Agilent N4861A MIPI D-PHY Stimulus Probe

User's Guide

Agilent Technologies

Notices

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Contents

1
Introduction

About this Manual

This manual will help you connect an N4861A stimulus probe to your board and to an Agilent logic analysis system.

Additional Information Sources

This manual is intended to be used with these other documents:

- See the *Agilent N4851A/N4861A Probes for MIPI D-PHY Design Guide* for information on how to design the necessary connectors into your board. This document is available by searching for “N4851A” at www.agilent.com.
- See the N4851A/N4861A product data sheet for a description of the product and its characteristics.
- See the online help in the logic analysis system for more information on using the software tools.
- Detailed information on Agilent probes (such as the Agilent E5381A differential flying lead probe) is available by searching for the product number at www.agilent.com.
- Additional application notes or white papers may be available from your Agilent representative.

Product Overview

The Agilent N4861A stimulus probe connects an Agilent Technologies logic analyzer between the peripheral and baseband components on a device under test, to allow decoding and display of MIPI D-PHY signals. Software is provided to decode the DSI version 1.01 and CSI-2 protocols.

The acquisition probe may be connected to a production board, as long as it incorporates the necessary connectors, or the probe may be connected to a test platform.

The Agilent N4851A acquisition probe allows you to generate the digital signals, emulating either a master or slave IC. The stimulus probe is usually connected to a test platform which contains only one of the two ICs.

Connection to the device under test

The 90-pin cable on the Agilent N4861A stimulus probe is the same as the ones which are used on Agilent 1695x-series logic analyzer cards. This allows you to choose from a variety of probes to make the physical connection. See *Probing Solutions for Logic Analyzers*, available from www.agilent.com/find/logic.

The Agilent N4861A stimulus probe is connected to the device under test using four or six SMA cables.

The parts of a measurement system

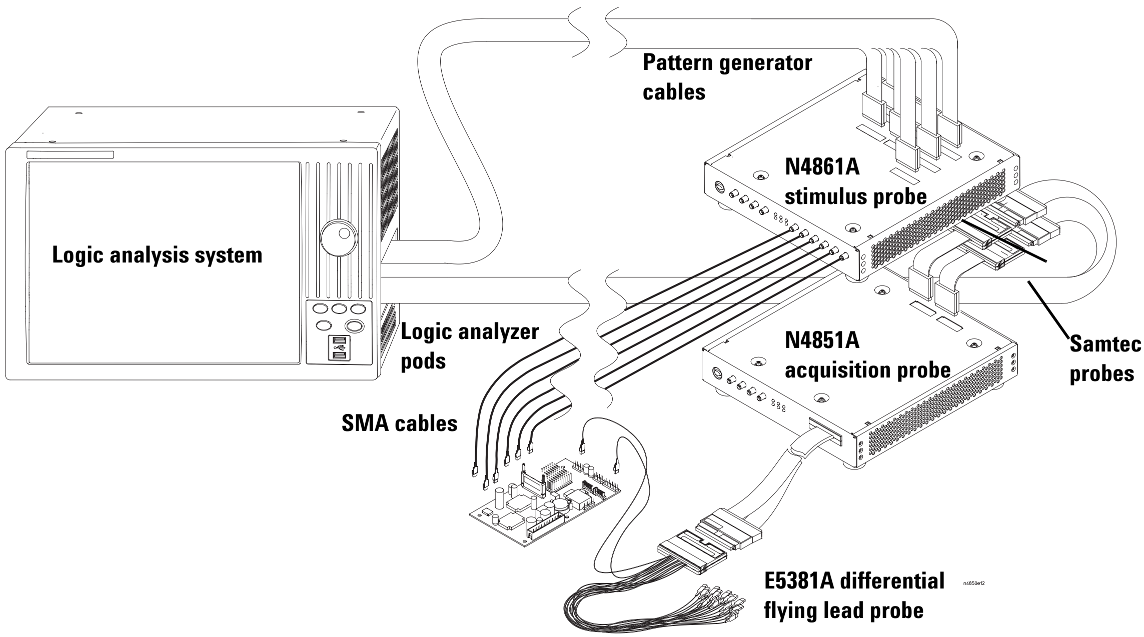


Figure 1 A complete measurement system

The device under test (**DUT**) is your board, which might include an master IC, a slave IC, or both.

The Agilent N4851A digital **acquisition probe** captures the digital signal between the sides of a link. A **differential flying lead probe** (or another kind of probe, if needed) connects the DUT to the cable on the acquisition probe.

The Agilent N4861A **stimulus probe** can emulate a master or slave IC by supplying the missing digital signals. The stimulus probe connects to the DUT via 50-ohm coaxial cables using SMA connectors.

The acquisition probe and stimulus probe are connected to one another through a short **option cable**.

A **logic analysis system** collects data from the acquisition probe and controls the stimulus probe. The logic analysis system must contain at least one **logic analyzer** card. If you are using the N4861A stimulus probe, the logic analysis system must also contain a **pattern generator** card.

Each of the cables coming out of the logic analyzer card is called a **pod**. These pods require adapter cables, called **Samtec probes**, to mate with the connectors on the acquisition probe and stimulus probe.

For some logic analyzers, the logic analyzer card and pattern generator are built in, rather than being separate cards.

Software installed on the logic analysis system decodes the digital data and displays it as decoded packets.

Equipment Supplied

The Agilent N4861A product includes:

- The Agilent N4861A stimulus probe.
- A power supply.
- A power cord appropriate for your country.
- An option cable for connecting the N4851A acquisition probe.
- This *User's Guide*.
- Regulatory compliance documents.

Additional Equipment and Software Required

You *must* have the following additional equipment to use the N4861A stimulus probe:

- An Agilent 16800-series or 16900-series logic analysis system with an Agilent 16720A pattern generator.
- An Agilent N4851A acquisition probe, along with its associated probes and software.
- A pulse generator to provide the clock input.
- SMA cables. The cables should be the same length, and of good quality. A set of four 40-inch SMA cables is available from Agilent as N4860A Option 040. Four SMA cables are required if you are probing one data lane, and six cables are required if you are probing two data lanes. An additional SMA cable is required to connect the pulse generator to the clock input.
- A torque wrench for the SMA connectors. The wrench should provide 0.8 to 0.9 N•m (7 to 8 inch-pounds) of torque. An Agilent 3.5mm torque wrench (part number 8710-1765) will provide the appropriate amount of torque.
- A means of generating stimulus data.

Overview of Installation and Setup

Note: Do not turn on the device under test until step 11 below.

1. Check that you received all of the necessary equipment. See "Equipment Supplied" on page 11 and "Additional Equipment and Software Required" on page 12.
2. Check that the device under test has the necessary connectors. Make sure you know (or can find out) the name and voltage level of the signal at each connector. See the *Agilent N4851A/N4861A Probes for MIPI D-PHY Design Guide*.
3. Set up the logic analysis system, if necessary.
4. Install the software on the logic analysis system. See "Installing the Software" on page 17.
5. Make the physical connections. This includes:
   - connecting the stimulus probe to the pattern generator
   - connecting the stimulus probe to the acquisition probe
   - connecting the stimulus probe to the device under test
   - connecting power to the stimulus probe
6. Turn on the logic analysis system.
7. Turn on the acquisition probe and the stimulus probe. See "Connecting the Probe to a Power Source" on page 34.
8. Load a configuration file. See "Loading a Configuration File" on page 17.
9. Configure the output voltage levels.
10. Enable the SMA outputs. Do not do this until you are sure the output voltage levels have been set correctly.
11. Turn on the device under test.
12. Create patterns for the pattern generator.
13. Run the pattern generator.

This chapter describes how to create the data which the N4861A stimulus probe will send to the device under test.

Understanding the Data Flow

You must create some data for the N4861A stimulus probe to send to the device under test.

You have many options for creating the stimulus data. Figure 2 shows a few examples of the ways data can be created and then translated into a form that can be used for stimulus.

