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CY8CKIT-003

PSoC® 3 FirstTouch™ Starter Kit Guide

Document # 001-49613 Rev. *H

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Contents

1.   Introduction

1.1   Welcome

Thank you for your interest in the CY8CKIT-003 PSoC® 3 FirstTouch™ Starter Kit. This kit is designed to introduce you to the PSoC programmable system-on-chip design methodology and Cypress's new PSoC 3 architecture. This full-featured starter kit ships with an array of sensors, I/Os, projects, and software to quickly get you up to speed with PSoC Creator™ and our powerful design methodology so you can easily evaluate PSoC and see what values the solution can provide.

This kit, in addition to the new PSoC 3 architecture, features the following:

- PSoC Creator development software with an integrated, free-edition Keil C51 Compiler
- USB-based serial wire debugging (SWD) protocol programmer and debug interface
- Accelerometer analog sensor
- Thermistor analog sensor
- Proximity analog sensor
- CapSense® analog touch-sensing interface
- 28-pin general purpose I/O pins
- 12-pin wireless module header

This guide provides instructions on how to easily evaluate the PSoC 3 architecture and PSoC Creator design methodology through five code examples.

If you have questions about or need help with this kit, visit our online technical support center at http://www.cypress.com/go/support for support options, or contact your local Cypress sales representative or authorized distributor.

1.2   Kit Contents

PSoC 3 FirstTouch Starter Kit contains:

- Evaluation board
- Quick start guide
- Kit CD/DVD
- USB A to mini B cable
- Proximity wire (for use as proximity detection antenna)
- 9 V battery

1.3   Additional Learning Resources

Visit http://www.cypress.com/go/psoc3 for additional learning resources in the form of datasheets, technical reference manual, and application notes.

1.3.1   Beginner Resources

AN54181 - PSoC 3 - Getting Started with a PSoC 3 Design Project

PSoC Creator Training

1.3.2   Engineers Looking for More

AN54460 - PSoC 3 and PSoC 5 Interrupts

AN52705 - PSoC 3 and PSoC 5 - Getting Started with DMA

AN52701 - PSoC 3 - How to Enable CAN Bus Communication

AN54439 - PSoC 3 and PSoC 5 External Crystal Oscillators

AN52927 - PSoC 3: Segment LCD Direct Drive

Cypress continually strives to provide the best support. Click here to view a growing list of application notes for PSoC 3 and PSoC 5.

1.3.3   Learning from Peers

Cypress Developer Community Forums

1.4 Document Revision History

Table 1-1. Revision History

Revision	PDF Creation Date	Origin of Change	Description of Change
**	02/19/09	KKU/VED	New kit user guide.
*A	06/19/09	KKU/ AESA	Updated Guide to the latest FTK Board Revision
*B	07/28/09	KKU	Updated Guide to the latest FTK Board Revision
*C	04/20/11	SASH	Updated PSoC Rocks schematic Updated to PSoC Programmer 3.12.3 Updated to PSoC Creator 1.0 Production
*D	12/16/11	SASH	Updated PSoC Creator release.
*E	01/31/11	RKAD	No change. Sunset review
*F	05/03/12	SASH	Added the Additional Resources section
*G	07/19/2012	SASH	Added Safety Information chapter on page 5. Updated Install Software on page 12 (Added a note at the end of the section). Updated ThermistorTemperatureSense on page 24 (Updated How the ThermistorTemperatureSense Project Works on page 24 (Updated Temperature Sensing Design Principle on page 25)). Added Regulatory Compliance Information on page 43. Replaced all instances of CD with CD/DVD across the document.
*H	09/06/2012	SASH	Updated board images. Added 2.1.1 Protection Circuit and 2.1.2 ESD Protection on USB Lines Updated 3.3 Verify Kit Version

1.5 Documentation Conventions

Table 1-2. 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.

2.   Getting Started

2.1   Hardware

The PSoC 3 FirstTouch Starter Kit contains these components and sensors.

Figure 2-1. PSoC 3 FirstTouch Starter Kit
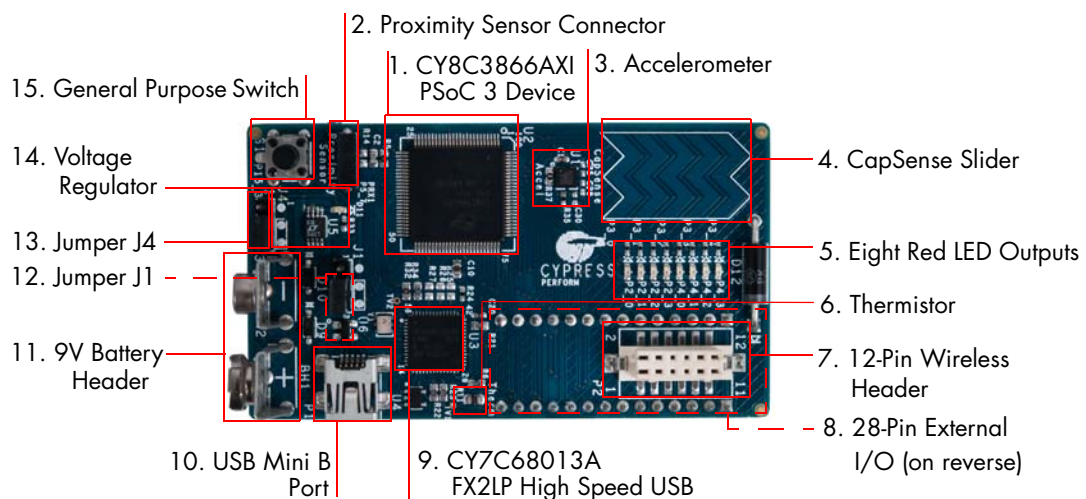
The components indicated in Figure 2-1 are:

