CY3268

PowerPSoC® Lighting Starter Kit Guide

Document No. 001-67149 Rev. *D



WARNING: HIGH BRIGHTNESS LEDs CAN CAUSE PERMANENT DAMAGE!

Do not look at the HBLEDs directly. The HBLEDs illuminate at a very high intensity and can cause permanent eye damage. Use a thick white sheet of paper as diffuser if there is no optical diffuser available.

WARNING: Generally all lab work in power electronics must be done with extreme care. Caution must be exercised when using power supplies and/or power related equipment.

Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709

Phone (USA): 800.858.1810
Phone (Intnl): 408.943.2600
http://www.cypress.com

[+] Feedback

Copyrights

© Cypress Semiconductor Corporation, 2011. The information contained herein is subject to change without notice. Cypress Semiconductor Corporation assumes no responsibility for the use of any circuitry other than circuitry embodied in a Cypress product. Nor does it convey or imply any license under patent or other rights. Cypress products are not warranted nor intended to be used for medical, life support, life saving, critical control or safety applications, unless pursuant to an express written agreement with Cypress. Furthermore, Cypress does not authorize its products for use as critical components in life-support systems where a malfunction or failure may reasonably be expected to result in significant injury to the user. The inclusion of Cypress products in life-support systems application implies that the manufacturer assumes all risk of such use and in doing so indemnifies Cypress against all charges.

Any Source Code (software and/or firmware) is owned by Cypress Semiconductor Corporation (Cypress) and is protected by and subject to worldwide patent protection (United States and foreign), United States copyright laws and international treaty provisions. Cypress hereby grants to licensee a personal, non-exclusive, non-transferable license to copy, use, modify, create derivative works of, and compile the Cypress Source Code and derivative works for the sole purpose of creating custom software and or firmware in support of licensee product to be used only in conjunction with a Cypress integrated circuit as specified in the applicable agreement. Any reproduction, modification, translation, compilation, or representation of this Source Code except as specified above is prohibited without the express written permission of Cypress.

Disclaimer: CYPRESS MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARD TO THIS MATERIAL, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Cypress reserves the right to make changes without further notice to the materials described herein. Cypress does not assume any liability arising out of the application or use of any product or circuit described herein. Cypress does not authorize its products for use as critical components in life-support systems where a malfunction or failure may reasonably be expected to result in significant injury to the user. The inclusion of Cypress' product in a life-support systems application implies that the manufacturer assumes all risk of such use and in doing so indemnifies Cypress against all charges.

Use may be limited by and subject to the applicable Cypress software license agreement.

PSoC Designer™ and Programmable System-on-Chip™ are trademarks and PSoC® is a registered trademark of Cypress Semiconductor Corp. All other trademarks or registered trademarks referenced herein are property of the respective corporations.

Flash Code Protection

Cypress products meet the specifications contained in their particular Cypress PSoC Data Sheets. Cypress believes that its family of PSoC products is one of the most secure families of its kind on the market today, regardless of how they are used. There may be methods, unknown to Cypress, that can breach the code protection features. Any of these methods, to our knowledge, would be dishonest and possibly illegal. Neither Cypress nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as 'unbreakable'.

Cypress is willing to work with the customer who is concerned about the integrity of their code. Code protection is constantly evolving. We at Cypress are committed to continuously improving the code protection features of our products.

Contents

1. Introduction **5**

1.1 Kit Contents 5
1.2 Additional Learning Resources 6
1.2.1 References 6
1.3 Document History 7
1.4 Documentation Conventions 7

2. Getting Started **9**

2.1 Introduction 9
2.2 Kit Installation 9
2.3 PSoC Designer 13
2.4 PSoC Programmer 14
2.5 Install Hardware 14

3. Kit Operation **15**

3.1 Introduction 15
3.2 Programming PowerPSoC Device 15
3.3 CY3268 PowerPSoC Lighting Starter Kit Operation 17

4. Hardware **19**

4.1 System Block Diagram 19
4.2 Functional Description 20
4.2.1 Power Supply 21
4.2.2 PowerPSoC 21
4.2.3 Programming Interface 25
4.2.4 CapSense Sensors 25
4.2.5 HBLEDs 26
4.2.6 RESET Button 27
4.2.7 Debug Port 27
4.2.8 Temperature Sensor 28

5. Code Examples **29**

5.1 Code Example 1: CY3268_Example1 29
5.1.1 Project Description 29
5.1.2 Hardware Connections 29
5.1.3 Program Flow Diagram 31
5.1.4 Verify Output 33
5.2 Code Example 2: CY3268_Heartbeat 33
5.2.1 Project Description 33
5.2.2 Hardware Connections 33
5.2.3 Program Flow Diagram 36
5.2.4 Verify Output 38

A. Appendix **39**

A.1 Schematic 39
A.2 Board Layout 40
A.3 Bill of Materials 42
A.4 Safety Precautions 44

1. Introduction

Thank you for your interest in the CY3268 PowerPSoC® Lighting Starter Kit. You can use this kit with the help of guides and code examples that are provided. The project ‘CY3268_Example1’ is programmed on the CY3268 PowerPSoC Lighting Starter Kit as the default project for demonstration purposes. For more information on this project, see Chapter 5.

The CY3268 PowerPSoC Lighting Starter Kit demonstrates the ability of PowerPSoC to create scalable HBLED management solutions and enables designers to evaluate PowerPSoC. The PowerPSoC family of devices features high-performance power electronics including 1 A, 2 MHz rated power FETs, hysteretic controllers, current sense amplifiers, and PrISM™ technology to create a complete solution for HBLED power management.

This kit also enables designers to test and evaluate preliminary prototype designs using PowerPSoC and understand the design flow using PSoC Designer™ software for the PowerPSoC device family.

Chapter 2 describes how to install and configure software. Chapter 3 explains how to program a PowerPSoC device with PSoC Programmer and use the kit with the help of a code example. Chapter 4 details the hardware operation. Chapter 5 gives a description of the code examples. The Appendix section provides the schematics and bill of materials (BOM).

1.1 Kit Contents

The CY3268 PowerPSoC Lighting Starter Kit contains:

- CY3268 PowerPSoC board
- 12 V, 1 A power supply
- Two jumper shunts
- Five PowerPSoC CY8CLED04D01-56LTXI samples
- Kit CD, which includes:
  - PSoC Designer
  - PSoC Programmer
  - Demo firmware
  - Design files
  - Related documents

Inspect the contents of the kit; if any parts are missing, contact your nearest Cypress sales office for help.

This kit does not contain the MiniProg, a device that is required to program PowerPSoC. You can purchase the MiniProg online from the Cypress web store: http://www.cypress.com/go/CY3217-Miniprog1.

[+] Feedback

1.2 Additional Learning Resources

Visit www.cypress.com/go/powerpsoc for additional learning resources in the form of data sheets, technical reference manuals, and application notes.

1.2.1 References

- CY3268_PowerPSoC Lighting Starter Kit_Board Schematic.pdf
  http://www.cypress.com/?rID=36572
- CY3268_PowerPSoC Lighting Starter Kit_Board Layout.zip
  http://www.cypress.com/?rID=36572
- CY3268 Kit documentation
  http://www.cypress.com/go/CY3268
- For a list of PSoC Designer-related trainings, see
  http://www.cypress.com/?rID=40543
- PowerPSoC Intelligent LED Driver data sheet
  http://www.cypress.com/?rID=41013
- For more information regarding PSoC Designer functionality and releases, refer to the user guide and release notes on the PSoC Designer web page:
  www.cypress.com/go/psocdesigner
- For more information regarding PSoC Programmer, supported hardware, and COM layer, go to the PSoC Programmer web page:
  www.cypress.com/go/psocprogrammer
- PrISM™ Technology for LED Dimming – AN47372
  http://www.cypress.com/?rID=2922
- Multi Channel Color Mixing Using HB LEDs – AN51188
  http://www.cypress.com/?rID=34809
- PowerPSoC Firmware Design Guidelines – AN51012
  http://www.cypress.com/?rID=35365
- Switching Regulators Component Design Guide – AN50099
  http://www.cypress.com/?rID=34331
- Modulation Techniques for LED Dimming – AN49262
  http://www.cypress.com/?rID=34683

1.3 Document History

Revision	PDF Creation Date	Origin of Change	Description of Change
**	02/02/2011	SNVN	Initial version of kit guide
*A	02/11/2011	SNVN	Updated document properties
*B	04/25/2011	SNVN	Content updates throughout the document to implement review comments
*C	05/25/2011	SNVN	Section 2.2: CD long name corrected to short name. 'CY3268 PowerPSoC'. Removed redundant step 3 in installation. Section 4.2.3.1. ISSP/I2C changed to ISSP. Section 5.2.4 : 'Example code' changed to 'code example'
*D	06/02/2011	SNVN	Corrected formatting in table of contents

1.4 Documentation Conventions

Table 1-1. Document Conventions for Guides

Convention	Usage
`Courier New`	Displays file locations, user entered text, and source code: `C:\...cd\icc\`
Italics	Displays file names and reference documentation: Read about the *sourcefile.hex* file in the *PSoC Designer User Guide*.
[**Bracketed, Bold**]	Displays keyboard commands in procedures: [**Enter**] or [**Ctrl**] [**C**]
File > Open	Represents menu paths: File > Open > New Project
Bold	Displays commands, menu paths, and icon names in procedures: Click the **File** icon and then click **Open**.
Times New Roman	Displays an equation: 2 + 2 = 4
Text in gray boxes	Describes cautions or unique functionality of the product.

[+] Feedback

2. Getting Started

2.1 Introduction

This chapter describes how to install and configure the CY3268 PowerPSoC Lighting Starter kit.

2.2 Kit Installation

To install the kit software, follow these steps:

1. Insert the kit CD into the CD drive of your PC. The CD is designed to auto-run and the kit installer startup screen appears; you can also download the latest kit installer ISO file from http://www.cypress.com/go/CY3268 and create the installer CD; the other option is to extract the ISO using WinRar and install the executables.
2. Click **Install the CY3268 PowerPSoC** to start the installation, as shown in Figure 2-1.

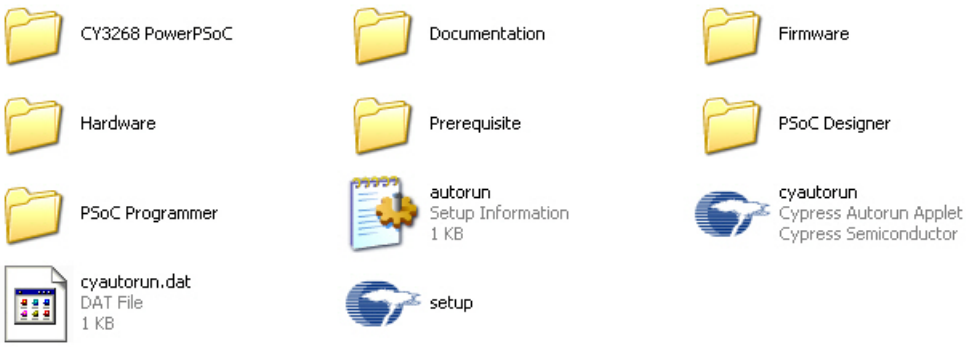
Figure 2-1. Kit Installer Startup Screen



Note If auto-run does not execute, double-click the *cyautorun.exe* file on the root directory of the CD, as shown in Figure 2-2.

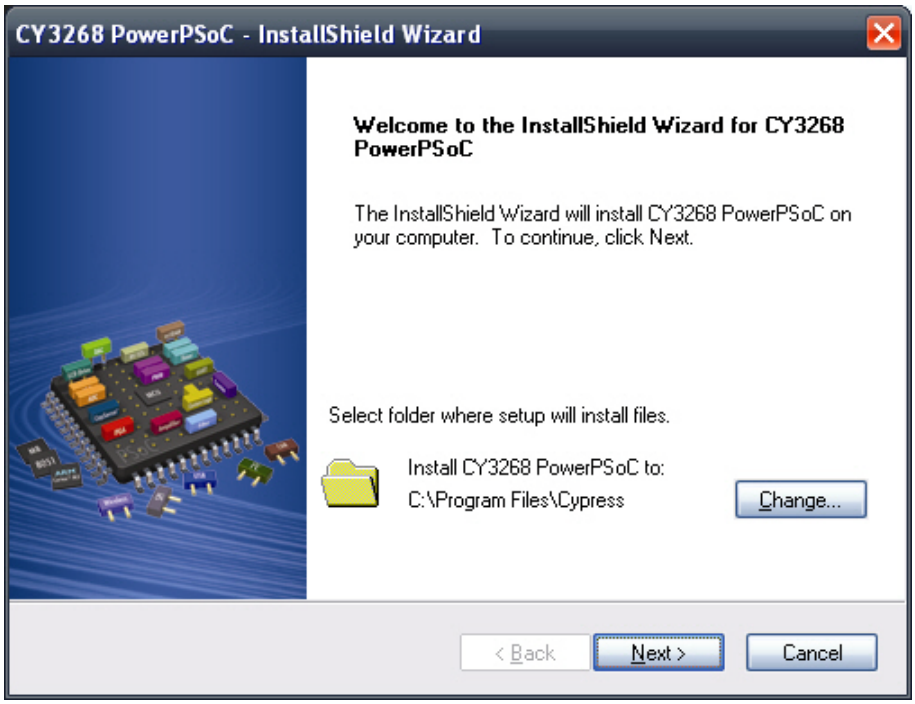
[+] Feedback

Figure 2-2. Root Directory of the CD



3. The **CY3268 PowerPSoC - InstallShield Wizard** screen appears. Choose the folder location to install the setup files. You can change the location of the folder for the setup files using **Change**, as shown in Figure 2-3.
4. Click **Next** to launch the kit installer.

