

User Manual

GreenPAK Advanced Development Platform

UM-GP-002

Abstract

This user manual provides basic guidelines for the developers to get familiar with the GreenPAK Advanced Development Platform. It gives an overview of the hardware, as well as the functional description of this platform, and shows the example projects using SLG46721.

Contents

| | |
|--|-----------|
| Abstract | 1 |
| Contents | 2 |
| Figures..... | 3 |
| Tables | 3 |
| 1 Terms and Definitions..... | 4 |
| 2 Introduction..... | 5 |
| 2.1 GreenPAK Designer..... | 5 |
| 2.2 Support..... | 5 |
| 3 Getting Started | 6 |
| 3.1 Introduction | 6 |
| 3.2 Install Hardware | 6 |
| 3.3 Install Software..... | 6 |
| 3.4 Uninstall Software | 6 |
| 4 Hardware | 7 |
| 4.1 Overview | 7 |
| 4.2 Functional Description..... | 7 |
| 4.2.1 Power Supply..... | 7 |
| 4.2.2 USB Communication | 8 |
| 4.2.3 GND Connections..... | 8 |
| 4.2.4 Pin Test Points..... | 8 |
| 4.2.5 LEDs | 8 |
| 4.2.6 Socket Connector | 8 |
| 4.2.7 Expansion Connector | 8 |
| 4.2.8 Generators..... | 12 |
| 4.2.9 Pins Connectivity | 13 |
| 5 Example Projects using SLG46721 | 15 |
| 5.1 Project: Counter with Clock Enable | 15 |
| 5.2 Project: LED String with Direction..... | 25 |
| 6 Conclusion | 31 |
| Appendix A Electrical Specification | 32 |
| Appendix B Schematic Diagram | 34 |
| Appendix C BOM | 38 |
| Revision History | 40 |

GreenPAK Advanced Development Platform

Figures

| | |
|---|----|
| Figure 1: GreenPAK Advanced Development Board, Top View | 7 |
| Figure 2: USB Interface | 8 |
| Figure 3: GreenPAK Expansion Connector Schematic..... | 9 |
| Figure 4: Expansion Connector Control in GreenPAK Designer..... | 9 |
| Figure 5: Socket and Expansion Connector Schematic..... | 10 |
| Figure 6: Internal Power Source..... | 11 |
| Figure 7: Internal Power Source for GreenPAK Chip and External Development Platform | 11 |
| Figure 8: Expansion Connector. Pin with Protection Resistor..... | 12 |
| Figure 9: Choosing Generators | 12 |
| Figure 10: Managing Buttons | 13 |
| Figure 11: Global Linkage Settings | 13 |
| Figure 12: Pin Signal Sources/Loading Schematics | 14 |
| Figure 13: GreenPAK Designer..... | 15 |
| Figure 14: GreenPAK Components List..... | 16 |
| Figure 15: Pin 20 Mode | 17 |
| Figure 16: Look Up Table Properties Configured as AND Gate | 18 |
| Figure 17: Look Up Table Properties Configured as NOR Gate | 19 |
| Figure 18: Counter Properties | 20 |
| Figure 19: GreenPAK Designer..... | 20 |
| Figure 20: GreenPAK Designer, Emulation Tool | 21 |
| Figure 21: Signal Generator Connected to V _{DD} Pin | 21 |
| Figure 22: Signal Generator Settings | 22 |
| Figure 23: Logic Generator Properties | 23 |
| Figure 24: Waveform, Triggered on Button Pressed..... | 23 |
| Figure 25: Waveform, no Triggered on Button Released..... | 24 |
| Figure 26: Waveform of the Pulse Width of the Logic Generator and Count End Signal | 24 |
| Figure 27: Used Blocks for Current Project..... | 25 |
| Figure 28: Sine Waveform Generated with Signal Generator | 25 |
| Figure 29: Emulation Window, with Buffered LED and Signal Generator | 26 |
| Figure 30: Pin Properties..... | 27 |
| Figure 31: Pin Properties..... | 28 |
| Figure 32: Look Up Tables Properties Configured as XOR Gate | 28 |
| Figure 33: ACMP Properties..... | 29 |
| Figure 34: GreenPAK Designer..... | 29 |
| Figure 35: LED Output with Direction (Pin 2) Low | 30 |
| Figure 36: LED Output with Direction (Pin 2) High..... | 30 |
| Figure 37: MCU | 34 |
| Figure 38: Analog Switches, Protection Diodes and LEDs | 35 |
| Figure 39: Socket and Expansion Connectors | 35 |
| Figure 40: Signal Generator | 36 |
| Figure 41: Boost Converter USB Interface..... | 36 |
| Figure 42: Port Extender | 36 |
| Figure 43: USB Protection..... | 37 |

Tables

| | |
|--|----|
| Table 1: Available Connections for Each Test Point | 13 |
| Table 2: Pin Configuration for Counter with Clock Enable | 17 |
| Table 3: Pin Configuration for LED String with Direction | 26 |

1 Terms and Definitions

| | |
|-----------------|------------------------------------|
| ACMP | Analog Comparator |
| ADC | Analog-to-Digital Converter |
| BOM | Bill of Materials |
| GND | Ground |
| IDE | Integrated Development Environment |
| LED | Light Emitting Diode |
| LUT | Look Up Table |
| OTP | One-Time Programmable |
| PWM | Pulse-Width Modulation |
| RAM | Random-Access Memory |
| TP | Test Point |
| USB | Universal Serial Bus |
| V _{DD} | Power Supply |

GreenPAK Advanced Development Platform

2 Introduction

Thank you for choosing Renesas Electronics Corporation's products. The GreenPAK Advanced Development Platform allows you to develop your custom design using GreenPAK mixed signal ICs. You can design your own projects starting from a blank project or by altering the sample projects provided at <https://www.renesas.com/>.

2.1 GreenPAK Designer

GreenPAK Designer is an easy-to-use full-featured integrated development environment (IDE) that allows you to specify exactly how you want the device to be configured. This provides you a direct access to all GreenPAK device features and complete control over the routing and configuration of a PAK project with just one tool.

With GreenPAK Designer, you can:

- Design the configuration which corresponds to your project needs
- Verify the project using software interface to GreenPAK Advanced Development Platform hardware
- With simple-to-use and intuitive software and hardware tools you can reduce your project development time and get to market faster

To start working with GreenPAK Designer please take the following steps:

- Download and install GreenPAK Designer software
- Configure modules that you will need for your project
- Interconnect and configure modules
- Specify the pin out
- Test your design with the GreenPAK Advanced Development Platform

2.2 Support

Free support for GreenPAK Advanced Development Platform is available online at <https://www.renesas.com/>.

GreenPAK Designer will automatically notify you when a new version of software is available. For manual updates please go to <https://www.renesas.com/software-tool/go-configure-software-hub>.

These resources are also available under the **Help** menu of GreenPAK Designer.

3 Getting Started

3.1 Introduction

This chapter describes how to install and configure the GreenPAK Advanced Development Platform. Section 4 provides the details of hardware operation. Section 5 provides instructions on how to create a simple project example.

3.2 Install Hardware

No hardware installation is required for this platform.

3.3 Install Software

GreenPAK Designer software is available free of charge from the Renesas website at <https://www.renesas.com/software-tool/go-configure-software-hub> page.

3.4 Uninstall Software

The software can be uninstalled in the way typical for your operating system. Please refer to your operating system support documentation if you need the specific instructions or visit Section 2.2 of this document for additional support from Renesas.

GreenPAK Advanced Development Platform

4 Hardware

4.1 Overview

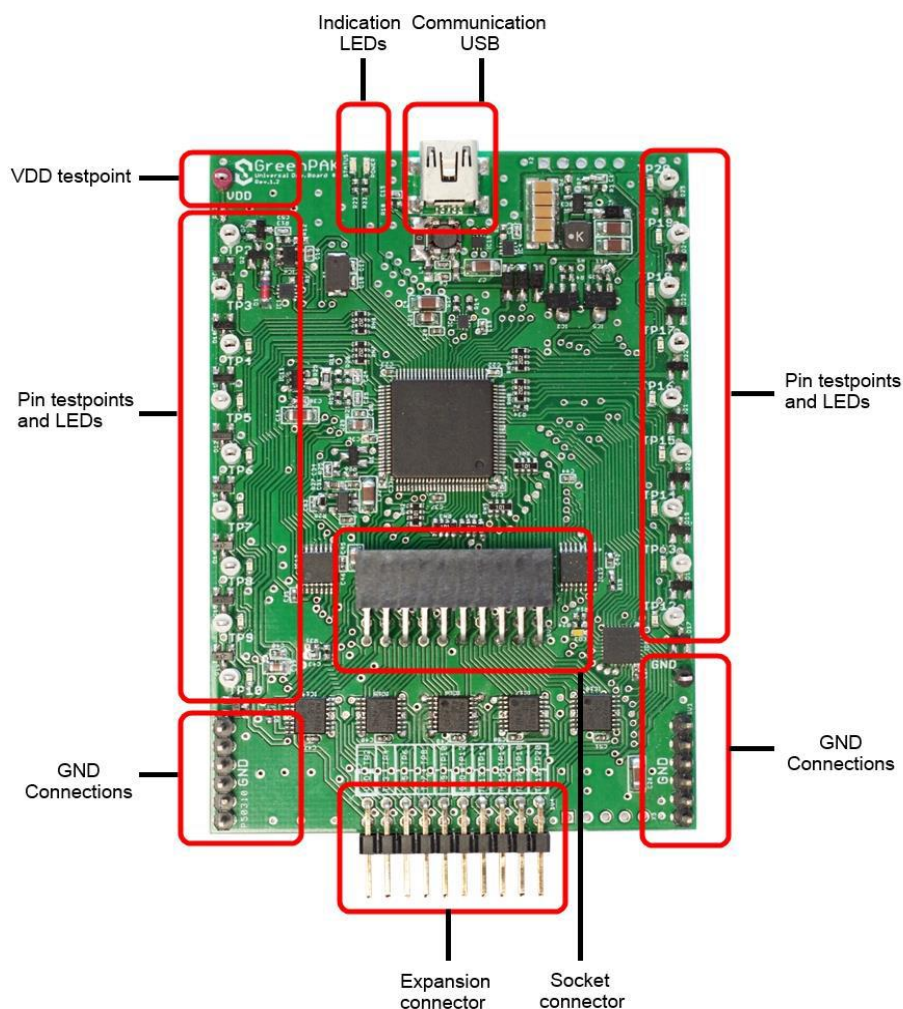


Figure 1: GreenPAK Advanced Development Board, Top View

Note: all test points were designed only for observation of signals on the pins. Please do not try to connect external power/signal source to test points, this will affect GreenPAK Advanced Development Board functionality and may even damage it.

4.2 Functional Description

4.2.1 Power Supply

The main power source of the GreenPAK Advanced Development Board is the USB power line. The Development Board can deliver power from 0 to 5.5 V. To provide this power range, the Development Board is equipped with a boost converter. A Signal generator with a buffered output controls the GreenPAK chip power rail. For more information about GreenPAK electrical specification, please refer to the datasheet.

GreenPAK Advanced Development Platform

4.2.2 USB Communication

The board has the USB communications interface that uses the USB mini-B connector, as shown in [Figure 2](#). This interface provides communication with the software control tool and supplies power to the platform, as discussed in [4.2.1](#).



Figure 2: USB Interface

4.2.3 GND Connections

There are 6 GND pins on the left side, 6 pins and 1 header on the right side. These can be used for test equipment (oscilloscope, multimeter, and others) ground reference connection or to connect external test circuitry ground.

4.2.4 Pin Test Points

Each GreenPAK chip pin including V_{DD} has its own observation test point. These test points were designed only for observation. To connect an external signal source use a software-controlled expansion connector.

4.2.5 LEDs

All the pins except Pin 2 can be connected to buffered LEDs. This option allows visualization of digital levels on chip pins. There are 2 selection modes:

- Buffered LED (with high impedance input)
- Inverted Buffered LED (with high impedance input)

This option can be enabled in GreenPAK Designer.

4.2.6 Socket Connector

The GreenPAK Advanced Development Board should be used with a detachable socket board. Its main purpose is to connect the GreenPAK chip to the Development Board. It's easy to use the programmed chip in external circuits, or to measure current consumption of the project.

4.2.7 Expansion Connector

This port was designed to connect the GreenPAK Advanced Development Board to external circuits and apply external power, signal sources and loads. It can be used to apply the GreenPAK chip into your custom design with minimal additional tools. For schematic diagram refer to [Figure 3](#).

