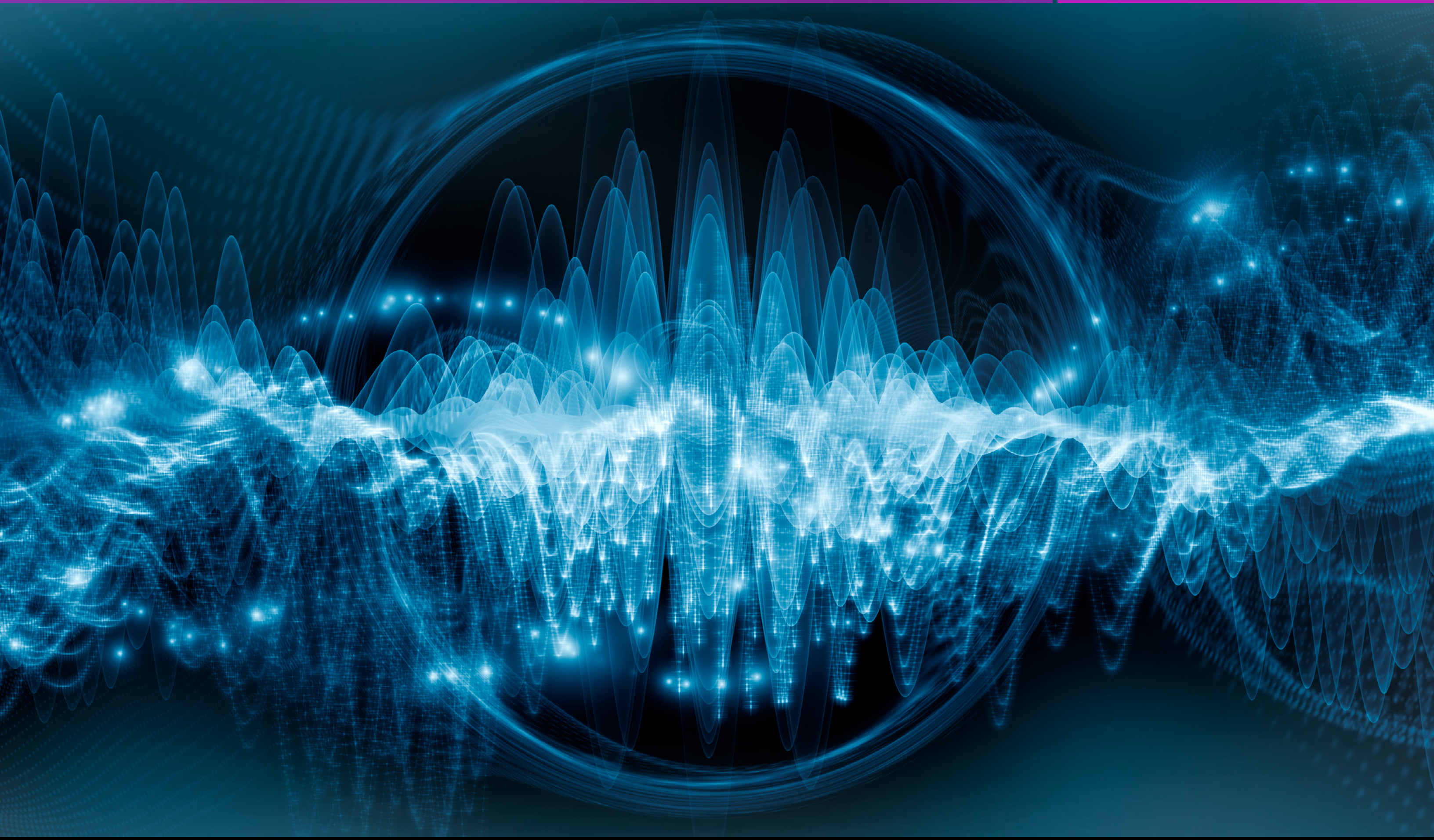
WHITE PAPER



Using a Waveform Generator to Create a Pseudorandom Binary Sequence Signal

KEYSIGHT

Introduction

This white paper outlines how you can overcome various test challenges using a waveform generator to create pseudorandom binary sequence signals. Learn how to simulate noise in a variety of frequency bandwidths and perform acoustic testing of a structure. Also covered is the stimulus process for eye pattern testing.

