AN75320

Getting Started With PSoC® 1

Author: Robert Murphy, Ashutosh Srivastava

Associated Project: Yes

Associated Part Family: All PSoC 1 Families

Software Version: PSoC Designer™ 5.4 SP 1 and higher

Related Application Notes: For a complete list of the application notes, click here.

To get the latest version of this application note, or the associated project file, click here.

AN75320 introduces you to PSoC® 1, an 8-bit processor with programmable digital and analog blocks that enable implementation of custom functions. This application note describes the PSoC 1 architecture and development tools, and shows how to create your first design. This document guides you to more resources to accelerate in-depth learning about PSoC 1.

Contents

1 Introduction

PSoC 1 is a true **programmable embedded system-on-chip**, integrating custom analog and digital peripheral functions, memory, and an M8C microcontroller on a single chip. This is different from most mixed-signal embedded systems, which use a combination of a microcontroller (MCU) and external analog and digital peripherals. This type of system typically requires many integrated circuits in addition to the MCU, such as opamps, ADCs, and digital ASICs.

PSoC 1 provides a low-cost alternative to the combination of MCU and external ICs. In addition to reducing overall system cost, the programmable analog and digital sub-systems allow great flexibility, in-field tuning of the design, and accelerates time to market.

The system resources of PSoC 1 can be dynamically reconfigured during run time to perform completely different functions. Dynamic reconfigurability is possible during instances where the resources have been consumed in a design. This allows you to reuse PSoC 1 system resources and maximize the integration value proposition.

The capacitive touch-sensing feature in PSoC 1, known as CapSense®, offers unprecedented signal-to-noise ratio (SNR), best-in-class waterproofing, and a wide variety of sensor types such as buttons, sliders, trackpads, and proximity sensors.

This application note helps you explore the PSoC 1 architecture and development tools, and learn how to create your first project using PSoC Designer™, the development tool for PSoC 1. This document also guides you to more resources to accelerate in-depth learning about PSoC 1.

In addition to PSoC 1, the Cypress PSoC portfolio also contains PSoC 3, PSoC 4, and PSoC 5LP devices. These PSoC devices offer different system architecture and peripherals. For more information, refer to the Cypress Platform PSoC Solutions Roadmap.

2 Get Started

Cypress provides a wealth of data at www.cypress.com to help you to select the right PSoC device for your design, and to help you to quickly and effectively integrate the device into your design. For a comprehensive list of resources, see the knowledge base article How to Design with PSoC® 1, PowerPSoC®, and PLC – KBA88292. Following is an abbreviated list for PSoC 1:

- Overview: PSoC Portfolio, PSoC Roadmap
- Product Selectors: PSoC 1, PSoC 3, PSoC 4, PSoC 5LP
- In addition, PSoC Designer includes a device selection tool.
- Application notes: Cypress offers a large number of PSoC application notes covering a broad range of topics, from basic to advanced level. Recommended application notes for getting started with PSoC 1 are:
  - AN75320 - Getting Started with PSoC® 1.
  - AN2094 - PSoC® 1 - Getting Started with GPIO.
  - AN74170 - PSoC® 1 Analog Structure and Configuration with PSoC Designer™
  - AN2041 - Understanding PSoC® 1 Switched Capacitor Analog Blocks
  - AN2219 - PSoC® 1 Selecting Analog Ground and Reference

Note: For CY8C29X66 devices related application notes, click here.

- Development Kits:
  - CY3210-PSoCEval1 supports all PSoC 1 mixed-signal array families, including automotive, except the CY8C25/26xxx devices. The kit includes an LCD module, potentiometer, LEDs, and breadboarding space.
  - CY3214-PSoCEvalUSB features a development board for the CY8C24x94 PSoC device. Special features of the board include USB and CapSense development and debugging support.

Note: For CY8C29X66 devices related development kits, click here.

The MiniProg1 and MiniProg3 devices provide interfaces for flash programming and debug.

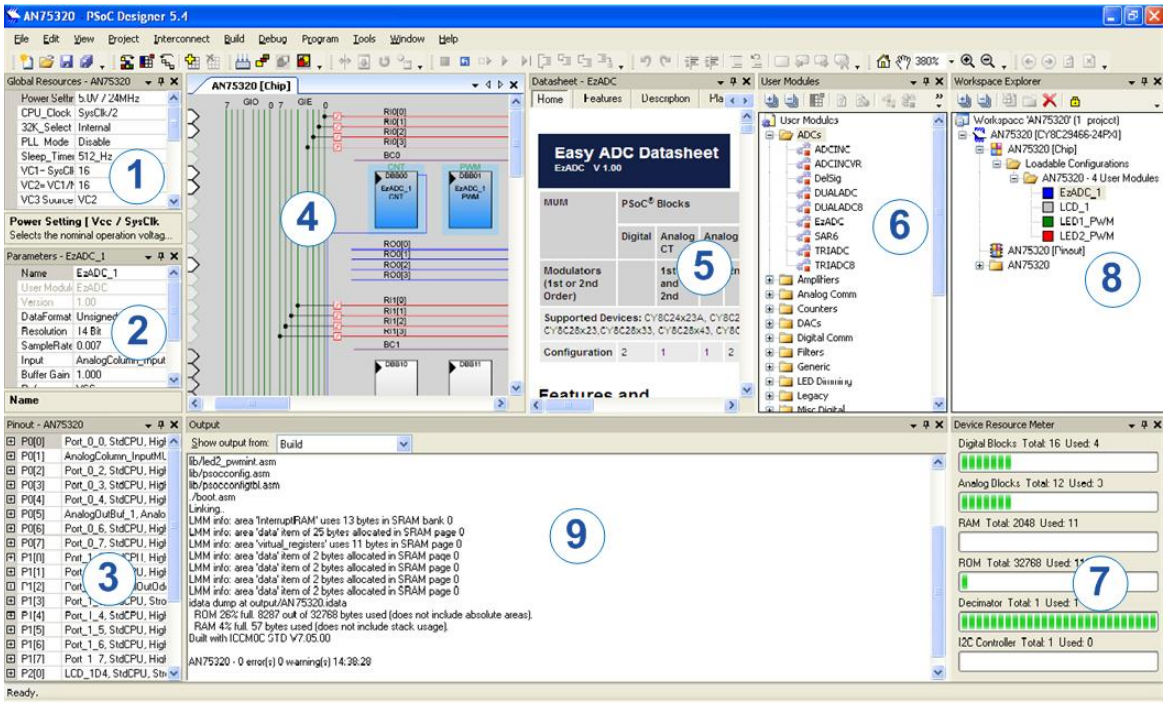
2.1 PSoC Designer

PSoC Designer is a free Windows-based Integrated Design Environment (IDE). Develop your applications using a library of pre-characterized analog and digital peripherals in a drag-and-drop design environment. Then, customize your design leveraging the dynamically generated API libraries of code. Figure 1 shows PSoC Designer windows. **Note:** This is not the default view.

1. Global Resources – all device hardware settings.
2. Parameters – the parameters of the currently selected User Modules.
3. Pinout – information related to device pins.
4. Chip-Level Editor – a diagram of the resources available on the selected chip.
5. Datasheet – the datasheet for the currently selected UM
6. User Modules – all available User Modules for the selected device.
7. Device Resource Meter – device resource usage for the current project configuration.
8. Workspace – a tree level diagram of files associated with the project.
9. Output – output from project build and debug operations.

Note: For detailed information on PSoC Designer, open PSoC Designer IDE, go to **Help** > **Documentation**, open the "Designer Specific Documents" folder, and open the "IDE User Guide.pdf" document.

Figure 1. PSoC Designer Layout



2.2 Code Examples

The following webpage lists the PSoC Designer based code examples. These code examples can speed up your design process by starting you off with a complete design, instead of a blank page, and also show how PSoC Designer User Modules can be used for various applications.

http://www.cypress.com/documentation/code-examples/psoc-1-code-examples

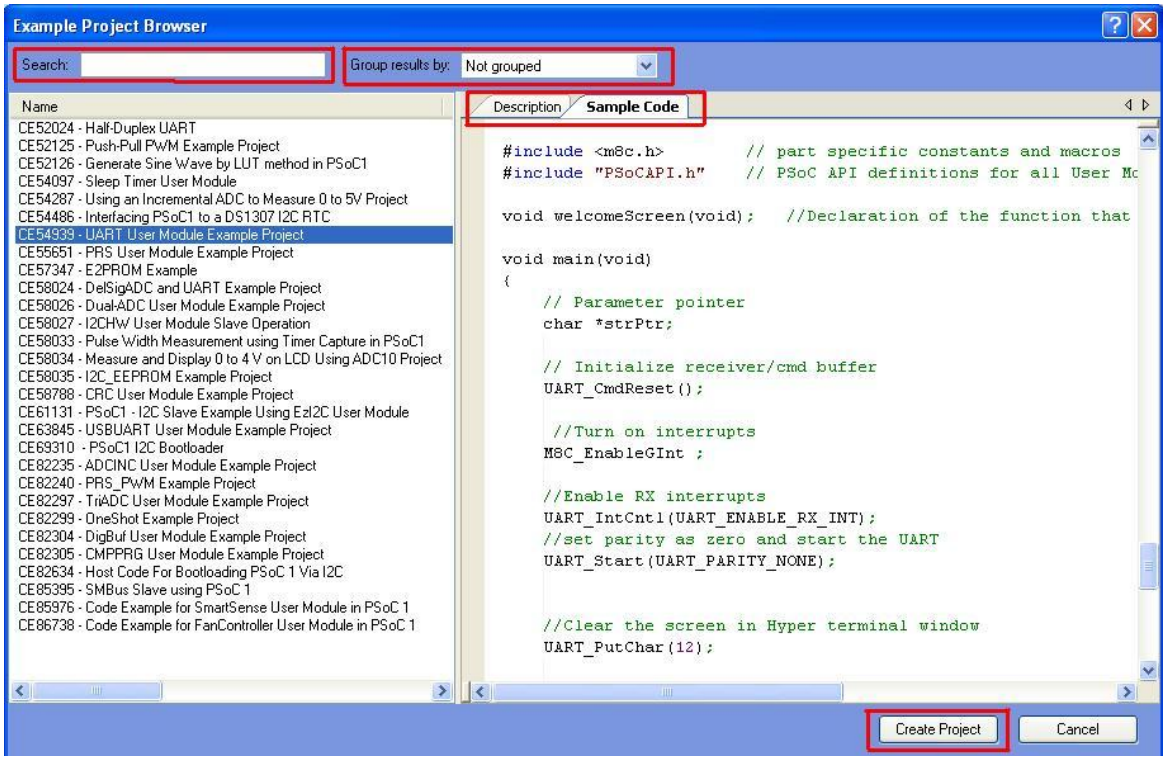
To access the code examples integrated with PSoC Designer, follow the path **Start Page > Design Catalog > Launch Example** *Browser* as shown in Figure 2.

