PSoC® 4000 New Product Introduction

PSoC = Programmable System-on-Chip

Quickly Upgrade Your Product With 32-Bit Performance And Reliable CapSense
Agenda

For the next 30 minutes, we will discuss:
Your opportunity with this new product: what’s in it for you
Technical terms
Design problems your customers’ engineers face and their solutions
Competitive product comparison
Fit questions: where to fish
New product specification
Embedded System Design Is Evolving

Embedded system designs now require higher performing MCUs at the same cost
Legacy 8-bit and 16-bit MCUs are being broadly replaced by 32-bit ARM Cortex-M MCUs

Reliable, easy-to-use solutions accelerate time-to-market
Embedded system designs now require reliable, easy-to-use solutions, such as touch sensing

Embedded system designs have moved to power-optimized solutions for battery-powered applications

“2013 Semiconductor of the Year” award
Semiconductor Industry News

“PSoc 4 is truly a revolutionary device that symbolizes a new era of flexibility in design.”
- Wataru Izumiya, President of Sangyo Times, Publisher of Semiconductor Industry News

“Most Innovative Product” of 2013
Embedded Computing Design

“We selected the PSoC 4 architecture as an Editor’s Choice Product for its combination of flexible analog and digital resources with capacitive touch technology and the 32-bit ARM Cortex-M0 MCU.”
- Warren Webb, Editorial Director at Embedded Computing Design
PSoC: The World’s First Programmable Embedded Design Platform

PSoC is a programmable embedded design platform that:
- Includes the 32-bit ARM Cortex-M MCU
- Accelerates embedded system design with reliable, easy-to-use solutions, such as touch sensing
- Optimizes power consumption

PSoC is as proven, and reliable, solution that has sold over 1.7 billion units
- Cypress has invested in PSoC continuously since 2000
- PSoC is used in applications in the industrial, consumer, medical, networking and automotive segments

2002
PSoC 1
Cypress launches the world’s first one-chip solution integrating programmable analog, digital logic and a microcontroller

2005
CapSense
Cypress ships its first-generation PSoC-based capacitive touch-sensing solution

2006
Cypress ships its 100-millionth PSoC unit

2009
PSoC 3
Cypress enters into a partnership with ARM® to expand the PSoC portfolio

2011
PSoC 5
Cypress ships its one-billionth PSoC unit

2013
PSoC 4
Cypress launches the world’s most flexible, lowest-power ARM® Cortex™-M0 one-chip solution for $1
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 and CapSense

Programmable Analog Block
A hardware block that is configured using PSoC Components¹ to create
- Analog Front Ends (AFEs), signal conditioning circuits with opamps and filters
- Includes analog-to-digital converters (ADCs) and digital-to-analog converters (DACs)

Programmable Digital Block
A hardware block that is configured using PSoC Components¹ to implement
- custom digital peripherals and glue logic
- Includes Timer, Counter, PWM (TCPWM) Blocks

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

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

¹ Free embedded ICs represented by an icon in PSoC Creator software
**PSoC Terms**

**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 Configuration Tools**
Simple graphical user interfaces in PSoC Creator embedded in each Component
Used to customize Component parameters

**SmartSense™ Auto-tuning**
CapSense algorithm that automatically sets sensing parameters for optimal performance after the design phase
Continuously compensates for system, manufacturing and environmental changes

**PSoC 4**
A PSoC with an ARM® Cortex®-M0 MCU
Terms You Will Hear Today

Liquid Tolerance
The ability of a Capacitive Sensing System to work properly in the presence of liquid droplets, streaming liquids or mist

Proximity Sensor
A sensor that can detect the presence of nearby objects without any physical contact

Signal-to-Noise Ratio (SNR)
The ratio of the sensor signal, when touched, to the noise signal of an untouched sensor

Manual Tuning
The manual process of setting Sensing Parameters for optimal performance during the design phase
Required on an ongoing basis to compensate for system, manufacturing and environmental changes during the prototyping and manufacturing phases
Design Problems Engineers Face

Legacy 8-bit and 16-bit MCUs do not offer the performance required for today’s applications
8-bit and 16-bit MCUs do not meet customer requirements for processing speed and power consumption

Reliable touch-sensing solutions are difficult to design
Touch-sensing solutions require specialized expertise to implement
Curved or thick overlays, gloves and noisy environments reduce SNR performance
Advanced features like proximity sensing and Liquid Tolerance further complicate the system design