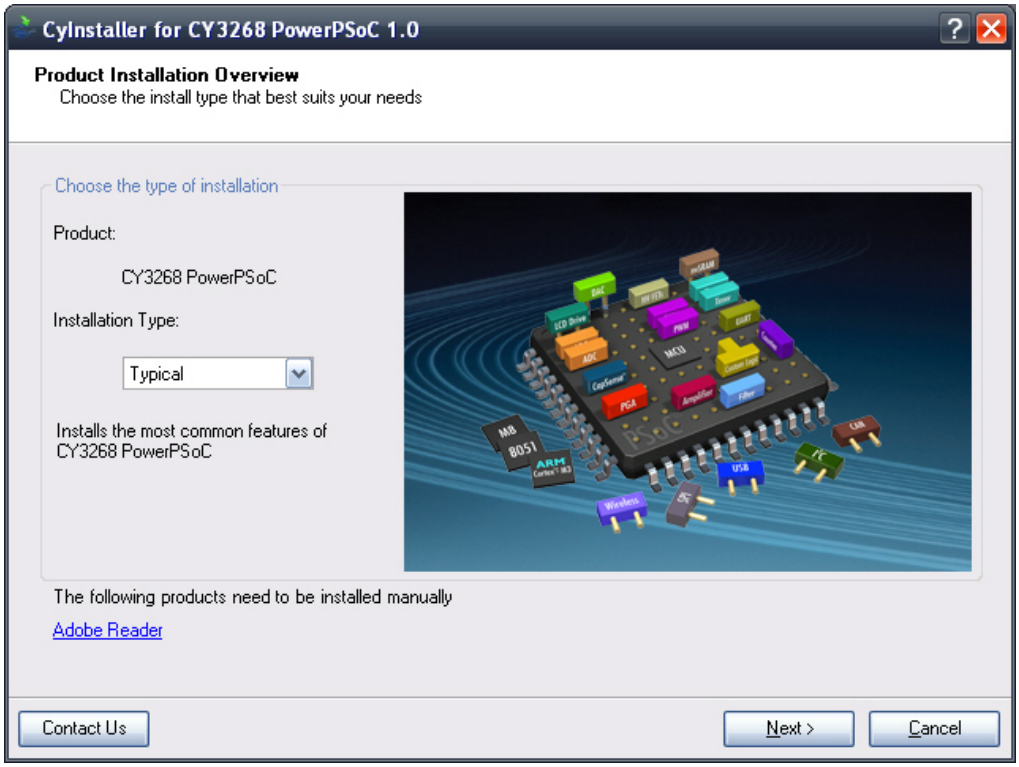
Figure 2-3. CY3268 PowerPSoC - InstallShield Wizard



[+] Feedback

5. On the **Product Installation Overview** screen, select the installation type that best suits your requirement. The drop-down menu has the options **Typical, Complete,** and **Custom**, as shown in Figure 2-4.
6. Click **Next** to start the installation.

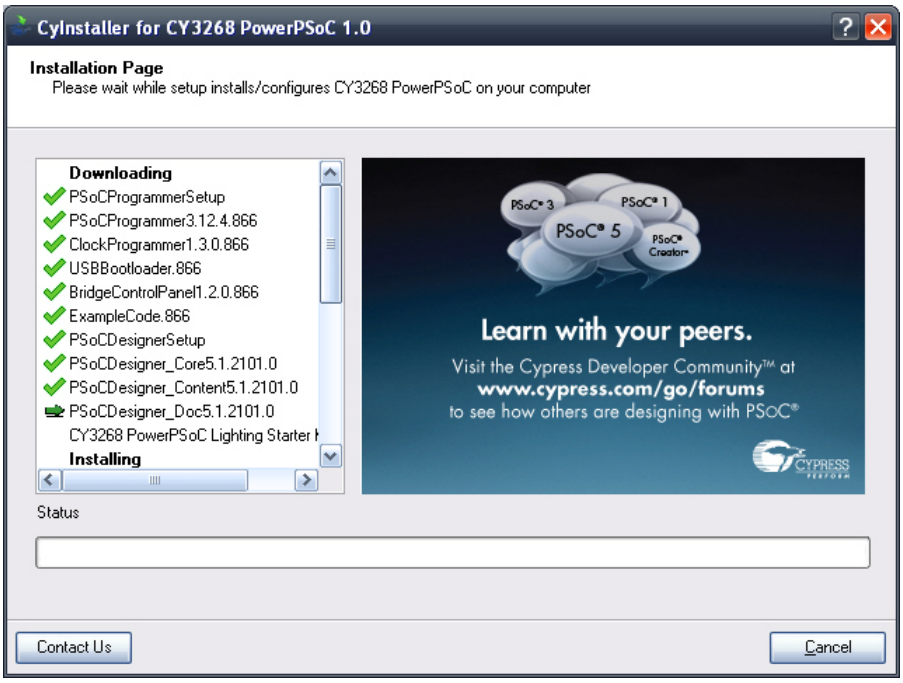
Figure 2-4. Installation Type Options



7. When the installation begins, a list of all packages appears on the **Installation Page**.
8. A green check mark appears adjacent to every package that is downloaded and installed, as shown in Figure 2-5.
9. Wait until all the packages are downloaded and installed successfully.

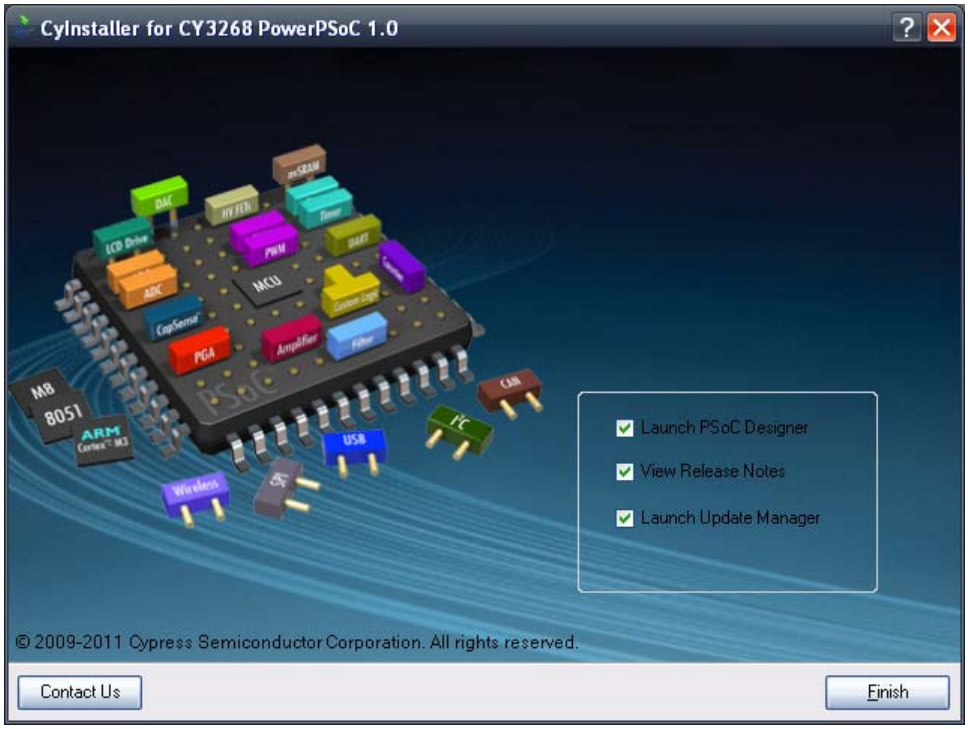
[+] Feedback

Figure 2-5. Installation Page



10. Click **Finish** to complete the installation, as shown in Figure 2-6.

Figure 2-6. Installation Completion Page



[+] Feedback

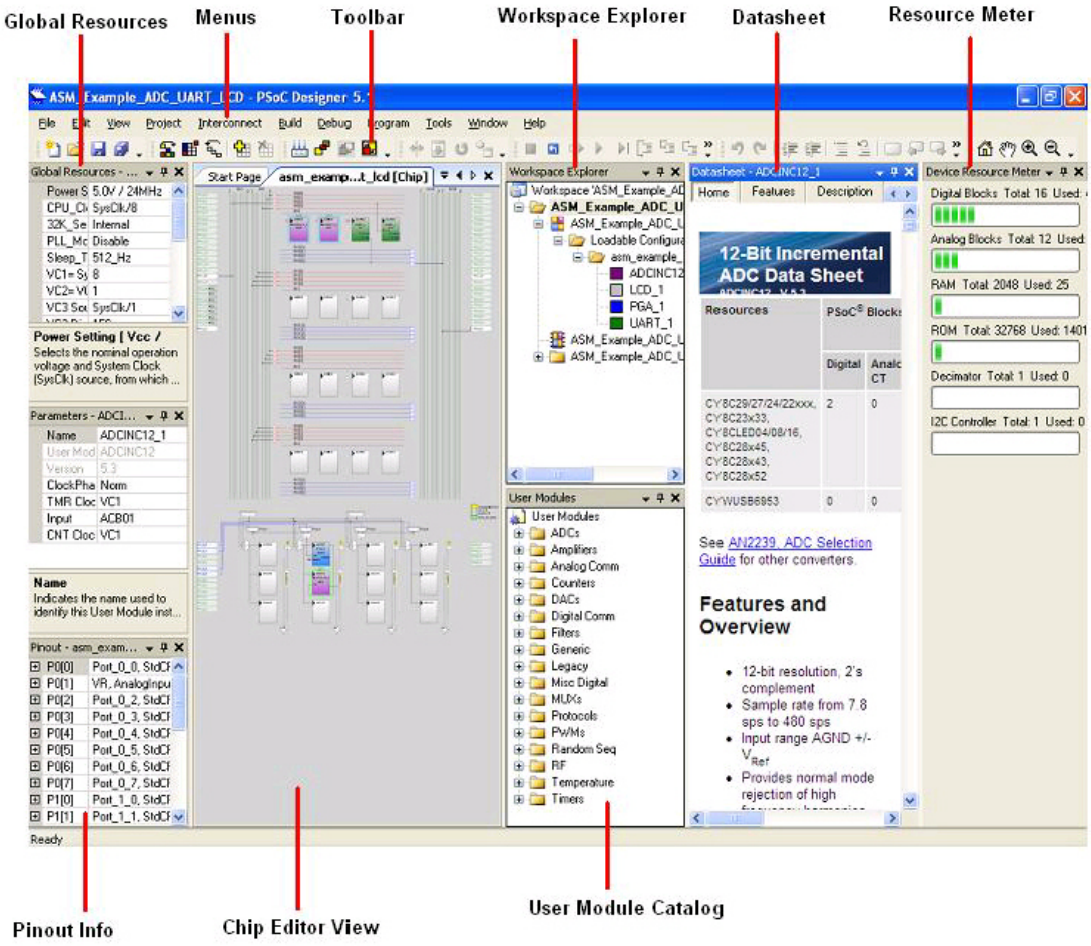
After installing the software, verify that you have all hardware and drivers set up for the MiniProg by connecting the MiniProg to your PC through its USB interface. Because this is the first time you have connected the board to this PC, initial drivers are installed. Follow the on-screen dialogs for USB detection to complete the installation process.

Verify your installation and setup by opening PSoC Programmer with the MiniProg attached over USB.

2.3 PSoC Designer

1. Click **Start** > **All Programs** > **Cypress** > **PSoC Designer <version>** > **PSoC Designer <version>** (Figure 2-7)
2. Click **File** > **New Project** to create a new project or go to **File** > **Open Project/Workspace** to work with an existing project

