

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

Ab	stract		
Co	ntents	;	
Fig	ures		
Tal	oles		
1	Term	s and De	finitions4
2	Introd	duction	
	2.1	GreenPA	AK Designer
	2.2	Support.	5
3	Gettin	ng Starte	d6
	3.1	Introduct	tion6
	3.2	Install Ha	ardware
	3.3	Install So	oftware
	3.4	Uninstall	Software6
4	Hard	ware	
	4.1	Overview	Ν7
	4.2	Function	al Description7
		4.2.1	Power Supply7
		4.2.2	USB Communication 8
		4.2.3	GND Connections 8
		4.2.4	Pin Test Points
		4.2.5	LEDs
		4.2.6	Socket Connector 8
		4.2.7	Expansion Connector
		4.2.8	Generators
		4.2.9	Pins Connectivity 13
5	Exam	ple Proje	ects using SLG46721 15
	5.1	Project:	Counter with Clock Enable15
	5.2	Project:	LED String with Direction
6	Conc	lusion	
Ар	pendix	x A Elect	rical Specification
Ар	pendix	x B Scerr	natic Diagram
Ар	pendix	x C BOM	
Re	vision	History.	

Figures

Figure 1: GreenPAK Advanced Development Board, Top View	
Figure 2: USB Interface	8
Figure 3: GreenPAK Expansion Connector Schematic	
Figure 4: Expansion Connector Control in GreenPAK Designer	
Figure 5: Socket and Expansion Connector Schematic	
Figure 6: Internal Power Source	11
Figure 7: Internal Power Source for GreenPAK Chip and External Development Platform	
Figure 8: Expansion Connector. Pin with Protection Resistor	
Figure 9: Choosing Generators	
Figure 10: Managing Buttons	
Figure 11: Global Linkage Settings	
Figure 12: Pin Signal Sources/Loading Schematics	
Figure 13: GreenPAK Designer	
Figure 14: GreenPAK Components List	
Figure 15: Pin 20 Mode	
Figure 16: Look Up Table Properties Configured as AND Gate	
Figure 17: Look Up Table Properties Configured as NOR Gate	
Figure 18: Counter Properties	
Figure 19: GreenPAK Designer	
Figure 20: GreenPAK Designer, Emulation Tool	
Figure 21: Signal Generator Connected to V _{DD} Pin	
Figure 22: Signal Generator Settings	
Figure 23: Logic Generator Properties	
Figure 24: Waveform, Triggered on Button Pressed	
Figure 25: Waveform, no Triggered on Button Released	24
Figure 26: Waveform of the Pulse Width of the Logic Generator and Count End Signal	
Figure 27: Used Blocks for Current Project Figure 28: Sine Waveform Generated with Signal Generator	
Figure 29: Emulation Window, with Buffered LED and Signal Generator Figure 30: Pin Properties	
Figure 30. Fin Properties	
Figure 31: Fin Flopenies Figure 32: Look Up Tables Properties Configured as XOR Gate	20 20
Figure 32: ACMP Properties	20
Figure 33. ACMF Fropenties	
Figure 35: LED Output with Direction (Pin 2) Low	
Figure 36: LED Output with Direction (Pin 2) High	
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	36
Figure 42: Port Extender	
Figure 43: USB Protection	
	57

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
· · · · · · · · · · · · · · · · · · ·	



UM-GP-002

GreenPAK Advanced Development Platform

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 Programable
PWM	Pulse-Width Modulation
RAM	Random-Access Memory
TP	Test Point
USB	Universal Serial Bus
V _{DD}	Power Supply

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.



4 Hardware

4.1 Overview

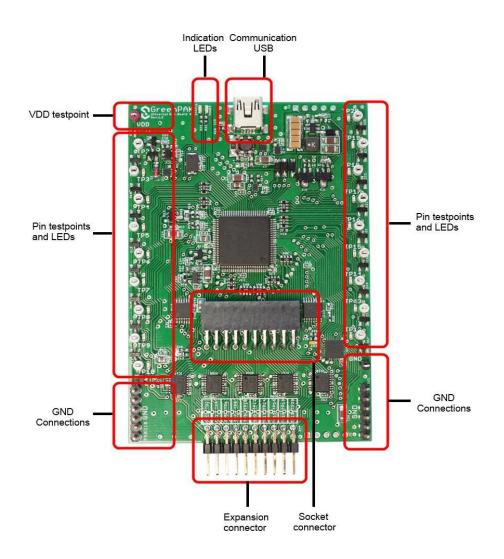


Figure 1: GreenPAK Advanced Development Board, Top View

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.