It is difficult to achieve the lowest power at the required performance level
Optimizing performance in a low-power system requires careful use of low-power modes

Cypress’s PSoC 4000 family solves these problems
The PSoC 4000 family uses a 32-bit ARM Cortex-M0 MCU to quickly upgrade legacy 8-bit and 16-bit MCUs
Complicated customer requirements are simple to meet using PSoC Creator Components and your application code
The PSoC 4000 family enables reliable CapSense designs that work under all conditions using SmartSense Auto-tuning
PSoC Creator simplifies power optimization using the PSoC 4000 low-power modes

PSoC 4000 enables you to quickly upgrade your product with 32-bit performance, reliable CapSense and low power consumption
PSoC 4000 Makes It Easy to Design A Low-Power CapSense Solution

Reducing the overall system power of a battery-powered capacitive trackpad using an ARM Cortex-M0 MCU featuring the industry’s best touch-sensing hardware and firmware IP…

Is simplified using PSoC Creator Components and the Component Configuration Tools…

And prototyped quickly using the CY8CKIT-040 Evaluation Kit to create a low-power capacitive trackpad.
The PSoC 4000 family has a 32-bit ARM Cortex-M0 MCU to upgrade legacy 8-bit and 16-bit MCUs. The ARM Cortex-M0 processes instructions three times faster than the MSP430 and 45 times faster than the PIC18. Faster instruction processing enables the ARM Cortex-M0 to spend more time in sleep modes, reducing system power consumption.

DMIPS = Dhrystone million instructions per second; data referenced from *The Definitive Guide to the ARM Cortex-M0*, ISBN: 978-0-12-385477-3
Cypress’s reliable CapSense solution is proven in production
Industry’s No. 1 solution in sales by 4x over No. 2
CapSense buttons “just work” because of rigorous engineering and testing

The PSoC 4000 family enables CapSense designs with:
Up to 16 CapSense I/Os that can be used as buttons, sliders and Proximity Sensors
Robust noise immunity with a practical system SNR > 100:1
Robust standing and running Liquid Tolerance capability
Reduced time-to-market and increased manufacturing robustness with SmartSense Auto-tuning
Low power consumption (5 µA average)

The CapSense Component Configuration Tool makes it easy to design buttons, sliders, Proximity Sensors and trackpads without writing code
The PSoC Creator IDE simplifies power optimization using the PSoC 4000 family’s low-power modes

<table>
<thead>
<tr>
<th>Power Mode</th>
<th>Current Consumption</th>
<th>Code Execution</th>
<th>Digital Peripherals Available</th>
<th>Analog Peripherals Available</th>
<th>Clock Sources Available</th>
<th>Wake-Up Sources</th>
<th>Wake-Up Time</th>
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<tr>
<td>Active</td>
<td>2 mA @ 6 MHz</td>
<td>Yes</td>
<td>All</td>
<td>All</td>
<td>All</td>
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<td>-</td>
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<td>Sleep</td>
<td>1.1 mA</td>
<td>No</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>Any interrupt source</td>
<td>0</td>
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<tr>
<td>Deep-sleep</td>
<td>2.5 µA</td>
<td>No</td>
<td>WDT¹, I²C</td>
<td>POR²</td>
<td>32-kHz ILO</td>
<td>GPIO, WDT, I²C</td>
<td>35 μs</td>
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</table>

The PSoC 4000 family enables efficient designs with low power consumption by utilizing:
The deep-sleep power mode with wake-on-interrupt and I²C address detect
Watchdog timer operation during both the sleep and deep-sleep power modes
Instantaneous wake-up from sleep

PSoC Creator’s APIs simplify power management by:
Enabling changes between power modes
Controlling the power of individual PSoC Components

1 WDT: Watchdog timer
2 POR: Power-on-reset
3 Graph is not to scale in order to illustrate the differences in PSoC 4 low-power modes

PSoC 4000 Current Consumption in Different Power Modes

System Current (mA)
Average Current (mA)
CapSense Starter Project on Six Windows in the PSoC Creator IDE

1. Explore the library of 75+ Components
2. Complete your hardware system design by dragging and dropping Component icons
3. Configure Components using a Component-specific configuration tool
4. Access Component datasheets directly from the configuration tool for technical specification
5. Codesign your application firmware and hardware using the PSoC Creator IDE C-based compiler
6. Review the Components’ application notes for usage guidelines
## PSoC 4000 vs. Low-Cost MCUs With Capacitive Sensing