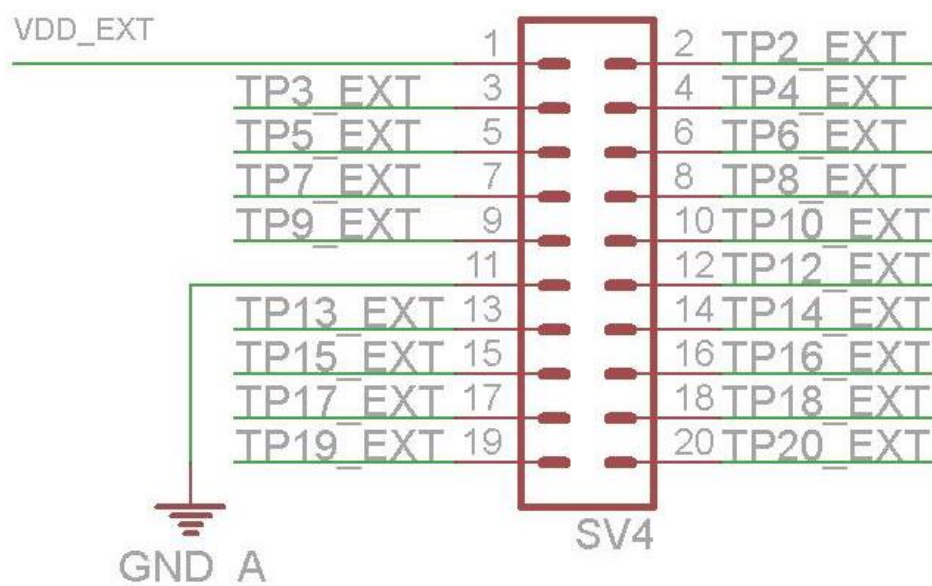


Figure 3: GreenPAK Expansion Connector Schematic

Each pin except Pin 11 (GND) is controlled through an individual analog switch. Expansion connector is a standard 0.1" double row connector. GreenPAK Designer can enable or disable external pins, as it is shown in the [Figure 4](#). The main purpose of the Expansion connector is to connect an external signal/power source safely to the GreenPAK Advanced Development Board.

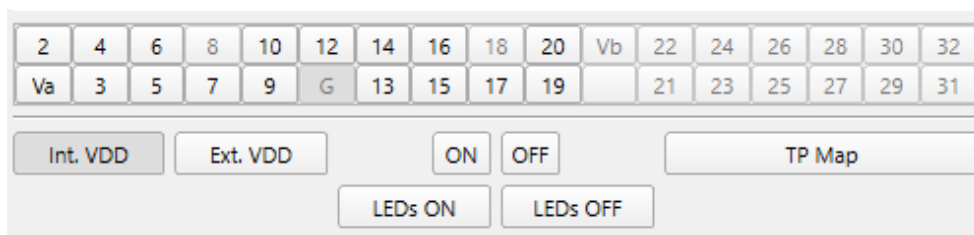


Figure 4: Expansion Connector Control in GreenPAK Designer

[Figure 5](#) demonstrates the schematic diagram of the expansion connector control.

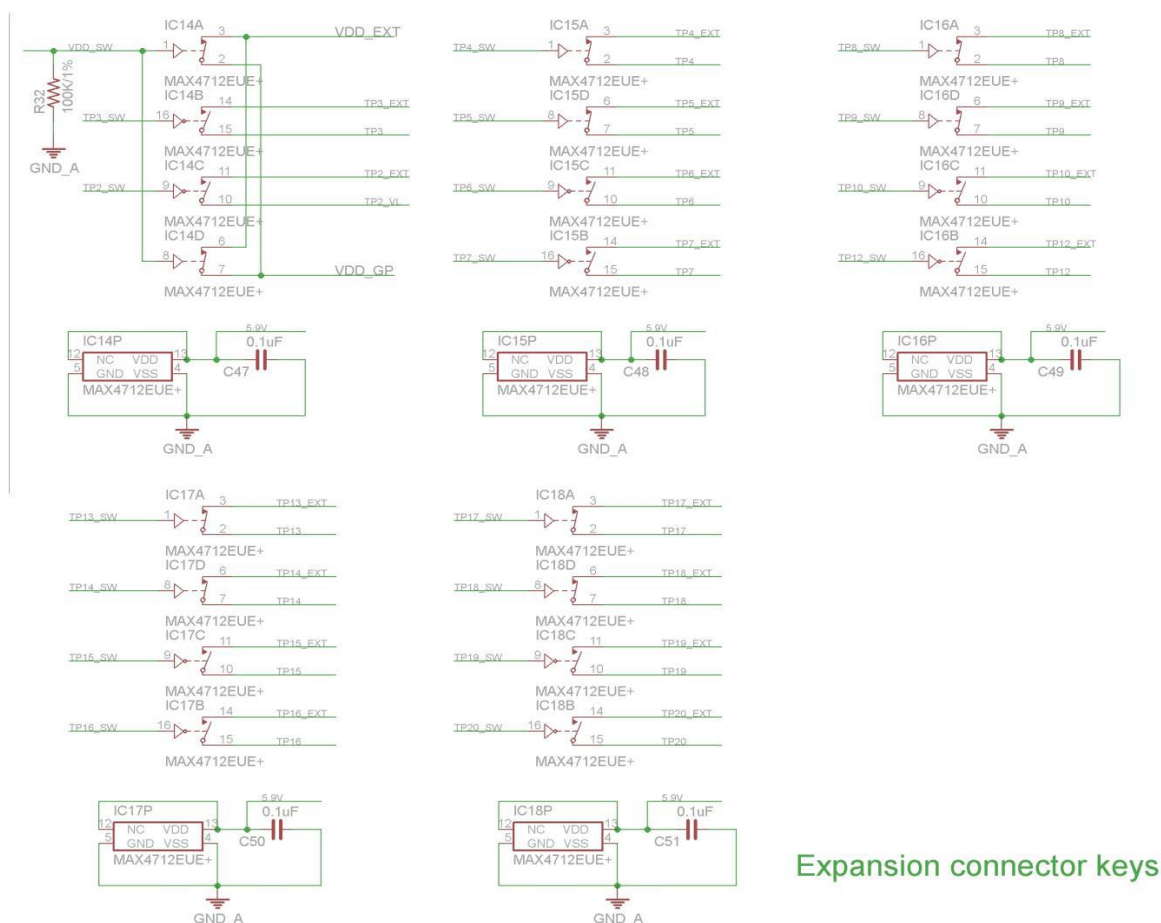


Figure 5: Socket and Expansion Connector Schematic

Expansion connector is enabled only in Emulation mode or Test mode. To enter either of these two modes the GreenPAK chip must be in the socket. When the Test mode button is pressed the software will first read the chip to verify if it was inserted and then configure the GreenPAK Advanced Development Board as set in Emulation Tool window. When the Test mode button is gray then the Development Platform is in Default state and all expansion port switches are open (disconnected). After Emulation button is pressed, the software will automatically perform the following steps:

- check chip presence
- open all expansion port switches (external signals/loads can be left connected to expansion port)
- use internal power and load configuration to the chip
- only for case #3: adjust internal power source to external power level → close external power switch → open internal power switch
- configure Development Board as set in Emulation Tool window

Parasitic effects should be also considered while using the GreenPAK Advanced Development Board in-circuit with analog signals. The entire Development Board circuitry along with the wiring have a significant amount of mutual capacitance and inductance. The detachable socket can also be used for the in-circuit development with programmed chips (the Development Board and socket connectors have the same pinout).

The GreenPAK Advanced Development Board provides three possible ways of using expansion connector:

- 1) Internal power is used to run the chip, no external power output is needed, external signal sources and loads can be connected between pins and GND.

GreenPAK Advanced Development Platform

The configuration steps:

- close internal and open external power switch
- close all used expansion port switches in the software
- hit Emulation/Test mode button

This is the common way of using an Expansion connector.

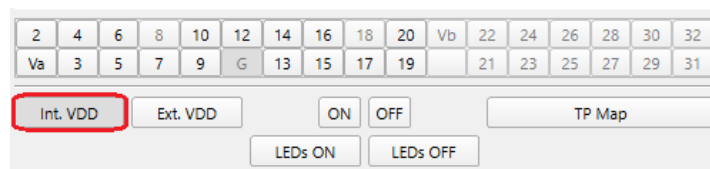


Figure 6: Internal Power Source

- 2) Internal power is used to run the chip and external circuit (internal power source/sink current is limited to 50 mA).

The configuration steps:

- close internal power switch
- close external power switch
- close all used expansion port switches in the software
- hit Emulation/Test mode button

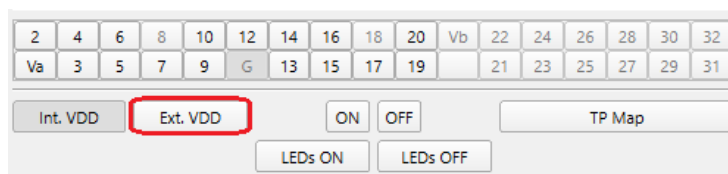


Figure 7: Internal Power Source for GreenPAK Chip and External Development Platform

- 3) External power is used to run the chip and external circuit (internal source output is in Hi-Z state).

The configuration steps:

- open internal power switch
- close external power switch
- close all used expansion port switches in the software
- hit Emulation/Test mode button (External power should be applied before this step)

Note that the GreenPAK chip has internal OTP memory which is normally loaded into RAM registers at initialization time. "Emulation mode" will bypass this load, and write the updated version of the project directly into the RAM register inside the GreenPAK chip many times, but after power loss all internal data will be lost. When the GreenPAK chip is already programmed the user can use Emulation mode to load another project and test it on the emulation tool in Emulation mode, in that case emulation data will be cleared. The "Emulation" mode is not necessary for checking programmed parts: in this case the "Test mode" is used.

Expansion connector can be divided by types of connections:

1. V_{DD}
2. GND
3. Data connections

The V_{DD} connection enables the user to connect/disconnect external and internal power source. This connection meets next requirements:

- External power range: 1.8 - 5.5 V
- High resistance voltage dividers are not recommended

GreenPAK Advanced Development Platform

The GND connection is connected directly to the Development Board, and cannot be controlled by GreenPAK Designer.

Data connections are the easiest way to connect external lines to the GreenPAK chip. They are software controlled switches. Every line is connected with a 100 W resistor.

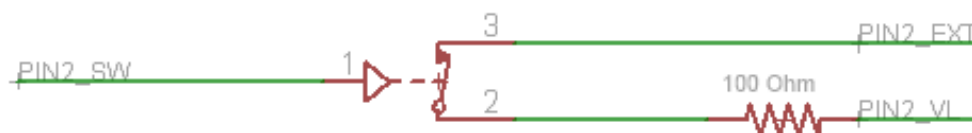


Figure 8: Expansion Connector. Pin with Protection Resistor

4.2.8 Generators

Three types of generator can be connected to a defined TP: Logic generator, Signal generator, or I²C generator. The user can add generator to highlighted green pins with the help of Add button or use a context menu of the TP.

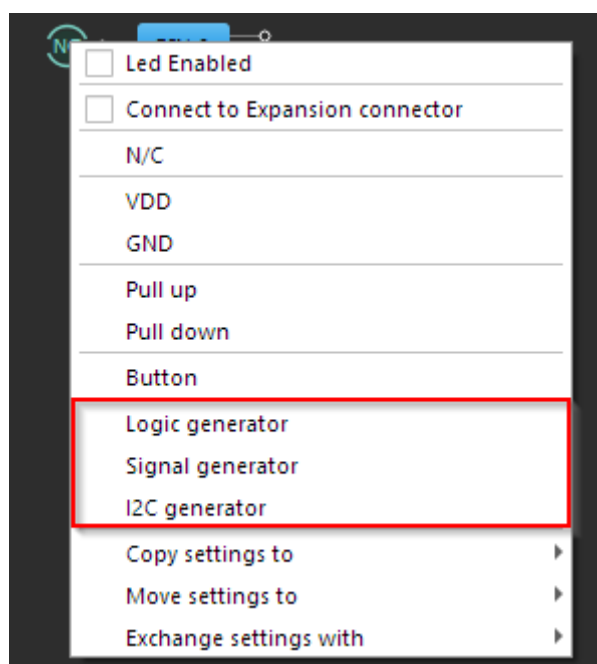


Figure 9: Choosing Generators

Logic generator is used for generating logic pulses.

I²C generator allows the user to create I²C signals based on logic generators. There are two logic generators combined together as SDA and SCL lines. The user can combine predefined I²C settings to generate a needed waveform and choose SCL frequency.

SCL sends I²C-compatible SCL signal to the line. SCL works only in a 'read-only' mode. SCL clock can be configured by choosing predefined frequency. The set of those frequencies depends on the development platform.

SDA sends I²C-compatible SDA signal to the line. In Signal Wizard special editor shows sequence of commands. There are some actions in command editor the user can do.

Signal generator is used to generate analog signals: constant voltage level, sine, trapeze (trapezoid), logic pattern, and user-defined.

GreenPAK Advanced Development Platform

There is a possibility to start all the generators using buttons at Debugging controls panel.

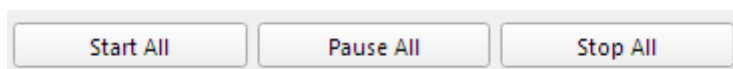


Figure 10: Managing Buttons

Note: these buttons can be controlled only by generators with installed Global Linkage flag.



Figure 11: Global Linkage Settings

4.2.9 Pins Connectivity

The GreenPAK Advanced Development Board supports connecting eight types of loads and signal sources. Each source has its own special purpose. The List of available connections for each test point is presented in [Table 1](#).

