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CY8CKIT-003

PSoC[®] 3 FirstTouch[™] Starter Kit Guide

Spec. # 001-49613 Rev. *D

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1. Introduction



1.1 Welcome

Thank you for purchasing the CY8CKIT-003 PSoC[®] 3 FirstTouch[™] Starter Kit.

The PSoC 3 FirstTouch Starter 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/O's, 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 you.

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

- PSoC Creator development software with an integrated, free-edition Keil C51 Compiler
- USB-based Serial Wire Debugging 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

In this guide you will find instructions on how to easily evaluate the PSoC 3 architecture and PSoC Creator design methodology through five included example projects. Experience the development software for yourself and discover how we truly have changed the way you change the world!

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
- USB A to Mini B cable
- Proximity wire (for use as proximity detection antenna)
- 9 V battery

1.3 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	05/24/11	SASH	Updated PSoC Creator release

1.4 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\
<i>Italics</i>	Displays file names and reference documentation: Read about the <i>sourcefile.hex</i> file in the <i>PSoC Designer User Guide</i> .
[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.

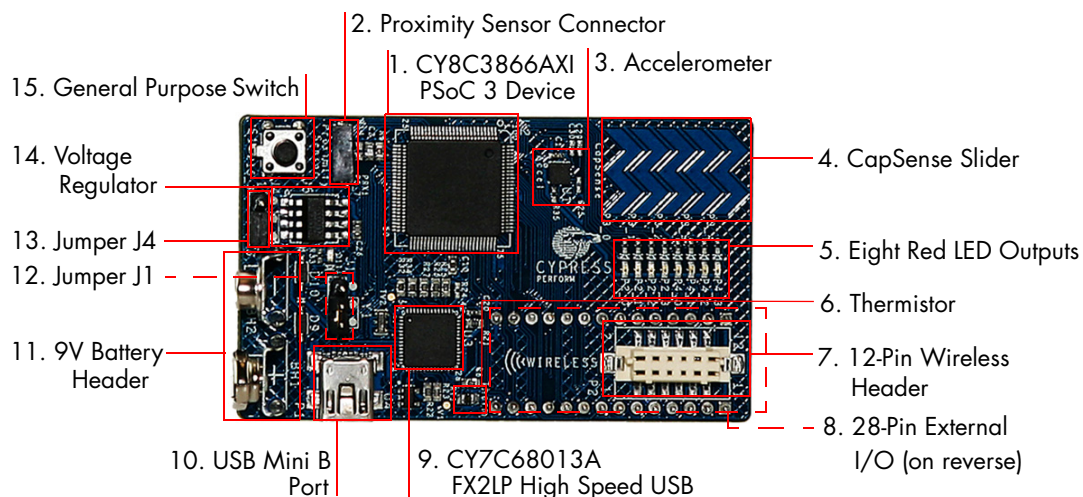
2. Getting Started



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. 9V 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

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 board. You may design your own radio module using the Cypress' CyFI-Low power chip CYRF7936-40LXI.

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 9V 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 3.3V operation. This requires J1-2 to connect to J1-3 and J4-2 to connect to J4-3. For all other configurations see section [5.1.1 Hardware Jumpers on page 33](#).

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

Figure 3-2. Auto Run File View

Name	Size	Type
Files Currently on the CD		
Documentation		File Folder
Firmware		File Folder
Hardware		File Folder
Prerequisite		File Folder
PSoC 3 FirstTouch Starter Kit		File Folder
PSoC Creator		File Folder
PSoC Programmer		File Folder
autorun.inf	1 KB	Setup Information
cyautorun.dat	1 KB	DAT File
cyautorun.exe	1,418 KB	Application
setup.ico	10 KB	Icon

2. The kit cd's 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 to begin this installation.

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 you have all hardware and drivers setup for the PSoC 3 FirstTouch Starter Kit by connecting the kit board to your PC via its USB interface. As this is the first time you have connected this board to this PC, initial driver installations occur. Should any on-screen dialogs appear, follow them 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 on to the next section to experiment with the included example projects.