Pseudorandom binary sequence (PRBS) generates signals using linear feedback shift registers (LFSRs). This is a series of shift registers in combination with the logical Exclusive-OR (XOR) gates.

Generating standardized PRBS signals allows you to perform

- simulated eye diagram measurements
- cross-talk measurements
- compliance tests
- jitter tests
- signal integrity measurements
- stress tests for receivers

PRBS Generation

Modern function generators are incredibly versatile — they can generate basic waveforms such as sine, square, triangle, ramp, pulse, and arbitrary waveforms. They also create noise, modulation, and PRBS signals.

Figure 1 shows the generation sequence of the linear feedback shift register (LFSR) results. The branches after register cells 5 and 9 are taps. The configuration of the LFSR and its taps determine the PRBS waveform.

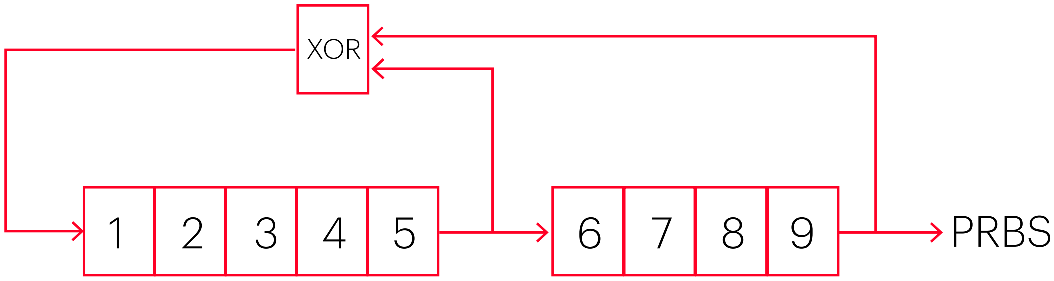


Figure 1. Diagram of a linear feedback shift register

Figure 2 shows an example of a PRBS pseudorandom bitstream signal generated by a function generator with variable settings. These settings are bit rate, amplitude, transition edge time, and the type of PRBS data or polynomial function number.