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.

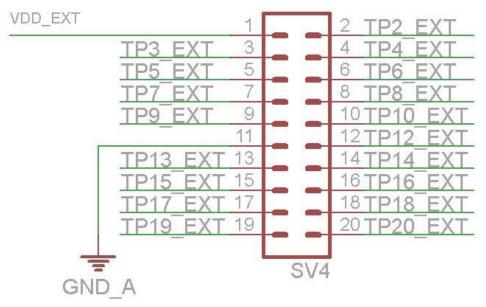


Figure 3: GreenPAK Expansion Connector Schematic

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.

2	4	6	8	10	12	14	16	18	20	Vb	22	24	26	28	30	32
Va	3	5	7	9	G	13	15	17	19		21	23	25	27	29	31
Int. VDD Ext. VDD ON OFF												TP	Мар			
LEDs ON LEDs OFF																

Figure 4: Expansion Connector Control in GreenPAK Designer

Figure 5 demonstrates the schematic diagram of the expansion connector control.



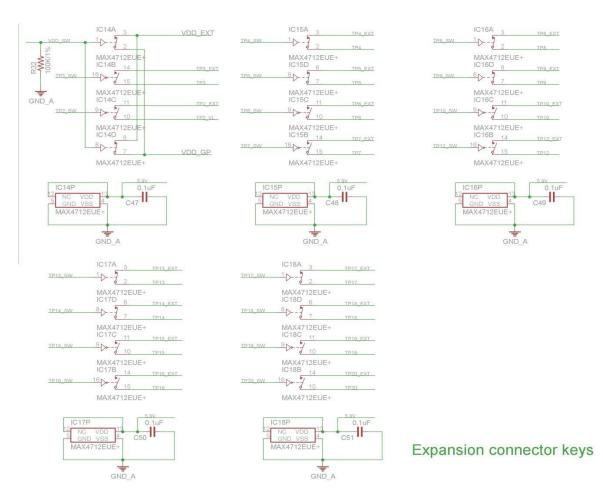


Figure 5: Socket and Expansion Connector Schematic

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.

User Manual	Revision 2.4	21-Mar-2022

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.

2	4	6	8	10	12	14	16	18	20	Vb	22	24	26	28	30	32
Va	3	5	7	9	G	13	15	17	19		21	23	25	27	29	31
Int. VDD Ext. VDD ON OFF											ТР	Мар				
LEDs ON LEDs OFF																

Figure 6: Internal Power Source

 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

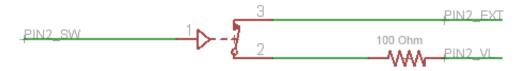
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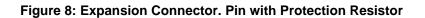
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The GND connection is connected directly to the Development Board, and cannot be controlled by GreenPAK Designer.

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.





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.

	<u>>.</u>								
ع	Led Enabled								
	Connect to Expansion connector								
	N/C								
	VDD								
	GND								
	Pull up								
	Pull down								
	Button								
	Logic generator								
	Signal generator								
	I2C generator								
	Copy settings to	2							
	Move settings to								
	Exchange settings with	•							

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.

User Manual	Revision 2.4	21-Mar-2022
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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.

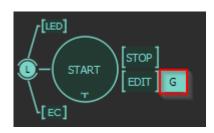


Figure 11: Global Linkage Settings

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.

Pin	1: Availa Set to VDD	Set to GND	Pull- up	Pull- down	Set Configurable Button	LED	Signal Generator	Logic Generator	l ² C Generator
#	1	2	3	4	5	6	7	8	
Vdd	-	-	-	-	-	-	+	-	-
TP2	+	+	+	+	+	-	-	+	+
TP3	+	+	+	+	+	+	-	+	+
TP4	+	+	+	+	+	+	-	+	+
TP5	+	+	+	+	+	+	-	+	+
TP6	+	+	+	+	+	+	+	+	+
TP7	+	+	+	+	+	+	+	+	+
TP8	+	+	+	+	+	+	+	+	+
TP9	+	+	+	+	+	+	-	+	+
TP10	+	+	+	+	+	+	+	+	+
TP12	+	+	+	+	+	+	+	+	+
TP13	+	+	+	+	+	+	+	+	+
TP14	+	+	+	+	+	+	+	+	+
TP15	+	+	+	+	+	+	-	+	+
TP16	+	+	+	+	+	+	-	+	+
TP17	+	+	+	+	+	+	-	+	+
TP18	+	+	+	+	+	+	-	+	+
TP19	+	+	+	+	+	+	-	+	+
TP20	+	+	+	+	+	+	-	+	+