Figure 2. Code Examples in PSoC Designer

In the Example Projects Browser shown in Figure 3, you have the following options.

- Keyword search to filter the projects.
- Listing the projects based on category.
- Review the datasheet for the selection (on the Description tab).
- Review the code example for the selection. You can copy and paste code from this window to your project, which can help speed up code development, or
- Create a new project (and a new workspace if needed) based on the selection. This can speed up your design process by starting you off with a complete, basic design. You can then adapt that design to your application.

Figure 3. Code Example Projects, with Sample Codes



2.3 PSoC Designer Help

Visit the PSoC Designer home page to download the latest version of PSoC Designer. Then, launch PSoC Designer and navigate to the following items:

- **IDE User Guide**: Choose **Help > Documentation > Designer Specific Documents > IDE User Guide.pdf**. This guide gives you the basics for developing PSoC Creator projects.
- **Simple User module Code Examples**: Choose **Start Page > Design Catalog > Launch Example Browser**. These code examples demonstrate how to configure and use PSoC Designer User modules.
- **Technical Reference Manual**: Choose **Help > Documentation > Technical Reference Manuals**. This guide lists and describes the system functions of PSoC 1 devices.
- **User module datasheets**: Right-click a User module and select “Datasheet.” This datasheet explains the parameters and APIs of the selected user module.
- **Device Datasheet**: Choose **Help > Documentation > Device Datasheets** to pick the datasheet of a particular PSoC 1 device.
- **Imagecraft Compiler Guide**: Choose **Help > Documentation > Compiler and Programming Documents > C Language Compiler User Guide.pdf**. This guide provides the details about the Imagecraft compiler specific directives and Functions.

2.4 Technical Support

If you have any questions, our technical support team is happy to assist you. You can create a support request on the Cypress Technical Support page.

If you are in the United States, you can talk to our technical support team by calling our toll-free number: +1-800-541-4736. Select option 8 at the prompt.

You can also use the following support resources if you need quick assistance.

- Self-help
- Local Sales Office Locations

3 Comparison of PSoC 1 Families

PSoC 1 includes thirteen device families. Table 1 shows the features available in these device families.

Table 1. PSoC 1 Device Selector Summary Table

Features	Device Family											
	29x66	28xxx	27x43	24x94	24x93	24x33	24x23A	23x33	22x45	21x45	21x34	21x23
Flash (KB)	32K	16K	16K	16K	32K	8K	4K	8K	16K	8K	8K	4K
SRAM (KB)	2K	1K	256B	512B	2K	256B	256B	256B	1K	512B	512B	256B
ADC 1 (DS/SS)	14-bit (DS)	4x14-bit (DS)	11-bit (DS)	14-bit (DS)	10-bit (INC)	11-bit (DS)	11-bit (DS)	11-bit (DS)	8-bit (SS)	8-bit (SS)	10-bit (SS)	10-bit (SS)
ADC 2 (SAR)	-	10-bit (150 Ksps)	-	-	-	8-bit (300 Ksps)	-	8-bit (300 Ksps)	10-bit (150 Ksps)	10-bit (150 Ksps)	-	-
Comparator	4	4	4	2	2	2	2	2	4	4	2	2
DAC (8-bit)	4	4	4	2	-	2	2	2	-	-	-	-
PGA (x48 Gain)	4	4	4	2	-	2	2	2	-	-	-	-
TCPWM (16-bit)	8	6	4	2	3 (Timer)	2	2	2	4	2	2	2
UART/SPI	4	3	2	1	1 SPI	1	1	1	2	1	1	1
I2C	1	2	1	1	1 (Slave)	1	1	1	1	1	1	1
CapSense Buttons	-	43	-	49	-	-	-	-	37	23	23	-
GPIO	64	44	44	50	36	26	24	26	38	24	24	16
USB	-	-	-	FS 2.0	FS 2.0	-	-	-	-	-	-	-
ECO	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	N
SMP	Y	Y	Y	N	N	N	Y	N	Y	Y	Y	Y
MAC	2	2	1	2	0	1	1	1	1	1	0	0

FS = Full Speed, **SMP** = Switch Mode Pump, **ECO** = External Crystal Oscillator, **MAC** = Multiply Accumulate, **INC** = Incremental, **DS** = Dual Slope, **SS** = Single Slope, **PGA** = Programmable Gain Amplifier, **TCPWM** = Timer Counter Pulse Width Modulator, **UART** = Universal Asynchronous Receiver Transmitter, **SPI** = Serial Peripheral Interface, **I2C** = Inter-Integrated Circuit

4 PSoC 1 Feature Set

PSoC 1 has a large set of capabilities and features, which include a CPU core, a digital subsystem, an analog subsystem, a memory subsystem, and system resources, as Figure 4 shows. The following sections give brief descriptions of each feature. For more information, see the PSoC 1 family device datasheet, technical reference manual (TRM), and application notes listed in PSoC 1 Learning Resources.

Figure 4. PSoC 1 Architecture (CY8C29466)

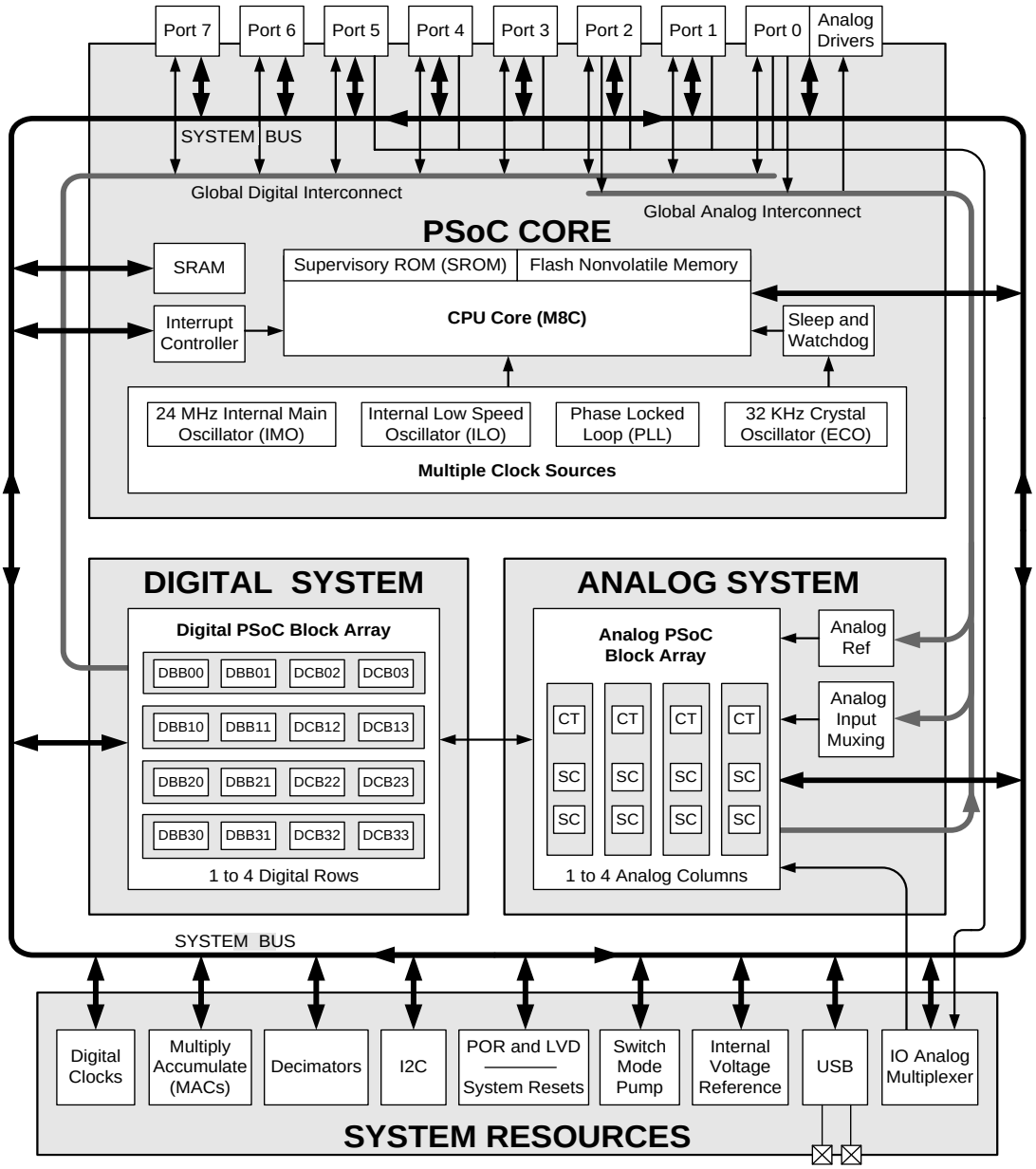


Figure 4 shows the feature available in the CY8C29466 device. Subsets of these features are available in other devices; see Table 1.