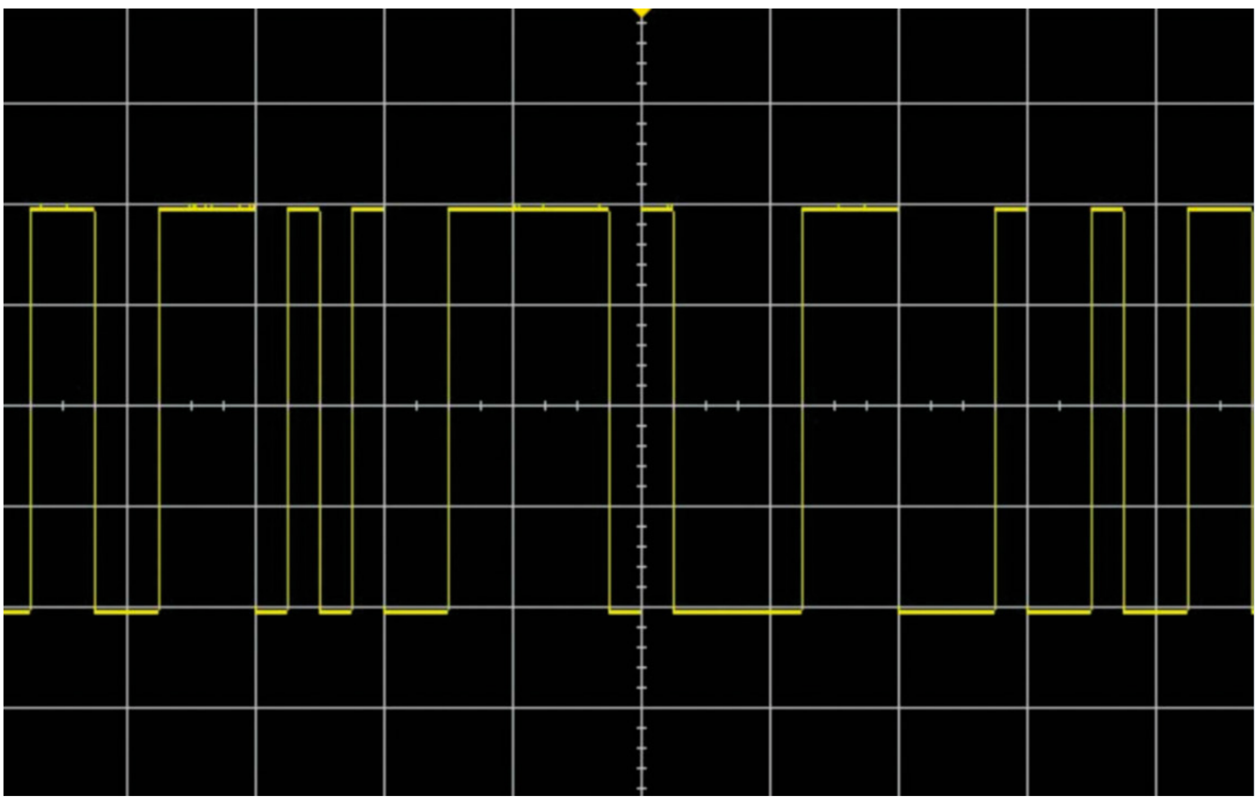


Figure 2. Example of a PRBS signal

The PRBS data or polynomial function results let you choose your pseudorandom sequence. The higher the polynomial number, the longer the maximum length of the binary sequence. The signals comply with the Telecommunication Standardization Sector (ITU-T) recommendations, which are common in digital transmission testing. Varying the bit rate and polynomial function allows you to generate noise with different frequency content (Figure 3).