Table 1: Available Connections for Each Test Point

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User Manual
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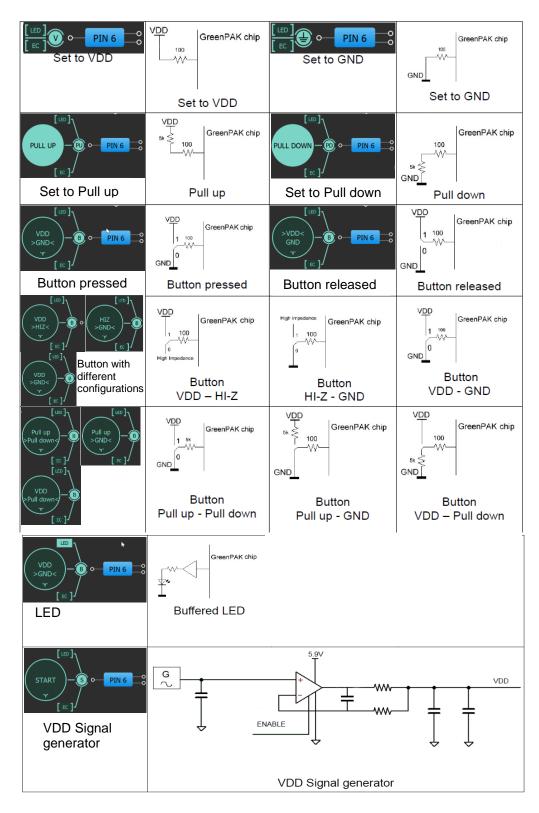


Figure 12: Pin Signal Sources/Loading Schematics

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.

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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

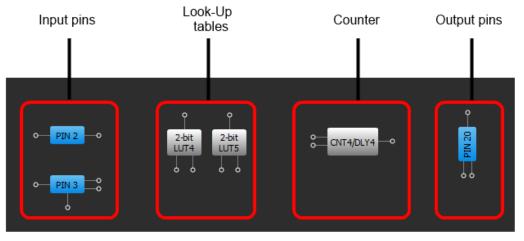


Figure 13: GreenPAK Designer



Componer	nts List
	Components
Ē I/O ₽	ADs
	VDD
···· •	PIN 2
	PIN 3
-	_ PIN 4 PIN 5
	PIN 6
	PIN 7
· · · · [PIN 8
	PIN 9
-	PIN 10
	GND PIN 12
	PIN 12
	PIN 14
···· [PIN 15
····	PIN 16
	PIN 17
-	_ PIN 18 PIN 19
–	PIN 19
	gates
E	INVO
I [INV1
	binatorial Logic
	3-bit LUTO
	3-bit LUT1
	3-bit LUT4
····	3-bit LUT5
-	3-bit LUT6
-	3-bit LUT7 3-bit LUT9
- L	og Comparators
T [A CMP0
· · · · [A CMP1
	A CMP2
	A CMP3
Coun	Iters / Delays 14-bit CNT0/DLY0
	8-bit CNT4/DLY4
	8-bit CNT5/DLY5
····· _	8-bit CNT6/DLY6
- Spec	ial components
-	FILTER 0 FILTER 1
	RC OSC
	P DLY
· · · · [VREF0
	VREF1
·····	POR
- Com	bination Function components 2-bit LUT0/DFF/LATCH 4
	2-bit LUT 1/DFF/LATCH 5
	2-bit LUT2/DFF/LATCH 6
	2-bit LUT3/DFF/LATCH 7
	3-bit LUT2/DFF/LATCH 2
	3-bit LUT3/DFF/LATCH 3
5	3-bit LUT8/Pipe Delay
	A BRUTO (ONTO DUVO
	4-bit LUT0/CNT2/DLY2 4-bit LUT1/CNT3/DLY3

Figure 14: GreenPAK Components List

User Manual	U	ser	Μ	lan	ua	
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Revision 2.4

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	Туре	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.