<table>
<thead>
<tr>
<th>Feature</th>
<th>CY8C4014LQI-422</th>
<th>LPC1112LVFH-N24</th>
<th>LPC812M101-JDH20</th>
<th>PIC16F688</th>
<th>MSP430G2432</th>
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<td><strong>CPU Core</strong></td>
<td>Cortex-M0</td>
<td>Cortex-M0</td>
<td>Cortex-M0+</td>
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<td>16 bit</td>
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<td><strong>Touch-Sensing System:</strong></td>
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<td></td>
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<td>Capacitive Sensing Channels</td>
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<td>8</td>
<td>-</td>
<td>8</td>
<td>16</td>
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<td>Tuning Method</td>
<td>SmartSense™</td>
<td>Manual Tuning</td>
<td>-</td>
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<td>Proximity Sensing</td>
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<td>No</td>
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<td>Liquid Tolerance</td>
<td>Yes (Any liquid)</td>
<td>No</td>
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<td>Typ Current/Channel</td>
<td>5 µA</td>
<td>N/A¹</td>
<td>-</td>
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<td>Price/CapSense® Button</td>
<td>As low as $0.05</td>
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<td>Serial Interfaces</td>
<td>1 I²C</td>
<td>1 SPI, 1 I²C, 1 UART</td>
<td>2 SPI, 1 I²C, 3 UART</td>
<td>1 SPI, 1 I²C, 1 UART</td>
<td>1 SPI, 1 I²C, 1 UART</td>
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<td>Timer/Counter/PWMs</td>
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<td>4/3/0</td>
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<td>Pin Count (GPIO)</td>
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<td>20 (18)</td>
<td>14 (12)</td>
<td>20 (16)</td>
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<td>Supply Voltage (V)</td>
<td>1.71-5.5</td>
<td>1.65-1.95</td>
<td>1.8-3.6</td>
<td>2.0-5.5</td>
<td>1.8-3.6</td>
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</table>

¹ Current consumption per Capacitive Sensing Channel is not published online
## PSoC 4 Capacitive-Sensing Solution Value

### Competitor
Capacitive Sensing Controller: NXP LPC1112LVFHN24
Price: $1.07\(^1\)

### BOM Integration
Liquid Tolerance: Opamp (LM324DR2G) to implement shield electrode
Price: $0.12\(^2\)
Proximity Sensing: 47-nF X7R capacitor (GRM21BR71H473KA01L)
Price: $0.03\(^2\)

### Additional Value
SmartSense Auto-tuning: Saves four man-weeks of engineering effort at $2k per man-week, amortized over 40,000 units
Value Added: $0.20

<table>
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<tr>
<th>Component</th>
<th>Value</th>
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<tbody>
<tr>
<td>Competitor</td>
<td>$1.07</td>
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<tr>
<td>Liquid Tolerance</td>
<td>$0.12</td>
</tr>
<tr>
<td>Proximity Sensing</td>
<td>$0.03</td>
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<tr>
<td>Total Additional Value</td>
<td>$0.20</td>
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<tr>
<td>Total Value Delivered</td>
<td>$1.42</td>
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</table>

1. Mouser 1ku pricing as of 6/26/2014
2. Digikey 1ku pricing as of 6/26/2014

Target PSoC Solution: CY8C4014LQI-422
Total Cost: $1.25\(^2\)
12% Total Savings: $0.17
## PSoC® 4 Portfolio

### ARM® Cortex™-M0 | CapSense®

<table>
<thead>
<tr>
<th>PSoC MCU</th>
<th>Intelligent Analog PSoC 4100</th>
<th>Programmable Digital PSoC 4200</th>
<th>Programmable Analog PSoC 4400</th>
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</thead>
<tbody>
<tr>
<td>PSoC 4000</td>
<td>CY8C4127-M 24 MHz, 128K/16K</td>
<td>CY8C4247-M 48 MHz, 128K/16K</td>
<td>CY8C4248-BL 48 MHz, 256K-32K</td>
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<td>CY8C4128-6 24 MHz, 256K/32K</td>
<td>CY8C4246-6 48 MHz, 64K/8K</td>
<td>CY8C44x6 48 MHz, 64K/16K</td>
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<td>CY8C4129-M 24 MHz, 256K/32K</td>
<td>CY8C4248-M 48 MHz, 64K/8K</td>
<td>CY8C44x8 48 MHz, 64K/8K</td>
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<td>TCPWM, UDB</td>
<td>TCPWM, BLE</td>
<td>Contact Sales</td>
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</tbody>
</table>

