitizing Voltmeter (DVM)
2. 50 Ω Feedthrough Termination, 0.1%, 10 W Adapter.
3. BNC to dual banana plug (HP 1251-2277)
Procedure  Connect HP 8110A to the DVM as shown:

Connecting the DVM for High and Low Levels Tests
Test 7.1: High Level, 50 Ohms into 50 Ohms

1. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”

2. On the HP 8110A press **MORE** and set up **OUTPUT 1** and **OUTPUT 2** pages as shown in the following illustrations:

   ![Configuring Output Screen 1](image)

   **Configuring Output Screen 1**

   ![Configuring Output Screen 2](image)

   **Configuring Output Screen 2**

   **Note**

   When you are testing instruments with 2 output channels it is necessary to:

   a. Configure *both* channels.

   b. Switch OFF the channel that is not being tested

   If you then test the other channel:

   c. Switch ON the channel you are testing, and switch OFF the other channel.
3. Set the DVM HP 3458A to:

   Function: DCV

   Trigger: TRIG EXT

   AD-Converter integration time NPLC: 0.1
   (Number of Power Line Cycles)

4. Check the HP 8110A high level at the following high level settings with the low level set to 0.0 V.

   Table 5-13.
   High Level Settings (50 ohms - 50 ohms)
   and TR Reference

<table>
<thead>
<tr>
<th>High Level</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0 V</td>
<td>9.86 V to 10.15 V</td>
<td>7.1 - 1</td>
</tr>
<tr>
<td>5.0 V</td>
<td>4.90 V to 5.10 V</td>
<td>7.1 - 2</td>
</tr>
<tr>
<td>3.0 V</td>
<td>2.92 V to 3.08 V</td>
<td>7.1 - 3</td>
</tr>
<tr>
<td>1.0 V</td>
<td>0.94 V to 1.06 V</td>
<td>7.1 - 4</td>
</tr>
<tr>
<td>0.5 V</td>
<td>445 mV to 555 mV</td>
<td>7.1 - 5</td>
</tr>
<tr>
<td>0.1 V</td>
<td>49 mV to 161 mV</td>
<td>7.1 - 6</td>
</tr>
</tbody>
</table>

The low level may vary within ±1% of amplitude ±50 mV
Test 7.2: Low Level, 50 Ohms into 50 Ohms

1. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”

2. On the HP 8110A press MORE and set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

**Configuring Output Screen 1**

**Configuring Output Screen 2**

---

**Note**

When you are testing instruments with 2 output channels it is necessary to:

a. Configure both channels.
b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.
3. Check the HP 8110A low level at the following low level settings with the high level set to 0.0 V

<table>
<thead>
<tr>
<th>Low Level</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.1 V</td>
<td>-49 mV to -151 mV</td>
<td>7.2 - 1</td>
</tr>
<tr>
<td>-0.5 V</td>
<td>-445 mV to -555 mV</td>
<td>7.2 - 2</td>
</tr>
<tr>
<td>-1.0 V</td>
<td>-0.94 V to -1.06 V</td>
<td>7.2 - 3</td>
</tr>
<tr>
<td>-3.0 V</td>
<td>-2.92 V to 3.08 V</td>
<td>7.2 - 4</td>
</tr>
<tr>
<td>-5.0 V</td>
<td>-4.90 V to -5.10 V</td>
<td>7.2 - 5</td>
</tr>
<tr>
<td>-10.0 V</td>
<td>-9.85 V to 10.15 V</td>
<td>7.2 - 6</td>
</tr>
</tbody>
</table>

The high level 0.0 V may vary ±1% of amplitude ±50 mV.
Test 7.3: High Level, 1K Ohms into 50 Ohms

1. Set up the HP 8110A as described in "Initial Setup of the HP 8110A"

2. On the HP 8110A press MORE and set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

![Configuring Output Screen 1](image1)

**Configuring Output Screen 2**

![Configuring Output Screen 2](image2)

**Note**

When you are testing instruments with 2 output channels it is necessary to:

a. Configure both channels.
b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

Testing the HP 8110A  5-51
3. Check the HP 8110A high level at the following high level settings with the low level set to 0.0 V.

Table 5-15.
High Level Settings (1 Kohms - 50 ohms)
and TR Reference

<table>
<thead>
<tr>
<th>High Level</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.0 V</td>
<td>18.71 V to 19.29 V</td>
<td>7.3 - 1</td>
</tr>
<tr>
<td>10.0 V</td>
<td>9.80 V to 10.20 V</td>
<td>7.3 - 2</td>
</tr>
<tr>
<td>5.0 V</td>
<td>4.85 V to 5.15 V</td>
<td>7.3 - 3</td>
</tr>
<tr>
<td>1.0 V</td>
<td>0.89 V to 1.11 V</td>
<td>7.3 - 4</td>
</tr>
<tr>
<td>0.2 V</td>
<td>98 mV to 302 mV</td>
<td>7.3 - 5</td>
</tr>
</tbody>
</table>

The low level 0.0 V may vary ±1% of amplitude ±100 mV.
Test 7.4: Low Level, 1K Ohms into 50 Ohms

1. Set up the HP 8110A as described in "Initial Setup of the HP 8110A"

2. On the HP 8110A press **MORE** and set up **OUTPUT 1** and **OUTPUT 2** pages as shown in the following illustrations:

![Configuring Output Screen 1](image)

**Configuring Output Screen 1**

![Configuring Output Screen 2](image)

**Configuring Output Screen 2**

**Note**

When you are testing instruments with 2 output channels it is necessary to:

a. Configure *both* channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

---

Testing the HP 8110A  5-53
3. Check the HP 8110A low level at the following low level settings with the high level set to 0.0 V.

Table 5-16.
Low Level Settings (1 Kohms - 50 ohms) and TR Reference

<table>
<thead>
<tr>
<th>Low Level</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.2 V</td>
<td>-98 mV to -302 mV</td>
<td>7.4 - 1</td>
</tr>
<tr>
<td>-1.0 V</td>
<td>-0.89 mV to -1.11 V</td>
<td>7.4 - 2</td>
</tr>
<tr>
<td>-5.0 V</td>
<td>-4.85 V to -5.15 V</td>
<td>7.4 - 3</td>
</tr>
<tr>
<td>-10.0 V</td>
<td>-9.80 V to 10.20 V</td>
<td>7.4 - 4</td>
</tr>
<tr>
<td>-19.0 V</td>
<td>-18.71 V to -19.29 V</td>
<td>7.4 - 5</td>
</tr>
</tbody>
</table>

The high level 0.0 V may vary ± 1% of amplitude ± 100 mV

Note

Repeat the High and Low Level tests for the second channel, if it is installed.
Test 8: Transition Time

The following tests are required:

1. \( \leq \pm 5 \text{V window:} \)
   a. Minimum Leading Edge and Leading Edge range
   b. Minimum Trailing Edge and Trailing Edge range

2. \( > \pm 5 \text{V window:} \)
   a. Minimum Leading Edge
   b. Minimum Trailing Edge

**Test Specifications**

<table>
<thead>
<tr>
<th>Range</th>
<th>2.0 ns to 200 ms (measured between 10% and 90% of amplitude)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Transitions</td>
<td>( \leq 2.0 \text{ ns} ) for levels within ( \pm 5 \text{ V window} ), ( &lt; 2.5 \text{ ns} ) for all levels, (typical 1.4 ns for levels within ( \pm 5 \text{ V window measured between 20% and 80% of amplitude} ))</td>
</tr>
<tr>
<td>Resolution</td>
<td>3 digits, best case 10 ps</td>
</tr>
<tr>
<td>Accuracy</td>
<td>( \pm 10% \pm 200 \text{ ps} )</td>
</tr>
<tr>
<td>Linearity</td>
<td>typical 3% for transitions &gt; 100 ns</td>
</tr>
</tbody>
</table>

**Equipment Needed**

Digitizing Oscilloscope with Accessories
Procedure  Perform the tests as shown in the following sections:

Test 8.1a: Leading Edge Test

Minimum Leading Edge and Leading Edge ranges within \( \leq \pm 5V \) window.

