81110A Pulse Pattern Generator

Simulating Distorted Signals for Tolerance Testing

Application Note

Agilent Technologies

Introduction

Industry sectors including computer and components, aerospace defense and education all require precise one or two channel signal sources. In typical measurement setups, the Agilent Technologies Pulse Pattern Generators are often used as reference clocks, system trigger or simply as data stimulus for transceiver tests. The analyzing is covered by Mixed-Signal Oscilloscopes (MSO), Digital-Signal Oscilloscopes (DSO) or Logic Analyzers.

Noise, jitter, crosstalk and reflections can cause distortions so valid clocks are not seen, spikes are mistaken for valid clocks or data is misinterpreted. Such effects cause system failures and must be minimized in the design to ensure accurate and reliable operation. Therefore, devices need to be stressed with these kinds of distortion during design, validation and production.

The essential features for measurement equipment to create the correct test conditions are two output channels, with channel adding, programmable patterns, and adjustable delays and transitions. The Agilent Technologies 81104A (80 MHz) and 81110A Pulse Pattern Generators meet all of these conditions, with the 81110A having the further flexibility of either Agilent Technologies 81111A (165 MHz) or 81112A (330 MHz) Output Channels.

This application note describes how to use the 81110A

• To create distorted signals
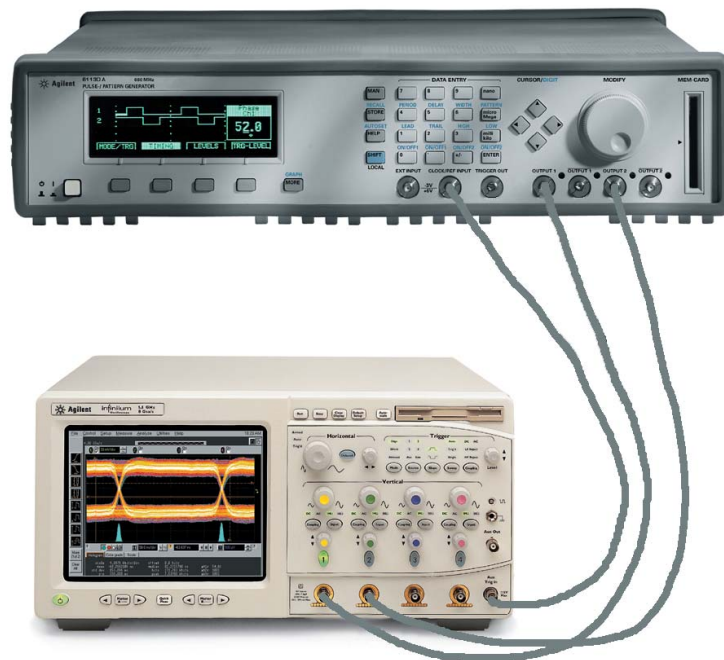• To inject noise for full stress testing of devices

Figure 1: The setup of an Agilent Pulse Generator and an Agilent Infiniium oscilloscope

Producing Distorted Signals

Principle of distorted signals

As shown in Figure 2, perfect data or clock signals are defined by their rising and falling edges, the width and the delay of the pulse. The width and delay are defined at the 50 % points of the edges. An ideal pulse pattern generator lets the user define each of these parameters individually.
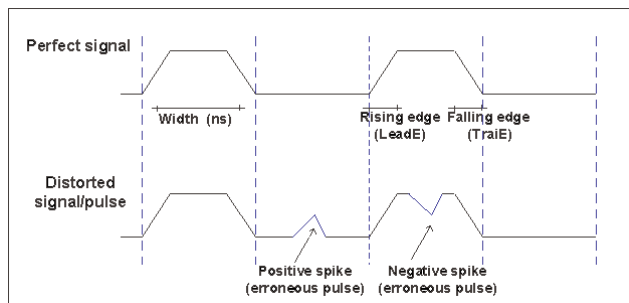