3.3 Verify Kit Version

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

You can also check the silicon marketing part number on the board. If the part number is CY8C3866AXI-040, then congratulations, you own the latest version and This kit is equipped with production PSoC 3 silicon.

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

4. Example Projects



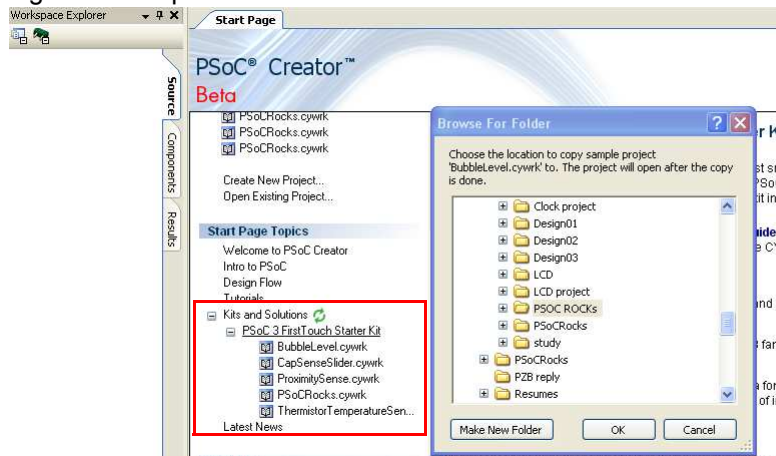
4.1 PSoC Rocks

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.

4.1.1 Open the PSoC Rocks Project

1. Click on the example project PSoC Rocks from **Kits and Solutions** present on the Startup page of the PSoC Creator.
2. Make a folder in the desired location and click **OK**.
3. Project opens up in the PSoC Creator and gets saved in that folder.
4. Build the project to generate the `.hex` file.

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



4.1.2 Modify the 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) desired 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
 - Open Project

Figure 4-2. main.c File View

```

61 | /*****
62 | * Main function performs following functions:
63 | * 1: Initializes all variables
64 | * 3: Turn off All LEDs on POR
65 | * 2: Initializes the accelerometer
66 | * 3: Converts the string to display into a rasterized data array
67 | * 4: Start ADC to read acceleration value from Y axis of Accelerometer
68 | * 5: Waits for an acceleration from a wave to be detected.
69 | * 5: Updates the LEDs with the rasterized message at a periodic rate
70 | *****/
71 |
72 | /* Messages to be displayed when board is waved (messages must not be longer t
73 | const char8 DisplayString[MAX_MESSAGE_NUMBER][STRING_MAX_LEN] =
74 | {
75 |     "PSoC Rocks",
76 |     "Customize Message",
77 |     "By Installing",
78 |     "PSoC Creator",
79 |     "From Kit CD",
80 |     "Open Project",
81 | };
82 | /* Number of wave cycles to display each message defined in 'DisplayString' */
83 | const uint8 StringCycles[MAX_MESSAGE_NUMBER] =
84 | {
85 |     30,

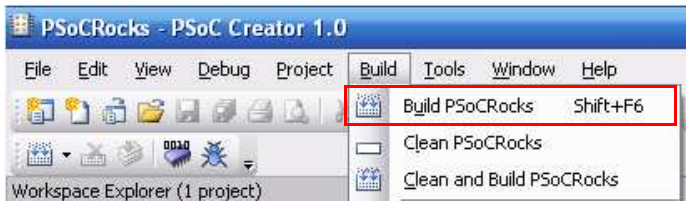
```

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 1-255.