1. PSoC 3 100-pin TQFP (Cypress CY8C3866AXI-040 TQFP100)
2. Proximity sensor connector (Samtec Inc, BCS-101-L-S-HE)
3. Three-axis accelerometer (Kionix, KXSC7-2050)
4. Five-segment CapSense slider
5. Bank of eight LEDs (also referred as LED display in this user guide)
6. Thermistor (Murata, NCP21XV103J03RA)
7. Wireless expansion connector
8. General-purpose expansion connector (22 GPIO, 2 VDD, 2 GND, 2 SIO)
9. USB programming and debugging interface (Cypress CY7C68013A-56LFXC)
10. USB connector
11. 9-V DC battery holder
12. Jumper J1 Vddio power source select

13. Jumper J4 voltage regulator source select

14. Voltage regulator (Zetex Inc, ZLDO330)

15. General-purpose push button switch

The VDDIO1 and VDDIO3 power domains are always powered by 3.3 V. The VDDIO0 and VDDIO2 can range from 1.8 V to 5 V depending on the J1 and J4 jumper settings. See Hardware Jumpers on page 34 for more details.

Note Wireless modules such as ArtaFlex Radio Modules or Cypress Low-power Radio modules such as CYWM6934/35 (not provided with the kit) can be plugged into the Wireless expansion connector on the board. You can design your own radio module using the Cypress CyFI low-power chip CYRF7936-40LXI.

2.1.1 Protection Circuit

The protection circuit consists of an 800 mA positive temperature coefficient (PTC) resettable fuse and a 5.6 V/5 W Zener diode for VDDIO pins on header J2 and J3. When an external voltage more than 5.6 V is applied, the Zener diode enters the break down region and draws large current. Large current passing through the PTC fuse cuts off the power line and resets when power supply is disconnected as current or temperature of the fuse reduces. When a revere voltage is applied, the Zener diode is forward-biased (Vf= 0.7 V) and a closed path is available through the fuse. Hence, a large current is drawn from the supply leading to a rise in the temperature of fuse. This cuts off the supply, protecting the PSoC from reverse voltage. Similarly, when a short circuit occurs, the fuse opens or breaks within 2 ms; this is because a large current is drawn through the fuse, which increases the temperature of the fuse and protects the regulator. The protection circuit allows two-way power supply at the header allowing you to power externally from 1.8 V to 5.5 V or use the onboard power supply for powering external components with maximum of around 0.324 V series drop at 270 mA current across the PTC fuse as the maximum fuse resistance is 1.2 Ω.

2.1.2 ESD Protection on USB Lines

As a best practice, USB lines are protected from ESD up to ±8 kV contact / ±15 kV air discharge by using the CD143A-SR05LC integrated chip.

2.1.3 Battery Specifications

Use batteries with the following specifications:

■ Battery size: 9 V (6LR61)

■ Output voltage: 9 VDC

■ Type: Non-rechargeable alkaline consumer batteries

■ RoHS status: RoHS compliant

■ Lead free status: Pb-free

Some recommended part numbers include 6LR61XWA/1SB (Panasonic), MN1604 (Duracell), and 6LR61 (Energizer).

3.   Installation

3.1   Install Hardware

This section shows you how to use the PSoC 3 FirstTouch Starter Kit.

Note This kit comes with a factory programmed demonstration to display "PSoC Rocks!" message on the LED display when the board is waved.

1. Unpack the PSoC 3 FirstTouch Starter Kit.

2. Connect a 9-V DC battery to the battery connector on the kit board.

3. Hold the board and battery exposing the LEDs. Then, continuously wave the board from side to side in the plane of the PCB (shown in Figure 3-1).

4. As you wave the board, the rasterized image of the message "PSoC Rocks!" appears, as shown in the following figure.

5. Keep waving. The message changes every few seconds.

Figure 3-1. Rasterized Image of "PSoC Rocks!"

3.1.1   Hardware Jumpers

There are two jumpers for power configuration. All examples are run with the default setup of 3.3 V operation. This requires J1-2 to connect to J1-3 and J4-2 to connect to J4-3. For all other configurations, see section Hardware Jumpers on page 34.

3.2   Install Software

When installing the PSoC 3 FirstTouch Starter Kit, the installer checks if the prerequisites, PSoC Creator, PSoC Programmer, Windows Installer, Windows.NET, Acrobat Reader, and Keil C51 Compiler, are installed in your PC. If these applications are not installed, then the installer prompts you to install them.