Table 1: Available Connections for Each Test Point

| Pin | Set to V _{DD} | Set to GND | Pull-up | Pull-down | Set Configurable Button | LED | Signal Generator | Logic Generator | I ² C Generator |
|-----------------|------------------------|------------|---------|-----------|-------------------------|-----|------------------|-----------------|----------------------------|
| # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| V _{DD} | - | - | - | - | - | - | + | - | - |
| TP2 | + | + | + | + | + | - | - | + | + |
| TP3 | + | + | + | + | + | + | - | + | + |
| TP4 | + | + | + | + | + | + | - | + | + |
| TP5 | + | + | + | + | + | + | - | + | + |
| TP6 | + | + | + | + | + | + | + | + | + |
| TP7 | + | + | + | + | + | + | + | + | + |
| TP8 | + | + | + | + | + | + | + | + | + |
| TP9 | + | + | + | + | + | + | - | + | + |
| TP10 | + | + | + | + | + | + | + | + | + |
| TP12 | + | + | + | + | + | + | + | + | + |
| TP13 | + | + | + | + | + | + | + | + | + |
| TP14 | + | + | + | + | + | + | + | + | + |
| TP15 | + | + | + | + | + | + | - | + | + |
| TP16 | + | + | + | + | + | + | - | + | + |
| TP17 | + | + | + | + | + | + | - | + | + |
| TP18 | + | + | + | + | + | + | - | + | + |
| TP19 | + | + | + | + | + | + | - | + | + |
| TP20 | + | + | + | + | + | + | - | + | + |

GreenPAK Advanced Development Platform

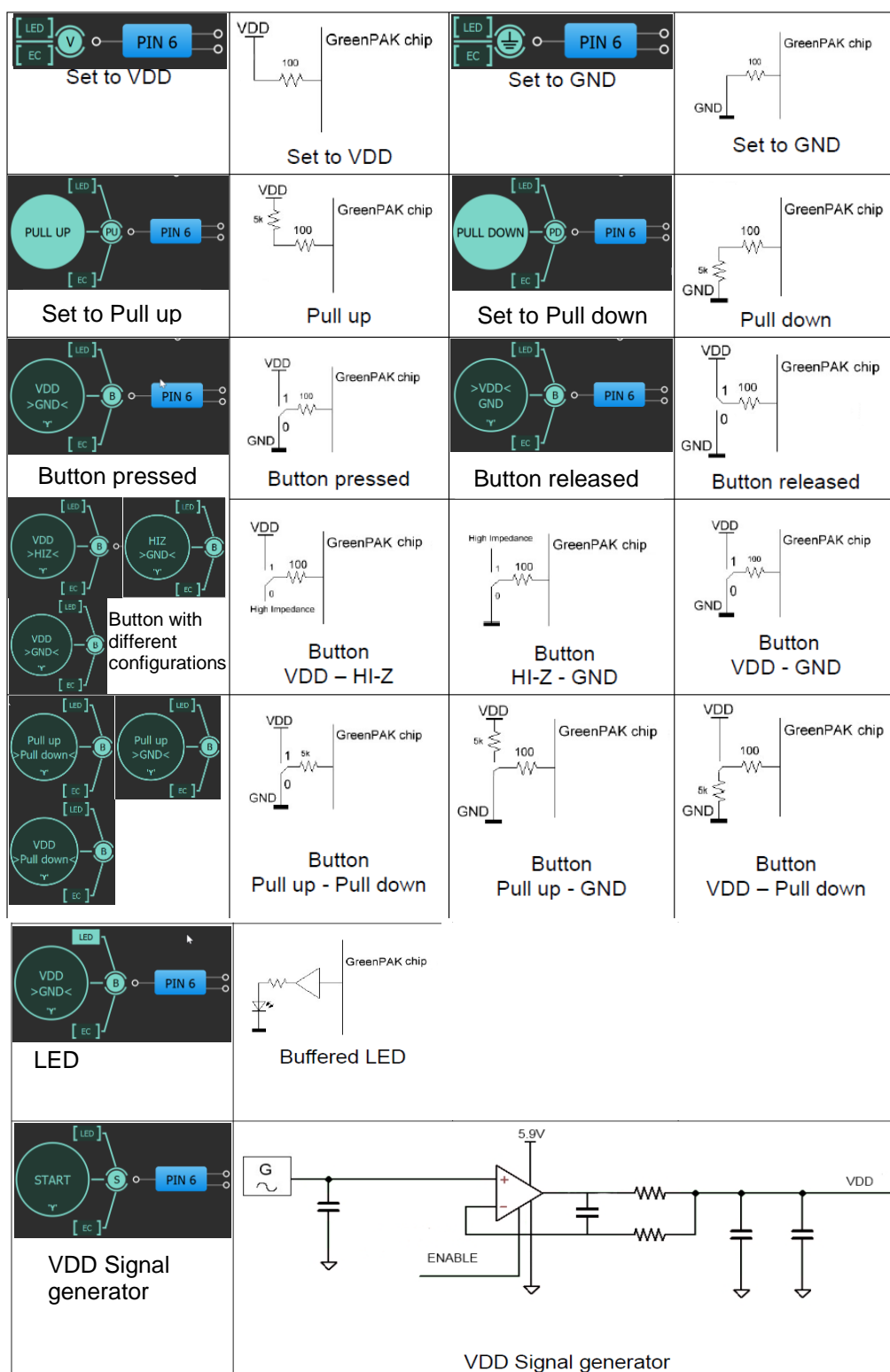


Figure 12: Pin Signal Sources/Loading Schematics

Note: V_{DD} Signal generator works similar to other Signal generators but has wider output voltage range. It can provide maximum supply level of 5.5 V.

5 Example Projects using SLG46721

5.1 Project: Counter with Clock Enable

Blocks required:

- 2 digital inputs
- 1 digital output
- 1 Look Up Table with two inputs
- 1 Counter

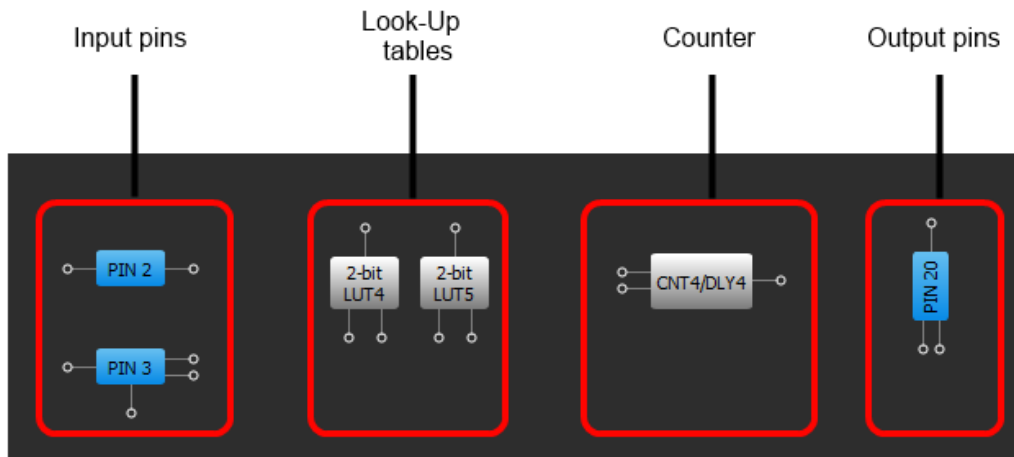


Figure 13: GreenPAK Designer

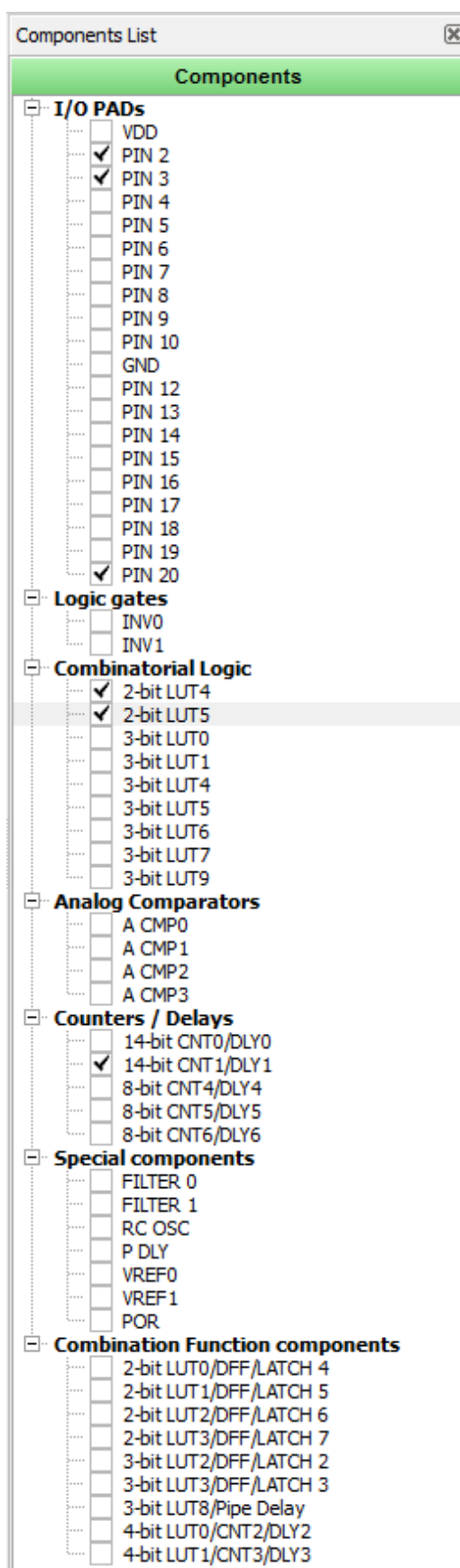


Figure 14: GreenPAK Components List

GreenPAK Advanced Development Platform

All these components can be found in components list. If there are no components on the work area - make sure this component is enabled.

Table 2: Pin Configuration for Counter with Clock Enable

| Pin # | Pin Name | Type | Pin Description |
|-------|-----------------|------------------|-----------------|
| 1 | V _{DD} | PWR | Supply Voltage |
| 2 | Clock | Digital input | Digital input |
| 3 | Enable | Digital Input | Digital Input |
| 11 | GND | GND | Ground |
| 20 | Counter Output | Push-Pull output | Digital input |

All components used in the project are shown in [Figure 13](#), next step is to configure selected blocks. Double click on Pin 20 to open “Properties” panel. Select “1x push pull” from the drop-down menu in Pin 20 properties and hit “Apply” button.

Properties

PIN 20

I/O selection: Digital Output

Input mode: None
OE = 0

Output mode: 1x push pull
OE = 1

Resistor: Pull Down

Resistor value: 1M

Information

Electrical Specifications

| | 1.8 V min/max | 3.3 V min/max | 5.0 V min/max |
|-----------------|------------------|------------------|------------------|
| V _{OH} | 1.690/-- | 2.735/-- | 4.190/-- |
| V _{OL} | --/0.015 | --/0.228 | --/0.270 |
| I _{OH} | 1.110/-- | 6.045/-- | 22.080/-- |
| I _{OL} | 0.917/-- | 4.875/-- | 7.215/-- |
| -- | --/-- | --/-- | --/-- |
| -- | --/-- | --/-- | --/-- |

Detailed Info Apply

Figure 15: Pin 20 Mode

The next component in this design is the Look Up Table. First Look Up Table (LUT4) is used to generate logic “1” only when there are high logic levels on both inputs (AND gate). Select AND gate from “Standard gates” drop-down menu or set table manually. Second Look Up Table (LUT5) is configured as NOR gate. It is used to generate reset signal for counter on Pin 3 falling edge.