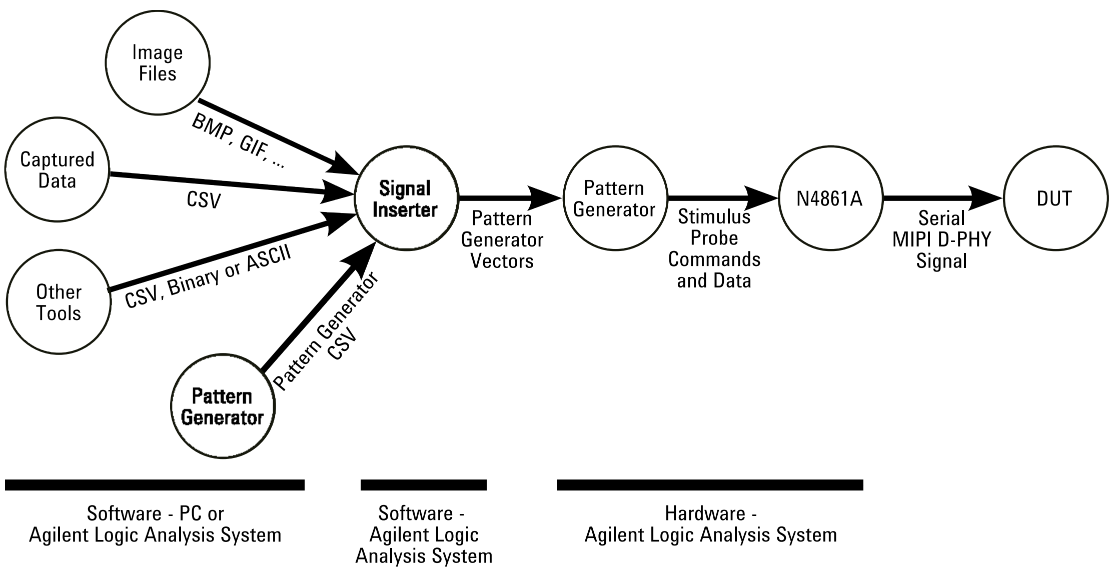


Figure 2 Data flow through the N4861A stimulus probe

The N4861A stimulus probe drives its outputs based on commands it receives from the pattern generator.

The pattern generator acts as an intelligent buffer for the stimulus probe commands. It takes its input from a pattern generator CSV (comma separated variable) file.

The signal inserter is a tool which will help you translate data from other formats into a format which can be used for stimulus.

In general, you will need to create two kinds of data: control data and payload packets.

Control Data

Control data, such as synchronization packets or LP mode signals, will generally need to be “hand-crafted.”

Usually, you will need to create the control data for the pattern generator CSV file in one of two ways:

- Use the pattern generator’s Sequence tab to create a sequence, then export it as a CSV file.
- Use a text editor to create the CSV file.

You may also be able to use captured data or data which has been generated by a script or other tool.

Payload Frames

The signal inserter tool can take payload data in a variety of formats and turn it into pattern generator vectors.

Some sources of data include, but are not limited to:

Captured data You can capture data from a working link using the N4851A acquisition probe, extract the data using the signal extractor tool, then save it as a CSV file.

Image files You can create an image in one of several formats, then save it as a CSV file.

2
Installing and Configuring the Software

Installing the Software

The N4861A stimulus probe uses the same software as the N4851A acquisition probe.

NOTE

Refer to your *Agilent N4851A MIPI D-PHY Acquisition Probe User's Guide* for software installation information.

Loading a Configuration File

You configure the logic analyzer by loading a configuration file.

NOTE

Refer to your *Agilent N4851A MIPI D-PHY Acquisition Probe User's Guide* for information about loading configuration files.

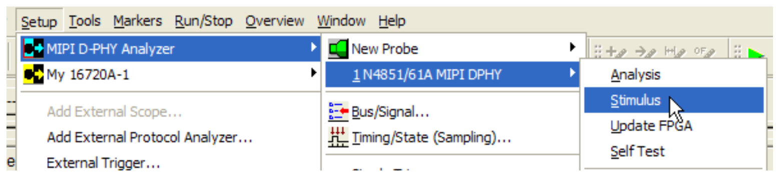
Setting up the Probe for Your Device Under Test

To open the probe setup dialog

Before you can make any measurements, you need to configure the acquisition probe for the type of link you are stimulating.

1 Make sure the acquisition probe is connected and turned on. See "Connecting to Your Board" on page 25.

2 Open the Stimulus dialog.



Once you have configured the acquisition probe, remember to select **File>Save As...** and save the logic analyzer configuration.

To set up the N4851A acquisition probe

Before you set up the N4861A stimulus probe, set up the N4851A acquisition probe. See the Agilent *N4851A MIPI D-PHY Acquisition Probe User's Guide* and the online help for more information.

Voltage and Slew Rate Settings

Voltage settings

Set the voltage levels which should be present *at the receiver*. The probe calculates the output voltages which are necessary to achieve those voltages. For more information on those calculations, see "Working with non-standard termination schemes" on page 21.

Slew rate

Select the Slew Rate to match the signal characteristics of your circuit. The selections are Fast, Medium, Slow, Slowest. Each setting slows down the slew rate by a factor of about 25% slower than the next highest setting.

Output Enable Control

The SMA outputs will be disabled until this is set to ON.

The N4861A stimulus probe will not enable the SMA outputs until you have done all of the following:

- Set SMA Outputs to **ON**.
- Connected Vsense to VDD or some other signal which indicates that the DUT is running (via the N4851A acquisition probe).
- Click **Apply** or **OK**.
- Start the DUT running.

This is a protection feature to protect your circuit while changing settings. When the outputs are OFF, the N4861A stimulus probe is set to high impedance and all six lights display amber.

If absolutely necessary, you can tell the N4861A stimulus probe to ignore this safety check. This is not recommended for routine operation.

CAUTION **Set the voltage levels correctly before enabling the SMA outputs.** If the output voltage level is configured at a level too high for your board, your board may be damaged.

Waveform Timing Controls

By default, the N4861A stimulus probe issues signals with timings which comply with the MIPI D-PHY specification.

Use the waveform timing controls to adjust those delays. You might want to do this to test the DUT's response to out-of-spec inputs, or to accommodate a DUT which has nonstandard timing requirements.

Most adjustments may be made with 5 ns resolution. The value you enter will be rounded up to the next value permitted by the resolution.

Table 1 Resolution of waveform timing controls

Time	Resolution
CLK-PRE	2 UI
CLK-ZERO	8 UI
HS-ZERO	8 UI
All others	5 ns

If the Stimulus tab is not visible

The Stimulus tab is only visible when the N4861A stimulus probe is connected.

✔ Check that the ribbon cable is connected between the option connector on N4851A acquisition probe and the N4861A stimulus probe.

✔ Check that the pattern generator cables are connected to the N4861A stimulus probe.

✔ Check that both the N4851A acquisition probe and the N4861A stimulus probe are powered on.

Working with non-standard termination schemes

The user interface easily supports the MIPI D-PHY standard for terminating the differential outputs (a 100 ohm resistor between the signals).

If a different termination scheme is used on the board, the N4861A can probably support it, although you must calculate the correct voltages. This section describes the circuit model used to calculate the voltages and provides some examples.

The MIPI D-PHY standard calls for 80-ohm to 125-ohm HS line termination at the receiver. In LP mode, the termination is "switched out" to make an un-terminated, single-ended receiver.

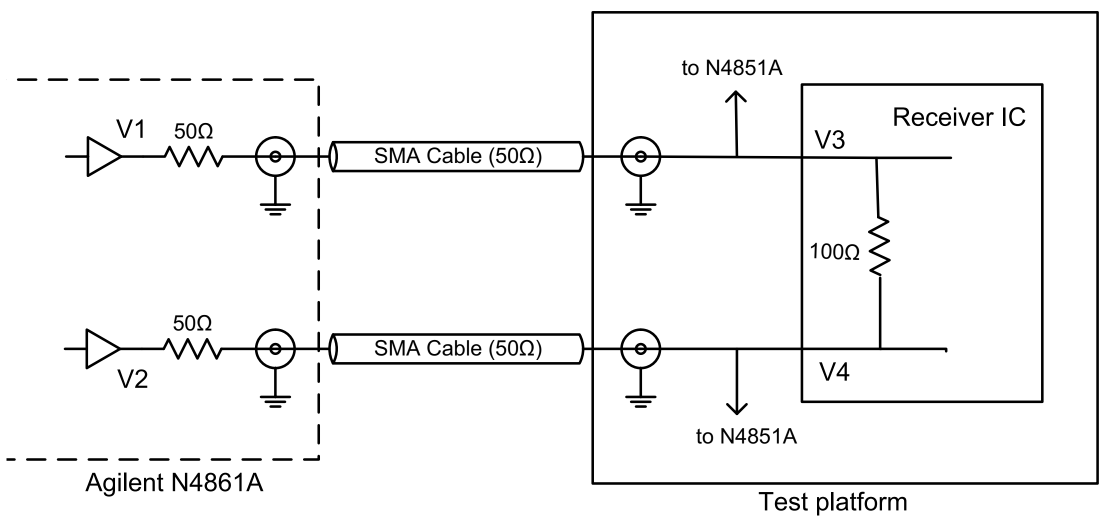


Figure 3 HS line termination

The N4861A stimulus probe controls voltages V1 and V2 independently to generate the desired differential output voltage. The probe uses these values to set the different voltages as the output is switched from HS transmissions to LP transmissions. V2 is set to a single value (usually ground).

The fields on the Stimulus tab refer to the voltages you want the probe to present at V3 and V4. The probe then calculates the values actually set for V1 and V2 internally.