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



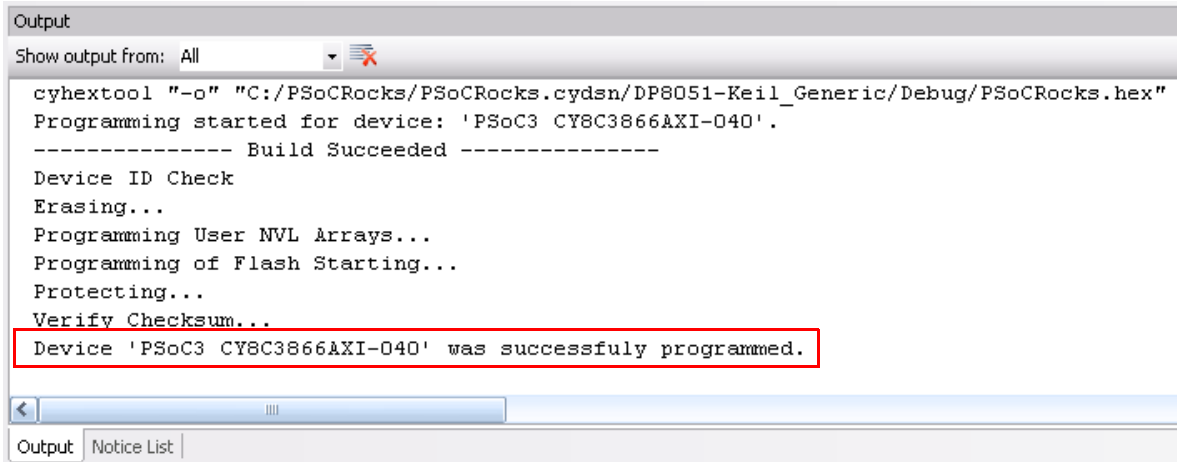
2. Connect the PSoC 3 FirstTouch Starter Kit board to your PC by using a USB cable.
3. Click the **Program** icon.

Figure 4-4. Program



4. The project is programmed successfully as shown in [Figure 4-5 on page 15](#).

Figure 4-5. Program Successful



```

Output
Show output from: All
cyhextool "-o" "C:/PSoCRocks/PSoCRocks.cydsn/DP8051-Keil_Generic/Debug/PSoCRocks.hex"
Programming started for device: 'PSoC3 CY8C3866AXI-040'.
----- Build Succeeded -----
Device ID Check
Erasing...
Programming User NVL Arrays...
Programming of Flash Starting...
Protecting...
Verify Checksum...
Device 'PSoC3 CY8C3866AXI-040' was successfully programmed.

```

5. When the download is complete, remove the USB cable from the PSoC 3 FirstTouch Starter Kit board and connect a 9V battery to the battery connector.
6. Follow the steps in section [3.1 Install Hardware on page 9](#) to see your message displayed.

4.1.4 Schematic Design PSoC Creator

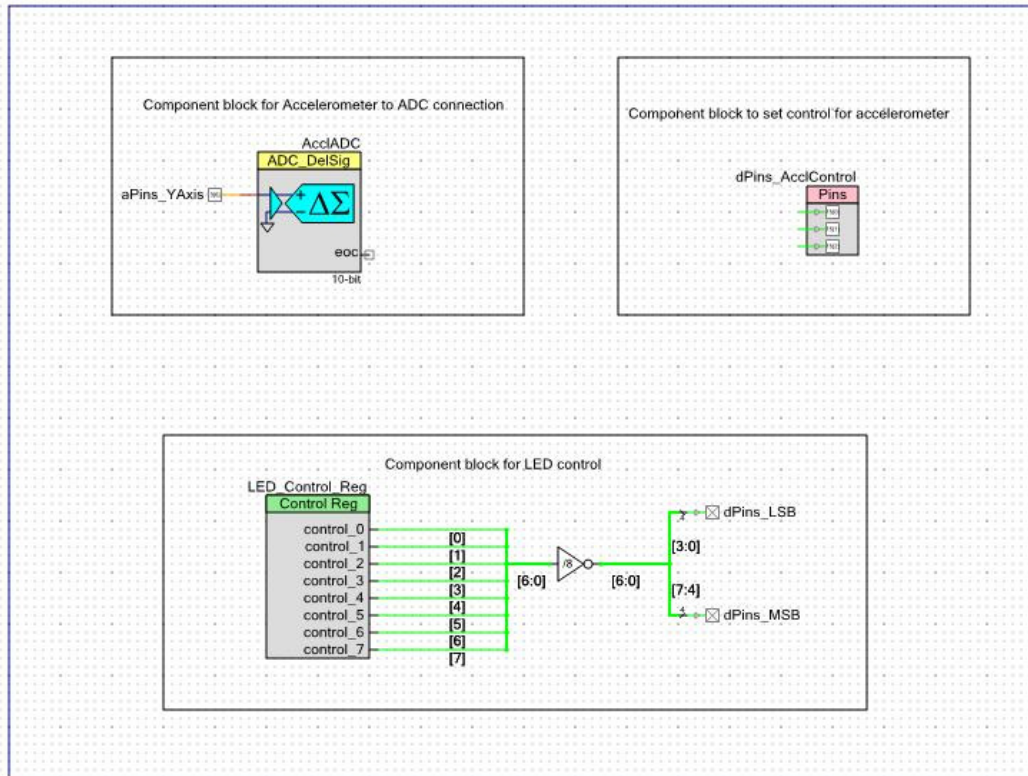
This project's customized hardware configuration is viewed by opening the *TopDesign.cysch* file located in the Workspace Explorer window. PSoC Creator's schematic design entry methodology, using pre-defined peripheral functions called components, allows rapid hardware definition and implementation.

