

Keysight Technologies

Generating Looped Test Patterns or PRBS Signals with a Preamble

Application Note



Problem statement

Some digital integrated circuits (IC) use special modes to test all the internal states of operation. To get into such a mode the IC requires a defined command be sent to the device under test (DUT). As shown in Figure 1, in some instances a portion of the test pattern is used once to advance the special IC mode to an area of operation that requires repetitive use of a test pattern in order to thoroughly test the device.



Figure 1: Flow chart of the test signal generation

It is very important that the test pattern and the preamble are correctly timed and generating such a sequence may not be a trivial task. If the test pattern is not received at the necessary time, the device can time out and return into a pre-defined state, delaying testing, because the preamble must be rerun to bring the DUT back into the desired test mode.

Solution proposal

Both the Keysight Technologies, Inc. 81150A and 81160A pulse function arbitrary generators have the capability to generate such test signals. They offer two ways to create these signals. One way is through the use of the built-in pattern sequencer; the other is using the channel add capability. To illustrate these functions, this application note provides examples using the 81160A model shown in Figure 2, though they also apply to the 81150A. Additionally, this paper highlights the advantages and disadvantages of each of the options.



Figure 2: The Keysight Technologies 81160A pulse function arbitrary generator.

Pattern sequencer solution approach

Using the pattern sequencer is a very simple and straight forward way to generate test signals. In the Pattern Editor menu of the 81160A (shown in Figure 3) the user defines the preamble and the required test data pattern, then uses a pointer to define the beginning of the loop sequence. The number of loops is defined in the Burst menu and typically the user defines when the test signal should start playing. Once the output is activated, the test signal can be captured and visualized with the help of an oscilloscope.

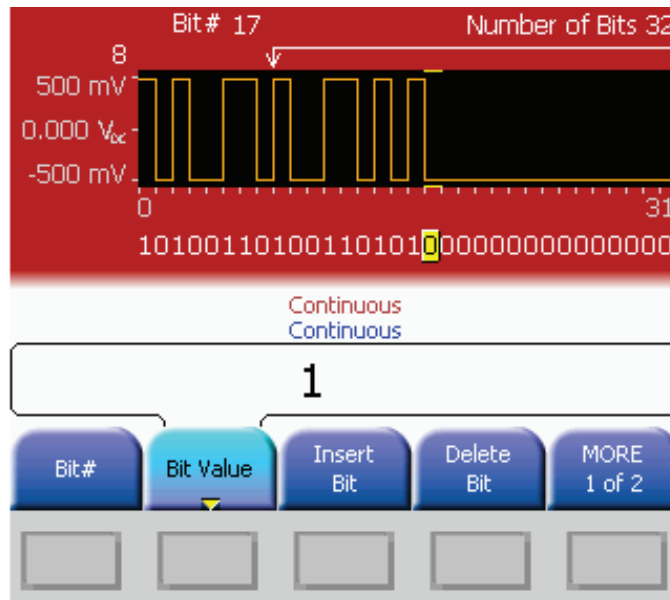


Figure 3: Pattern Editor menu of the 81150A and 81160A.

Pattern sequencer solution approach (continued)

A pattern sequencer is easy to use. Setup requires only one cable connection between the generator and the DUT. Creating a short, user-defined pattern is done directly on the front panel of the generator instead of programming the pattern using a computer and then downloading it to the instrument.

While a one-channel generator unit is sufficient for testing one channel of the device, a two-channel unit can be used to generate signal distortions and add them internally to the signal waveform to refine the test of the DUT.

For longer and more comprehensive test patterns, such as a PRBS, a free Pattern Editor and Sequencer software tool is available for downloading at: [Download Pattern Editor and Sequencer](#). A screenshot of the software tool's user interface is shown in Figure 4.

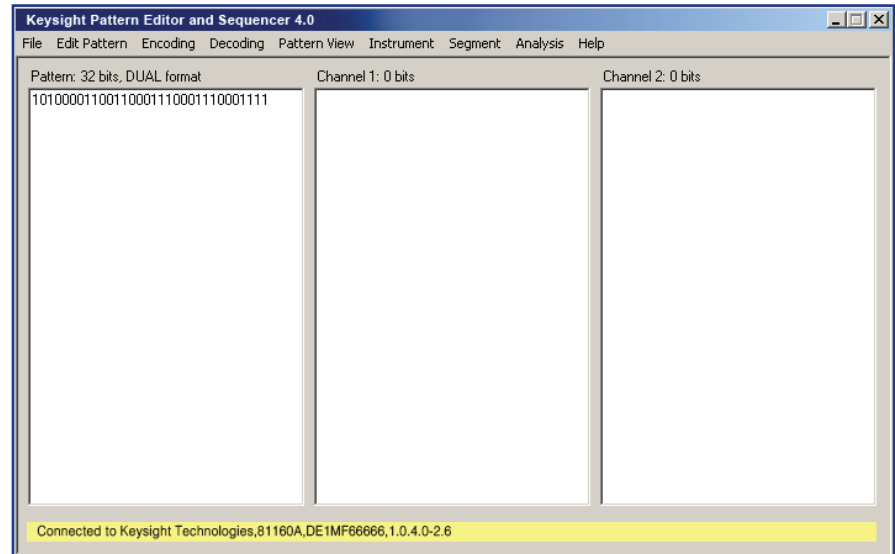


Figure 4: Screen shot of the Pattern Editor and Sequencer user interface

Channel add solution approach

A second method for generating an initial test mode signal is through the use of the channel add capability of the 81150A and 81160A instruments. As shown in Figure 5, the principle is very simple:

- On Channel 1 the user defines the preamble of the signal that should enable the test mode within the device.
- On Channel 2 the PRBS or other test pattern is generated. It can be programmed to play only once or multiple times.
- The channel add functionality adds the signals internally and routes the resulting signal to Output 1.

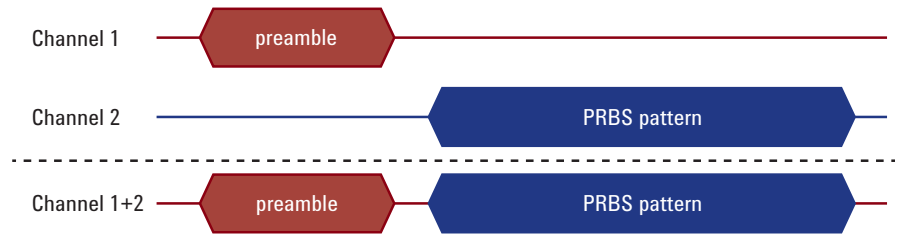


Figure 5: Signal diagram for the Channel Add approach.

To ensure that the signal pattern on Channel 2 is generated only after the preamble pattern on Channel 1 has ended, the strobe output of Channel 1 is used to trigger the start of the pattern on Channel 2 (refer to Figure 6).

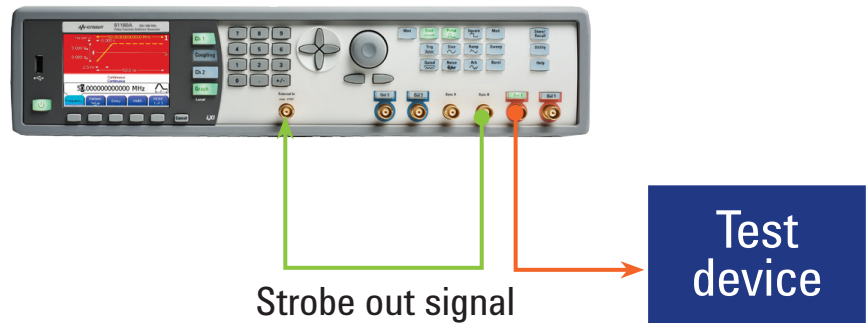


Figure 6: Connection diagram for the Channel Add solution proposal.

If the test pattern is a PRBS pattern, using the channel add solution makes setup convenient. The user simply loads the pre-installed PRBS pattern from the instrument menu instead of having to program it externally and load it into the generator. Adding the channels also doubles the possible memory length for the final signal. The tradeoff is that an additional cable connection between the Strobe Out and External is needed and a two-channel unit is required to create one test channel.

Step-by-step setup guide

Pattern sequencer setup

This section provides instructions for using the pattern sequencer and channel add methods for generating test signals. In this section, words in bold with brackets refer to instrument keys on the function generator. Words in bold refer to soft keys.

Figure 7 shows a very simple connection diagram for using the pattern sequencer solution.

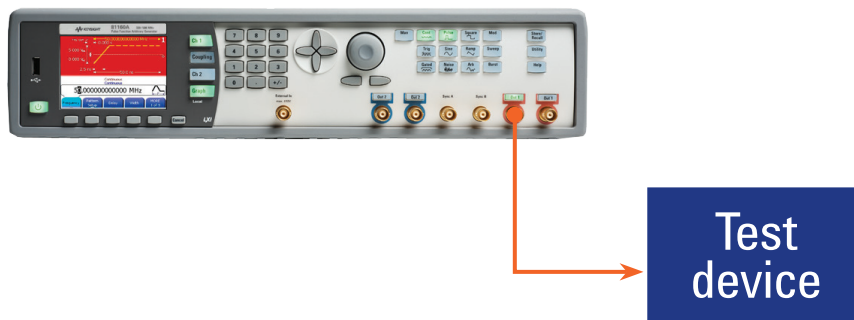


Figure 7: Connection diagram for the pattern sequencer solution.

Step 1

To begin, resetting the instrument to its default settings by pressing [Store/Recall] is recommended. Next, select Set to Defaults and then Yes (refer to Figure 8.)