Figure 2: Perfect and distorted signal with clean rising and falling edges

A distorted signal has either positive or negative spikes added to the perfect signal at a specific place. With the 81110A it is possible to create such distorted signals by adding two pulse signals. The first one is a perfect pulse, the second reflects the distortion. This is why it is necessary to have a pulse pattern generator with two channels that can be added together. Also, the pattern needs to be programmable and the delay and transition of the rising and falling edges need to be adjustable.
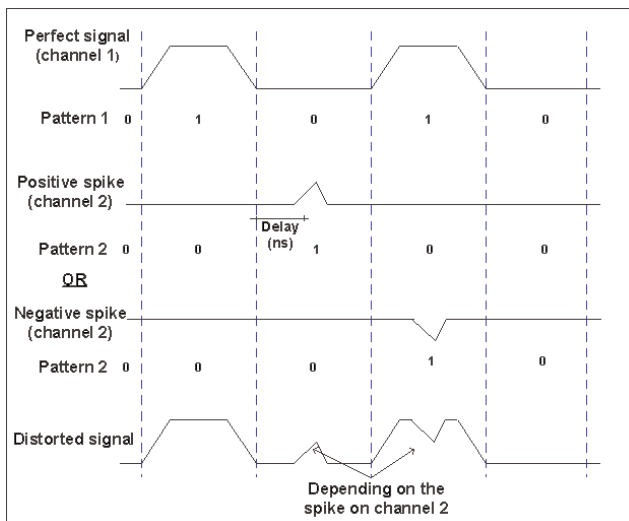

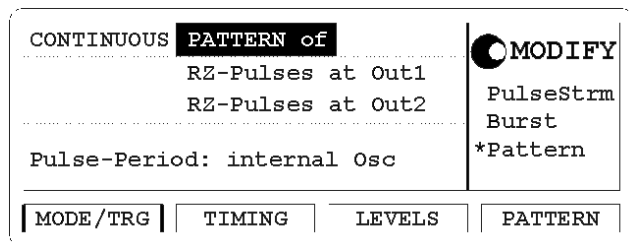Figure 3: Distorted signal composed from two independent patterns

In Figure 3, we show how to define and combine the signals from each channel. The first channel has the perfect signal, including the logic patterns. On the second output channel, we define the spikes. These can be either positive or negative. Adding the two (that is the perfect signal and one of the spikes) we get the distorted signal.

Setting Up the Pulse Pattern Generator

Figure 1 shows the setup used for the following measurements. In this section we show the four easy steps to set up the pulse pattern generator. This is, defining the pattern mode, entering the pattern, defining the pulse timing and finally, setting the signal levels. You can enter the parameters using either the front panel or SCPI programming.
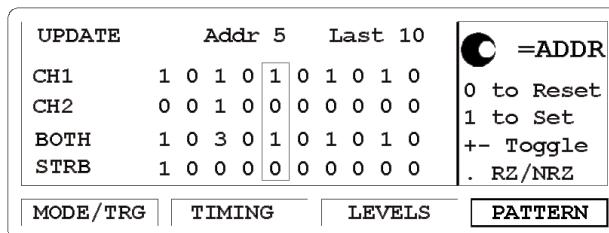
Step One:

1.1   Reset the instrument by selecting RECALL+0 (SHIFT, STORE+0).

1.2   Press MODE/TRG, and then select the PATTERN mode.

Step Two:

2.1   Press PATTERN, and then set up the following pattern for each channel.


```
 UPDATE         Addr 5    Last 10    ◖  =ADDR

 CH1        1 0 1 0 1 0 1 0 1 0    0 to Reset
 CH2        0 0 1 0 0 0 0 0 0 0    1 to Set
 BOTH       1 0 3 0 1 0 1 0 1 0    +- Toggle
 STRB       1 0 0 0 0 0 0 0 0 0    . RZ/NRZ
 ┌─────────┐┌────────┐ ┌────────┐ ┌─────────┐
 │MODE/TRG │││ TIMING │ │ LEVELS │ │ PATTERN │
 └─────────┘└────────┘ └────────┘ └─────────┘
```

Step Two (a): Parameters set in the PATTERN menu

2.2   Press PATTERN again and the pulse pattern generator shows the waveform for each channel.


```
 CONTINUOUS █PATTERN of█        ◖MODIFY
            RZ-Pulses at Out1    PulseStrm
            RZ-Pulses at Out2    Burst
                                 *Pattern
 Pulse-Period: internal Osc
 ┌─────────┐┌────────┐ ┌────────┐ ┌─────────┐
 │MODE/TRG │││ TIMING │ │ LEVELS │ │ PATTERN │
 └─────────┘└────────┘ └────────┘ └─────────┘
```

