Automotive PSoC 4 Introduction

ATV MC HSMM
Aug, 2021

Agenda

1. Introduction
2. Roadmap, Product Overviews
3. Automotive PSoC™ 4S Product features
4. Competitive Comparison
5. Application Examples
6. Ecosystem
7. Getting Started
8. Q & A

PSoC™: One-stop-shop for automotive HMI & smart sensors

Door handle and foot-kick detection

Buttons/sliders

Touchpads

Touchscreens

Optical navigation

Capacitive navigation

Biometrics and navigation

Hands-on detection

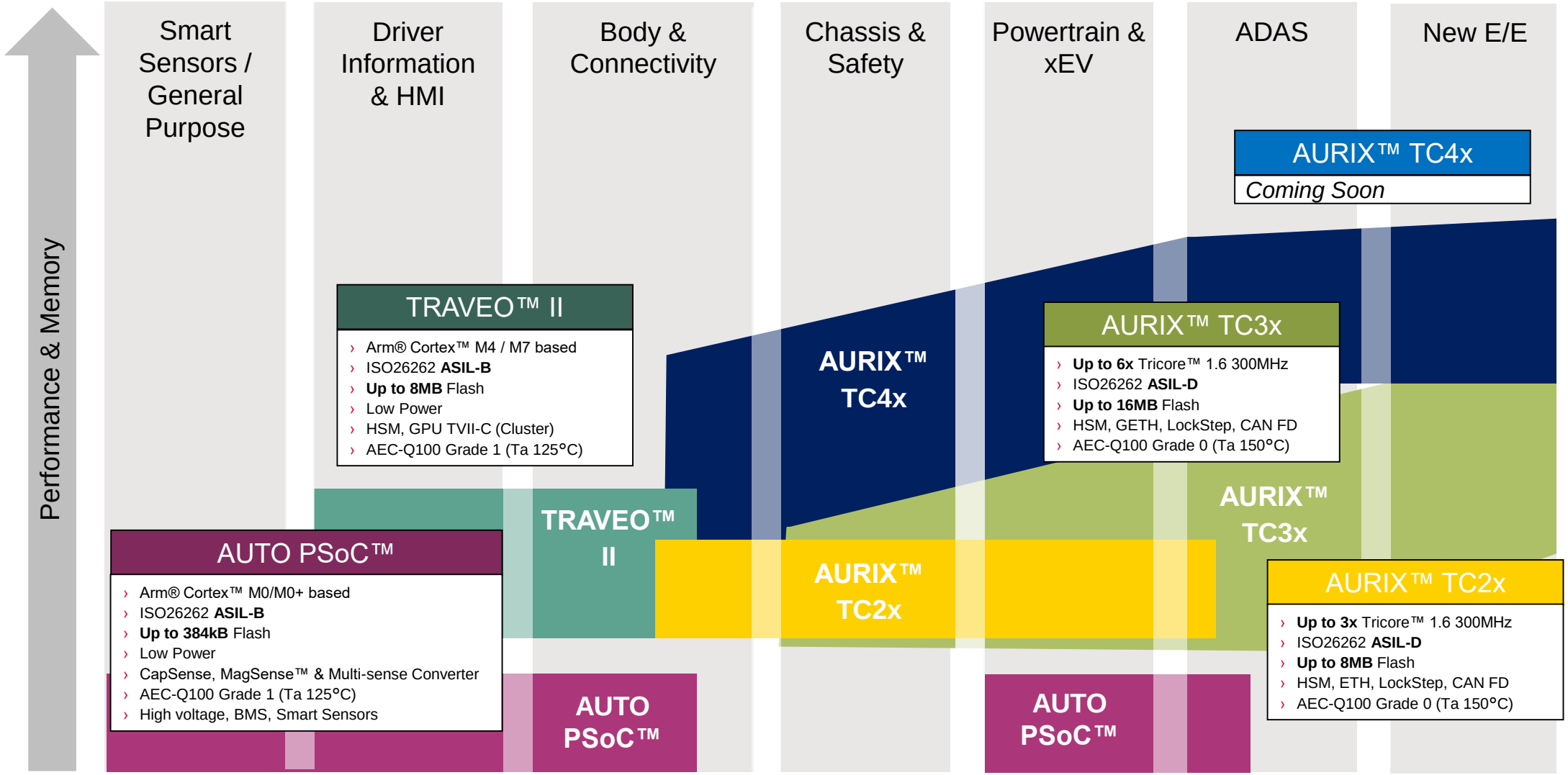
Liquid-level sensing

Occupant detection

Intelligent battery sensors

Smart ignition systems

PSoC™ Automotive, TRAVEO™ & AURIX™ architectures meet a broad set of application requirements and provide a strong roadmap (Public)



Auto PSoC™ Portfolio

› PSoC 4 S

- Arm M0/M0+ MCU, Programmable Analog, Robust HMI, Scalable platform
- 16KB – 384KB Flash

› PSoC 4 HV MS (Coming Soon)

- Arm M0+ MCU, Programmable Analog, Robust HMI, **12V LDO, LIN PHY, ASIL-B compliant**
- 32KB – 512KB Flash

› PSoC 4 HV PA (Coming Soon)

- Arm M0+ MCU, **Precision Analog, 12V LDO, LIN PHY, ASIL-C compliant**
- 64KB – 192KB Flash