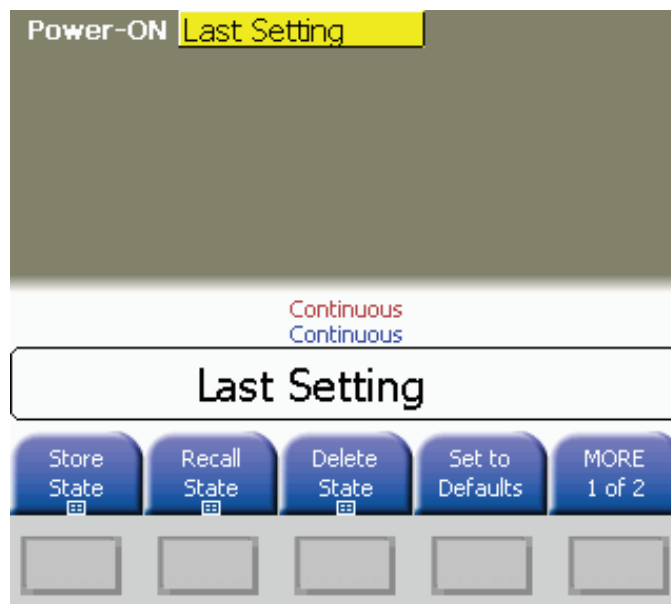


Figure 8: Screen after pressing [Store/Recall].

Step 2

Activate the Channel 1 menu by pressing [Ch 1] and select [Pulse] mode. On the screen select Pattern Setup (see Figure 9).

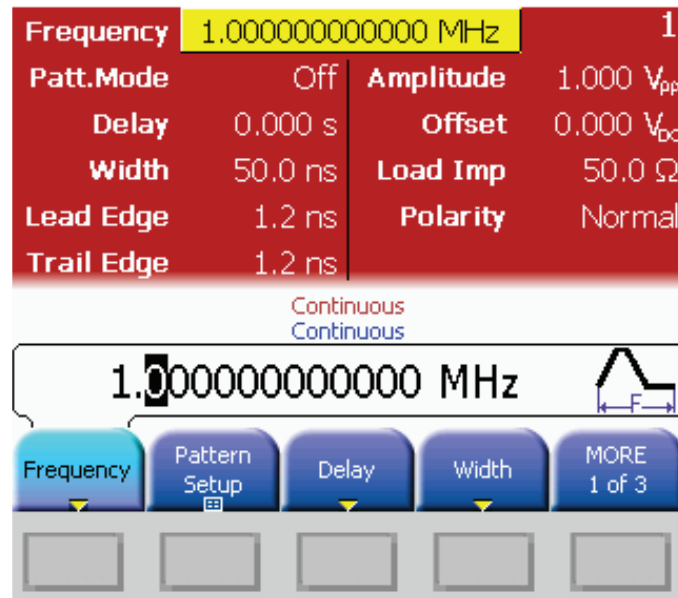


Figure 9: Pulse mode screenshot.

Step 3

In Pattern Setup (shown in Figure 10), turn Pattern Mode to On. Ensure Pattern Source is set to Internal and Bit Shape is set to NRZ. Pattern Name can be ignored, as the field will be replaced by the name of the new pattern being loaded. To load the pattern press Edit Pattern.

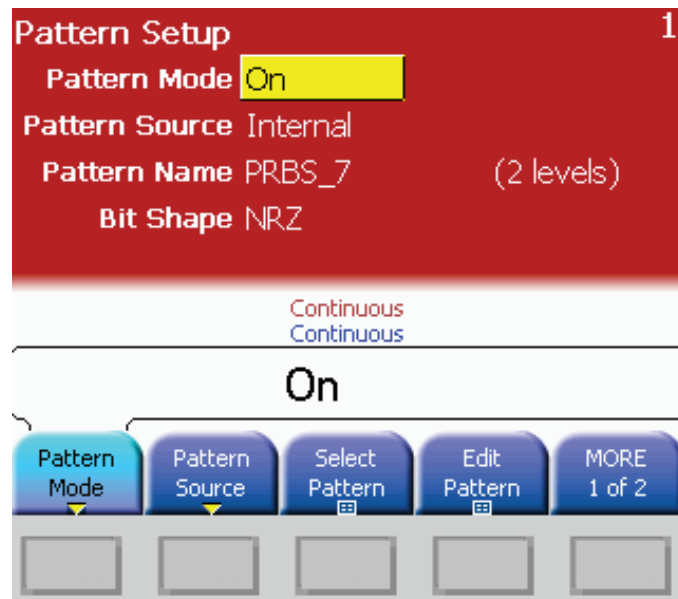


Figure 10: Pattern Setup menu.

Step 4

On the next screen select Create New. You should now see the screen shown in Figure 11.