Figure 2-7. PSoC Designer Interconnect View



3. To experiment with the code examples, go to Code Examples chapter on page 29

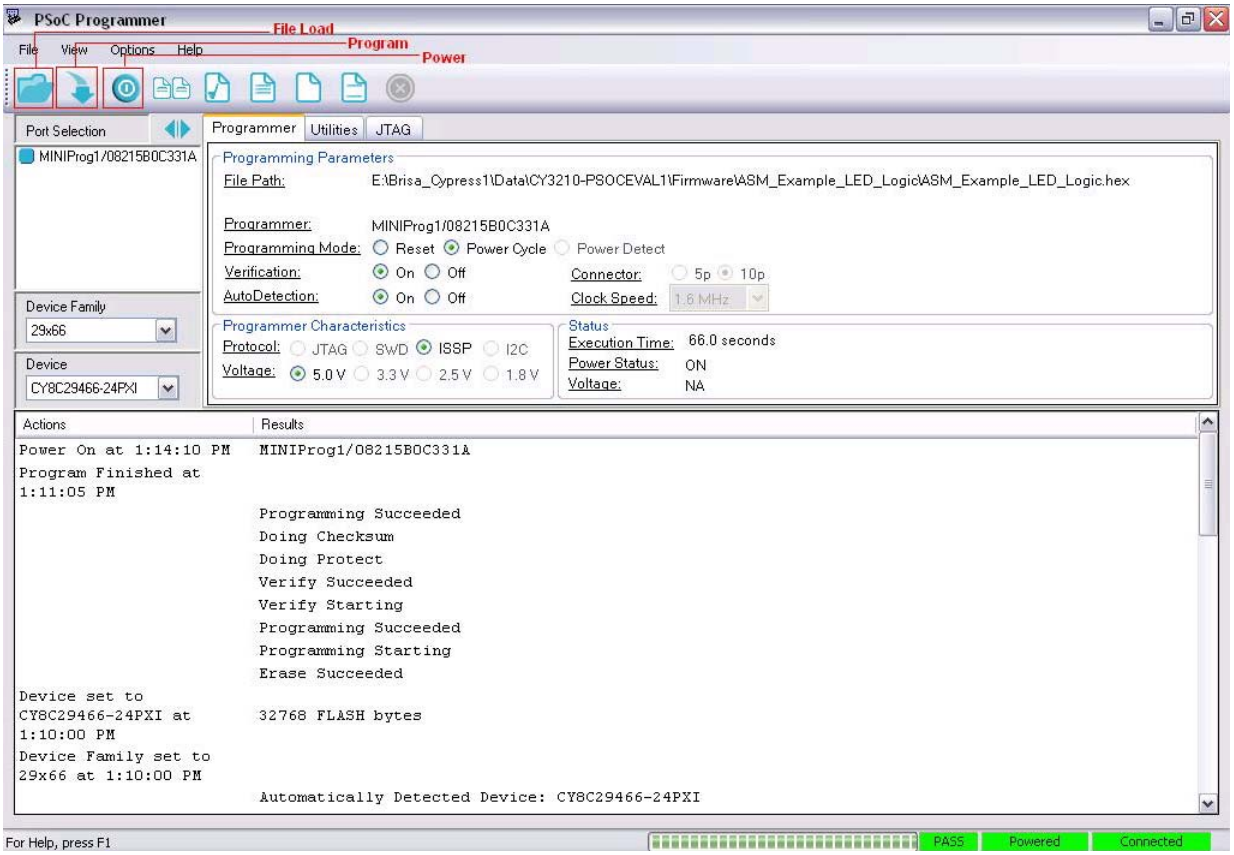
Note For more details on PSoC Designer, go to **Help Topics** from the following directory: `<Install_Dir>\Cypress\PSoC Designer\<version>\PSoC Designer 5\Help`

[+] Feedback

2.4 PSoC Programmer

1. Click **Start** > **All Programs** > **Cypress** > **PSoC Programmer <version>** > **PSoC Programmer <version>** (Figure 2-8)
2. Connect to the MiniProg listed from the **Port Selection** tab of PSoC Programmer, as shown in Figure 2-8

Figure 2-8. PSoC Programmer Window



3. Click on the **File Load** button to load the hex file
4. Use the **Program** button to program the hex file on to the chip
5. When the file is successfully programmed, **Programming Succeeded** appears on the Action pane
6. Close PSoC Programmer

Note For more details on PSoC Programmer, go to **Help Topics** from the following path: `<Install_Dir>\Cypress\Programmer\<version>\PSoc_Programmer.chm`.

2.5 Install Hardware

No hardware installation is required for this kit.

[+] Feedback

3. Kit Operation

3.1 Introduction

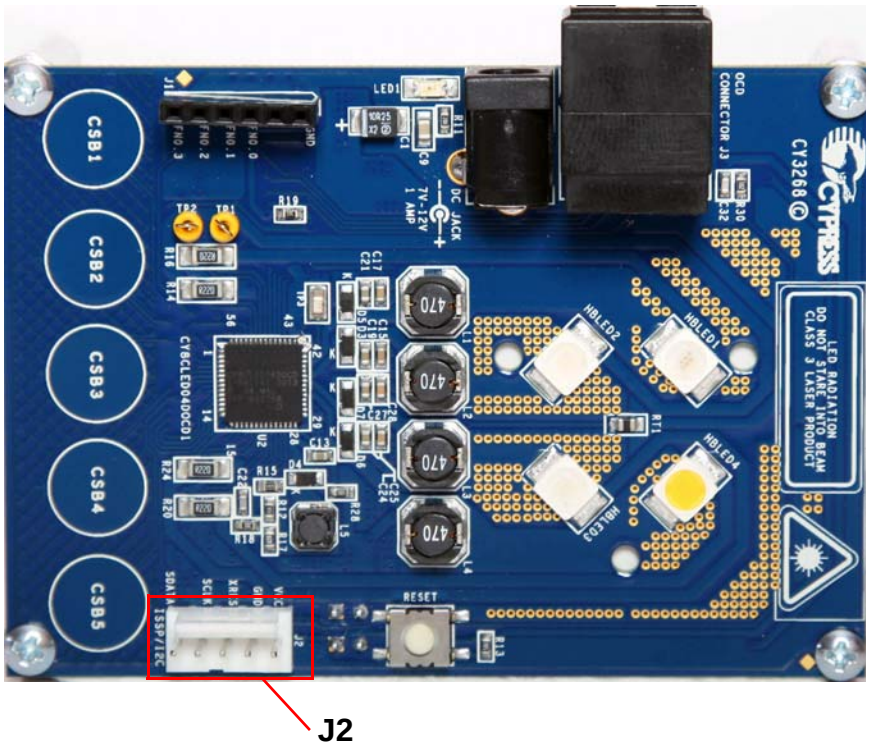
The CY3268 PowerPSoC Lighting Starter Kit examples help you develop applications using the PowerPSoC family of devices. The kit is designed to develop lighting applications using PowerPSoC.

This chapter assists you in understanding the functionality of the kit.

3.2 Programming PowerPSoC Device

The PowerPSoC device on the board can be programmed using a MiniProg. To use MiniProg for programming, use the ISSP programming header J2 on the board, as shown in the following figure.

Figure 3-1. ISSP (J2) Programming Header



[+] Feedback

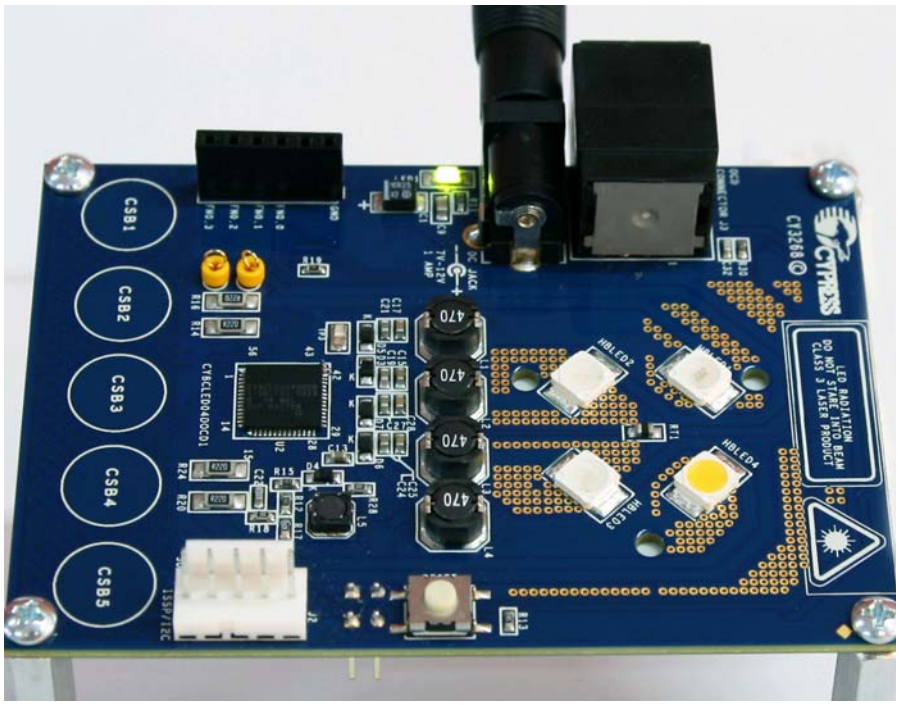
Figure 3-2. Connect MiniProg



Connect the MiniProg, as shown in the Figure 3-2 and program the board using PSoC Programmer.

3.3 CY3268 PowerPSoC Lighting Starter Kit Operation

Figure 3-3. Kit Board



The code example 1 is pre-loaded in the kit, when shipped.

1. Connect the power supply to a wall outlet and to the board.
2. Touch the CapSense® buttons CSB1 to CSB4 to turn on the HBLEDs initially.
3. Touch the CapSense buttons CSB1 to CSB4 to select/deselect corresponding HBLEDs. The HBLEDs blink when selected.
4. Touch the CapSense button CSB5 to increase/decrease the brightness of the selected HBLED. Touching CSB5 repeatedly increases the brightness of the selected HBLED. When the maximum brightness is reached, further touching CSB5 decreases the brightness.
5. Turn off the board by removing the power supply from the wall outlet.



WARNING: HIGH BRIGHTNESS LEDs CAN CAUSE PERMANENT DAMAGE!

Do not look at the HBLEDs directly. The HBLEDs illuminate at a very high intensity and can cause permanent eye damage. Use a thick white sheet of paper as diffuser if there is no optical diffuser available.

WARNING: Generally all lab work in power electronics must be done with extreme care. Caution must be exercised when using power supplies and/or power related equipment.

[+] Feedback

[+] Feedback

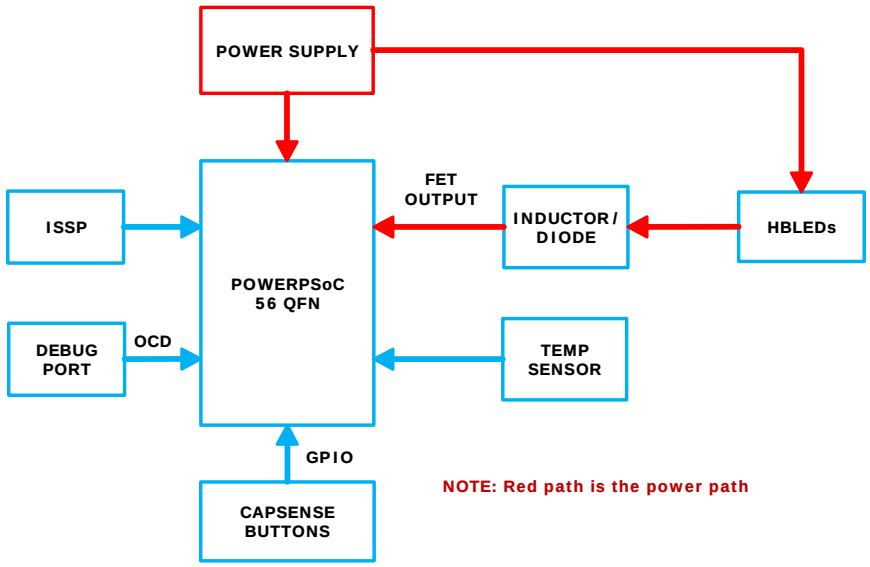
4. Hardware

4.1 System Block Diagram

The CY3268 PowerPSoC Lighting Starter Kit has the following sections:

- Power supply system
  - Power on indicator LED (green)
- Programming interface
  - ISSP/I^{2}C header
- Four HBLEDs (300 mA rating)
- Five CapSense buttons
- One reset switch
- Debug port
- Temperature sensor

