Customer Training Workshop:

Introduction to PSoC 4

Featuring the PSoC 4 M-Series Pioneer Kit

Replace Legacy 8-/16-Bit Platforms With the World's Most Flexible 32-Bit ARM® Cortex®-M0 One-Chip Solution

Workshop Objectives

By the end of this workshop, you will

Understand the PSoC® 4 Programmable System-on-Chip architecture

Learn how to use Cypress's solutions and integrated development environment (IDE) to implement:

- Digital designs with PSoC 4
- CapSense® touch-sensing user interface designs with PSoC 4
- One-chip, sensor-based system designs with PSoC 4

Workshop Agenda

Time	Page	Topic
0:00 (15 min)	4	Set Up and Install Software
0:15 (10 min)	5	PSoC Terms
0:25 (15 min)	9	Demo #1: PSoC Creator™[1] Overview
0:40 (30 min)	11	Lab #1: PSoC 4 M-Series[2] Pioneer Kit Overview and Blinking LED
1:10 (20 min)	14	PSoC 4 Architecture
1:30 (10 min)	20	Demo #2: Micrium µC/Probe[3] Overview
1:40 (10 min)	22	Session Break
1:50 (30 min)	23	Lab #2: Digital System Design
2:20 (45 min)	25	Lab #3: CapSense Touch-Sensing Design
3:05 (45 min)	30	Lab #4: Sensor-Based System Design
3:50 (10 min)	35	Wrap-up
4:00		End of workshop

[1] PSoC 3, PSoC 4 and PSoC 5 Integrated Design Environment (IDE) software that installs on your PC
[2] A PSoC 4 with up to 128KB flash, 55 I/Os, Direct Memory Access, 2x CAN, 12 Programmable Analog Blocks and 16 Programmable Digital Blocks
[3] A firmware development tool by Micrium that installs on your PC and helps debug system designs

Set Up and Install Software

Required software and initial steps

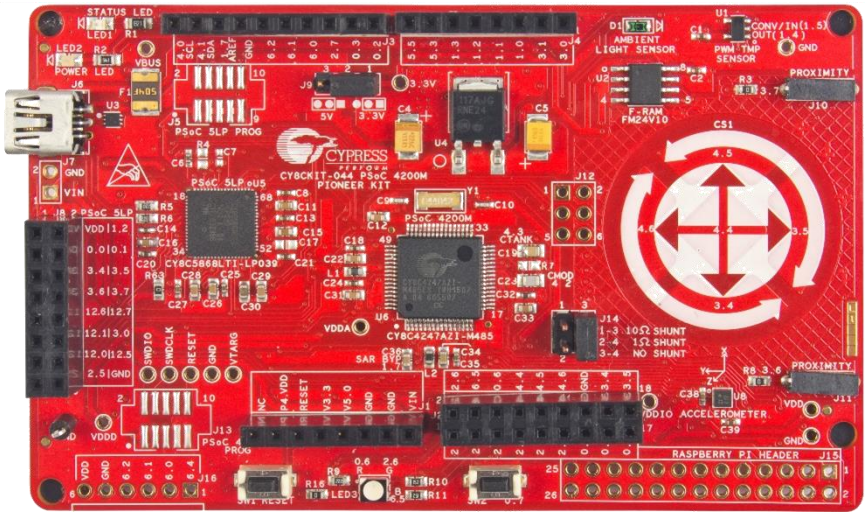
Copy the contents of the provided USB drive onto your laptop and install the software listed in the table below

Follow the on-screen instructions to complete the installation in approximately 15 minutes

Software	Version	File Name
PSoC Creator[1] Installer	3.2	*"PSoCCreatorSetup_3.2_es100"*
Micrium µC/Probe[2]	3.5 (or newer)	*"Micrium-uC-Probe-Setup-Release-3.5.15.300.exe"*
PSoC 4 M-Series[3] Pioneer Kit Installer	1.0 (or newer)	*"CY8CKIT044PIONEERKITSetupOnlyPackage_RevSS.exe"*
PSoC 4 M-Series[3] Lab Exercise Files	1.0	*"PSoC_4_M-Series_Workshop.zip"*

Required hardware:

PSoC 4 M-Series[3] Pioneer Kit (CY8CKIT-044), shown at right



Raise your hand if you need help!

[1] PSoC 3, PSoC 4 and PSoC 5 Integrated Design Environment (IDE) software that installs on your PC
[2] A firmware development tool by Micrium that installs on your PC and helps debug system designs
[3] A PSoC 4 with up to 128KB flash, 55 I/Os, Direct Memory Access, 2x CAN, 12 Programmable Analog Blocks and 16 Programmable Digital Blocks

PSoC Terms

PSoC

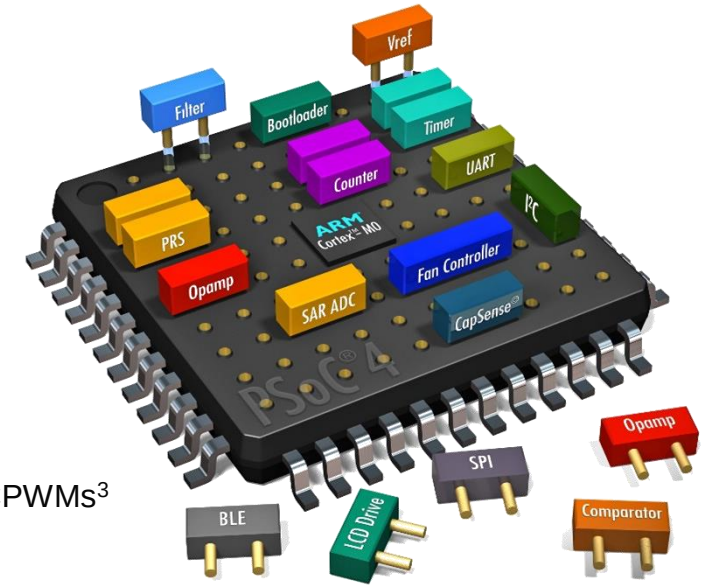
PSoC is the world's only programmable embedded **system-on-chip** integrating an MCU core, **Programmable Analog Blocks**, **Programmable Digital Blocks**, **Programmable Interconnect and Routing**[1] and **CapSense**

Programmable Analog Block

A hardware block that is configured using **PSoC Components**[2] to create Analog Front Ends (AFEs), among other capabilities

Includes **Continuous Time Blocks**, analog-to-digital converters (ADCs) and digital-to-analog converters (DACs)

Illustration of a PSoC Device Being Flexibly Configured by Plugging in PSoC Components[2]



Continuous Time Block (CTB)

A **Programmable Analog Block** that is used to implement continuous time analog circuits such as opamps and programmable gain amplifiers (PGAs)

Programmable Digital Block

A hardware block that is configured using **PSoC Components**[2] to implement custom digital peripherals and glue logic

Includes **Universal Digital Blocks,** Serial Communication Blocks (SCBs) and TCPWMs[3]

Universal Digital Block (UDB)

A PSoC **Programmable Digital Block** that contains: two programmable logic devices (PLDs), one programmable data path with an arithmetic logic unit (ALU), one status register and one control register

Configured in **PSoC Creator**[4] using **PSoC Components**[2], or the graphical state machine editor or Verilog code

Serial Communication Block (SCB)

A PSoC **Programmable Digital Block** that is configurable as a UART, SPI or I²C interface

[1] Connects the Programmable Analog Blocks, Programmable Digital Blocks and I/Os
[2] Free embedded ICs represented by an icon in PSoC Creator software
[3] Timer, counter, pulse-width modulator (PWM)
[4] PSoC 3, PSoC 4 and PSoC 5 Integrated Design Environment (IDE) software that installs on your PC

PSoC Terms

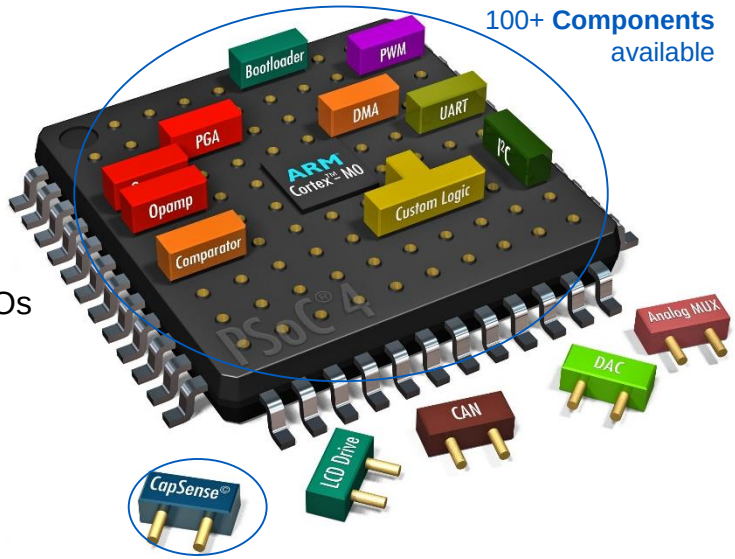
Timer, Counter, PWM (TCPWM) Block

A PSoC **Programmable Digital Block** that is configurable as a 16-bit timer, counter, PWM or quadrature decoder

CapSense®

Cypress's third-generation touch-sensing user interface solution that "just works" in noisy environments and in the presence of water

The industry's No. 1 solution in sales by 4x over No. 2



CapSense is used to create **touch buttons and sliders**

Programmable Interconnect and Routing

Connects the Programmable Analog Blocks, Programmable Digital Blocks and I/Os

Enables flexible connections of internal analog and digital signals to internal buses and external I/Os

PSoC Creator™

PSoC 3, PSoC 4 and PSoC 5 Integrated Design Environment (IDE)

Software that installs on your PC that allows:
- Concurrent hardware and firmware design of PSoC systems, or
- PSoC hardware design followed by export to popular IDEs

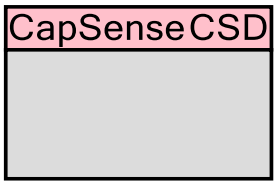
Components

Free embedded ICs represented by an icon in **PSoC Creator** software

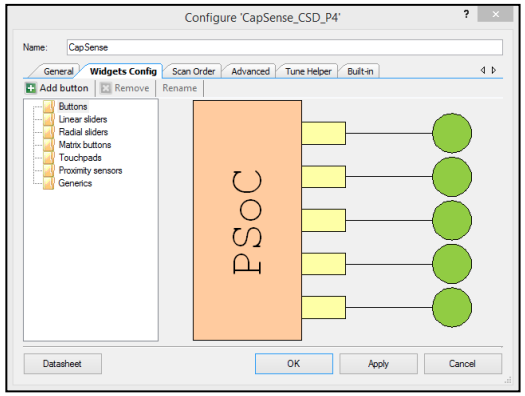
Used to **integrate multiple ICs** and system interfaces into one **PSoC**

Dragged and dropped as icons to design systems in PSoC Creator

Component Icon



Component Configuration Tool



Component Configuration Tools

Simple graphical user interfaces in PSoC Creator embedded in each Component

Used to customize Component parameters

PSoC Terms

PSoC 4

A PSoC with an ARM® Cortex®-M0 MCU

PSoC 4 "Base-Series"

A PSoC 4 with up to 32KB flash, 36 I/Os, 8 **Programmable Analog Blocks** and 10 **Programmable Digital Blocks**

The original PSoC 4 family introduced in 2013 with over 2 million units in the field

PSoC 4 M-Series

A PSoC 4 with up to 128KB flash, 55 I/Os, DMA[1], 2x CAN[2], 12 **Programmable Analog Blocks** and 16 **Programmable Digital Blocks**

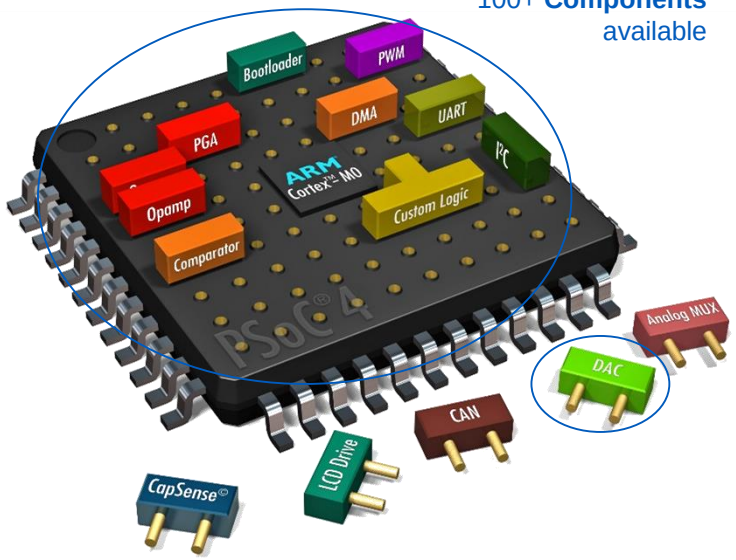
PSoC 4 L-Series

A PSoC 4 with up to 256KB flash, 98 I/Os, DMA[1], 2x CAN[2], USB, 13 **Programmable Analog Blocks** and 20 **Programmable Digital Blocks**