The equations for V3 and V4 in terms of V1,V2, and Rterm are:

$$V3 = \frac{(V1 - V2)}{100 + R_{term}} \cdot (50 + R_{term}) + V2$$

$$V4 = \frac{(V1 - V2)}{100 + R_{term}} \cdot (50 + R_{term}) + V2$$

After some math, the equations for V1 and V2 in terms of V3, V4, and Rterm are:

$$V1 = \frac{50V3 - 50V4 + V3 \times R_{term}}{R_{term}}$$

$$V2 = \frac{-(-(V4R_{term}) + 50V3 - 50V4)}{R_{term}}$$

Calculating V4

Since V2 can only be set to a single voltage – the actual voltage for V4 in HS mode is calculated. In this case V4 = 3(V3-V2) + V2. Or in other words,

HS VLow = 3(HS VHigh – LP VLow) + LP VLow.

Example: 150 ohm resistor

What would you set VHigh and VLow to be if you have a 150 ohm resistor loaded?

If we want Vhigh to be 1V and Vlow to be 0V when a 150ohm resistor is loaded (for LP mode), we actually program V1 to be 1333mV and V2 to be -333mV.

To do this:

- Set "LP VHigh" to 1333 mV

- Set "LP VLow" to -333 mV

Limits of VHigh and VLow

CAUTION

Double-check the voltage settings by using an external resistor connected to the N4861A's outputs and verify that the Vhigh and Vlow are correct for your part.

As you can tell from the equations, if you enter wrong data into the dialog boxes, or if you think there is a termination resistor there but it isn't actually installed, you can drive voltages that will harm your device.

3
Connecting to Your Board

To connect the N4861A stimulus probe to the device under test (DUT), follow these steps:

1. Check that the device under test has the necessary connectors, as specified in the *Agilent N4851A/N4861A Probes for MIPI D-PHY Design Guide*.
2. Make sure you know the name and voltage level of the signal at each connector.
3. Position the N4861A stimulus probe for easy access and good ventilation. See "Positioning the Probe" on page 26.
4. Connect the stimulus probe to the acquisition probe.
5. Connect the stimulus probe to the pattern generator cables. See "Connecting to the Logic Analysis System" on page 28.
6. Connect the stimulus probe to the device under test.
7. Connect power to the stimulus probe.
8. Turn on the logic analysis system, then the N4851A acquisition probe, then the N4861A stimulus probe. See "Connecting the Probe to a Power Source" on page 34.
9. Turn on the DUT only after you are sure the voltage levels have been set correctly. See "Voltage and Slew Rate Settings" on page 18.

Positioning the Probe

Take care to allow space for the probe be placed near the device under test and the logic analysis system. You will also need plenty of space near the probe for the logic analysis system.

The N4861A stimulus probe is designed to be stacked on top of the N4851A acquisition probe. The feet on the bottom of the N4861A stimulus probe provide just enough space for the logic analyzer cables coming out of the acquisition probe.

See "Mechanical Characteristics" on page 73 for probe dimensions.

Position the probe and power supply so that it is not difficult to unplug the power cord.

If possibly, try to allow at least 12 cm (4.5 in) clearance above the probe for the pattern generator cables.

Allow at least 5 cm (2 in) clearance on both sides of the probe for proper cooling.

CAUTION Do not block the airflow holes on the sides of the probe box. Blocked airflow may cause overheating and equipment damage

Connecting to the Acquisition Probe

The stimulus probe relies upon output from the N4851A acquisition probe to properly function.

The acquisition probe must always connect to the data signals being stimulated, Clk, and the Vsense signal. Vsense can be any signal, such as Vdd, which indicates that the DUT has power. Vsense is used to determine if the target IC has power and will disable driving the stimulus lines when power is off.

NOTE Remember, both the stimulus probe and acquisition probe must be connected to the device under test for the stimulus to function properly.

A 20-pin ribbon cable (called an option cable) is supplied with the N4861A stimulus probe.

Place the N4861A stimulus probe on top of the N4851A acquisition probe, then connect the ribbon cable between the "option connectors" on the back of the two probes.

Connecting to the Logic Analysis System

The N4861A stimulus probe has seven connectors on the top side for the cables from a pattern generator card.

Each pattern generator cable should be labelled with a number. If the cables are not numbered, use Figure 4 as a guide.

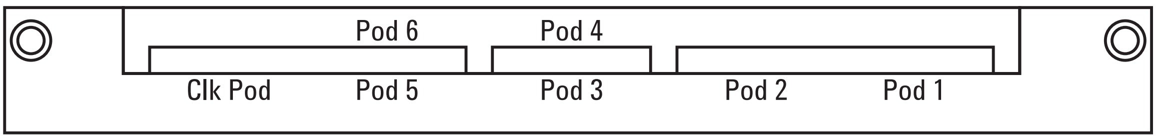


Figure 4 Numbering of pattern generator cables

Connect each able according to the legend printed on the top of the N4861A stimulus probe.

The cables should be connected directly to the N4861A stimulus probe. No adapters are required.

Connecting to the device under test

CAUTION

Set the voltage levels correctly before enabling the SMA outputs.

Make sure you know what voltage levels are appropriate for your device under test. If the output voltage level is configured at a level too high for your board, your board may be damaged.

To reduce the risk of damage, the N4861A stimulus probe will not drive the SMAs until both:

- SMA Outputs is set to ON on the Stimulus tab, and
- Vsense is asserted (at a level determined by the Target VDD setting on the Stimulus tab.

Making SMA connections

See the *Agilent N4851A/N4861A Probes for MIPI D-PHY Design Guide* for information about how to design the connectors into your DUT.

Use a torque wrench to tighten the SMA connector.

Apply 0.8 to 0.9 N•m (7 to 8 inch-pounds) of torque. An Agilent 3.5mm torque wrench (part number 8710-1765) will provide the appropriate amount of torque.

Some torque wrenches, such as the Agilent SMA torque wrench (part number 8710-1582) provide only 5 in-lbs of torque. If you apply too little torque, the electrical connection may not be reliable.

CAUTION

Apply no more than 0.9 N•m (8 inch-pounds) of torque. If you apply too much torque, the N4861A stimulus probe or your DUT may be damaged.

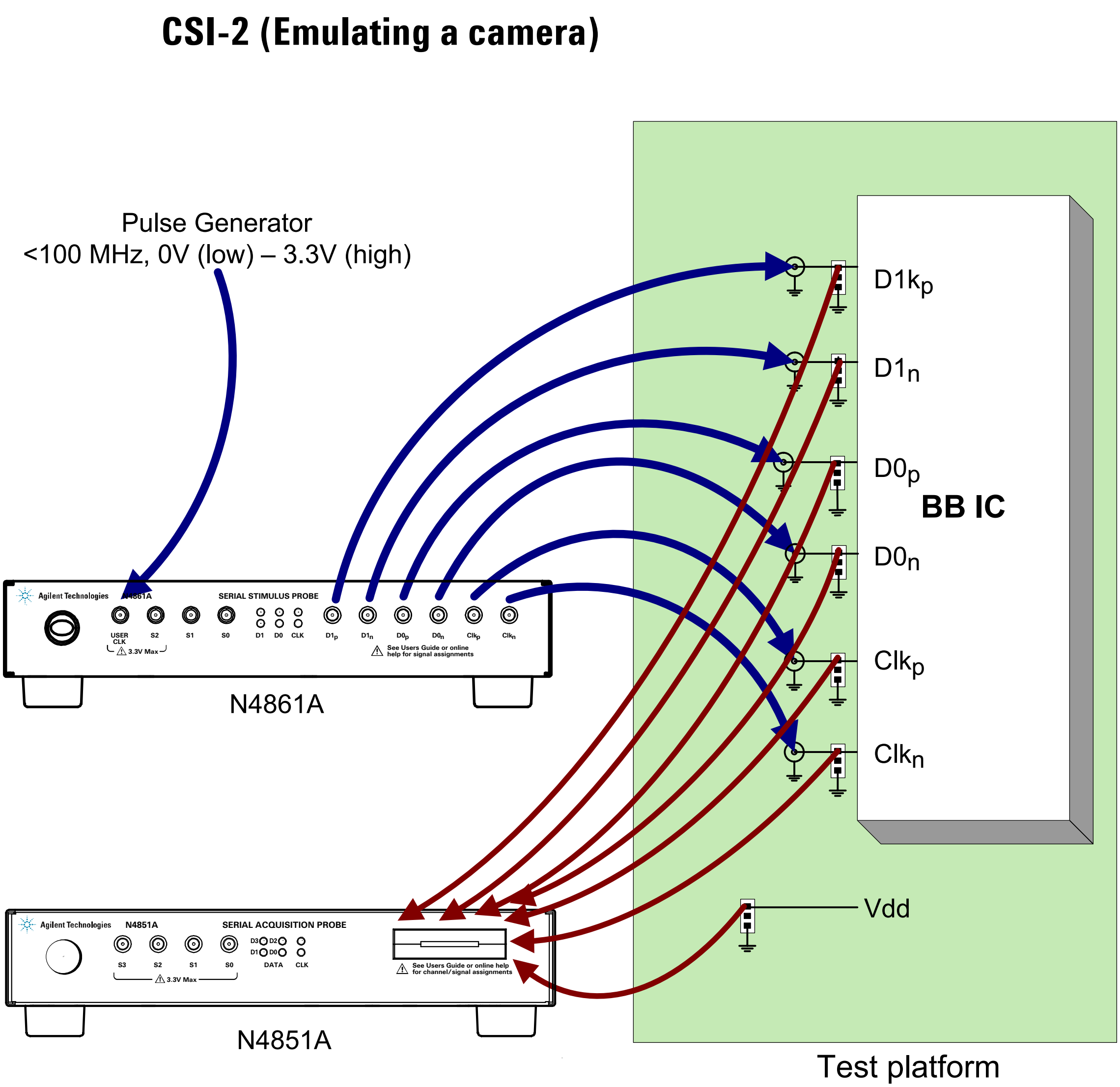


Figure 5 Signal connections for CSI-2

Connect Clkp, Clkn, D0p, D0n, and optionally D1p and D1n. You will need a corresponding number of length-matched SMA cables of approximately 1 meter length.