**Integration:****

1. Flash KB/SRAM KB
2. Comparator
3. Analog-to-digital converter
4. Serial communication block programmable as PC/SP/UART
5. Current-output digital-to-analog converter
6. Timer/counter/PWM block
7. Bluetooth Low Energy
8. Universal digital block

**Status Availability:**

- Production
- Sampling
- Development
- Concept

**001-91927 Owner: JFMD**
PSoC 4000 Programmable System-on-Chip New Product Introduction (Distribution)

16
PSOC 4000 (CY8C40xx) Family

PSOC MCU Family

Applications

- MCU and discrete analog replacement
- User interface for button replacement
- User interface for heating, ventilation, air conditioning

Features

32-bit MCU subsystem
- 16-MHz ARM® Cortex™-M0 MCU
- Up to 16KB flash and 2KB SRAM

Programmable analog
- Two IDACs (7 bit and 8 bit); digitally controlled current source
- One comparator (CMP)

CapSense® with SmartSense™ Auto-tuning
- One Cypress Capacitive Sigma-Delta™ (CSD) controller
- Capacitive sensing supported on up to 16 pins

Programmable digital
- One configurable 16-bit timer, counter or pulse-width modulator (TCPWM) block
- One I2C master or slave

Packages
- 8-SOIC, 16-SOIC, 16-QFN, 24-QFN, 28-SSOP

Collateral

- Datasheet: www.cypress.com/Psoc4000Datasheet
- Application Note: www.cypress.com/go/AN79953

Availability

- Sampling: Now
- Production: Now

Datasheet: www.cypress.com/Psoc4000Datasheet
Application Note: www.cypress.com/go/AN79953
Here’s How to Get Started

1. Identify accounts that we can visit jointly

2. Contact them with our scripted email

3. Sell the $30 CY8CKIT-040 Evaluation Kit to get customers started

4. Sign them up for an Introduction to PSoC 4 workshop

**CY8CKIT-040 Evaluation Kit provides simple, rapid development**
- Direct access to all PSoC 4000 I/O
- Easy access to PSoC 4000 power measurement test points
- Form-factor compatible with Arduino™ shields
- Onboard Cypress F-RAM memory IC for implementing data-logging operations

**CY8CKIT-040 Evaluation Kit provides an advanced debug interface**
- Onboard PSoC 5LP, factory-programmed to be a programmer and debugger
- USB program and debug channel for target PSoC 4000 device
- USB-to-serial communication interface with the target PSoC 4000 device
APPENDIX
## PSoC 4000 Product Selector Guide

### Part Numbering Decoder

<table>
<thead>
<tr>
<th>Part Number</th>
<th>CPU Speed (MHz)</th>
<th>Flash Size (KB)</th>
<th>SRAM (KB)</th>
<th>CapSense</th>
<th>7-bit IDAC</th>
<th>8-bit IDAC</th>
<th>TCPWM</th>
<th>CMP</th>
<th>FC</th>
<th>Package</th>
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**Notes:**

1. **IDAC** = Current-output digital-to-analog converter
2. **TCPWM** = Timer/counter/Pulse Width Modulator (PWM) block
3. **CMP** = Comparator

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### Capabilities

- **Device Identification Number** that corresponds to the part feature set
- **Temperature Range:** I = Industrial
- **Package:** LQ = QFN, SX = SOIC, PV = SSOP
- **Flash Size:** 3 = 8KB, 4 = 16KB
- **CPU Speed:** 1 = 16 MHz
- **Product Type:** 40 = MCU
- **Marketing Code:** 8C = PSoC Platform
- **Company ID:** CY = Cypress
References and Links

Print or download this document: www.cypress.com/go/p4000disti
PSoc 4000 customer presentation: www.cypress.com/go/p4000customer

Introductory video: www.cypress.com/psoc4000

CY8CKIT-040 Evaluation Kit page: www.cypress.com/go/CY8CKIT-040

App Note AN79953: Getting Started with PSoC 4
www.cypress.com/go/AN79953
App Note AN86233: PSoC 4 Low-Power Modes and Power Reduction Techniques
www.cypress.com/go/AN86233

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

Cypress Platform PSoC Product Roadmap: www.cypress.com/go/PSocRoadmaps

Introduction to PSoC 4 Workshop Registration page: www.cypress.com/training/workshops