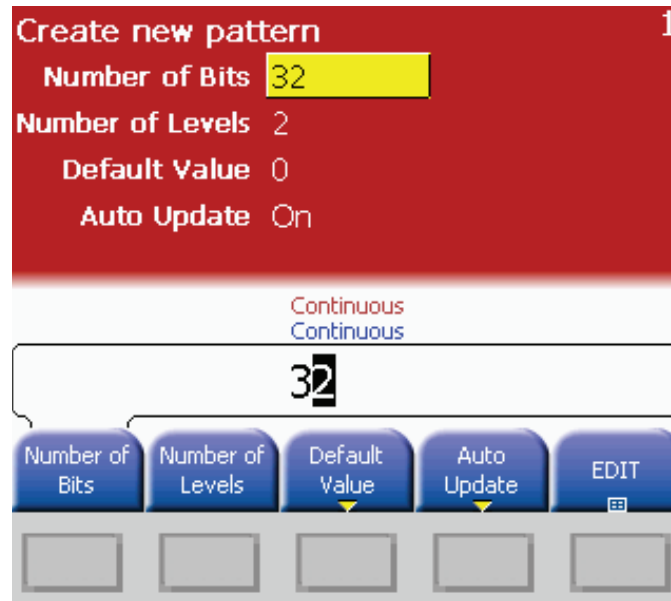


Figure 11: Create new pattern screen menu.

In the dialog box, define the listed presets as desired:

Number of bits	The length of the total pattern.
Number of levels	The logical levels of the digital signal: 2, 3, or 4. This value means multi-level signals can be generated directly.
Default value	Represents the preset digital values in the pattern. In our case all bits will be set to 0 initially.
Auto update	Set On or Off. Ensures the changes done in the GUI immediately take effect at the output of the instrument.

After all settings are done press EDIT.

Step 5

At this point, you can define your own pattern. To change the Bit Value press [1] and [0]. It is also possible to add or remove bits from the stream by selecting Insert Bit or Delete Bit (refer to Figure 12).

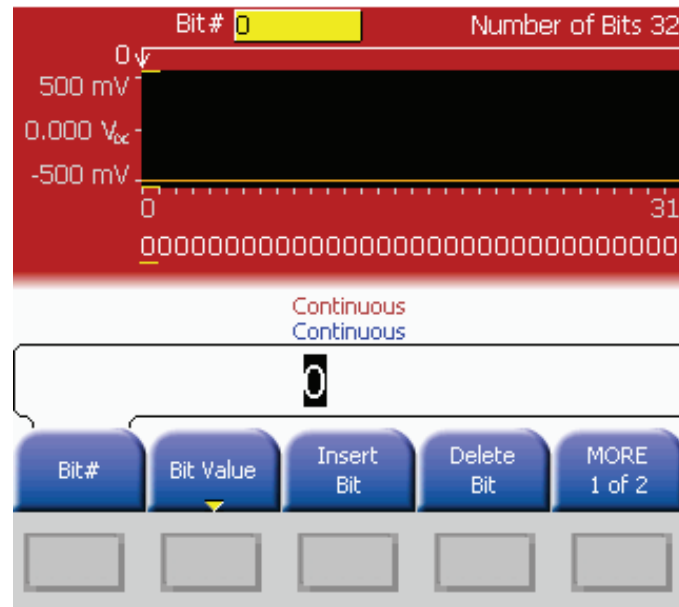


Figure 12: Pattern EDIT screen menu number 1 of 2.

By pressing [MORE 1 of 2], you will find a second set of settings including the Loop Offset.

Step 6

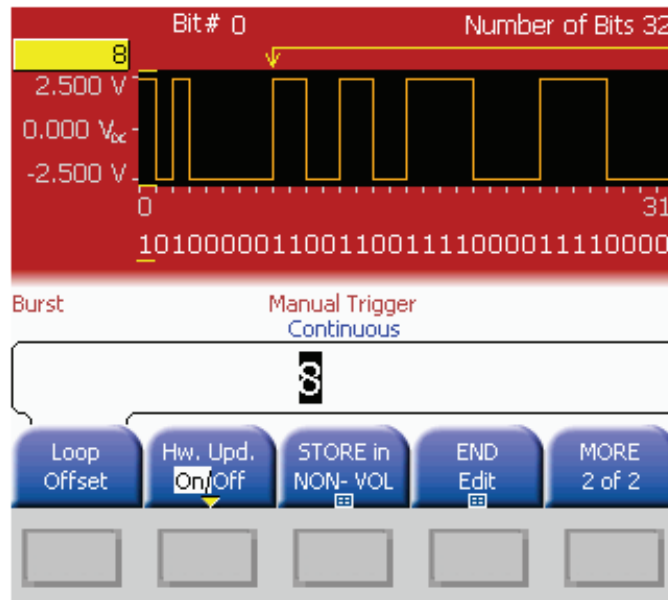


Figure 13: Pattern EDIT screen menu number 2 of 2.

In the screen shown in Figure 13 the Loop Offset is set to 8. The offset defines the position of the pattern, beginning from where the repeat section is starting. All bit positions lower than the loop offset will be played only once and all bit positions higher than the loop offset, or equal to it, will be looped multiple times.

Next, under the [Burst] menu, define the number of times the loop pattern should be repeated (see Figure 14).