1. Connect HP 8110A to the Scope as shown:

![Diagram: Connecting HP 8110A to the Scope]

2. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”
3. On the HP 8110A press MORE and set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

![Configuring Output Screen 1](image1)

**Configuring Output Screen 1**

![Configuring Output Screen 2](image2)

**Configuring Output Screen 2**

When you are testing instruments with 2 output channels it is necessary to:

a. Configure both channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

4. Set the Digitizing Oscilloscope HP 54121T:

- Press [AUTOSCALE]
- Center one pulse on screen, e.g.: TIME/DIV = 50 µs/div, DELAY = 365 µs,
- Select the Display menu and set the Number of Averages to 32
- Select the Channel menu and set the Attenuation factor to 10
Select the Delta V menu and turn the voltage markers On
Set the Preset Levels = 10-90% and press AUTO LEVEL SET
Select the Timebase menu and set TIME/DIV = 2 ns/div, DELAY = 29 ns
Select the Delta t menu and turn the markers On
Set START ON EDGE = POS1 and STOP ON EDGE = POS1

5. Set period of HP 8110A to: Period = 1 µs

6. After the averaging, while the oscilloscope is in the Delta t menu, Press the [PRECISE EDGE FIND] key

7. Check the HP 8110A rise times at the following leading edge settings:

<table>
<thead>
<tr>
<th>Oscilloscope TIME/DIV</th>
<th>Period</th>
<th>Leading Edge</th>
<th>Trailing Edge</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 ns/div</td>
<td>1 µs</td>
<td>1.8 ns *</td>
<td>2 ns</td>
<td>≤2 ns</td>
<td>8.1a - 1</td>
</tr>
<tr>
<td>5 ns/div</td>
<td>1 µs</td>
<td>10 ns</td>
<td>5 ns</td>
<td>8.8 ns to 11.2 ns</td>
<td>8.1a - 2</td>
</tr>
<tr>
<td>10 ns/div</td>
<td>1 µs</td>
<td>50 ns</td>
<td>50 ns</td>
<td>44.8 ns to 55.2 ns</td>
<td>8.1a - 3</td>
</tr>
<tr>
<td>100 ns/div</td>
<td>5 µs</td>
<td>500 ns</td>
<td>500 ns</td>
<td>449.8 ns to 550.2 ns</td>
<td>8.1a - 4</td>
</tr>
<tr>
<td>1 µs/div</td>
<td>50 µs</td>
<td>5 µs</td>
<td>5 µs</td>
<td>4.4998 µs to 5.5002 µs</td>
<td>8.1a - 5</td>
</tr>
<tr>
<td>10 µs/div</td>
<td>500 µs</td>
<td>50 µs</td>
<td>50 µs</td>
<td>45 µs to 50 µs</td>
<td>8.1a - 6</td>
</tr>
<tr>
<td>100 µs/div</td>
<td>5 ms</td>
<td>500 µs</td>
<td>200 µs</td>
<td>450 µs to 550 µs</td>
<td>8.1a - 7</td>
</tr>
<tr>
<td>10 ms/div</td>
<td>500 ms</td>
<td>50 ms</td>
<td>50 ms</td>
<td>45 ms to 55 ms</td>
<td>8.1a - 8</td>
</tr>
</tbody>
</table>

* Programming down to 1.8 ns is allowed, to meet this specification.
Test 8.1b: Trailing Edge Test

Minimum Trailing Edge and Trailing Edge range within $\pm 5V$ window.

1. Set up the HP 8110A as described in "Initial Setup of the HP 8110A"

2. On the HP 8110A press [MORE] and set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

![Configuring Output Screen 1]

![Configuring Output Screen 2]

Note

When you are testing instruments with 2 output channels it is necessary to:

a. Configure both channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.
3. Set the digitizing oscilloscope HP 54121T:
   - Select the oscilloscopes Timebase menu and set
     TIME/DIV to 2 ns/div and DELAY to approximately
     529 ns
   - Select the oscilloscopes Delta t menu and set START
     ON EDGE = NEG1 and STOP ON EDGE = NEG1

4. While the oscilloscope is in the Delta t menu, press the
   PRECISE EDGE FIND key

5. Check the HP 8110A output signal falls at the
   following trailing edge settings:

   Table 5-18.
   Trailing Edge Settings and TR Reference

<table>
<thead>
<tr>
<th>Oscilloscope TIME/DIV</th>
<th>Delay</th>
<th>Period</th>
<th>Trailing Edge</th>
<th>Leading Edge</th>
<th>Acceptable Range</th>
<th>TR Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 ns/div</td>
<td>529 ns</td>
<td>1 μs</td>
<td>1.8 ns *</td>
<td>2 ns</td>
<td>≤ 2 ns</td>
<td>8.1b - 1</td>
</tr>
<tr>
<td>5 ns/div</td>
<td>529 ns</td>
<td>1 μs</td>
<td>10 ns</td>
<td>5 ns</td>
<td>8.8 ns to 11.2 ns</td>
<td>8.1b - 2</td>
</tr>
<tr>
<td>10 ms/div</td>
<td>529 ns</td>
<td>1 μs</td>
<td>50 ns</td>
<td>50 ns</td>
<td>44.8 ns to 55.2 ns</td>
<td>8.1b - 3</td>
</tr>
<tr>
<td>100 ns/div</td>
<td>25 μs</td>
<td>5 μs</td>
<td>500 ns</td>
<td>50 ns</td>
<td>449.8 ns to 550.2 ns</td>
<td>8.1b - 4</td>
</tr>
<tr>
<td>1 μs/div</td>
<td>25 μs</td>
<td>50 μs</td>
<td>5 μs</td>
<td>5 μs</td>
<td>4.4968 μs to 5.5002 μs</td>
<td>8.1b - 5</td>
</tr>
<tr>
<td>10 μs/div</td>
<td>250 μs</td>
<td>500 μs</td>
<td>50 μs</td>
<td>50 μs</td>
<td>45 μs to 55 μs</td>
<td>8.1b - 6</td>
</tr>
<tr>
<td>100 μs/div</td>
<td>2.5 ms</td>
<td>5 ms</td>
<td>600 μs</td>
<td>200 μs</td>
<td>450 μs to 550 μs</td>
<td>8.1b - 7</td>
</tr>
<tr>
<td>10 ms/div</td>
<td>250 ms</td>
<td>600 ms</td>
<td>50 ms</td>
<td>50 ms</td>
<td>45 ms to 55 ms</td>
<td>8.1b - 8</td>
</tr>
</tbody>
</table>

   * Programming down to 1.8 ns is allowed, to meet this
     specification.
Test 8.2a: Min. Leading edge for Level Window \( > \pm 5V \)

1. Connect HP 8110A to the Scope as shown:

Connecting HP 8110A to the Scope

2. Set up the HP 8110A as described in "Initial Setup of the HP 8110A"

3. On the HP 8110A press [MORE] and set up OUTPUT 1 and OUTPUT 2 pages as shown in the following illustrations:

Configuring Output Screen 1

Configuring Output Screen 2
When you are testing instruments with 2 output channels it is necessary to:

a. Configure both channels.
b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