Remember, the N4851A acquisition probe must also be connected. In particular, VSense may need to be connected before the stimulus outputs will be enabled (depending on how you configure the probe).

DSI (Stimulating a display device)

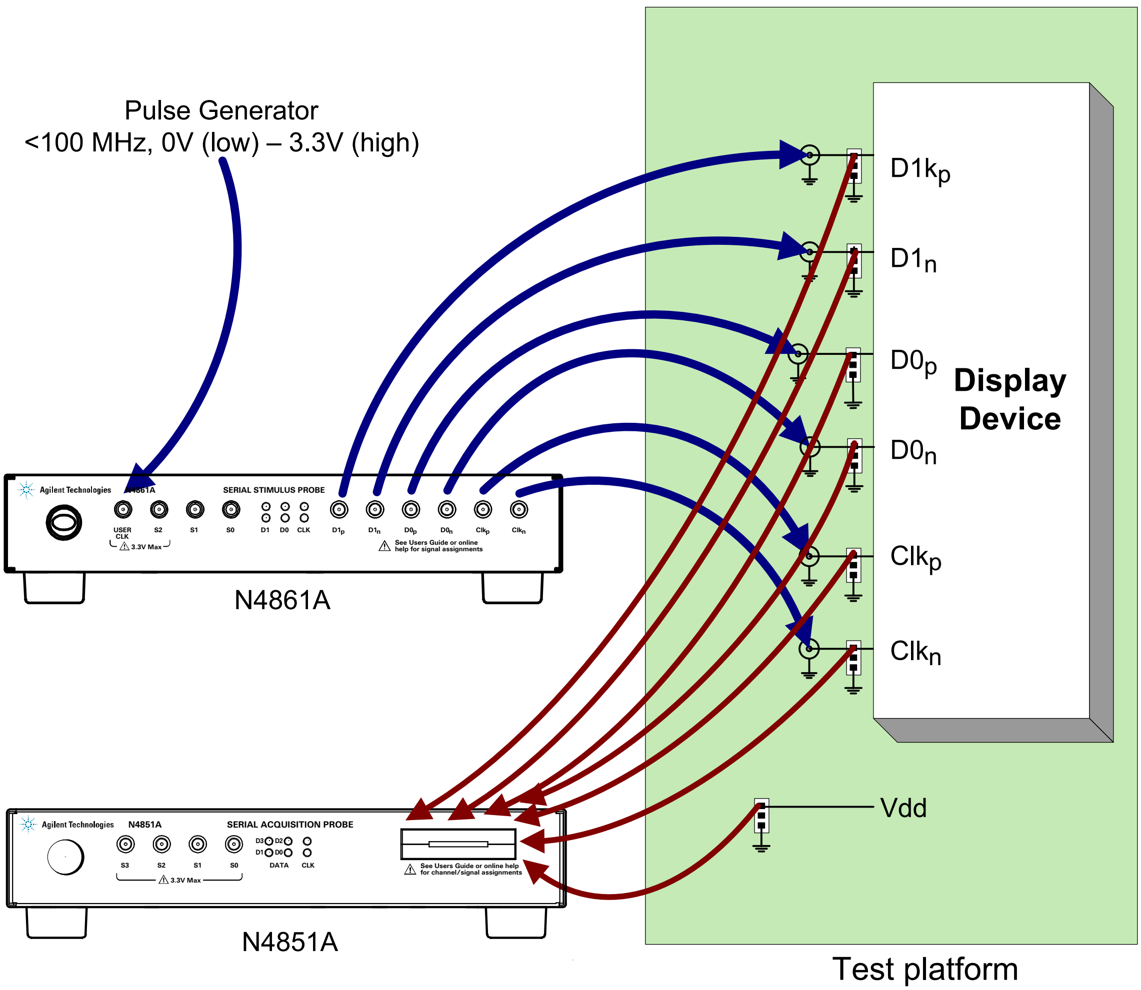


Figure 6 Signal connections for DSI

Connect Clkp, Clkn, D0p, D0n, and optionally D1p and D1n. You will need a corresponding number of length-matched SMA cables of approximately 1 meter length.

Remember, the N4851A acquisition probe must also be connected. In particular, VSense may need to be connected before the stimulus outputs will be enabled (depending on how you configure the probe).

Generating the clock

Connect USER CLK to a source such as an external signal generator.

In most cases, you will want to use a pulse generator to provide the clock input to the N4861A stimulus probe. This allows you to test the response of your device under test to different clock rates. The pulse generator should be connected to SMA labelled “USER CLK” on the N4861A stimulus probe .

CAUTION **The USER CLK input must be non-negative. Measure the output voltage swing of your voltage generator before connecting it to the N4861A stimulus probe.** If a negative voltage is applied to the SMA, the N4861A stimulus probe may be damaged.

The USER CLK input to the N4861A stimulus probe must be non-negative. CMOS levels (0V–3.3V swing) are recommended. The 80MHz Agilent 33250A function/arbitrary waveform generator is an example of an instrument which works well for this purpose.

Note that most signal generators need a 50-Ohm in-line termination resistor installed to produce the recommended voltage swing.

The clock frequency must be within a certain range, which is determined by the bit rate you set on the Analysis tab. See “Input Reference Clock Information” on the Stimulus tab for the range of allowable input clock frequencies for the selected bit rate.

Connecting the Probe to a Power Source

The probe is shipped from the factory with a power supply and cord appropriate for your country. If the cord you received is not appropriate for your electrical power outlet type, contact Agilent.

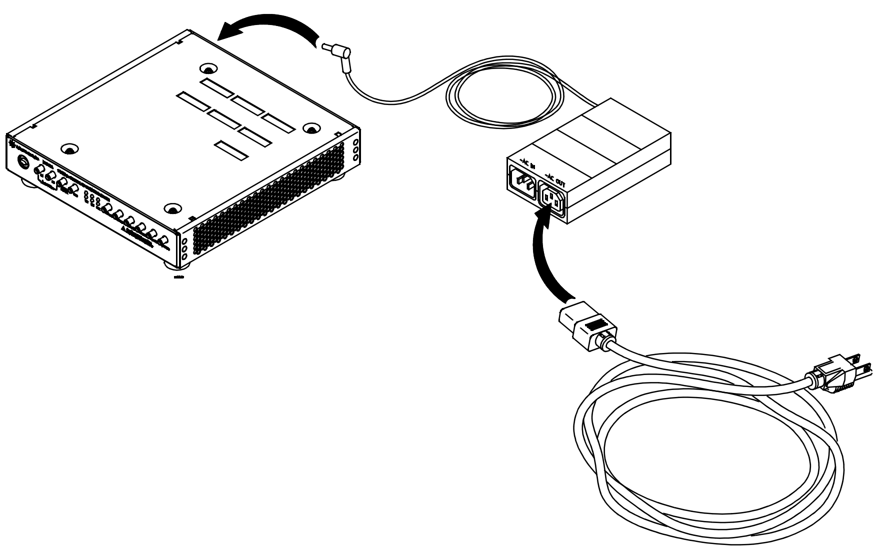
Position the probe and power supply so that it is not difficult to unplug the power cord.

WARNING **Maintain ground to avoid electrical shock.** Use only the power supply and power cord supplied with the probe. Connect the power cord only to a properly grounded electrical power outlet.

1 Connect the power cord to the power supply and to a socket outlet.

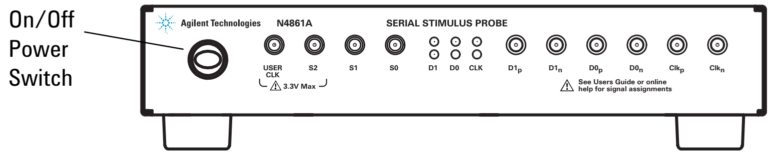
2 Connect the 12V power cord to the back of the probe.