Properties ✕

2-bit LUT4

| IN3 | IN2 | IN1 | IN0 | OUT |
|-----|-----|-----|-----|-----|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |

Standard gates
Defined by user

All to 0
All to 1

i Detailed Info ↻ Apply

Properties ✕

2-bit LUT4

| IN3 | IN2 | IN1 | IN0 | OUT |
|-----|-----|-----|-----|-----|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |

Standard gates
Defined by user

All to 0
All to 1

i Detailed Info ↻ Apply

Figure 16: Look Up Table Properties Configured as AND Gate

Properties

2-bit LUT5

| IN3 | IN2 | IN1 | IN0 | OUT |
|-----|-----|-----|-----|-----|
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |

Standard gates
 NOR

All to 0
 All to 1

Detailed Info Apply

Figure 17: Look Up Table Properties Configured as NOR Gate

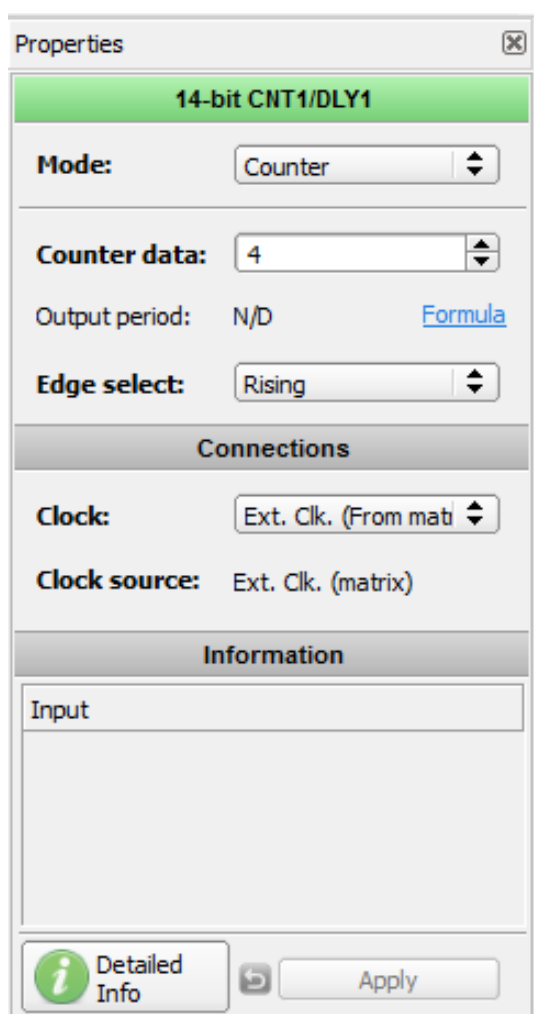



Figure 18: Counter Properties

The final step is to connect used components. Use Wire tool to perform this action. To connect two pins select "Set Wire"  and then click on the first and the second pin of the module or modules that you want to connect. The trace will be automatically routed.

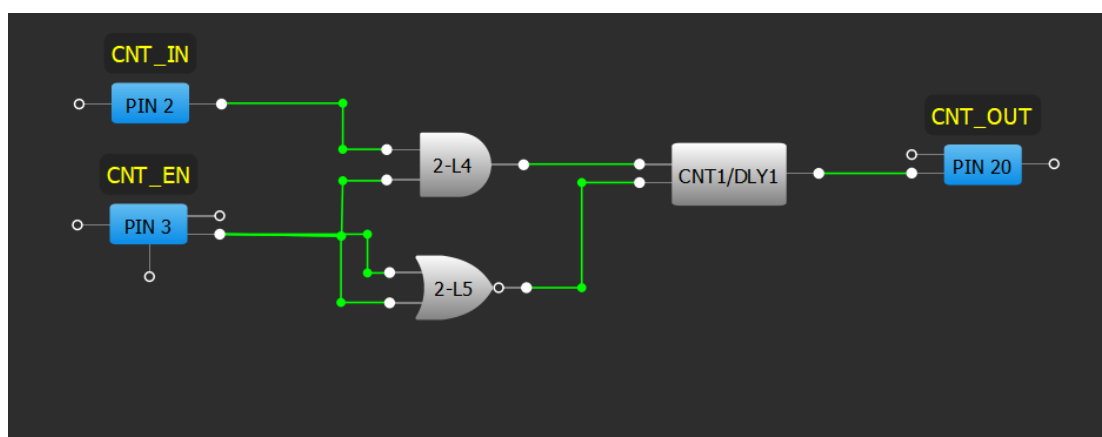


Figure 19: GreenPAK Designer

Figure 19 displays ready project with configured blocks and wire connections.

GreenPAK Advanced Development Platform

Use the GreenPAK Advanced Development Board to test this project. Connect the GreenPAK Advanced Development Board to the PC and press “Emulation” button. This will load the code of your project to the chip and will enable Test functionality of your Development Board.

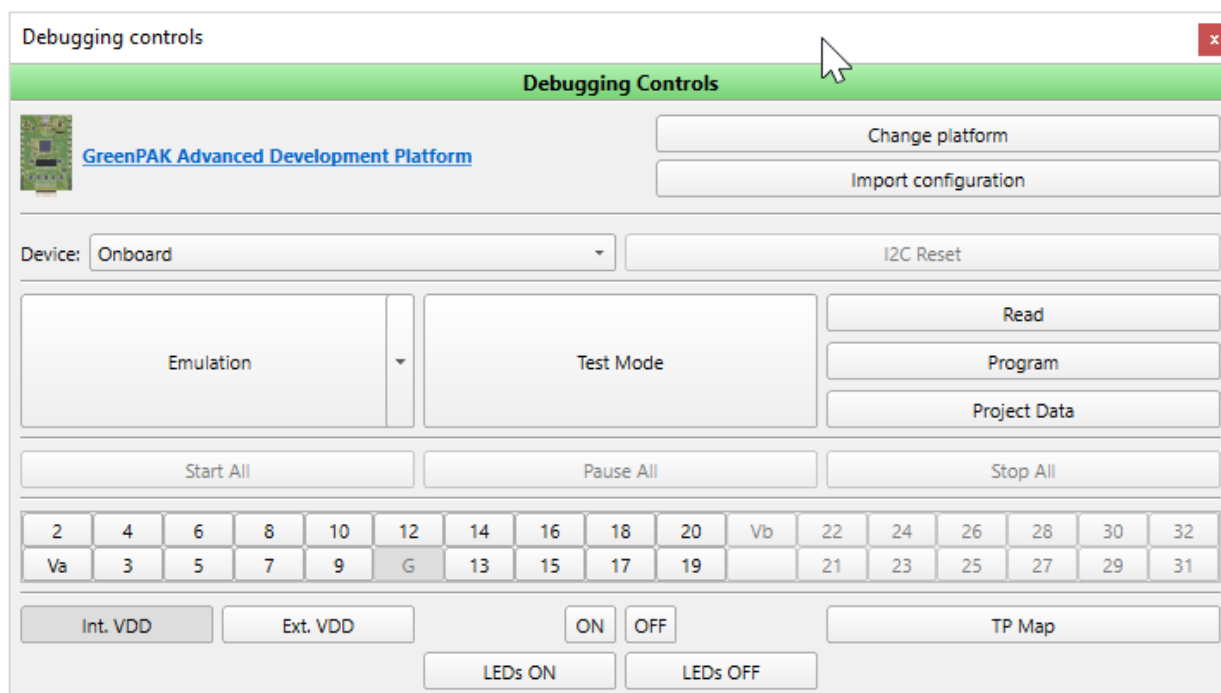


Figure 20: GreenPAK Designer, Emulation Tool

To test this project we will use the following tools:

- Signal generator. Signal generator is applied to V_{DD} pin to power GreenPAK chip
- Logic generator. Logic generator serves as clock source
- Button is a software simulation of the real button. It switches Pin between V_{DD} and GND signal levels
- Inverted buffered LED
- Buffered LED

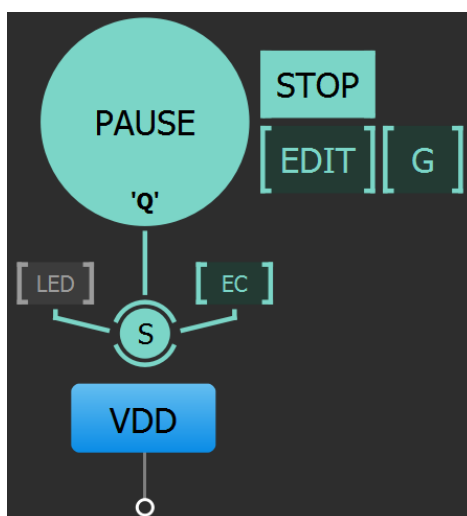


Figure 21: Signal Generator Connected to V_{DD} Pin

Signal generator is presented as a power source for GreenPAK chip. It's configured to output source constant 3.3 V.

| Options | |
|---------------------------|-----------------------------------|
| General | |
| Generator: | PIN1 (VDD) - Constant Voltage L ▾ |
| Shown period: | Auto ▾ |
| Start point: | 0.000 ▾ ms ▾ |
| Stop point: | 0.100 ▾ ms ▾ |
| Global linkage: | Unlinked ▾ |
| Sync Power Rails: | Disabled ▾ |
| Repeat: | Cyclic ▾ |
| Repeat count: | 2 ▾ |
| Pre-start state: | Start point (V0) ▾ |
| Pre-start delay: | 0.000 ▾ ms ▾ |
| End state: | Pre-start state ▾ |
| Output type: | High-Z ▾ |
| Pause type: | Last state ▾ |
| Signal Generator Settings | |
| Type: | Const. voltage ▾ |
| U: | 3.299 ▾ V ▾ |
| Tolerance: ±30 mV | |

Figure 22: Signal Generator Settings

The purpose of the logic generator is to provide clock pulses for the Counter block. It is configured for 10 Hz clock source as shown in the [Figure 23](#).

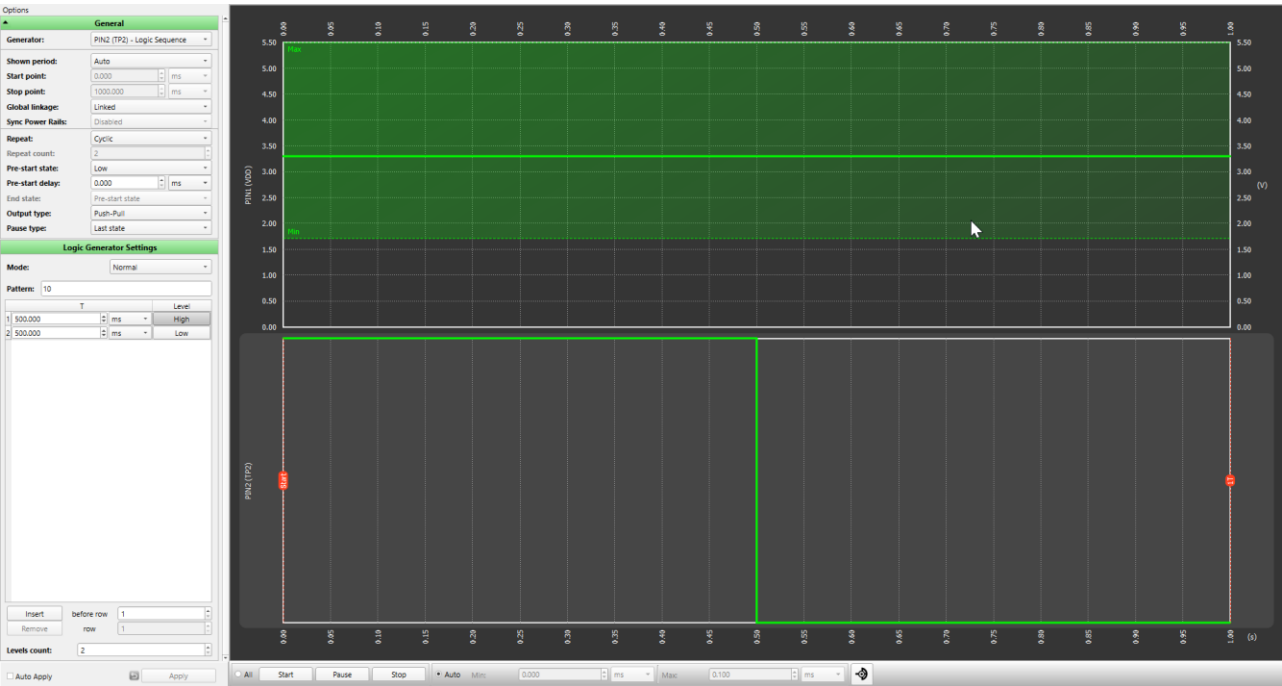


Figure 23: Logic Generator Properties

Functionality Waveform

Channel 1 (yellow/top) – Logic generator
Channel 2 (light blue/2nd line) – Button, 1 - enable Counter; 0 - disable Counter
Channel 3 (magenta/3rd line) – Counter output

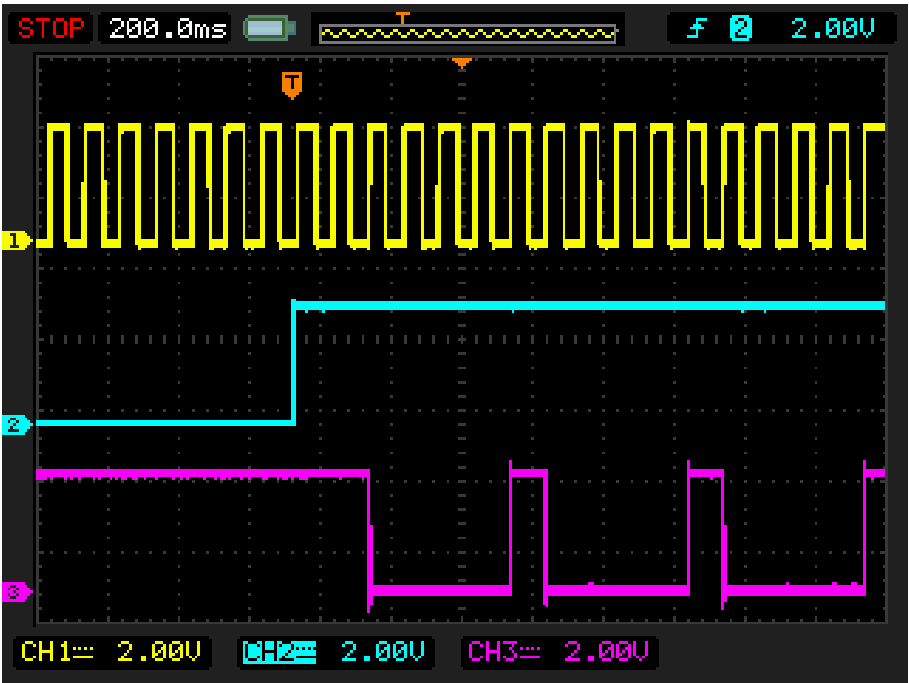


Figure 24: Waveform, Triggered on Button Pressed

Channel 1 (yellow/top) – Logic generator
Channel 2 (light blue/2nd line) – Button, 1 - enable Counter; 0 - disable Counter
Channel 3 (magenta/3rd line) – Counter output