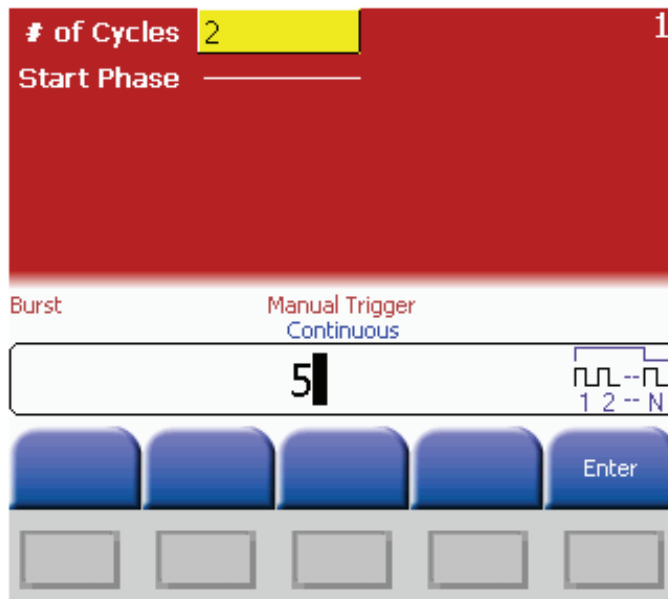


Figure 14: Setting the number of cycles for the loop in the [Burst] menu.

Step 7

The value in the # of Cycles (see Figure 14) represents the number of loop counts. For this example, set it to [5] and press Enter to confirm the setting.

Step 8

At this point, it is useful to verify the signal setting by putting the generator into a Triggered mode. Based on our settings, on the trigger event, the generator will play the preamble only once and then loop the rest 5 times. After that it will stop and wait for the next trigger event. To set up the trigger conditions press [Trig] and More 1 of 3, and set Source to MAN (see Figure 15).

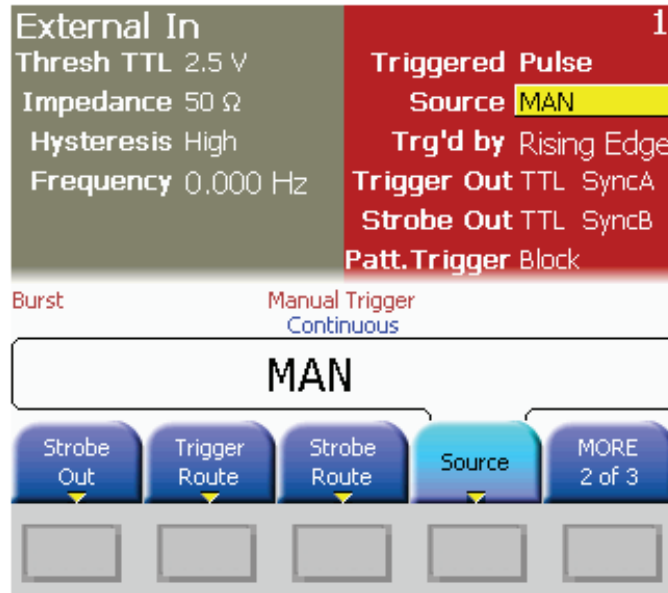


Figure 15: Setting up of the trigger condition

This will activate the manual trigger. Every time [Man] is pressed on the front of the instrument, the generator will receive a trigger event and it will start playing the programmed waveform. To capture that, the oscilloscope should be set to Triggered mode and the trigger should react on a rising edge. Figure 16 provides a scope screen capture of the described example. In the image you can clearly see the two short pulses for the preamble and the repetition of longer pulses during the loop sequence.

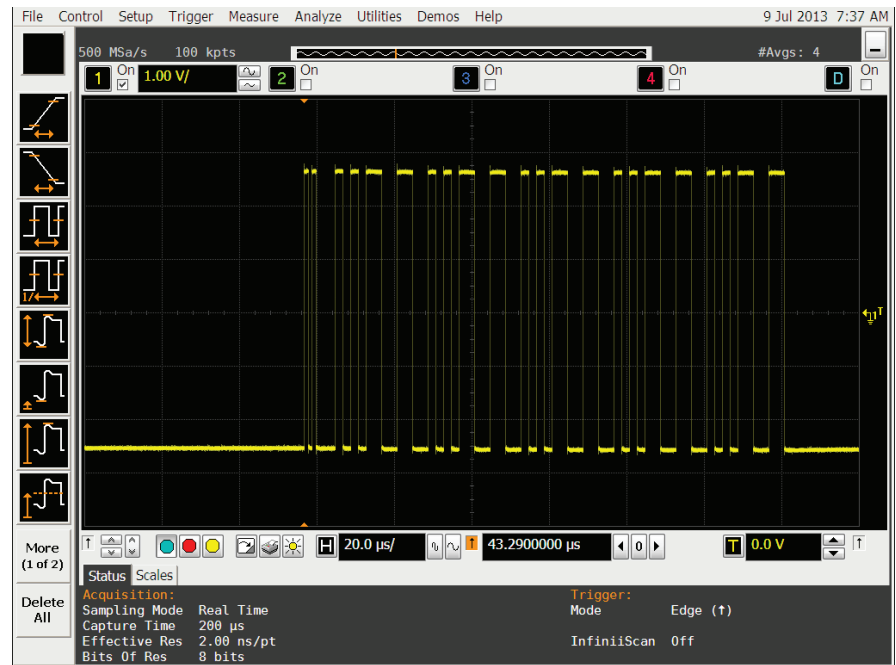


Figure 16: Screen shot of the test waveform created with the Pattern Sequencer method.