Propertie	es		×						
		PIN 20							
I/O se	election:	Digital Output							
Input OE = 0	mode:	None 🔷							
Outpu OE = 1	t mode:	1x push pull							
Resis	tor:	Pull Down 🔷							
Resist	tor value:	1M	\$						
	Information								
Electrica	l Specificatio	ons							
	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	5	Apply						

Figure 15: Pin 20 Mode

UM-GP-002

GreenPAK Advanced Development Platform

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.

operties 🛞						Pr	opertie	s				
2-bit LUT4								2-bit	LUT4			
IN3	IN2	IN1	IN0	OUT	·		IN3	IN2	IN1	IN0		OUT
0	0	0	0	0	\$		0	0	0	0	0	\$
0	0	0	1	0	\$		0	0	0	1	0	\$
0	0	1	0	0	\$		0	0	1	0	0	\$
0	0	1	1	0	\$		0	0	1	1	0	
0	1	0	0	0	\$		0	1	0	0	1	
0	1	0	1	0	\$		0	1	0	1	0	Ŧ
0	1	1	0	0	\$		0	1	1	0	0	- I ‡
0	1	1	1	0	\$		0	1	1	1	0	+
1	0	0	0	0	\$		1	0	0	0	0	14
1	0	0	1	0	\$		1	0	0	1	0	
1	0	1	0	0	\$		1	0	1	0	0	1
1	0	1	1	0	\$		1	0	1	1	0	1
1	1	0	0	0	\$		1	1	0	0	0	14
1	1	0	1	0	\$		1	1	0	1	0	+
1	1	1	0	0	\$		1	1	1	0	0	+
1	1	1	1	0	\$		1	1	1	1	0	
Stand	lard gat	tes —		All to 0			Stand	lard gat	es —			ll to 0
Defined by user							Defin	ied by u	Jser	\$	\geq	ll to 1
Detailed Detailed Detailed Detailed Apply												

Figure 16: Look Up Table Properties Configured as AND Gate



IN3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	IN2 0 0 0	IN1 0 0	IN0 1	1	UT
0 0 0 0	0 0 0	0	0	1	
0 0 0 0	0	0)	‡
0	0	-	1		
0	-	1		0	\$
	0	-	0	0	\$
0		1	1	0	†
	1	0	0	0	- 1 🗢
0	1	0	1	0	- 1 🗢
0	1	1	0	0	
0	1	1	1	0	
1	0	0	0	0	
1	0	0	1	0	- 1
1	0	1	0	0	\$
1	0	1	1	0	- 1
1	1	0	0	0	- 1
1	1	0	1	0	- 1
1	1	1	0	0	- 1
1	1	1	1	0	- 1
Standa	rd gat	es			to 0
NOR			•	<u> </u>	to 1

Figure 17: Look Up Table Properties Configured as NOR Gate

User Manual



Properties	×					
14-bit CNT1/DLY1						
Mode:	Counter					
Counter data:	4					
Output period:	N/D <u>Formula</u>					
Edge select:	Rising					
Connections						
Clock:	Ext. Clk. (From mati 🗢					
Clock source:	Ext. Clk. (matrix)					
Ir	nformation					
Input						
Detailed Info	Apply					

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.

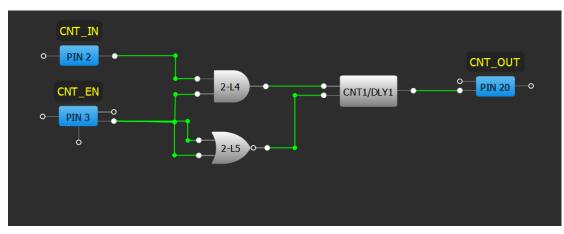


Figure 19: GreenPAK Designer

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

User Manual	Revision 2.4	21-Mar-2022

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.

Debugging controls																×
	Debugging Controls															
	GreenPA	K Advan	ced Dev	elopme	nt Platfo	orm						Change	platform	١		
STERN											In	nport co	nfigurati	on		
Device:	Onboar	ď						•				I2C Re	set			
									Read							
	Emulation 👻 Test Mod						le	Program								
													Proj	ect Data		
		Start /	All					Pause A	1	Stop All						
2	4	6	8	10	12	14	16	18	20	Vb	22	24	26	28	30	32
Va	3	5	7	9	G	13	15	17	19		21	23	25	27	29	31
	nt. VDD		Ex	t. VDD					FF				Т	P Map		
						LED	s ON		LEDs	OFF						

Figure 20: GreenPAK Designer, Emulation Tool

To test this project we will use the following tools:

- Signal generator. Signal generator is applied to VDD 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

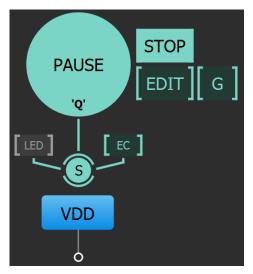


Figure 21: Signal Generator Connected to V_{DD} Pin

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

User Manual	Revision 2.4	21-Mar-2022

Options	
^	General
Generator:	PIN1 (VDD) - Constant Voltage Li *
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 🔹
Signa	I Generator Settings
Type: Const. volta	age 🔹
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.