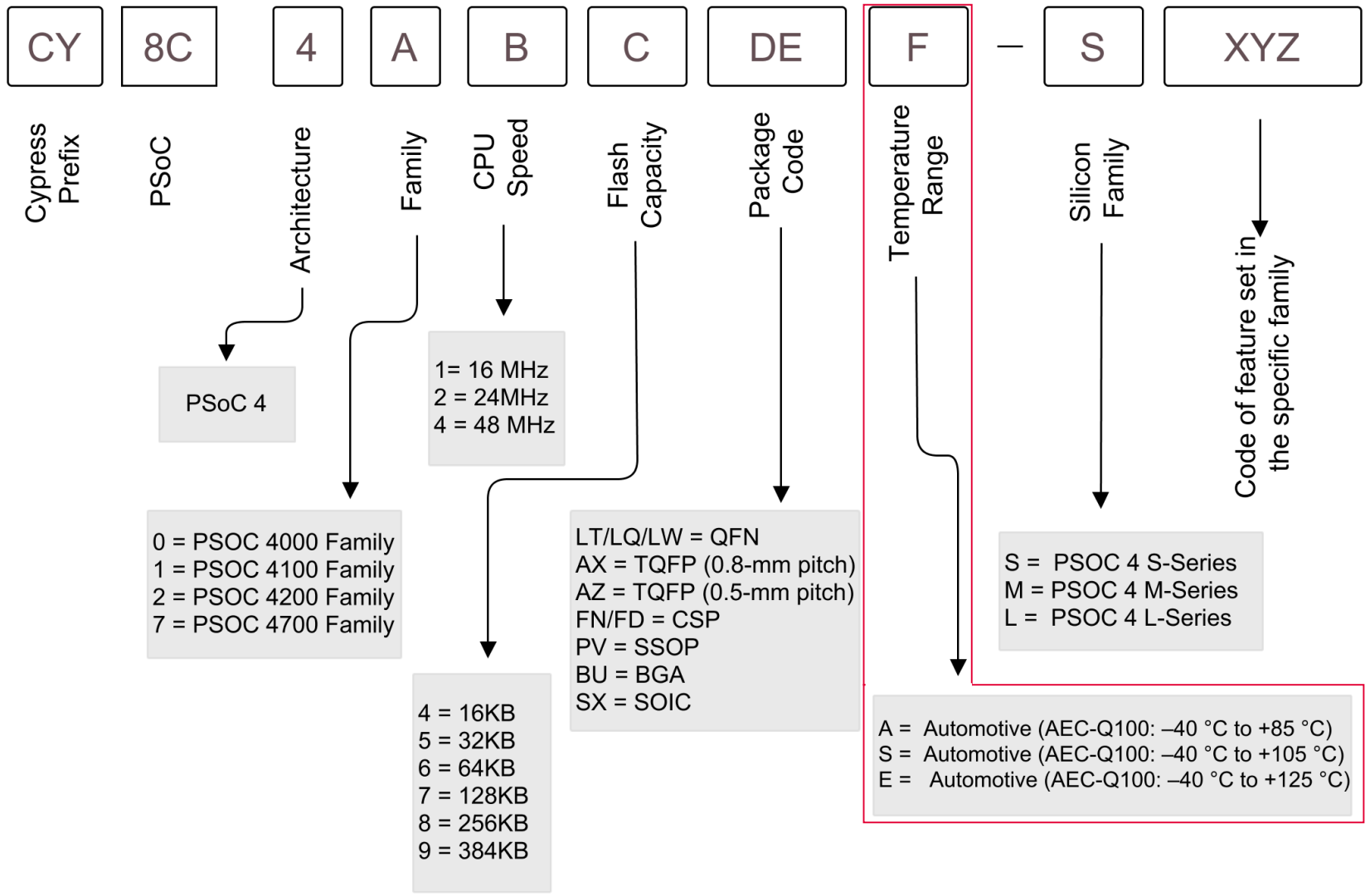
› PSoC 4 HV BMS (Coming Soon)

- Arm M0+ MCU (DCLS), Precision Analog, 110V, BLE, ASIL-D compliant
- 128KB – 256KB Flash

› TrueTouch and Fingerprint

- Register-configurable solutions for HMI applications such as touchscreens and fingerprint
- Very high sensitive capacitive measurements of up to aF (Attofarad)

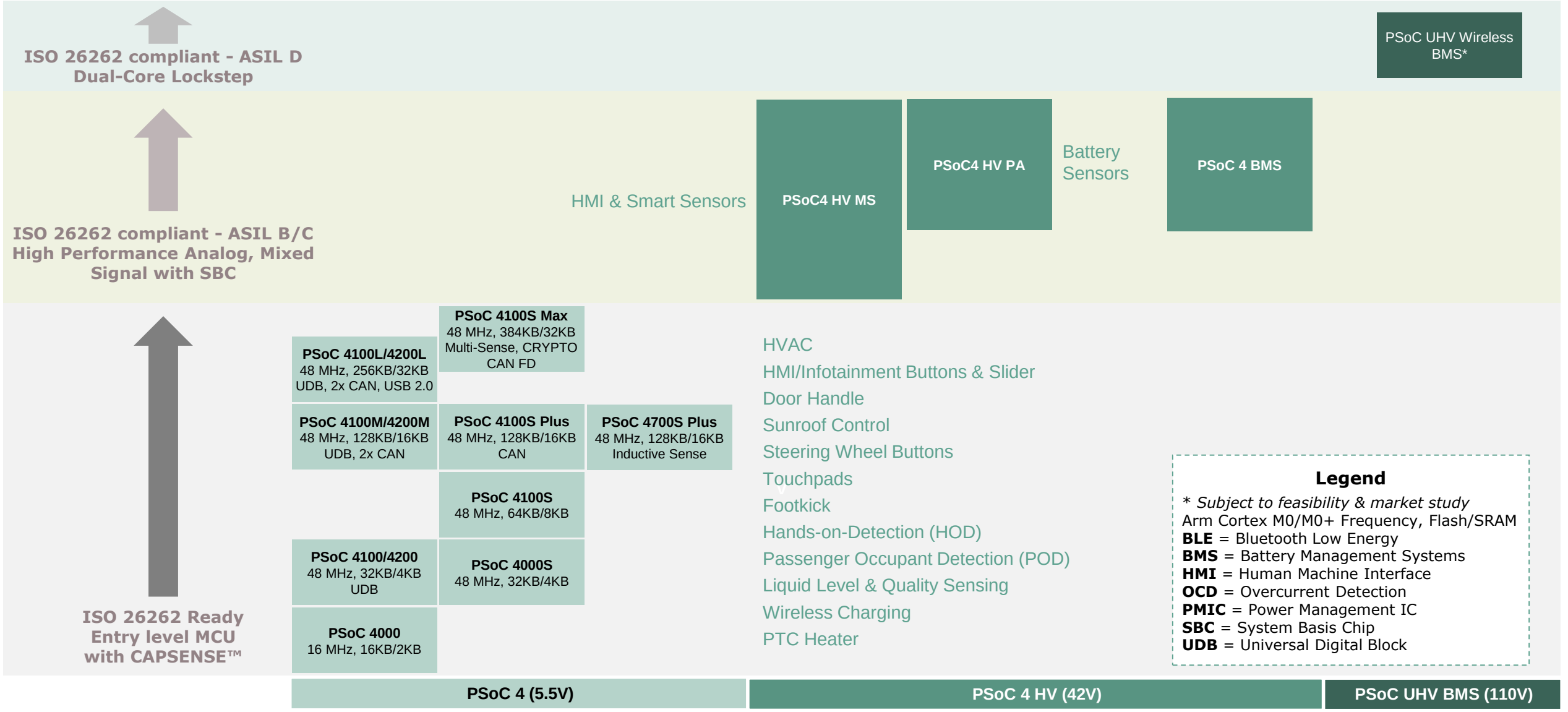
Marketing Part Number Decoder



Roadmap, Product overviews

Scalable PSoC™ 4 Roadmap

From MCU with CAPSENSE™ to Multi-Sense, High Performance Analog, SBC and BLE integration (Public)



