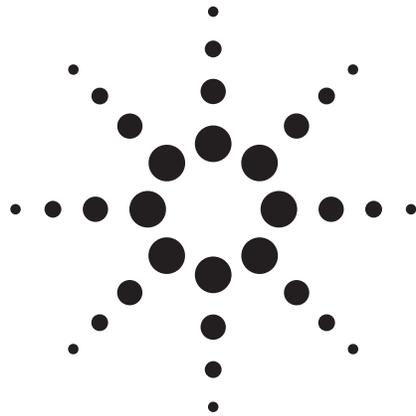


# Generating/Measuring Jitter with the Agilent 81134A Pulse/Pattern Generator & 54855A Infiniium Scope

Product Note



With the 81134A it is easy to add jitter to any kind of data or clock signal. This is very useful if you need to test the jitter tolerance of your circuit designs, e.g. data receivers or clock recovery circuits.

The 54855A Infiniium Scope allows you to measure and characterize the jitter that disturbs your signals. Knowing the details about the jitter makes it much easier to identify the source of the jitter and to debug it.

The 81134A can not only be used to generate high speed data signals, but also to stress test a device under test, by adding a well-defined jitter to the ideal signal. Figures 1 and 2 show the eye diagram of a 2.5 Gb/s data stream with and without the additional jitter.

In addition to the normal eye measurements (figure 3), the 54855A Infiniium Scope offers the possibility of analyzing the jitter in more detail (figure 4). The jitter can be viewed in the time and the frequency domain, which is a great help for finding the reason for unwanted jitter in a design.

Required equipment:

- 81134A Pulse/Pattern Generator
- 54855A Infiniium Scope with Accessories
- 33250A Arbitrary Waveform Generator
- 15435A Transition Time Converter (150 ps)
- SMA cables, SMA to BNC converter