1. Insert the kit CD/DVD into the your PC. The CD/DVD is designed to automatically open an installation dialog (see Figure 3-3). If it does not automatically open, manually open this by running *cyautorun.exe* on the kit CD/DVD.

Figure 3-2. Auto Run File View

2. The kit CD/DVD installation dialog prompts you to open this file or begin installing the development environment software. Click the **Install PSoC 3 FirstTouch Starter Kit** menu item.

Figure 3-3. Installation Dialog.

3. As specified, this installation process first determines if you have all prerequisite software. Follow the on-screen dialogs to complete all required installations. After following these steps, you must have the following software installed:

   a. PSoC Creator 1.0 SP1 or later

   b. PSoC Programmer 3.12.4 or later

   c. Keil C51 Compiler (Cypress edition)

d. GNU GCC Compiler (for PSoC 5 development)

e. PSoC 3 FirstTouch Starter Kit example projects and documentation

4. Following the software installation, verify if you have all hardware and drivers set up for the PSoC 3 FirstTouch Starter Kit by connecting the kit board to your PC via its USB interface. Because this is the first time you have connected this board to this PC, initial driver installations occur. Follow any on-screen dialogs that appear to complete the installation process.

5. Now, verify your installation and setup by opening PSoC Programmer with the kit board attached over USB. Open PSoC Programmer. In the port selection frame, you should see the PSoC 3 FirstTouch starter kit. If you do, you have successfully installed all required software and drivers to begin your PSoC 3 evaluation. Congratulations!

6. Close PSoC Programmer.

7. Open PSoC Creator and continue to the next section to experiment with the included code examples.

Note Important for Win7 and Vista users: Rename the *_tools.ini file in <Install_Directory>:\PSoC Creator\<version>\PSoC Creator\import\keil\pk51\<version> to "tools.ini" for the Keil registration to be successful.

3.3   Verify Kit Version

To know the kit revision, look for the white sticker on the bottom left on the reverse of the kit box. If the revision reads CY8CKIT-003B Rev **, then, you own the latest version.

To upgrade CY8CKIT-003/CY8CKIT-003A to CY8CKIT-003B, you can purchase our latest kits at www.cypress.com/go/CY8CKIT-003.

4. Code Examples

4.1 PSoC Rocks

The PSoC Rocks project displays a rasterized image of the user defined message ("PSoC Rocks!") using persistence of vision. Waving the circuit board back and forth quickly in the plane of the board generates the message.

Note On connecting the board to PC for the first time, a Windows Logo testing warning may pop up. Please ignore this warning by clicking "Continue Anyway".

4.1.1 Open the PSoC Rocks Project

1. Click on the PSoC Rocks code example from **Examples and Kits > Kits** on the Start Page of PSoC Creator.
2. Create a folder in the desired location and click **OK**.
3. The project opens up in PSoC Creator and is saved in that folder.
4. Build the project to generate the.hex file.

Figure 4-1. Open PSoC Rocks from Examples and Kits

4.1.2 Modify PSoC Rocks Project

1. From the Workspace Explorer, open the *main.c* file, as shown in Figure 4-2.
2. Replace the "PSoC Rocks!" string in the DisplayString[ ] [ ] array of strings with "Cypress" or any other message(s) up to 25 characters. By default, it displays the following messages one by one:
   - ❏ PSoC Rocks!
   - ❏ Customize Message
   - ❏ By Installing
   - ❏ PSoC Creator

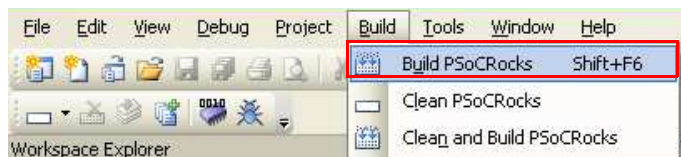❏ From Kit CD/DVD

❏ Open Project

Figure 4-2. main.c File View

3. The number of times each string in the array is displayed can be adjusted by modifying the respective entry in the StringCycles[ ] array. Valid entries are 1 to 255.