Automotive PSoC 4 Packages

Family	Package	QFN						SOIC	SSOP	TQFP			
	Pins	24	32	40	48	56	64	16	28	48	64	80	100
	Body Size (mm)	4 x 4	6 x 6	6 x 6	7 x 7	8 x 8	9 x 9	3.8 x 9.9	5.3 x 10.3	7 x 7	10 x 10	12 x 12	14 x 14
	Pitch (mm)	0.5	0.5	0.5	0.6	0.5	0.5	1.27	0.65	0.5	0.5	0.5	0.5
PSoC 4	4000	✓						✓					
	41/42XX								✓				
	40XXS	✓[1]		✓[1]	✓[1]				✓				
	41XXS	✓[1]		✓[1]	✓[1]				✓				
	41XXS Plus			✓[1]	✓[1]		✓[1]				✓		
	41XXS Max				✓[1]						✓		✓
	41/42XXM					✓[1]				✓	✓		
	47XXS	✓[1]		✓[1]					✓		✓		
	HV PA		✓[1]		✓[1]								
	HV MS		✓[1]		✓[1]	✓[1]	✓[1]						

[1] Wettable flanks package to allow automated optical inspection (AOI)

Planned packages

PSoC 4 S-Series: Scalable, Smart MCU Portfolio

	PSoC 4000	PSoC 4000S	PSoC 4100/4200	PSoC 4100S	PSoC 4100S Plus	PSoC 4 M-Series	PSoC 4 L-Series	PSoC 4100S Max
Flash Size/SRAM	16KB/2KB	32KB/4KB	32KB/4KB	64KB/8KB	128KB/16KB	128KB/16KB	256KB/32KB	384KB/32KB
DMA Channels	0	0	0	0	8	8	8	8
ADC	10-bit Del Sig @ 58 sps	10-bit Single-Slope ADC @ 46.8 ksps	12-bit SAR[1] @ 1 Msps	12-bit SAR @1Msps, 10-bit Single-Slope ADC @ 46.8 ksps	12-bit SAR[1] @ 1 Msps 10-bit Single-Slope ADC @ 46.8 ksps	12-bit SAR[1] @ 1 Msps	12-bit SAR[1] @ 1 Msps	12-bit SAR[1] @ 1 Msps
Opamps	0	0	1	2	2	4	4	2
Comparators[2]	1	4	4	4	4	6	6	2
CapSense	3rd Generation	4th Generation	4th Generation	4th Generation	4th Generation	3rd Generation (x2)	3rd Generation (x2)	5th Generation (x2)
CapSense Avg. Current[3], SNR	6 µA, >100:1	3 µA, >300:1	6 µA, >100:1	3 µA, >300:1	3 µA, >300:1	6 µA, >100:1	6 µA, >100:1	<3 µA, >300:1
UDB Programmable Logic	0	0	4	0	0	4	8	0
Audio I2S	-	-	Yes (with UDB)	-	-	Yes (with UDB)	Yes (with UDB)	Yes
Timers/Counters/PWMs[4]	1/1/1	5/5/5	4/4/6	5/5/5	8/8/8	12/12/16	12/12/16	8/8/8
SPI/I²C/UART/LIN Slave[5]	0/1/0/0	2/2/2/2	2/2/2/2	3/3/3/2	4/5/5/2	6/4/5/2	6/4/5/2	4/5/5/2
USB Full Speed	-	-	-	-	-	-	Yes	-
Crypto (HW encryption module)	No	No	No	No	No	No	No	Yes
CAN Controller	0	-	0	-	1	2	1	1 CAN FD
I/Os, All With CapSense	16	24	24	34	54	51	98	84
Smart I/Os	0	16	0	16	24	0	0	24

1 Successive approximation register ADC
2 Maximum number of comparators (including comparators configured using opamps)
3 Average current consumption per sensor
4 Maximum number of hardware-based timers, counters and PWMs, using timer/counter/PWM (TCPWM) blocks and universal digital blocks (UDB)
5 Maximum number of hardware-based SPI, I²C, UART, and LIN Slave interfaces, using SCBs and UDBs

PSoC™ 4000S-Series
PSoC MCU

Applications

User interface for infotainment systems, user interface for heating, ventilation, air conditioning

Features

32-Bit MCU Subsystem
- 48-MHz Arm® Cortex®-M0+ CPU
- Up to 32KB Flash
- 4KB SRAM
- Real-time clock (RTC) capability with a watch crystal oscillator (WCO)

Programmable Analog Blocks
- One 10-bit, 46.8-ksps single-slope analog-to-digital converter (ADC)[1]
- Two low-power comparators (CMP)
- One CapSense® block that supports low-power operation with self- and mutual-capacitance sensing
- Two 7-bit current-output digital-to-analog converters (IDAC) configurable as a single 8-bit IDAC

Programmable Digital Blocks
- Five 16-bit timer/counter/pulse-width modulation (TCPWM) blocks
- Two serial communication blocks (SCB) that are configurable as I²C, SPI, UART or LIN Slave