4. Set the Digitizing Oscilloscope HP 54121T:

   • Press [AUTOSCALE]
   • Select the Display menu and set the Number of Averages to 32
   • Select the Channel menu and set the Attenuation factor to 20
   • Select the Timebase menu and set TIME/DIV = 50 µs/div, DELAY = 365 µs
   • Select the Delta V menu and turn the voltage markers On
   • Set the Preset Levels = 10-90% and press [AUTO LEVEL SET]
   • Select the Timebase menu and set TIME/DIV = 2 ns/div, DELAY = 29 ns
   • Select the Delta t menu and turn the markers On
   • Set START ON EDGE = POS1 and STOP ON EDGE = POS1

5. Set HP 8110A Period = 1 µs

6. On the Scope press [PRECISE EDGE FIND] in the Delta t menu

7. Check that the HP 8110A rise time is < 2.5 ns

8. Enter the result in the Test Report as TR entry 8.2a - 1
Test 8.2b: Min. Trailing edge for Level Window ≥±5v

1. Set the Scope timebase to:
   ■ TIME/DIV = 2 ns/div
   ■ DELAY = 529 ns
   ■ Select the Delta t menu and turn the markers ON
   ■ Set START ON EDGE = NEG1 and STOP ON EDGE = NEG1
   ■ Press [Precise Edge Find]

2. Check that the HP 8110A fall time is < 2.5 ns

3. Enter the result in the Test Report as TR entry 8.2b - 1

Note: Repeat the entire test for the second channel, if it is installed
Test 9: Pulse Aberration Test

The following tests are required:

Overshoot and Ringing
Preshoot

Test Specifications
Overshoot/Preshoot/Ringing
±5% of amplitude ±20 mV

Equipment Needed
Digitizing Oscilloscope with Accessories

Procedure

1. Connect HP 8110A to the Scope as shown:

Connecting HP 8110A to the Scope

2. Set up the HP 8110A as described in “Initial Setup of the HP 8110A”
3. On the HP 8110A press \textit{MORE} and set up \textit{OUTPUT 1} and \textit{OUTPUT 2} pages as shown in the following illustrations:

![Configuring Output Screen 1](image1)

![Configuring Output Screen 2](image2)

\textbf{Note}

When you are testing instruments with 2 output channels it is necessary to:

a. Configure \textit{both} channels.

b. Switch OFF the channel that is not being tested

If you then test the other channel:

c. Switch ON the channel you are testing, and switch OFF the other channel.

\textbf{Overshoot and Ringing}

4. Set the digitizing oscilloscope HP 54121T:

- Press \textit{AUTOSCALE}
- Select the Display menu and set the Number of Averages to 32
- Select the Channel menu and set the Attenuation factor to 10

\textit{Testing the HP 8110A}  \textit{5-65}
- Center one pulse horizontally and vertically on screen (e.g. TIME/DIV = 50μs/div, DELAY = 365 μs)
- Select the delta V menu and turn the voltage markers On
- Set the VARIABLE LEVELS = 95% - 105% and press [AUTO LEVEL SET]
- Select the channel menu and center vertically the top pulse (offset = 5 V)
- Set the VOLTS/DIV = 200 mV/div
- Select the Timebase menu and set TIME/DIV = 5 ns/div, DELAY = 16 ns

5. Set the HP 8110A to period = 500 ns

6. Check that Overshoot and Ringing are within the ±5% of amplitude ±20 mV window

7. Enter the result in the Test Report as TR entry 9 - 1

---

**Note**

Take the oscilloscope's trace flatness error (GaAs input circuit) into account.

---

8. Set HP 8110A to: high level = 500 mV

9. Repeat the Overshoot and Ringing test, but this time set the VARIABLE LEVELS = 91% - 109% and press [AUTO LEVEL SET]

10. Enter the result in the Test Report as TR entry 9 - 2

---

**Preshoot**

11. Set HP 8110A to:
- Period = 500 μs
- High Level = 5 V
- Low Level = 0 V
- Delay = 10 ns

12. Set the digitizing oscilloscope, HP 54121T:
- Press [AUTOSCALE]
- Select the Display menu and set the Number of Averages to 32
Select the Channel menu and set the Attenuation factor to 10
- Center one pulse horizontally and vertically on screen (e.g. TIME/DIV = 50μs/div, DELAY = 365 μs)
- Select the delta V menu and turn the voltage markers On
- Set the VARIABLE LEVELS = -5% to +5% and press (AUTO LEVEL SET)
- Select the channel menu and center vertically the bottom of the pulse (offset = 0 V)
- Set the VOLTS/DIV = 200 mV/div
- Select the Timebase menu and set TIME/DIV = 5 ns/div, DELAY = 16 ns

13. Set HP 8110A to period = 500 ns

14. Check that Preshoot is within the ±5% of amplitude ±20 mV window.

15. Enter the result in the Test Report as TR entry 9 - 3
HP 8110A Performance Test Records

Test Facility:

_________________________  Report No.  __________________________

_________________________  Date  __________________________

_________________________  Customer  __________________________

_________________________  Tested By  __________________________

Model  HP 8110A 150 MHz Pulse Generator

Serial No.  ___________________  Ambient temperature  ___ °C

Options  ___________________

_________________________

_________________________

Firmware Rev.  ___________________  Line frequency  ___ Hz

Special Notes:

_________________________

_________________________

_________________________

_________________________

5-68  Testing the HP 8110A
<table>
<thead>
<tr>
<th>Description</th>
<th>Model No.</th>
<th>Trace No.</th>
<th>Cal. Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Oscilloscope</td>
<td>HP 54121T</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Counter</td>
<td>HP 5334B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Digital Voltmeter</td>
<td>HP 3458A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Pulse Generator</td>
<td>HP 8112A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Delay Line</td>
<td>HP 54008A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Test Results for HP 8110A Mainframe

Serial No.  ________________ Ambient temperature  __________ °C
Customer  ________________ Relative humidity  __________ %
CSO#      ________________ Line frequency  __________ Hz
Tested by  ________________ Date  __________

Comments:
______________________________________________________________
______________________________________________________________
______________________________________________________________
### Internal Oscillator Period

Scope Uncertainty factor

<table>
<thead>
<tr>
<th>TR Entry</th>
<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 1</td>
<td>6.65 ns</td>
<td>6.2175 ns</td>
<td></td>
<td>7.0825 ns</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>1 - 2</td>
<td>9.99 ns</td>
<td>9.390 ns</td>
<td></td>
<td>10.589 ns</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>1 - 3</td>
<td>10.0 ns</td>
<td>9.4 ns</td>
<td></td>
<td>10.6 ns</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>1 - 4</td>
<td>50.0 ns</td>
<td>47.4 ns</td>
<td></td>
<td>52.6 ns</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>1 - 5</td>
<td>99.9 ns</td>
<td>94.805 ns</td>
<td></td>
<td>104.995 ns</td>
<td>___</td>
<td>___</td>
</tr>
</tbody>
</table>

Counter Uncertainty factor

<table>
<thead>
<tr>
<th>TR Entry</th>
<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 6</td>
<td>100 ns</td>
<td>94.9 ns</td>
<td></td>
<td>105.1 ns</td>
</tr>
<tr>
<td>1 - 7</td>
<td>500 ns</td>
<td>474.9 ns</td>
<td></td>
<td>525.1 ns</td>
</tr>
<tr>
<td>1 - 8</td>
<td>1 μs</td>
<td>949.9 ns</td>
<td></td>
<td>1050.1 ns</td>
</tr>
</tbody>
</table>
### Internal Oscillator Period (continued)