4.1.3 Build, Program, and Run the PSoC Rocks Project
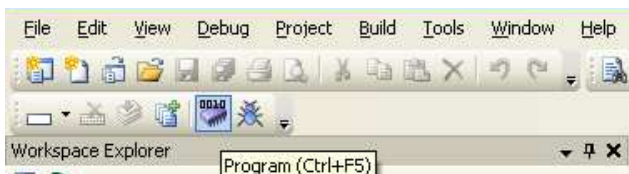
1. Build the project by selecting **Build → Build PSoCRocks**.
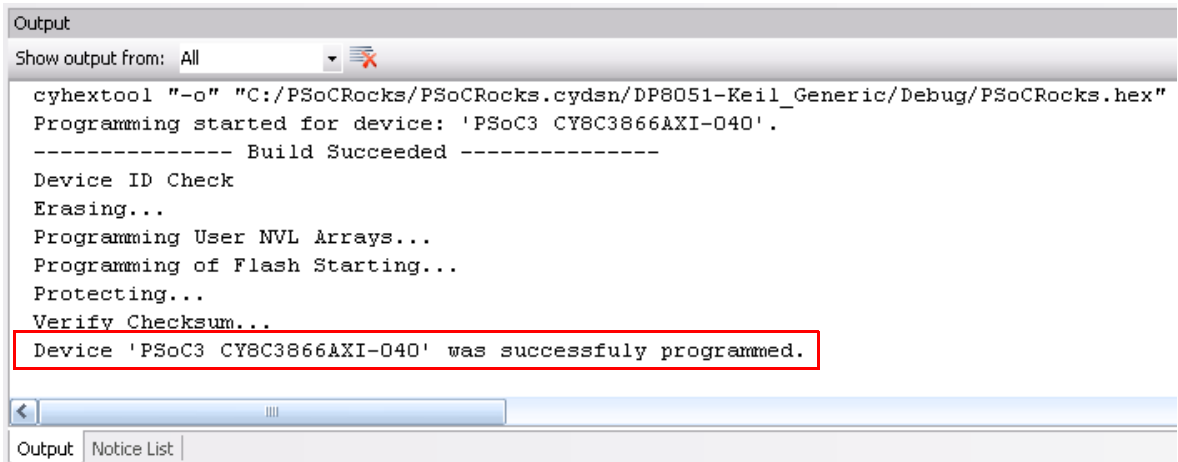
Figure 4-3. Build PSoCRocks

2. Connect the PSoC 3 FirstTouch Starter Kit board to your PC by using a USB cable.

3. Click the **Program** icon.

Figure 4-4. Program

4. The project is programmed successfully, as shown in .

Figure 4-5. Program Successful

5. When the download is complete, remove the USB cable from the PSoC 3 FirstTouch Starter Kit board and connect a 9-V battery to the battery connector.

6. Follow the steps in section Install Hardware on page 11 to see your message displayed.

4.1.4 Schematic Design PSoC Creator

To view this project's customized hardware configuration, open the *TopDesign.cysch* file located in the Workspace Explorer window. PSoC Creator's schematic design entry methodology, using pre-defined peripheral functions called components, allows rapid hardware definition and implementation.

The schematic entry system works similar to standard circuit board schematic entry tools, with the exception that all components and routing are automatically implemented within the PSoC device rather than on a PCB. This allows you to create custom solutions using peripherals commonly found in MCU designs as well as analog peripherals, digital peripherals, and logic, not possible with any other microcontroller or system-on-chip. In many designs, traditionally external resources can be fully integrated within the PSoC device.

The PSoC Rocks design schematic uses several peripheral and circuit elements. A single analog input pin connected to the accelerometer's Y axis is routed to an ADC. A pin component with three pins is used to control the functionality of the accelerometer and another pair is used to drive the LEDs. The last schematic element is a control register that is used to drive the LED pins. The control register output is inverted to sink current from the LEDs. This allows the LEDs to be driven externally with the highest possible current and brightness without adding complexity to the design. Conventional systems require firmware overhead to decode and invert the data for each of the affected LED pins.