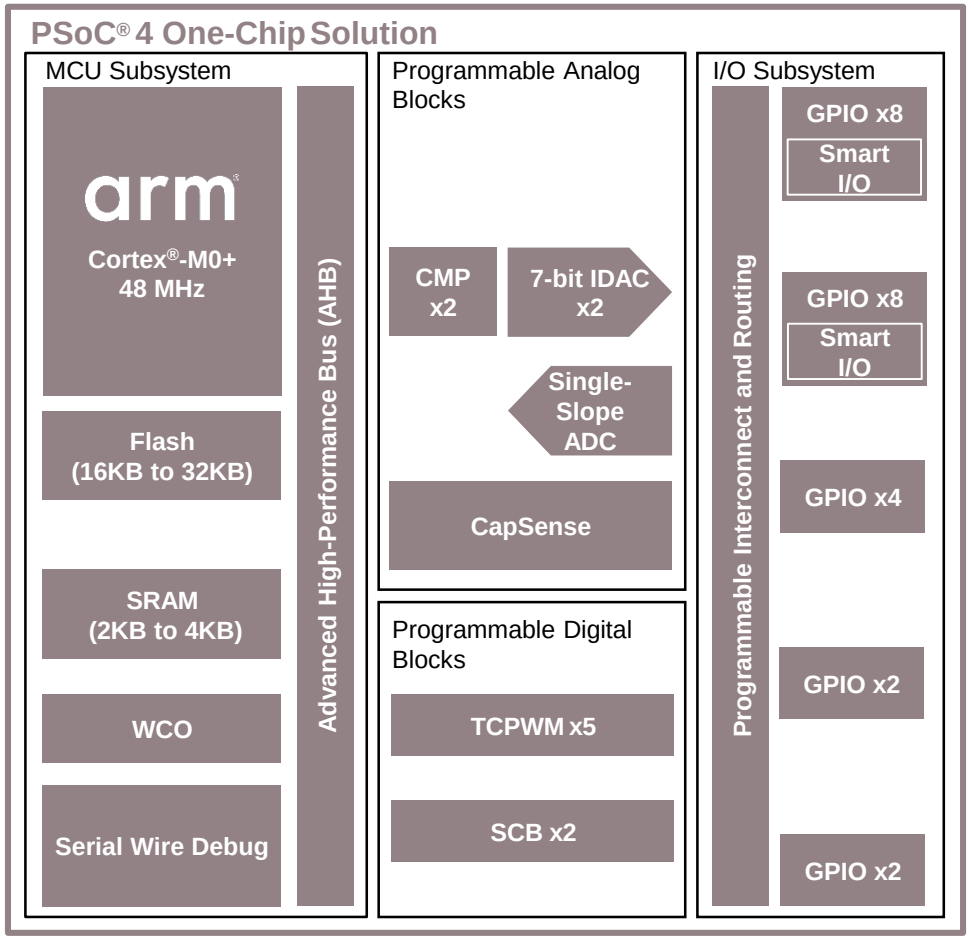
Packages
- 24-pin QFN and 28-pin SSOP

I/O Subsystem
- Up to 24 GPIOs, including 16 Smart I/Os[2]

Collateral

Datasheet: PSoC 4000S

[1] A simple ADC used to measure slow-movingsignals
[2] Embedded programmable digital logic in the I/Osubsystem



Availability

Sampling: Now **Production:** Now

PSoC™ 4100S Max (NPI in Q421)
Intelligent Analog

Applications

User interface for HMI applications, Body Control, and HVAC applications

Features

32-Bit MCU Subsystem
- 48MHz Arm® Cortex®-M0+ CPU with a DMA controller
- 384KB flash and 32KB SRAM
- External MHz oscillator (ECO) with PLL and 32KHz watch crystal oscillator (WCO)
- CRYPTO block include AES, TRNG, CRA, PRNG and SHA

Programmable Analog Blocks
- One 12-bit, 1-Msps SAR ADC
- Two opamps configurable as programmable gain amplifiers (PGAs), comparators (CMPs), etc.
- Two low-power comparators
- Two MSC (Multi-Sense Convertor) blocks integrating 5th generation CapSense and MagSense

Programmable Digital Blocks
- Eight 16-bit timer/counter/pulse-width modulator (TCPWM) blocks
- Five serial communication blocks (SCBs) that are configurable as I^2C, SPI, or UART
- Segment LCD
- Audio I^2S for sound output

One CAN-FD (Controller Area Network with Flexible Data-rate) Controller

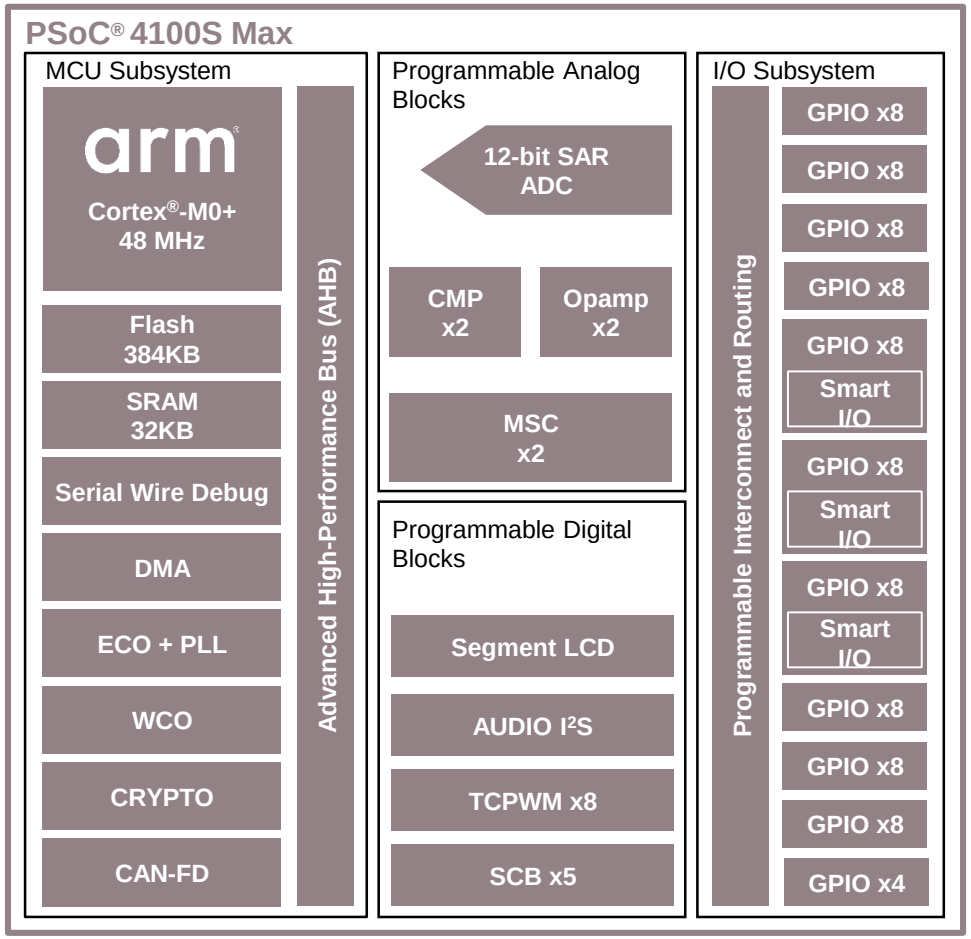
Packages
- 48-QFN, 64-TQFP and 100-TQFP

I/O Subsystem
- Up to 84 GPIOs, including 24 Smart I/Os[1]

Collateral

Datasheet: Contact Sales

[1] Embedded programmable digital logic in the I/O subsystem



Availability

Sampling: Industrial (Now) **;** Automotive (Q421)

Automotive PSoC 4 Features

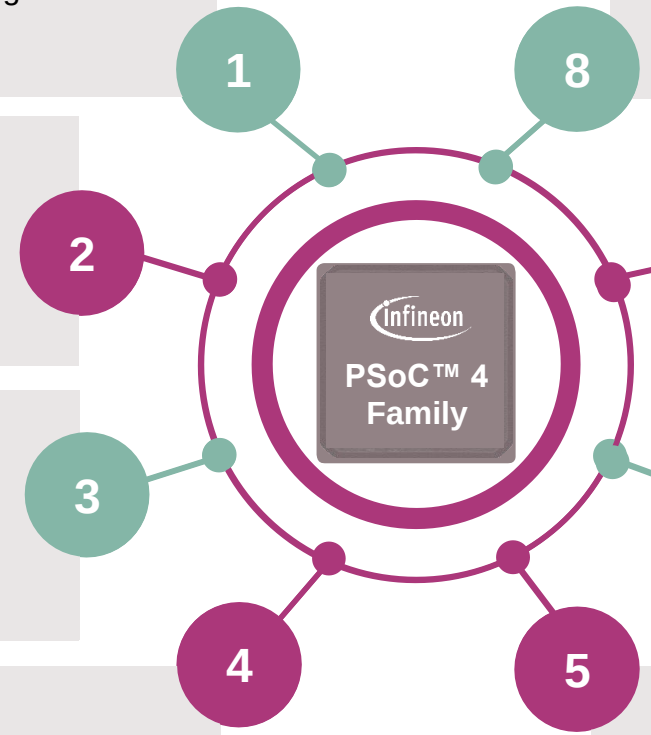
Key Features – PSoC 4 for HMI & Smart Sensors

