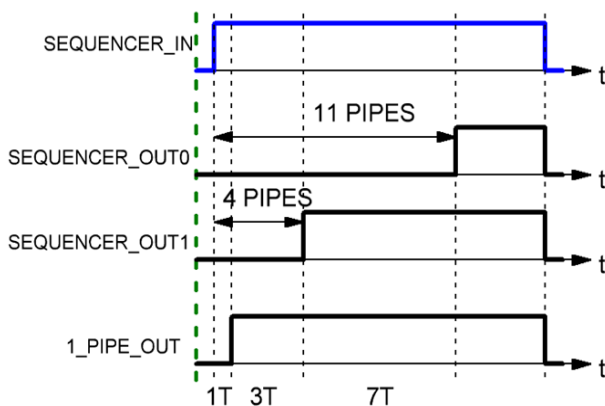


## Introduction

Sequencers are functions that with the permission of the input signal change their output states with a given sequence. This simple unit has one data input, and three data outputs. Main part of the design is Pipe Delay cell with nRESET input to return outputs in startup state, see Figure 1.

## Sequencer Circuit Design

As can be seen on Figure 4, Sequencer is implemented using Pipe Delay with data and reset inputs connected to SEQUENCER\_IN (PIN2), clock input to CNT0/DLY0 output (as it together with LUT3-bit0 forms an oscillator), 1 PIPE OUT to 1\_PIPE\_OUT (PIN10), OUT1 to SEQUENCER\_OUT1 (PIN11), OUT0 to SEQUENCER\_OUT0 (PIN12), all outputs have Output Enable connected to VDD as they are configured as push-pull.

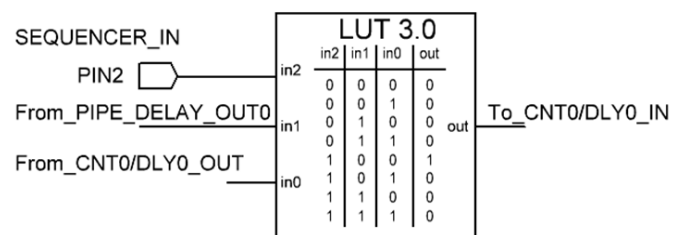


**Figure 1. Sequencer Timing Diagrams**

## Digital Sequencer circuit analysis

When HIGH signal comes in to SEQUENCER\_IN (PIN2), it allows, pipe delay with sourced data input from the same PIN2 and clock from Sequencer Oscillator which produces pulses with width of 1/29.11kHz and period  $T=10\text{ms}$  due to CNT0/DLY0

set as rising edge delay. 1 PIPE OUT will switch HIGH after first rising edge of clocking signal (in 10ms), OUT1 after 4<sup>th</sup> (40ms), OUT0 after eleven clocks (110ms). When pipe delay's OUT0 is set HIGH the Sequencer Oscillator will turn OFF (see Figure2). Sequencer will hold its output states until SEQUENCER\_IN (PIN2) goes LOW.



**Figure 2. Sequencer Oscillator LUT Truth Table**

Functionality waveform of real Sequencer circuit created in GreenPAK2 Designer is shown on Figure 3, where Channel1 (yellow/top line) – PIN2 (SEQUENCER\_IN), Channel2 (light blue/2<sup>nd</sup> line) – PIN12 (SEQUENCER\_OUT0), Channel 3 (magenta/3<sup>rd</sup> line) – PIN11 (SEQUENCER\_OUT1), Channel4 (blue/bottom line) – PIN10 (1\_PIPE\_OUT). As can be seen from Figure 3 the real waveforms coincide with the theoretical shown in Figure 1.

## Related Files

Programming code for **GreenPAK Designer**.