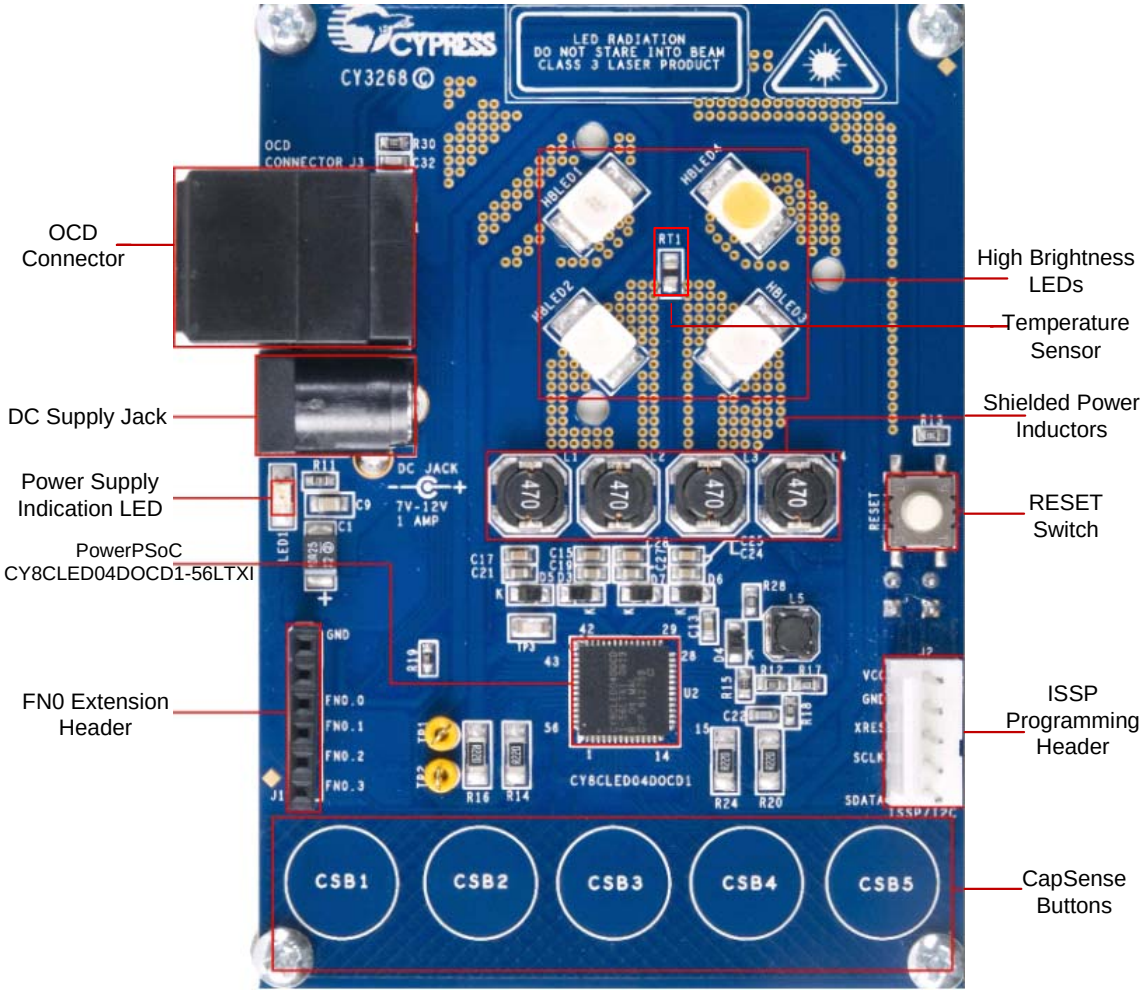
Figure 4-1. Block Diagram



[+] Feedback

4.2 Functional Description

Figure 4-2. Components on the CY3268 PowerPSoC Board



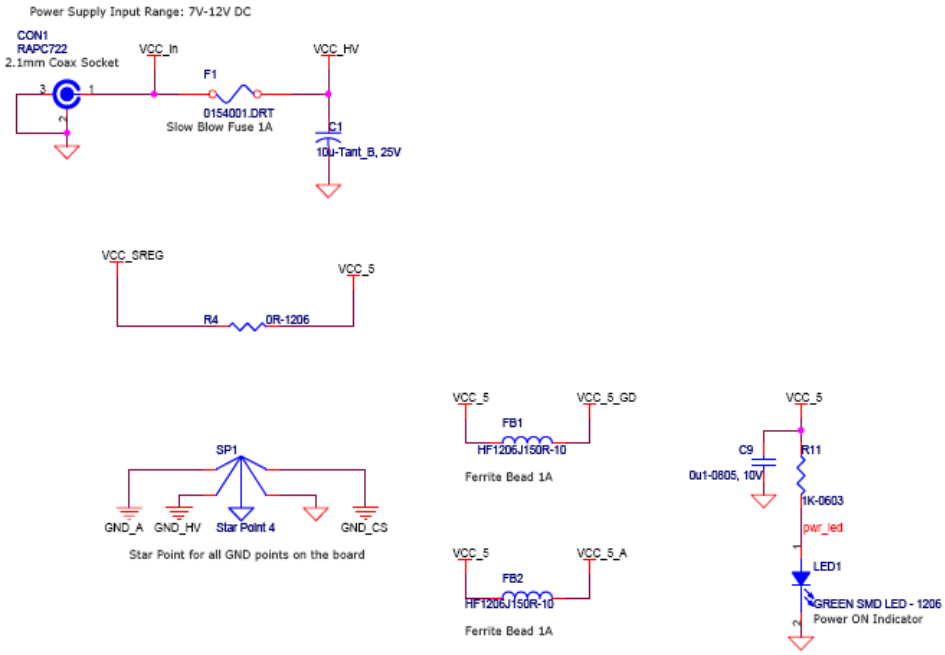
[+] Feedback

4.2.1 Power Supply

The power supply system on this board is versatile. It takes input supply from the following source:

7 V - 12 V wall wart supply using connector CON1

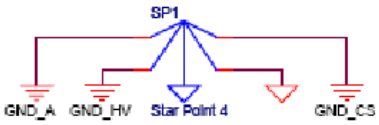
Figure 4-3. Power System Structure



4.2.1.1 Grounding Scheme

Star Point for all GND points on the board.

Figure 4-4. Star Grounding Scheme



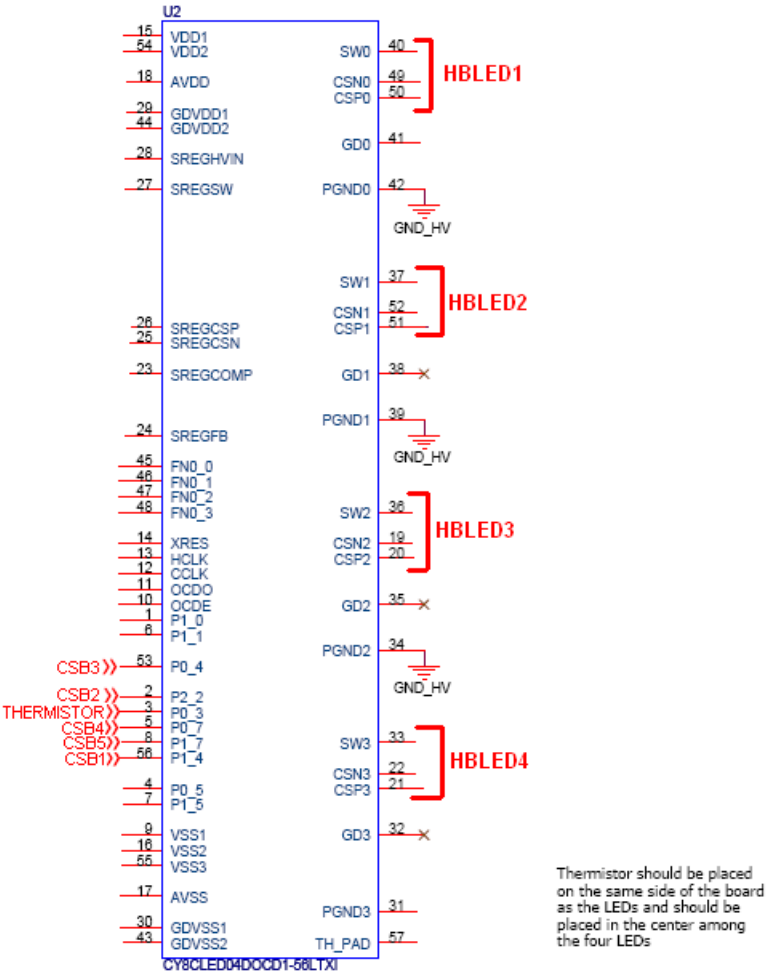
4.2.2 PowerPSoC

The CY3268 PowerPSoC Lighting Starter Kit is designed as the HBLED driver circuit. The specifications of the driver circuit in this design are:

- Input voltage: 7 V minimum and 12 V maximum
- HBLED output current per channel: 300 mA maximum
- Expected efficiency: > 90%
- Expected switching frequency: 800 kHz
- Inductor current ripple: 30% of load current, that is, 30% of 300 mA = 90 mA

[+] Feedback

Figure 4-5. PowerPSoC Connections



4.2.2.1 *Applications of PowerPSoC*

- Stage lighting
- Architectural lighting
- General purpose lighting
- Automotive and emergency vehicle lighting
- Landscape lighting
- Display lighting
- Effects lighting
- Signage lighting

[+] Feedback

4.2.2.2 Pin Details

Table 4-1. Pin Description

Pin No.	Name	Description	Connected To
1	P1[0]	GPIO/I2C SDA (Secondary)/ISSP SDATA	ISSP SDATA (J2)
2	P2[2]	GPIO/Direct Switch Cap connection	CSB2
3	P0[3]	GPIO/Analog Input (Column 0)/ Analog Output (Column 0)	Thermistor
4	P0[5]	GPIO/Analog Input (Column 0)/ Analog Output (Column 1) / CapSense Ref Cap	GND
5	P0[7]	GPIO/Analog Input (Column 0)/CapSense Ref Cap	CSB4
6	P1[1]	GPIO/I2C SCL (Secondary)/ISSP SCLK	ISSP_SCK (J2)
7	P1[5]	GPIO/I2C SDA (Primary)	GND
8	P1[7]	GPIO/I2C SCL (Primary)	CSB5
9	VSS	Digital Ground	
10	OCDE	On Chip Debugger Port	J3 (Used to interface with the ICE for debugging)
11	OCDO	On Chip Debugger Port	J3 (Used to interface with the ICE for debugging)
12	CCLK	On Chip Debugger Port	J3 (Used to interface with the ICE for debugging)
13	HCLK	On Chip Debugger Port	J3 (Used to interface with the ICE for debugging)
14	XRES	External Reset	ISSP_XRES(J2, J3, Reset push button)
15	VDD	Digital Power Supply	
16	VSS	Digital Ground	
17	AVSS	Analog Ground	
18	AVDD	Analog Power Supply	
19	CSN2	Current Sense Negative Input 2	
20	CSP2	Current Sense Positive Input and Power Supply - CSA2	
21	CSP3	Current Sense Positive Input and Power Supply - CSA3	
22	CSN3	Current Sense Negative Input 3	
23	SREGCOMP	Voltage Regulator Error Amp Comp	
24	SREGFB	Regulator Voltage Mode Feedback Node	
25	SREGCSN	Current Mode Feedback Negative	
26	SREGCSP	Current Mode Feedback Positive	
27	SREGSW	Switch Mode Regulator OUT	
28	SREGHVIN	Switch Mode Regulator IN	
29	GDVDD	Gate Driver Power Supply	
30	GDVSS	Gate Driver Ground	
31	PGND3[2]	Power FET Ground 3	

Table 4-1. Pin Description

Pin No.	Name	Description	Connected To
32	GD3	External Low Side Gate Driver 3	
33	SW3	Power Switch 3	
34	PGND2[2]	Power FET Ground 2	
35	GD2	External Low Side Gate Driver 2	
36	SW2	Power Switch 2	
37	SW1	Power Switch 1	
38	GD1	External Low Side Gate Driver 1	
39	PGND1[2]	Power FET Ground 1	
40	SW0	Power Switch 0	
41	GD0	External Low Side Gate Driver 0	
42	PGND0[2]	Power FET Ground 0	
43	GDVSS	Gate Driver Ground	
44	GDVDD	Gate Driver Power Supply	
45	FN0[0]	Function I/O	J1 (GPIO 6x1 TH Header (F))
46	FN0[1]	Function I/O	J1 (GPIO 6x1 TH Header (F))
47	FN0[2]	Function I/O	J1 (GPIO 6x1 TH Header (F))
48	FN0[3]	Function I/O	J1 (GPIO 6x1 TH Header (F))
49	CSN0	Current Sense Negative Input 0	
50	CSP0	Current Sense Positive Input and Power Supply - CSA0	
51	CSP1	Current Sense Positive Input and Power Supply - CSA1	
52	CSN1	Current Sense Negative Input 1	
53	P0[4]	GPIO/Analog Input (Column 1) / Bandgap Output	CSB3
54	VDD	Digital Power Supply	
55	VSS	Digital Ground	
56	P1[4]	GPIO / External Clock Input	CSB1

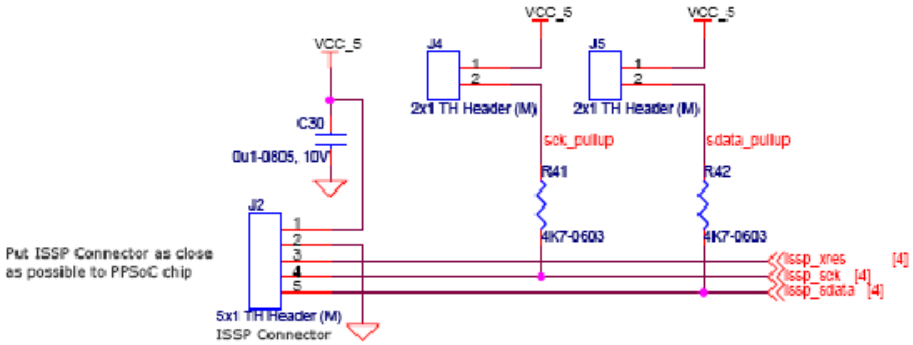
4.2.3 Programming Interface

This kit allows programming using the ISSP/I^{2}C programming interface that uses a MiniProg.

4.2.3.1 ISSP Programming

The board also provides the option of using the MiniProg. This interface is faster and the ISSP programming is done through the 5-pin connector, J2.

Figure 4-6. ISSP Programming



The ISSP programming using J2 requires a programmer that can be purchased from here.

Connector	Functionality
J4	Used with issp_sck pin for programming; short pins 1 and 2 to enable pull-ups on I^{2}C
J5	Used with issp_sdata pin for programming; short pins 1 and 2 to enable pull-ups on I^{2}C

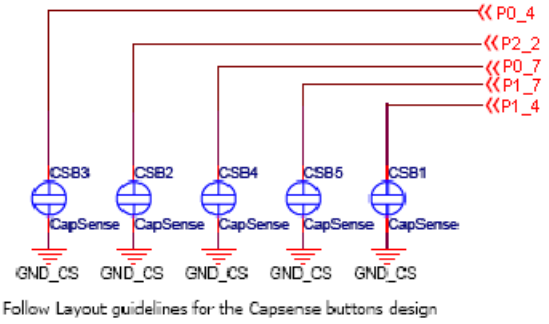
4.2.4 CapSense Sensors

The board has five CapSense buttons. The board layout has considered the special requirements for CapSense. The CapSense button (CSB1) is connected to pin P1[4], CapSense button (CSB2) is connected to P2[2], CapSense button (CSB3) is connected to P0[4], CapSense button (CSB4) is connected to P0[7], and CapSense button (CSB5) is connected to P1[7].