CapSense
- Robust and reliable detection
- Low-power sensing for wake-up applications

EMI/EMC
- ISO 11452-2 (RI)
- CISPR-25 (RE)
- IEC62132-4 (CI)
- IEC61967-4 (CE)

Multi-Sense Converter
- MagSense (inductive)
- Resistive and current sensing

Security
- CRYPTO with AES256, SHA, CRC, Pseudo and True Random number generator



Scalability
- Complete Portfolio
- Memory Density
- Package Lineup
- Performance

Connectivity
- SENT
- LIN incl. 2 Slaves
- CAN/CAN FD

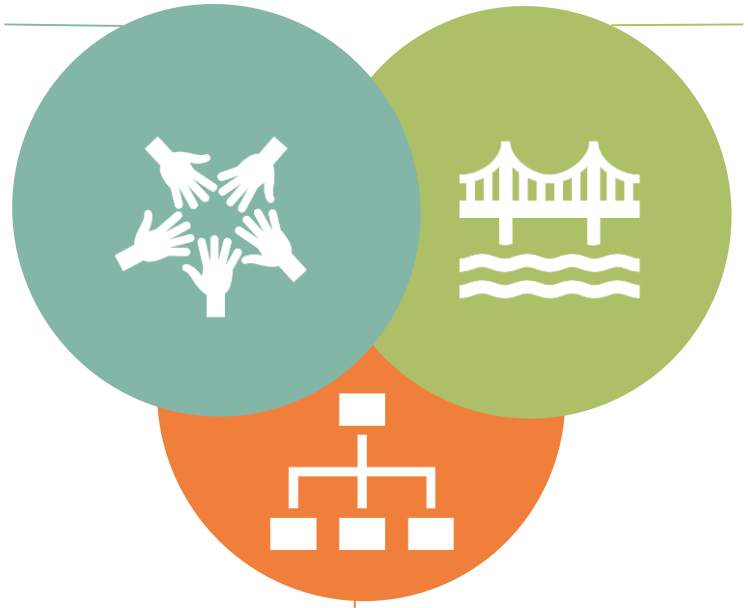
Safety
- Supporting documents and FMEDA for multiple devices
- ISO 26262 Ready

Temperature
- AEC-Q100 Grade 3, 2, 1
- With mission profile up to +150°C

What makes Infineon's CAPSENSE™ solution superior?

Elegant HMI

- Wide variety of rich HMI solutions on end products
- Various form factor/size HMIs - buttons, sliders, trackpads
- Supports different product overlay materials such as glass, acrylic, polycarbonate etc.
- Can resolve a 0.1 pF-touch with 5:1 SNR, enables touch through >5-mm thick overlays



Performance

- High-performance AFE ensures the most robust sensing and reliable operation
- Continuous improvements in noise immunity achieved over decades of innovation
- Robust operation even in automotive EMC conditions
- Hybrid sensing – Self-cap, mutual-cap and inductive
- Absolute capacitance measurement for a wide range
- Low-power consumption

Portfolio

- CapSense™ is available in different flavors enabling lower overall system BOM cost
- PSoC™ 4: MCU + Integrated CapSense™ + Analog Front End (AFE) + Digital Peripherals for low-mid memory footprint applications
- PSoC™ 4 HV MS: MCU + Integrated CapSense™ + LDO + LIN PHY + Analog Front End (AFE) + digital peripherals for low-mid memory footprint applications

PSoC 4 S-Series enables reliable, low-power Smart Sensor designs

Cypress' fourth-generation, low-power CapSense solution provides:

- An average current consumption of 3 µA per sensor (50% improvement over previous CapSense solutions)
- An SNR >300:1 that delivers robust noise immunity and liquid tolerance (3x improvement over previous CapSense solutions)
- Support for grounded-water rejection[1] for reliably functioning automotive exterior HMI designs such as door handles
- Support for mutual-capacitance sensing[2] to implement advanced features like liquid-level sensing[3]

PSoC Creator's APIs simplify power management by:

- Enabling changes between power modes
- Controlling the power of individual PSoC Components

Power Mode	Current Consumption	Code Execution	Digital Peripherals Available	Analog Peripherals Available	Clock Sources Available	Wake-Up Sources	Wake-Up Time
Active	2 mA @ 6 MHz	Yes	All	All	All	-	-
Sleep	1.1 mA	No	All	All	All	Any interrupt source	0
Deep-Sleep	2.5 µA	No	WDT, I^2C	POR	32-kHz ILO	GPIO, WDT, I^2C	35 µs

1 The ability of a capacitive sensing system to reject large water droplets as false touches on a ground plane that is in proximity to the capacitive sensors
2 A capacitive sensing method that drives a current on a transmit pin and measures the charge on a receive pin; typically used in systems with a large number of closely spaced capacitive sensors
3 A method to detect liquid-level height using capacitive sensors

Fully compliant with Automotive EMC Safety Standards

CapSense in PSoC 4 MCUs meets automotive electromagnetic compatibility (EMC) requirements by:

- Eliminating false touches in harsh automotive environments
- Reducing radiated emissions by following hardware best practices and easily modifying CapSense parameters such as frequency hopping in PSoC Creator

Cypress' EMI/EMC Tests Show PSoC 4 Meets the Most Challenging Automotive EMC Specifications