The schematic entry system works similarly 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 are able to 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 3 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 would 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 16](#)) provides a small sample of how custom hardware and peripherals are possible in PSoC devices. Each component selected from the component catalog and placed onto the project schematic provides a GUI, configurable parameters, and full data sheet 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



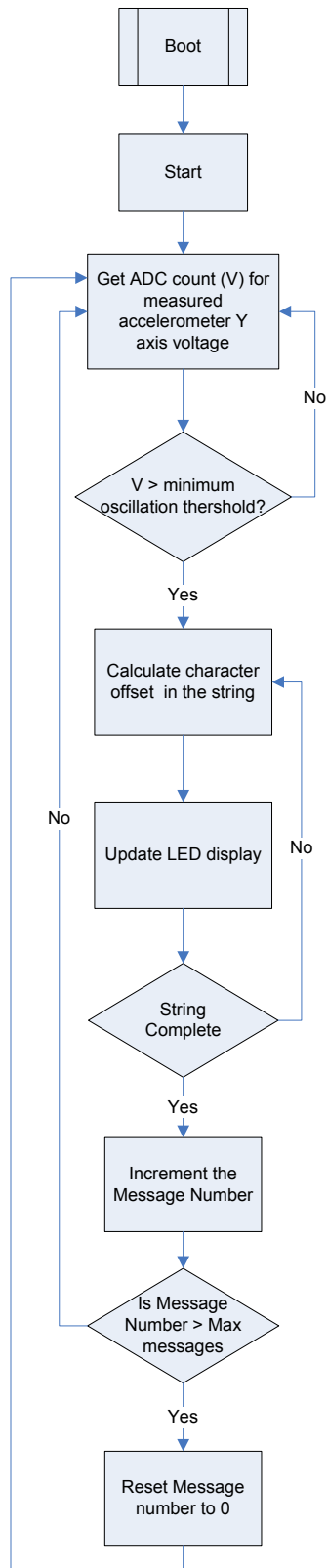
4.1.5 How the PSoC Rocks Project Works

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 instantaneous 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. On start of a new wave 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 prior to 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.