CSB 1	LED 1	ON/OFF
CSB 2	LED 2	ON/OFF
CSB 3	LED 3	ON/OFF
CSB 4	LED 4	ON/OFF
CSB 5	DIM	CYCLE COLORS

[+] Feedback

Figure 4-7. CapSense Sensors

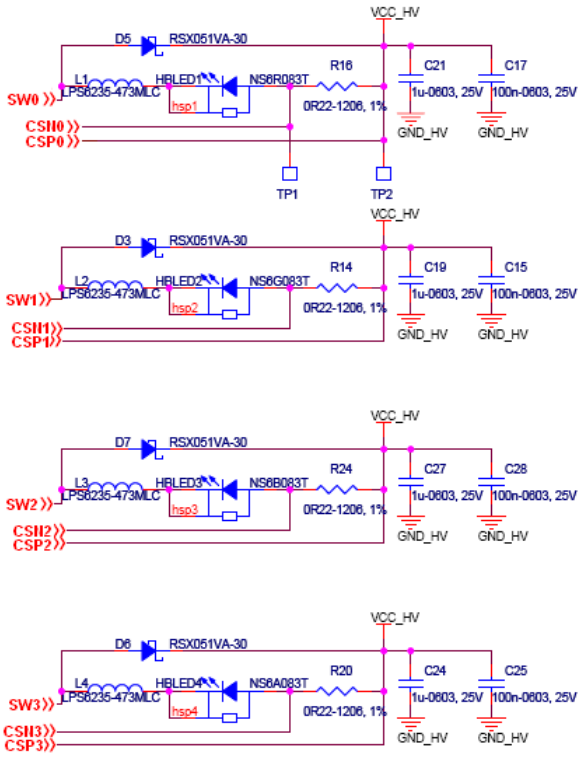


4.2.5 HBLEDs

HBLEDs used in this kit are 300-mA rated.

The third pin of the HBLED is for heatsink slug and is internally connected with the cathode of the HBLED terminals, but each heat slug must be electrically isolated when connected with a common heatsink.

Figure 4-8. Converter Circuit for HBLED Operation (All four channels are shown)



Inductors

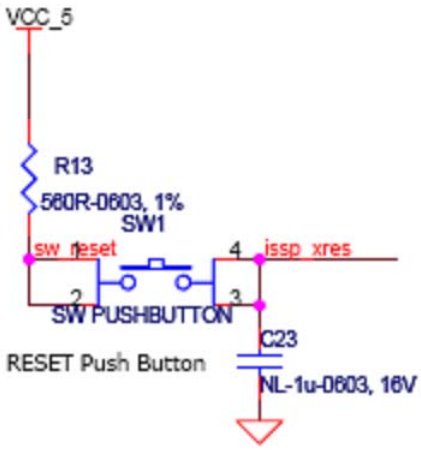
Shielded power inductors are normally used for noise suppression and are currently used in all applications.

[+] Feedback

4.2.6 RESET Button

There is a reset button (SW1) in this kit.

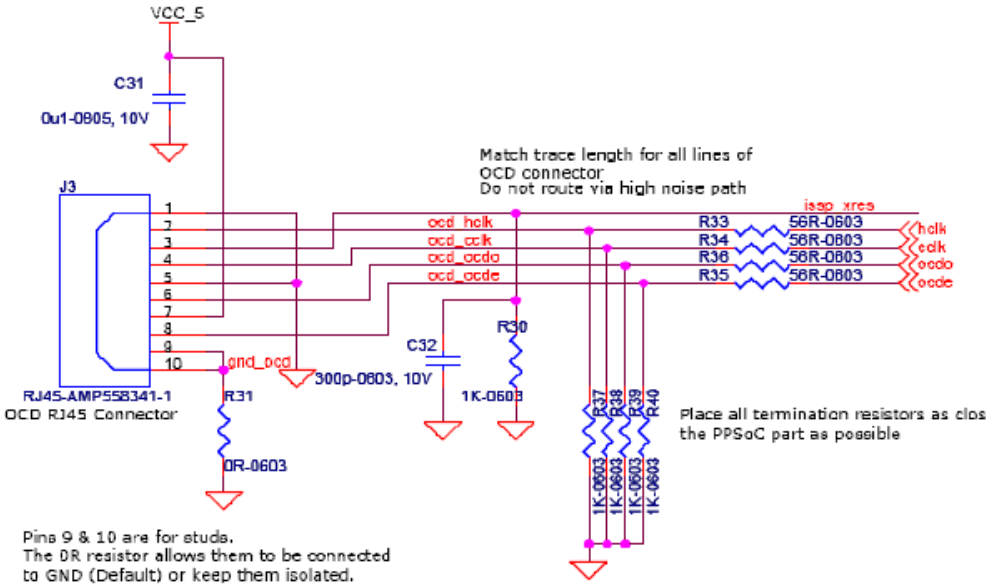
Figure 4-9. RESET Circuit



4.2.7 Debug Port

There is a debug port to connect to the on-chip debugger (OCD) device to enable debugging.

Figure 4-10. RJ45 - PCB Mounted Jack

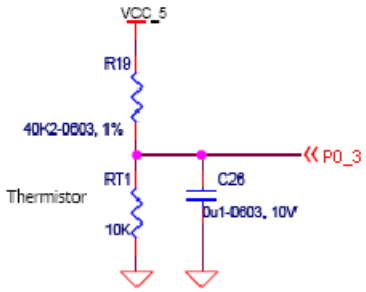


[+] Feedback

4.2.8 Temperature Sensor

There is a thermistor on board that helps to measure the temperature of HBLEDs.

Figure 4-11. Thermistor Circuit



[+] Feedback

5. Code Examples

All code examples are available in the kit CD or in the installed directory `<Install_Dir>\Cypress\CY3268 PowerPSoC\<version>\Firmware`

To create a project for HBLED applications using PowerPSoC, see application note AN51012 - *PowerPSoC Firmware Design Guidelines*.

This code example provides a basic understanding of the user modules available in PowerPSoC and how to use them.

5.1 Code Example 1: CY3268_Example1

5.1.1 Project Description

This code example uses CapSense sensors to illuminate an HBLED. When the CapSense sensor (CSB1 to CSB4) is tapped, the corresponding HBLEDs glow. By tapping the CapSense sensor (CSB5), a selected HBLED goes from low to high brightness and back to low brightness.

5.1.2 Hardware Connections

No hardware connections are required for this project because all connections are hardwired to specific pins on the board.

The functional blocks of CY3268_Example1 are illustrated in Figure 5-1 on page 30. The user module has functional blocks such as CSA, CSD, PRISM, and HYSTCTRL.

5.1.2.1 Current Sense Amplifier (CSA):

The CSA consists of two amplifier stages, stage 1 and stage 2. Stage 1 is used to level shift and amplify a high side input. The stage 1 gain is fixed at 4. stage 2 is used to amplify the stage 1 output. The stage 2 gain is fixed and is equal to 5. As a result, the total gain is fixed and is equal to 20. The CSA performs continuous time differential amplification of the input voltage.

5.1.2.2 CapSense Sigma Delta (CSD):

CSD is used to scan the active capacitive sensors. The sensing is possible up to 15 mm glass overlay. It has high immunity to AC mains noise, EMC noise, and power supply voltage changes. It supports different combinations of independent and slide capacitive sensors.

The CSD provides CapSense functionality using the switched capacitor technique with a sigma-delta modulator to convert the sensing switched capacitor current to digital code.

5.1.2.3 Precise Intensity Signal Modulation (PrISM):

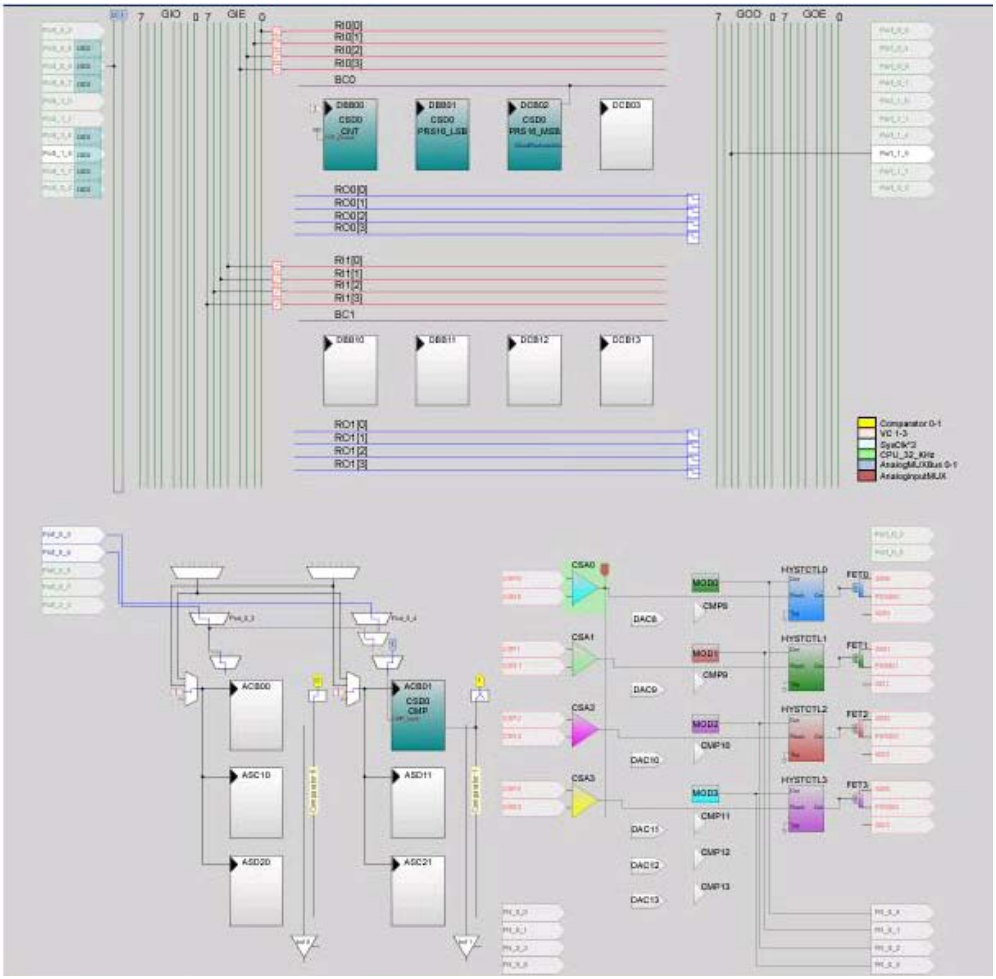
The PrISM compares the output of a pseudo-random counter with a signal density value. The comparator output asserts when the count value is less than (or less than or equal to) the value in the signal density register.

[+] Feedback

5.1.2.4 *Hysteretic Controller (HYSTCTRL):*

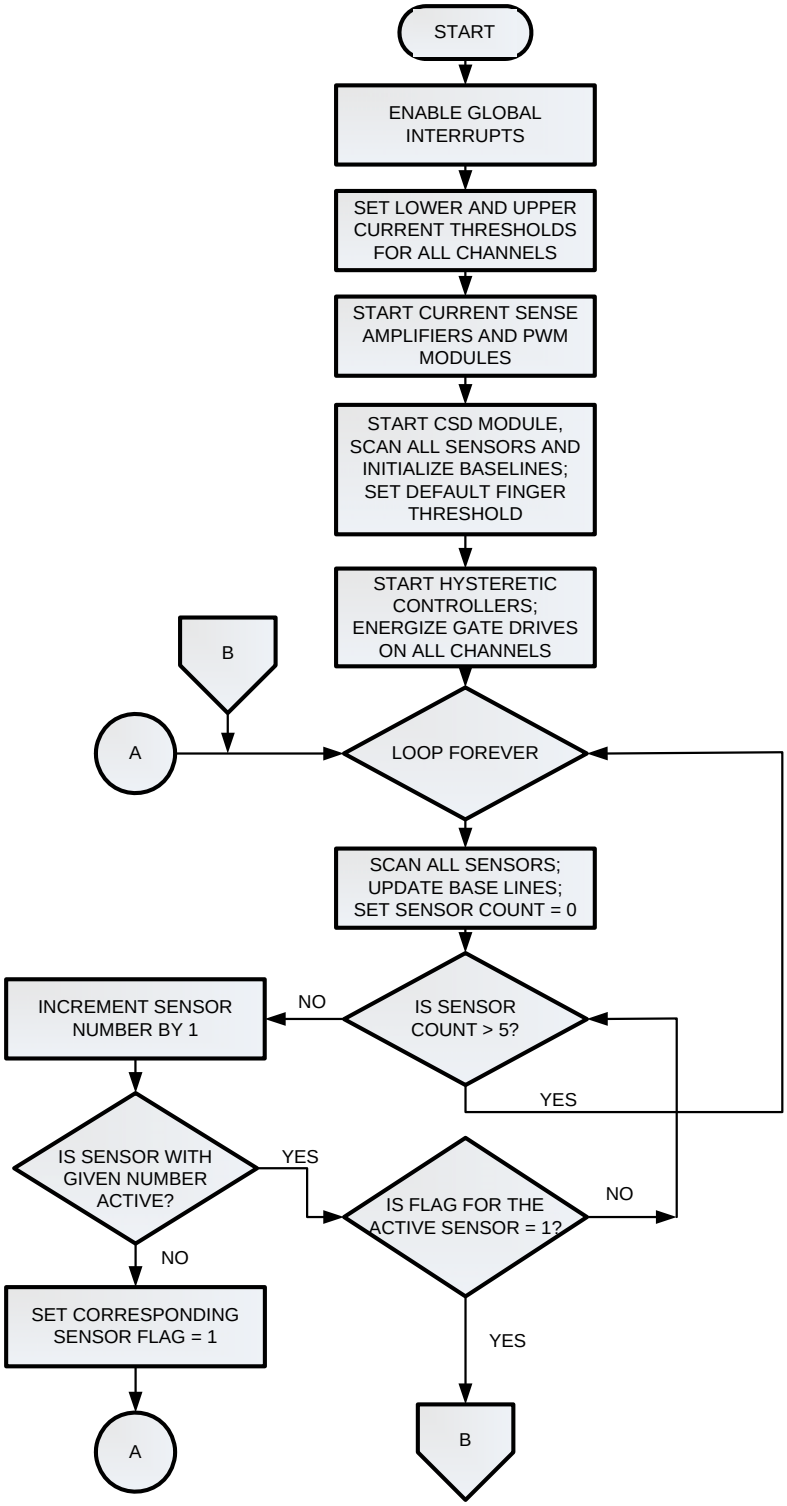
The HYSTCTRL User Module is intended for use in HBLED applications as an intelligent controller for HBLEDs. It provides cycle-by-cycle switch control with a fast transient response. The hysteretic controller simplifies system design because it does not require external compensation. The gate drivers are used to drive either internal or external power FETs.