<table>
<thead>
<tr>
<th>TR Entry</th>
<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 9</td>
<td>5 μs</td>
<td>4.75μs</td>
<td></td>
<td>5.25 μs</td>
<td></td>
</tr>
<tr>
<td>1 - 10</td>
<td>50 μs</td>
<td>47.5 μs</td>
<td></td>
<td>52.5 μs</td>
<td></td>
</tr>
<tr>
<td>1 - 11</td>
<td>500 μs</td>
<td>475 μs</td>
<td></td>
<td>525 μs</td>
<td></td>
</tr>
<tr>
<td>1 - 12</td>
<td>5 ms</td>
<td>4.75ms</td>
<td></td>
<td>5.35 ms</td>
<td></td>
</tr>
<tr>
<td>1 - 13</td>
<td>50 ms</td>
<td>47.5 ms</td>
<td></td>
<td>52.5 ms</td>
<td></td>
</tr>
<tr>
<td>1 - 14</td>
<td>500 ms</td>
<td>475 ms</td>
<td></td>
<td>525 ms</td>
<td></td>
</tr>
</tbody>
</table>

### Internal Period Jitter

Scope Uncertainty factor

<table>
<thead>
<tr>
<th>TR Entry</th>
<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2 - 1</td>
<td>50 ns</td>
<td></td>
<td>50 ps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2 - 2</td>
<td>500 ns</td>
<td></td>
<td>175 ps</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Test Results for HP 81103A 2ns/10V Output Board

Serial No. _______________ Ambient temperature __________ °C
Customer _______________ Relative humidity ________ %
CSO# _______________ Line frequency __________ Hz
Tested by _______________ Date __________

Comments:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Width
Scope Uncertainty factor

<table>
<thead>
<tr>
<th>TR Entry</th>
<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - 1</td>
<td>3.30 ns</td>
<td>2.885 ns</td>
<td></td>
<td>3.715 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 2</td>
<td>6.60 ns</td>
<td>6.020 ns</td>
<td></td>
<td>7.180 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 3</td>
<td>9.99 ns</td>
<td>9.240 ns</td>
<td></td>
<td>10.739 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 4</td>
<td>10.0 ns</td>
<td>9.250 ns</td>
<td></td>
<td>10.750 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 5</td>
<td>50.0 ns</td>
<td>47.25 ns</td>
<td></td>
<td>52.75 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 6</td>
<td>99.9 ns</td>
<td>94.655 ns</td>
<td></td>
<td>105.145 ns</td>
<td></td>
<td></td>
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<tr>
<td>3 - 7</td>
<td>100 ns</td>
<td>94.75 ns</td>
<td></td>
<td>105.25 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 8</td>
<td>500 ns</td>
<td>474.75 ns</td>
<td></td>
<td>525.25 ns</td>
<td></td>
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### Width (continued)

Counter Uncertainty factor

<table>
<thead>
<tr>
<th>TR Entry</th>
<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - 9</td>
<td>1 μs</td>
<td>949.75 ns</td>
<td></td>
<td>1050.25 μs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 10</td>
<td>5 μs</td>
<td>4.75 μs</td>
<td></td>
<td>5.25 μs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 11</td>
<td>50 μs</td>
<td>47.5 μs</td>
<td></td>
<td>52.5 μs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 12</td>
<td>500 μs</td>
<td>475 μs</td>
<td></td>
<td>525 μs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 13</td>
<td>5 ms</td>
<td>4.75 ms</td>
<td></td>
<td>5.25 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 14</td>
<td>50 ms</td>
<td>47.5 ms</td>
<td></td>
<td>52.5 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - 15</td>
<td>500 ms</td>
<td>475 ms</td>
<td></td>
<td>525 ms</td>
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### Width Jitter

Scope Uncertainty factor

<table>
<thead>
<tr>
<th>TR Entry</th>
<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2 - 1</td>
<td>50 ns</td>
<td></td>
<td>50 ps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2 - 2</td>
<td>500 ns</td>
<td></td>
<td>175 ps</td>
<td></td>
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Delay

Scope Uncertainty factor

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<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 - 1</td>
<td>0.00 ns</td>
<td></td>
<td></td>
<td>Fixed Delay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 2</td>
<td>5.00 ns</td>
<td>3.75 ns</td>
<td></td>
<td>6.25 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 3</td>
<td>9.99 ns</td>
<td>8.49 ns</td>
<td></td>
<td>11.49 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 4</td>
<td>50.0 ns</td>
<td>46.5 ns</td>
<td></td>
<td>53.5 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 5</td>
<td>99.9 ns</td>
<td>93.905 ns</td>
<td></td>
<td>105.895 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 6</td>
<td>100 ns</td>
<td>94 ns</td>
<td></td>
<td>106 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 7</td>
<td>500 ns</td>
<td>474 ns</td>
<td></td>
<td>526 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Delay (continued)

Counter Uncertainty factor

<table>
<thead>
<tr>
<th>TR Entry</th>
<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 - 8</td>
<td>1 µs</td>
<td>949 ns</td>
<td></td>
<td>1051 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 9</td>
<td>5 µs</td>
<td>4.749 µs</td>
<td></td>
<td>5.251 µs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 10</td>
<td>50 µs</td>
<td>47.5 µs</td>
<td></td>
<td>52.5 µs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 11</td>
<td>500 µs</td>
<td>475 µs</td>
<td></td>
<td>525 µs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 12</td>
<td>5 ms</td>
<td>4.75 ms</td>
<td></td>
<td>5.25 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 13</td>
<td>50 ms</td>
<td>47.5 ms</td>
<td></td>
<td>52.5 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 14</td>
<td>500ms</td>
<td>475 ms</td>
<td></td>
<td>525 ms</td>
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</tr>
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</table>

5-76 Testing the HP 8110A
## Delay Jitter

Scope Uncertainty factor

<table>
<thead>
<tr>
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<th>Test</th>
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<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3 - 1</td>
<td></td>
<td></td>
<td>50 ps</td>
<td>175 ps</td>
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<td>6.3 - 2</td>
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### Double Pulse Delay

#### Scope Uncertainty factor

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<th>Limit Maximum</th>
<th>Pass Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 - 1</td>
<td>6.65 ns 6.0675 ns</td>
<td></td>
<td></td>
<td>7.2325 ns</td>
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<tr>
<td>5 - 2</td>
<td>9.99 ns 9.241 ns</td>
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<td></td>
<td>10.74 ns</td>
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<tr>
<td>5 - 3</td>
<td>50.0 ns 47.25 ns</td>
<td></td>
<td></td>
<td>52.75 ns</td>
<td></td>
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<tr>
<td>5 - 4</td>
<td>99.9 ns 94.655 ns</td>
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<td>105.145 ns</td>
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#### Counter Uncertainty factor

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<th>Limit Maximum</th>
<th>Pass Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 - 5</td>
<td>100 ns 94.75 ns</td>
<td></td>
<td></td>
<td>105.25 ns</td>
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<tr>
<td>5 - 6</td>
<td>500 ns 474.75 ns</td>
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<td></td>
<td>525.25 ns</td>
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<tr>
<td>5 - 7</td>
<td>1 μs 949.75 ns</td>
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<td></td>
<td>1050.25 μs</td>
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<td>5 - 8</td>
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<td>5 - 10</td>
<td>500 μs 475 μs</td>
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<td>525 μs</td>
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<tr>
<td>5 - 11</td>
<td>5 ms 4.75 ms</td>
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<td>5.25 ms</td>
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<tr>
<td>5 - 12</td>
<td>50 ms 47.5 ms</td>
<td></td>
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<td>52.5 ms</td>
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<tr>
<td>5 - 13</td>
<td>500 ms 475 ms</td>
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<td>525 ms</td>
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### High Level 500-500