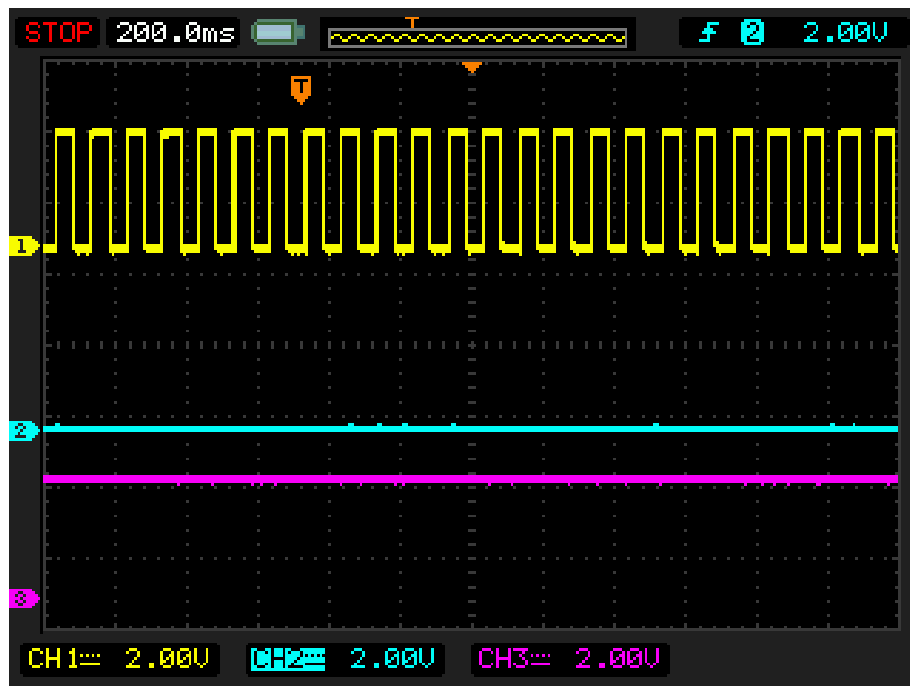


Figure 25: Waveform, no Triggered on Button Released

Channel 1 (yellow/top) – Logic generator

Channel 2 (light blue/2nd line) – Button, 1 - enable Counter; 0 - disable Counter

Channel 3 (magenta/3rd line) – Counter output

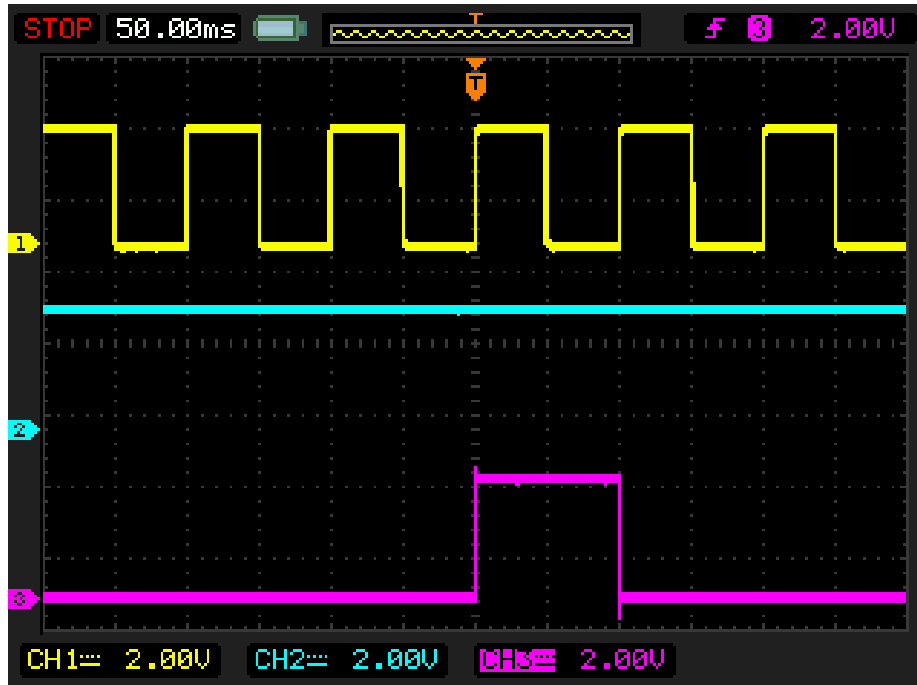


Figure 26: Waveform of the Pulse Width of the Logic Generator and Count End Signal

As shown in [Figure 25](#) and [Figure 26](#) Counter works only when the button is pressed.

5.2 Project: LED String with Direction

For this project we will need:

- Analog pin for input data
- Digital pin for PWM output
- ADC block
- PWM block

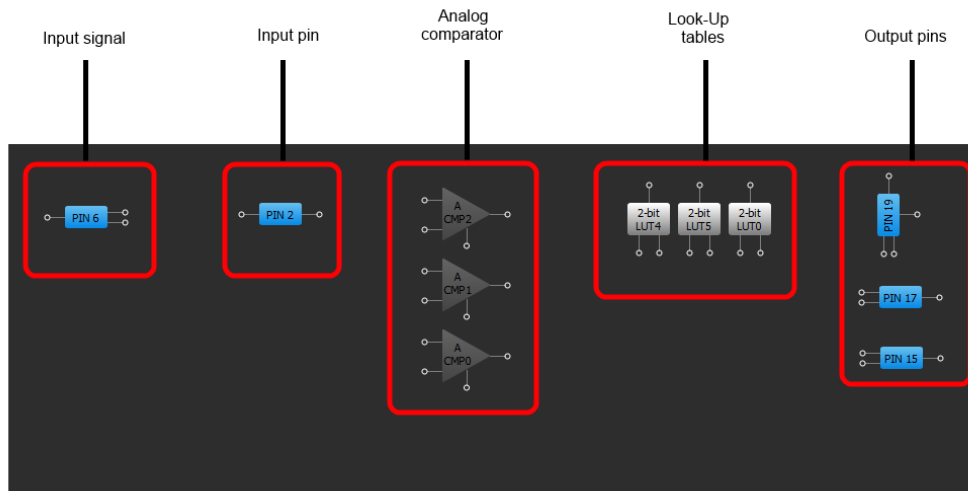


Figure 27: Used Blocks for Current Project

For testing this project, the Signal generator with sine waveform is used.

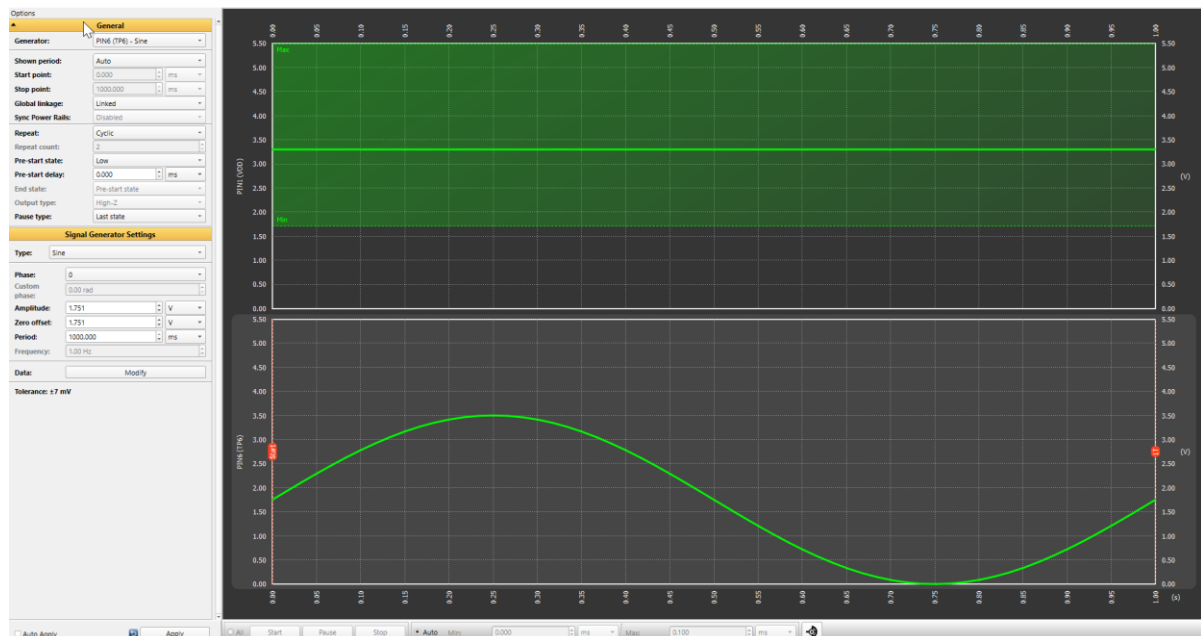


Figure 28: Sine Waveform Generated with Signal Generator

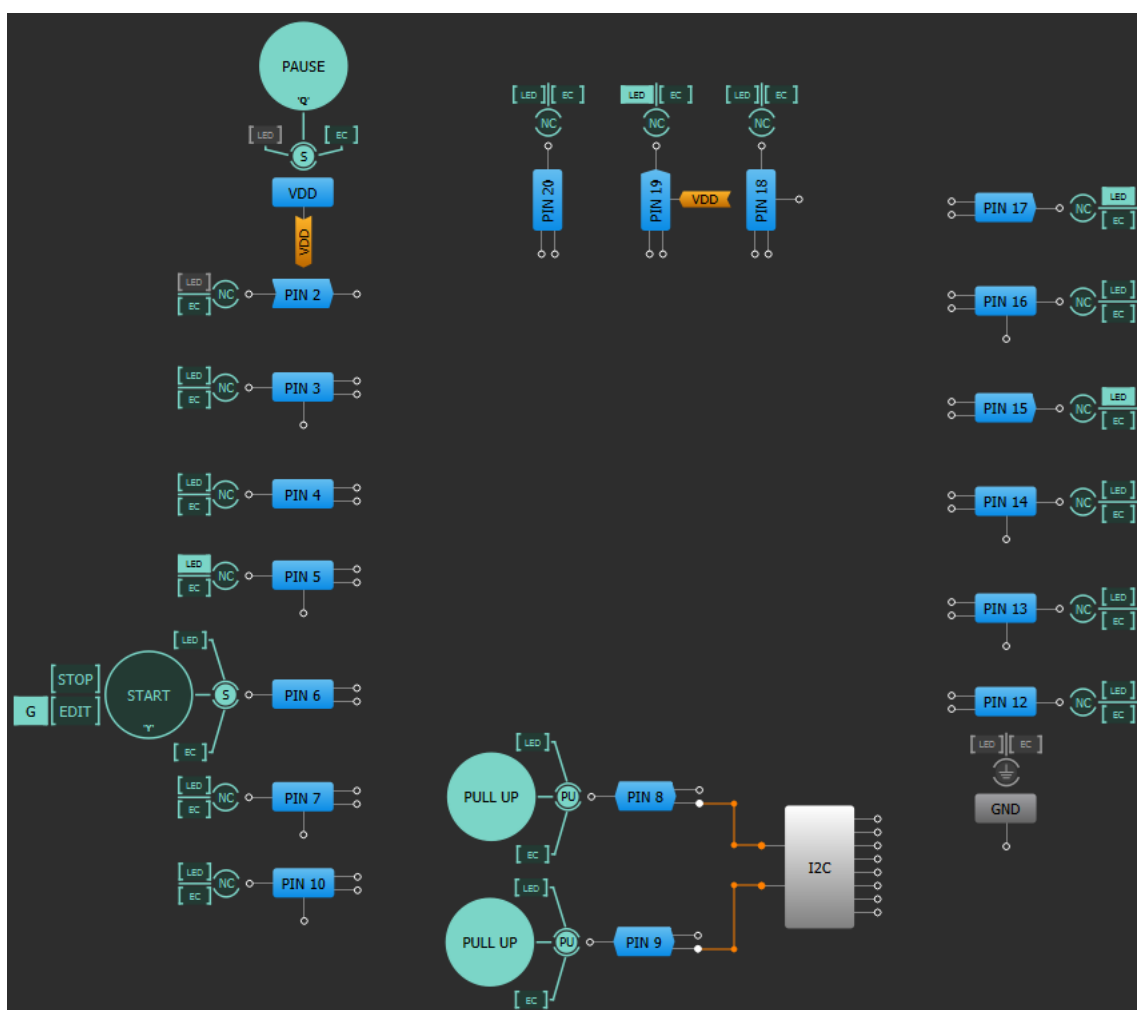


Figure 29: Emulation Window, with Buffered LED and Signal Generator

Table 3: Pin Configuration for LED String with Direction

| Pin # | Pin Name | Type | Pin Description |
|-------|-----------------|--------|--------------------|
| 1 | V _{DD} | PWR | Supply Voltage |
| 2 | DIRECTION | Input | Controls direction |
| 6 | SIGNAL | Input | Analog Input |
| 11 | GND | GND | Ground |
| 15 | LED_A | Output | LED |
| 17 | LED_B | Output | LED |
| 19 | LED_C | Output | LED |

Properties

PIN 2

I/O selection: Digital Input

Input mode:
OE = 0
Digital in without Sc

Output mode:
OE = 1
None

Resistor: Pull Down

Resistor value: 1M

Information

Electrical Specifications

| | 1.8 V min/max | 3.3 V min/max | 5.0 V min/max |
|-----------------|------------------|------------------|------------------|
| V _{IH} | 1.100/-- | 1.780/-- | 2.640/-- |
| V _{IL} | --/0.690 | --/1.210 | --/1.840 |
| -- | --/-- | --/-- | --/-- |
| -- | --/-- | --/-- | --/-- |
| -- | --/-- | --/-- | --/-- |
| -- | --/-- | --/-- | --/-- |

Detailed Info

Apply

Figure 30: Pin Properties

Pin 6 is configured as analog input-output. This pin is used for generating SINE waveform.