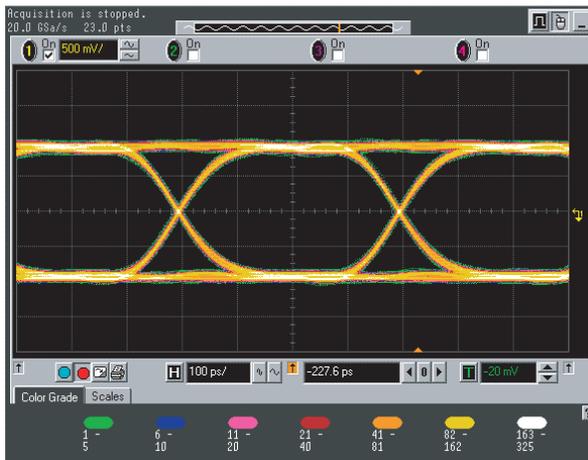


Figure 1: "original" Datastream

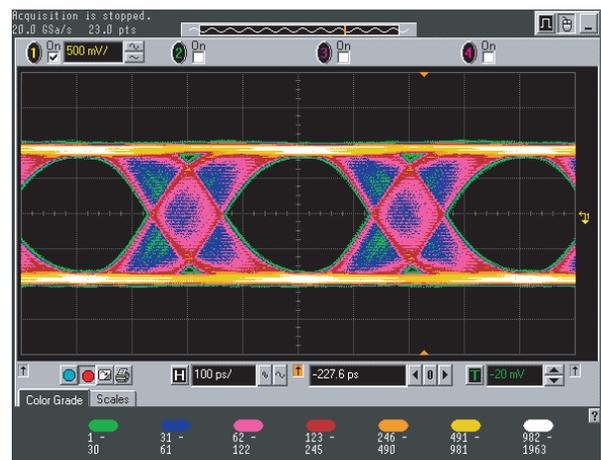


Figure 2: Jitter added to the signal

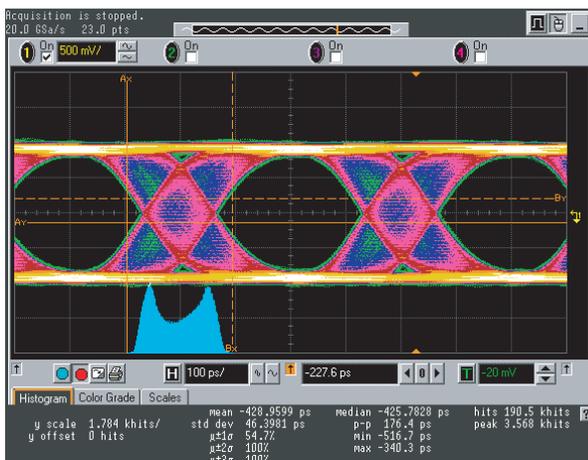


Figure 3: Normal eye measurement

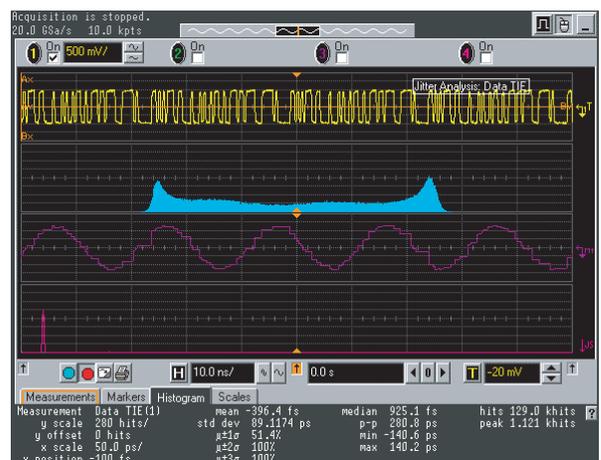


Figure 4: 54855 Jitter measurements

### How to connect and setup the instruments (see figure 5)

Before disconnecting/connecting any cables make sure that the 81134A output channels are turned off!

- Connect the 33250A output to the channel 1 delay control input of the 81134A (use the BNC-SMA adaptor)
- Connect the Transition Time Converter to the Scope channel 1 input (use the scope's SMA adaptor)
- Connect the 81134A channel 1 output to the transition time converter.
- Connect the 81134A trigger output to the scope channel 2 input
- Power on the three units.

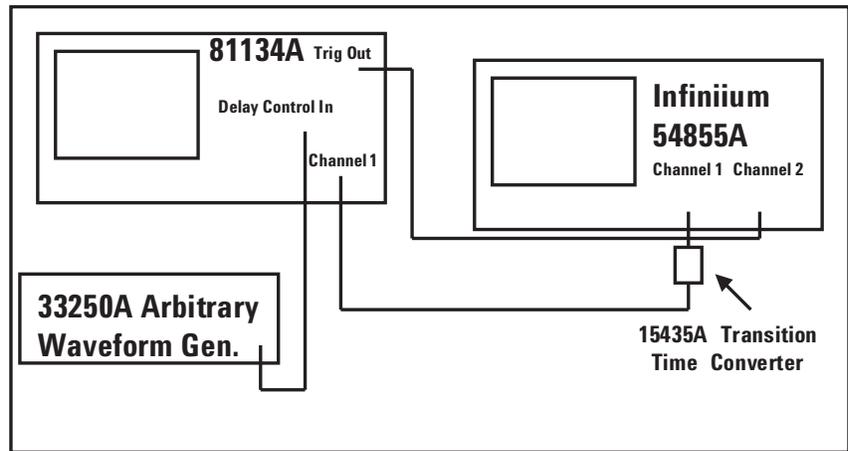


Figure 5: How to setup the instruments

### Setup of the 81134A

- Go to the 'Channel 1' screen and set the output frequency to 2.5 GHz
- Set the output mode to PRBS 2<sup>6</sup>-1 with NRZ pulses
- Set the levels to "High"-1 V and "Low" - 1 V
- Set the "Delay Control Input" to 250 ps
- Select the 'Aux' screen and set the Trigger Output levels to "High"-1 V and "Low"-1 V.
- Select the Trigger Output Mode "Pulse" in the drop-down menu
- The screens should now look like the pictures on the right
- Switch on the trigger output and the channel 1 output. The screens now should look like it is shown in figures 6 and 7.
- Switch off the delay control input again by pressing the key near the input connector