<table>
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<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
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<tbody>
<tr>
<td>7.1 - 1</td>
<td>10.0 V</td>
<td>9.85 V</td>
<td></td>
<td>10.15 V</td>
<td></td>
<td></td>
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<tr>
<td>7.1 - 2</td>
<td>5.0 V</td>
<td>4.90 V</td>
<td></td>
<td>5.10 V</td>
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<td></td>
</tr>
<tr>
<td>7.1 - 3</td>
<td>3.0 V</td>
<td>2.92 V</td>
<td></td>
<td>3.08 V</td>
<td></td>
<td></td>
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<tr>
<td>7.1 - 4</td>
<td>1.0 V</td>
<td>0.94 V</td>
<td></td>
<td>1.06 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1 - 5</td>
<td>0.5 V</td>
<td>445 mV</td>
<td></td>
<td>555 mV</td>
<td></td>
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<tr>
<td>7.1 - 6</td>
<td>0.1 V</td>
<td>49 mV</td>
<td></td>
<td>151 mV</td>
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### High Level 1K0-500

<table>
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<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.3 - 1</td>
<td>19.0 V</td>
<td>18.71 V</td>
<td></td>
<td>19.29 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3 - 2</td>
<td>10.0 V</td>
<td>9.80 V</td>
<td></td>
<td>10.20 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3 - 3</td>
<td>5.0 V</td>
<td>4.85 V</td>
<td></td>
<td>5.15 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3 - 4</td>
<td>1.0 V</td>
<td>0.89 V</td>
<td></td>
<td>1.11 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3 - 5</td>
<td>0.2 V</td>
<td>98 mV</td>
<td></td>
<td>302 mV</td>
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</tbody>
</table>
### Low Level 500-50Ω

<table>
<thead>
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<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
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</thead>
<tbody>
<tr>
<td>7.2 - 1</td>
<td>-0.1 V</td>
<td>-49 mV</td>
<td></td>
<td>-151 mV</td>
<td></td>
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</tr>
<tr>
<td>7.2 - 2</td>
<td>-0.5 V</td>
<td>-445 mV</td>
<td></td>
<td>-555 mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2 - 3</td>
<td>-1.0 V</td>
<td>-0.94 V</td>
<td></td>
<td>-1.06 V</td>
<td></td>
<td></td>
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<tr>
<td>7.2 - 4</td>
<td>-3.0 V</td>
<td>-2.92 V</td>
<td></td>
<td>3.08 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2 - 5</td>
<td>-5.0 V</td>
<td>-4.90 V</td>
<td></td>
<td>-5.10 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2 - 6</td>
<td>-10.0 V</td>
<td>-9.85 V</td>
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<td>10.15 V</td>
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### Low Level 1KΩ-50Ω

<table>
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<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
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</thead>
<tbody>
<tr>
<td>7.4 - 1</td>
<td>-0.2 V</td>
<td>-98 mV</td>
<td></td>
<td>-302 mV</td>
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<td></td>
</tr>
<tr>
<td>7.4 - 2</td>
<td>-1.0 V</td>
<td>-0.89 mV</td>
<td></td>
<td>-1.11 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.4 - 3</td>
<td>-5.0 V</td>
<td>-4.85 V</td>
<td></td>
<td>-5.15 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.4 - 4</td>
<td>-10.0 V</td>
<td>-9.80 V</td>
<td></td>
<td>10.20 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.4 - 5</td>
<td>-19.0 V</td>
<td>-18.71 V</td>
<td></td>
<td>-19.29 V</td>
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</table>
Leading Edge for $\leq \pm 5V$ Level Window

Scope Uncertainty factor

<table>
<thead>
<tr>
<th>TR Entry</th>
<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1a - 1</td>
<td>1.8 ns</td>
<td></td>
<td></td>
<td>$\leq 2$ ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1a - 2</td>
<td>10 ns</td>
<td>8.8 ns</td>
<td></td>
<td>11.2 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1a - 3</td>
<td>50 ns</td>
<td>44.8 ns</td>
<td></td>
<td>55.2 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1a - 4</td>
<td>500 ns</td>
<td>449.8 ns</td>
<td></td>
<td>550.2 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1a - 5</td>
<td>5 $\mu$s</td>
<td>4.4998 $\mu$s</td>
<td></td>
<td>5.5002 $\mu$s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1a - 6</td>
<td>50 $\mu$s</td>
<td>45 $\mu$s</td>
<td></td>
<td>55 $\mu$s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1a - 7</td>
<td>500 $\mu$s</td>
<td>450 $\mu$s</td>
<td></td>
<td>550 $\mu$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1a - 8</td>
<td>50 ms</td>
<td>45 ms</td>
<td></td>
<td>55 ms</td>
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### Trailing Edge for $\leq \pm 5$V Level Window

<table>
<thead>
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<th>TR Entry</th>
<th>Test</th>
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<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1b - 1</td>
<td>1.8 ns</td>
<td></td>
<td></td>
<td>$\leq 2$ ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1b - 2</td>
<td>10 ns</td>
<td>8.8 ns</td>
<td></td>
<td>11.2 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1b - 3</td>
<td>50 ns</td>
<td>44.8 ns</td>
<td></td>
<td>55.2 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1b - 4</td>
<td>500 ns</td>
<td>449.8 ns</td>
<td></td>
<td>550.2 ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1b - 5</td>
<td>5 $\mu$s</td>
<td>4.4998 $\mu$s</td>
<td></td>
<td>5.5002 $\mu$s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1b - 6</td>
<td>50 $\mu$s</td>
<td>45 $\mu$s</td>
<td></td>
<td>55 $\mu$s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1b - 7</td>
<td>500 $\mu$s</td>
<td>450 $\mu$s</td>
<td></td>
<td>550 $\mu$s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1b - 8</td>
<td>50 ms</td>
<td>45 ms</td>
<td></td>
<td>55 ms</td>
<td></td>
<td></td>
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### Leading Edge for $> \pm 5$V Level Window

<table>
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<tr>
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<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.2a - 1</td>
<td>2 $\mu$s</td>
<td></td>
<td></td>
<td>$&lt; 2.5$ $\mu$s</td>
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### Trailing Edge for > ±5V Level Window

<table>
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<th>Test Limit</th>
<th>Actual Limit</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.2b - 1</td>
<td>2 µs</td>
<td></td>
<td>&lt;2.5 µs</td>
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</table>

### Overshoot and Ringing

Scope Uncertainty factor

<table>
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<th>Test Limit</th>
<th>Actual Limit</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 - 1</td>
<td>5V</td>
<td>±5% of ampl.</td>
<td></td>
</tr>
<tr>
<td>9 - 2</td>
<td>500mV</td>
<td>±5% of ampl.</td>
<td></td>
</tr>
</tbody>
</table>

### Preshoot

<table>
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<th>Test Limit</th>
<th>Actual Limit</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 - 3</td>
<td>0 V</td>
<td>±5% of ampl.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>±20mV</td>
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</tr>
</tbody>
</table>
Test Results for HP 81106A PLL/External Clock Board

Serial No. ___________ Ambient temperature ________ °C
Customer ___________ Relative humidity ________ %
CSO# ___________ Line frequency ________ Hz
Tested by ___________ Date ________

Comments:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
### PLL Period
(Results measured as frequency by counter)