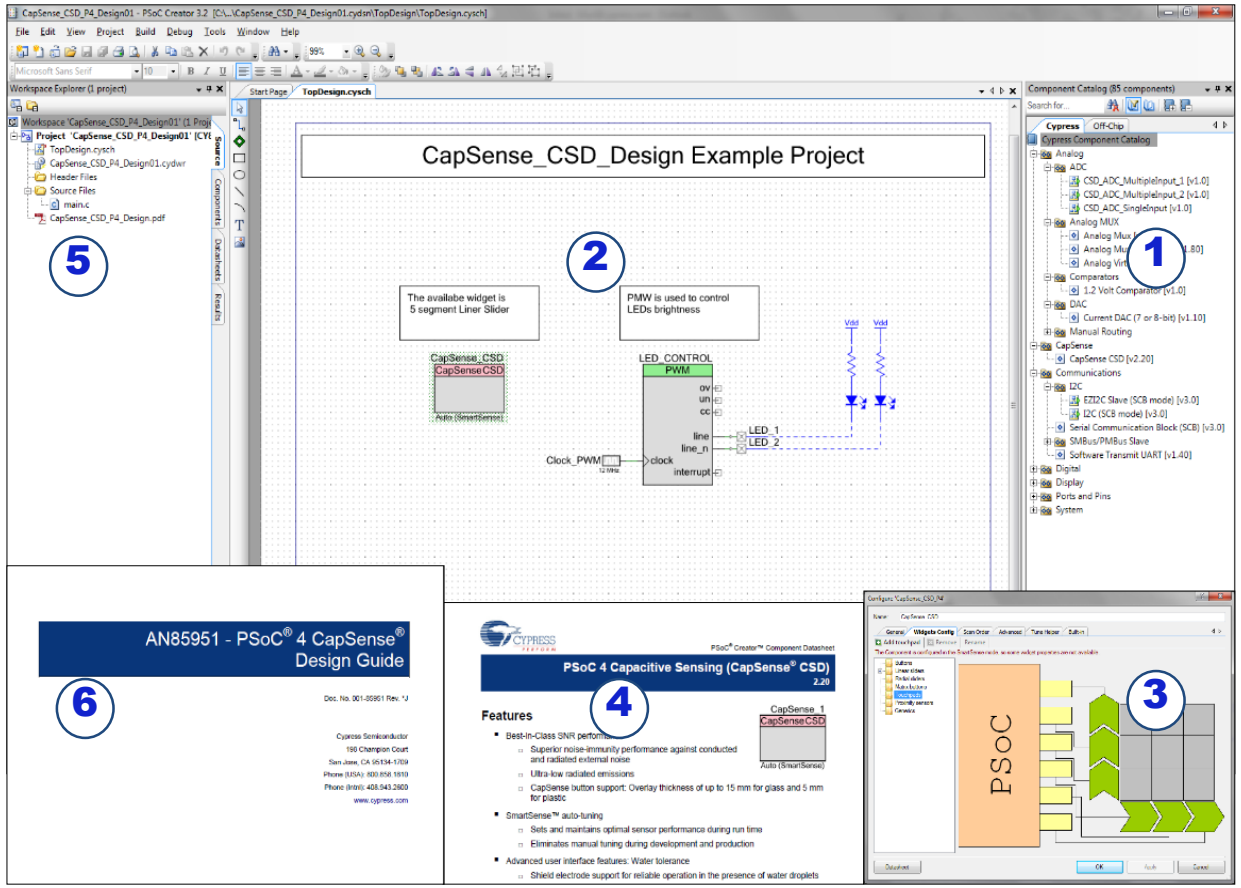
Conditions	Specifications	No. of Tests[1]	Compliance
Radiated Emissions	CISPR 25	14	Pass
Radiated Immunity	ISO 11452-2	16	Pass
Bulk Current Injection	ISO 11452-2	18	Pass
Conducted Emissions	IEC61967-4	4	Pass
Conducted Immunity	IEC62132-4	6	Pass
Electrostatic Discharges	IEC61000-4-2	12	Pass

[1] Compliance tests are done at different frequency ranges, antenna polarizations, and field strengths. Email automotive@cypress.com to get the comprehensive test report

Automotive OEMs conduct EMC tests in an anechoic chamber before mass production

PSoC Creator: Concurrent Hardware & Firmware Design

Example of a CapSense Starter Project on Six Windows in the PSoC Creator IDE



CapSense Design Guide

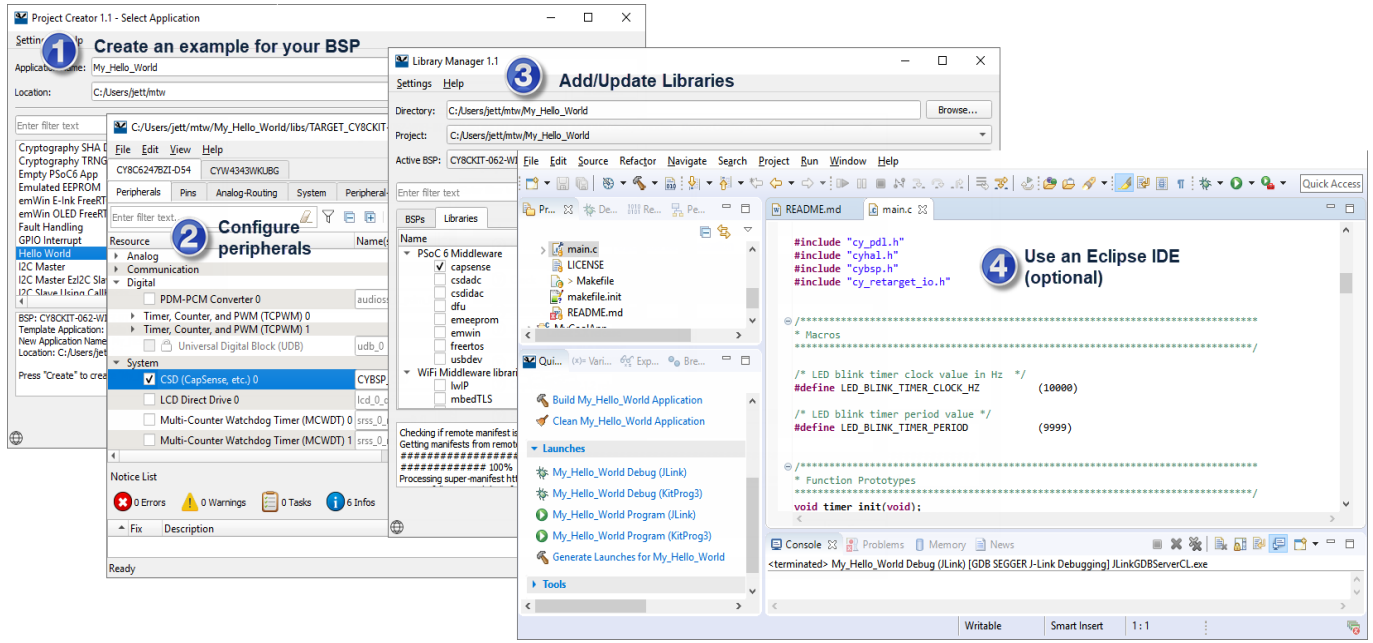
CapSense Component Datasheet

CapSense Component Configuration Tool

1. Explore the library of 100+ Components
2. Complete your hardware system design by dragging and dropping Component icons to build your hardware system design in the main design workspace
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