Channel add setup

To use the channel add signal generation method follow the connection diagram in Figure 17.

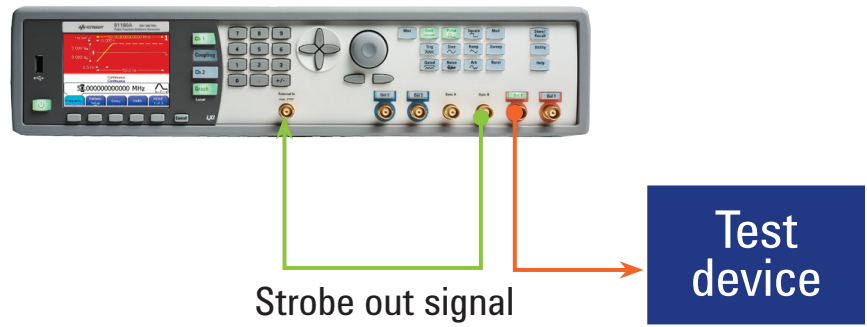


Figure 17: Connection diagram for the channel add configuration

Steps 1 thru 5

Repeat Steps 1 thru 5 defined in the prior section: Pattern sequencer setup.

Step 6

At this stage we ignore the loop count pointer at the top of the screen. Everything set up now relates to the preamble and is only played once within the scenario.

Set the preamble test content to:

10101100 11001010 11001100 10100001 as shown in Figure 18.

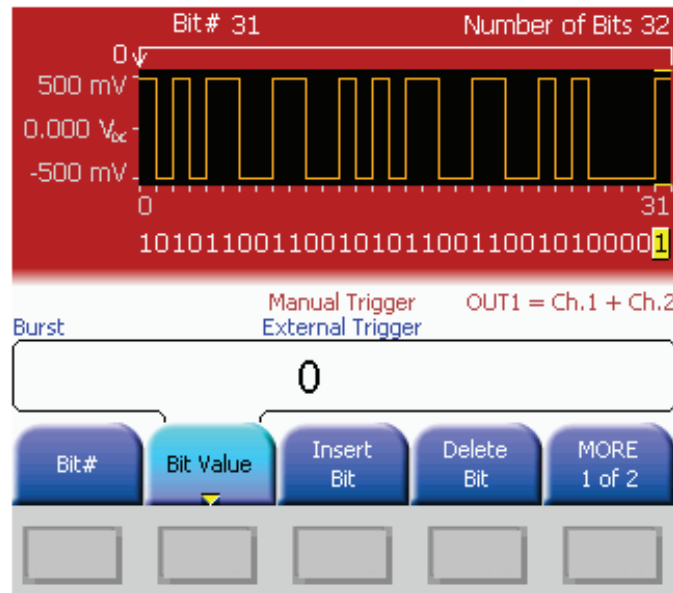


Figure 18: Defining the content of the preamble

Step 7

To prepare the test data press [Ch 2]. Set [Pulse] and activate the Pattern Setup. The screen in Figure 19 will be the next result you should see.

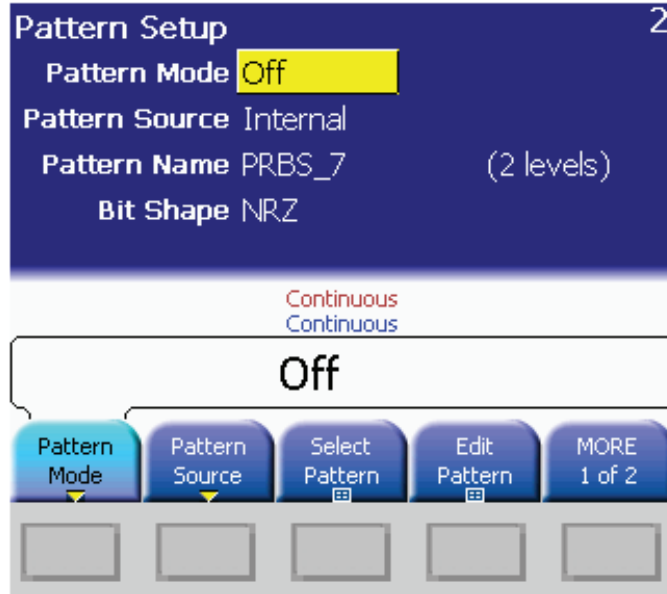


Figure 19: Setting up the content for the looped section.

Step 8

Turn Pattern Mode to On and set the Pattern Setup values as follows:

Pattern mode On

Pattern source Internal

Pattern name Choose a pre-installed pattern: PRBS_7 (shown), or one accessed by selecting Select Pattern. For the purpose of this demonstration selected PRBS_11, although you may choose another built-in pattern or user-defined pattern (see Figure 20).