Figure 5-1. PowerPSoC Interconnect Diagram for CY3268_Example1

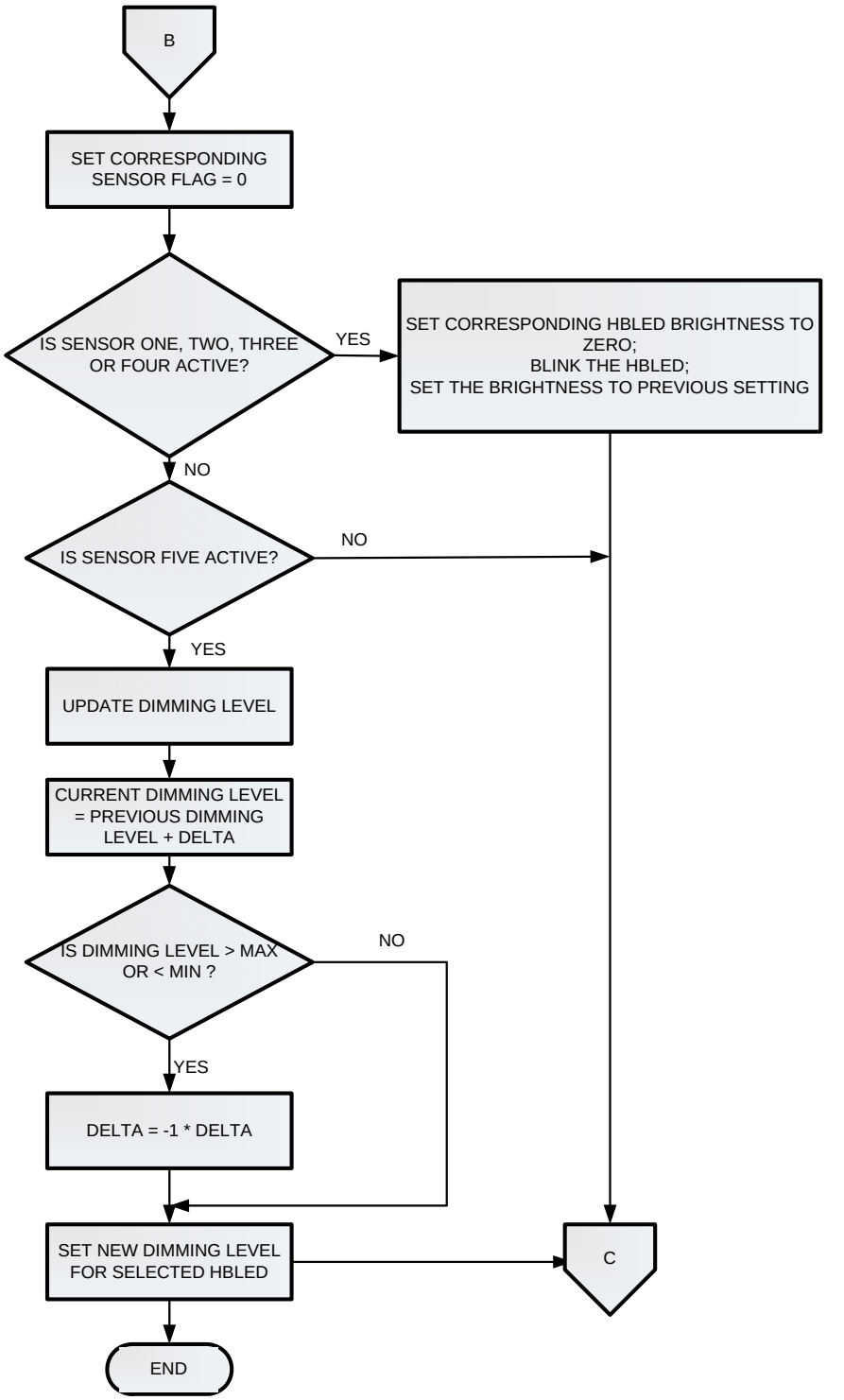


[+] Feedback

5.1.3 Program Flow Diagram



[+] Feedback

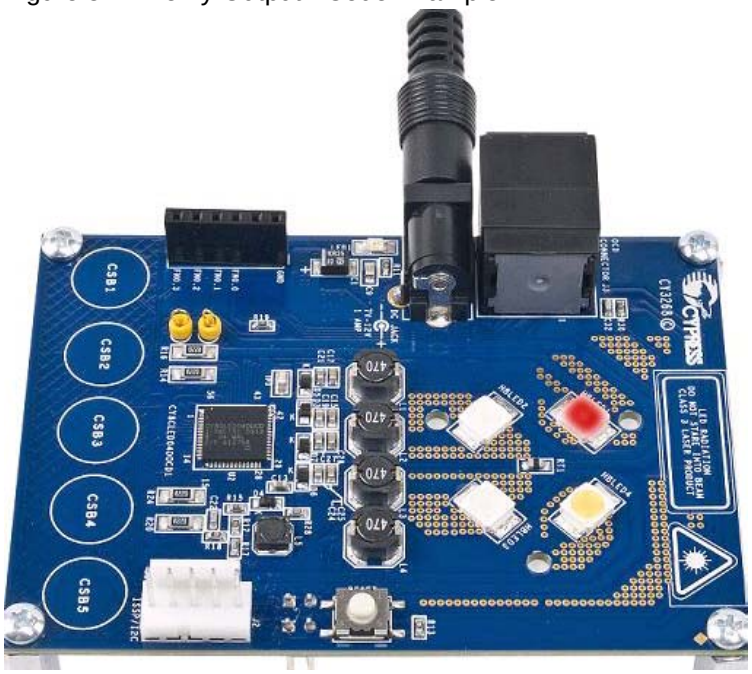

B
SET CORRESPONDING SENSOR FLAG = 0
IS SENSOR ONE, TWO, THREE OR FOUR ACTIVE?
YES
SET CORRESPONDING HBLED BRIGHTNESS TO ZERO;
BLINK THE HBLED;
SET THE BRIGHTNESS TO PREVIOUS SETTING
NO
IS SENSOR FIVE ACTIVE?
NO
YES
UPDATE DIMMING LEVEL
CURRENT DIMMING LEVEL = PREVIOUS DIMMING LEVEL + DELTA
IS DIMMING LEVEL > MAX OR < MIN ?
NO
YES
DELTA = -1 * DELTA
SET NEW DIMMING LEVEL FOR SELECTED HBLED
C
END

[+] Feedback

5.1.4 Verify Output

When the code example is built and programmed into the device, the output of HBLED1, HBLED2, HBLED3, and HBLED4 glows when you tap the CapSense buttons (CSB1 to CSB4); it changes intensity when you tap CapSense button (CSB5) (see Figure 5-2).

Figure 5-2. Verify Output - Code Example



- CapSense button 1: Touch this button to turn on red HBLED and select it
- CapSense button 2: Touch this button to turn on green HBLED and select it
- CapSense button 3: Touch this button to turn on blue HBLED and select it
- CapSense button 4: Touch this button to turn on amber HBLED and select it
- CapSense button 5: Touch this button to vary the brightness of the selected HBLED

5.2 Code Example 2: CY3268_Heartbeat

5.2.1 Project Description

The code example demonstrates the use of four channel color mixing algorithm using PowerPSoC. This example cycles through preset colors indefinitely when the CapSense button CSB5 is tapped. CSB1 to CSB4, when tapped, turn the HBLEDs on/off. Additionally, to stop cycling of colors, touch and hold CSB5 momentarily.

5.2.2 Hardware Connections

No hardware connections are required for this project because all connections are hardwired to specific pins on the board. The functional blocks are illustrated in Figure 5-3.

The user module has functional blocks such as CSD, PRISM, CSA, and HYSTCTRL.

[+] Feedback

5.2.2.1 CapSense Sigma Delta (CSD):

CSD is used to scan the active capacitive sensors. The sensing is possible up to 15 mm glass overlay. It has high immunity to AC mains noise, EMC noise, and power supply voltage changes. It supports different combinations of independent and slide capacitive sensors.

The CSD provides CapSense functionality using the switched capacitor technique with a sigma-delta modulator to convert the sensing switched capacitor current to digital code.

5.2.2.2 Precise Intensity Signal Modulation (PrISM):

The PrISM compares the output of a pseudo-random counter with a signal density value. The comparator output asserts when the count value is less than (or less than or equal to) the value in the signal density register.

5.2.2.3 Current Sense Amplifier (CSA):

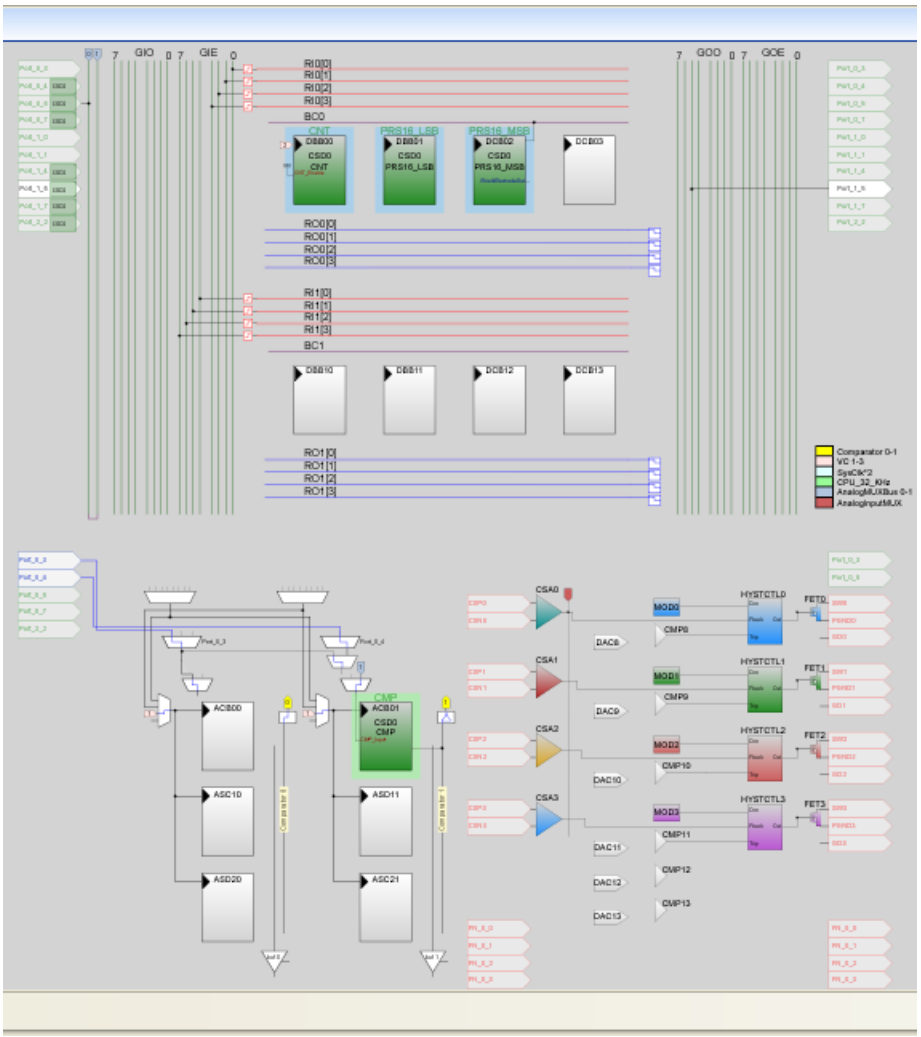
The CSA consists of two amplifier stages, stage 1 and stage 2. Stage 1 is used to level shift and amplify a high side input. Stage 1 gain is fixed at 4. Stage 2 is used to amplify stage 1 output. Stage 2 gain is fixed and is equal to 5. As a result, the total gain is fixed and is equal to 20. The CSA performs continuous time differential amplification of the input voltage.