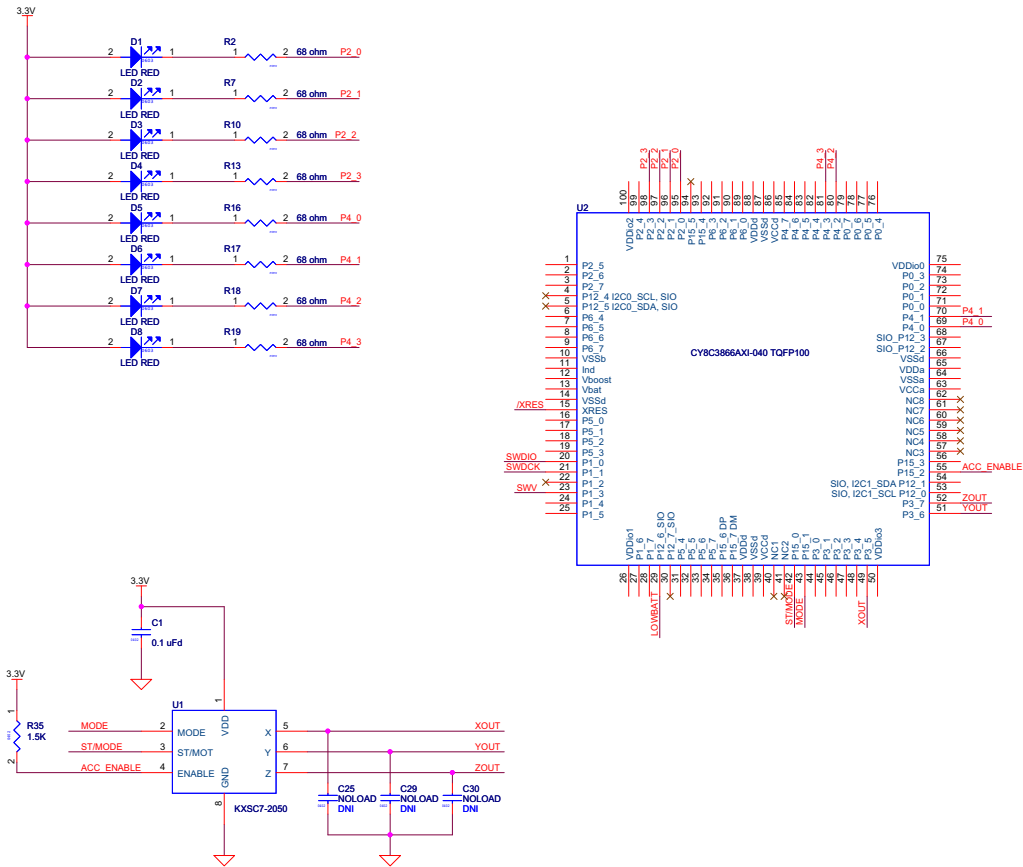
For a particular character in the message, a look up table determines which LEDs to turn on. When the board is waved back and forth rapidly, due to persistence of vision, the user defined image appears to float in the air. Multiple strings may be configured with each string being displayed for an adjustable number of wave cycles.

Figure 4-7. PSoC Rocks Project Flowchart



4.1.6 PCB Schematic

Figure 4-8. PSoC Rocks Project PCB Schematic



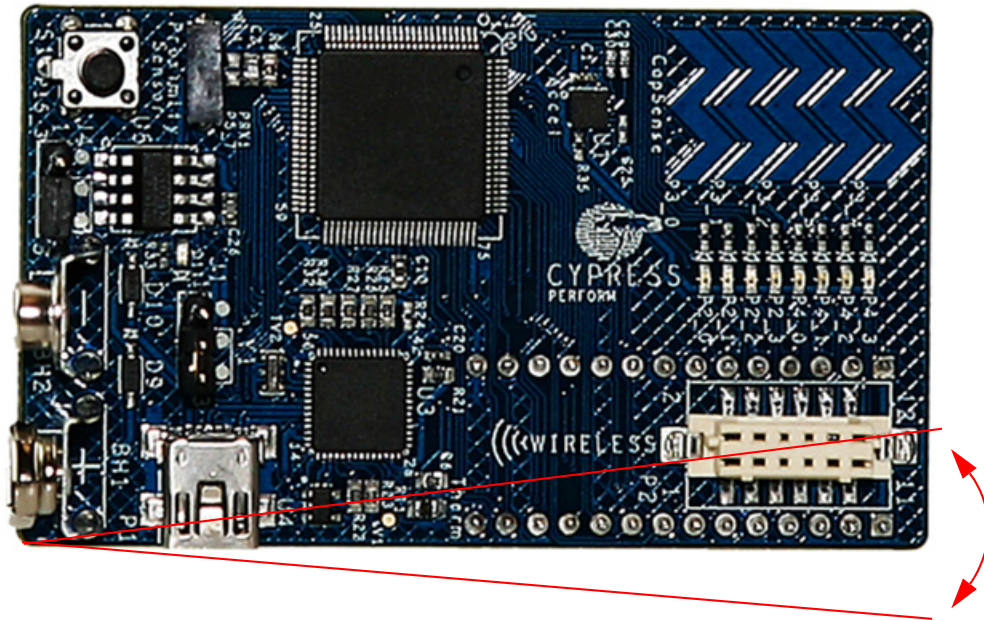
4.2 Bubble Level Emulator

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 example project BubbleLevel from **Kits and Solutions** present on the Startup page of the PSoC Creator.
3. Make a folder in the desired location and click **OK**.
4. Project opens up in the PSoC Creator and gets 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 14](#) 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 9V 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](#). As you tilt the board, you could see the direction of the tilt on the LED display.