The PSoC Rocks schematic (see Figure 4-6 on page 18) provides a small sample of how custom hardware and peripherals are possible in PSoC devices. Each component selected from the component catalog and placed on to the project schematic provides a GUI, configurable parameters, and datasheet to further customize its operation in the design. During the project build process, each component generates the required hardware configuration and firmware APIs as necessary to provide a truly custom hardware configuration.
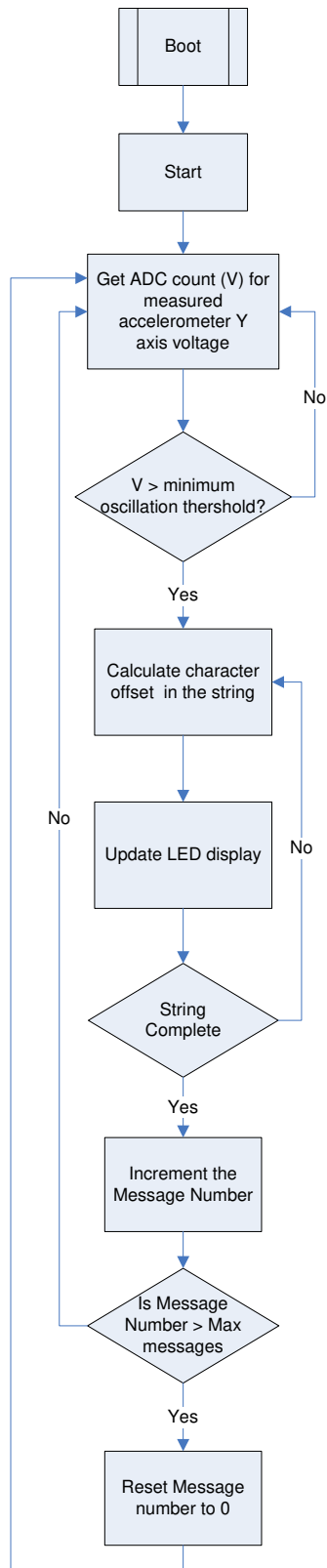
Figure 4-6. PSoC Rocks Schematic
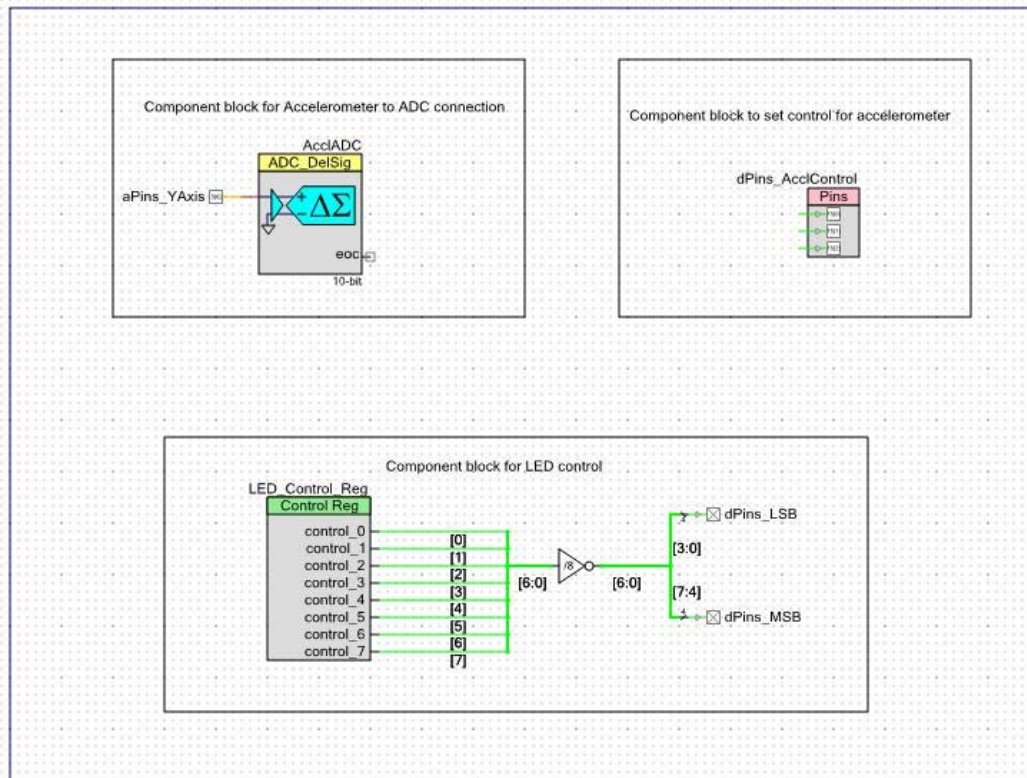
4.1.5 How the PSoC Rocks Project Works

This example displays a message using a bank of LEDs, that when swung in a back and forth arcing motion, produces a rasterized character display. The PSoC 3 FirstTouch Starter Kit has a three-axis accelerometer. The accelerometer detects the instant acceleration of the board when in motion. The instantaneous voltage at each axis of the accelerometer is directly proportional to the acceleration along that axis.