PSoC 4 BLE

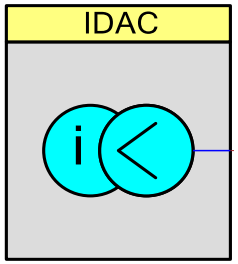
A PSoC 4 with up to 256KB flash, 36 I/Os, 10 **Programmable Analog Blocks**, 10 **Programmable Digital Blocks** and an integrated BLE[4] radio with a royalty-free BLE[4] Protocol Stack

100+ **Components** available

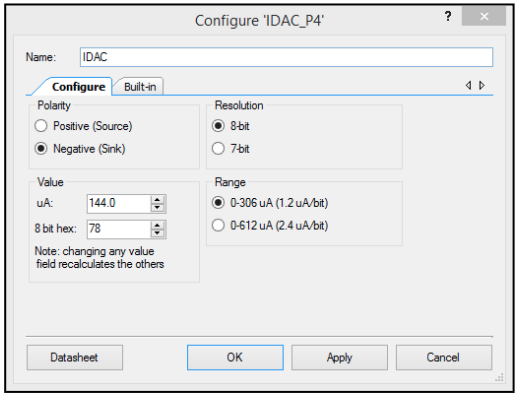


IDAC[3] Component used to create **custom Analog Front Ends**

Component Icon



Component Configuration Tool



[1] Direct Memory Access
[2] Controller Area Network
[3] Current-output digital-to-analog converter
[4] Bluetooth Low Energy wireless solution designed for short-range, low-power wireless applications

Additional Terms

Analog Front End (AFE)

An analog signal-conditioning circuit that uses opamps, filters and comparators to interface to an analog-to-digital converter (ADC)

Coprocessor

A specialized hardware block designed to offload compute-intensive tasks, such as signal processing or communication interfaces, from the main processor

Simplifies the application firmware design in the main processor by moving functions to specialized hardware blocks

Direct Memory Access (DMA)

A method to transfer data directly between memory and input/output subsystems

Allows fast data transfers, bypassing the CPU during the read/write operation

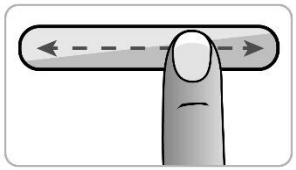
Controller Area Network (CAN)

A serial communication standard designed to provide highly reliable communication between devices

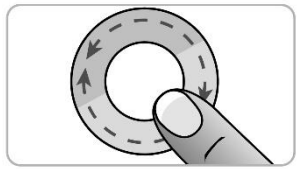
CapSense Gesture Pad

A set of capacitive sensors designed in a pattern on a PCB to implement touch-based swipe and circular gestures, as shown to the right

Swipe Gesture



Circular Gesture



Micrium® µC/Probe™

A firmware development tool by Micrium that installs on your PC and helps debug system designs

A free 30-day Professional Edition License is available with the purchase of a PSoC 4 M-Series Pioneer Kit

Introduction to PSoC 4

DEMO #1: PSoC CREATOR OVERVIEW

Demo #1: PSoC Creator Overview

Objectives:

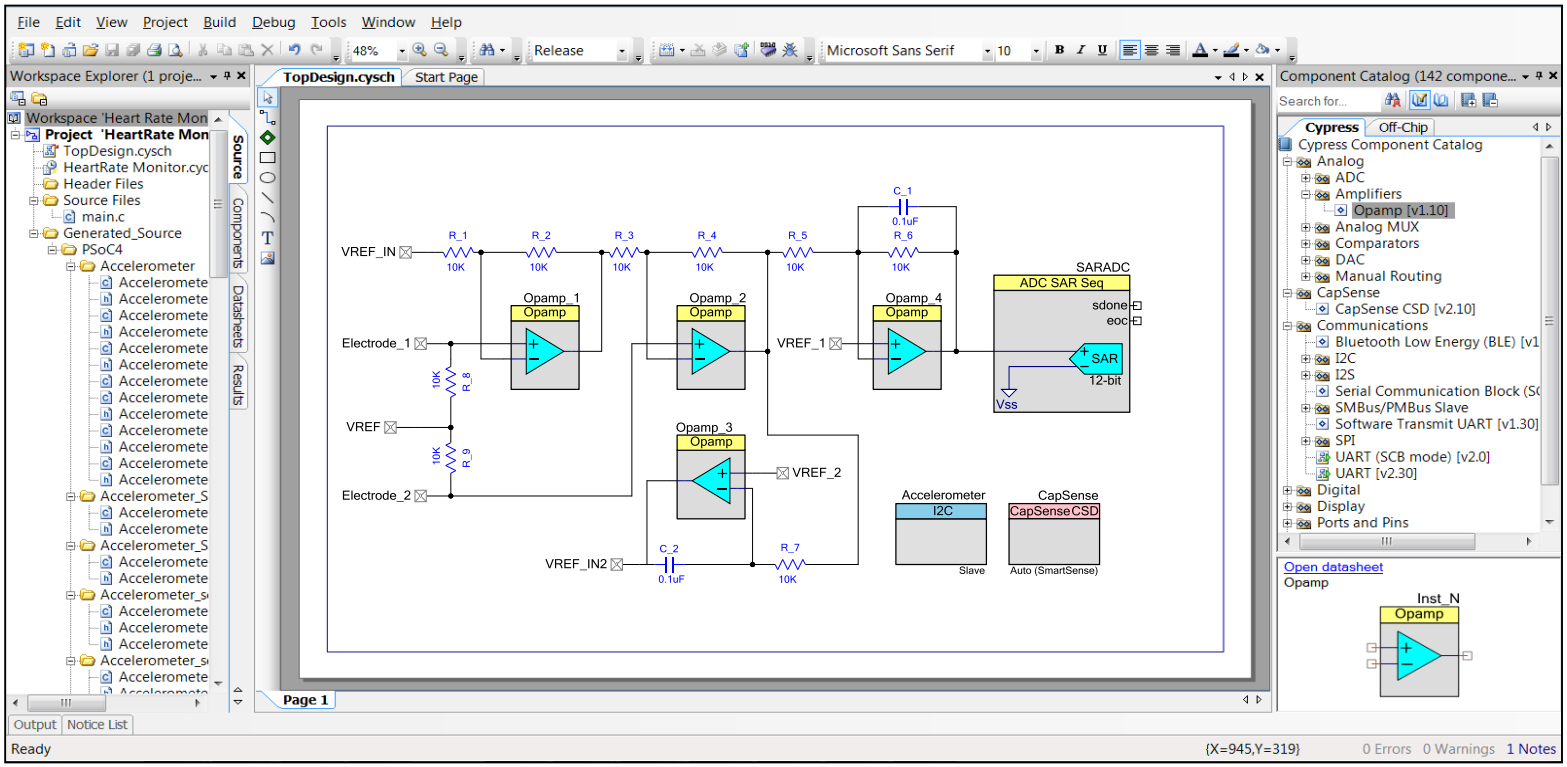
Learn about the PSoC Creator workflow:

- Create a new project
- Find 100s of example projects
- Place and configure a Component
- Open a datasheet
- Assign signals to pins
- Build and debug a design

Software tool:

PSoC Creator

A Heart Rate Monitor Example Project in PSoC Creator



Introduction to PSoC 4

LAB #1: PSoC 4 M-SERIES PIONEER KIT OVERVIEW AND BLINKING LED

PSoC 4 M-Series Pioneer Kit Overview

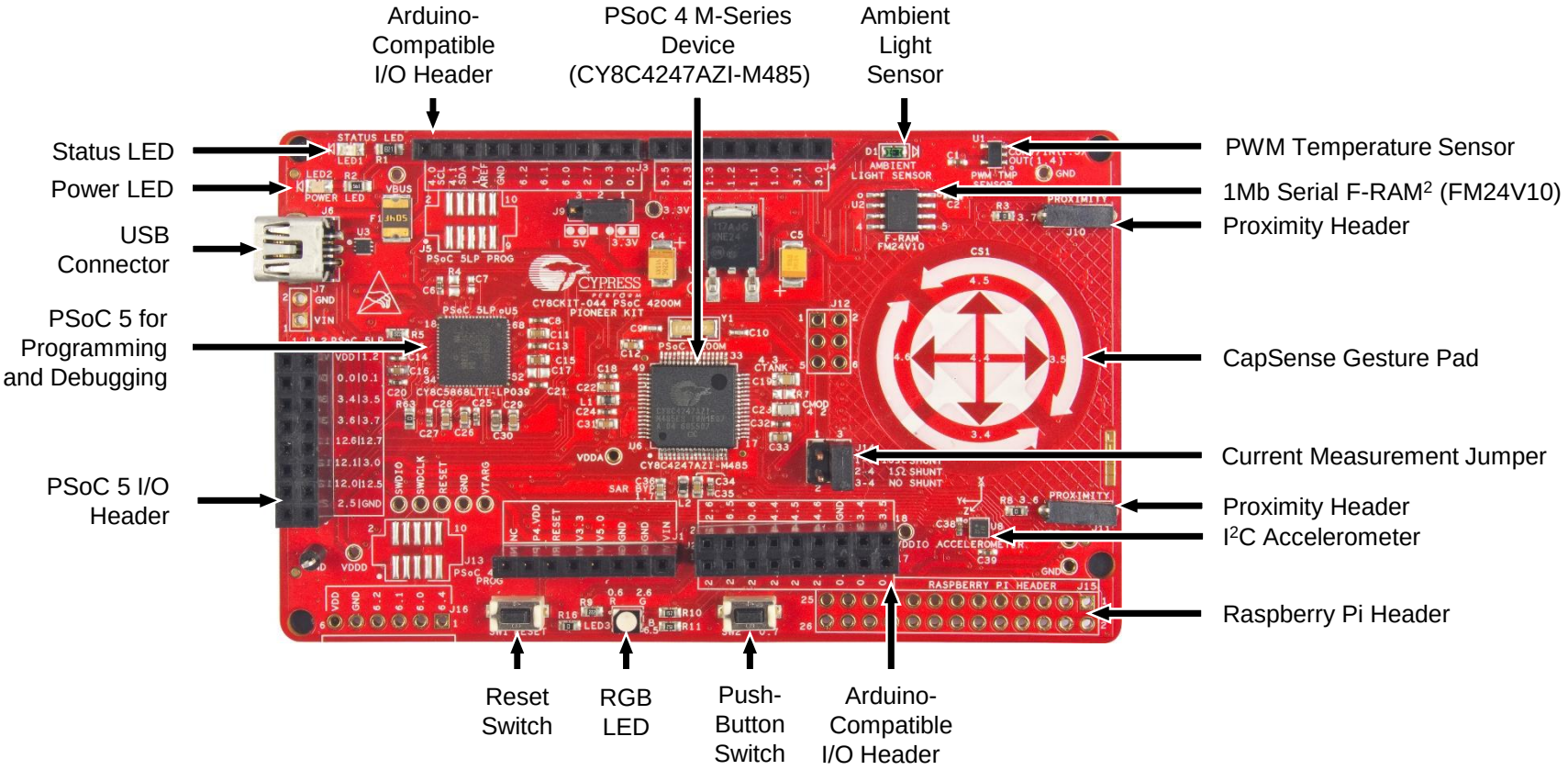
$25 PSoC 4 M-Series Pioneer Kit (CY8CKIT-044)

Is form-factor compatible with the Arduino™ and Raspberry Pi hobbyist kit ecosystems

Features a CapSense Gesture Pad and proximity[1] headers

Includes on-board sensors such as an ambient light sensor, an accelerometer and a PWM temperature sensor

Contains a PSoC 5 for programming and debugging



[1] A method to detect the presence of approaching objects without a physical touch

[2] Ferroelectric RAM with an I²C serial interface

Lab #1: Blinking LED

Objectives:

Learn how to use PSoC Creator to implement and debug PSoC designs

Implement a simple blinking LED design

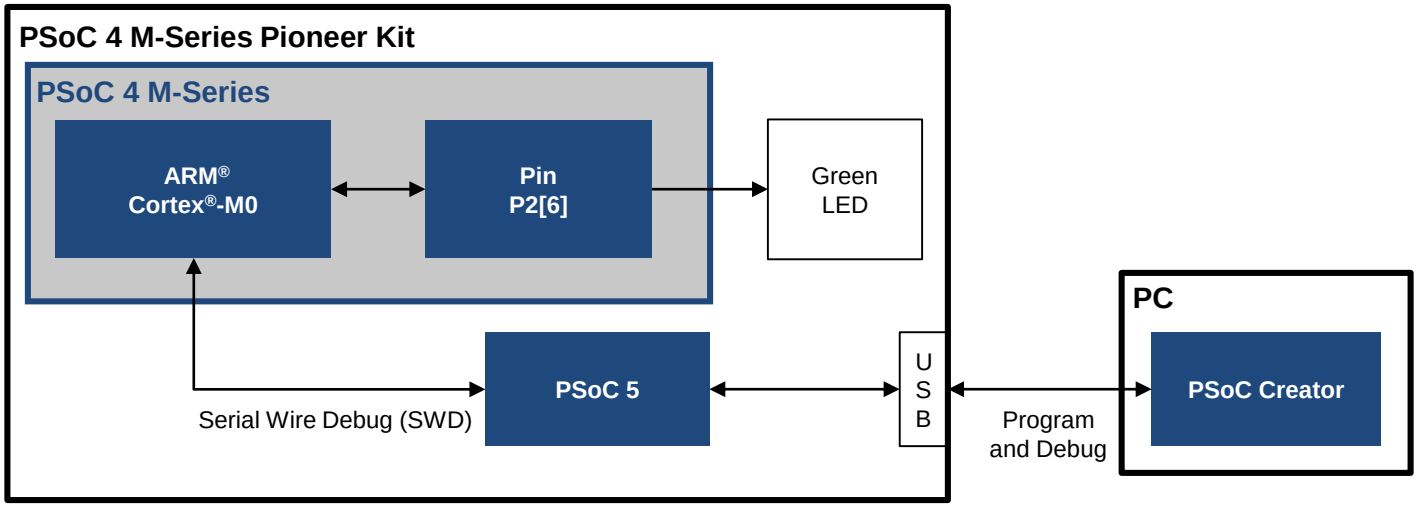
Software tool:

PSoC Creator

Component:

Pin Component (configured as a digital output)

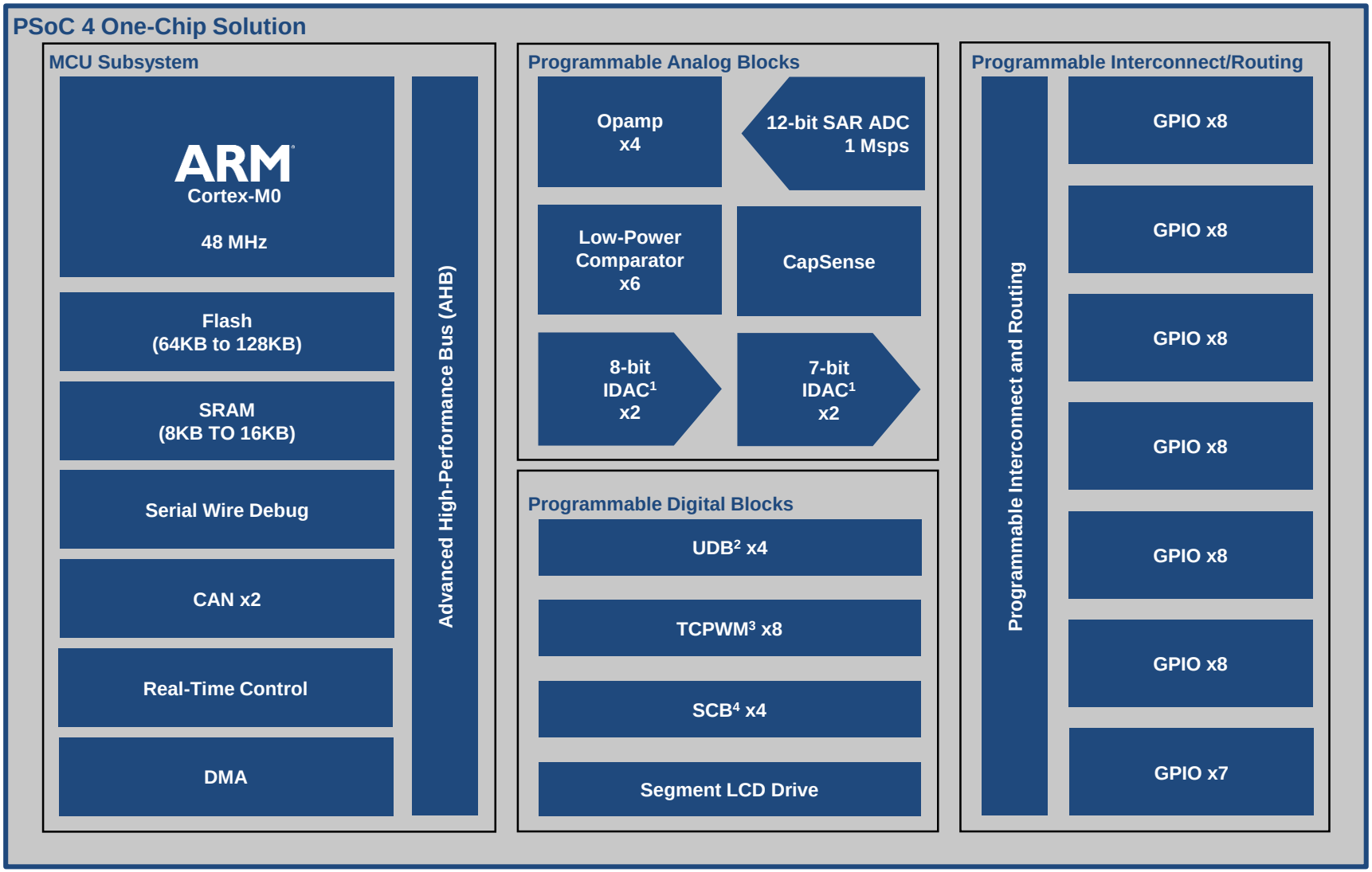
Lab 1: Block Diagram



Introduction to PSoC 4

PSoC 4 ARCHITECTURE

PSoC 4 Architecture



[1] Current-output digital-to-analog converter
[2] Universal Digital Block
[3] Timer, Counter, PWM block
[4] Serial Communication Block; programmable as I²C/SPI/UART

Programmable Digital Blocks Used for Coprocessors and Serial Interfaces

PSoC 4 implements Coprocessors and serial interfaces without increasing cost, size or power with:

Universal Digital Blocks (UDBs) that can be configured as:

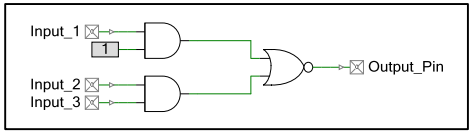
- Timing-critical Coprocessors that simplify firmware and interrupt handling by replacing "bit-banging" firmware[1]
- Custom serial communication interfaces for emerging standards that replace external glue logic ICs (e.g., Microwire[2])

Serial Communication Blocks that can be configured as serial communication interfaces like I²C, UART, SPI or LIN

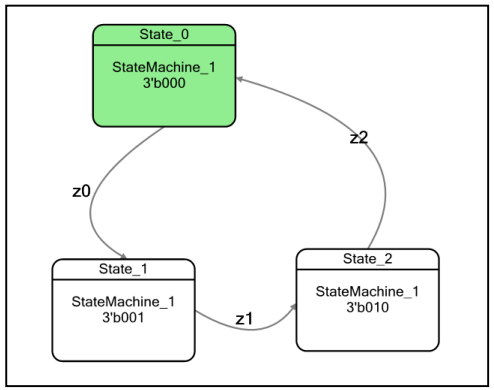
TCPWM Blocks that can be configured as timers, counters, PWMs or quadrature decoders

Three Design Methods Used to Create Custom Digital Logic Using UDBs in PSoC Creator

1. Use digital logic Components in the PSoC Creator schematic…



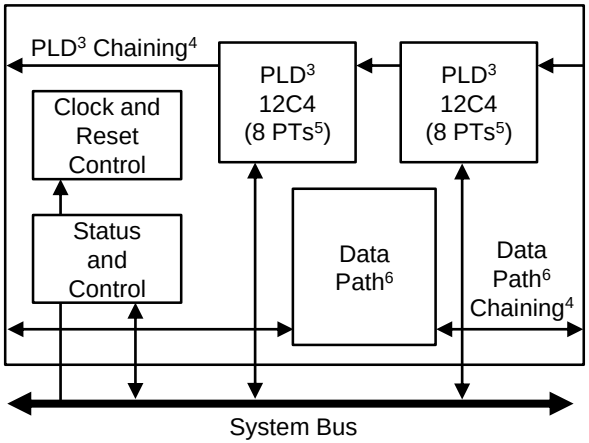
2. Or the graphical state machine editor…



3. Or Verilog code in the code editor…

```
/* ==================== State Machine: StateMachine_1 ====
always @ (posedge clock)
begin : State_0_state_logic
    case(StateMachine_1)
        State_0 :
        begin
            if (( z0 ) == 1'b1)
            begin
                StateMachine_1 <= State_1 ;
            end
        end
        State_1 :
        begin
            if (( z1 ) == 1'b1)
            begin
                StateMachine_1 <= State_2 ;
            end
        end
        State_2 :
        begin
            if (( z2 ) == 1'b1)
            begin
                StateMachine_1 <= State_0 ;
            end
        end
        default :
        begin
            StateMachine_1 <= State_0;
        end
    endcase
end
```

To program the UDB



[1] A technique using firmware to directly control the state of I/Os
[2] A serial communication interface based on a subset of the SPI protocol

[3] Programmable logic device (12C4 = 12 inputs with 4 combinatorial outputs)
[4] A technique used to combine elements of a UDB to form wider elements
[5] Product term: A logical conjunction of Boolean inputs
[6] A programmable element of a UDB that contains an arithmetic logic unit

Programmable Analog Blocks Used for Custom AFEs and Sophisticated UIs

PSoC 4 enables custom AFE designs and sophisticated UIs without increasing cost, size or power with:

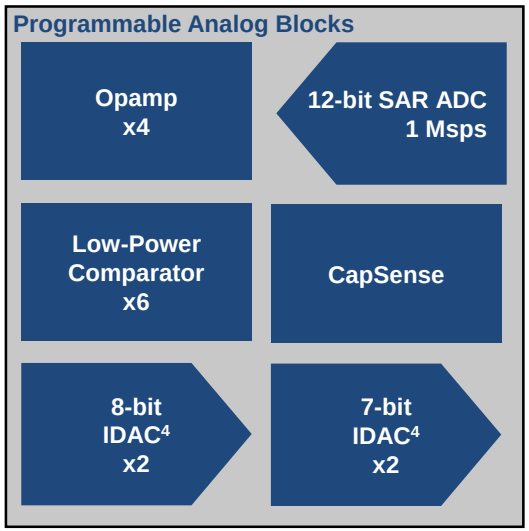
A differential 1-Msps, 12-bit SAR ADC and high-performance opamps with ±1-mV-input offset voltage and 6-MHz gain bandwidth that offer discrete analog performance

A 1- to 55-channel analog multiplexer that can be used to create custom AFE designs

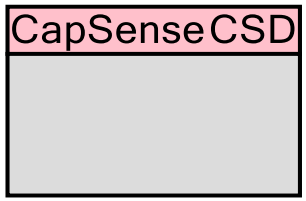
A 5-V input voltage that provides over 50% more analog input signal range than 3.3-V input voltages in most ARM® Cortex®-M0 MCUs

A CapSense hardware block for sophisticated, capacitive touch-sensing user interfaces with advanced features such as proximity sensing[1], water tolerance[2] and SmartSense™ AutoTuning[3]

PSoC 4 M-Series Programmable Analog Blocks

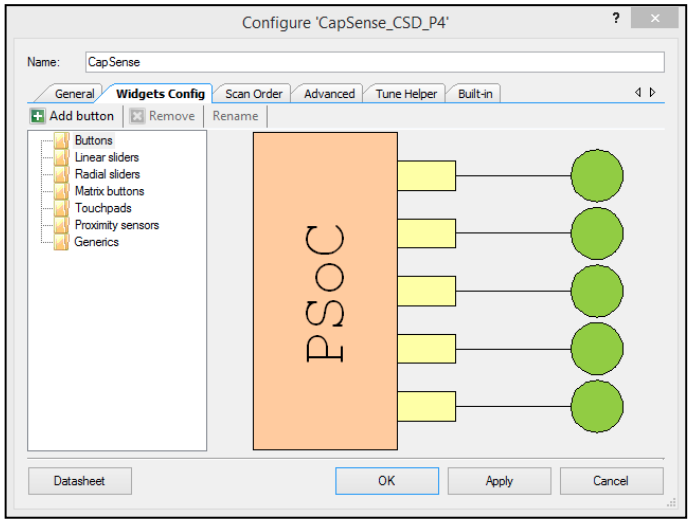


CapSense Component With Configuration Tool in PSoC Creator



CapSense drag-and-drop design Component icon

The CapSense graphical Component Configuration Tool simplifies parameter configuration



[1] A method to detect the presence of approaching objects without a physical touch
[2] The ability of a capacitive sensing solution to work in the presence of water droplets or mist
[3] A Cypress algorithm that automatically sets parameters for optimal performance after the design phase and continuously compensates for system, manufacturing and environmental changes
[4] Current-output digital-to-analog converter