Step One: Parameters set in the MODE/ TRG menu


```
 UPDATE         Addr 5    Last 10    KNOB=ADDR

 CH1                                 0 to Reset
 CH2                                 1 to Set
 BOTH       1 0 3 0 1 0 1 0 1 0    +- Toggle
 STRB                                . RZ/NRZ
 ┌─────────┐┌────────┐ ┌────────┐ ┌─────────┐
 │MODE/TRG │││ TIMING │ │ LEVELS │ │ PATTERN │
 └─────────┘└────────┘ └────────┘ └─────────┘
```
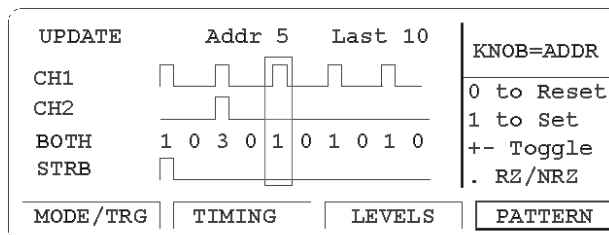
Step Two (b): The signal pattern

Step Three:

3.1   Press TIMING.
3.2   Set up the perfect signal with rising and falling edges of 5 ns, a pulse width of 20 ns and a frequency of 30 MHz.
3.3   Set up the spike with rising and falling edges of 2 ns, a pulse width of 5 ns. For a negative spike, set a delay of 8 ns. For a positive spike, set a delay of 25 ns.

Step Four:

Finally, define the voltage levels.

4.1   Press LEVELS.
4.2   Set up the perfect signal for a high level of 2.5 V.
4.3   For a negative spike, set the high level to 0 V and the low level to - 800 mV. Select COMPLEMENT mode.
       For a positive spike, set the high level to 1 V and the low level to 0 V. Select NORAMAL mode.
4.4   Finally, select that channel 2 (with the spike) is added at output 1.

```
 1  ON      Freq 30.00MHz      2  ⬤MODIFY
 Delay       0ps Delay    8.00ns
 Width    20.00ns Width   5.000ns  5.000
 LeadE     5.00ns LeadE    2.00ns
 TraiE    =LeadE  TraiE   =LeadE        ns
 ┌─────────┐┌──────────┐┌─────────┐┌─────────┐
 │ MODE/TRG ││  TIMING  ││  LEVELS ││ PATTERN │
 └─────────┘└──────────┘└─────────┘└─────────┘
```

Step Three: Parameters set in the TIMING menu for the perfect signal and a negative spike

```
 1  ON   Normal │Complmnt    2  ⬤MODIFY
        Added at Output 1         Seperate
 High     +2.50V High    +0.0mV  *Added
 Low      +0.0mV Low    -800mV
 50Ω into 50.0Ω
 ┌─────────┐┌──────────┐┌─────────┐┌─────────┐
 │ MODE/TRG ││  TIMING  ││  LEVELS ││ PATTERN │
 └─────────┘└──────────┘└─────────┘└─────────┘
```

Step Four: Parameters set in the LEVELS menu for the perfect signal and a negative spike

Examining the Output Signal

The two following screen shots (made with an Agilent oscilloscope) show the resulting distorted signal.

The pulse width of the positive spike is long when compared with the negative spike. Varying the delay, moves the spike forwards and backwards. If the delay of the positive spike is reduced, the spike merges with the perfect signal and creates a "multilevel signal".
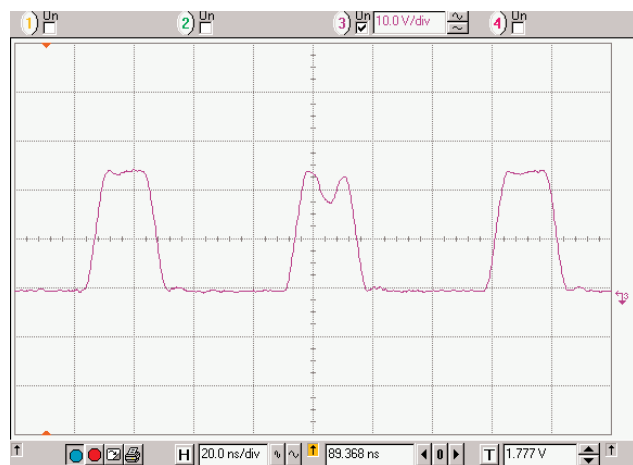