Bit shape NRZ

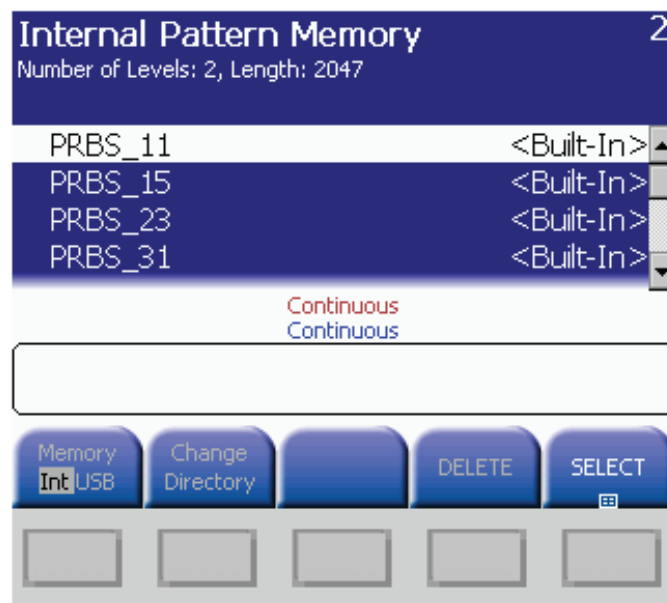


Figure 20: Selection of built in patterns.

Step 9

Having set the content of the two parts of the signal, we need to make sure that the second part of the signal is played after the first one, and that the first one is repeated only once while the second is looped several times. In the next step we stay with Channel 2 and define the loop count by pressing [Burst].

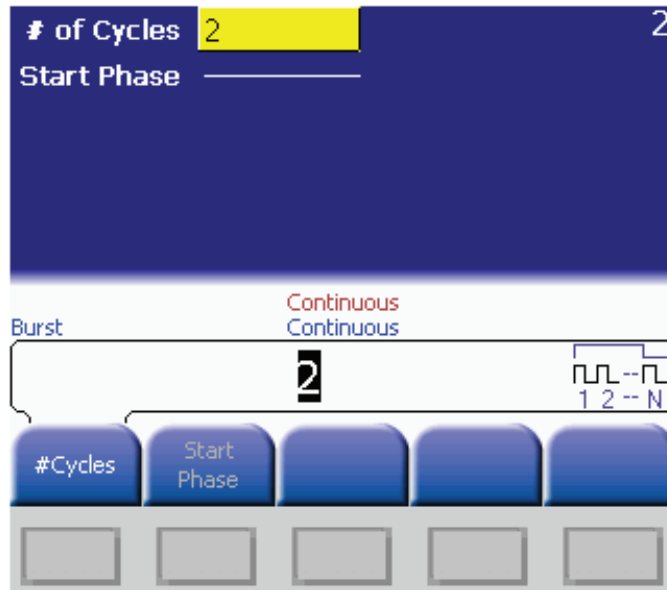


Figure 21: Setting the number of cycles for the loop in the Burst menu.

From the # of Cycles tab (Figure 21), leave the value at 2. This value means the PRBS stream will be repeated twice.

Step 10

To address the timing order we use the trigger capability of the generator combined with a strobe output. A strobe signal goes high once the signal starts, and it goes low once the signal stops playing. Keeping this in mind, it means that the falling edge of the strobe output of Channel 1 marks the end of the preamble. Now, this can be used as trigger to start the PRBS loop on Channel 2.

To configure this is setup on the instrument:

- Press [Trig] for the trigger settings of Channel 2.
- Select External In Threshold and set it to 1.5 V.
- Leave Source at External In. This is the external BNC input, which receives its signal from Strobe Out of Channel 1.
- Set Trig'd by to Falling Edge.
- Leave the rest of the parameters to their standard settings as shown in Figure 22.

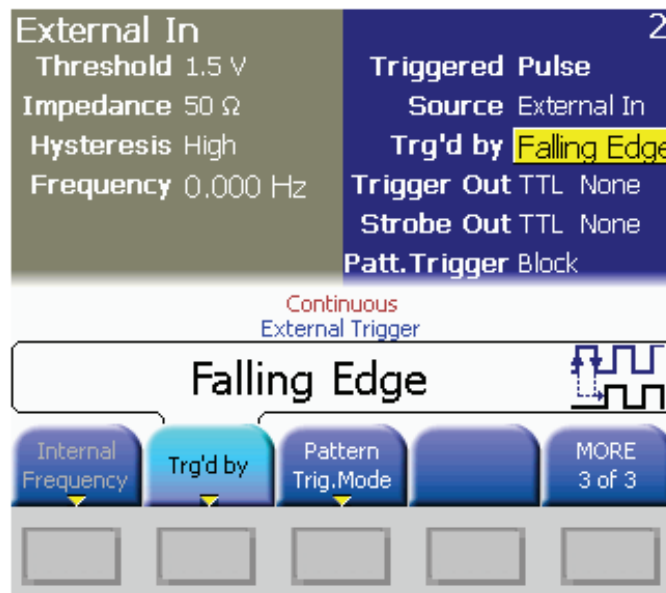


Figure 22: Defining the trigger conditions for the looped test data.