4.1 M8C Processor and Memory

PSoC 1 has an M8C processor, which is an 8-bit RISC CPU with Harvard architecture. It is capable of operating at a maximum frequency of 24 MHz, providing 4 MIPS performance. The M8C has 37 instructions. PSoC 1 devices have as much as 2 KB of SRAM and as much as 32 KB of flash, as Table 1 shows. For more details, refer to the PSoC 1 Technical Reference Manual.

4.2 Programmable Digital Subsystem

The digital subsystem of PSoC is unique because of its programmability and routing systems. Table 1 lists the various PSoC 1 parts and the digital resources available in each device. The digital blocks in PSoC 1 are sub-divided into Digital Basic Blocks (DBBs) and Digital Communication Blocks (DCBs). The number of DBBs and DCBs are always equal.

4.2.1 Digital Basic Blocks (DBBs)

DBBs are basic configurable digital resources, which you can program to function as timers, counters, or PWMs. Each DBB allows you to place an 8-bit resource. Creating a 16-bit, a 24-bit, or a 32-bit digital resource requires two, three, or four DBBs, respectively.

4.2.2 Digital Communication Blocks (DCBs)

DCBs not only allow you to place basic digital resources (timer, counter, or PWM), but they also allow you to place communication resources, such as SPI and UARTs. You can place DBB components in DCBs. However, you cannot place DCB resources in DBBs.

4.3 Programmable Analog Subsystem

The unique analog subsystem of PSoC 1 is composed of analog blocks arranged in a column configuration. These analog blocks are either continuous time (CT) or switched capacitor (SC) blocks.

4.3.1 Continuous Time (CT) Blocks

The CT blocks inside PSoC are programmable analog blocks that you can configure as either comparators or programmable gain amplifiers (PGAs). The CT blocks are built around low-noise and low-offset opamps. The large number of analog multiplexers in the CT block provides high configurability. For more information on the structure and composition of CT blocks, refer to Chapter 22 of the PSoC 1 Technical Reference Manual.

4.3.2 Switched Capacitor (SC) Blocks

SC blocks are also built around low-noise, low-offset opamps surrounded by analog multiplexers. These blocks are unique because groups of capacitors and switches surround the opamps and multiplexers. There is no resistor array as there are in the CT blocks. For additional information on the SC block architecture, refer to Chapter 23 of the PSoC 1 Technical Reference Manual or AN2041 – Understanding PSoC 1 Switch Capacitor Analog Blocks.

4.4 System-wide Resources

4.4.1 Clocking System

PSoC includes an advanced clocking system with multiple clock sources, many of which are programmable. You can derive the main clock source from either the internal 24-MHz internal main oscillator (IMO) or an external clock source of up to 24 MHz. In addition, for a low-speed oscillator, you can use either a 32-kHz oscillator circuit or an internal low-speed oscillator (ILO). For more information on clocks available in PSoC 1, refer to AN32200 - PSoC® 1 - Clocks and Global Resources.

4.4.2 Switch Mode Pump (SMP)

The switch mode pump (SMP) is a DC/DC boost circuit supported by PSoC to allow the device to operate from a single 1.5-V battery. PSoC has an internal FET and an independent PWM hardware to run the boost circuit. You need only an external battery, inductor, diode, and capacitor to complete the boost circuitry. For more information, refer to Chapter 30 of PSoC 1 Technical Reference Manual.

4.4.3 Multiply Accumulate (MAC)

The Multiply Accumulate, or MAC, provides an 8-bit signed multiplier with a 32-bit accumulator for summation. The MAC is extremely useful in performing math operations and implementing digital filters. You can use the MAC by writing to and reading from certain registers of the device. After multiplication, you can either read the value out of the register or store it in the accumulator. You can clear the accumulator reset it to a value of zero by writing to the clear registers (MACx_CL1 and MACx_CL2). For more information, refer to Chapter 26 of PSoC 1 Technical Reference Manual.

4.4.4 Voltage Reference

PSoC 1 contains many options for voltage references. The three main terms are:

1. AGND
2. RefHi
3. RefLo

Analog signals in the device are biased to analog ground (AGND). The voltage location of AGND depends on the developer, who has a range of options. Analog signals higher than AGND are considered positive, while voltages below it are considered negative. RefHi and RefLo refer to the upper and lower limits of the analog system. For more details, refer to AN2219 - PSoC® 1 Selecting Analog Ground and Reference.

4.4.5 Dedicated I^2C Hardware

The I^2C communications block is a serial-to-parallel processor, designed to interface the PSoC device to a two-wire I^2C serial communications bus. To eliminate the need for excessive M8C microcontroller intervention and overhead, the block has I^2C-specific support for status detection and generation of framing bits.

Following are the major features and capabilities of the PSoC I^2C hardware controller:

- Industry-standard Philips® I^2C bus-compatible interface
- Master and slave operation, multi-master capable
- Only two pins (SDA and SCL) are required to interface to the I^2C bus
- Standard data rate of 100/400 kbps; also supports 50 kbps
- 7-bit addressing mode; 10-bit addressing supported

Additional information on using I^2C can be found in AN50987: Getting Started with I2C in PSoC 1.

4.5 GPIO System

The GPIO system provides an interface between the CPU, the peripherals, and the outside world. Each GPIO, when used as a digital I/O, can source 10 mA per pin and can sink 25 mA per pin. In total, the device is capable of sinking 200 mA, with 100 mA per side. Therefore, even number pins on any port can handle a total of 100 mA, and odd number pins on any port can handle an additional 100 mA. The device can source a total of 80 mA or 40 mA per side. For more details, refer to Chapter 6 of the PSoC 1 Technical Reference Manual and AN2094 - PSoC® 1 - Getting Started with GPIO.

4.6 CapSense

Some PSoC 1 devices support capacitive touch sensing known as CapSense. Capacitive touch sensors are user-interface devices that use human body capacitance to detect the presence of a finger on or near (proximity) a sensor. Capacitive sensors are aesthetically superior, easy-to-use, and have long lifetimes. CapSense allows you to replace expensive and unreliable mechanical buttons with capacitive buttons that are simple copper traces on the PCB. CapSense supports a wide variety of sensors such as buttons, sliders, trackpads and proximity sensors. To see which PSoC 1 devices support CapSense, see Table 1. For additional information, refer to AN64846 - Getting Started with CapSense.

4.7 Dynamic Reconfigurability

With PSoC 1, you can start a project design without knowing all the details of the end product, and then add resources as needed. As long as the digital or analog resources are available, you can adjust, adapt, and grow. Even in instances where the resources have been consumed in a design, PSoC can be dynamically reconfigured during run time to perform a different function. This allows you to reuse resources in PSoC and maximize the integration value proposition. For details, refer to AN2104 - PSoC® 1 - Dynamic Reconfiguration With PSoC® Designer™.

5 Development Tools

Cypress supports PSoC 1 with high-quality development tools such as the PSoC Designer software tool, hardware tools including development kits, programming hardware, and debugging hardware. These tools help you to configure the device, develop the application code, then build, debug, and deploy an embedded design.

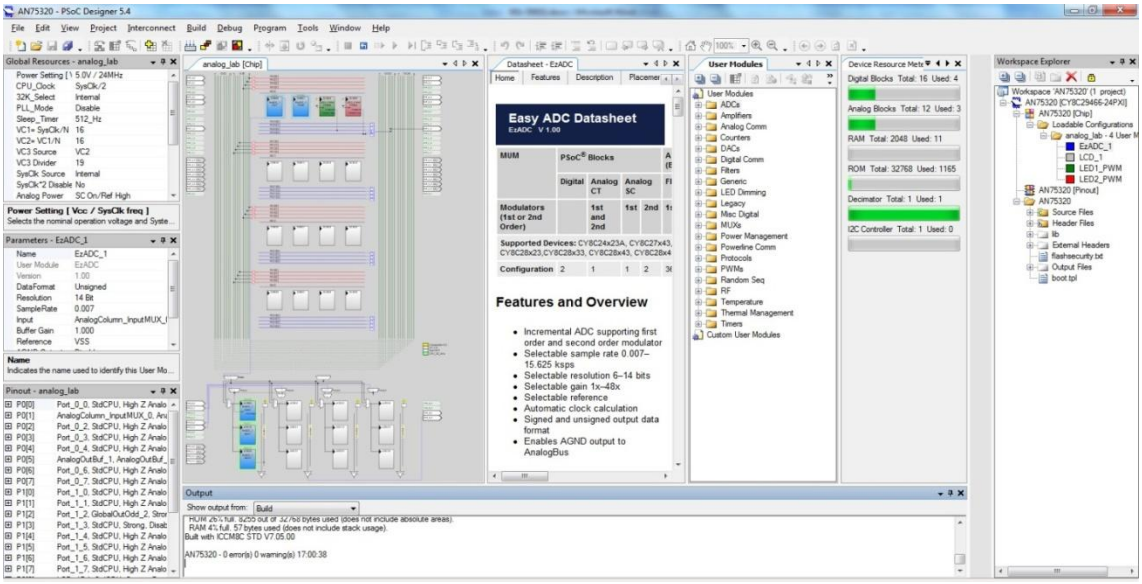
5.1 Software: PSoC Designer IDE

Cypress's PSoC Designer is an integrated development environment (IDE) used to customize, configure, and program PSoC 1 devices. You can download this tool from http://www.cypress.com/products/psoc-designer.

PSoC Designer is a fully-contained environment where you can create your PSoC application by configuring the analog and digital peripherals, write application code, and perform other functions discussed in this application note. In addition, this software lets you program a PSoC device and debug a project using the PSoC ICE-Cube debug platform.