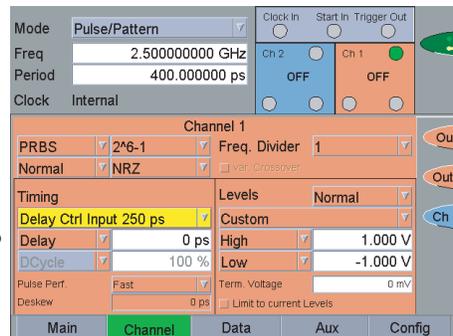


Figure 6: Setup of the 81134A

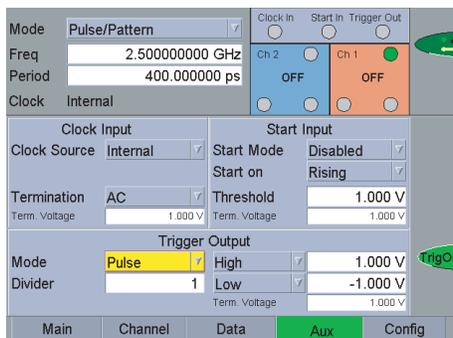


Figure 7: Setup of the 81134A

### The settings can also be stored

- On the 'Main' screen use the 'Store' and 'Recall' softkeys to store or recall the complete settings in one of the nine non-volatile memories
- Default values can be recalled by recalling memory "0".

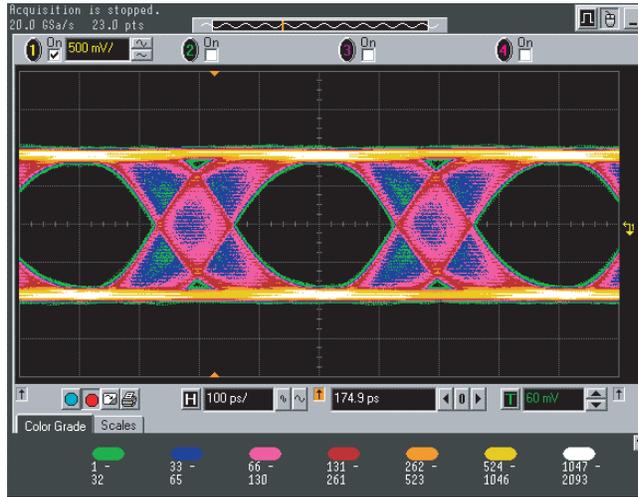
### Setup of the 33250A

Program a 50 MHz sine wave with an amplitude of 250 mVpp:

- Press the 'Freq' soft key
- With the numeric key pad enter '50' as the magnitude of the frequency
- Select the desired unit 'MHz' by pressing the corresponding soft key
- Press the 'Ampl' soft key
- Enter the value '250' with the numeric keypad
- Press the 'mVpp' soft key to select the desired unit.

**View the eye diagrams on the Infiniium 54855A**

- Switch on the 81134A outputs
- On the scope:
  - ‘Default Setup’ the scope
  - press ‘Auto Scale’
  - switch off the channel 2 display and center the channel 1 signal
  - go to the drop down menu ‘Setup > Display’
  - select ‘color grade’ and click ‘close’.

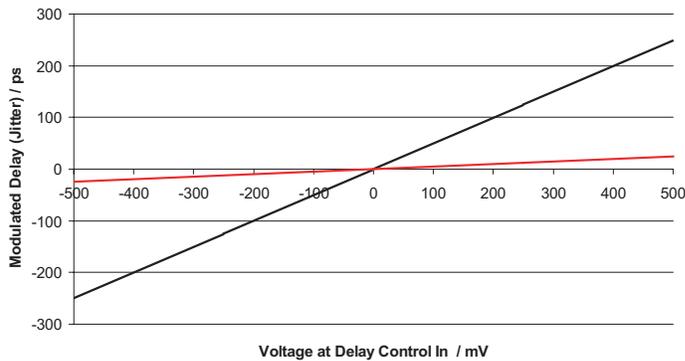


**Figure 8: View the eye diagrams on the Infiniium 54855A**

The oscilloscope now shows an ideal, clean data signal with very low jitter. If the DUT needs to be stressed with a jittered data-stream, jitter can be added to the 81134A’s output signal:

- Switch on the delay control input of the 81134A
- Switch on the 33250A output
- To refresh the screen press ‘Clear Display’ on the scope.