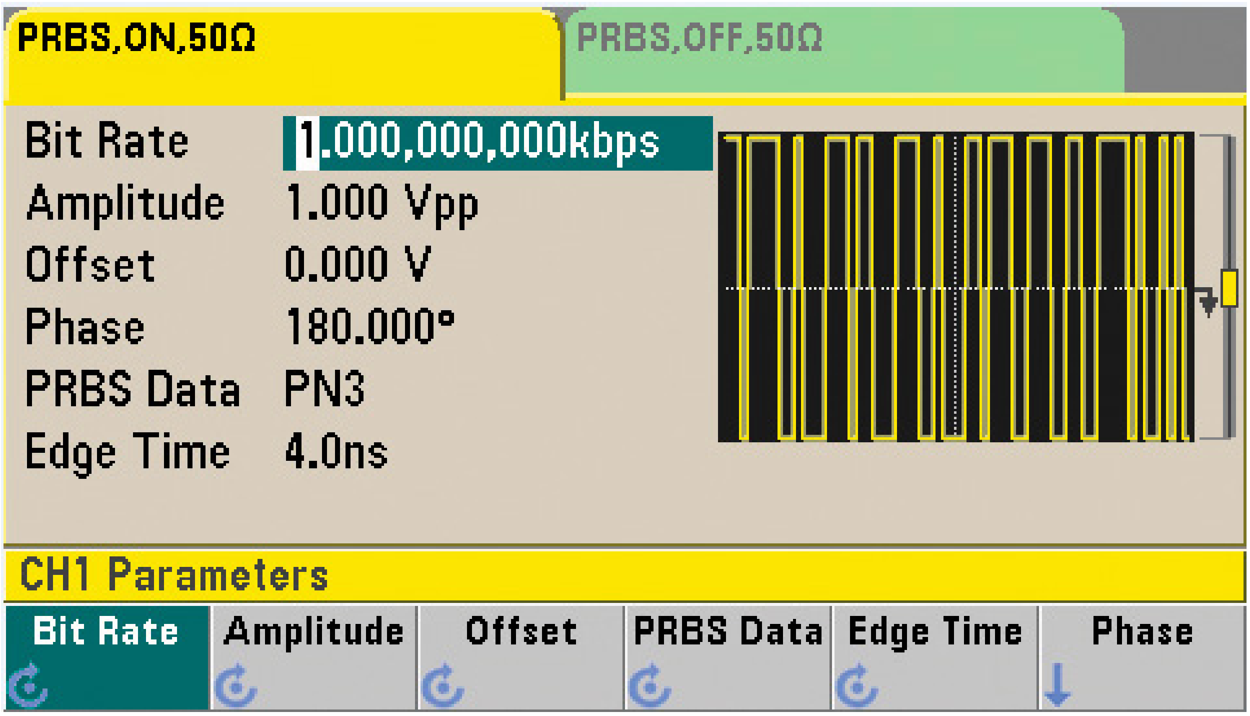


Figure 3. Example of varying the PRBS signal bit rate and polynomial function

Function generators have a sync output that provides an external clock reference to aid transmission analysis. The external clock is useful for jitter analysis or the construction of eye diagrams (Figure 4). It requires a connection to the sync output of the generator to your measurement device. The connection ensures the sync output is enabled. The better a function generator's jitter stability, the more useful it is for system analysis.

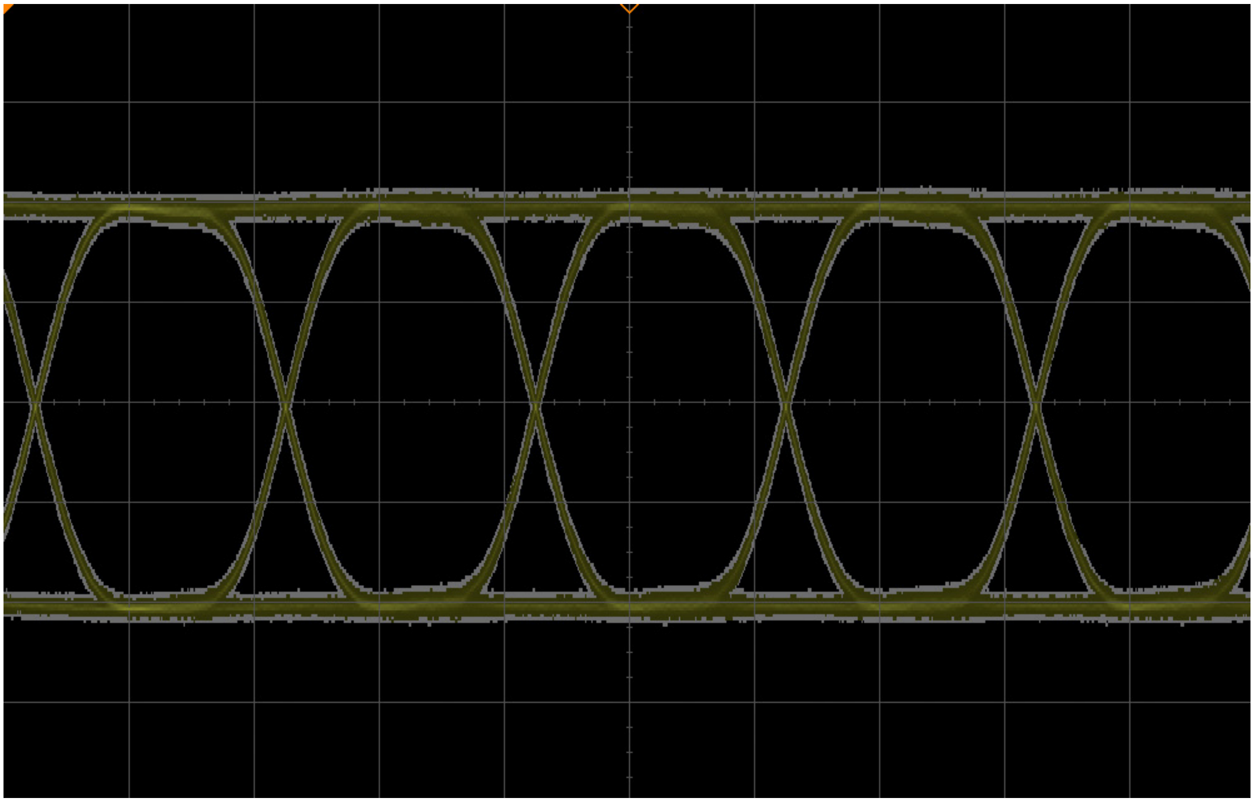


Figure 4. Sample of waveform generator eye diagram

How to Overcome Test Challenges Using PRBS Signals

1. Testing a transmission line

When testing the integrity of a digital transmission system, you need to determine if your system is robust enough to transmit at your data rates. The industry-accepted method involves using a PRBS to test the integrity of your link. The PRBS signal has random and autocorrelation properties that help determine if your connection is acceptable. You can use a function generator that generates PRBS to simulate the test signals if your design does not include a signal source capable of generating this test signal.