Programmable Interconnect and Routing Enables Flexible Hardware Designs

PSoC 4 enables flexible hardware designs with:

Programmable Interconnect and Routing that connects internal analog and digital signals to any I/O

Programmable I/Os that support:

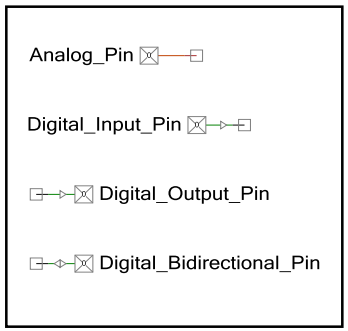
- Eight drive modes[1] to interface with a variety of analog and digital peripherals such as analog and digital sensors
- MCU interrupts on the rising edge, falling edge or both edges of a digital input signal

PSoC Creator simplifies designs by:

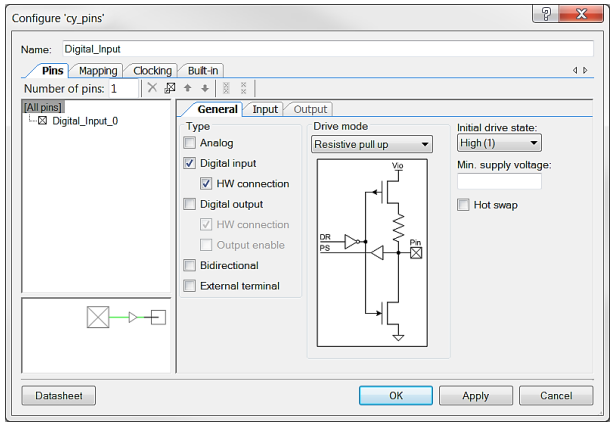
Providing Pin Components to configure the programmable I/Os

Automatically routing signals between the system bus, Programmable Analog Blocks, Programmable Digital Blocks and I/Os

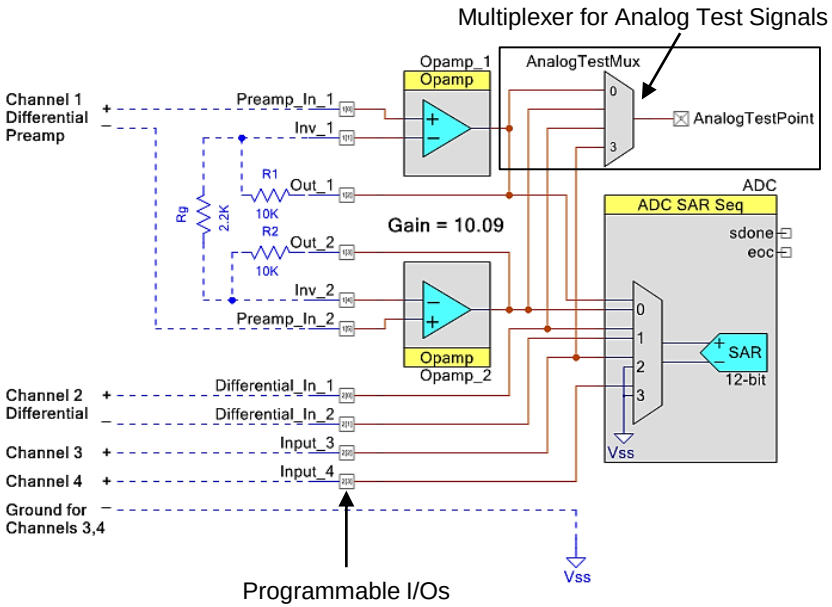
Pin Components in PSoC Creator



Pin Component Configuration Tool



PSoC Creator Design Using Programmable I/Os and Routing to Provide Internal Test Signals to the System Bus



[1] The eight drive modes are: Strong Drive, Open-Drain High Drive, Open-Drain Low Drive, Resistive Pull-up, Resistive Pull-down, Resistive Pull-up/down, High-Impedance Digital, High-Impedance Analog. Refer to the product datasheet for more information on these modes.

PSoC® 4 Portfolio

ARM® Cortex®-M0 | CapSense®

PSoC MCU PSoC 4000	Intelligent Analog PSoC 4100	Programmable Digital PSoC 4200	Programmable Analog PSoC 4400
BL = BLE-Series	M = M-Series	L = L-Series	

Performance

CY8C4128-BL Q215
24 MHz, 256K/32K[1], 36 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], BLE[7]

NEW **CY8C4248-L** Q315
48 MHz, 256K/32K[1], 53-98 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], UDB[8], CAN[9], USB

CY8C4248-BL Q215
48 MHz, 256K/32K[1], 36 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], BLE[7], UDB[8]

NEW **CY8C4127-M** Q215
24 MHz, 128K/16K[1], 51-55 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], CAN[9]

NEW **CY8C4127-BL**
24 MHz, 128K/16K[1], 36 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], BLE[7]

NEW **CY8C4247-M** Q215
48 MHz, 128K/16K[1], 51-55 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], UDB[8], CAN[9]

NEW **CY8C4247-L** Q315
48 MHz, 128K/16K[1], 38-98 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], UDB[8], CAN[9], USB

NEW **CY8C4247-BL**
48 MHz, 128K/16K[1], 36 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], BLE[7], UDB[8]

NEW **CY8C4126-M** Q215
24 MHz, 64K/8K[1], 38-51 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6]

NEW **CY8C4246-M** Q215
48 MHz, 64K/8K[1], 38-55 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], UDB[8]

NEW **CY8C4246-L** Q315
48 MHz, 64K/8K[1], 38-57 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], UDB[8], CAN[9], USB

CY8C44x6
48 MHz, 64K/16K[1]
Concept Only
Contact Sales

CY8C4125
24 MHz, 32K/4K[1], 22-36 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6]

CY8C4245
48 MHz, 32K/4K[1], 22-36 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], UDB[8]

CY8C44x5
48 MHz, 32K/8K[1]
Concept Only
Contact Sales

CY8C4014
16 MHz, 16K/2K[1], 5-20 I/O, CMP[2], I²C, IDAC[5], TCPWM[6]

CY8C4124
24 MHz, 16K/4K[1], 22-36 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6]

CY8C4244
48 MHz, 16K/4K[1], 22-36 I/O, CMP[2], Opamp, ADC[3], SCB[4], IDAC[5], TCPWM[6], UDB[8]

CY8C4013
16 MHz, 8K/2K[1], 5-13 I/O, CMP[2], I²C, IDAC[5], TCPWM[6]

Integration

[1] Flash KB/SRAM KB
[2] Comparator
[3] Analog-to-digital converter
[4] Serial Communication Block; programmable as I²C/SPI/UART
[5] Current-output digital-to-analog converter
[6] Timer, counter, PWM block
[7] Bluetooth Low Energy
[8] Universal Digital Block
[9] Controller Area Network

	Production	Sampling	Development	Concept
Status				
Availability	QQYY	QQYY		

Introduction to PSoC 4

DEMO #2: MICRIUM µC/PROBE

Demo #2: Micrium µC/Probe Overview

Objectives:

Learn about the Micrium µC/Probe Tool and workflow:

- Create a new project
- Place and map Micrium virtual controls[1] and indicators[1] to the internal registers and memory locations in a PSoC 4 device
- Debug a PSoC 4 design by monitoring internal PSoC 4 registers

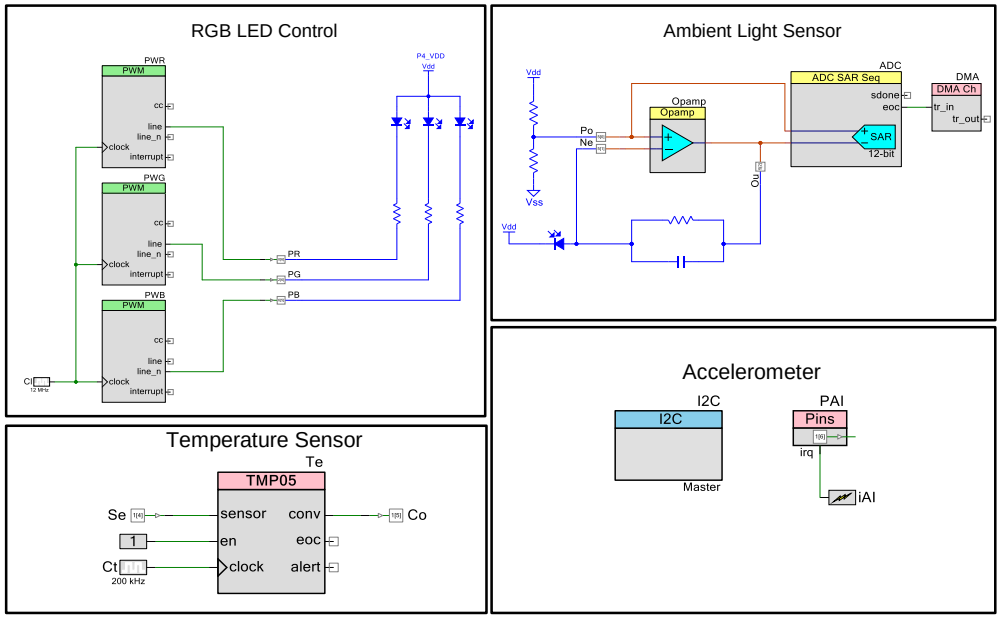
Software tools:

Micrium µC/Probe

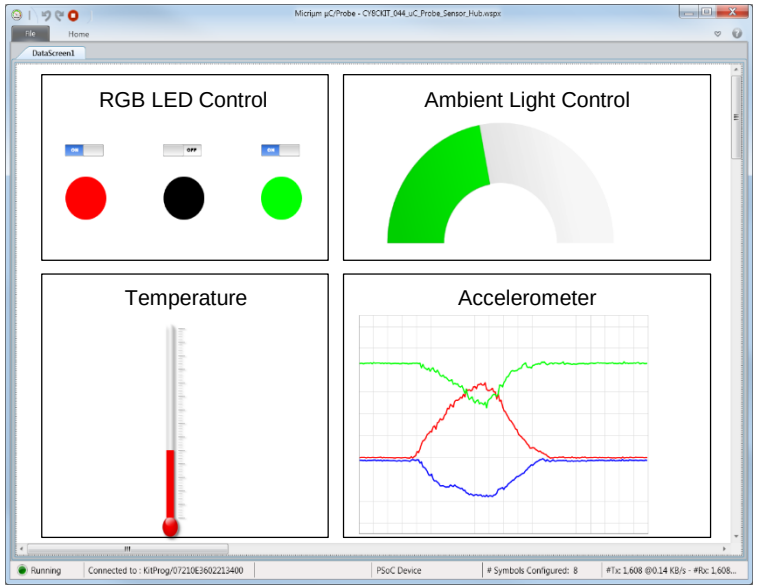
PSoC Creator

Micrium µC/Probe Debug Tool Enables Visual Debugging of Systems

A design created in **PSoC Creator**…



Is graphically debugged with **Micrium µC/Probe**



[1] Graphical representation of firmware parameters using buttons, gauges, charts and numeric indicators

Introduction to PSoC 4

SESSION BREAK

Introduction to PSoC 4

LAB #2: DIGITAL SYSTEM DESIGN

Lab #2: Digital System Design

Objectives:

Measure the ambient temperature of the PWM temperature sensor using a TMP05[1] Component that is implemented using UDBs

Implement a breathing LED using the TCPWM and XOR Digital Logic Components

Debug a system design with the Micrium µC/Probe Tool

Software tools:

PSoC Creator

Micrium µC/Probe

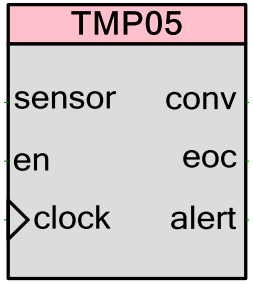
Components:

TMP05[1] Component

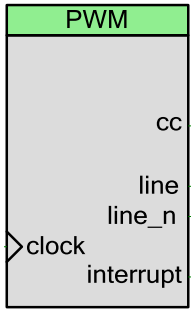
TCPWM Component

XOR Component

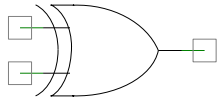
TMP05[1] Component Icon



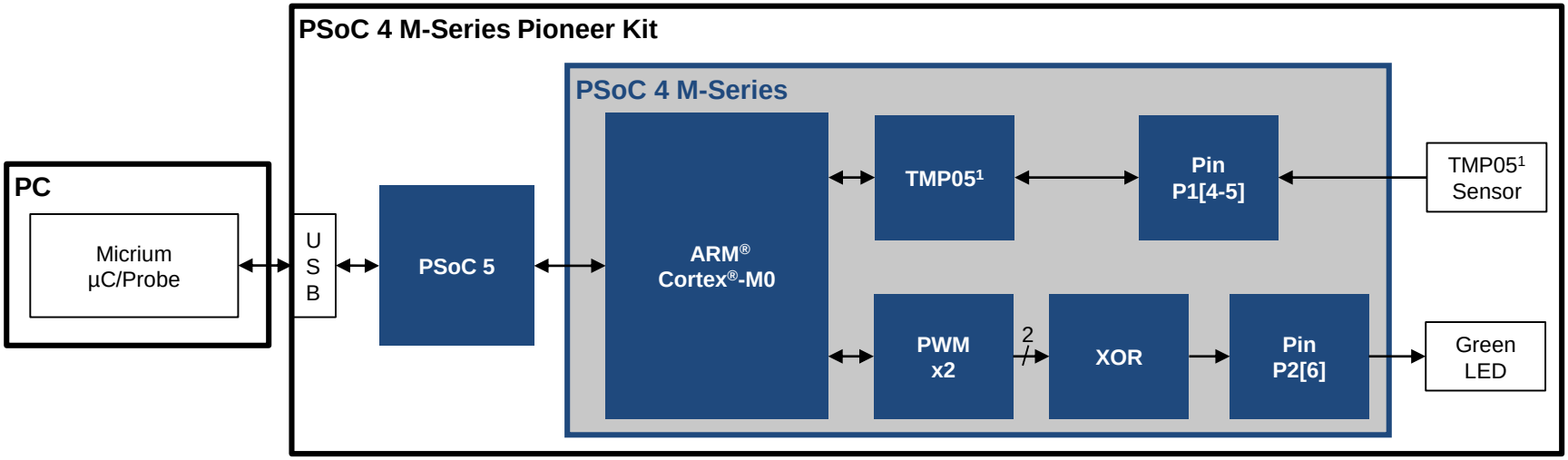
TCPWM Component Icon



XOR Component Icon



Lab 2: Block Diagram



[1] A digital temperature sensor that generates a pulse-modulated signal based on the temperature

Introduction to PSoC 4

LAB #3: CapSense TOUCH-SENSING DESIGN

CapSense Touch Sensing

CapSense replaces mechanical buttons

A capacitive sensor is used to measure the change in capacitance between a pin and ground

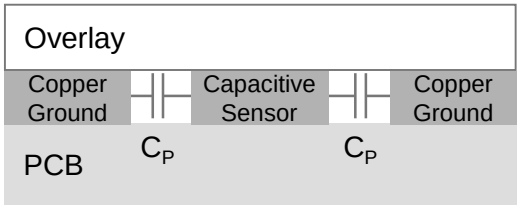
CapSense algorithms and analog circuitry convert the measured capacitance to a raw count

A finger touch increases the capacitance of the system, which in turn increases the raw count

An increase in the raw count above a user-defined threshold registers a touch

Refer to the *Getting Started With CapSense Guide* for details on CapSense algorithms

Capacitive Sensor
Without a Finger Touch

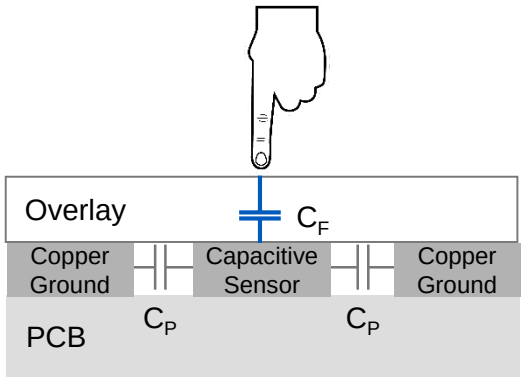


$C_X = 2C_P$

C_X = Total Capacitance on the capacitive sensor node

C_P = Parasitic capacitance

Capacitive Sensor
With a Finger Touch

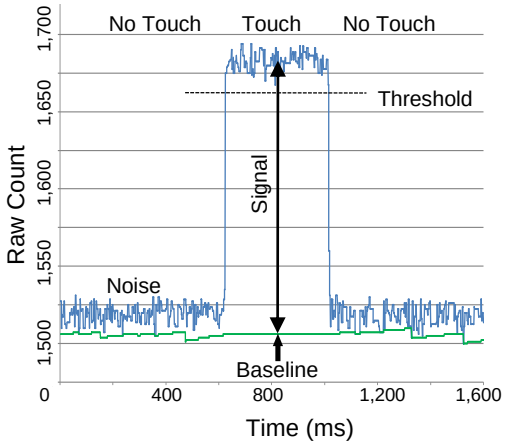


$C_X = 2C_P + C_F$

C_F = Capacitance added by a finger touch

C_F is dependent on the overlay material, overlay thickness and the dimensions of the finger (typical = 9mm) and sensor capacitances

Raw Count Variation on Finger Touch



CapSense algorithms use analog circuits to convert the capacitance to raw count, which is compared to the user-defined threshold to record a touch

SmartSense Auto-tuning

SmartSense Auto-tuning sets, monitors and continuously maintains optimal capacitive sensor performance

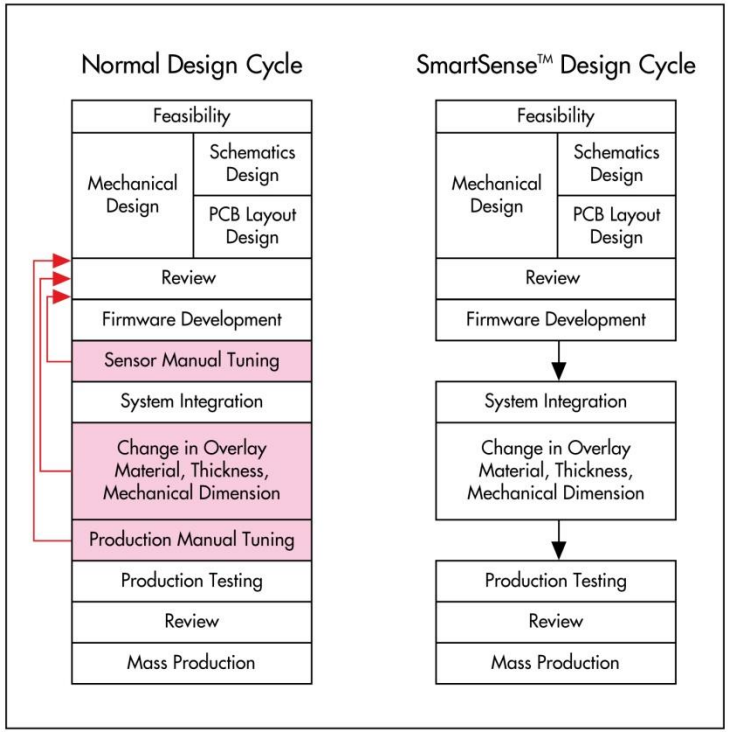
Reduces design effort by eliminating manual tuning (of baseline and threshold values) after the design phase

Adapts to manufacturing variations in PCB, overlay and paint that degrade touch-sensing performance

Adapts to changes in system environment due to RF noise sources

Allows a platform design approach that uses different overlays, button shapes and trace lengths with the same electronics

SmartSense Auto-tuning Cuts Design Cycle Time



SmartSense Auto-tuning eliminates time-consuming manual tuning and the design iterations caused by it

CapSense Touch Sensing Enables Sophisticated User Interfaces

PSoC 4 tracks finger movements and touch-based gestures in two dimensions

Swipe gestures track up, down, left and right finger movements

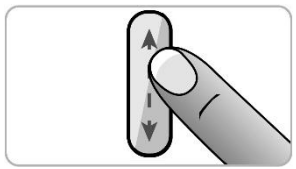
Circular gestures track clockwise and counter-clockwise finger movements

Refer to the *PSoC 4 M-Series Pioneer Kit Guide* for details on touch-based gestures

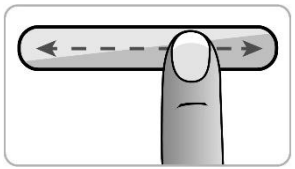
CapSense maintains touch accuracy even in wet conditions

Refer to the *Getting Started With CapSense Guide* for details on liquid tolerance

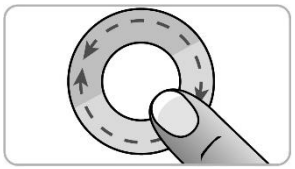
Swipe Gesture: Up/Down



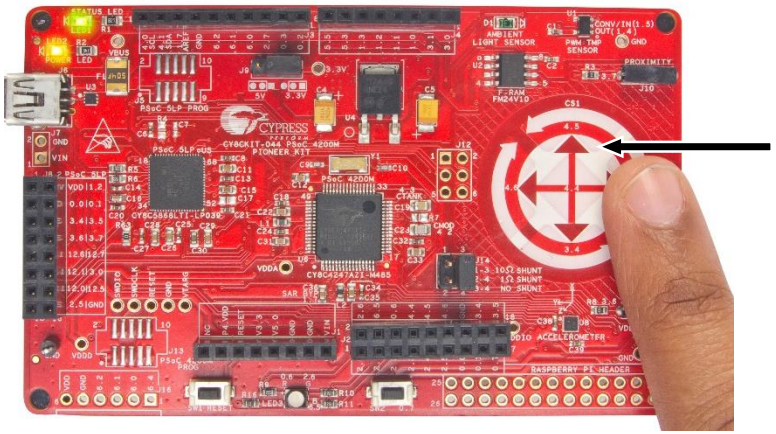
Swipe Gesture: Left/Right



Circular Gesture: Clockwise/ Counter-Clockwise



CapSense Gestures on the PSoC 4 M-Series Pioneer Kit (CY8CKIT-044)



Washing Machine With a Liquid-Tolerant UI

Touch-sensing user interfaces are designed into end products that are exposed to liquids

The PSoC 4 M-Series Pioneer Kit provides a platform to implement touch-based gestures rapidly

Lab #3: CapSense Touch-Sensing Design

Objectives:

Adjust the RGB LED color and intensity using three TCPWM Components

Implement CapSense touch-based gestures using the CapSense Gesture Pad

Software tool:

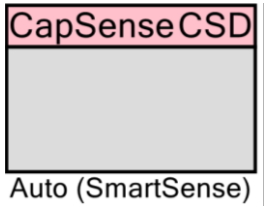
PSoC Creator

Components:

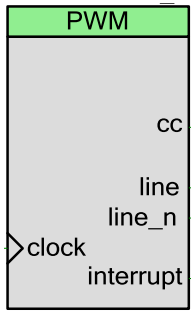
TCPWM Components

CapSense CSD Component

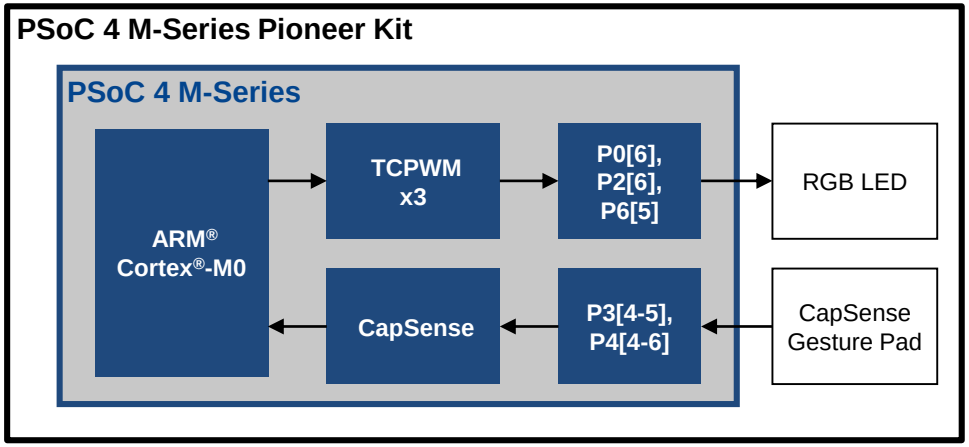
CapSense CSD Component Icon



TCPWM Component Icon



Lab 3: Block Diagram



Introduction to PSoC 4

LAB #4: SENSOR-BASED SYSTEM DESIGN

Sensor-Based System Design

Fitness monitors are examples of sensor-based system designs

Fitness monitors can have up to 8 or more analog and digital sensors to track activities

To learn more about fitness monitors, download our *Wearables Solutions Catalog*

Fitness monitors require:

A heart rate monitor

Activity monitoring and a step counter

A touch-based user interface

Maximum battery life

A low system BOM cost

Designing a fitness monitor requires:

AFEs with opamps and an ADC to amplify, buffer and capture heart rate signals

An accelerometer to capture changes in motion

A touch-sensing IC to detect touches and gestures

ICs with low-power modes to minimize system power consumption

PSoC 4 delivers a low-cost, single-chip solution for today's sensor-based system designs