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Properties ✕

PIN 6

I/O selection: Analog Input/Output

Input mode: Analog input
OE = 0

Output mode: Analog output
OE = 1

Resistor: Pull Down

Resistor value: 1M

Information

Electrical Specifications

| | 1.8 V min/max | 3.3 V min/max | 5.0 V min/max |
|----|------------------|------------------|------------------|
| -- | --/-- | --/-- | --/-- |
| -- | --/-- | --/-- | --/-- |
| -- | --/-- | --/-- | --/-- |
| -- | --/-- | --/-- | --/-- |
| -- | --/-- | --/-- | --/-- |
| -- | --/-- | --/-- | --/-- |

i Detailed Info ↶ Apply

Properties ✕

PIN 19

I/O selection: Digital Output

Input mode: None
OE = 0

Output mode: 1x push pull
OE = 1

Resistor: Pull Down

Resistor value: 1M

Information

Electrical Specifications

| | 1.8 V min/max | 3.3 V min/max | 5.0 V min/max |
|-----------------|------------------|------------------|------------------|
| V _{OH} | 1.690/-- | 2.735/-- | 4.190/-- |
| V _{OL} | --/0.015 | --/0.228 | --/0.270 |
| I _{OH} | 1.110/-- | 6.045/-- | 22.080/-- |
| I _{OL} | 0.917/-- | 4.875/-- | 7.215/-- |
| -- | --/-- | --/-- | --/-- |
| -- | --/-- | --/-- | --/-- |

i Detailed Info ↶ Apply

Figure 31: Pin Properties

Properties ✕

2-bit LUT4

| IN3 | IN2 | IN1 | IN0 | OUT |
|-----|-----|-----|-----|-----|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |

Standard gates: XOR ↶ Apply

i ↶ Apply

Properties ✕

2-bit LUT5

| IN3 | IN2 | IN1 | IN0 | OUT |
|-----|-----|-----|-----|-----|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |

Standard gates: XOR ↶ Apply

i ↶ Apply

Properties ✕

2-bit LUT0/DF/LATCH4

Type: LUT

| IN3 | IN2 | IN1 | IN0 | OUT |
|-----|-----|-----|-----|-----|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |

Standard gates: XOR ↶ Apply

i ↶ Apply

Figure 32: Look Up Tables Properties Configured as XOR Gate

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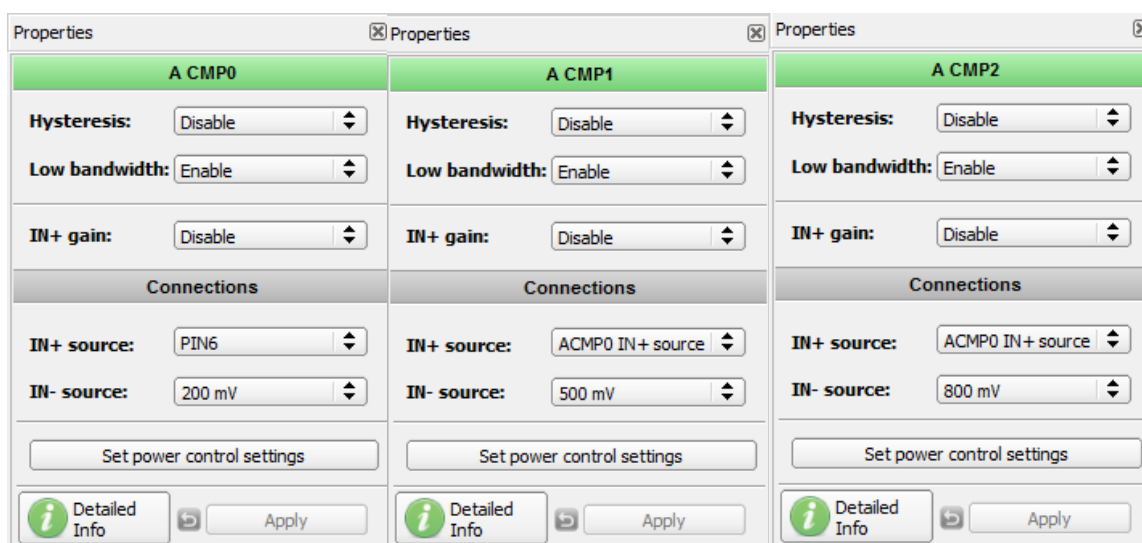


Figure 33: ACMP Properties

Pins 15, 17, 19 - configured as output with Push-Pull 1x. They are used for testing purpose.

All comparators positive inputs are connected to the Pin 6 analog input. When the voltage on the positive input is higher than the voltage on the negative input, comparator will set logic “1” on its output. ACMP0 positive input is 200 mV, ACMP1 is 500 mV, and ACMP2 is 800 mV, creating 4 states:

- All LEDs are off
- LED_A is on
- LED_A and LED_B are on
- All LEDs are on

If Pin 2 logic level is set to “1”, these states will transform into:

- All LEDs are on
- LED_A and LED_B are on
- LED_A is on
- All LEDs are off

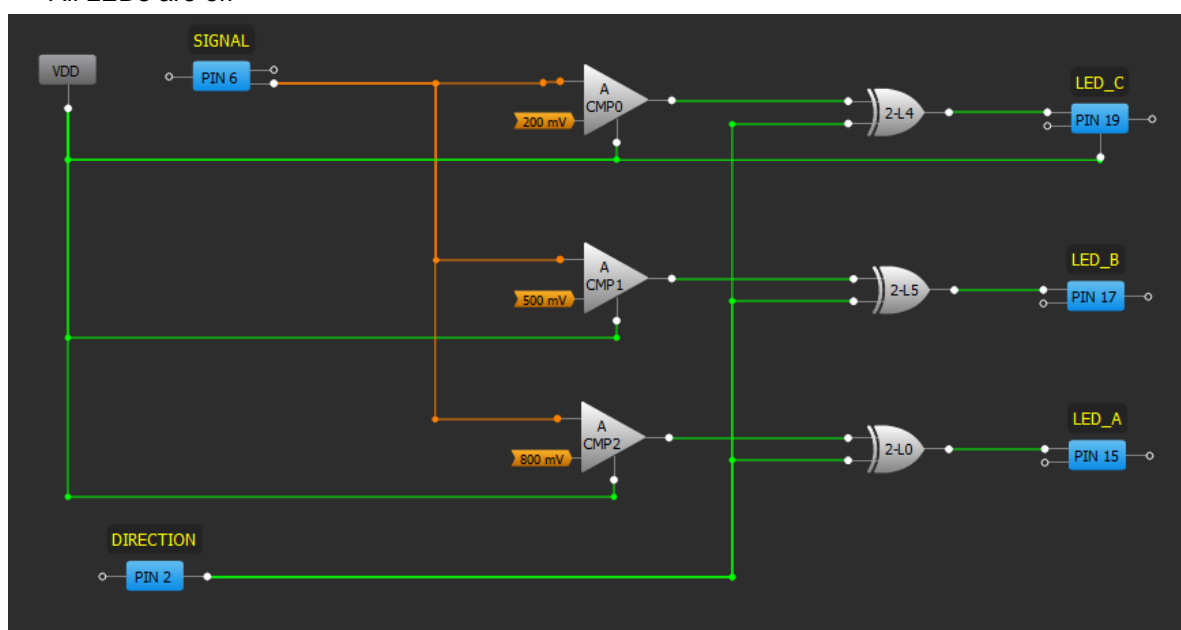


Figure 34: GreenPAK Designer

Functionality Waveform

Channel 1 (yellow/top) – Direction

Channel 2 (light blue /2nd line) – LED_A

Channel 3 (magenta/3rd line) – LED_B

Channel 4 (blue / 4th line) – LED_C

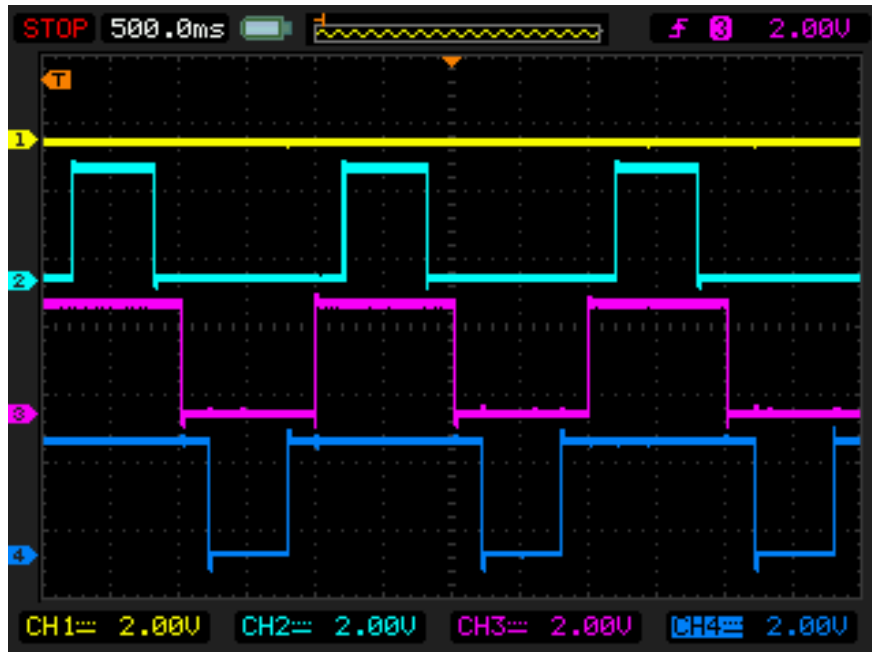


Figure 35: LED Output with Direction (Pin 2) Low

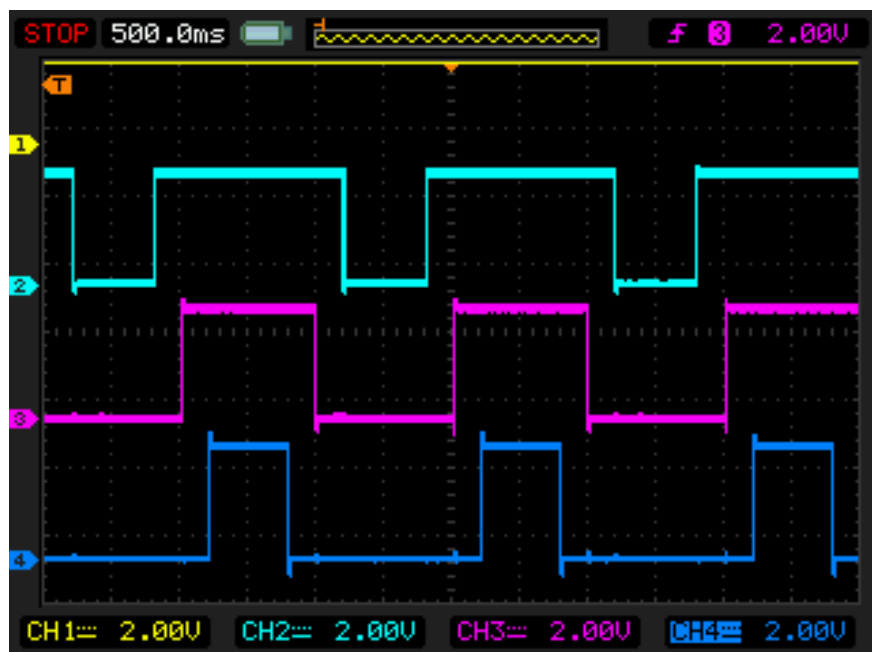


Figure 36: LED Output with Direction (Pin 2) High

The PWM duty cycle rises up to 100% when analog signal is close to 1 V.