With the signal at the delay control inputs of the 81134A the pulse delay can be modulated individually for each of the two channels. The modulated delay directly follows the signal at the input, as shown in figure 9. Two different sensitivities can be selected: 25 ps/500 mV or 250 ps/500 mV. For example a voltage of 250 mV will result in an additional delay of either 125 ps or 12.5 ps.

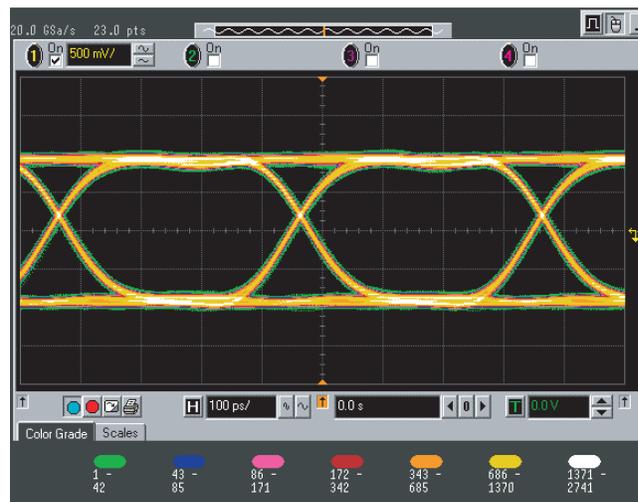


**Figure 9: Modulated Delay (Jitter) vs Voltage Level at Delay-Control-Input for ±250ps and ±25ps settings**

Different modulation signals result in different jitter patterns.

Additional control over the signal quality is offered with the ‘Variable Crossover Point’ feature (figure 10):

- On the 81134A’s ‘Channel 1’ screen, switch off the delay control
- Activate the ‘var. Crossover’ (located below the Frequency Divider settings).



**Figure 10: Generating and measuring Jitter**

### Characterize the jitter with the scope's jitter wizard

With the settings from the previous eye measurements:

- Switch off the 81134A trigger output
- Switch off the variable crossover.
- On the scope
  - 'Default Setup' the scope
  - Press 'Auto Scale'
  - If necessary, switch off the channel 2 display
  - Adjust vertical for large signal without clipping
- The display should now look similar to the screen shot in figure 11.

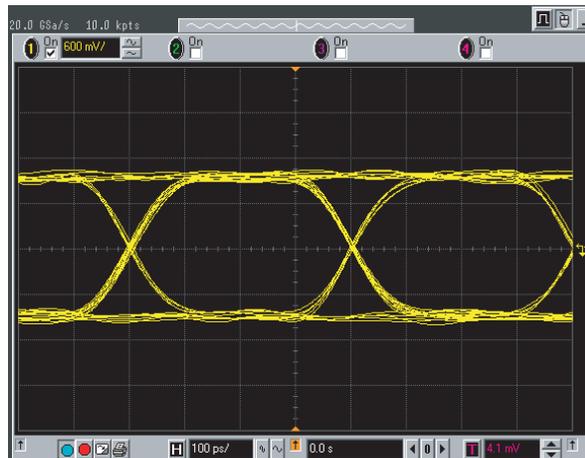


Figure 11: Characterize the jitter with the scope's jitter wizard

To simulate the debugging of a digital design a 2.5 GHz serial data stream is used, a speed that is used in serial busses, like PCI-Express for example. For these designs knowledge of the jitter characteristics is needed, so it can be known whether or not the design will tolerate. With the jitter Jitter Setup Wizard it is very easy to set up a Time Interval Error (TIE) jitter measurement, which will analyze the statistical, amplitude, temporal and spectral characteristics or the TIE jitter. (The TIE is the time variation of the data bit edge relative to an ideal clock signal without any jitter or drift).

- Set up the Jitter Measurement using the setup wizard:
  - Select the drop down menu 'Measure>Jitter>Jitter Setup'
  - Click 'Jitter Setup Wizard', walk through the dialog box and click 'Next'
  - Keep the 'Maximum Sample Rate' enabled to get the best accuracy – click 'Next'
  - Click on 'Select Jitter Measurement'
  - Select 'Time Interval Error (TIE) > TIE Data'
  - Select the desired units – either Unit Intervals or Seconds – and click 'Next'.
  - Click on 'set 50% of Vpp' to set the threshold crossing for jitter. (This tells the scope to measure the jitter from the 50% point of the waveform, which is typical for single ended signals). Click 'Next'.
- On the following screens enable the Histogram (shows the statistical view) and the Trend. The trend shows with time, correlated with the clock signal trace. This is useful for observing the amplitude and 'shape' of TIE, and for correlating the TIE jitter to other signals such as crosstalk from another signal.
- Disable Smoothing in order to see all the occurring jitter frequencies and enable the Spectrum.
- Click 'Finish' and then 'Close'.