Up3 Fitness Monitor by Jawbone

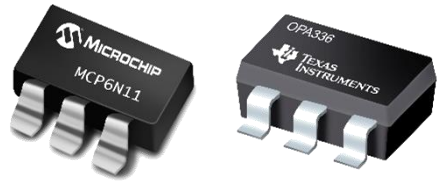
The newest Jawbone Up3 features a heart rate monitor and a touch-sensing interface to mobile devices

Microsoft Band Fitness Monitor

The new Microsoft Band includes a state-of-the-art heart rate monitor and a touch-sensing interface to mobile devices

PSoC 4 Integrates AFEs, Digital Logic and an MCU

Multiple AFE ICs, a CPLD IC and a legacy MCU…



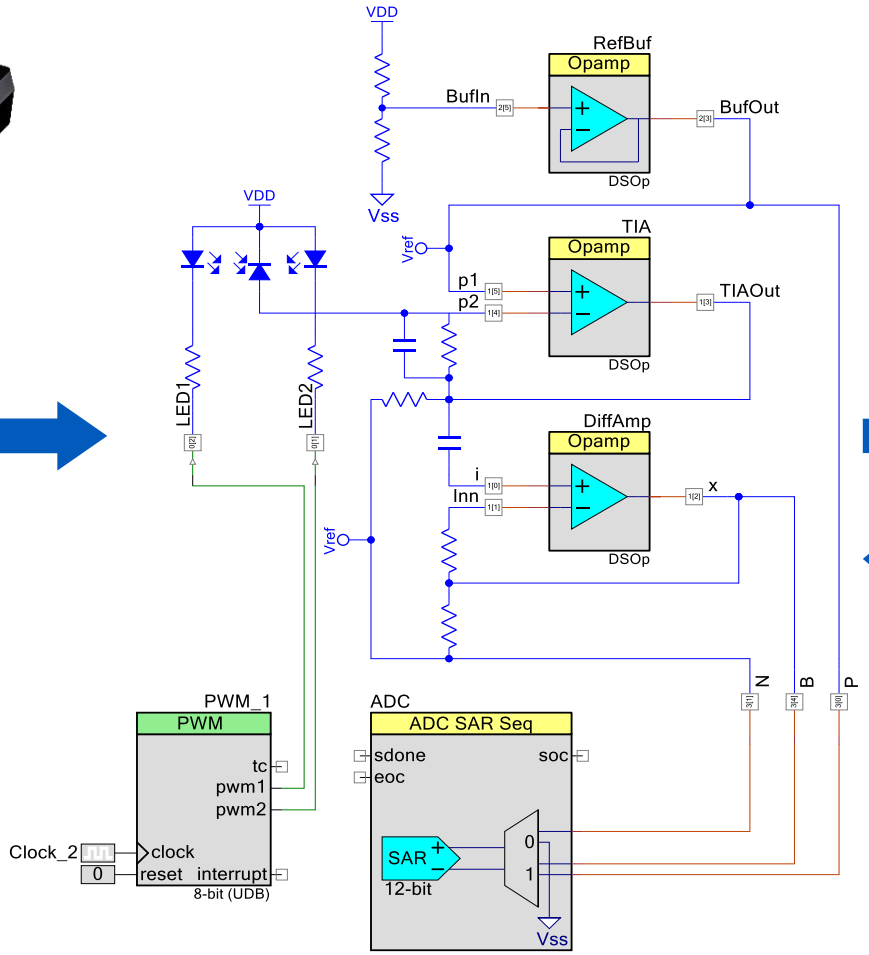
Instrumentation Amplifier

Dual-Channel Opamp

Complex Programmable Logic Device (CPLD)

16-Bit MCU

Are integrated using **Components** in **PSoC Creator**…



And **rapidly prototyped** to create a **one-chip solution**…

That can be **changed in software** without costly PCB spins.

$25 PSoC 4 M-Series Pioneer Kit (CY8CKIT-044)

PSoC 4 Delivers Five Flexible, Easy-to-Use Low-Power Modes

Power Mode	Current Consumption	Code Execution	Digital Peripherals Available	Analog Peripherals Available	Clock Sources Available	Wake-Up Sources	Wake-Up Time
Active	2.2 mA @ 6 MHz	Yes	All	All	All	-	-
Sleep	1.3 mA	No	All	All	All	Any interrupt source	0
Deep-Sleep	1.3 µA	No	WDT[1], LCD[2], I²C/SPI	Comparator, opamps, POR[3], BOD[4]	WCO[5], 32-kHz ILO[6]	Comparator, GPIO[7], WDT, SCB[8]	25 µs
Hibernate	150 nA	No	No	Comparator, POR, BOD	No	Comparator, GPIO	2 ms
Stop	20 nA	No	No	No	No	Wake-Up pin, XRES[9]	2 ms

PSoC 4 has best-in-class low-power modes

Consumes the lowest current in Stop mode with I/O-state retention

Retains SRAM data in Hibernate mode

Retains complete system status, as well as opamp and comparator functionality, in Deep-Sleep mode

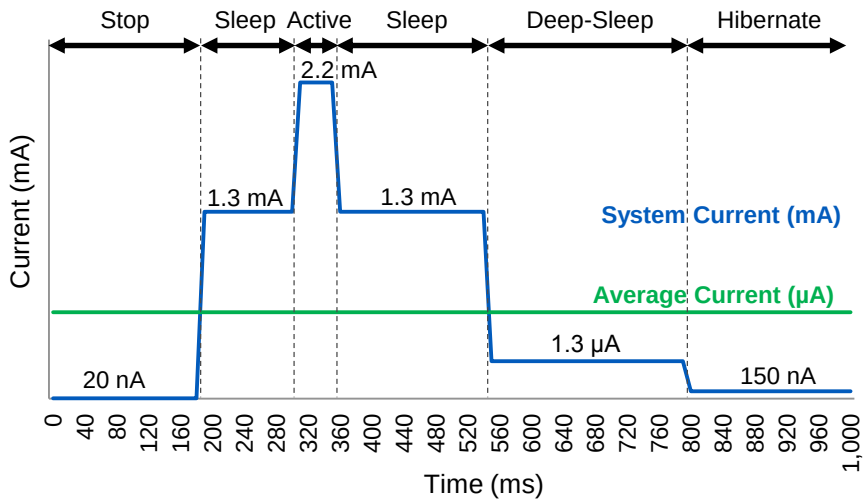
Immediate wake-up from Sleep mode, unlike some 8-/16-bit MCUs

PSoC Creator simplifies power optimization

Provides APIs to switch easily between low-power modes

Provides APIs to control the power of PSoC Components

PSoC 4 Current Consumption in Different Power Modes



[1] Watchdog timer
[2] Liquid crystal display
[3] Power-on-reset
[4] Brownout-detect
[5] 32-kHz watch crystal oscillator
[6] 32-kHz internal low-speed oscillator
[7] General-purpose input/output
[8] Serial Communication Block
[9] External reset

Lab #4: Sensor-Based System Design

Objectives

Measure ambient light intensity using an ambient light sensor

Control the LED intensity based on the ambient light intensity

Software tools

PSoC Creator

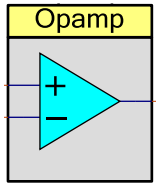
Micrium µC/Probe

Components

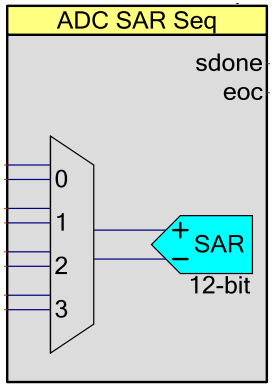
SAR[1] ADC Component

Opamp Component

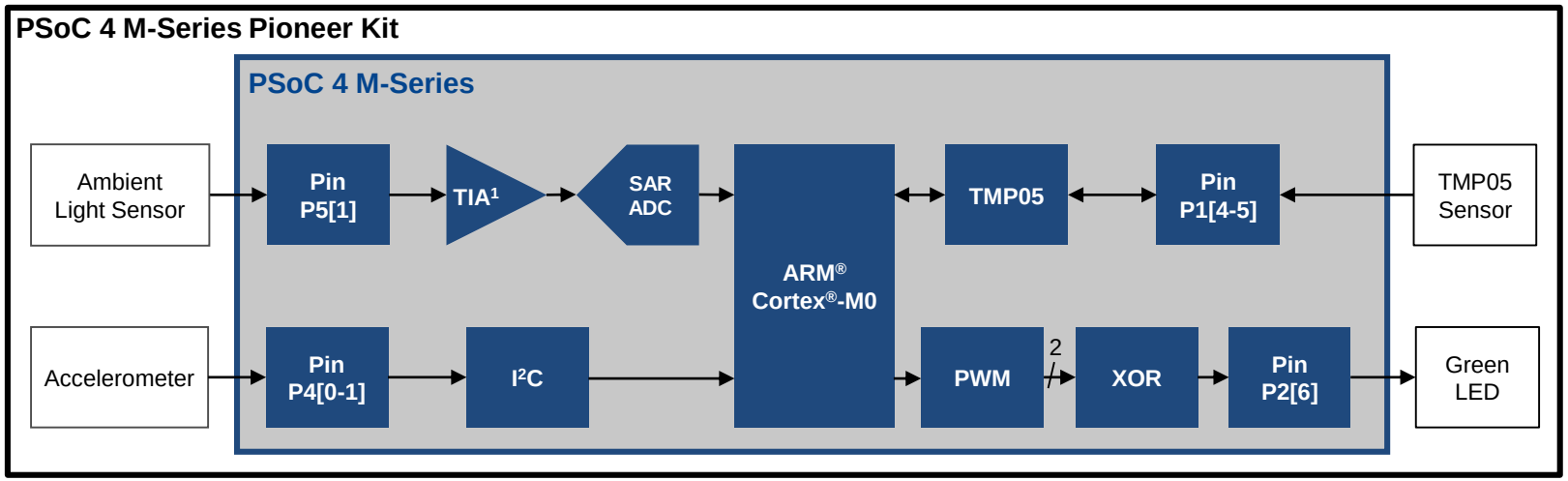
Opamp Component



SAR ADC Component



Lab 4: Block Diagram



[1] Trans-impedance amplifier using PSoC 4 Programmable Analog Blocks

Introduction to PSoC 4

WRAP-UP

References and Links

Product Webpages:

PSoC 4 Product webpage: www.cypress.com/PSoC4
PSoC 4100 datasheet: www.cypress.com/go/cy8c41datasheet
PSoC 4200 datasheet: www.cypress.com/go/cy8c42datasheet
PSoC 4100M datasheet: www.cypress.com/PSoC4100MDatasheet
PSoC 4200M datasheet: www.cypress.com/PSoC4200MDatasheet
PSoC 4 BLE datasheet: www.cypress.com/PSoC4BLEDatasheet
PSoC Product roadmap: www.cypress.com/PSoCRoadmap
PSoC 4 M-Series Pioneer Kit: www.cypress.com/CY8CKIT-044
PSoC Creator IDE: www.cypress.com/PSoCCreator
Micrium µC/Probe: www.micrium.com/tools/ucprobe

Application Notes:

Getting Started With PSoC 4 (AN79953): www.cypress.com/go/AN79953
PSoC 4 Low-Power Modes and Power Reduction Techniques (AN86233): www.cypress.com/go/AN86233
PSoC 4 Intelligent Fan Controller (AN89346): www.cypress.com/go/AN89346
PSoC 4 I²C Bootloader (AN86526): www.cypress.com/go/AN86526
PSoC 4 and PSoC 5LP ARM® Cortex® Code Optimization (AN89610): www.cypress.com/go/AN89610
PSoC 3, PSoC 4, PSoC 5LP Digital Design Best Practices (AN81623): www.cypress.com/go/AN81623
PSoC 4100/4200 Hardware Design Considerations (AN88619): www.cypress.com/go/AN88619
Designing PSoC Creator™ Components With UDB Datapaths (AN82156): www.cypress.com/go/AN82156
Implementing Programmable Logic Designs With Verilog (AN82250): www.cypress.com/go/AN82250

Design Guides:

PSoC 4 CapSense Design Guide: www.cypress.com/go/AN85951

General Online Resources

Cypress Resources

PSoC Product webpage: www.cypress.com/PSoC

Cypress Roadmap: www.cypress.com/Roadmap

Kits: www.cypress.com/kits

Support: www.cypress.com/support

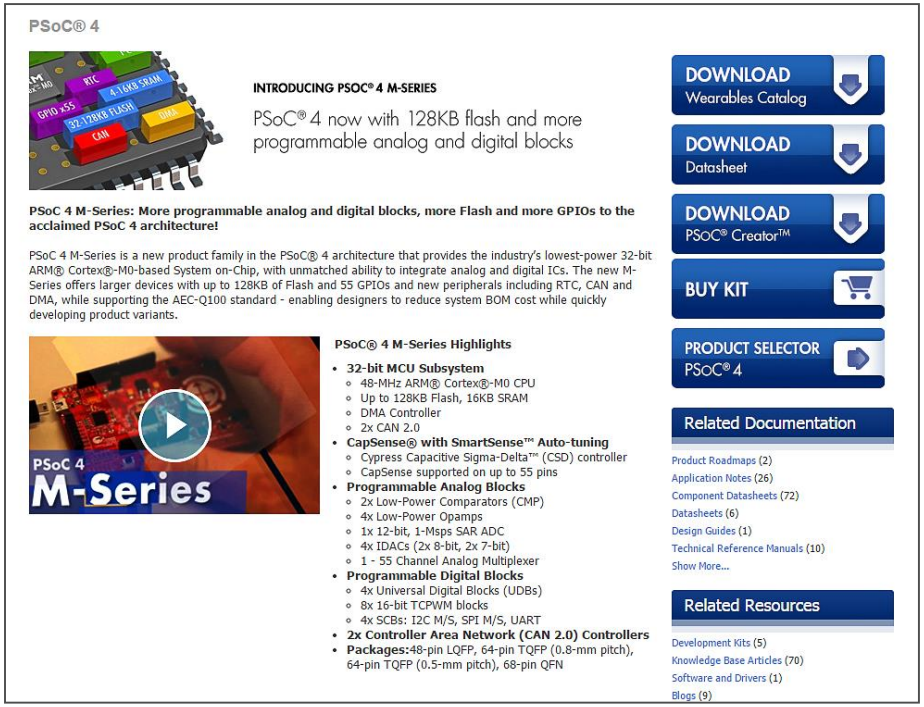
Workshops: www.cypress.com/workshops

Cypress Online Store: www.cypress.com/store

Developer Community & Forums: www.cypress.com/forums

App Notes: www.cypress.com/AppNotes

Cypress PSoC 4 M-Series Solutions: www.cypress.com/PSoC4



Cypress's PSoC 4 M-Series webpage is your one-stop-shop for everything, including product datasheets, development kits, app notes, software downloads, example projects and demo videos

Workshop Objectives Recap

You should now:

Understand the architecture of the PSoC 4 Programmable System-on-Chip

Know how to use the PSoC Creator IDE and the PSoC 4 M-Series Pioneer Kit to design with PSoC 4, to implement:

- Digital designs with PSoC 4
- CapSense touch-sensing user interface designs with PSoC 4
- One-chip, sensor-based system designs with PSoC 4

Please help us improve this workshop by completing our feedback form

Introduction to PSoC 4

APPENDIX

PSoC® 4100
Intelligent Analog Family

Applications

User interface for home appliances
Digital and analog sensor hub
MCU and discrete analog replacement

Features

32-bit MCU Subsystem
24-MHz ARM® Cortex®-M0 CPU
Up to 32KB flash and 4KB SRAM

CapSense® with SmartSense™ Auto-tuning
Cypress Capacitive Sigma-Delta™ (CSD) controller
CapSense supported on up to 36 pins

Programmable Analog Blocks
Two comparators (CMP)
Two opamps, programmed as PGAs, CMPs, filters, etc.
One 12-bit, 1-Msps SAR[1] ADC
Two IDACs[2] (2x 8-bit, 2x 7-bit)

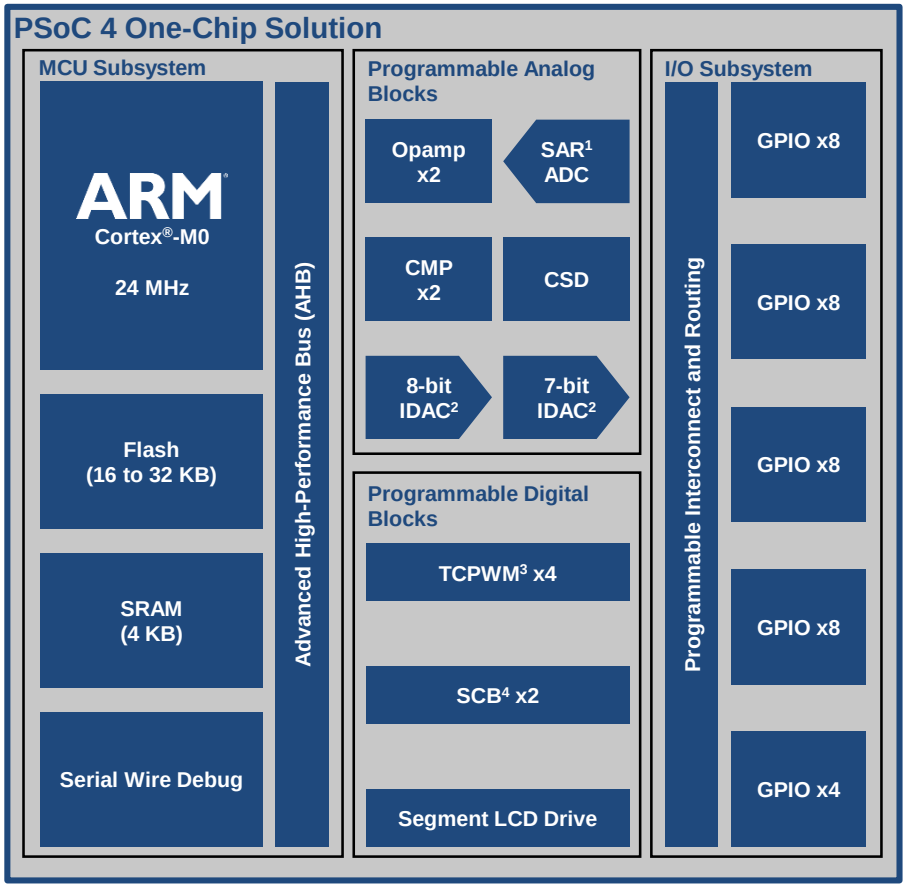
Programmable Digital Blocks
Four programmable 16-bit TCPWM[3] blocks
Two SCBs[4]: I²C master or slave, SPI master or slave, or UART

Packages: 28-pin SSOP, 40-pin QFN, 44-pin TQFP, 48-pin LQFP

Collateral

Datasheet: PSoC 4100 datasheet

Block Diagram



Availability

Sampling: Now
Production: Now

[1] Successive approximation register
[2] Current-output digital-to-analog converter
[3] Timer, counter, PWM block
[4] Serial Communication Block, programmable as I²C/SPI/UART

PSoC® 4200
Programmable Digital Family

Applications

User interface for home appliances
Digital and analog sensor hub
MCU and discrete analog replacement

Features

32-bit MCU Subsystem
48-MHz ARM® Cortex®-M0 CPU
Up to 32KB flash and 4KB SRAM

CapSense® with SmartSense™ Auto-tuning
Cypress Capacitive Sigma-Delta™ (CSD) controller
CapSense supported on up to 36 pins

Programmable Analog Blocks
Two comparators (CMP)
Two opamps, programmed as PGAs, CMPs, filters, etc.
One 12-bit, 1-Msps SAR[1] ADC
Two IDACs[2] (2x 8-bit, 2x 7-bit)

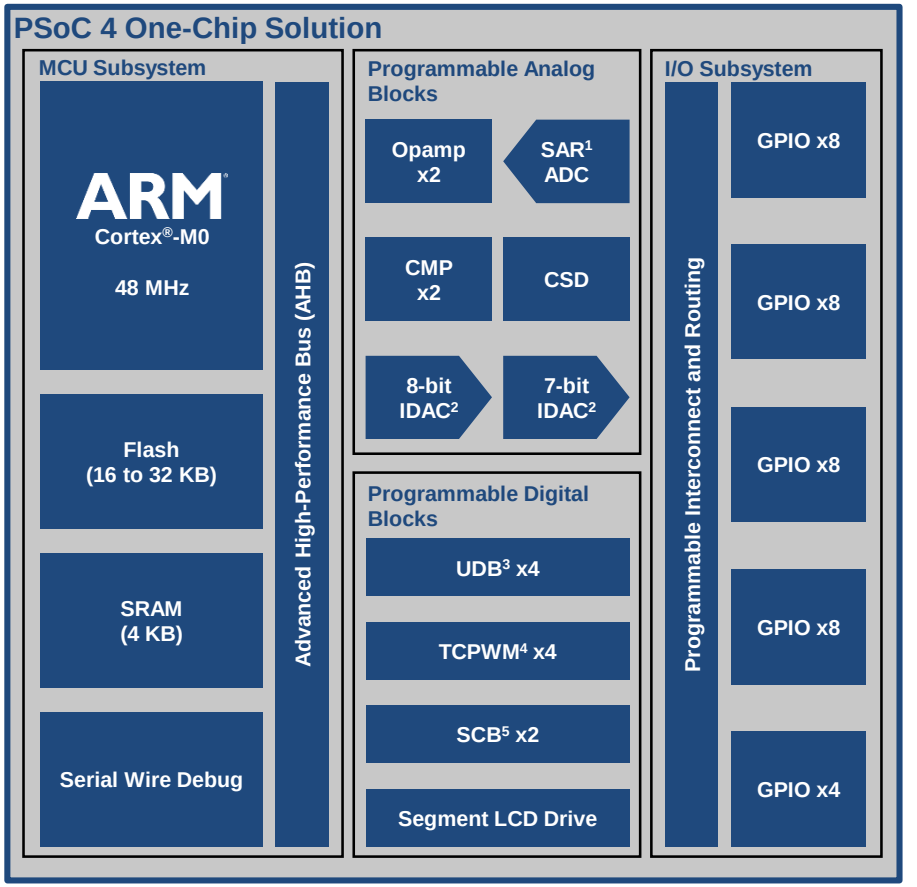
Programmable Digital Blocks
Four Universal Digital Blocks (UDBs[3]): custom digital peripherals
Four programmable 16-bit TCPWM[4] blocks
Two SCBs[5]: I²C master or slave, SPI master or slave, or UART

Packages: 28-pin SSOP, 40-pin QFN, 44-pin TQFP, 48-pin LQFP

Collateral

Datasheet: PSoC 4200 datasheet

Block Diagram



Availability

Sampling: Now
Production: Now

[1] Successive approximation register
[2] Current-output digital-to-analog converter
[3] Universal Digital Block
[4] Timer, counter, PWM block
[5] Serial Communication Block, programmable as I²C/SPI/UART

PSoC® 4100 BLE-Series

Intelligent Analog Family with Bluetooth Low Energy

Applications

Sports and fitness monitors, wearable electronics, medical devices, home automation solutions, game controllers, sensor-based low-power systems for the Internet of Things (IoT)

Features

32-bit MCU subsystem
24-MHz ARM® Cortex®-M0 CPU
Up to 256KB flash and 32KB SRAM

Programmable Analog Blocks
Four opamps, configurable as PGAs, comparators, filters, etc.
One 12-bit, 1-Msps SAR[1] ADC

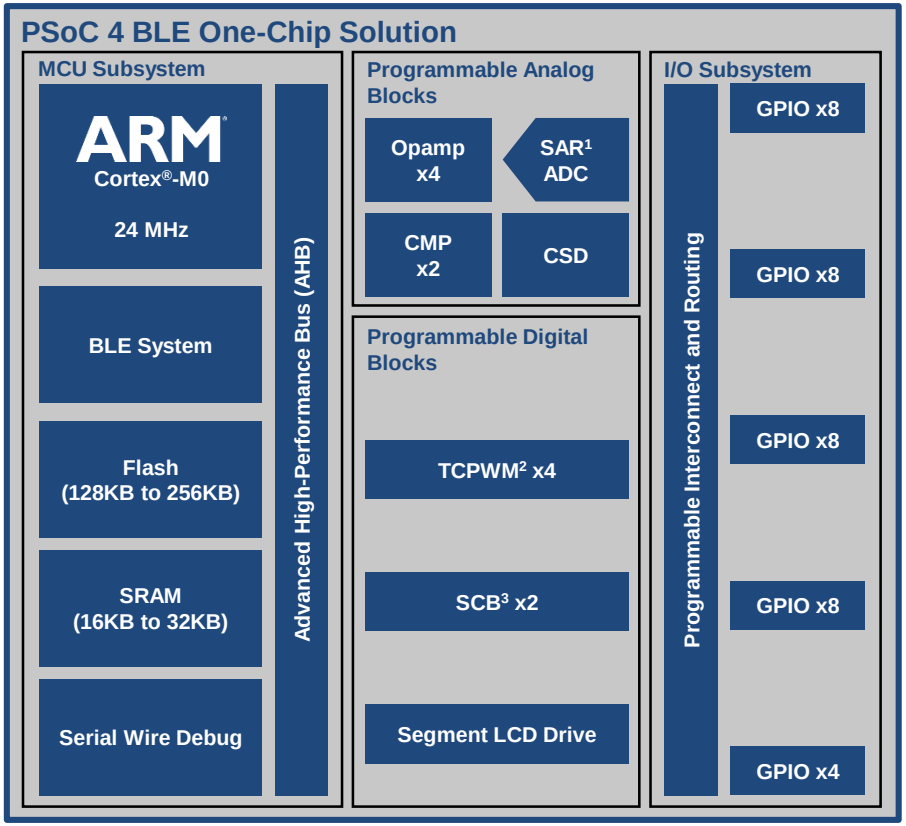
CapSense® with SmartSense™ Auto-tuning
One Cypress Capacitive Sigma-Delta™ (CSD) controller with touchpad capability