Figure 5 shows the layout of PSoC Designer and a description of each section of the IDE is given in the PSoC Designer section. Note that this is not the default layout of PSoC Designer. Any windows seen in the following figure that do not appear when you open Designer can be added by navigating through the **View** dropdown menu in the toolbar.

Figure 5. PSoC Designer Layout



5.2 Hardware

Cypress provides various PSoC 1 hardware kits to fulfill your design requirements. To choose your PSoC 1 device, refer to PSoC 1 Kits and PSoC 1 Kit Selector Guide. The following section provides a list of the development kits, the programming hardware, and the debugging hardware.

5.2.1 Development Kits

Cypress provides several development kits to help you easily prototype your PSoC 1 design. Table 2 lists the some of the development kits that support the evaluation of PSoC 1. For complete list of the development kits/board, refer to Development Kits.

Table 2. PSoC 1 Development Kits

Development Kit	Description
CY3210-PSOCEVAL1	The CY3210 PSoC Eval1 Kit enables you to evaluate and experiment Cypress's PSoC 1 programmable system-on-chip design methodology and architecture
CY8CKIT-001	The CY8CKIT-001 PSoC Development Kit provides a common development platform where you can prototype and evaluate different solutions.

5.2.2 Programming Hardware

You can choose from several options for programming devices from Cypress-provided and third-party tools. Cypress offers four programming devices: MiniProg1, MiniProg3, ICE-Cube, and CY3207-ISSP.

MiniProg1

The MiniProg1 is the ISSP programmer that is included with many PSoC 1 kits. You can use this programmer for all PSoC 1 devices, except the CY25/26xxx devices. The MiniProg1 cannot be used to program PSoC 3 or PSoC 5 devices.

MiniProg3

The MiniProg3 is the ISSP programmer that comes with the CY8CKIT-001 Development Kit. The MiniProg3 is an all-in-one programmer for PSoC 1, PSoC 3, and PSoC 5 devices, a debug tool for PSoC 3 and PSoC 5 architectures, and a USB-I^2C bridge for debugging I^2C serial connections and communicating with PSoC devices.

Third-Party Programmers

See the list of third-party programmer tools at http://www.cypress.com/documentation/development-kitsboards/general-psoc-programming. These tools have been designed, tested, and qualified by Cypress to support programming of PSoC 1 devices.

5.2.3 Debugging Hardware

CY3215A-DK

CY3215A-DK In-Circuit Emulation Lite Development Kit includes an in-circuit emulator (ICE). While the ICE-Cube is primarily used to debug PSoC 1 devices, it can also program PSoC 1 devices using ISSP. Rather than using the blue CAT5 cable or the flex cable to interface with debug pods, you can use the yellow ISSP cable to program devices. This makes the ICE-Cube useful for both debug and production environments. See AN73212 – Debugging with PSoC 1 for more details.

6 PSoC 1 Learning Resources

This section provides a list of PSoC 1 learning resources to help you to get started and to develop complete applications with PSoC 1. Many resources are available for PSoC 1 developers, including datasheets, reference manuals, videos, and application notes.

6.1 PSoC 1 Data Sheets

Visit the PSoC 1 Datasheets page for PSoC 1 datasheets that list the features and electrical specifications of all PSoC 1 device families.

6.2 Learning PSoC 1 Designer

Visit the PSoC Designer home page to download the latest version of PSoC Designer.

Launch PSoC Designer and navigate to the following items:

PSoC Designer User Guides: Visit the PSoC Designer User Guide page for a PSoC Designer User Guide.

6.2.1 IDE User Guide:

Launch **PSoC Designer** > **Help** > **Documentation** > **Designer Specific Documents** > **IDE User Guide**. This guide gives you the basics on developing PSoC Designer projects.

6.2.2 Example Projects:

Launch **PSoC Designer** > **Design Catalog** > **Example projects**. These example projects demonstrate how to configure and use PSoC Designer Components.

6.2.3 PSoC Designer Training

These trainings help to design and demonstrate the Intro to PSoC Designer, Dynamic Reconfiguration, and Debugging with PSoC.

6.2.4 Component Datasheets:

Launch **PSoC Designer** > **Workspace Explorer**. Under the Chip tab, right-click on a Component and select Datasheet.

6.3 Application Notes

Application notes assist you with understanding specific features of the device and designing your PSoC 1 application. Visit the PSoC 1 Application Notes page for a complete list of PSoC 1 application notes.

6.4 Knowledge Base Articles

These are a database of frequently asked technical support questions and their answers. Visit the Knowledge Base Articles page for a complete list of PSoC 1 knowledge base articles.

6.5 Technical Reference Manual (TRMs)

The TRM provides complete detailed descriptions of the internal architecture of the PSoC 1 devices. Visit the PSoC 1 Technical Reference Manuals page for a list of PSoC 1 TRMs.

6.6 Device Errata

These documents list any specification of the device that deviates from either the device datasheet or technical reference manual. Visit the Device Errata page for a list device errata documents.

6.7 Technical Support

If you have any queries or questions, our technical support team is happy to assist you. You can create a support request using the Cypress Technical Support link.

If you are in the United States, you can talk to our technical support team by calling our toll-free number +1-800-541-4736. Select option 8 at the prompt.

You can also use the following support resources if you need quick assistance:

- Self-help
- Local Sales Office Locations

7 My First PSoC 1 Design

This section shows you the step-by-step process of building a simple design with PSoC 1 using PSoC Designer, then programming it into a PSoC device, and configuring PSoC 1 demonstration boards to view the results of the application.

7.1 About the Design

This design creates a simple project that produces two PWM outputs (one using a hardware resource and the other using software) on two GPIOs. One GPIO will display a blinking LED at a fixed rate, while another GPIO will show a pulsing, or heartbeat, LED. The project also measures an analog voltage using an ADC User Module.

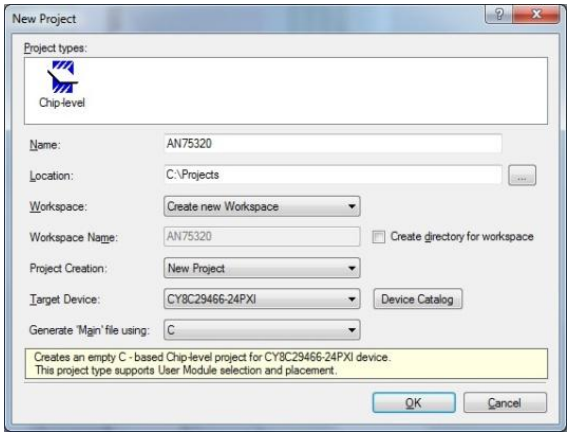
7.2 Creating My First PSoC 1 Design

7.2.1 Create Project

You start with creating a project in PSoC Designer. Here, you select the device, and then set the development language as C. This example project uses CY8C29466-24PXI, because that is the part that accompanies the CY3210-PSoCEval1 kit.

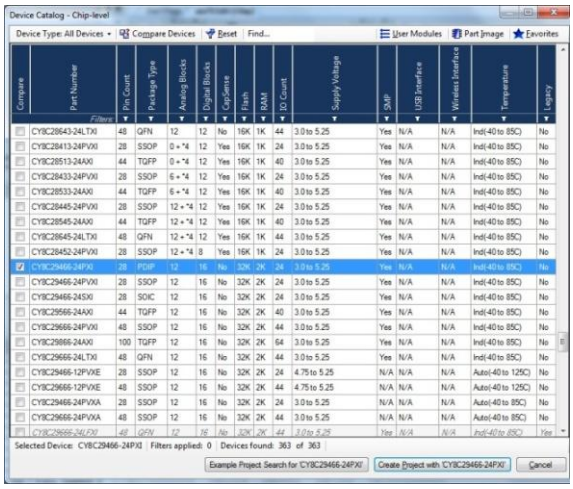
1. In PSoC Designer, select **File** > **New Project** and name it *AN75320*, as shown in Figure 6.

Figure 6. Creating a New PSoC Designer Project



2. Click on **Device Catalog** to select the device as shown in Figure 7.

Figure 7. Device Catalog



Note If you are developing this project with another kit, use the following part numbers:

- CY3214-PSoCEvalUSB: CY8C24994-24LTXI
- CY3271-PSoC First Touch: CY8C20634-12FDXI

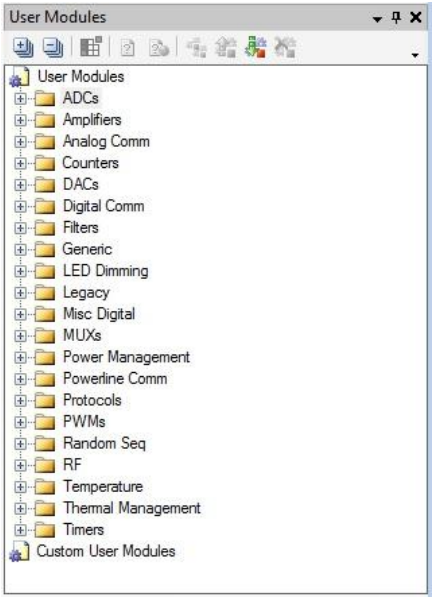
3. Click on Create Project with '**CY8C29466-24PXI' and th**en click **OK**.

The project workspace opens, and displays the Chip Editor and the Workspace Explorer. Press Ctrl and click to zoom in the Chip Editor view, which shows the block diagram of the selected device.

7.2.2 Select User Module

In this step, you select the required components from the User Module catalog and configure them. The user module window is on the lower right as shown in Figure 8; select **View** > **User Module Catalog** to display it.

Figure 8. User Module Catalog Window



This project uses the following user modules:

- One ADC User Module
- Two PWM8 User Modules
- One LCD User Module

1. To place the user modules, perform the following steps: On the User Module Catalog, expand the **ADCs** folder.
2. Right-click **EzADC** and select Place. The EzADC Configuration window opens.
3. In the Configuration window, select Double Stage Modulator and click OK. (This configuration uses two switched-capacitor blocks for better performance).
4. Under the PWMs folder, right-click PWM8, and select Place.
5. Repeat the placement process to place two PWM8 User Modules in the design.
6. From the Misc Digital folder, right-click **LCD**, and select **Place**.