Figure 4: Distorted signal with a negative spike

Please Note: Though the timing system of the 81110A has a frequency up to 330 MHz, the 81111A output channel has a maximum frequency of 165 MHz. If you set the frequency of an 81111A channel to 330 MHz, you will receive a warning. This over-programming is not critical, but means the specifications are no longer guaranteed.
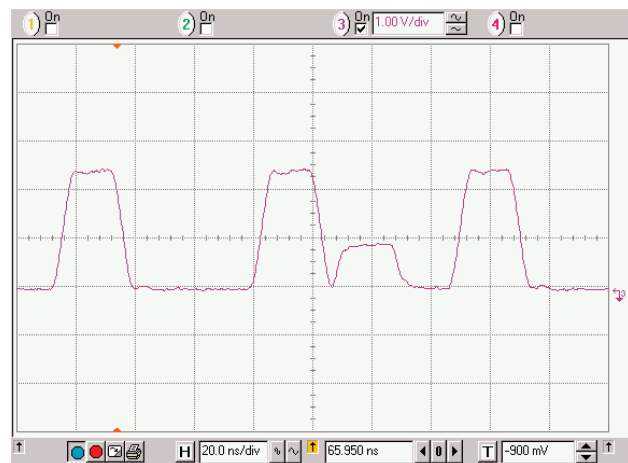

Figure 5: Distorted signal with a positive spike

Injecting Noise

Devices can and need to be stressed in different ways by applying distorted signals, jitter or noise. For low speed applications, analyzing the behavior under common mode or differential noise conditions is the second important test. Common mode noise means the same noise signal is on both the data and the data complement line. Differential (also known as cross-talk) noise means the noise is on one data line only.

Noise is added as AM (amplitude modulation) to the data sequence. Using a function generator this noise can be sinusoidal, rectangular or random. For the high-speed data, the AM is achieved by connecting to the terminating resistors. By applying the modulating signal to the far side of the terminating resistors, normally the ground, this signal is added to the data sequence at the receiver (RX) input.

Figure 6 shows the set up for noise injection. The pattern generator provides the data sequence on the differential lines. A power divider is included into both signal lines to add the modulation signal. This must be done in a way that keeps the electrical length of both data lines, between generator output and receiver input, the same.

For the measurement, we connect an oscilloscope (as shown in Figure 1.0) instead of the device under test (DUT) in Figure 6. Configure one output channel of the pulse pattern generator (81110A) (either an 81111A, 165 MHz channel or an 330 MHz 81110A channel) is enough. To stress the DUT with noise, the pulse pattern generator creates a simple pattern - for channel 1 and the strobe, as shown in steps 1 to 3 above.