5.2.2.4 Hysteretic Controller (HYSTCTRL):

The HYSTCTRL user module is intended for the use in HBLED applications as an intelligent controller for high brightness HBLEDs. It provides cycle-by-cycle switch control with a fast transient response. The hysteretic controller simplifies system design because it requires no external compensation. The gate drivers are used to drive either internal or external power FETs

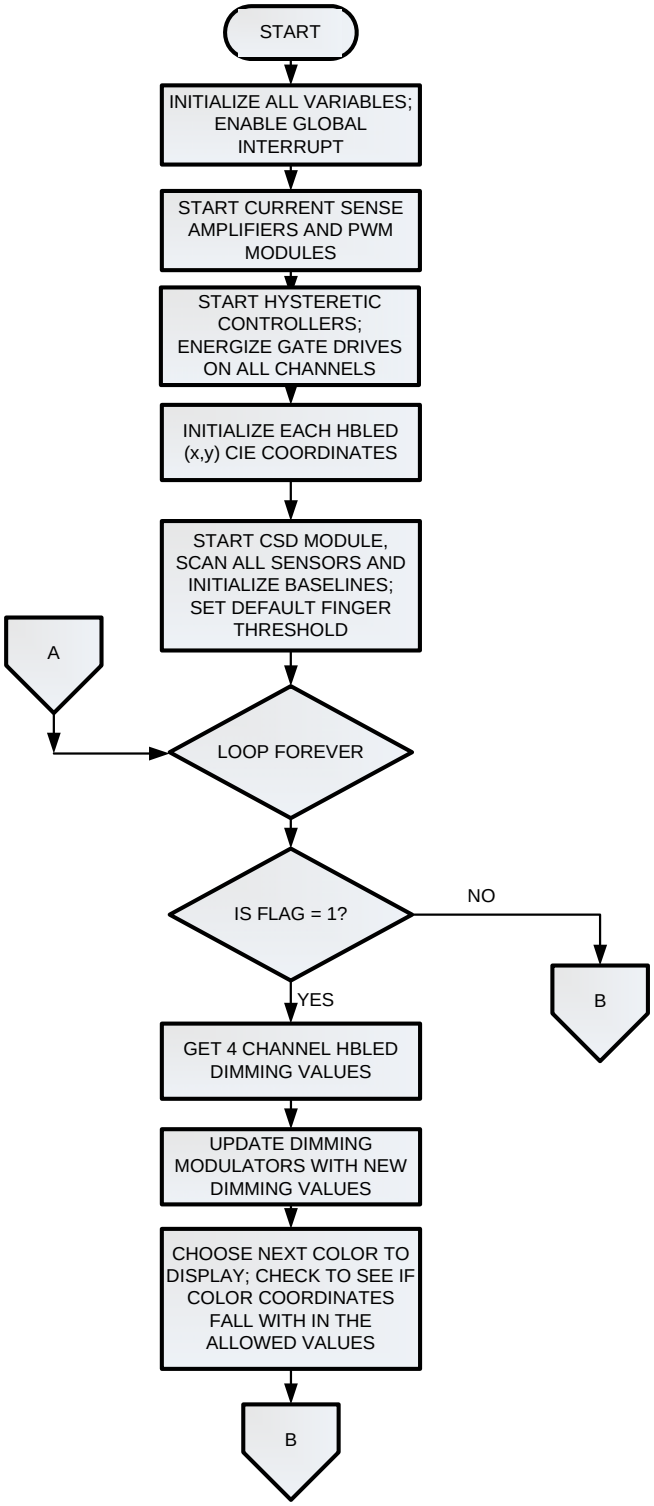
[+] Feedback

Figure 5-3. PowerPSoC Interconnect Diagram for CY3268_Heartbeat

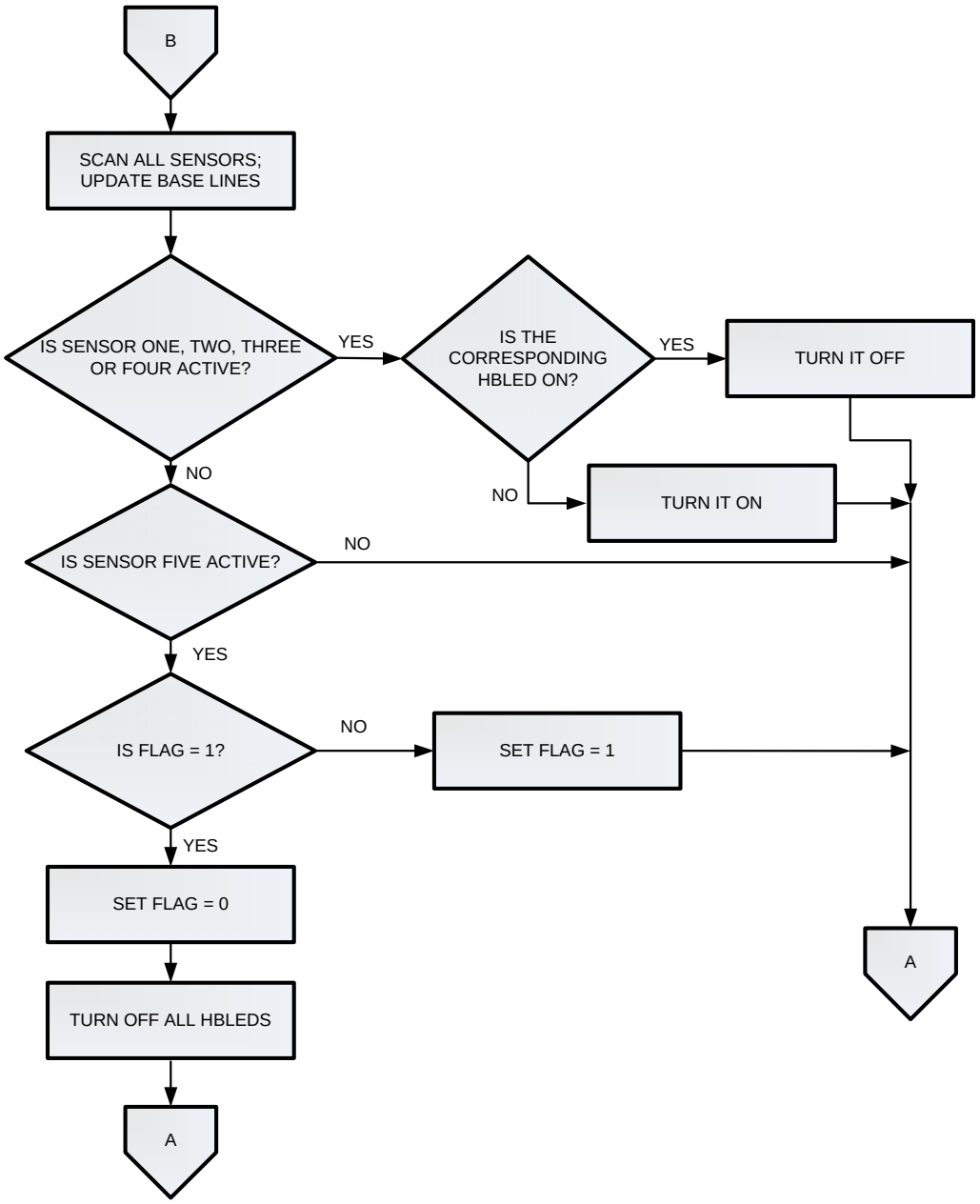


[+] Feedback

5.2.3 Program Flow Diagram



[+] Feedback

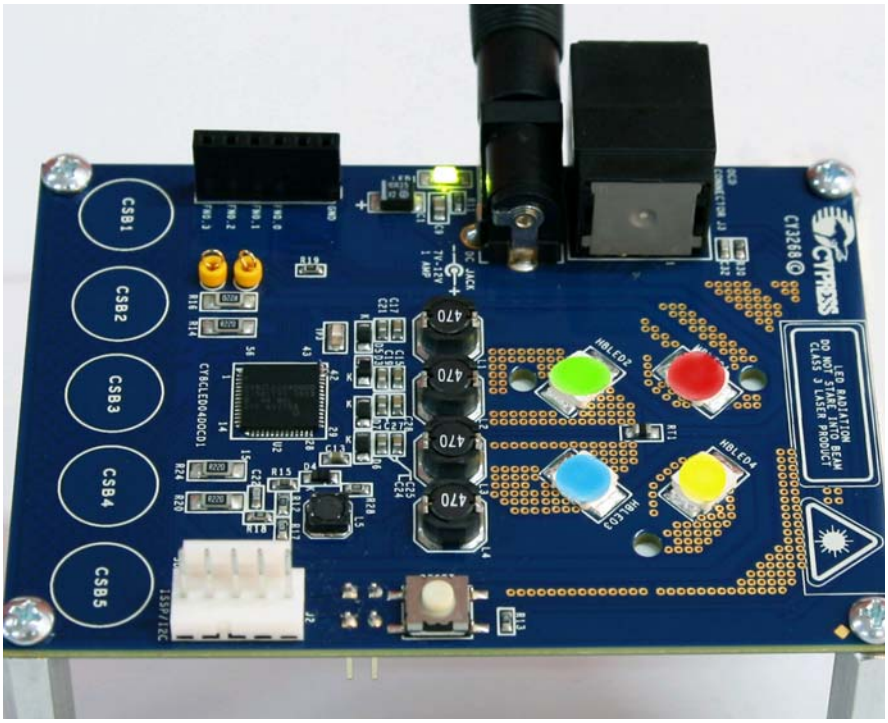

B
SCAN ALL SENSORS; UPDATE BASE LINES
IS SENSOR ONE, TWO, THREE OR FOUR ACTIVE?
YES
IS THE CORRESPONDING HBLED ON?
YES
TURN IT OFF
NO
NO
TURN IT ON
IS SENSOR FIVE ACTIVE?
NO
YES
IS FLAG = 1?
NO
SET FLAG = 1
YES
SET FLAG = 0
TURN OFF ALL HBLEDS
A
A

[+] Feedback

5.2.4 Verify Output

When this code example is built and programmed into the device, all the HBLEDs glow indefinitely when CSB5 is touched. The output of HBLED1, HBLED2, HBLED3, and HBLED4 can be turned off and on by touching corresponding CapSense buttons.

Figure 5-4. Verify Output - HeartBeat



- CapSense button 1: Touch to turn red HBLED on/off
- CapSense button 2: Touch to turn green HBLED on/off
- CapSense button 3: Touch to turn blue HBLED on/off
- CapSense button 4: Touch to turn amber HBLED on/off
- CapSense button 5: Touch to start indefinite sequencing of colors. Touch and hold to stop.

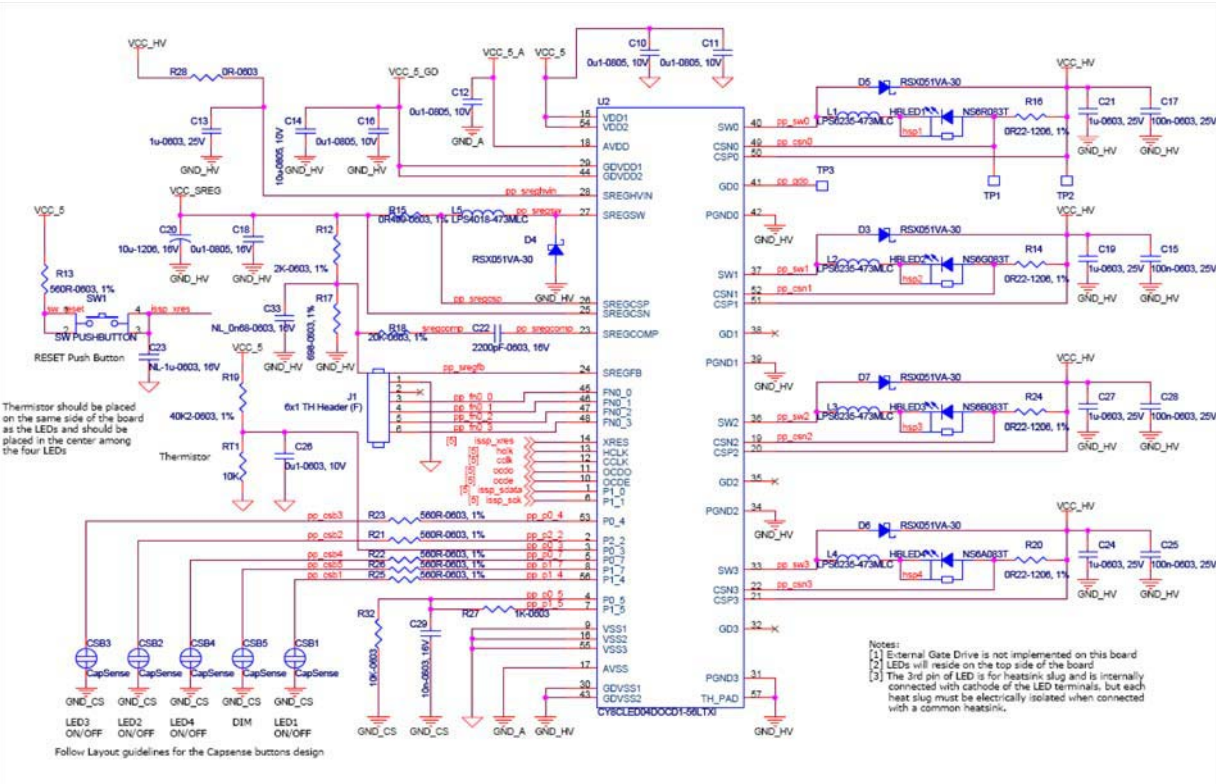
Note It is recommended not to look at the HBLEDs directly with the naked eye. For best viewing of colors, place a thick white sheet of paper on the HBLEDs or focus the light on a white wall.