Step 11

The last step is to set the whole test to run on a manual trigger. This provides the flexibility to define the start of the test as it is required (see Figure 23):

- Change to [Ch 1]
- Select [Trig] and MORE 1 of 3, then set Strobe Route to SyncB
- Set Source to MAN (for manual)
- Leave the rest of the parameters on their standard settings as shown in Figure 23

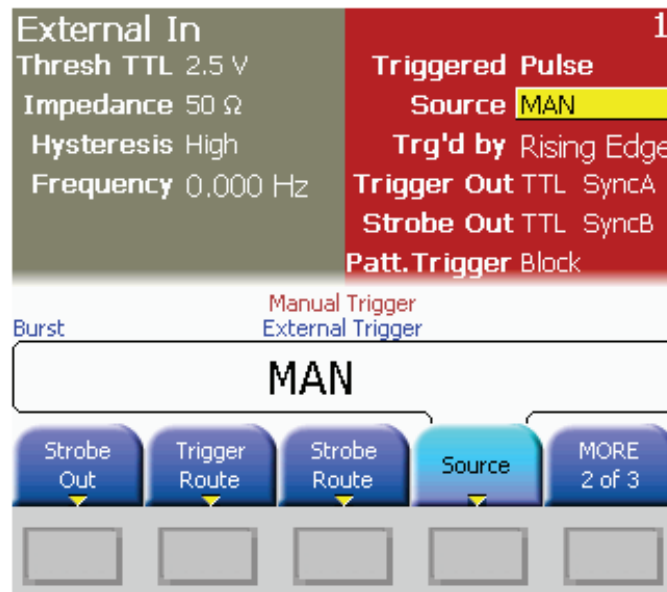


Figure 23: Defining the trigger condition for the whole test

To verify the signal, you can connect an oscilloscope instead of the test device as illustrated in Figure 17. By pressing [Man] a pattern series is going to be released that is captured by the oscilloscope. The preamble is played once and the PRBS is looped twice. The beginning of the resulting waveform can be seen in Figure 24.

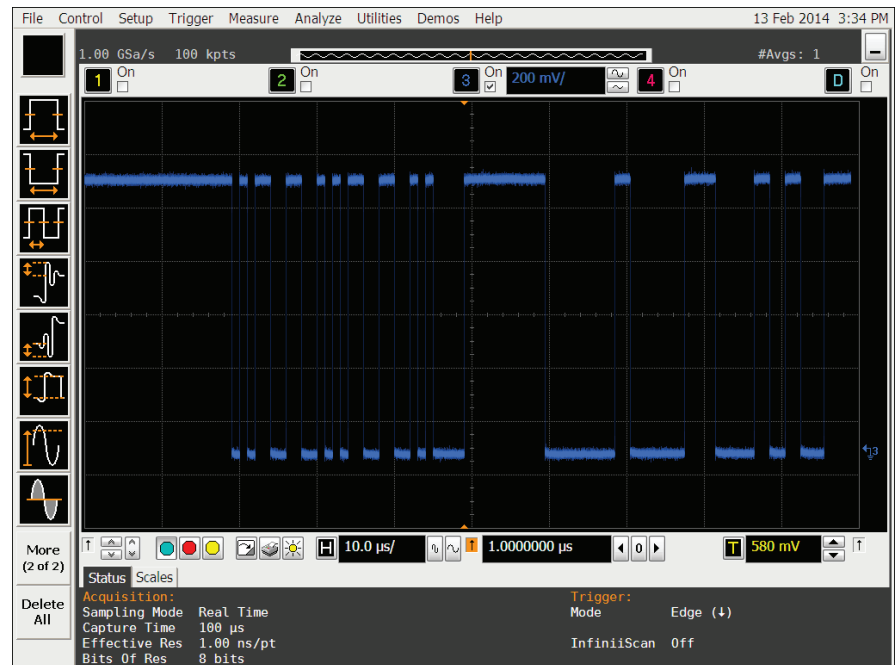


Figure 24: Screen shot of the test waveform created with the Channel add method

Conclusion

In this application brief two methods have been presented for generating test signals that require a specific preamble followed by looped test data. The content of the preamble usually contains commands that signal the test device to go into a specific test mode. The test data can then be correctly interpreted and the device thoroughly tested. Both methods have their advantages and disadvantages. For highest efficiency and when working with custom test patterns, using the pattern sequencer option is recommended. Using the channel add method is recommended when PRBS test patterns are needed.

Related literature

- 81150A and 81160A, Data Sheet 5967-5984EN
- Pulse Pulse Parameter Definitions, Application Note 5991-1943EN
- 81150A and 81160A Pulse Function Arbitrary Noise Generators, Brochure 5989-7860EN
- Pulse Pattern Generators, Selection Guide 5991-1757EN



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