Modus ToolBox (MTB) and Peripheral Driver Library (PDL)

- Comprehensive
  - it has the resources you need
- Flexible
  - you can use the resource in your own workflow
- Atomic
  - you can get just the resources you want
- Infineon provides a large collection of code repositories on GitHub. This includes:
  - Board Support Packages (BSPs) aligned with Infineon kits
  - Low-level resources, including a hardware abstraction layer (HAL) and peripheral driver library (PDL)
  - Middleware enabling industry-leading features such as CAPSENSE



Programmable analog blocks easily create custom AFEs

PSoC Creator simplifies analog front end (AFE) design and saves time on debugging with:

›Analog Components that are dragged and dropped as icons to create custom AFEs

›Component Configuration Tools that simplify parameter configuration with a graphical user interface

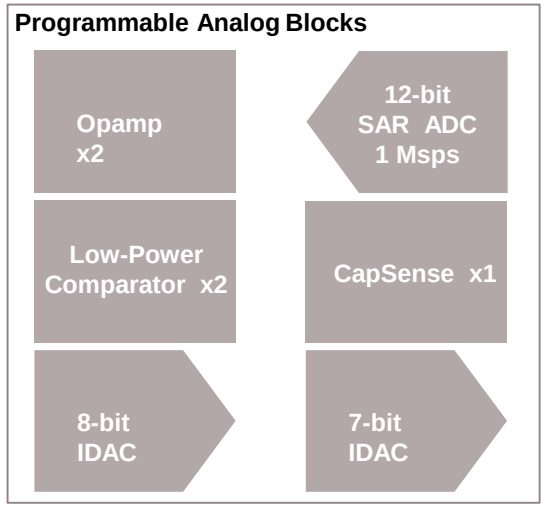
PSoC 4 MCUs integrate AFE designs by delivering:

›Discrete analog performance with a differential 1-Msps, 12-bit SAR ADC, and two high-performance opamps with ±1-mV-input offset voltage and 6-MHz gain bandwidth

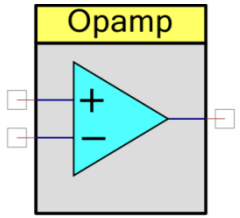
›A 1- to 54-channel analog multiplexer (AMUX) that can be flexibly configured to create custom AFE designs

›A 5-V operating voltage that provides over 50% more analog input signal range vs. 3.3 V

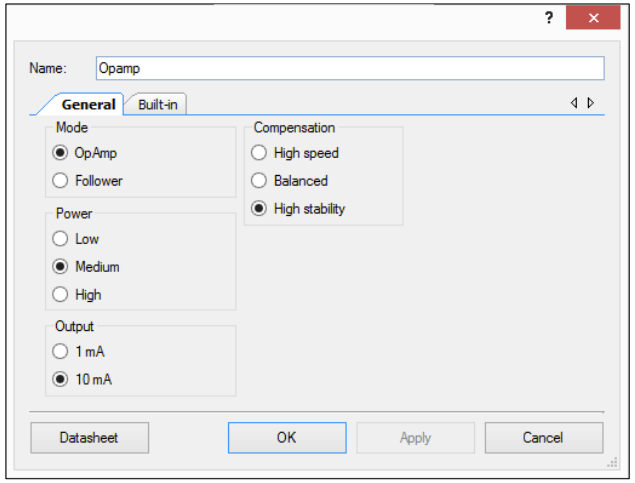
PSoC 4 S-Series Programmable Analog Blocks



Opamp Component with Configuration Tool in PSoC Creator



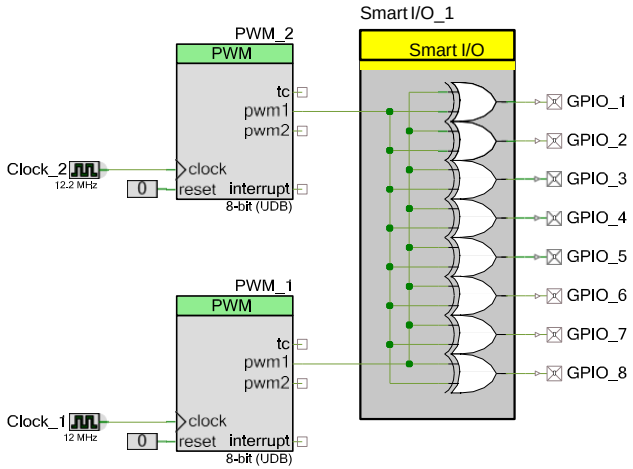
The opamp graphical Component Configuration Tool simplifies parameter configuration



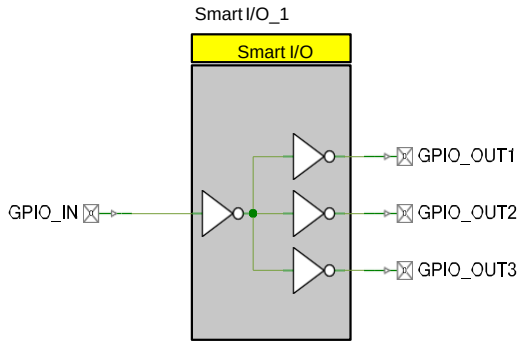
Smart I/Os enable rapid prototyping

PSoC 4 S-Series MCUs further enable rapid prototyping with unique Smart I/Os that:

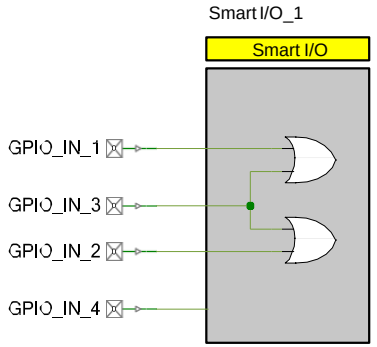
- Deliver pin-level digital logic functionality with programmable interconnect and routing to implement basic Boolean operations on I/O signals
- Enable unique capabilities such as digital buffers or combinatorial logic to tasks while keeping the CPU turned off
- Integrate discrete logic like AND and OR gates to reduce system BOM costs and avoid "blue-wires"[1]



Smart I/Os configured as digital XOR logic gates with PWM inputs to implement eight breathing LEDs



Smart I/Os configured as digital buffers to provide signal or clock replication of an input signal from a GPIO pin



Smart I/Os configured as digital OR gates to implement a priority encoder function[2] and that stores the result in the Smart I/O register

[1] A common practice used during prototyping and debugging to fix or adjust signal inputs and outputs by using external wires on a board
[2] A circuit or algorithm that compresses multiple binary inputs into a smaller number of outputs