After you have placed the required user modules, the Designer window will look like Figure 9. In addition, the placed user modules are displayed in the Workspace Explorer. Note that each user module placed is named as ComponentName_1, and so on. For example, the EzADC User Module is listed as EzADC_1.

Figure 9. EzADC and PWM User Modules Placement in the Chip Editor (Digital Blocks)

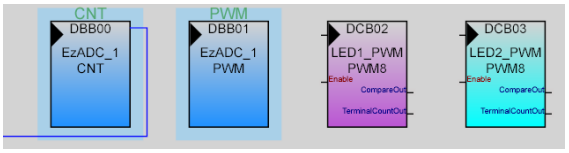
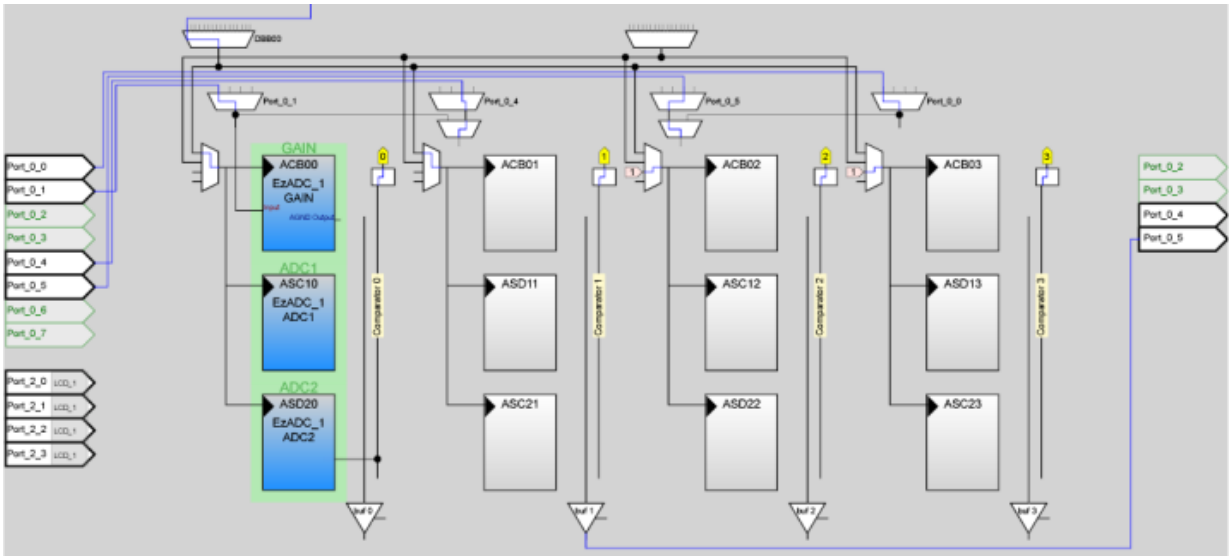


Figure 10. EzADC User Module Placement in the Chip Editor (Analog Blocks)



7.2.3 Set User Module Parameters

In this step, you configure the parameters for the user modules that you placed in the design.

When you click on a user module from either the Workspace Explorer or the Chip Editor, the Parameters window for the selected user module appears on the left hand side, where you can edit the parameters.

Refer to the diagrams for the parameters to set or change.

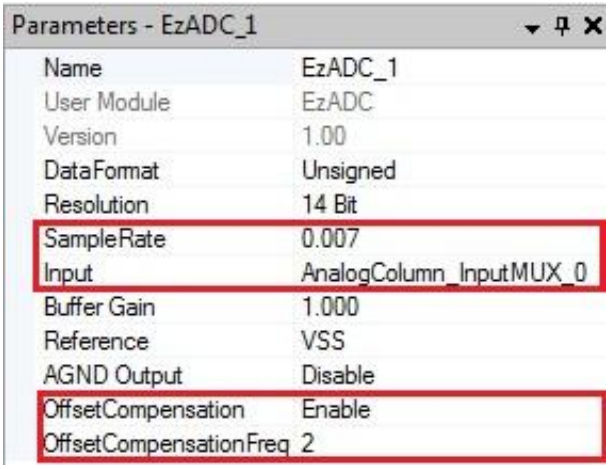
1. Select **EzADC_1** and change its parameters based on Table 3. After you have made the changes, the window looks similar to Figure 11. Parameters that are to be changed from their default values are highlighted.

Table 3. EzADC_1 User Module Parameters

Parameter	Value	Description
Name	EzADC_1	Give the User Module name
Data Format	Unsigned	Sets the output to unsigned data as input is positive only
Resolution	14 Bit	Sets the max resolution for EzADC
Sample rate	0.007	Sample rate depend on resolution. See the user module datasheet of EzADC.
Input	Analog Column_Input MUX_0	Select the analog input data bus to receive the input analog voltage for the source.
Offset Compensation	Enable	Enables the correlated double sampling
Buffer Gain	1.000	Sets the PGA gain to 1 for unity amplification

Parameter	Value	Description
Reference	VSS	Sets the reference for the PGA to perform offset compensation
AGND Output	Disable	Disables the AGND output. This option can be used to bring out the internal AGND to connect bipolar signals to the ADC
Offset Compensation Frequency	2	Sets the number of ADC samples after which offset is corrected

Figure 11. EzADC_1 User Module Parameters

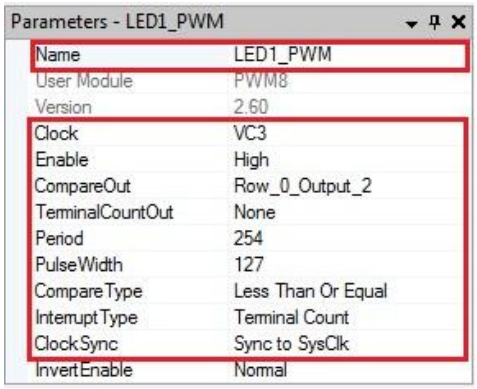


Select **PWM8_1** and change its parameters as per Table 4. After you have made the changes, the window appears as shown in Figure 12. Note that the user module is now renamed as **LED1_PWM**.

Table 4. LED1_PWM User Module Parameters

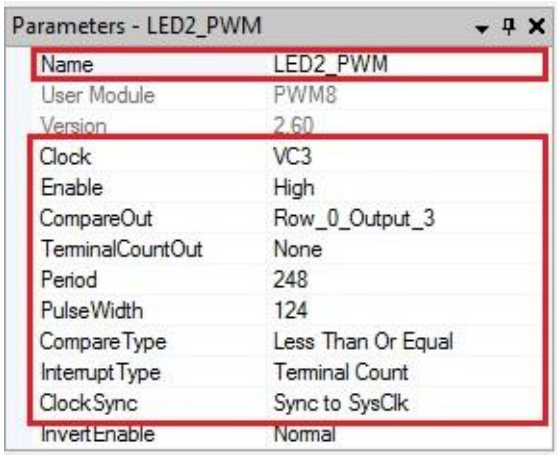
Parameter	Value	Description
Name	LED1_PWM	Assign a name to the User Module.
Clock	VC3	Choose the clock source as **VC3**.
Enable	High	Select enable as High for continuous count.
Compare Out	Row_0_Output_2	Connect the compare output to a GPIO via a row output bus.
Terminal Count Out	None	This is an auxiliary counter. You don't need to connect it to any of the row output buses.
Period	254	Set the period of the counter.
Pulse Width	127	Sets the pulse width of the PWM output (50% duty cycle).
Compare Type	Less Than Or Equal	Select full range for the compare type function.
Interrupt Type	Terminal Count	This selection triggers the interrupt on the terminal count of the counter register.
Clock Sync	Sync to SysClK	Synchronizes the clock input to system clock
Invert Enable	Normal	This determines the sense of the enable input signal.

Figure 12. PWM_1 User Module Parameters



2. Select **PWM8_2** and edit its parameters to the settings as Figure 13 shows. Note that the user module is now renamed to **LED2_PWM**.

Figure 13. PWM_2 User Module Parameters

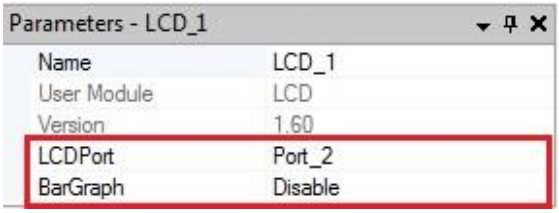


3. Select the **LCD**_1 user module and change its parameters as per Table 5. After you have made the changes, the window looks similar to Figure 14.

Table 5. LCD_1 User Module Parameter

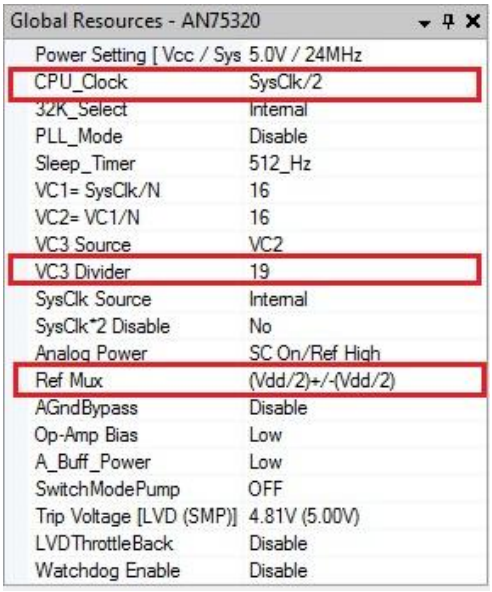
Parameter	Value	Description
Name	LCD_1	Give the User Module name
LCD Port	Port_2	This sets interfaces the LCD display module to assigned Port
BarGraph	Disable	Disables the bar graph function

Figure 14. LCD Parameters



4. Open Global Resources window from **View > Global Resources** to configure the source clock VC3 for PWMs clock frequency and the Ref Mux for ADC input data range. Leave other parameter to their default value. After changes, the Global Resources window looks similar to Figure 15. For more information on Global Resources, see the IDE User Guide.