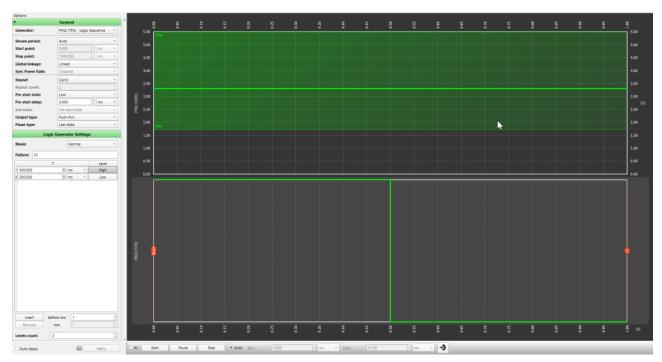


Figure 23: Logic Generator Properties

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

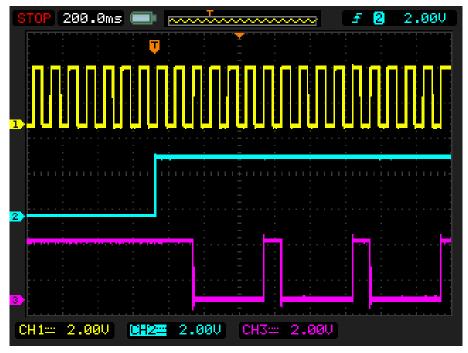


Figure 24: Waveform, Triggered on Button Pressed

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

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User Manual
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Revision 2.4



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

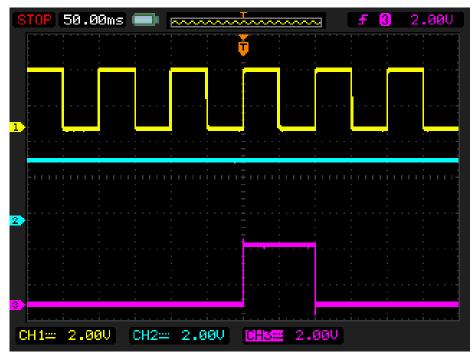


Figure 26: Waveform of the Pulse Width of the Logic Generator and Count End Signal

As shown in Figure 25 and Figure 26 Counter works only when the button is pressed.

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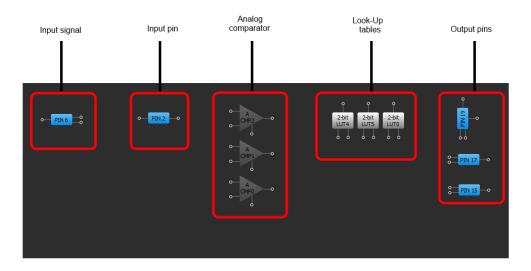
UM-GP-002