Ensure the power supply plug is completely seated in the power input receptacle.



To turn power ON

- Press the power button on the front of the probe.



The power button is lighted when the switch is ON.

It is best to power on the probe *before* loading a configuration file into the logic analysis system.

You may turn the probe on before or after the logic analysis system is turned on. You may connect and disconnect the cables while the probe and logic analyzer are powered on.

When you turn on the probe, self-test and loading of calibration factors can take up to 45 seconds.

To turn power OFF

- Press the power button on the front of the probe.

4
Creating Stimulus Vectors

This chapter describes the format of the vectors which the pattern generator sends to the N4861A stimulus probe. Each vector is a stimulus command—which tells the N4861A stimulus probe to do something, such as sending some data on the link or waiting for a specified period of time—or data to be inserted into a packet. Note that MIPI D-PHY interface control data and payload packets are both considered to be “just data” by the N4861A stimulus probe.

“Understanding the Data Flow” on page 14 shows where these vectors fit into the process of creating stimulus data.

The vectors in this chapter are shown as they appear in the pattern generator's Sequence tab. Each row represents a pattern generator vector—a group of bits which is issued in parallel by the pattern generator. Each column represents to a bit or group of bits (called a signal or bus in the world of logic analyzers) which will be output by the pattern generator.

You can manually set up a sequence of vectors in the pattern generator's Sequence tab. This can be handy if you are just testing how the DUT responds to control packets. You can use pattern generator macros to make it easier to insert a vector or set of vectors.

However, in most cases you will need to use another tool to generate some data, then use the signal inserter tool to translate the data into a pattern generator vectors. The vectors are stored in a pattern generator CSV (comma separated variable) file.

The Structure of a Vector

Each pattern generator vector consists of the following buses and signals:

DATA Data to be sent over the link. Remember, at this point, frame headers and payloads are “just data” so they are not distinguished in any way. 32 bits wide.

TNUM Indicates whether a timer command applies to timer 0 or timer 1. 1 bit wide.

ESCAPE Indicates the start of an LP escape sequence. This bit should only be set to “1” at the beginning of an escape sequence. 1 bit wide.

TURNAROUND Indicates that the N4861A stimulus probe should request a bus turnaround. The probe will release control of the bus; once the DUT has completed its communication and requested its own bus turnaround, the probe will take back control.

CLKENABLE Enables the clock output. CLKENABLE=1 means that the probe will output the clock signal. 1 bit wide.

SOP The "SOP" bit actually means "Request HSDT". It's not actually the start of a packet. The packet definitions are passed in the data field. The hardware has no knowledge of a packet structure since MIPI D-PHY support several packet-level protocols. 1 bit wide.

TWAIT TWAIT=1 indicates that the N4861A stimulus probe should wait until the timer (specified by TNUM) reaches the value in the DATA bus before proceeding to the next command. 1 bit wide.

TSET TSET=1 indicates that the timer (specified by TNUM) should be set to the value in the DATA bus. 1 bit wide.

RESET RESET=1 is used as a reset vector to theN4861A stimulus probe. All of the current internal states of the N4861A module are reset. All data waiting to be sent is cleared.

EOP Indicates the last byte in the transmission. This is true for both HSDT and LPDT. 4 bits wide.

ULPC A ULPC=1 places the clock in the ULP state. 1 bit wide.

Special values of DATA

If the MSB of the "DATA" label is 0x87, it will also indicate the start of a LPDT.

If the MSB of the “DATA” label is 0x78, it indicates that the data bus should enter the ULP state. The data is sent similarly to the high-speed transmission. ULP is exited by simply requesting either an HSDT or LPDT. The probe will wait at least Twake-up before continuing after entering the ULP state.

Notes on CLKENABLE

CLKENABLE must be true to send high-speed data. If it is kept low, the data will never be sent since the D-PHY specification requires a clock for high-speed data.

Never try to start or stop the clock during an LPDT.

The Structure of a Vector Sequence

The sequence of vectors which you set up in the pattern generator will usually consist of an initialization sequence and a looping sequence.

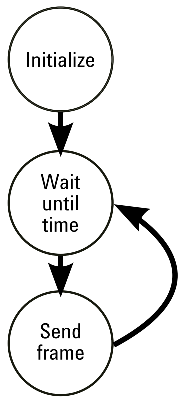


Figure 7 State diagram for a basic sequence

The initialization sequence is usually a pair of vectors which initialize communication with the N4861A stimulus probe, and possibly some vectors with commands to set up the DUT.

The looping sequence is usually a series of commands which tell the N4861A stimulus probe to wait until a timer reaches a particular value then send a MIPI D-PHY frame.

Example Sequence #1

Here is a short pattern generator vector sequence:

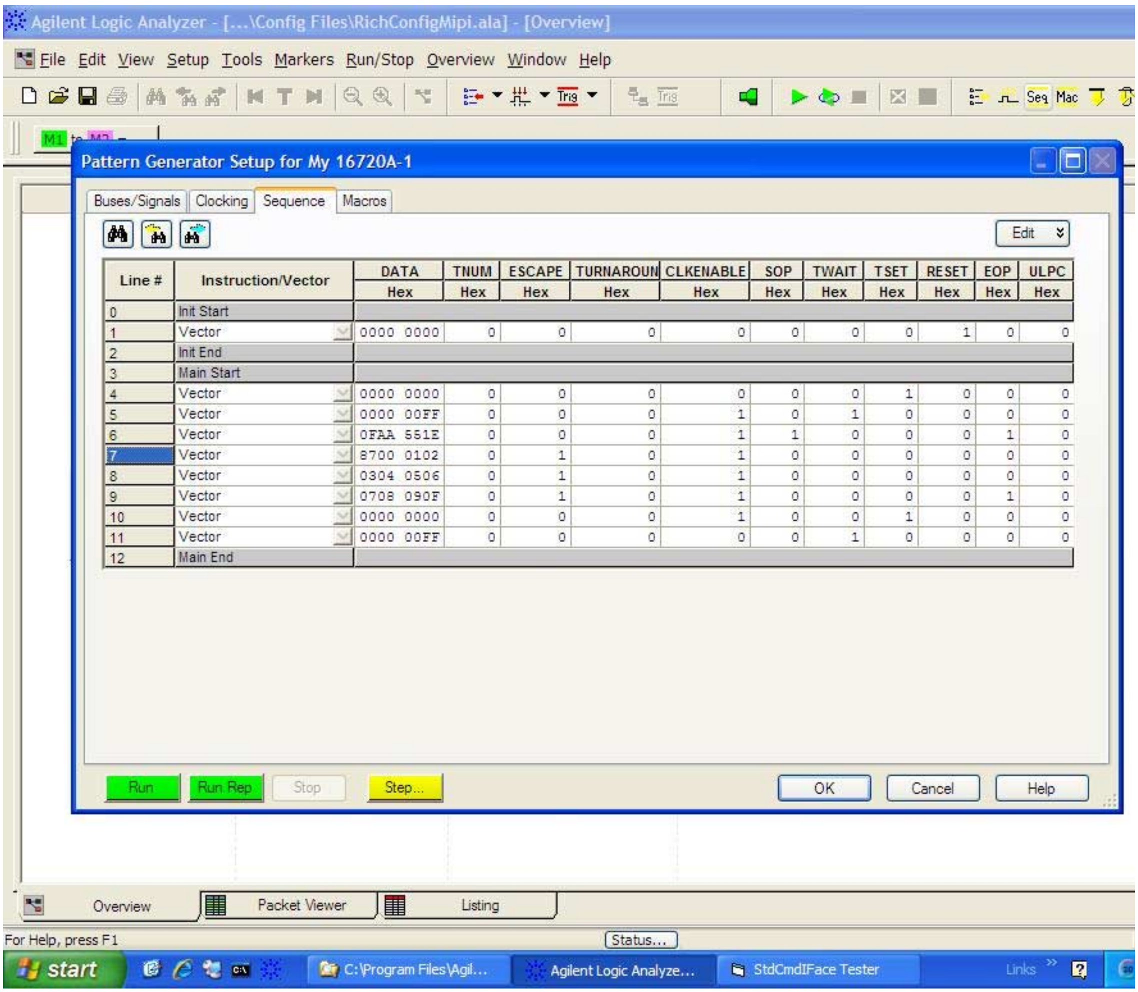


Figure 8 Example sequence

Line 1 The first line resets the state machines and transmitters. It forces the stimulus to stop and prepare for new data.

Line 4 Line 4 sets timer 0 to 0 (there are two timers, timer 0 and timer 1). The timer value is passed in the "DATA" label. The bus also starts up at this time since the reset has been removed. This means that the bus initialization sequence is started.