In this project, the firmware uses the Y axis voltage output of the accelerometer. This voltage is routed to an ADC in the PSoC. This digital value is now a measure of acceleration detected by the accelerometer. If the acceleration exceeds a maximum value, it signals the start of a new wave event. The firmware delays for a fixed period of time to start the first character in the proper position of the wave. The current string is converted into a rasterized display data array before the start of the wave. Each column of the rasterized data array is sequentially output after a fixed delay. The delay periods may be adjusted in firmware.
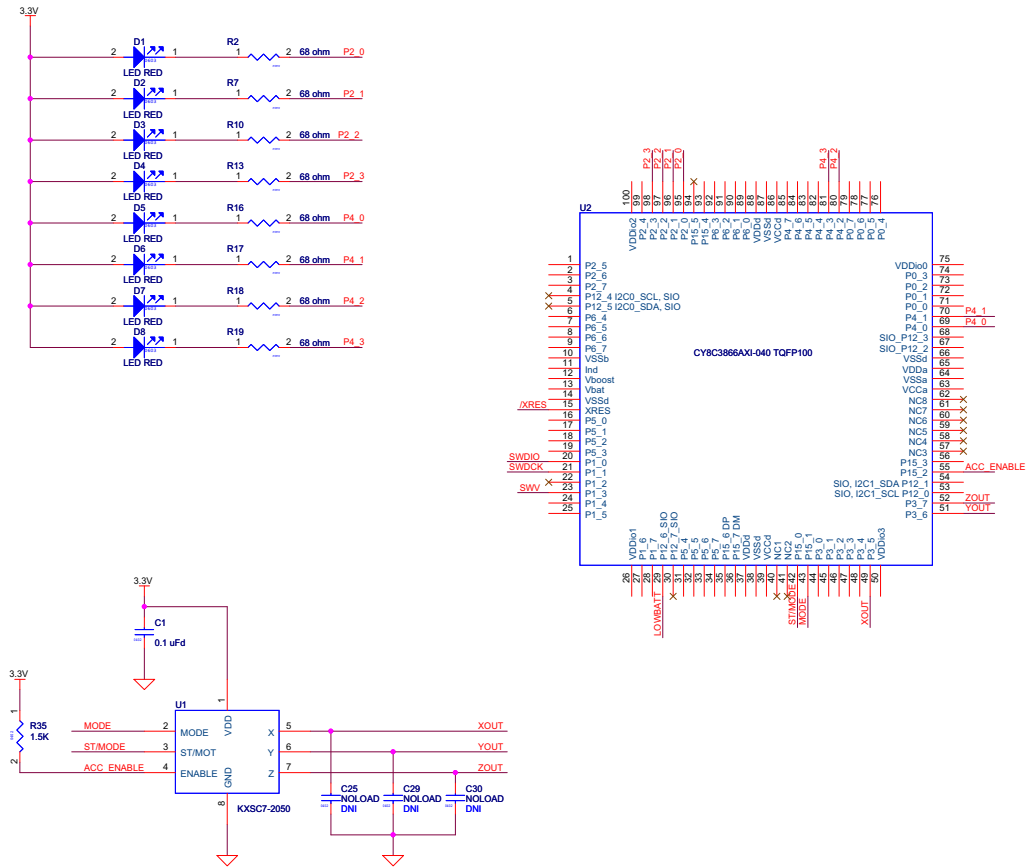
For a particular character in the message, a look up table determines which LEDs to turn on. When the board is waved back and forth rapidly, due to persistence of vision, the user defined image appears to float in the air. Multiple strings may be configured with each string being displayed for an adjustable number of wave cycles.

Figure 4-7. PSoC Rocks Project Flowchart

Boot

Start

Get ADC count (V) for measured accelerometer Y axis voltage

No

V > minimum oscillation thershold?

Yes

Calculate character offset in the string

No

Update LED display

No

String Complete

Yes

Increment the Message Number

Is Message Number > Max messages

Yes

Reset Message number to 0

4.1.6   PCB Schematic

Figure 4-8. PSoC Rocks Project PCB Schematic

CY8CKIT-003 PSoC 3 FirstTouch Starter Kit Guide, Document # 001-49613 Rev. *H
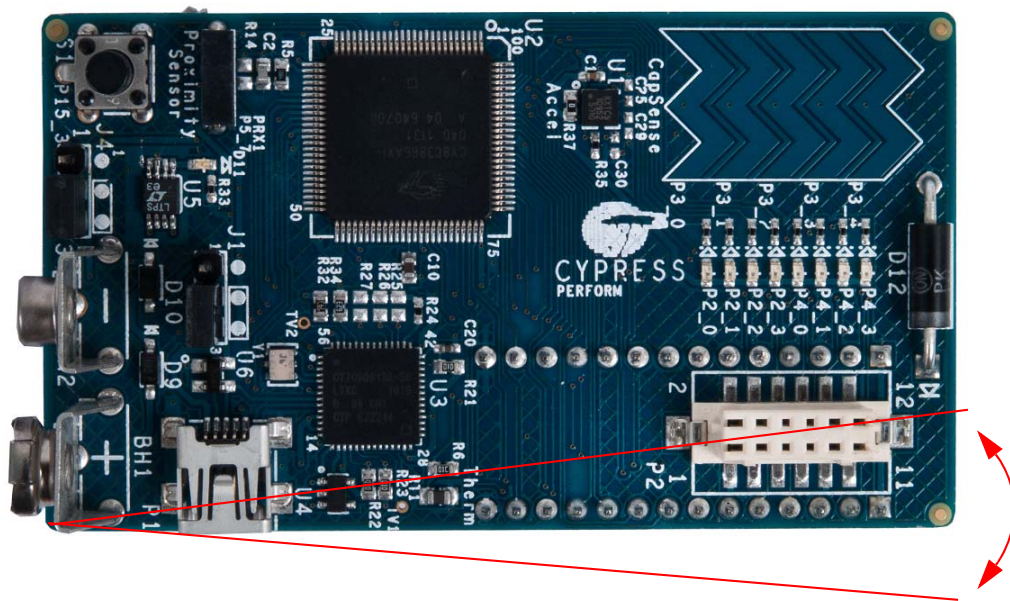
4.2   Bubble Level Emulator

This project emulates a glass bubble level instrument using the onboard accelerometer and the LED display. When the program is run, the LEDs shows the direction in which the board is tilted.

Running the Bubble Level Emulator project:

1. Connect the PSoC 3 FirstTouch Starter Kit board to the USB port of the PC using the USB cable.

2. Click on the BubbleLevel example from **Examples and Kits** present on the Start Page of PSoC Creator.

3. Create a folder in the desired location and click **OK**.

4. The project opens up in PSoC Creator and is saved in that folder.

5. Follow step 1 to 4 in section 4.1.3 Build, Program, and Run the PSoC Rocks Project on page 16 to program the project into the PSoC 3 FirstTouch Starter Kit board.