Figure 15. Global Resources Parameters



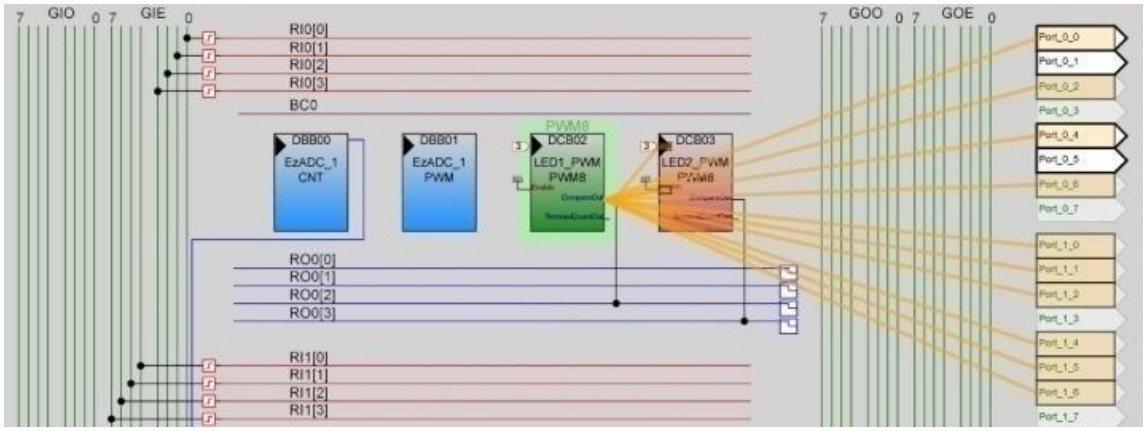
7.3 Route PWM Signals

In this section, you route the PWM signals from PWM user modules to selected GPIO. To see the signal on a GPIO pin, you must implement routing for the PWM signals.

In addition, this design implements the logic in the row outputs by feeding the two PWM outputs into an XOR. The difference of the period of the two PWM signals, XORed together, will create the effect of pulsing (heartbeat).

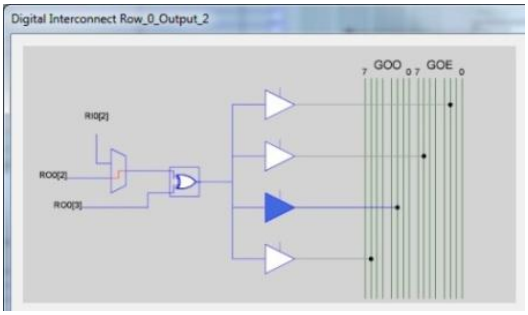
1. Connect CompareOut of LED1_PWM to Row_0_Output_2.
2. Connect the CompareOut of LED2_PWM to Row_0_Output_3.
3. Connect the CompareOut of LED1_PWM to Port_1_2 using auto routing. Press **Shift** and select the CompareOut pin of LED1_PWM and connect it with Port_1_2 as Figure 16 shows. You may also manually connect LED1_PWM to Port_1_2 using GlobleOutOdd_2

Figure 16. PWMs Connected to Row Outputs



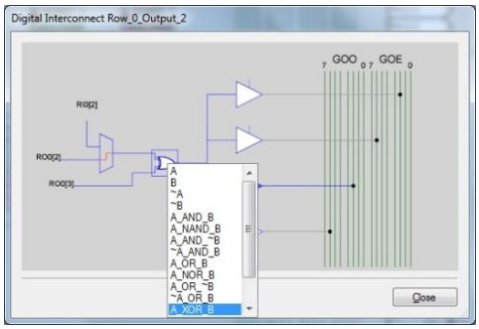
4. Click on the Row_0_Output_2 Digital Interconnect to open the configuration options as shown in Figure 17.

Figure 17. RO0[2] Digital Interconnect View



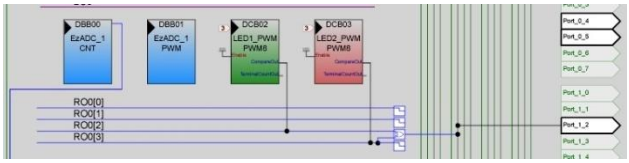
5. Click on the LogicTable_Select (indicated by the square box in the middle) and select A_XOR_B from the drop-down list as shown in Figure 18, and then click **Close**.

Figure 18. Digital Interconnect Configuration



6. Confirm that the digital routing diagram looks as Figure 19 shows. If they match, then the configuration of the pulsing heartbeat LED is now complete.

Figure 19. Designer Chip View



7.4 Add Coding

In this step, you add the code to configure all the user modules and GPIOs to implement a software LED that will produce a blinking LED. You add the custom code that follows on to the *main.c* file for the project.

1. In Workspace Explorer, locate the **Source Files** folder under the **AN75320 Folder** and open the *main.c* file.
2. Copy the C code listed below and pastes it into the *main.c* file, replacing the existing code.

Code 1. Project 1 main.c

```
/* part specific constants and macros */
#include <m8c.h>

/* PSoC API definitions for all User Modules */
#include "PSoCAPI.h"

/* Definitions for all input and output operation */
#include "stdio.h"
```

```
/* Macros to set ADC parameters */
#define GAIN                1
#define MAX_ADC_COUNTS      16383
#define ADC_RANGE           5000

/* Macros to select port 1 */
#define PORT_1_3         PRT1DR

/* Variable to store the ADC result */
WORD adc_result;

/* Variable to store the measured input in millivolts */
WORD v_in;
void main(void)
{
    static unsigned int index;

   /* Buffer used for the long to ASCII conversion */
   char LCDBuffer[17];

   /* Initializes LCD to use the multi-line 4-bit interface  */
   LCD_1_Start();

   /* Enable global interrupts */
   M8C_EnableGInt ;

   /* Set the position to print the character */
   LCD_1_Position(0,0);

   /* print the Hello World in the first line */
   LCD_1_PrCString("Hello World!");

   /* Starts the LED1_PWM and LED2_PWM, high enable input begins the Counter */
   LED1_PWM_Start();
   LED2_PWM_Start();

   /* Initializes and starts the EzADC User Module resources */
   EzADC_1_Start(EzADC_1_HIGHPOWER);

   /* Starts the ADC conversion */
   EzADC_1_GetSamples(0);
            while(1)
{
                    /* Wait for the ADC result to be available */
                    while(!(EzADC_1_fIsDataAvailable()));

                    /* Read the ADC result and clear the data ready flag */
                    adc_result = EzADC_1_iGetDataClearFlag();

                    /* Calculate input voltage in mV */
                    v_in = (DWORD)adc_result*ADC_RANGE / MAX_ADC_COUNTS / GAIN;

                    /* Convert the input voltage to an ascii string */
                    csprintf(LCDBuffer, "ADC INPUT:%4dmV", v_in);

                    /* Set the position to print the character */
                    LCD_1_Position(1,0);

                    /* print the voltage in the second line */
                    LCD_1_PrString(LCDBuffer);
```

```
                    /* Toggle the pin 1[3]*/
                    PORT_1_3 ^= 0x08;

                    /* Give some delay to view toggling effect*/
                for(index = 0; index < 22000; index++);
                }
}
```

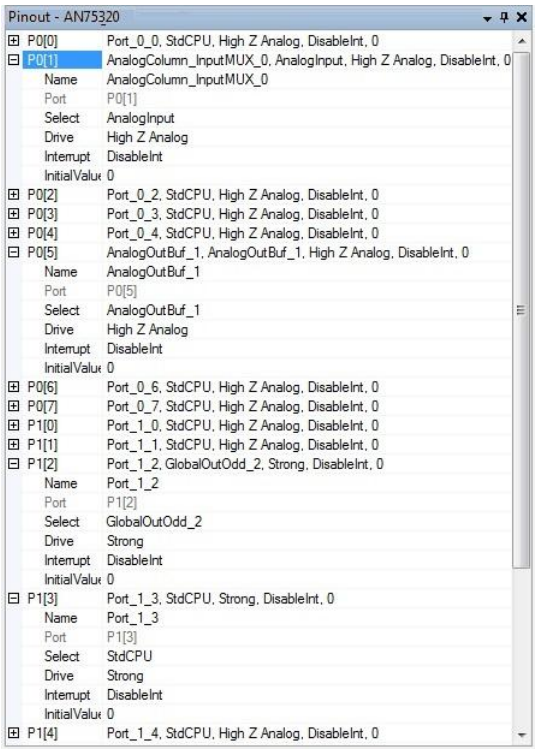
3. Include *local.mk* file attached with the project to enable floating point for the ADC. See the *local.mk* file for more information on this function.

7.5 Configure Pinout

In this step, you configure the GPIO drive mode for the pin to drive the LED. You configure the pinout for the selected device from the Pinout view. (**View** > **Pinout**). The Pinout panel appears on the lower-left side of the workspace.

1. On the Pinout view, expand the options for P0[1], P0[5,]P1[2], and P1[3]. Configure the pins as shown in Figure 20.

Figure 20. Pin Configuration

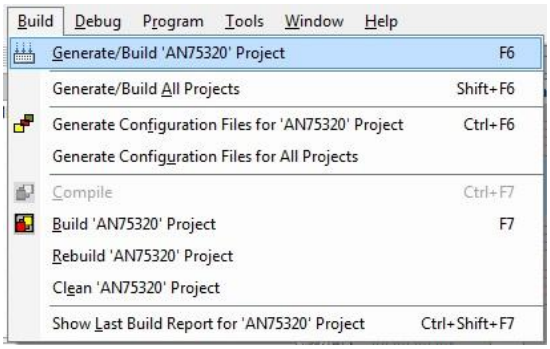


7.6 Build and Program

In this step, you connect the MiniProg1 device to your computer, and the program the PSoC device with the built project.