GreenPAK Advanced Development Platform

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





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



Figure 28: Sine Waveform Generated with Signal Generator

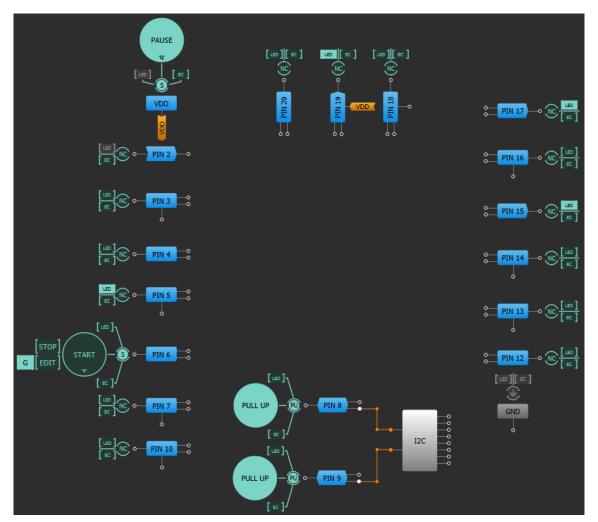


Figure 29: Emulation Window, with Buffered LED and Signal Generator

Pin #	Pin Name	Туре	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					

Table 3: Pin Configuration for LED String with Direction

Properties 🛞								
	PIN 2							
I/0 s	election:	Digital In	put 🔷					
Inpu OE =	t mode: 0	Digital in	without Sd 🗢					
Outp OE =	ut mode: 1	None	\$					
Resi	stor:	Pull Down	n (\$					
Resi	stor value:	1M	\$					
	In	formation						
Electric	al Specificat	ions						
	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					
	/	/	/					
	/	/	/					
	/	/	/					
	/	/	/					
0	Detailed Info Apply							

Figure 30: Pin Properties

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

User	Manual
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UM-GP-002

Prop	oerties		×	Propertie	es		×
		PIN 6				PIN 19	
1/	0 selection	n: Analo	g Input/Outpu 🗢	I/O se	election:	Digital Out	tput 🔷
	put mode: = 0	Analo	g input 🔰	Input OE = 0	mode:	None	\$
	i tput mod = 1	e: Analo	g output 🔷	Outpu OE = 1	it mode:	1x push p	ull 🔷
Re	esistor:	Pull D	own 🗘	Resis	tor:	Pull Down	\$
Re	Resistor value: 1M 🗣 Re		Resis	tor value:	1M	\$	
		Informati	on		Inf	ormation	
Elec	trical Specif	ications		Electrical Specifications			
	1.8 V min/max	3.3 V min/max	5.0 V min/max		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 Detailed Detailed Detailed Apply						

Figure 31: Pin Properties

perties				×	Properties				2	Properties				
	2	-bit LUT	4			2	-bit LUT	5			2-bit Ll	JT0/DFF/	LATCH4	ļ.
IN3	IN2	IN1	IN0	OUT	IN3	IN2	IN1	IN0	OUT	Type:		LUT		
0	0	0	0	0	0	0	0	0	0					
0	0	0	1	1	0	0	0	1	1	IN3	IN2	IN1	IN0	OU
0	0	1	0	1	0	0	1	0	1	0	0	0	0	0
0	0	1	1	0	0	0	1	1	0	0	0	0	1	1
0	1	0	0	0	0	1	0	0	0	0	0	1	0	1
0	1	0	1	0	0	1	0	1	0	0	0	1	1	0
0	1	1	0	0	0	1	1	0	0	0	1	0	1	0
0	1	1	1	0	0	1	1	1	0	0	1	1	0	0
1	0	0	0	0	1	0	0	0	0	0	1	1	1	0
1	0	0	1	0	1	0	0	1	0	1	0	0	0	0
1	0	1	0	0	1	0	1	0	0	1	0	0	1	0
1	0	1	1	0	1	0	1	1	0	1	0	1	0	0
1	1	0	0	0	1	1	0	0	0	1	0	1	1	0
1	1	0	1	0	1	1	0	1	0	1	1	0	0	0
1	1	1	0	0	1	1	1	0	0	1	1	0	1	0
1	1	1	1	0	1	1	1	1	0	1	1	1	0	0
andard	nates				Standard	laates				1	1	1	1	0
	gates			to 0		rgates			l to 0	Standard	gates		A	l to 0
XOR			A	to 1	XOR		•	A	l to 1	XOR		•	A	l to 1
Reg	ular shap	e	Ir	vert	Reg	gular shaj	pe	Ir	nvert	Reg	gular sha	pe	Ir	nvert

Figure 32: Look Up Tables Properties Configured as XOR Gate

UM-GP-002

GreenPAK Advanced Development Platform

Properties		Properties	×	Properties	×	
	А СМРО		A CMP1		A CMP2	
Hysteresis:	Disable	Hysteresis:	Disable 🗘	Hysteresis:	Disable 🗧	
Low bandwidth:	Enable	Low bandwid	dth: Enable 🗘	Low bandwidth:	Enable 🔷	
IN+ gain:	Disable	IN+ gain:	Disable 🔷	IN+ gain:	Disable 🔷	
Co	nnections		Connections	Connections		
IN+ source:	PIN6	IN+ source:	ACMP0 IN+ source	IN+ source:	ACMP0 IN+ source	
IN- source:	200 mV	IN- source:	500 mV 🗘	IN- source:	800 mV 🔷	
Set powe	er control settings	Set	Set power control settings		er control settings	
Detailed Info	Apply	Detailed Info	D Apply	Detailed Info	Apply	