6 Conclusion

This Development Platform is a truly versatile tool. It allows the designer to create a custom project within minutes, without using additional devices (except oscilloscope).

For more information please visit our website <https://www.renesas.com/>.

Appendix A Electrical Specification

| Mode | Parameter | Min | Typ | Max | Units |
|---|---|-------|-----------------|------|-------|
| General | Test Point Capacitance | 19.5 | -- | -- | pF |
| | Input Leakage Current | -- | -- | 14 | nA |
| | Max Current through Protection Diode to V _{DD} | -- | -- | 200 | mA |
| | Ripple & Noise | 20 | -- | 40 | mVp-p |
| V _{DD} Power Supply Generator (V _{DD}) | Voltage Range | 1.5 | -- | 5.5 | V |
| | V _{DD} Max Current | -- | -- | 70 | mA |
| | Voltage Output Total Error | -- | ±30 | -- | mV |
| Logic generator | Number of Channels (TP2 to TP10, TP12 to TP20) | -- | -- | 18 | -- |
| | Output Voltage High | -- | V _{DD} | -- | V |
| | Output Voltage Low | 0.4 | -- | 0.8 | V |
| | Max Current per TP | -- | -- | 30 | mA |
| | Max Total Current per TPs | -- | -- | 250 | mA |
| | Rise Time | 4 | -- | 75 | ns |
| | Fall Time | 4 | -- | 60 | ns |
| | Full-Scale Settling Time (0 to 5.5 V) | 30 | 40 | 75 | ns |
| | Max Output Frequency | 0.152 | -- | 5000 | Hz |
| | Max Number of Points | -- | -- | 180 | -- |
| | Sample Rate | -- | 10 | -- | kSPS |
| | | | | | |
| Signal Generator | Number of Channels (TP3 to TP10, TP12 to TP18) | -- | -- | 15 | -- |
| | Output Voltage Range | 0 | -- | 5.5 | V |
| | DC Output Impedance | -- | 0.5 | -- | Ω |
| | Short-Circuit Current | -- | -- | 30 | mA |
| | Min Output Voltage | -- | -- | 19 | mV |
| | Output Total Error | -- | -- | ±7 | mV |
| | Output Frequency (SINE) | 0.01 | -- | 2500 | Hz |
| | Max Number of Points | -- | -- | 60 | -- |
| | Sample Rate | -- | 10 | -- | kSPS |
| Virtual Button, V _{DD} /GND, Pull-Up/Down Driver | Output Level High | -- | V _{DD} | -- | -- |
| | Output Level Low | -- | GND | -- | -- |
| | Strong Drive (V _{DD} /GND) Resistance | -- | 100 | -- | Ω |
| | Pull-Up/Down Resistance | 3.5 | 5.6 | 8.5 | kΩ |
| Expansion Connector Switch | Max Voltage | -- | -- | 5.5 | V |
| | Continuous Current through Any Terminal | -- | -- | ±30 | mA |
| | Switch On-Resistance | -- | 20 | 40 | Ω |
| | External V _{DD} Switch On-Resistance | -- | 10 | 20 | Ω |
| | On Leakage Current | -20 | -- | 20 | nA |

| Mode | Parameter | Min | Typ | Max | Units |
|----------------------------|---|-----|-----|------|-------|
| Expansion Connector Switch | Off Leakage Current | -10 | -- | 10 | nA |
| | Bandwidth | -- | -- | 10 | MHz |
| | Max V _{DD} Supply from External Source | -- | -- | 5.66 | V |