After enabling the delay variation on the 81134A, adjust the scope's timebase until you can see the shape of the delay modulation function in the jitter trend results (figure 12). A change from a sine wave to a square wave on the 33250A also results in a change of the jitter measurement (figure 13).

To obtain good results: Set the scope to single shot mode and update the picture by clearing the screen and then running the measurement again.

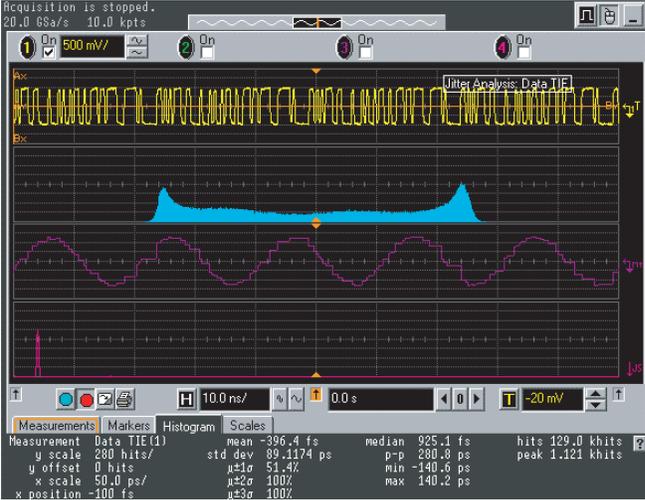


Figure 12: Generating and measuring jitter

**Analysis of the Measurement:**

- The second trace on the screen shows the histogram of the TIE. Clicking on the histogram tab at the bottom shows the statistics such as the peak to peak jitter measurement. The bimodal histogram indicates that this TIE is primarily deterministic.
- In the third trace the TIE is shown over time. This shows clearly the nature of the deterministic jitter, e.g. a sine wave. Also the frequency of the jitter can be measured in this trace.
- Sometimes deterministic jitter is too small to be seen in the trend trace, or it is composed of multiple frequencies. In this case, the spectrum of the jitter, shown in the bottom trace is a useful diagnostic tool.

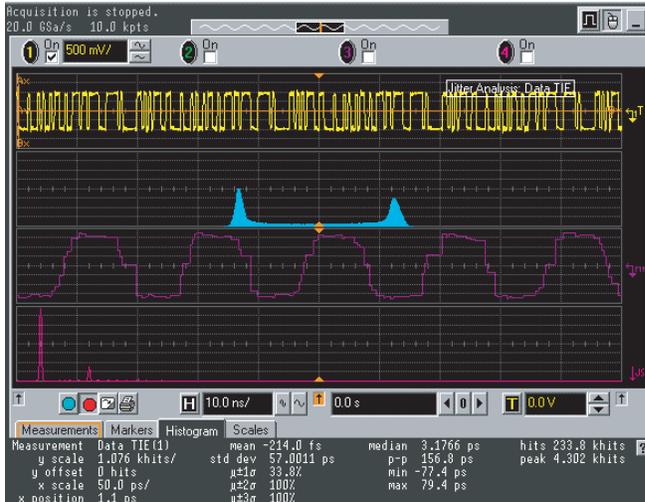


Figure 13: Generating and measuring jitter

## Related Literature

## Pub. No.

- *Agilent Technologies 81133A and 81134A, 3.35 GHz Pulse-/Pattern Generators, Data sheet* 5988-5549EN
- *3.35 GHz Pulse/Pattern Generators, Photocard* 5988-5935EN
- *Infinium 54850 Series Oscilloscope, InfiniiMax 1130 Series Probes, Data sheet* 5988-7976EN
- *Signal Integrity Brochure* 5988-5405EN
- *Jitter Solutions for Digital Circuits, Brochure* 5988-8427EN

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