Figure 4-9. Bubble Level Emulator - Perpendicular Motion



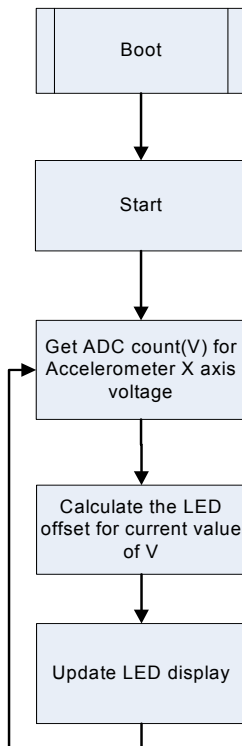
4.2.1 How the Bubble Level Emulator Project Works

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

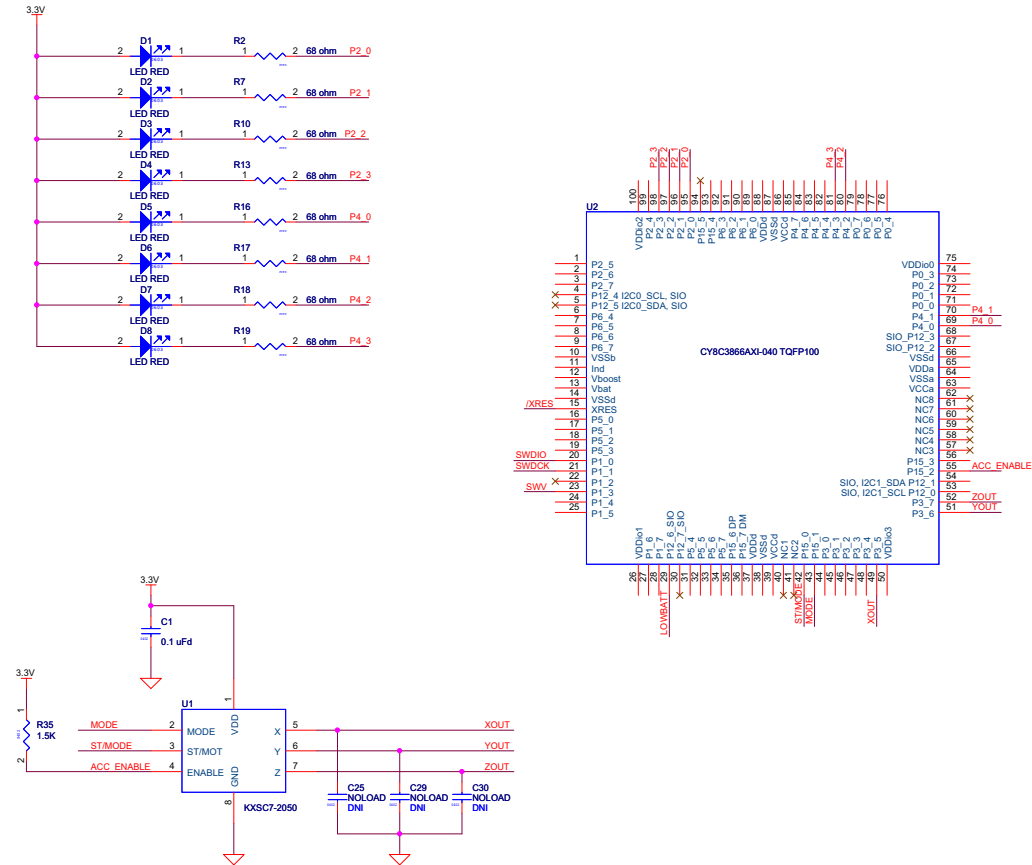
The accelerometer is always under the influence of gravity. When the board is placed flat on the ground, the static acceleration due to gravity along the X axis of the accelerometer is zero. In this position of the board, the two LEDs in the center of the LED display are turned on. As the board is tilted 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 accordingly keeps moving 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 example project ThemistorTemperatureSense from **Kits and Solutions** present on the Startup page of the PSoC Creator.
3. Make a folder in the desired location and click **OK**.
4. Project opens up in PSoC Creator and gets 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 14](#) 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 9V 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 9](#). 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:

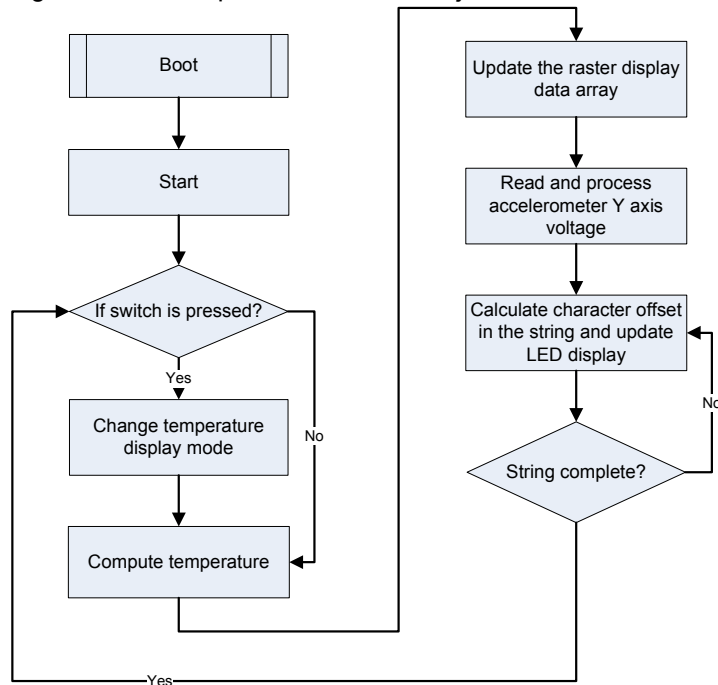
- A, B, and C are empirical constants known as Steinhart-Hart coefficients.
- R is the resistance of the thermistor in Ohms.
- T_k is the temperature in degree Kelvins.

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.

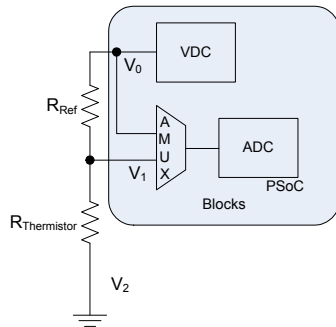
Figure 4-12. Temperature Sensor Project Flowchart



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 the two resistors in the resistor ladder.

$$R_{\text{thermistor}} = R_{\text{ref}} * (V_1 - V_2 / V_0 - V_1)$$

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.

4.4 CapSense Slider

This project shows how to detect the position of a finger on the CapSense slider of the PSoC 3 FirstTouch Starter Kit board and indicate its position on the LED display.

Running the CapSense 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 example project CapSenseSlider from **Kits and Solutions** present on the Startup page of the PSoC Creator.
3. Make a folder in the desired location and click **OK**.
4. Project opens up in PSoC Creator and gets 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 14](#) 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 9V DC battery to the battery connector of the PSoC 3 FirstTouch Starter Kit board.
7. Move your finger along the CapSense Slider and see the corresponding LEDs light up.

4.4.1 How the CapSense Slider Project Works

Capacitive sensing determines the presence of a conductive element, such as the finger, on a capacitive sensor incorporated on the PCB. The kit consists of a bank of CapSense sensors in the form of a slider. The size of the sensors and their position is designed such that when a finger is placed on any part of the slider, at least three sensors are active (it detects the presence of the finger by a change in its capacitance value).

The CapSense component provides APIs, which report the centroid (relative position) of the finger on the slider based on the active sensors. The firmware then lights up the LED corresponding to this centroid position.