Programmable Digital Blocks
Four configurable TCPWM[2] blocks: 16-bit timer, counter or PWM
Two configurable serial communication blocks (SCBs)[3]: I²C master or slave, SPI master or slave, or UART

Packages
56-pin QFN, 68-pin CSP

Bluetooth Smart connectivity with Bluetooth 4.1
2.4-GHz BLE radio with integrated Balun

Block Diagram



Collateral

Datasheet: PSoC 4100 BLE datasheet

Availability

Sampling: Now
Production: Now

[1] Successive approximation register
[2] Timer, counter, PWM block
[3] Serial Communication Block, programmable as I²C/SPI/UART

PSoC® 4200 BLE-Series

Programmable Digital Family with Bluetooth Low Energy

Applications

Sports and fitness monitors, wearable electronics, medical devices, home automation solutions, game controllers, sensor-based low-power systems for the Internet of Things (IoT)

Features

32-bit MCU subsystem
48-MHz ARM® Cortex®-M0 CPU
Up to 256KB flash and 32KB SRAM

Programmable Analog Blocks
Four opamps, configurable as PGAs, comparators, filters, etc.
One 12-bit, 1-Msps SAR[1] ADC

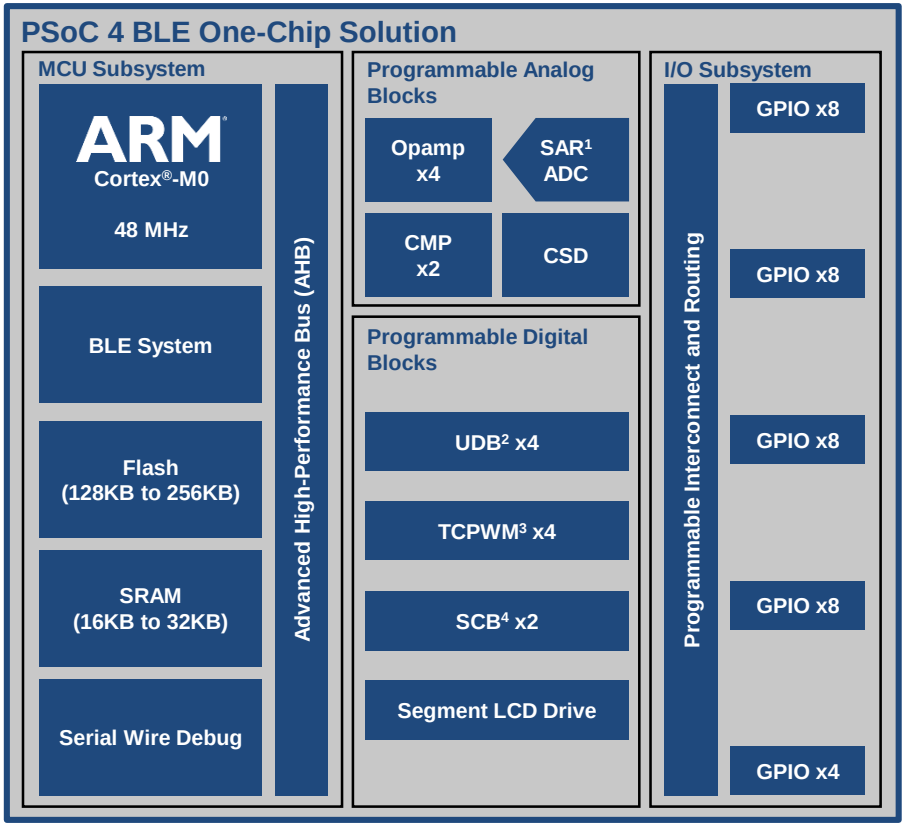
CapSense® with SmartSense™ Auto-tuning
One Cypress Capacitive Sigma-Delta™ (CSD) controller with touchpad capability

Programmable Digital Blocks
Four Universal Digital Blocks (UDBs[2]): custom digital peripherals
Four configurable TCPWM[3] blocks: 16-bit timer, counter or PWM
Two configurable serial communication blocks (SCBs[4]):
I²C master or slave, SPI master or slave, or UART

Packages
56-pin QFN, 68-pin CSP

Bluetooth Smart connectivity with Bluetooth 4.1
2.4-GHz BLE radio with integrated Balun

Block Diagram



Collateral

Datasheet: PSoC 4200 BLE datasheet

Availability

Sampling: Now
Production: Now

[1] Successive approximation register
[2] Universal Digital Block
[3] Timer, counter, PWM block
[4] Serial Communication Block, programmable as I²C/SPI/UART

PSoC® 4100 M-Series

Intelligent Analog Family

Applications

User interface and host processor for home appliances
Digital and analog sensor hub
MCU and discrete analog replacement

Features

32-bit MCU Subsystem
24-MHz ARM® Cortex®-M0 CPU with a DMA controller and RTC
Up to 128KB flash and 16KB SRAM
Up to 55 GPIOs supporting analog, digital and CapSense interfaces

CapSense® With SmartSense™ Auto-tuning
Cypress Capacitive Sigma-Delta™ (CSD) controller

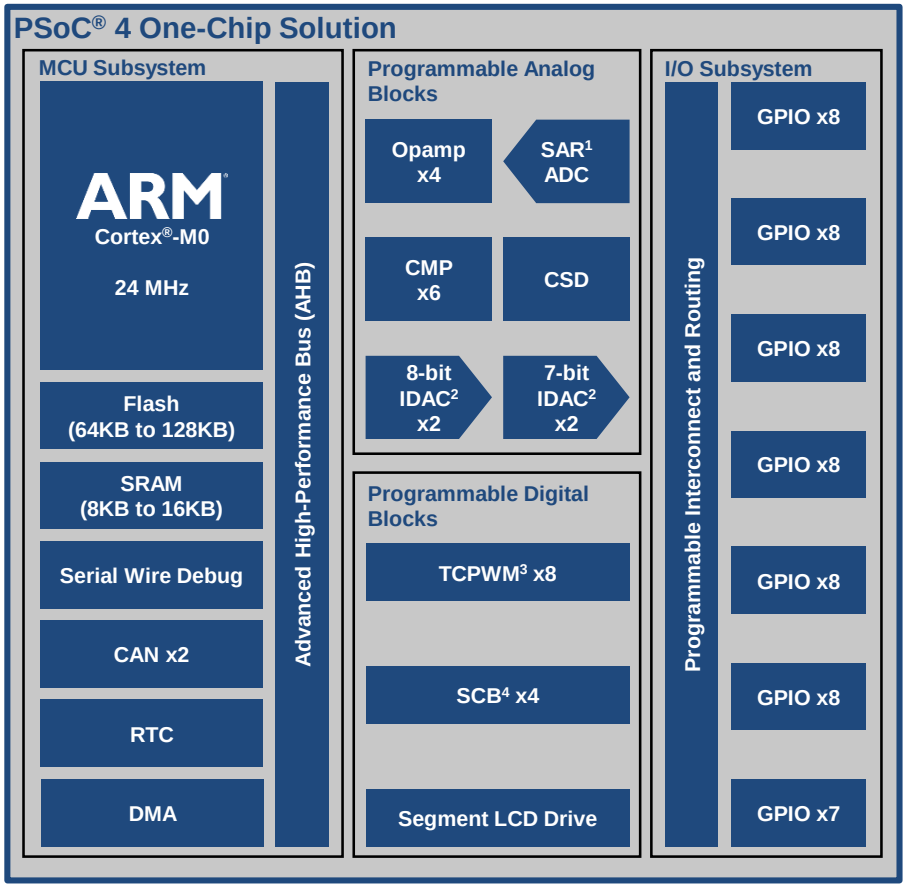
Programmable Analog Blocks
Six comparators (CMP)
Four opamps, programmable as PGAs, CMPs, filters, etc.
One 12-bit, 1-Msps SAR[1] ADC
Four IDACs[2] (2x 8-bit, 2x 7-bit)

Programmable Digital Blocks
Eight programmable 16-bit TCPWM[3] blocks
Four SCBs[4]: I²C master or slave, SPI master or slave, or UART

Two Controller Area Network (CAN) Controllers

Packages: 48-pin LQFP, 64-pin TQFP (0.8-mm pitch), 64-pin TQFP (0.5-mm pitch), 68-pin QFN

Block Diagram



Collateral

Datasheet: PSoC 4100M datasheet

Availability

Sampling: Now
Production: Q2 2015

[1] Successive approximation register
[2] Current-output digital-to-analog converter
[3] Timer, counter, PWM block
[4] Serial Communication Block, programmable as I²C/SPI/UART

PSoC® 4200 M-Series

Programmable Digital Family

Applications

User interface and host processor for home appliances
Digital and analog sensor hub
LED control and communication for lighting systems

Features

32-bit MCU Subsystem
48-MHz ARM® Cortex®-M0 CPU with a DMA controller and RTC
Up to 128KB flash and 16KB SRAM
Up to 55 GPIOs supporting analog, digital and CapSense interfaces

CapSense® With SmartSense™ Auto-tuning
Cypress Capacitive Sigma-Delta™ (CSD) controller

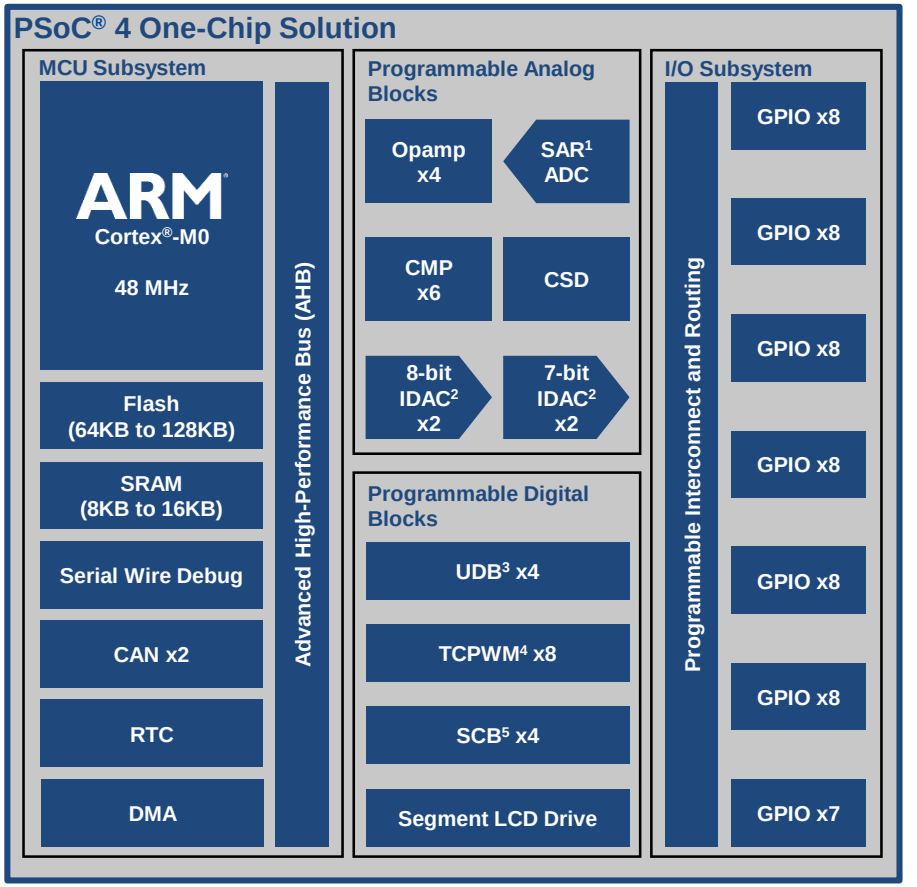
Programmable Analog Blocks
Six comparators (CMP)
Four opamps, programmable as PGAs, CMPs, filters, etc.
One 12-bit, 1-Msps SAR[1] ADC
Four IDACs[2] (2x 8-bit, 2x 7-bit)

Programmable Digital Blocks
Four Universal Digital Blocks (UDBs[3]): custom digital peripherals
Eight programmable 16-bit TCPWM[4] blocks
Four SCBs[5]: I²C master or slave, SPI master or slave, or UART

Two Controller Area Network (CAN) Controllers

Packages: 48-pin LQFP, 64-pin TQFP (0.8-mm pitch), 64-pin TQFP (0.5-mm pitch), 68-pin QFN

Block Diagram



Collateral

Datasheet: PSoC 4200M datasheet

Availability

Sampling: Now
Production: Q2 2015

[1] Successive approximation register
[2] Current-output digital-to-analog converter
[3] Universal Digital Block
[4] Timer, counter, PWM block
[5] Serial Communication Block, programmable as I²C/SPI/UART