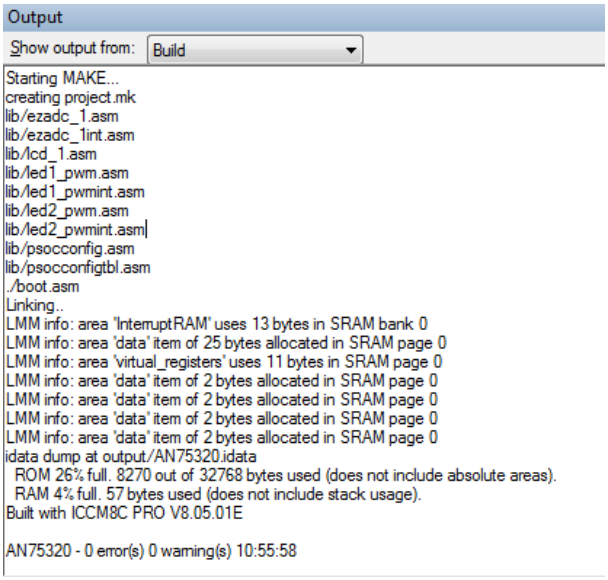
1. Select **Build** > **Generate/Build 'AN75320' Project** or press **F6**. (See Figure 21).

Figure 21. Build and Generate Option



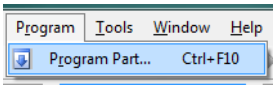
2. The output window should show the build status with RAM/Flash usage and number of errors and warnings as shown in Figure 22.

Figure 22. Output Window



3. Connect MiniProg 1 / MiniProg 3 to your computer.
4. Connect the MiniProg 1 / MiniProg 3 to the programming header of the board. For details, refer to step 4 in section Setting Up the CY3210-PSoCEval1 Board.
5. Select **Program** > **Program Part** (See Figure 23). The Program Part window appears as shown in Figure 24.

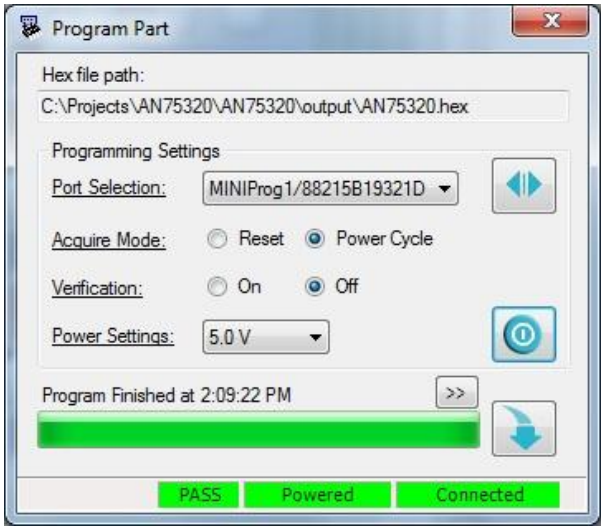
Figure 23. Program Part Option



6. On the Program Part window, do the following:
   a) Click the **Connect** button (next to the Port Selection field) to connect the device.
   b) Set the **Acquire Mode** to *Power Cycle* if the MiniProg is supplying power to the device and it can acquire the device by cycling power. This is the default option. For this project, use the default option.
   c) Set the **Acquire Mode** to *Reset* if the device is externally powered and the MiniProg can only acquire the device by resetting it.

7. Click the **Program** button to program the device as shown in Figure 24.

Figure 24. Programming Status

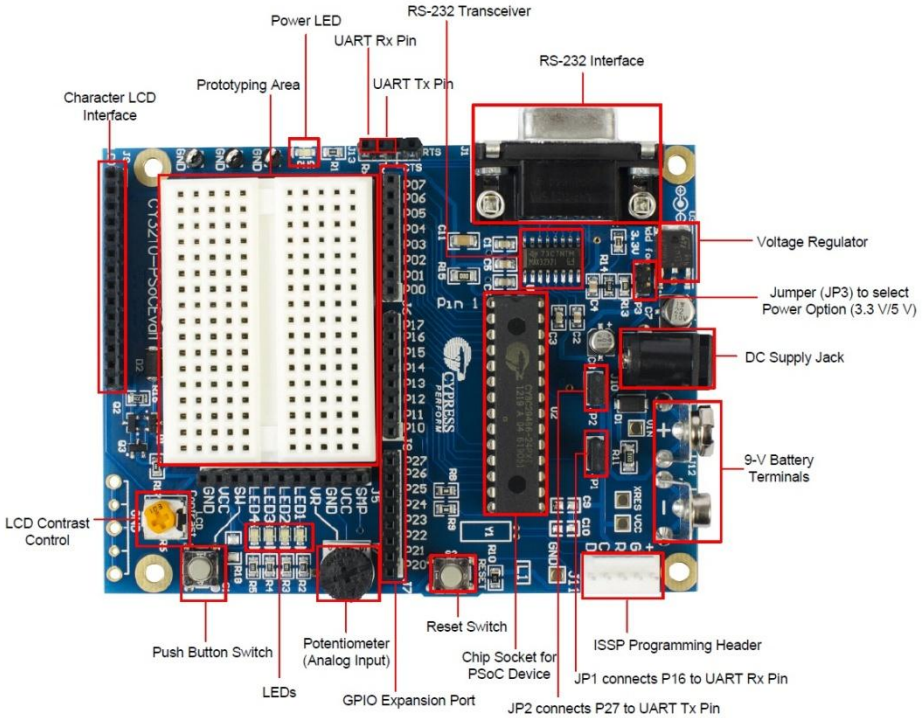


8. When the program operation is completed, press the **Power** button to toggle power for the device. The programmer now supplies power to the board. Observe one LED flashing and another LED fading in and out.

7.7 Setting Up the CY3210-PSoCEval1 Board

This demonstration is compatible with the CY3210-PSoCEval1 hardware. For more information on this kit, see http://www.cypress.com/documentation/development-kitsboards/cy3210-psoceval1.

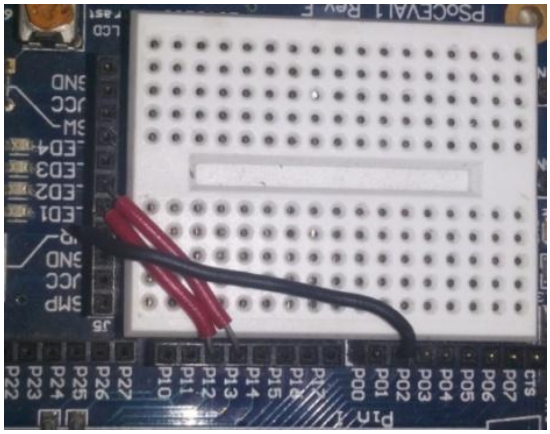
Figure 25. A View of the CY3210-PSoCEval1 Kit



Perform the following steps to configure and program the CY3210-PSoCEval1 kit. Note that this kit requires a programming device, such as a MiniProg or ICE-Cube.

1. With no cables connected to the demo board, ensure that J1, J2, and J3 are not in position.
2. Place a wire connecting P0[1] to VR, P1[2] to LED1, and another wire connecting P1[3] to LED2 (see Figure 26).

Figure 26. CY3210-PSoCEval1 Pin Connections



3. Ensure that a CY8C29466-24PXI is the device currently on the board.
4. To supply the board, connect the MiniProg 1 / MiniProg 3 to the programming header (J11). Alternatively, connect a 12-V DC power supply to J10 on the kit. Alternatively, you can connect a 9-V battery to J12. In addition, connect a programming device to J11. While using an external power supply or battery, use reset mode of programming. The board connections can be seen in Figure 27.

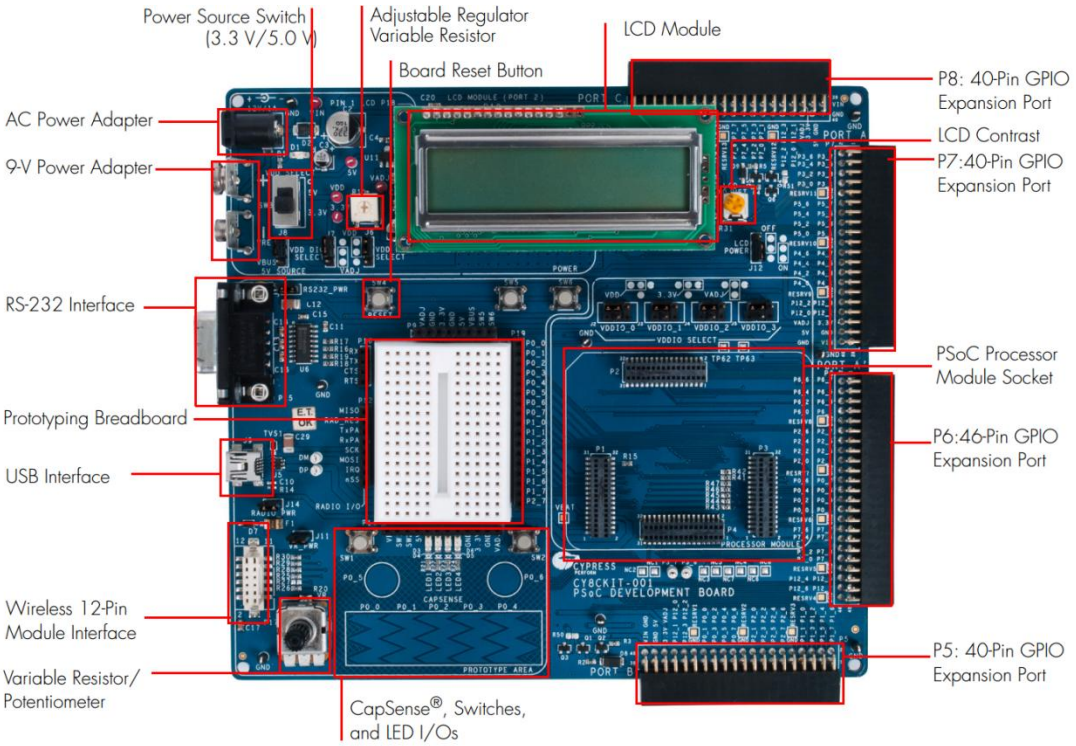
Figure 27. Power and Program Connections

7.8 Setting Up the CY8CKIT-001 Board

When you use a CY8C29x66 processor module, this demonstration is compatible with the CY8CKIT-001 hardware. For more information on this kit, see http://www.cypress.com/?rID=37464.