The power dividers use three resistors to ensure proper termination in each direction, though this means an amplitude loss of 50 % through the divider. For a specific swing, we need to double the amplitude on the pattern generator.
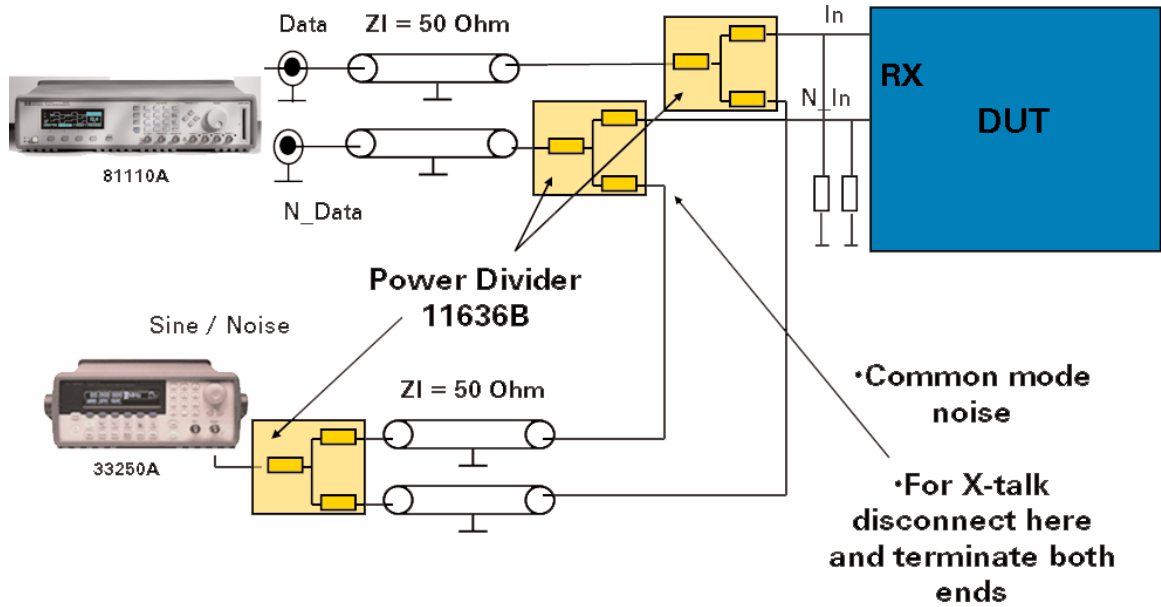
Figure 6: Test setup for noise testing with an 81110A/11A and Agilent Technologies 33250A Function Generator

For common mode noise we need to modulate both data lines with the same signal. Therefore we also need a power divider to split the noise from the function generator. This will provide the noise signal on both data lines with clean isolation of the data and data complement lines. To compensate for the modulation signals passing through two power dividers, the amplitude of the function generator must be set to 4-times the desired noise floor at the receiver input.

Figure 7 shows the principal influence of common mode noise on a signal. The injected noise causes a voltage range on the high and low levels of the signal. Jitter, on the other hand, would result in increasing the width of the rising and falling edges. For differential noise, we only need to connect the modulation signal to one of the power dividers in the data path. In this case, it is important to terminate both open ends. Some function generators may not have a good backwards termination, so it may be helpful to add a 3dB attenuator between the function generator and the power divider. This improves backwards termination significantly.
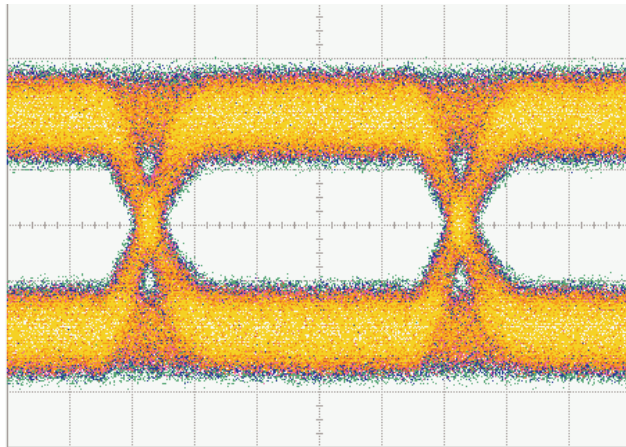

Figure 7: Influence of noise on the eye diagram

Related Literature	Publication Number
Pulse Pattern and Data Generators Digital Stimulus Solutions, Brochure	5980-0489EN
81100 Family of Pulse Pattern Generators Technical Specifications	5980-1215E
81100 Family of Pulse Pattern Generators Radar Distance Test to Airborne Planes Product Note 1	5968-5843E
81100 Family of Pulse Pattern Generators The Dual Clock Gbit Chip Test Product Note 2	5968-5844E
81100 Family of Pulse Pattern Generators Magneto-Optical Disk Drive Research Product Note 3	5968-5845E
Infiniium 54850 Series Oscilloscopes Data sheet	5988-7976E
Signal Integrity Solutions Brochure	5988-5405EN
Function/Arbitrary Waveform Generator Data Sheet	5968-8807EN

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