<table>
<thead>
<tr>
<th>TR Entry</th>
<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - 1</td>
<td>6.650 ns</td>
<td>150.3759 MHz</td>
<td></td>
<td>150.5264 MHz</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>2 - 2</td>
<td>9.999 ns</td>
<td>99.910 MHz</td>
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<td>100.110 MHz</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>2 - 3</td>
<td>10.00 ns</td>
<td>99.900 MHz</td>
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<td>100.100 MHz</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>2 - 4</td>
<td>50.00 ns</td>
<td>19.980 MHz</td>
<td></td>
<td>20.020 MHz</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>2 - 5</td>
<td>99.99 ns</td>
<td>9.991 MHz</td>
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<td>10.011 MHz</td>
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<tr>
<td>2 - 6</td>
<td>100 ns</td>
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<td>10.010 MHz</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>2 - 7</td>
<td>500 ns</td>
<td>1.998 MHz</td>
<td></td>
<td>2.002 MHz</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>2 - 8</td>
<td>1 µs</td>
<td>999 kHz</td>
<td></td>
<td>1.001 MHz</td>
<td>____</td>
<td>____</td>
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<tr>
<td>2 - 9</td>
<td>5 µs</td>
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<td>200.200 kHz</td>
<td>____</td>
<td>____</td>
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<tr>
<td>2 - 10</td>
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<td>20.020 kHz</td>
<td>____</td>
<td>____</td>
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<tr>
<td>2 - 11</td>
<td>500 µs</td>
<td>1.998 kHz</td>
<td></td>
<td>2.002 kHz</td>
<td>____</td>
<td>____</td>
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<td>2 - 12</td>
<td>5 ms</td>
<td>199.800 Hz</td>
<td></td>
<td>200.200 Hz</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>2 - 13</td>
<td>50 ms</td>
<td>19.980 Hz</td>
<td></td>
<td>20.020 Hz</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>2 - 14</td>
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<td></td>
<td>2.002 Hz</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>2 - 15</td>
<td>5 s</td>
<td>0.1998 Hz</td>
<td></td>
<td>0.2002 Hz</td>
<td>____</td>
<td>____</td>
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</table>
PLL Period Jitter

Scope Uncertainty factor

<table>
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<tr>
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<th>Test</th>
<th>Limit Minimum</th>
<th>Actual Result</th>
<th>Limit Maximum</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1b - 1</td>
<td>20 ns</td>
<td>_____________</td>
<td>20.6 ps</td>
<td>___ ___</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Specifications

Specifications describe the instrument's warranted performance. Non-warranted values are described as typical. All specifications apply after a 30 minute warm-up phase with 50 Ohm source, a 50 Ohm load resistance and separate channels. They are valid from 0°C to 55°C ambient temperature.

General

Environmental

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature:</td>
<td>0°C to +55°C</td>
</tr>
<tr>
<td>Storage temperature:</td>
<td>-40°C to +70°C</td>
</tr>
<tr>
<td>Humidity:</td>
<td>95% r.h. up to 40°C ambient temperature</td>
</tr>
<tr>
<td>EMC:</td>
<td>conforms to EN50082-1, EN55011, Class A</td>
</tr>
<tr>
<td>Battery:</td>
<td>Lithium (Panasonic CR2477-1HF)</td>
</tr>
</tbody>
</table>

Safety  IEC1010, CSA1010

Power requirements  100-240 Vac, ±10%, 50-60 Hz;
                   100-120 Vac, ±10%, 400 Hz
                   Power consumption: 300 VA max.
Maximum Dimensions (H x W x D)
89 mm x 426 mm x 445 mm
(3.5 in x 17.0 in x 17.5 in)

Weight
Net
8.5 kg (18.7 lb) Single Channel
9.2 kg (20.2 lb) Dual Channel

Shipping
13.8 kg (30.3 lb) Dual Channel

Recalibration period
1 year recommended

Warranty
3 years standard

Acoustic Noise Emission

Acoustic Noise Emission
For ambient temperature up to 30°C, under normal operation and at the typical operator position:

LpA = 46 dB

Measured in accordance with ISO 7779/EN 2779.

Geräuschemissionswerte
Bei einer Umgebungstemperatur bis 30°C

LpA = 46 dB

am Arbeitsplatz, normaler Betrieb.

Angabe ist das Ergebnis einer Typprüfung nach ISO 7779/EN 2779.
Declaration of Conformity

Manufacturer: Hewlett-Packard GmbH
Böblingen Instruments Division
Herrenberger Str. 130
71034 Böblingen Germany

We declare that the product

HP 8110A 150 MHz Pulse Generator conforms to the following standards:

Safety: IEC 1010 (1990)

EMC: EN 55011 (1991)/CISPR 11 Group 1, Class A
EN 50082-1 (1991)
IEC 801–2 ESD: 4kV cd, 8kV ad
IEC 801–3 Radiated Immunity: 3V/m
IEC 801–4 Fast Transients: 0.5kV, 1kV

Supplementary Information

During the measurement against EN 55011, the \( R \)/\( O \) ports were terminated with their normal impedance, the HP–IB connector was terminated with the cable HP 10833B. When the product is connected to other devices, the user must ensure that the connecting cables and the other devices are adequately shielded to prevent radiation.

Böblingen 19th April 1993

Robert Hofgardner
Quality Assurance Manager
HP 8110A Mainframe

HP 8110A 150 MHz Pulse Generator Mainframe

Timing

Period

Period can also be entered as frequency.

<table>
<thead>
<tr>
<th>Range: 6.65 ns to 990 ns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution: 5 digits, 10 ps best case¹</td>
</tr>
<tr>
<td>Accuracy: ±5% ± 100 ps¹</td>
</tr>
<tr>
<td>RMS-jitter: 0.03% ± 25 ps²</td>
</tr>
<tr>
<td>Frequency range: 1.00 Hz to 150 MHz</td>
</tr>
</tbody>
</table>

¹ This specification is improved if the HP 81106A PLL/External Clock module is fitted, see “HP 81106A PLL/External Clock for the HP 8110A”
² 0.05% ± 25 ps for 50–100 ns

Configuration

The HP 8110A mainframe can be configured with the following modules:

<table>
<thead>
<tr>
<th>Module</th>
<th>Description</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP 81103A</td>
<td>10 V/2 ns Output Channel</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>HP 81106A</td>
<td>PLL/External Clock</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>HP 81107A</td>
<td>Multichannel Deserializer</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Channel Addition

With two output channels fitted, 2-, 3- and 4-level complex signals can be generated by adding channel 2 to channel 1 at the OUTPUT 1 connector. OUTPUT 2 is disabled.

Output Modes

Pulses Mode

The output signal consists of single or double pulses, controlled by the Trigger mode.
Burst Mode

The output signal consists of bursts of single or double pulses, controlled by the Trigger mode.

| Burst count: | 2 to 65536 |
| Format: | single or double pulses |

Pattern Mode

The output signal consists of patterns of RZ or NRZ pulses, controlled by the Trigger mode.

| Pattern length: | 4096 bits/channel including STROBE OUT |
| Format: | RZ (return-to-zero) |
| | NRZ (non-return-to-zero) |
| | DNRRZ (delayed non-return-to-zero) |
| Random pattern: | PRBS $2^n - 1$, n = 7, 8, 9, 10, 11, 12 |
| | CCITT 0.151 standard |

Trigger Modes

Continuous

Generate continuous pulses, double pulses, bursts or patterns.

Triggered

Each active input transition (rising, falling or both) triggers a single or double pulse, a burst or a pattern.