6. When the download is complete, remove the PSoC 3 FirstTouch Starter Kit board from the USB port and connect a 9-V DC battery to the battery connector of the PSoC 3 FirstTouch Starter Kit board.

7. Tilt the board along the X axis of the accelerometer by holding the battery in a stationary position and move the edge opposite the battery up and down, as shown in Figure 4-9. When you tilt the board, you can see the direction of the tilt on the LED display.

Figure 4-9. Bubble Level Emulator - Perpendicular Motion

4.2.1 How the Bubble Level Emulator Project Works

A bubble level displays the amount the level deviates from horizontal using a bubble of air in a glass via level. In this project, a level is emulated by the accelerometer on the board.

In bubble level detection, LEDs display the tilt of the board along its length (corresponding to the X axis of the accelerometer).

The accelerometer is always under the influence of gravity. When the board is placed flat on the ground, the static acceleration due to gravity along the X axis of the accelerometer is zero. In this position, the two LEDs in the center of the LED display are turned on. Because the board is tilted in one direction, the force of gravity along that axis increases. This increases the static acceleration detected by the accelerometer. The X axis voltage output of the accelerometer is fed into an ADC in the PSoC. The ADC converts this voltage into digital count, which is the measure of the static acceleration detected by the accelerometer. PSoC determines the tilt of the board and lights up LEDs indicating the tilt. If the board is further tilted in one direction, the LED moves accordingly to the extreme of the LED display.

Figure 4-10. Bubble Level Emulator Project Flowchart
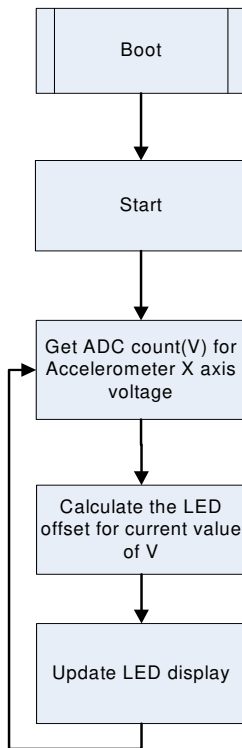
4.2.2 PCB Schematic

Figure 4-11. Bubble Level Emulator Project PCB Schematic
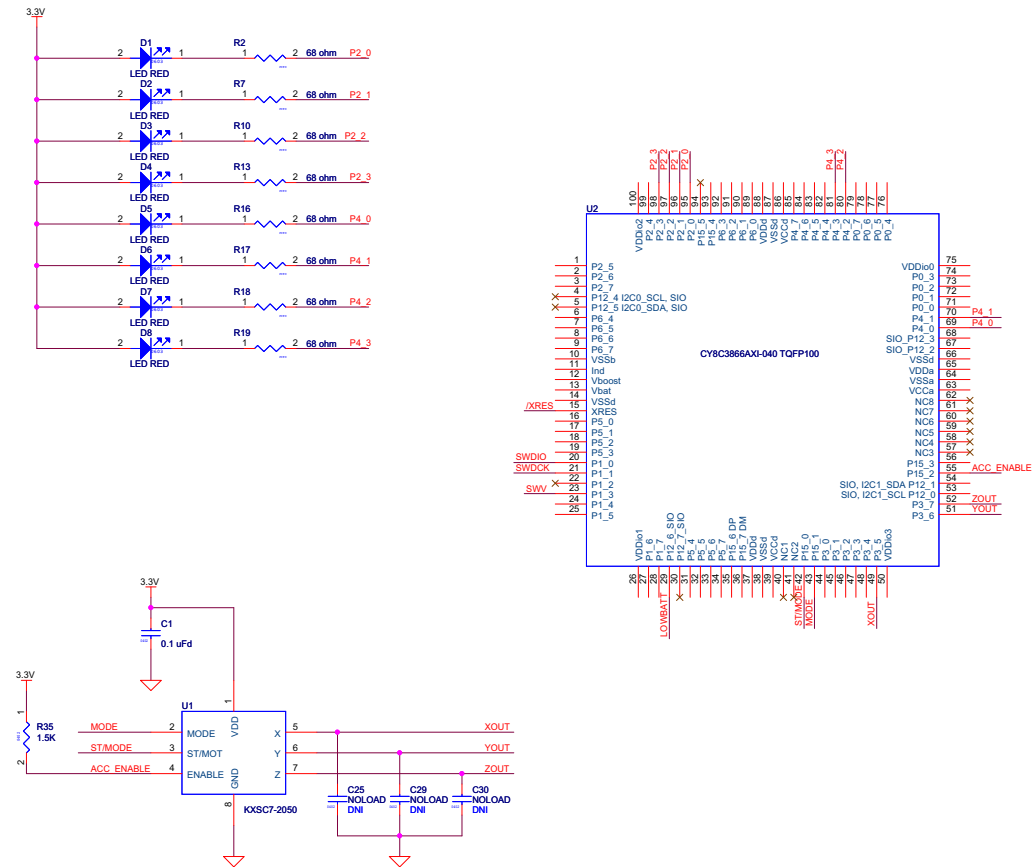
4.3   ThermistorTemperatureSense

This project measures the current room temperature and displays it as a rasterized image when the board is waved.