Line 5 Line 5 tells the stimulus engine to start the clock after waiting for the initialization sequence to complete and 1.275 ms.

The timer starts up right away and runs at 200MHz. This means that each timer tick is equivalent to 5 ns, so it might timeout prior to the initialization sequence completing.

Line 6 Line 6 requests a 4-byte, high-speed transmission. Notice that the lsb of the "EOP" label is set to '1'. This means that the last byte of the 4-byte DATA field is the last byte in the transmission.

The data is transmitted in the following order: 0x0F, 0xAA, 0x55, 0x1E with the lsb of each byte transmitted first.

Lines 7-9 Line 7 requests an escape sequence that is an LPDT request. This data transmission spans 3 lines, or 12 bytes, before ending with the "EOP" label set to '1' at Line 9.

Line 10 Line 10 once again sets timer 0 to 0.

Line 11 Line 11 stops the clock after 1.275 ms.

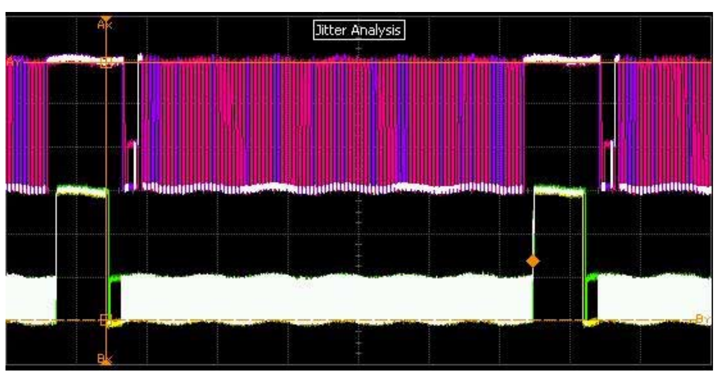


Figure 9 Output from the example sequence

Figure 9 shows the data created by the above sequence if the pattern generator is looped. Notice the short burst of high-speed data right after the clock starts. This is followed by a LPDT and then the clock is stopped. The sequence then starts over again.

Example Sequence #2

The example shows how to send a single stimulus command, using a CSV file.

It works well to put the command vector in the Init section.

Begin with a reset vector. This clears the pipeline of any older vectors.

Build your csv files like the following:

```
*Init Start
Reset vector
Command vectors …
*Init End
*Main Start
*Main End
```

Reset, then Run the pattern generator.

Stimulus Commands

Table 2 Stimulus command quick reference

Command	DATA	RESET	TNUM	TSET	TWAIT	CLKENABLE	ESCAPE
Reset	0	1	0	0	0	0	0
Timer Set	time	0	0 or 1	1	0	1	0
Timer Wait	time	0	0 or 1	0	1	1	0
Start LPDT	8700 0000	0	0	0	0	1	0
Enter ULP	7800 0000	0	0	0	0	1	0

Timing

How the pattern generator is clocked

The pattern generator is externally clocked by the N4861A stimulus probe. This allows the N4861A stimulus probe to control when it receives the next command.

Timers

The N4861A stimulus probe has two 32-bit internal timers which you may use to pace the stimulus.

The first timer is sometimes called an “absolute timer” and the second a “relative timer.” The timers both work in the same way, but the relative timer is usually used to count relative time (without having to calculate what the absolute time would be). It is suggested that one of the first vectors set the absolute timer to 0. It is also recommended to reset the timer on the start of the looping sequence.

Clock rate of the timers

These timers run at 200 MHz with 5 ns resolution. Thus the maximum delay using one timer command is about 20 seconds.

Timer latency

Evaluating or setting a timer takes one timer clock period (5 ns).

Size of timer values

Timer values are carried on the DATA label, which is 32 bits wide.

To set a timer (Timer Set)

1. Set TNUM to the number of the timer you wish to set (0 or 1).
2. Set TSET=1.
3. Set DATA to the value to load into the timer. This is often 0, to reset the timer.
4. Set all of the other buses/signals to 0.

To wait for until a timer reaches a certain value (Timer Wait)

1. Set TNUM to the number of the timer you wish to use for the wait (0 or 1).
2. Set TWAIT=1.
3. Set DATA to the value the timer should reach before proceding to the next stimulus command.
4. Set all of the other buses/signals to 0.

If the timer has already reached the value when the Timer Wait command is encountered, the next stimulus command will be executed (after the one clock period it takes to evaluate the timer).

5
Using the Signal Inserter

This chapter describes how to use the signal inserter tool to create the data which the N4861A stimulus probe will send to the device under test.

"Understanding the Data Flow" on page 14 shows how the signal inserter fits into the process of creating stimulus data.

What the signal inserter can do

The signal inserter tool is a standalone application which is installed as part of the main logic analysis system software package.

The signal inserter provides a way to output pattern generator CSV files from a variety of input sources:

- CSI-2/DSI ASCII frame format
- CSI-2/DSI binary frame format
- Image files (.bmp, .gif, .ico, .tga, .pcx, .wbmp, or .wmf)
- Captured CSI-2 or DSI data

The same tool is also used to create DigRF IQ data for the N4850A DigRF v3 stimulus probe.

The signal inserter can be controlled from a graphical user interface, or from the command line.

To start the signal inserter

The signal inserter is not part of the logic analysis system's menus. To start the signal inserter:

- Select **Start>All Programs>Agilent Logic Analyzer>Utilities>Signal Inserter**.

Using the signal inserter window

The **Generate CSI-2/DSI** tab is used to generate a Pattern Generator CSV file from an image file or from an ASCII or binary data file.

The **Translate CSI-2/DSI** tab is used to translate between pattern generator file formats. If the input file is a Module CSV file, it will be translated to a Pattern Generator CSV file. If the input is a Pattern Generator CSV file, it will be translated to a Module CSV file (which can then be used as an input to the packet decoder and other tools).

Using the Generate CSI-2/DSI tab

1. Select the protocol.
2. Select the file type.
3. Select the name of the input file.
4. Set the options.
5. Click Generate the Output CSV file.

Input File Type

The Input File Type field is used to specify the format of the data in a binary or ASCII file.

Binary Frame Format

This binary format is just header and payload bytes in transmission order.

For example, it could be a binary file containing these hex bytes

```
0F 08 80 00 10 00 00 00 00 00 10 02 00 00 02 20 00 00 …
```

The 0F is a header indicating a 4-byte frame. So the first 4 bytes make a frame. The next byte is 10, a 6-byte frame, etc. The sequence can include any legal header and payload.

CSI-2/DSI ASCII Frame Format

ASCII Format contains a one line header and comma separated ASCII hexadecimal values. Comments are allowed, delimited by either '/' or "#'. The one line header specifies the data in the following lines. The data lines each comprise the contents of one packet.

The header line must contain these labels:

Ticks number of 5 ns ticks to wait (from the beginning of the file) before outputting this line.

nsTime time in ns to wait (from the beginning of the file) before outputting this line.

LPS when 1, output this line in lower power state.

Escape when 1, enter escape mode.

ULPC when 1, enter ultra low power mode.

Data bytes of data for the packet.

There are two options for the header line:

```
// Example Init Packets in a CSI-2/DSI ASCII Format File
Ticks, LPS, Escape, ULPC, Data
0200, 1, 0, 0, 02, 00, 00, 00
0300, 0, 0, 0, 21, 00, 00, 00
```

```
// Example Main Packets in a CSI-2/DSI ASCII Format File
nsTime, LPS, Escape, ULPC, Data
// Start Image Frame 1
02000, 1, 0, 0, 01, 00, 00, 00
03000, 0, 0, 0, 21, 00, 00, 00
04000, 0, 0, 0, 0e, 09, 00, 00, ff, 00, 00, 00, ff, 00, 00,
   00, ff, 00, 00
```

Image File

An image file can be one of several image formats supported by Windows.

Selecting the Image File format enables image-related controls that allow you to specify the manner in which the pixels in the image file will be packetized.

If the **Generate Line Start/End Packets** box is checked, then there will be a Start Line packet before every line of pixels followed by an End Line packet.

If the **Generate ECC** box is checked then ECC will be generated in Packet Headers. If it is not checked all ECC will be set to zero.

If the **Generate CRC** box is checked then CRC will be generated in Packet Footers. If it is not checked all CRC will be set to zero.

If the **Generate EoT Packets** (DSI 1.01 only) box is checked then EoT packets will be generated before the end of a transmission.

After all the options are set up, select the Generate the Output CSV file button to generate the file.

Wait Time

The wait time is the length of time to wait between transmitting frames. This time is encoded as a time command in the Pattern Generator sequence.

The Wait Time can be input as Engineering Time (time in units of s, ms, us, ns, or ps) in the left box or as the number of 200 MHz clock ticks in the right box. These displays are kept in sync by the software. When you change the value in one box, the value automatically changes in the other box.