The trigger source can be selected from:

- External Input
- [MAN] Manual Trigger key
- PLL, if HP 81106A PLL/External Clock is fitted. The first pulse is undistorted.
Gated

The active input level (high or low) enables pulses, double pulses, bursts or patterns. The last pulse, double pulse, burst or pattern is always completed. The gate source can be selected from:

- External Input
- Manual Trigger key

External Width

The period and width of an External Input signal are maintained, levels, delay and transitions can be set.

| Maximum Frequency: | 100 MHz |

External Input

⚠️

<table>
<thead>
<tr>
<th>Input impedance:</th>
<th>500 or 10kΩ selectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threshold:</td>
<td>-10 V to +10 V</td>
</tr>
<tr>
<td>Maximum input voltage:</td>
<td>±15 V</td>
</tr>
<tr>
<td>Input transitions:</td>
<td>&lt;100 ns</td>
</tr>
<tr>
<td>Input frequency:</td>
<td>dc to 150 MHz</td>
</tr>
<tr>
<td>Minimum pulse width:</td>
<td>3.5 ns</td>
</tr>
<tr>
<td>Input sensitivity:</td>
<td>≤300 mVpp typical</td>
</tr>
</tbody>
</table>
Strobe Output

⚠️

<table>
<thead>
<tr>
<th>Level:</th>
<th>TTL or ECL selectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output impedance:</td>
<td>50 Ohm typical</td>
</tr>
<tr>
<td>Maximum external voltage:</td>
<td>2 V/±7 V</td>
</tr>
<tr>
<td>Transition times:</td>
<td>2 ns typical</td>
</tr>
<tr>
<td>Pattern:</td>
<td>4000 bits NBZ in pattern mode.</td>
</tr>
</tbody>
</table>

Typical Delay from EXT INPUT

<table>
<thead>
<tr>
<th>Pulse Mode</th>
<th>Period Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>PULSES</td>
<td>Internal Osc</td>
</tr>
<tr>
<td></td>
<td>PLL or CLK IN</td>
</tr>
<tr>
<td>BURST</td>
<td>No STROBE OUT signal</td>
</tr>
<tr>
<td>PATTERN</td>
<td>16.5 ns</td>
</tr>
<tr>
<td></td>
<td>16.5 ns + (1 &lt; n ≤ 2)x period</td>
</tr>
<tr>
<td></td>
<td>18.5 ns</td>
</tr>
<tr>
<td></td>
<td>18.5 ns + (1 &lt; n ≤ 2)x period</td>
</tr>
</tbody>
</table>

Trigger Output

⚠️

<table>
<thead>
<tr>
<th>Level:</th>
<th>TTL or ECL selectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output impedance:</td>
<td>50 Ohm typical</td>
</tr>
<tr>
<td>Trigger pulse width:</td>
<td>typically 50% of period</td>
</tr>
<tr>
<td>Maximum external voltage:</td>
<td>-2 V/±7 V</td>
</tr>
<tr>
<td>Transition times:</td>
<td>2 ns typical</td>
</tr>
</tbody>
</table>

Typical Delay from EXT INPUT

<table>
<thead>
<tr>
<th>Pulse Mode</th>
<th>Period Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>PULSES</td>
<td>Internal Osc</td>
</tr>
<tr>
<td></td>
<td>PLL or CLK IN</td>
</tr>
<tr>
<td>BURST</td>
<td>18.5 ns</td>
</tr>
<tr>
<td></td>
<td>18.5 ns + (1 &lt; n ≤ 2)x period</td>
</tr>
<tr>
<td>PATTERN</td>
<td>18.5 ns</td>
</tr>
<tr>
<td></td>
<td>18.5 ns + (1 &lt; n ≤ 2)x period</td>
</tr>
</tbody>
</table>

Specifications 6-7
Human Interface

Overprogramming
Parameter values can be entered exceeding the specified range.

Warnings and Errors
Warning messages indicate potentially conflicting parameters due to accuracy tolerances.
Error messages indicate conflicting parameters.

HELP key
Displays a context-sensitive message about the selected parameter. Concept help for getting started is also available. If warnings or errors occur, the HELP key displays the warning/error list accordingly.

Memory

Non-volatile memory
Actual setting is saved on power-down. 9 user and 1 default setting are also stored in instrument.

Memory-card
40 settings can be stored per 128 kB (MS-DOS, PCMCIA). Also used for convenient firmware updates.

Remote Control

Function Code: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0.
Programming times
(checks off and display off)

<table>
<thead>
<tr>
<th>Command</th>
<th>Typical execution time</th>
</tr>
</thead>
<tbody>
<tr>
<td>One parameter or mode</td>
<td>5 to 80 ms</td>
</tr>
<tr>
<td>Timing</td>
<td>8 to 20 ms</td>
</tr>
<tr>
<td>Levels</td>
<td>40 ms</td>
</tr>
<tr>
<td>Trigger modes</td>
<td>67 ms</td>
</tr>
<tr>
<td>Other modes</td>
<td>4 to 8 ms</td>
</tr>
<tr>
<td>Recall Setting</td>
<td>&lt; 250 ms</td>
</tr>
<tr>
<td>4066 bit pattern update</td>
<td>&lt; 70 ms</td>
</tr>
<tr>
<td>4066 bit pattern transfer</td>
<td>&lt; 1.7 s</td>
</tr>
</tbody>
</table>
HP 8110A 10 V/2 ns Output Channel for the HP 8110A

One or two output channels can be installed in one HP 8110A mainframe. The second output channel can be retrofitted without recalibration. All specifications apply for 50Ω source impedance with a 50Ω load.

Timing Parameters

All timing parameters are measured at 50% of amplitude at fastest transitions in continuous mode with 50Ω source and load impedance.

Common specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeatability</td>
<td>4 times better than accuracy</td>
</tr>
<tr>
<td>Resolution</td>
<td>5 digits, best case 10 ps</td>
</tr>
<tr>
<td>RMS Jitter</td>
<td>0.03% + 25 ps</td>
</tr>
</tbody>
</table>

1 0.05% + 25 ps for 50–100 ns

Width

Can be entered as absolute width, duty cycle or trailing-edge delay.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>3.30 ns to 990 ns</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±5% ± 250 ps</td>
</tr>
<tr>
<td>Duty cycle</td>
<td>0.01% to 99.9%</td>
</tr>
</tbody>
</table>

1 Max. value: Period = 3.3 ns

Delay

Measured between trigger output and main output. Can be entered as absolute delay, phase° or % of period.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed delay from TRIGGER OUT</td>
<td>34.0 ns typical</td>
</tr>
<tr>
<td>Additional variable range</td>
<td>0.00 ns to 990 ns</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±5% ± 1 ns</td>
</tr>
</tbody>
</table>

1 Maximum value: Period = 6.6 ns

6-10 Specifications
Double Pulse Delay

Double Pulse Delay and delay are mutually exclusive. Double Pulse Delay is the delay between the two pulses in Double Pulse mode.

<table>
<thead>
<tr>
<th>Double Pulse Delay range:</th>
<th>6.65 ns to 969 ns (\text{ns}^{-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy:</td>
<td>(\pm 5% \pm 250 \text{ps})</td>
</tr>
<tr>
<td>Min. period:</td>
<td>13.3 ns (75 MHz)</td>
</tr>
</tbody>
</table>

\(1\) Max. value: Period – Width – 3.3 ns

Transition Times

Measured between 10% and 90% of amplitude. Can be entered as leading/trailing edge or % of width.