Running the ThermistorTemperatureSense project:

1. Connect the PSoC 3 FirstTouch Starter Kit board to the USB port of the PC through the USB cable.
2. Click on the ThemistorTemperatureSense example from **Examples and Kits** on the Start Page of PSoC Creator.
3. Create a folder in the desired location and click **OK**.
4. Te project opens up in PSoC Creator and is saved in that folder.
5. Follow step 1 to 4 in section Build, Program, and Run the PSoC Rocks Project on page 16 to program the project into the PSoC 3 FirstTouch Starter Kit board.
6. When the download is complete, remove the PSoC 3 FirstTouch Starter Kit board from the USB port and connect a 9-V DC battery to the battery connector of the PSoC 3 FirstTouch Starter Kit board.
7. Hold the board and wave it continuously from left to right, as shown in Figure 3-1 on page 11. A rasterized image of the current measured temperature in degree Celsius is visible in the air. Press the S1 switch while waving the board to toggle the temperature from Celsius to Fahrenheit and vice-versa.

4.3.1   How the ThermistorTemperatureSense Project Works

The thermistor example demonstrates how the PSoC device senses temperature using a thermistor. The thermistor resistance varies with temperature following a predictable nonlinear curve. The temperature-resistance relationship is given by the Steinhart-Hart equation:

$$1 / T_k = A + B*ln(R) + C*(ln(R))^3$$
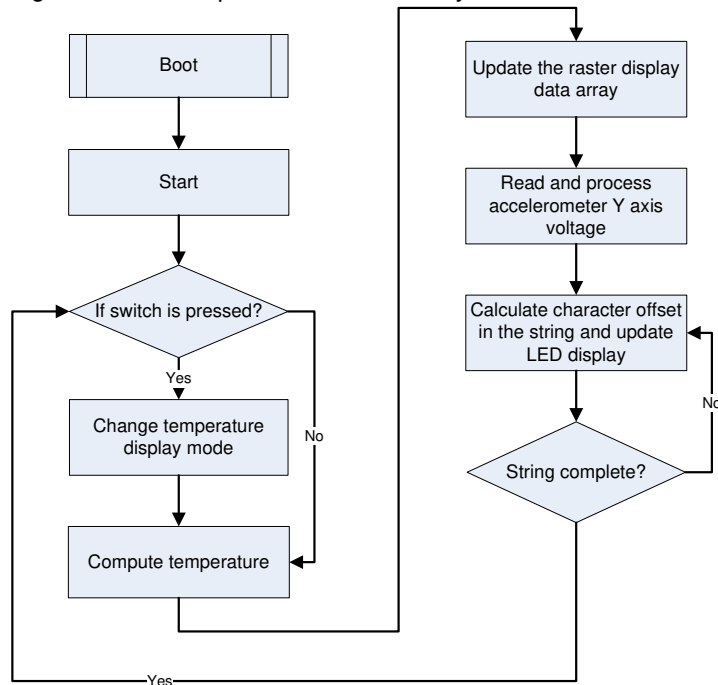
In this equation:

- A, B, and C are empirical constants known as Steinhart-Hart coefficients.
- R is the resistance of the thermistor in Ohms.
- T_k is the temperature in degree Kelvins.

The same equation, when converted to Celsius scale becomes:

$$T_c = T_k - 273.15$$

In this equation, T_c is the temperature in degree Celsius.

Figure 4-12. Temperature Sensor Project Flowchart

4.3.1.1 *Temperature Sensing Design Principle*

As shown in Figure 4-13, the design for temperature sensing uses a voltage divider with a precision resistor on one side and the thermistor on the other to estimate the thermistor resistance. The temperature calculations are as accurate as the resistance measurement of the thermistor.

Figure 4-13. Temperature Sensing Design Principle
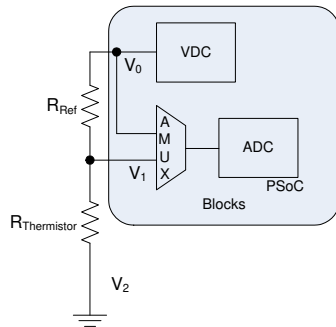
This setup significantly removes gain and offset errors from the resistance calculation.

The analog voltage output from the divider is converted to a digital signal using the ADC on the PSoC. To gain additional accuracy, the voltage at the input side of the divider is also measured. The resistor value is calculated using the ratio of the voltages across two resistors in the resistor ladder.

$$\text{Rthermistor} = \text{Rref} * (V_1 - V_2 / V_0 - V_1)$$

In this equation, $V_2 = 0$ (Ground voltage)

Offset errors, if any, are removed due to subtraction of the two measured voltages. The ratio of these two values removes the measurement path gain error. The error due to the reference resistor is reduced by using a precision resistance in series with the thermistor.