2. Noise simulation

One method to simulate generated broadband digital noise is to use a PRBS signal. If you need to calculate autocorrelation functions, PRBS signals are ideal since their binary composition helps simplify the process.

You can use your function generator to generate the PRBS signal. Once generated, you can change the parameters to vary sequence size and bit rate to simulate noise in a variety of bandwidths.

3. Acoustic testing

Another challenge is to test an acoustic structure. For example, the acoustic structure can be a room, a cavity, or the inside of a speaker box. You can use a speaker and microphone pair to test the acoustic properties of these structures. A PRBS test signal goes through the speaker to simulate white noise in a deterministic manner. A microphone connected to a scope reads the signal and helps to determine the loss through the structure.

4. Generating an eye pattern stimulus

One of the most important methods to determine the quality of a digital transmission system is to measure the bit error ratio (BER). You can calculate the BER by comparing the transmitted sequence of bits to the received bits by counting the number of errors. The ratio of the number of bits received in error over the number of total bits received is the BER. The measured ratio is affected by many factors, including signal-to-noise, distortion, and jitter. Using a PRBS signal determines the dropped bits — and its random properties allow you to test for weaknesses in your system.

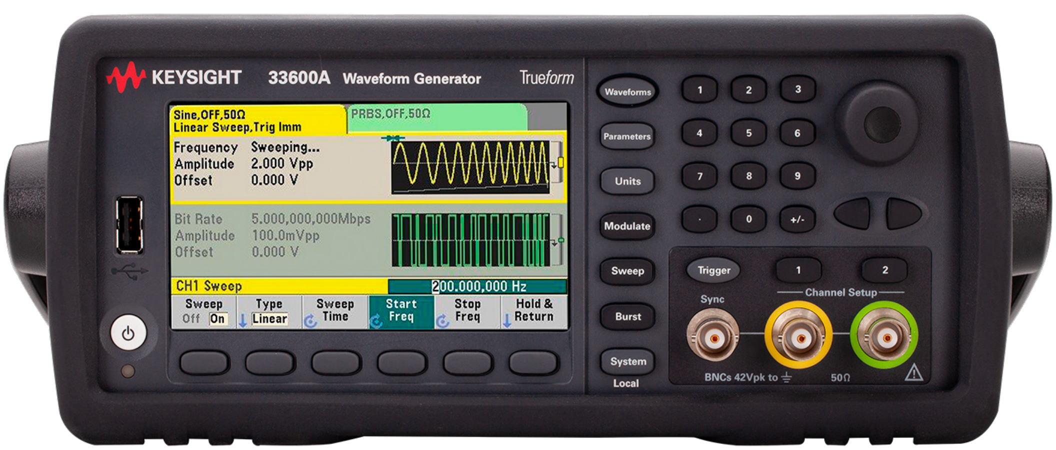
Conclusion

Pseudorandom binary sequences are periodic signals generated by using a linear feedback shift register. PRBS signals help you to qualify digital transmission systems. By sending a near-random bitstream through the digital network, you can simulate many conditions to look for weaknesses in your digital transmission system.

A pseudorandom binary sequence can overcome various test challenges. For example, you can simulate noise in a variety of frequency bandwidths, perform acoustic testing, and the stimulus process of eye pattern testing.

Not all function generators are the same, even though they can generate basic waveforms and advanced waveforms such as PRBS.

The Keysight 33600A Trueform Series has more PRBS data signals ranging from PN3 to PN32 to vary sequence sizes. You can generate PRBS signals up to 200 Mbps to give you more capabilities to vary your bit rates. Accuracy with an exceptionally low jitter at < 1 ps helps you isolate your signal source errors from transmission errors.



For more information on Keysight Trueform Series waveform generators, please visit: https://www.keysight.com/my/en/products/waveform-and-function-generators.html

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