<table>
<thead>
<tr>
<th>Range:</th>
<th>2.00 ns to 200 ns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. transition:</td>
<td>&lt; 2.0 ns for levels within (\pm 5) V window</td>
</tr>
<tr>
<td></td>
<td>&lt; 2.5 ns for all levels</td>
</tr>
<tr>
<td></td>
<td>1.4 ns typical for ECL levels (20% to 80% of amplitude)</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>(\pm 10% \pm 200 \text{ps})</td>
</tr>
<tr>
<td>Linearity:</td>
<td>3% typical for transitions &gt; 100 ns</td>
</tr>
</tbody>
</table>

Leading and trailing edges can be programmed independently within the following ranges (Maximum ratio 1:20):

![Diagram](image)

Figure 6-1. Leading/Trailing Edge ranges
Outputs

⚠️

<table>
<thead>
<tr>
<th>Source impedance:</th>
<th>selectable 50Ω or 1kΩ ± 1% typical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(480 or 500 Ω with Added Channels)</td>
</tr>
<tr>
<td>Maximum external voltage:</td>
<td>±25 V</td>
</tr>
<tr>
<td>Short circuit current:</td>
<td>±400 mA max.</td>
</tr>
<tr>
<td>Normal/complement:</td>
<td>selectable</td>
</tr>
<tr>
<td>ON/OFF:</td>
<td>relays connect/disconnect output (HIZ).</td>
</tr>
<tr>
<td>Limits:</td>
<td>high and low levels can be limited to protect the DUT.</td>
</tr>
<tr>
<td>Dynamic Crosstalk</td>
<td>&lt; 0.1% typical</td>
</tr>
</tbody>
</table>

External Load compensation

For loads ≠ 50Ω, the actual load impedance can be entered to correct the output values into a static load.

Level Parameters

Level parameters can be entered as voltage or current, as high/low-level or offset/amplitude in terms of voltage or current.

<table>
<thead>
<tr>
<th>Amplitude:</th>
<th>Voltage (50Ω into 500Ω) (^1)</th>
<th>Current (1kΩ into short)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-level</td>
<td>-9.90 V to +10.0 V</td>
<td>-386 mA to +400 mA</td>
</tr>
<tr>
<td>Low-level</td>
<td>-10.0 V to +9.90 V</td>
<td>-400 mA to +386 mA</td>
</tr>
<tr>
<td>Level Accuracy:</td>
<td>±(1% Amplitude + 50 mV)</td>
<td>-</td>
</tr>
<tr>
<td>Resolution:</td>
<td>10 mV</td>
<td>1 mA</td>
</tr>
</tbody>
</table>

\(^1\) Voltages double into open circuit
Table 6-1.
Typical Influence of Source Impedance on Timing and Levels

<table>
<thead>
<tr>
<th>Source Impedance</th>
<th>Separate Channels</th>
<th>Channels Added at OUTPUT 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>50 Ω ±1% typical</td>
<td>48 Ω ±1% typical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>500 Ω ±1% typical</td>
</tr>
<tr>
<td>Levels</td>
<td></td>
<td>OUTPUT 1</td>
</tr>
<tr>
<td>Voltage (500 Load)</td>
<td>(Doubles into open)</td>
<td>200 mV to 19.0 V</td>
</tr>
<tr>
<td>Amplitude</td>
<td>100 mV to 10.0 V</td>
<td>-18.0 V to -19.0 V</td>
</tr>
<tr>
<td>High-level</td>
<td>-9.90 V to +10.0 V</td>
<td>-18.8 V to +19.0 V</td>
</tr>
<tr>
<td>Low-level</td>
<td>-10.0 V to +9.80 V</td>
<td>-19.0 V to +18.8 V</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±1% Ampl. + 50 mV</td>
<td>±(1% Ampl. + 100 mV)</td>
</tr>
<tr>
<td>Resolution</td>
<td>10 mV</td>
<td>20 mV</td>
</tr>
</tbody>
</table>

Current (into short):  
- Amplitude: -4 mA to +400 mA  
- High-level: -396 mA to +400 mA  
- Low-level: -400 mA to +396 mA  
- 0 mA to +800 mA  
- -792 mA to +800 mA  
- -800 mA to +792 mA

Timing:  
- Min. Transitions: 2.0 ns (within ±5 V)  
- 2.5 ns  
- 6.65 ns  
- 3.3 ns  
- Delay Accuracy: ±(5% + 1 ns)  
- 0 ns  
- 0.6 ns

1 Amplitude up to 19.5 V applies to uni-polar signals only. Bipolar signals are restricted as shown in Figure 6-2. Highest and lowest level combinations.

Pulse Performance  
Overshoot/Preshoot, Ringing:

<table>
<thead>
<tr>
<th>Overshoot/Preshoot, Ringing: ±5% of amplitude ±20 mV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Settling time: 30 ns typical</td>
</tr>
</tbody>
</table>

Specifications 6-13
Figure 6-2. Highest and lowest level combinations

\[ V_{HL} = \text{highest level of output signal.} \]
\[ V_{LL} = \text{lowest level of output signal.} \]
\[ V_{PP} = V_{HL} - V_{LL} \]
\[ V_{PP} = \text{amplitude of output signal.} \]
Minimum \( V_{PP} = -0.2V. \)
HP 81106A PLL/External Clock for the HP 8110A

The PLL/External Clock module can be retrofitted without recalibration.

Clock Input/ PLL Reference Input

<table>
<thead>
<tr>
<th>Input Impedance:</th>
<th>500 or 10kΩ selectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threshold:</td>
<td>-10 V to +10 V</td>
</tr>
<tr>
<td>Maximum input voltage:</td>
<td>±15 V</td>
</tr>
<tr>
<td>Input transitions:</td>
<td>&lt;100 ns</td>
</tr>
<tr>
<td>Input Frequency:</td>
<td>dc to 150 MHz</td>
</tr>
<tr>
<td>Minimum pulse width:</td>
<td>8.3 ns</td>
</tr>
<tr>
<td>Input sensitivity:</td>
<td>&lt;300 mVpp typical</td>
</tr>
<tr>
<td>Delay to TRIGGER OUT:</td>
<td>22 ns typical</td>
</tr>
</tbody>
</table>

Rear panel BNC connector used as:
- External system clock input: pulse frequency = input frequency
- or 5 MHz or 10 MHz frequency reference input for internal PLL.

The input frequency can be measured.

Phase Locked Loop
- Locks either to an external frequency reference at the Clock/PLL Ref Input (5 MHz or 10 MHz selectable) or to its internal reference.
HP 81106A PLL/External Clock Module

- High accuracy period (frequency) source. When locked to the internal reference, period accuracy, range, resolution, and jitter are improved:

<table>
<thead>
<tr>
<th>Period Accuracy:</th>
<th>±0.1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period Range:</td>
<td>6 nanoseconds to 999 seconds</td>
</tr>
<tr>
<td>Period Resolution:</td>
<td>4 digits, best case 10 ps</td>
</tr>
<tr>
<td>Period RMS-jitter:</td>
<td>0.003% ± 20 ps</td>
</tr>
<tr>
<td>Period Stability:</td>
<td>±50 ppm/year typical</td>
</tr>
</tbody>
</table>

When locked to an external frequency reference, the external frequency affects these accuracies.

- Internal triggering of bursts and patterns: the internal PLL can replace an external trigger source, while the output period is determined by the normal internal oscillator.

External Clock

- The output period is determined by signal at clock input. Frequency accuracy can be increased by using a precise external clock.

- Trigger synchronously to external clock: the output period is synchronous to the signal at clock input. The signal at the External Input is used for arming.
HP 81107A Multichannel Deskew for the HP 8110A

Supports up to two output channels. The multichannel deskew can be used for two applications:

- Multichannel calibration: When using up to four HP 8110As synchronously (Maximum 8 channels), compensate for the delay between EXT INPUT and main outputs.

- Delay calibration: compensate for measurement system delays e.g. caused by cable delays or pre-trigger delays of oscilloscopes.

<table>
<thead>
<tr>
<th>Variable range:</th>
<th>0 ns to 28 ns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution:</td>
<td>10 ps</td>
</tr>
<tr>
<td>Additional fixed delay:</td>
<td>6.5 ns typical</td>
</tr>
</tbody>
</table>
# Index

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>50 Ohm Feedthrough Termination, 5-4</td>
</tr>
</tbody>
</table>

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