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

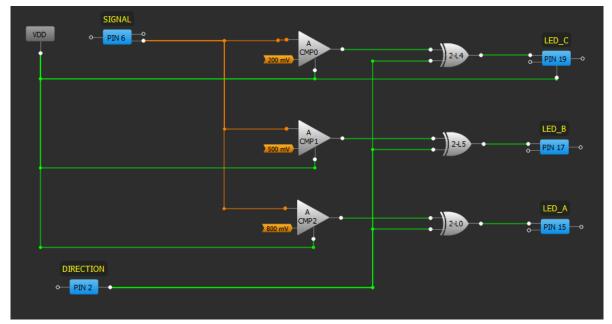


Figure 34: GreenPAK Designer

User Manual	Revision 2.4	21-Mar-2022

UM-GP-002

GreenPAK Advanced Development Platform

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 / 4rth line) – LED_C

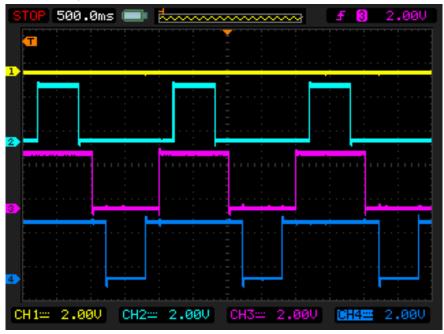
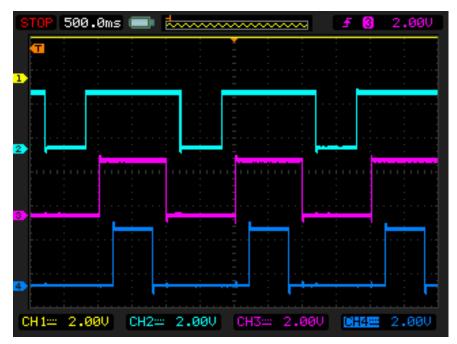


Figure 35: LED Output with Direction (Pin 2) Low





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/.

User Manual

Appendix A Electrical Specification

Mode	Parameter	Min	Тур	Max	Units
	Test Point Capacitance	19.5			pF
	Input Leakage Current			14	nA
General	Max Current through Protection Diode to V_{DD}			200	mA
	Ripple & Noise	20		40	mVp-p
	Voltage Range	1.5		5.5	V
V _{DD} Power Supply Generator (V _{DD})	V _{DD} Max Current			70	mA
	Voltage Output Total Error		±30		mV
	Number of Channels (TP2 to TP10, TP12 to TP20)			18	
	Output Voltage High		Vdd		V
	Output Voltage Low	0.4		0.8	V
	Max Current per TP			30	mA
Logic generator	Max Total Current per TPs			250	mA
Logic generator	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
	Number of Channels (TP3 to TP10, TP12 to TP18)			15	
	Output Voltage Range	0		5.5	V
	DC Output Impedance		0.5		Ω
Signal Generator	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
	Output Level High		V _{DD}		
Virtual Button, VDD/GND,	Output Level Low		GND		
Pull-Up/Down Driver	Strong Drive (V _{DD} /GND) Resistance		100		Ω
	Pull-Up/Down Resistance	3.5	5.6	8.5	kΩ
	Max Voltage			5.5	V
	Continuous Current through Any Terminal			±30	mA
Expansion Connector Switch	Switch On-Resistance		20	40	Ω
	External V _{DD} Switch On-Resistance		10	20	Ω
	On Leakage Current	-20		20	nA