Perform the following steps to configure and program the CY8CKIT-001 kit. Note that this kit requires a programming device, such as a MiniProg or ICE-Cube. Additionally, this kit supports on-chip debug when using the ICE-Cube.

Figure 28. A View of the CY8CKIT-001 Kit



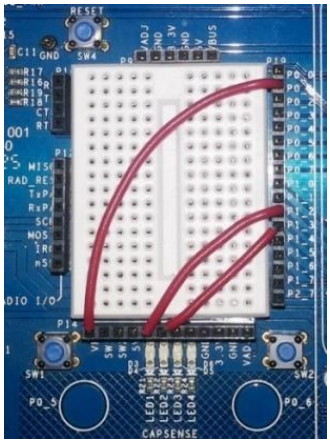
1. With no cables connected to the demo board, set the following jumpers to configure the development board as shown in Table 6:

Table 6. Jumper Settings

Jumper	Setting
VDD Select (SW3)	5-V (Up Position)
5-V Source (J8)	VREG (Upper two pins
VDD Digital (J7)	VDD (Upper two pins)
VDD Analog (J6)	VDD (Upper two pins)
LCD Power (J12)	ON (Lower two pins)
VDDIO Select (J2-J5)	VDD (Upper-left two pins)

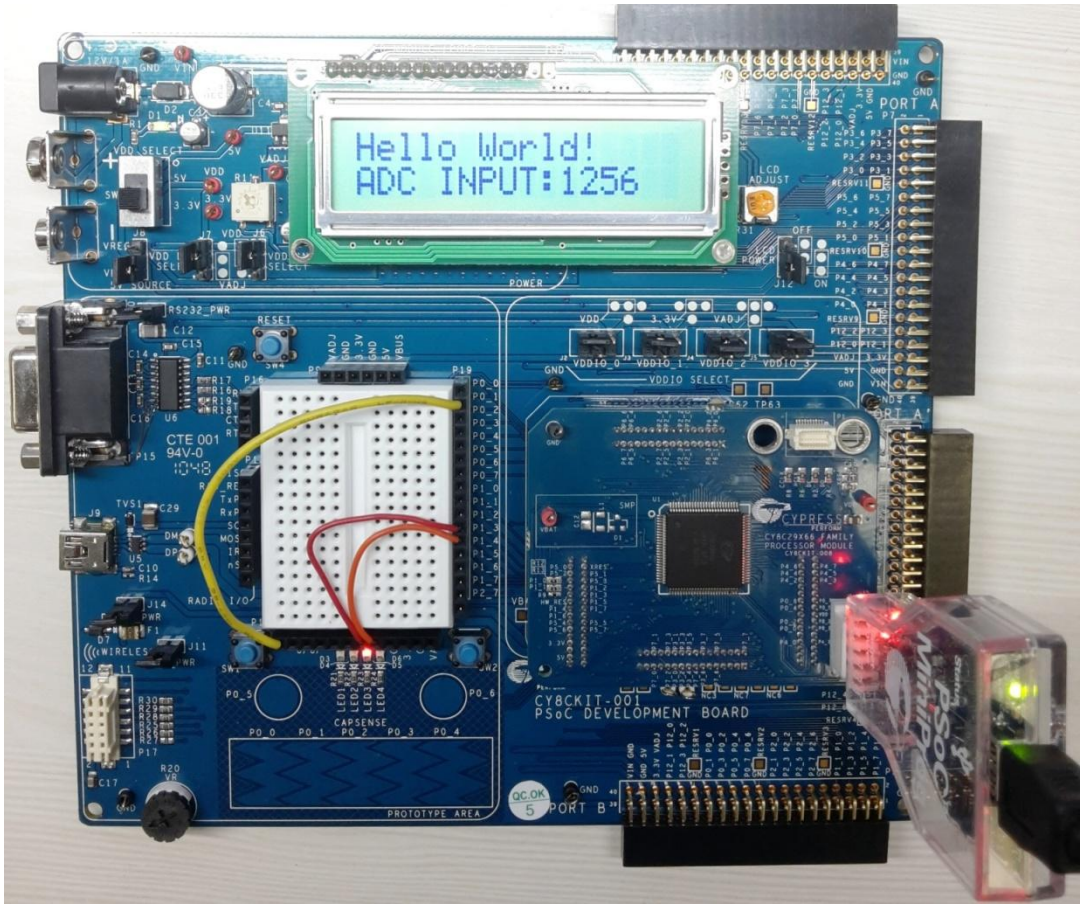
2. Place a wire connecting P0[1] to VR, P1[2] to LED1, and another wire connecting P1[3] to LED2 (See Figure 29).

Figure 29. Alternative View of Pin Connections



3. Connect a programming device, such as a MiniProg or ICE, to J5 on the PSoC 1 processor module.
4. Connect power to the board with either a 12-V DC power supply or a 9-V battery or using power from programmer. Ensure that while using an external power supply or battery, use reset mode of programming. See Figure 30 for board connections.

Figure 30. Power and Program Connections



Regardless of which development kit you use to test the application, you will observe the following:

1. The LCD displays “Hello World” and “ADC INPUT:----mV”
2. One LED blinks rapidly.
3. The second LED pulses with the light intensity alternatively and slowly increasing and decreasing.

8 Summary

This application note has explored the PSoC 1 architecture and development tools. This also described the tools you need to start PSoC 1 projects. PSoC 1 is a true programmable embedded system-on-chip integrating configurable analog and digital peripheral functions, memory, and an M8C microcontroller on a single chip.

This application note has also guided you to a comprehensive collection of resources to accelerate in-depth learning about PSoC 1.

For more information on any of the topics mentioned, refer to any of the links or references made, or visit http://www.cypress.com/products/psoc-1.

9 Related Application notes

This application note covers the basic details about PSoC 1. You can refer to specific application notes for more information and projects regarding a specific topic.

- Getting Started
  - AN54181 - Getting Started with PSoC 3
  - AN79953 – Getting Started with PSoC 4
  - AN77759 - Getting Started with PSoC 5LP
- Analog
  - AN2219 - PSoC® 1 Selecting Analog Ground and Reference
  - AN74170 – PSoC 1 Analog Structure and Configuration with PSoC Designer™
  - AN13666 - PSoC® 1 Driving Analog Buffer Output to the Rail
  - AN2096 - PSoC® 1 - Using the ADCINC Analog to Digital Converter
- Switched Capacitor Blocks
  - AN2041 – Understanding PSoC 1 Switch Capacitor Analog Blocks
  - AN2168 – PSoC 1 Understanding Switched Capacitor Filters
  - AN16833 - Signal Mixing with PSoC® Switched Capacitor Blocks
- GPIO
  - AN2094 - PSoC® 1 - Getting Started with GPIO
- Programming
  - AN44168 - PSoC® 1 Device Programming using External Microcontroller (HSSP).
- Digital
  - AN2141 - PSoC® 1 Glitch Free PWM
- Flash
  - AN2015 - PSoC 1 Reading and Writing Flash & E2PROM
- I2C
  - AN50987 – Getting Started with I2C in PSoC 1

- SPI
  - AN51234 - Getting Started with SPI in PSoC® 1
- Sleep Mode
  - AN47310 - PSoC® 1 Power Savings Using Sleep Mode
- LCD
  - AN56384 - PSoC® 1 Segment LCD Direct Drive
  - AN2152 - PSoC® 1 Graphics LCD and PSoC® Interface

Document History

Document Title: AN75320 - Getting Started With PSoC® 1

Document Number: 001-75320

Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	3498585	RLRM	1/17/2012	New application note
*A	3846596	GULA	12/19/2012	Updated project to PSoC Designer 5.3. Updated all the relevant screenshots. Removed incorrect mention of PSoC Creator Added references to all Application Notes and Technical Reference Manual. Corrected the SC-based Integrator circuit. Minor content edits.
*B	4064460	GULA	07/16/2013	Updated the UM parameters screenshots Updated the board images Added a section on Auto-routing Added links for the App Notes and kits Replaced section on CY3215-DK with details about CY3215A-DK. Added Next Steps section for details about the specific App Notes
*C	4365121	ASRI	04/29/2014	Updated all the section of the AN Added ADC functionally into AN project and modified the project Added links for the various document for PSoC 1 learning resources and kits
*D	4617532	DIMA	01/14/2015	Added Get Started. Completing Sunset Review.
*E	4905704	ASRI	09/02/2015	Minor updates in all the sections Added Figure 8, Figure 10 and Figure 22 Added links for documents in PSoC 1 learning resources Updated the project to PSoC Designer 5.4 SP1 Updated to new template Updated project to PSoC Designer 5.4 SP1. Updated all the relevant screenshots.
*F	5688070	AESATMP8	04/19/2017	Updated logo and Copyright.

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