All frames use the same wait time. There are several options for adjusting the wait time for specific frames: edit the resulting sequence, or use a script in the language of your choice to post-process the output CSV file.

Insert CSI-2 DSI ASCII Format Packets in Init

Use this option to insert packets into the Init part of the Pattern Generator sequence from a CSI-2/DSI ASCII Format file.

Using the Translate CSI-2/DSI tab

The Translate CSI-2/DSI tab is used to perform one of two translations:

Module CSV to Pattern Generator CSV This is useful for converting logic analyzer traces captured from an N4851A acquisition probe to Pattern Generator CSV suitable for the N4861A stimulus probe.

Pattern Generator CSV to Module CSV This is useful for translating a Pattern Generator CSV file suitable for the N4861A stimulus probe to a Module CSV file suitable for the Import Module, Packet Decoder and Packet Viewer, This allows you to view your stimulus before generating it.

The operation is chosen based upon the input file type. So in each case, the procedure is:

1 Select the protocol.
2 Select an input file.
3 Enter a name for the output CSV file.
4 Click **Generate the Output CSV file**.

If the input file is Licensed Pattern Generator format, you will get an error message. Translating Licensed Pattern Generator format to Module CSV is not supported.

Translating to Pattern Generator CSV

If the input file is a Module CSV file, it will be translated to a Pattern Generator CSV file.

You can create a Module CSV file yourself (see "Module CSV files" on page 54). You can also capture a signal using the N4851A acquisition probe, save it as a CSV file, then translate it to Pattern Generator CSV for use as stimulus.

Translating to Module CSV

If the input is a Pattern Generator CSV file, it will be translated to a Module CSV file. The Module CSV is the same format as the output of the N4851A acquisition probe. You can load the Module CSV file into the logic analysis system, and use all the analysis tools available there (such as the Packet Decoder tool, the Packet Viewer display, and the Signal Extractor).

This is useful for verifying that you have created the series of DigRF packets correctly.

Module CSV files

Module CSV differs from generic CSV in that it has a header that defines label widths and it always contains time stamps.

To create a Module CSV file, select **File>Export...** from the logic analysis system's main menu bar.

Signal inserter command line options

Protocol options:

```
/digrf  (DigRF v3)
/csi-2  (MIPI Camera Serial Interface 2)
/dsi    (MIPI Display Serial Interface V1.0)
```

```
/dsi_01 (MIPI Display Serial Interface V1.01.00)
/iq     (Raw IQ data, no protocol, no framing)
```

The default protocol is DigRF v3, omitting the protocol option is equivalent to specifying option /digrf. If there is more than one protocol on the command line, an error message is output and there is no action taken.

Action options:

```
/generate
/translate
/insert
```

These correspond to the “Generate the Output CSV file” on each tab of the dialog. If there is more than one action, an error message is output and there is no action taken.

File name options:

```
/input <filename>
/output <filename>
/replace <filename>
```

All actions require an input file and an output file, except Generate DigRF where the input file is optional. For the /insert action, a /replace file is required. The /replace file option is not allowed for the other actions.

Additional options for /generate:

```
/type <signal_file_type>
```

The <signal_file_type> is the file name, without extension, of the .XML file that describes the signal file. The defined files are:

File Name	Title (appears in user interface)
Binary_16-bit_IQ_lsb	Binary 16-bit, I-lsb, I-msb, Q-lsb, Q-msb
Binary_16-bit_IQ_msb	Binary 16-bit, I-msb, I-lsb, Q-msb, Q-lsb
Binary_16-bit_QI_lsb	Binary 16-bit, Q-lsb, Q-msb, I-lsb, I-msb
Binary_16-bit_QI_msb	Binary 16-bit, Q-msb, Q-lsb, I-msb, I-lsb
ESG_Arb_Format	ESG Arb Format
N5110A_Format	N5110A Format
TwoColumnAsciiDecimal	Two Column Ascii Decimal

```
/payload <size_in_bits>
  32, 64, 96, 128, 256, 512
```

```
/channel <data_channel_letter>
A, B, C, D, E, F, G or H

/cts <cts_bit>
0, 1

/size <IQ_size>
8, 12 or 16

/wait <time_string>
wait time in engineering time format, i.e. 2.083333us

/ticks <integer>
wait time as a decimal number of clock ticks

/control[1-4]
generate the control frame using the corresponding [1-4]
   options

/width[1-4] <size_in_bits>
  8, 32

/channel[1-4] <channel_number>
  0 (Interface Control)
  1 (Time Accurate Strobe)
  2 (RFIC Control; RFIC Read)
  3 (CTS Transfer)

/data[1-4] <hex_string>

/initframes <filename>
  path name of the Init Frames Module CSV file

/mainframes <filename>
  path name of the Main Frames Module CSV file

/linestart
  generate Line Start/End packets (MIPI image file only)

/ecc
 generate ECC in MIPI packet headers (MIPI image file only).
   If this option is not specified then zero is generated for
   all ECC.
```

```
/crc
 generate CRC in MIPI packet footers (MIPI image file only).
  If this option is not specified then zero is generated for
  all CRC.

/imagetype        CSI:              DSI:
              0 = RGB444            RGB565
              1 = RGB555            RGB666
              2 = RGB565            RGB666 Loosely Packed
              3 = RGB666            RGB888
              4 = RGB888            na
              5 = YUV420 8          na
              6 = YUV420 10         na
              7 = YUV420 8 Legacy   na
              8 = YUV420 8 Shifted  na
              9 = YUV420 10 Shifted na
              10 = YUV422 8         na
              11 = YUV422 10        na
The imagetype option indicates how to format image data in
  MIPI pixel packets.
```

Additional options for /insert:

```
/type <signal_file_type>  (same values as above)
/algorithm <replacement_algorithm>
```

The <replacement_algorithm> is the file name, without extension, of the .XML file that describes the algorithm. The defined files are:

```
File Name                            Title (appears in user interface)
Channel_A_128-bit_payload_8-bit_IQ   Insert to Channel A, 128-bit payload, 8-bit I and Q
etc.
```

Both of these options (/type and /algorithm) are required for the /insert action.

Other Options:

```
/nomessage
```

Do not output any messages. Messages require a response (Press enter to continue...). When using this command line in scripting languages that could cause an unwanted pause. Scripting language users may prefer to rely on the exit status, 0 for success, and 1 for failure.

```
/?
```

Print a command line summary

6
Running the Stimulus Probe

Basic Stimulus Tasks

To prepare the system

1 Make sure the software is installed (see "Installing the Software" on page 17).
2 Make the physical connections (see "Connecting to Your Board" on page 25).
3 Load a configuration file (see "Loading a Configuration File" on page 17).
4 Configure the N4861A stimulus probe (see "Setting up the Probe for Your Device Under Test" on page 18).
5 Load a pattern generator CSV file.

To start the stimulus

1 Chck that the pattern generator is set to external clock mode.

2 Reset the pattern generator (click the Reset icon).

   Resetting the pattern generator will pull CLKENABLE false and prepare the N4861A stimulus probe to begin accepting commands.

3 Run the logic analyzer.

   The N4851A acquisition probe must be acquiring data so that it can communicate information about the state of the link to the N4861A stimulus probe.

4 Run the pattern generator (using the run repetitive mode).

Understanding the Displays in the Logic Analysis System

To display an overview of tools in the logic analysis system

1 At the bottom of the logic analyzer window, click the **Overview** tab.

The Overview window lets you view how the data is sent from the logic analyzer data acquisition module to post-processing tools and display windows. Each icon represents a hardware or software tool you can use. The arrows represent the flow of data between tools.

The **Probes** column shows the probes which physically acquire the data.

The **Modules** column shows the logic analyzer cards which capture the data.

The **Tools** column shows post-processing tools which manipulate the captured data before it is displayed.

The **Windows** column shows the different display windows which you can use to display the captured data.

Tools may be accessed by clicking on their icon, by clicking on the tab at the bottom of the screen, or through the menus at the top of the screen.

See the online help in the logic analysis system for more information on how to add more tools and display windows. The online help also explains how to control the data flow between tools and windows, and how to control the appearance of the data within each window.

Overview window example

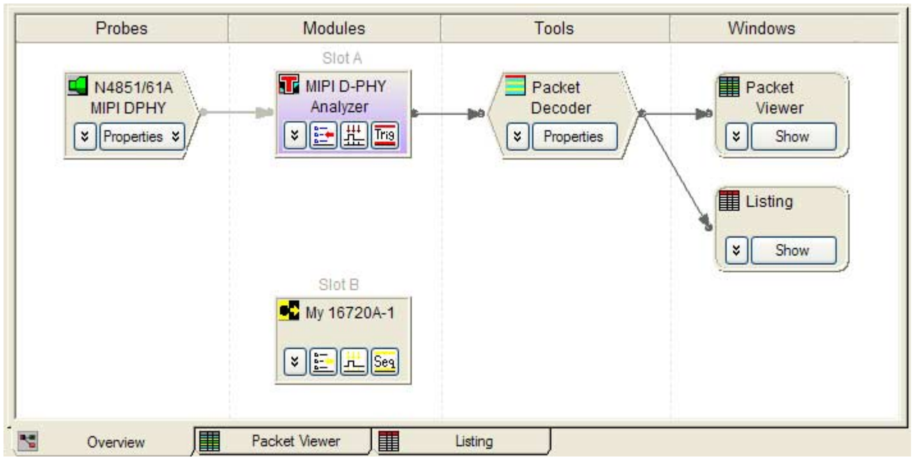


Figure 10 Overview display

Figure 10 shows a basic setup for the N4861A stimulus probe.