User Manual

Revision 2.4



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

Appendix B Scematic Diagram

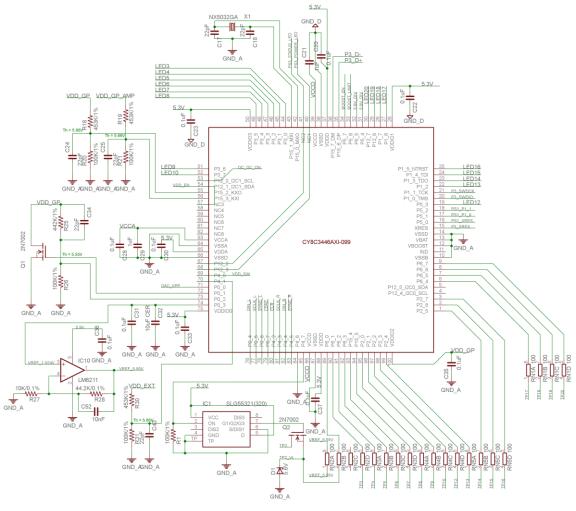


Figure 37: MCU

UM-GP-002



GreenPAK Advanced Development Platform

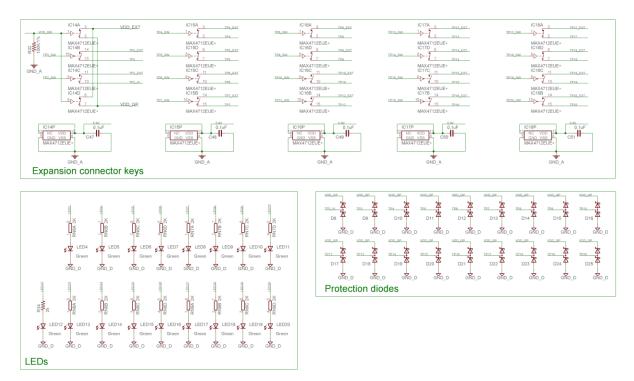


Figure 38: Analog Switches, Protection Diodes and LEDs

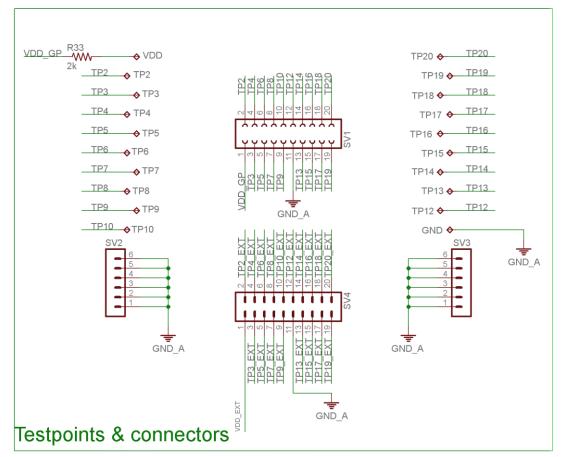


Figure 39: Socket and Expansion Connectors

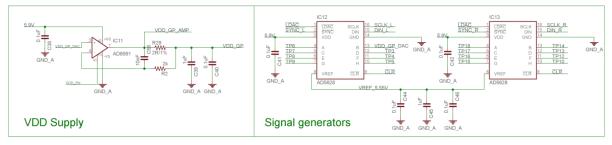


Figure 40: Signal Generator

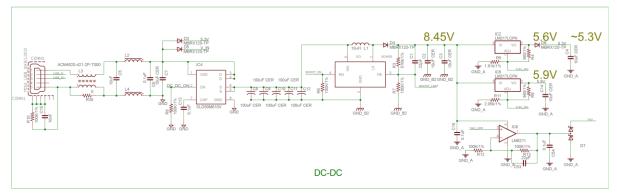


Figure 41: Boost Converter USB Interface

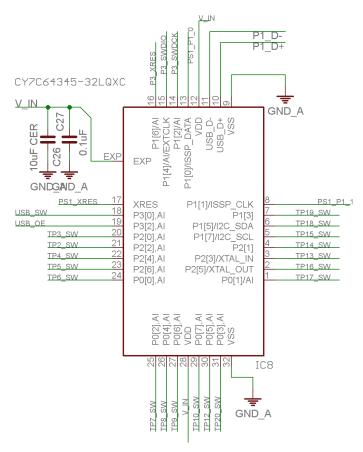


Figure 42: Port Extender

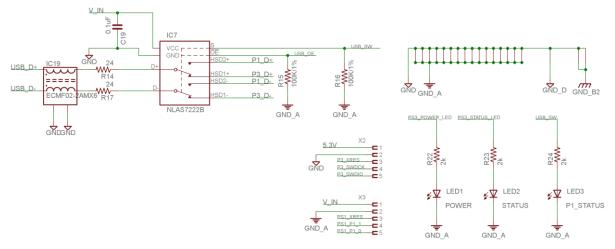


Figure 43: USB Protection

User Manual

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

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User Manual
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#	Items	Package	Quantity per Development Board	Symbol
30	C2012X7R1C105K/1.2 5	0805 (2012 Metric)	4	C21, C29, C39, C45
31	CC0402KRX7R9BB10 3	0402 (1005 Metric)	4	C5, C15, C52, C55
32	CC0402JRNPO9BN22 0	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

User Manual



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