Appendix B Scematic Diagram

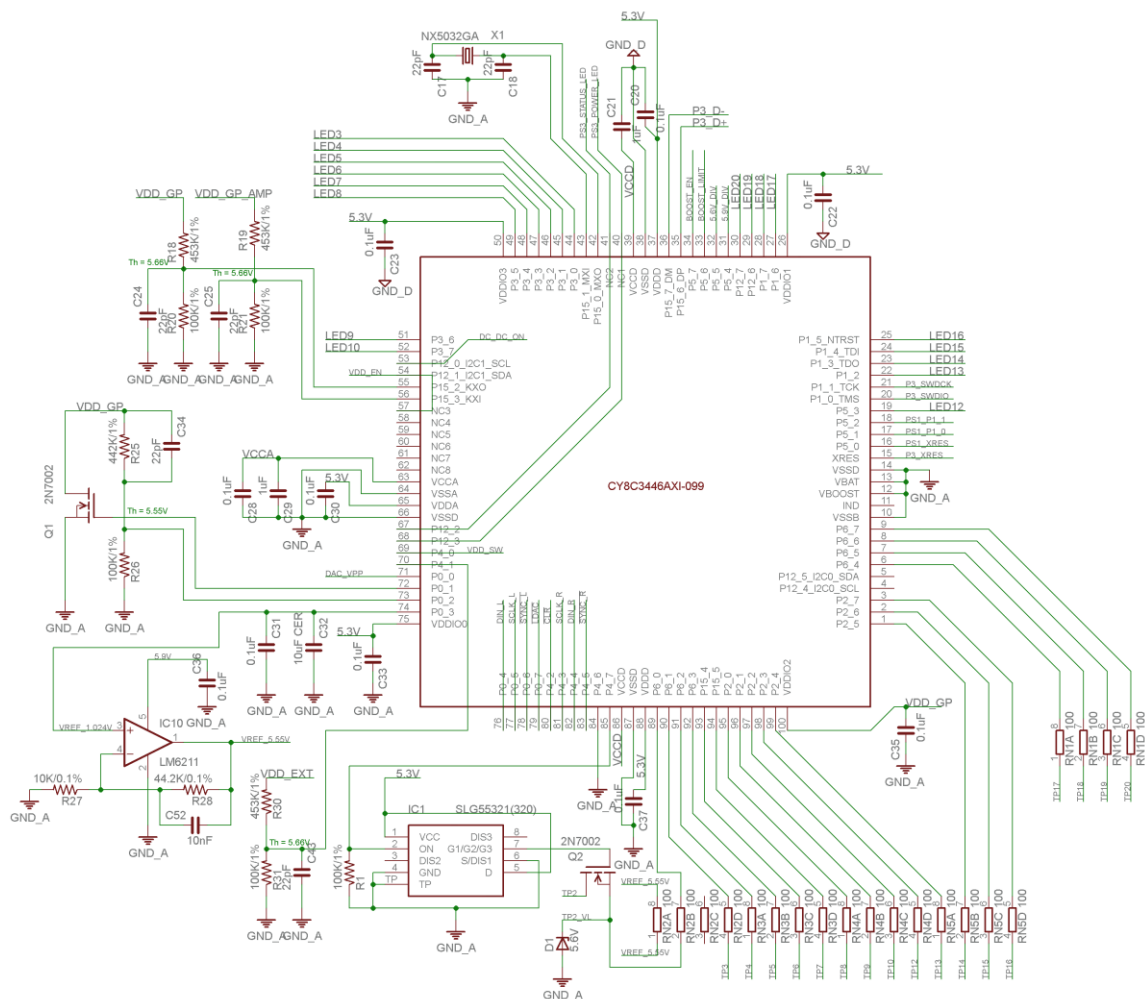


Figure 37: MCU

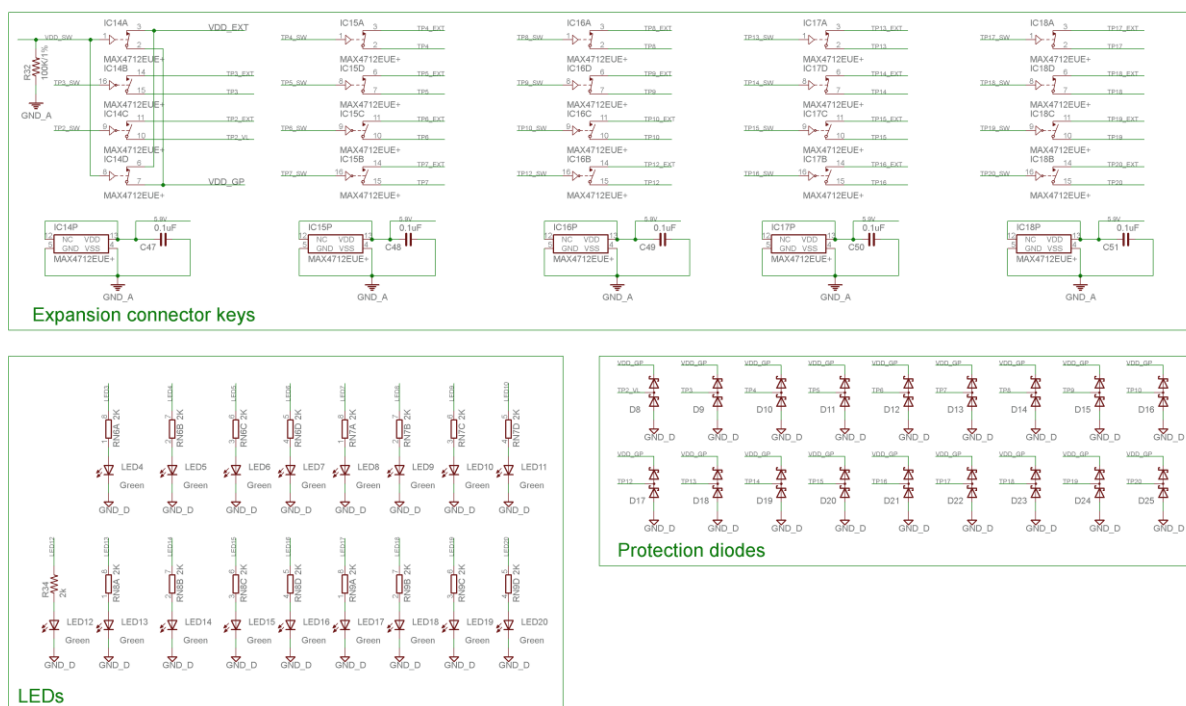


Figure 38: Analog Switches, Protection Diodes and LEDs

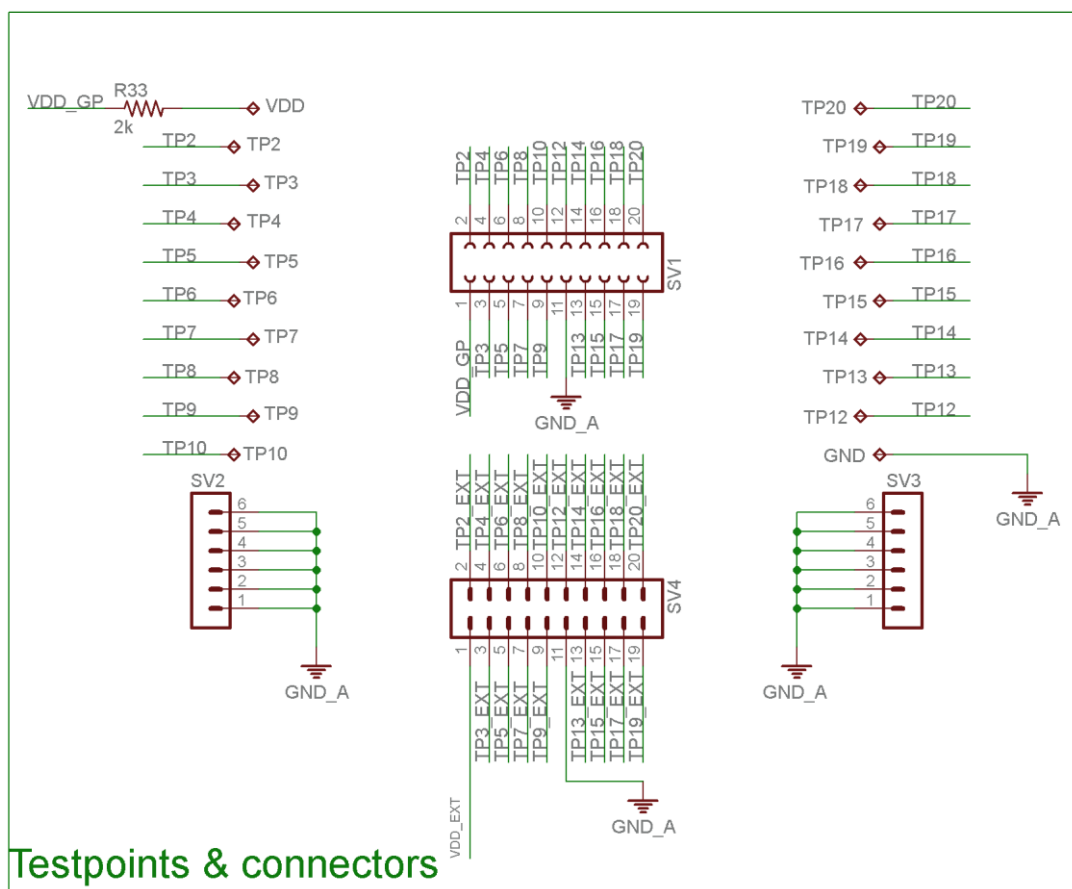


Figure 39: Socket and Expansion Connectors

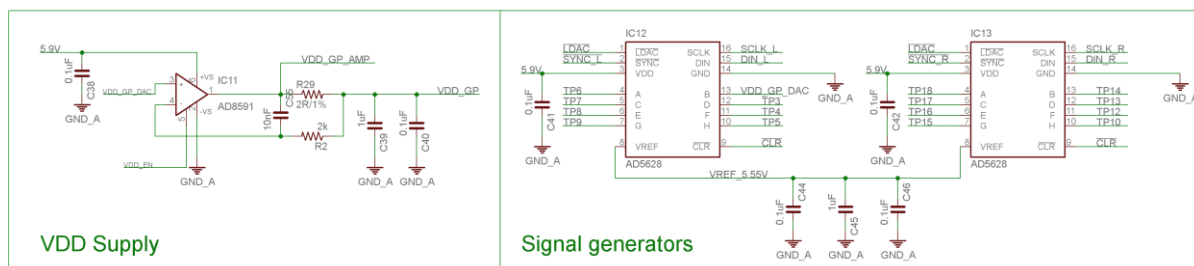


Figure 40: Signal Generator

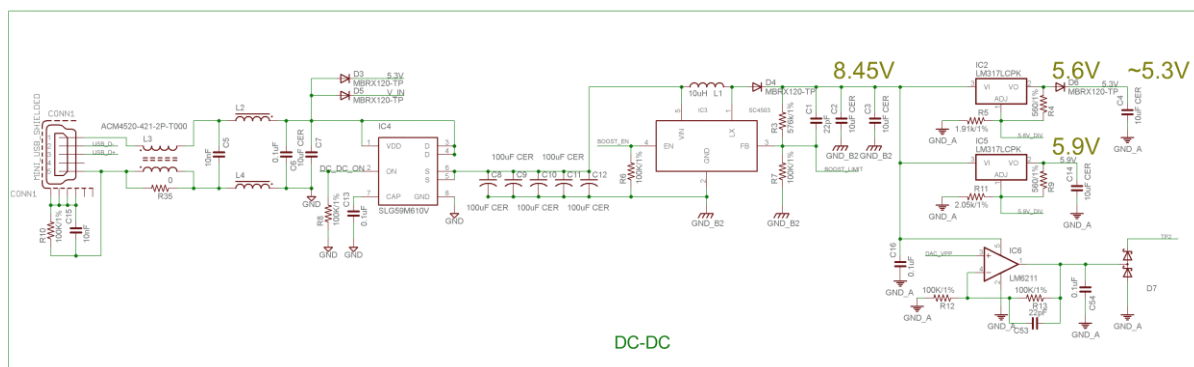


Figure 41: Boost Converter USB Interface

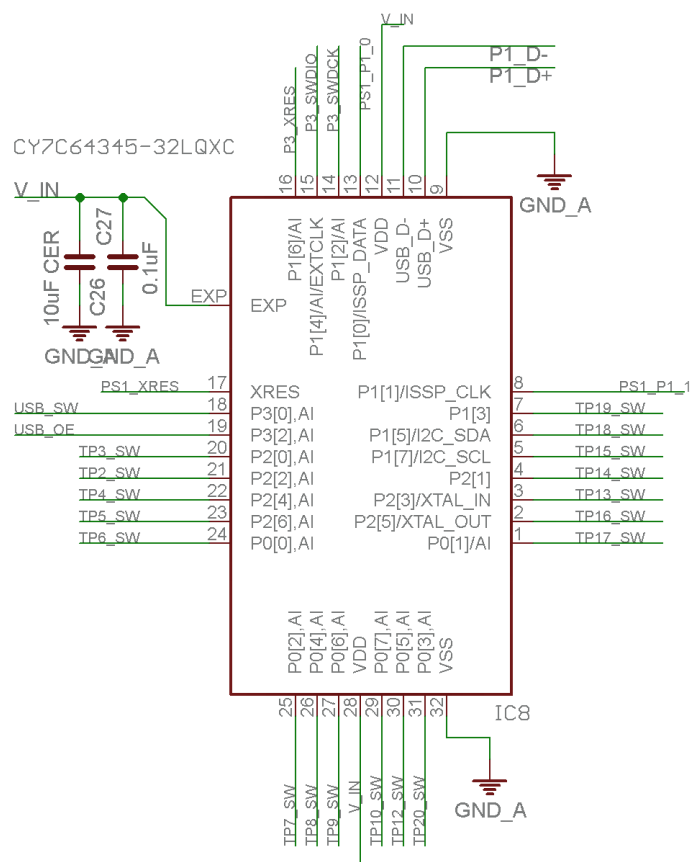


Figure 42: Port Extender

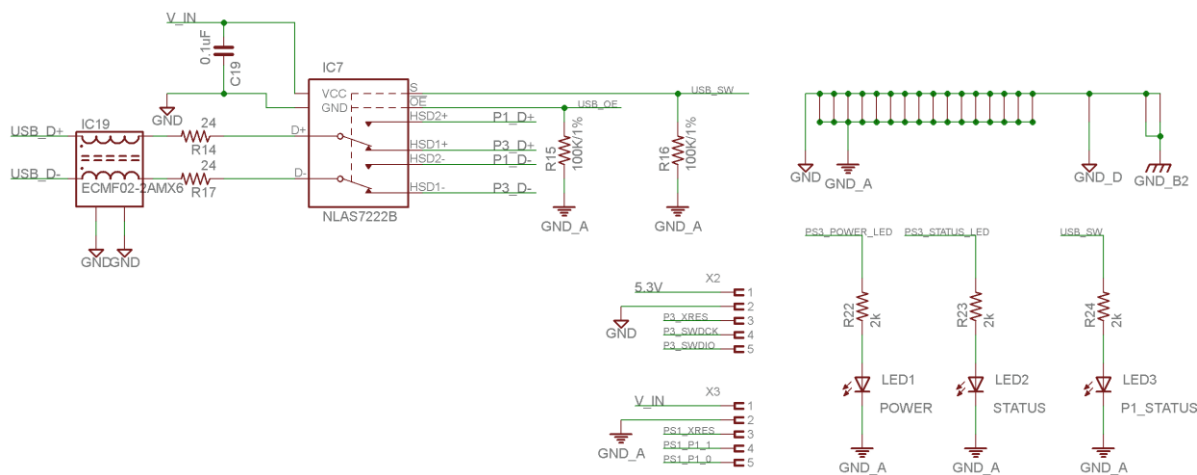


Figure 43: USB Protection

Appendix C BOM

| # | Items | Package | Quantity per Development Board | Symbol |
|----|-----------------------------|--------------------|--------------------------------|--|
| 1 | N/A | TQFN20 | 1 | |
| 2 | MCU | TQFN-100 | 1 | IC9 |
| 3 | CY7C64345-32LQXC | QFN-32 | 1 | IC8 |
| 4 | AD5628BRUZ-2 | 16TSSOP | 2 | IC12, IC13 |
| 5 | NLAS7222BMUTBG | 10-UFQFN | 1 | IC7 |
| 6 | MAX4712EUE+ | 16TSSOP | 5 | IC14-IC18 |
| 7 | BAS21SLT1G | SOT-23-3 | 19 | D7-D25 |
| 8 | GM1JS35200AE | 0603 (1608 Metric) | 1 | LED1 |
| 9 | LB Q39E-N1P1-35-1 | 0603 (1608 Metric) | 1 | LED2 |
| 10 | LW Q38G-Q1S1-3K6L-1 | 0603 (1608 Metric) | 1 | LED3 |
| 11 | LTST-C193KGKT-5A | 0603 (1608 Metric) | 17 | LED4-LED20 |
| 12 | NX5032-GA-25.0MHz-LN-CD-1 | 2-SMD | 1 | X1 |
| 13 | SC4503TSKTRT | TSOT23-5 | 1 | IC3 |
| 14 | USB-M26FTR | | 1 | CONN1 |
| 15 | 2N7002 | SOT-23-3 | 2 | Q1, Q2 |
| 16 | MBRX120-TP | SOD-123 | 4 | D3-D6 |
| 17 | SLG59M610V | TDFN-8 | 1 | IC4 |
| 18 | AD8591 | SOT-23-6 | 1 | IC11 |
| 19 | ECMF02 -2AMX6 | 6-UFQFN | 1 | IC19 |
| 20 | NRS4018T100MDGJ | 4.00x4.00x1.8mm | 1 | L1 |
| 21 | BLM18KG260TN1 | 0603 (1608 Metric) | 2 | L2, L4 |
| 22 | RESISTOR 10k OHM 1/10W 1% | 0603 (1608 Metric) | 1 | R27 |
| 23 | RESISTOR 44.2k OHM 1/10W 1% | 0603 (1608 Metric) | 1 | R28 |
| 24 | ACM4520-421-2P-T000 | 4.70x4.50mm | 1 | L3 |
| 25 | GRM31CF50J107ZE0 1L | 1206 (3216 Metric) | 5 | C8-C12 |
| 26 | LM317LCPK | SOT89-3 | 2 | IC2, IC5 |
| 27 | LM6211MF/NOPB | SOT23-5 | 2 | IC6, IC10 |
| 28 | GRM155F51C104ZA0 1D | 0402 (1005 Metric) | 28 | C6, C13, C16, C19, C20, C22, C23, C27, C28, C30, C31, C33, C35, C36, C37, C38, C40, C41, C42, C44, C46, C47, C48, C49, C50, C51, C54, Csoc |
| 29 | EMK316BJ106KL-T | 1206 (3216 Metric) | 7 | C2, C3, C4, C7, C14, C26, C32 |

GreenPAK Advanced Development Platform

| # | Items | Package | Quantity per Development Board | Symbol |
|----|-------------------------|--------------------|--------------------------------|--|
| 30 | C2012X7R1C105K/1.25 | 0805 (2012 Metric) | 4 | C21, C29, C39, C45 |
| 31 | CC0402KRX7R9BB103 | 0402 (1005 Metric) | 4 | C5, C15, C52, C55 |
| 32 | CC0402JRNPO9BN220 | 0402 (1005 Metric) | 8 | C1, C17, C18, C24, C25, C34, C43, C53 |
| 33 | RESISTOR 442k 1/16W 1% | 0402 (1005 Metric) | 1 | R25 |
| 34 | RESISTOR 100k 1/16W 1% | 0402 (1005 Metric) | 14 | R1, R6, R7, R8, R10, R12, R13, R15, R16, R20, R21, R26, R31, R32 |
| 35 | RESISTOR 453k 1/16W 1% | 0402 (1005 Metric) | 3 | R18, R19, R30 |
| 36 | RESISTOR 576k 1/16W 1% | 0402 (1005 Metric) | 1 | R3 |
| 37 | RESISTOR 560 1/16W 1% | 0402 (1005 Metric) | 2 | R4, R9 |
| 38 | RESISTOR 2.05 1/16W 1% | 0402 (1005 Metric) | 1 | R11 |
| 39 | RESISTOR 1.91k 1/16W 1% | 0402 (1005 Metric) | 1 | R5 |
| 40 | RESISTOR 2k 1/16W | 0402 (1005 Metric) | 6 | R2, R22, R23, R24, R33, R34 |
| 41 | RESISTOR 24 Ω | 0402 (1005 Metric) | 2 | R14, R17 |
| 42 | RESISTOR 2 Ω | 0805 (2012 Metric) | 1 | R29 |
| 43 | YC164-JR-072KL | 1206 (3216 Metric) | 4 | RN6, RN7, RN8, RN9 |
| 44 | YC164-JR-07100RL | 1206 (3216 Metric) | 5 | RN1, RN2, RN3, RN4, RN5 |
| 45 | 5000_ | | 1 | V _{DD} |
| 46 | 5001_ | | 1 | GND |
| 47 | 5002_ | | 18 | TP2-TP10, TP12-TP20 |
| 48 | SJ61A6 | | 5 | |
| 49 | TSW-110-08-L-D-RA | 0.100" (2.54mm) | 2 | SV4, SVsoc |
| 50 | SSQ-110-02-T-D-RA | 0.100" (2.54mm) | 1 | SV1 |
| 51 | 961106-6404-AR | 0.100" (2.54mm) | 2 | SV2, SV3 |
| 52 | 3021009-06 | | 1 | |
| 53 | RESISTOR 0 Ω | 1206 (3216 Metric) | 1 | R35 |
| 54 | SLG55321 | TDFN-8 | 1 | IC1 |
| 55 | BZV55C5V6-TP | SOD-80C | 1 | D1 |

Revision History

| Revision | Date | Description |
|----------|-------------|---|
| 2.4 | 21-Mar-2022 | Renesas rebranding |
| 2.3 | 14-Sep-2021 | Added section Generators |
| 2.2 | 21-Feb-2020 | Updated according to Dialog's Writing Guideline |

Status Definitions

| Status | Definition |
|-------------------------|--|
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