N4851A/61A MIPI DPHY provides the an interface where you can configure the N4861A stimulus probe.

My 16720A-1 is the pattern generator, which sends commands to the N4861A stimulus probe. The Overview window does not show that connection.

The other tools in the Overview window are used for acquiring, processing, and viewing activity on the link. Those tools are described in the *N4851A MIPI D-PHY Acquisition Probe User's Guide*.

7
Troubleshooting

If you see an error message while loading a configuration file

If you load a configuration file with the probe powered off, or not connected or incorrectly connected to the analyzer pods, the communication with the probe will fail and you will see an error message.

✔ Check that the probe is powered on.

✔ Check that the probe is connected to the logic analysis system.

To run the built-in self test

1 In the logic analysis system, open the N4861A stimulus probe's Self Test dialog.
2 Select the appropriate test.
3 Follow the directions listed for the test.
4 Click Run Self Test. The results of the test will be displayed.

If an error occurs during Self Test, select "Enable Log to File" and choose a file name, then run the test again.

Understanding the LEDs

The front panel LEDs indicate the status of the clock and data outputs. Each of the six LEDs on the front of the N4861A stimulus probe can be green, amber, or red.

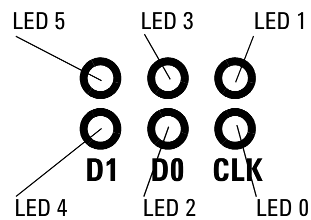


Figure 11 Names of the status LEDs

Table 3 What the colors of the LEDs mean

	Off	Green	Flashing green	Red
LED 0	Output clock is stopped	Output clock is running	Output clock is stopped, but a valid user clock is present.	—
LED 1	—	Valid USER CLK input	—	Invalid USER CLK input
LED 2	Data lane 0 is stopped	Lane 0 is enabled and transmitting	Lane 0 is enabled, but not currently transmitting	—
LED 3	Data lane 0 is disabled (in the Stimulus tab of the user interface)	Data lane 0 is enabled (in the Stimulus tab of the user interface)	—	Data lane 0 is enabled, but USER CLK is invalid
LED 4	Data lane 1 is stopped	Lane 1 is enabled and transmitting	Lane 1 is enabled, but not currently transmitting	—
LED 5	Data lane 1 is disabled (in the Stimulus tab of the user interface)	Data lane 1 is enabled (in the Stimulus tab of the user interface)	—	Data lane 1 is enabled, but USER CLK is invalid

Notes

When the N4861A stimulus probe is receiving no input, and it isn’t driving any outputs, all of the LEDs will be off.

Updating the Firmware

You can update the FPGAs in the probe by sending new configurations over the analyzer cables. It takes up to 60 minutes (the FLASH memory erase time is variable) to update the FPGAs. This should only be done when requested by Agilent.

1 Copy the new firmware to the logic analysis system. Save the files in the following directory:

```
C:\Program Files\Agilent Technologies\Logic Analyzer\AddIns\
   Agilent\N4851A\FPGA
```

2 Check that the N4861A stimulus probe is turned on and connected to the logic analysis system.
3 Open the N4851/61A MIPI DPHY probe Properties dialog.
4 Select the **Update FPGA** tab.
5 Select the module you wish to update and then which FPGA version you want to use.

Click **Update FPGA**.

8
Safety Notices

This apparatus has been designed and tested in accordance with IEC Publication 61010-1, Safety Requirements for Measuring Apparatus, and has been supplied in a safe condition. 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."

Warnings

- Before turning on the instrument, you must connect the protective earth terminal of the instrument to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. You must not negate the protective action by using an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.
- Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock or fire hazard.
- If you energize this instrument by an auto transformer (for voltage reduction or mains isolation), the common terminal must be 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.

- 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.
- 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.
- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
- Do not use the instrument in a manner not specified by the manufacturer.

To clean the instrument

If the analysis probe requires cleaning: (1) Remove power from the instrument. (2) Clean the external surfaces of the instrument with a soft cloth dampened with a mixture of mild detergent and water. (3) Make sure that the instrument is completely dry before reconnecting it to a power source.

Do not clean the cables.

Safety Symbols

“Caution” or “Warning” risk of danger marked on product. See “Safety Notices” on page 2 and refer to this manual for a description of the specific danger.

Hazardous voltage symbol.

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

9
Characteristics — N4861A

Operating characteristics

The following operating characteristics are not specifications, but are typical operating characteristics.

These characteristics are subject to change. Information in the product data sheet takes precedence over any information listed here.

Table 4 Protocols supported

Protocol	Version supported
MIPI D-PHY	version 0.9
CSI-2	version 1.00
DSI	version 1.01 (version 1.00 is not supported)

Table 5 N4861A Connectors

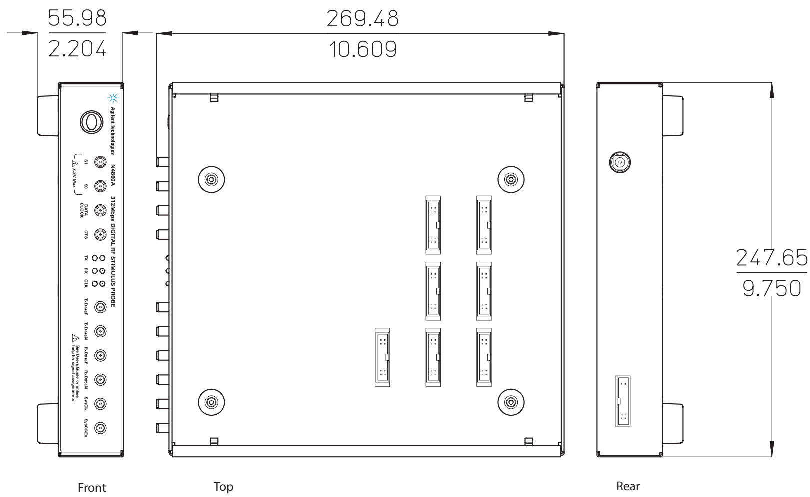
Connector	Characteristics
Pattern Generator Inputs	Seven connectors for use with an Agilent 16720A pattern generator or 16800-series portable logic analyzer with pattern generator.
S0, S1	SMA connector reserved for future use (input/output function configured in software). Min: 0.8V, Max: 3.3V, Max current 24mA DC-50 MHz. CAT I (Mains isolated)
D1p, D1n, D0p, D0n	SMA Differential Output. Min: -100mV, Max: 3.3V (user configurable), Slew rate: Fast/Medium/Slow/Slowest (user configurable) Max current 60 mA
Clkp, Clkn	SMA Differential Output. Min: -100mV, Max: 3.3V (user configurable), Slew rate: Fast/Medium/Slow/Slowest (user configurable) Max current 60 mA
USER CLK, S2	SMA Input. Min: -1.5 V, Max: 3.3V Maximum clock rate: 100 MHz Slew rate: Fast/Medium/Slow/Slowest (user configurable) Max current 60 mA
Option Connector	Reserved for use with the Agilent N4851A acquisition probe.

Table 6 Electrical Characteristics

Electrical Characteristics	
Power Requirements (Power Supply)	Input: 100-240 V, 1.5 A, 50/60 Hz, IEC 320 connector Output: 12 V, 5 A CAT II (Line voltage in appliance and to wall outlet)
Power Requirements (Agilent N4861A Probe)	Input: 12 V DC, 5 A. Use only with the provided power supply. CAT I (Mains isolated)
Load Model	See the documentation for the probe you are using.

Table 7 Mechanical Characteristics

Mechanical Characteristics	
Analysis Probe Dimensions	See "Positioning the Probe" on page 26 for ventilation requirements.



N4860A Dimensional Drawing

Weight	Probe: 2.0 kg (4.4 lb), not including power supply

Table 8 Environmental Characteristics (Operating)

Environmental Characteristics (Operating)	
Temperature	Operating/non-operating: +0° to +55° C (+32° to +131° F)
Altitude	Operating/nonoperating 3000 m (10,000 ft)
Humidity	8 to 80% relative humidity at 40° C (104° F).
	Avoid sudden, extreme temperature changes which could cause condensation on the circuit board. For indoor use only.
	Pollution degree 2: Normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by pollution may occur.

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