[+] Feedback

A. Appendix

A.1 Schematic

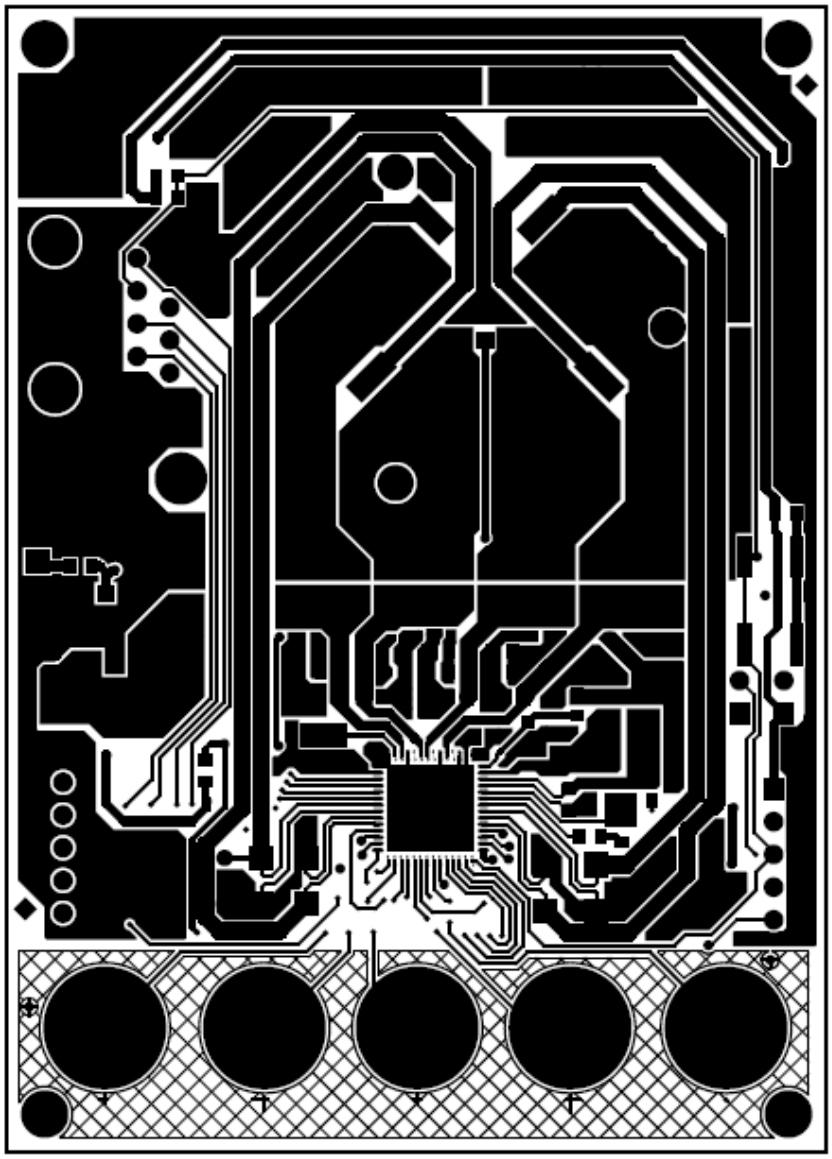
A.1.1 PowerPSoC Device Connections



[+] Feedback

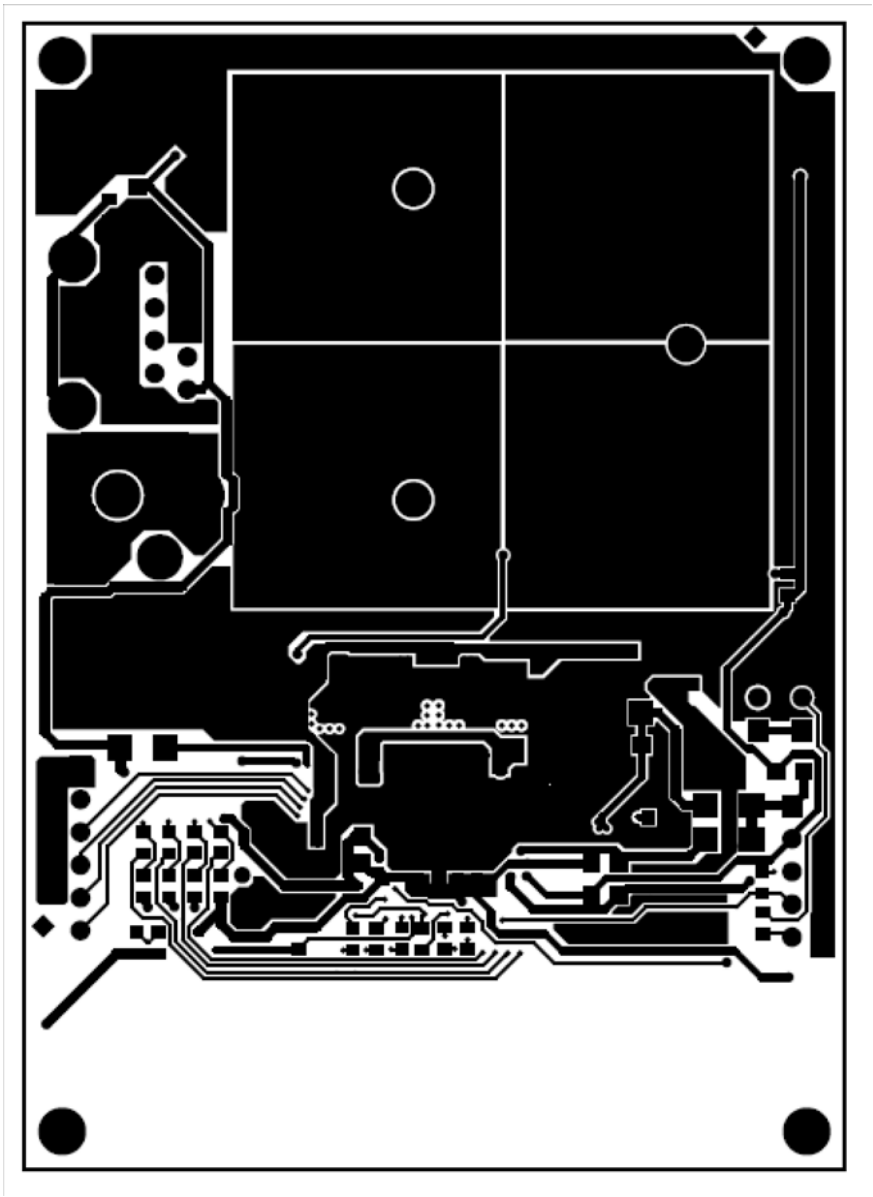
A.2 Board Layout

A.2.1 CY3268 PowerPSoC Board - Top Layer



[+] Feedback

A.2.2 CY3268 PowerPSoC Board - Bottom Layer



[+] Feedback

A.3 Bill of Materials

Quantity	Reference	Part Number	Description	Manufacturer
1	CON1	RAPC722X	CONN Powerjack Mini .08" R/A T/H	Switchcraft Inc.
1	C1	TR3B106K025C1100	CAP TANT 10 UF 25 V 10% SMD	Vishay
7	C9,C10,C11,C12,C16,C30,	LMK212SD104JG-T	CAP CER .10 UF 10 V 0805 LOW DIST	Taiyo Yuden
	C31			
5	C13,C19,C21,C24,C27	GRM188R61E105KA12D	CAP CER 1UF 25 V X5R 0603	Murata Electronics
1	C14	C0805C106K8PACTU	CAP CERM 10 UF 10 V X5R 0805	Kemet
4	C15,C17,C25,C28	C0603C104J3RACTU	CAP .1UF 25 V Ceramic X7R 0603	Kemet
1	C18	ECJ-2VB1C104K	CAP .1UF 16V Ceramic X7R 0805	Panasonic - ECG
1	C20	GRM31CR61C106KC31L	CAP CER 10UF 16 V 10% X5R 1206	Murata Electronics
1	C22	C0603C222J4RACTU	0603 SMD Ceramic Chip Capacitors 16 V 2200 pF X7R 5%	Kemet
1	C26	C0603C104K8RACTU	CAP .10UF 10V Ceramic X7R 0603	Kemet
1	C29	EMK107SD103JA-T	CAP CER 10000 PF 16 V 0603 LOWDIST	Taiyo Yuden
1	C32	GRM1885C1H301JA01D	CAP CER 300PF 50V 5% C0G 0603	Murata Electronics
5	D3,D4,D5,D6,D7	RSX051VA-30TR	Diode Schottky 30 V 500 MA TUMD2	Rohm
2	FB1,FB2	HF1206J150R-10	FERRITE 1A 19 Ω 1206 SMD	Steward
1	F1	0154001.DRT	FUSEBLOCK 1A SLO BLO SMD	Littelfuse Inc
1	HBLED1	NS6R083T	Red LED	Nichia
1	HBLED2	NS6G083T	Green LED	Nichia
1	HBLED3	NS6B083T	Blue LED	Nichia
1	HBLED4	NS6A083T	Amber LED	Nichia
1	J1	PPTC061LFBN-RC	CONN header female 6POS .1" TIN	Sullins Connector Solutions
1	J2	22-23-2051	CONN header 5POS .100 VERT TIN	Molex
1	J3	5558341-1	CONN MOD JACK 8-8 RT/A PCB 50AU	Tyco
2	J4,J5	22-28-4020	CONN header 2POS .100 VERT TIN	Molex/Waldom Electronics Corp
1	LED1	CMD15-21VGC/TR8	LED green clear 1206 SMD	CML innovative
4	L1,L2,L3,L4	LPS6235-473MLC	Inductor shield PWR 47UH SMD	Coilcraft
1	L5	LPS4018-473MLC	Inductor shield PWR 47UH SMD	Coilcraft
4	M1,M2,M3,M4	PMS 440 0025 PH	Screw machine Phillips 4-40X1/4	Building Fasteners
4	M9,M10,M11,M12	2205	Srandoff hex 4-40THR ALUM 1"	Keystone Electronics
1	RT1	2381 615 53103	Thermistor NTC 10K OHM 0805 SMD	Vishay
1	R4	ERJ-8GEY0R00V	RES 0 Ω 1/4W 5% 1206 SMD	Panasonic - ECG
7	R11,R27,R30,R37,R38,R39,	ERJ-3GEYJ102V	RES 1.0 KΩ 1/10W 5% 0603 SMD	Panasonic - ECG

Quantity	Reference	Part Number	Description	Manufacturer
	R40			
1	R12	ERJ-3EKF2001V	RES 2.00 KΩ 1/10W 1% 0603 SMD	Panasonic - ECG
6	R13,R21,R22, R23,R25,R26	MCR03EZPFX5600	RES 560 Ω 1/10W 1% 0603 SMD	Rohm
4	R14,R16,R20, R24	RL1632R-R220-F	RES .22 Ω 1/2W 1% 1206 SMD	Susumu Co Ltd
1	R15	SR731JTTDR499F	0603 1/10 watt Lo-ohm thick film current sense resistors 0.499 Ω 1% 200 PPM	KOA Speer
1	R17	ERJ-3EKF6980V	RES 698 Ω 1/10 W 1% 0603 SMD	Panasonic - ECG
1	R18	ERJ-3EKF2002V	RES 20.0K Ω 1/10 W 1% 0603 SMD	Panasonic - ECG
1	R19	ERJ-3EKF4022V	RES 40.2K Ω 1/10 W 1% 0603 SMD	Panasonic - ECG
2	R28,R31	RC0603JR-070RL	RES 0.0 Ω 1/10 W 5% 0603 SMD	Yageo Corporation
1	R32	MCR03EZPFX1002	RES 10.0K Ω 1/10 W 1% 0603 SMD	Rohm
4	R33,R34,R35, R36	MCR03EZPFX56R0	RES 56.0 Ω 1/10 W 1% 0603 SMD	Rohm
2	R41,R42	MCR03EZPFX4701	RES 4.70 KΩ 1/10W 1% 0603 SMD	Rohm
1	SW1	EVQ-QXS03W	Switch LT 6MM 160GF H=3.1MM SMD	Panasonic - ECG
2	TP1,TP2	5004	Test point PC MINI .040"D yellow, through hole	Keystone Electronics
1	TP3	5015	PC test point miniature SMT	Keystone Electronics
1	U2	CY8CLED04DOCD-56LTXI Rev C	PowerPSoC intelligent LED driver - OCD Part	Cypress Semiconductor
1	-	655-26AB	BGA heat sink low profile 0.26"	Wakefield Engineering
1	-	67-10-0150-t414	Thermally adhesive tape	Chomerics
Do Not Install				
5	CSB1,CSB2,CSB3,CSB4,CSB5			
1	C23	GRM188R61C105KA93D	CAP CER 1.0UF 16V 10% X5R 0603	Murata Electronics
1	C33	ECH-U1C681GX5	CAP.00068UF 16V PPS FILM 0603 2%	Panasonic - ECG
1	-	-	Optic	-

A.4 Safety Precautions

Preparing a circuit

- Use only isolated power sources (either isolated power supplies or AC power through isolation power transformers). This helps to use a grounded oscilloscope and reduces the risk of completing a circuit through your body or destroying the test equipment.

Powering the circuit

- Check all connections of the circuit and scope connections before powering the circuit, to avoid shorting or any ground loops that may lead to electrical shocks or damage of test equipment.
- Know your board well – It is recommended to have the board schematic printed out. Recheck your wiring and circuit connections.

Switching on the circuit

- Apply only lower current settings (preferably 50 mA) while using the hysteretic controller. The demo firmware is configured for driving 300 mA through LEDs.
- After functionality is proven, increase LED current by varying the hysteretic DAC thresholds, stopping at frequent levels to check for proper functioning of the circuit or to check if any components is hot or for any electrical noise that can affect circuit operation. Do not cross the limits for each of the thresholds mentioned in the sample code.
- Follow the FET ‘turn on’ sequence suggested in the demo firmware.

Switching off or shutting down the circuit

- Switch off all the power supplies and remove the power supply connections.