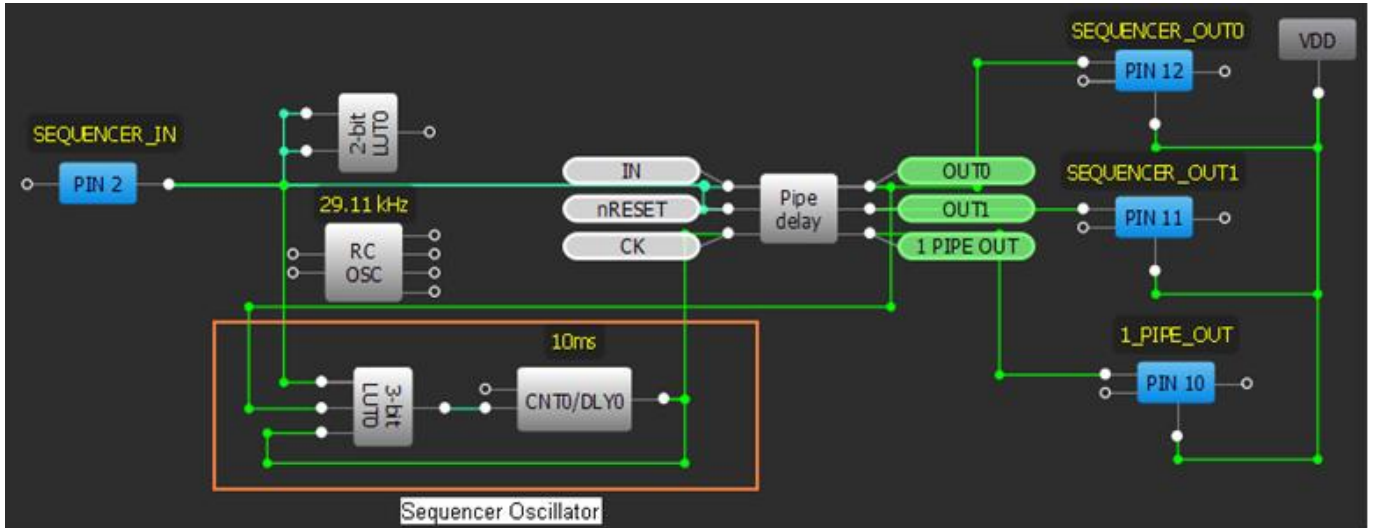


Figure 3. Sequencer circuit in GreenPAK2 Designer

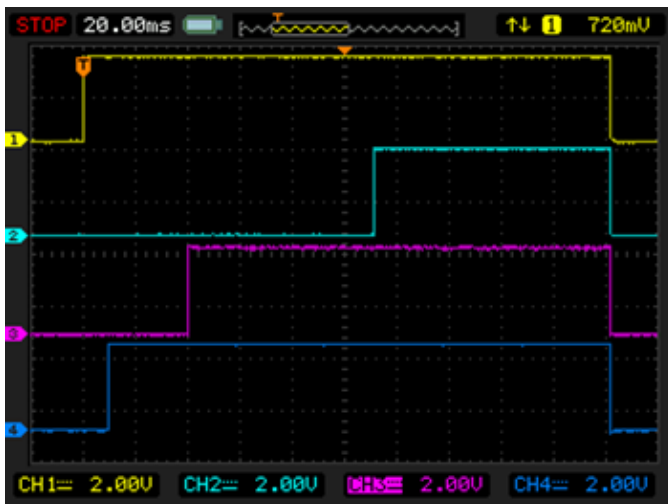


Figure 4. Sequencer Functionality Waveforms

## Conclusion

Digital Sequencer is a simple but useful function which can be used power management systems or switch LEDs.

*Note: for proper operation of circuit don't forget to configure input and output pins correctly. In case of schematic you see on Figure 4 inputs are configured as digital input with Schmitt trigger, and outputs as push-pull.*



## About the Author

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Background: Volodymyr Batig graduated from Ivan Franko Lviv National University in 2012, studying at the Department of Medical and Biomedical Electronics. Presently he's working with Configurable Mixed Signal ICs (CMICs) and their application notes. Moreover, for more than 10 years his particular sphere of interest has included design, modernization and repair of everything related to electronics.

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A	Volodymyr Batig	08/22/2013	New application note

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