Security features with CRYPTO

PSoC 4 CRYPTO block offers the following cryptography functionalities

- AES[1] functionality (block cipher), per FIPS[2] 197 standard
  - Forward block cipher (plaintext to ciphertext) with 128/192/256-bit key
  - Inverse block cipher (ciphertext to plaintext) with 128/192/256-bit key
- SHA[3] functionality (hash), per FIPS 180-4 standard
  - SHA1
  - SHA224, SHA256
- Cyclic Redundancy Check (CRC) functionality
- Pseudo Random (PR) number generator
- True Random (TR) number generator
- Programmable polynomial of up to 32-bits

PSoC 4100S Max series of devices integrate CRYPTO

[1] Advanced Encryption Standard
[2] Federal Information Processing Standards
[3] Secure Hash Algorithm

Functional Safety with PSoC 4

- PSoC 4 products were not developed according to ISO 26262 process for functional safety
- Cypress provides the following support for enabling functional safety at a system level:
  - **FMEDAs for individual PSoC4 products**
  - **PSoC 4 HW Safety Manual**
  - **Application Note, and training services**
- These documents can guide to help achieving functional safety at system-level
- Requirements have been derived to detect potential failure modes and to achieve the hardware architectural metrics for ASIL A/B

FMEDA Overview

Automotive PSoC 4100S Plus

HW metrics

	permanent	transient	total
SPFM:	94.2%	99.7%	99.5%
LFM:	99.6%	N/A	99.6%
residual failure rate:	3.11	5.91	9.02
latent failure rate:	0.20	N/A	0.20
failure rate:	55.93	1704.11	1760.04
failure rate (safety):	53.62	1701.93	1755.54

important metrics

Achievable ASIL:	B

HW Safety Manual

1.3 Document Structure

This document covers the following topics:

Introduction

- Provides an overview of this safety manual

Development Strategy

- Describes component development and resulting duties for the integrator

Architectural Overview

- Describes the architecture of PSoC 4
- Describes the assumed application context of PSoC 4
- Provides information about the intended use

Technical Safety Concept

- Provides assumptions of safety functions and top-level safety requirements
- Describes assumed operating conditions along with the required safety mechanisms
- Provides assumptions on the PSoC 4 safe state
- Describes failure modes
- Provides assumptions on fault tolerant time interval, and detection interval for multiple-point faults
- Provides assumptions of Hardware Requirements outside the PSoC that need to be implemented by the integrator
- Describes features and assumptions for each module

Safety Analysis

- Describes the Failure Modes, Effects and Diagnostics Analysis (FMEDA) with respect to hardware architectural metrics

Application Note

AN222117

Functional Safety of PSoC Devices in Automotive CapSense Button Applications

Author: Kishore Kumar Sukumar
Associated Part Family: PSoC® 4, PSoC 6
Related Application Notes: AN79973

More code examples? We heard you.

To access an ever-growing list of hundreds of PSoC code examples, please visit our code examples web page. You can also explore the PSoC video library here.

AN222117 introduces functional safety and the role of Cypress' PSoC devices in achieving functional safety in automotive CapSense® Button applications.

Contents

All FMEDAs, Safety Manuals, Application Notes and training services can be found on MyICP (see Slide 46 for more details)

Competitive Comparison

PSoC 4 S-Series MCU Competitive Comparison

Feature	CY8C4149-S	Competitor 1	Competitor 2	Competitor 3	Competitor 4	Competitor 5	Competitor 6
CPU Speed (MHz)	48	48	48	32	48	48	32
Flash Size (KB)	384	256	256	128	256	128	256
Family scalability	64KB-384KB	32KB-256KB	16KB-256KB	64KB-128KB	128KB-2MB	8KB-128KB	48KB-256KB
Sensing Modes	Self, Mutual, Inductive (Supported by 2 MSC blocks)	Self, Mutual	Self, Mutual	Self, Mutual	Self, Mutual	Self, Mutual	None
Sensing channels	84	32	52	16	0	0	0
Audio I2S for sound output	Yes	No	Yes	No	Yes	No	No
DAC for sound output	No	10-bit	10-bit	No	8-bit	6-bit	8-bit
Crypto (HW encryption module)	Yes	CRC supported	CRC supported	CRC supported	Yes	No	No
ADC	12-bit SAR	12-bit SAR	12-bit SAR	10-bit SAR	12-bit SAR	12-bit SAR	10-bit SAR
Opamps	**2**	-	-	-	-	-	-
Comparators	4	4	4	2	1	2	1
Timers/Counters/PWMs	8/8/8	8/8/2	5	7/7/7	8/8/8	10/10/10	5
Controller Area Network (CAN)	1x CAN FD	1x CAN, 1x CAN FD	-	-	1x CAN FD	1x MSCAN	1x CAN
Serial Interfaces	4 SPI, 5 I^2C, 5 UART	2 SPI, 2 I^2C, 2 USART	SPI, I^2C, USART, LIN	2 SPI, 2 I^2C, 2 UART	3 SPI, 2 I^2C, 3 UART	2 SPI, 2 I^2C, 3 UART	4 I^2C, 2 UART 4 CSI, 2x LIN
GPIOs	84	84	52	100	58	71	86
Supply Voltage (V)	1.71-5.5	2.7–5.5	1.62-3.63V	2-3.6	2.7-5.5	2.7-5.5	1.6–5.5
Smart Ios	24	-	-	-	-	-	-
Functional Safety	ASIL-B Ready	-	-	-	ASIL-B	-	-

CAPSENSE™ vs. Competition

		Infineon		Competitor A[1]		Competitor B[1]
Feature	**Customer benefit**	**PSoC 4100S Max**	**PSoC 4100S Plus / 4100S / 4000S**	**Product 1**	**Product 2**	**Product 1**
Sense architecture	Dedicated hardware block for capacitive-sensing	5th Generation CAPSENSE™ (Multi-Sense Converter/MSC)	4th Generation CAPSENSE™ (Capacitive Delta-Sigma/CSD)	Peripheral Touch Controller (PTC)	Capacitive Voltage-Divider (CVD)	Capacitive Touch Sensing Unit (CTSU)
Supported Sense Modes	Self: *single-touch* Mutual: *multi-touch* Inductive: *metal-touch*	Self, Mutual, **Inductive**	Self, Mutual, **Inductive**	Self, Mutual	Self	Self, Mutual
Max SNR w/ 5mm overlay	Thick overlays with thick glove support for seamless smart surfaces	**SNR > 40**	SNR > 5	~1.2	<no data>	<no data>
Max overlay with 5:1 SNR		**18mm**	5mm	~1mm	<no data>	<no data>
Parasitic cap. (Cp) Range with 5:1 SNR (Cf = 100 fF)	Support long/ large sensors	**230pF**	~40pF	~30pF	<no data>	<no data>
Absolute capacitance measurement (+/-1%)	Benefit for applications such as HOD/POD[2] Support “human/hands on start”	**Yes** (range & accuracy dependent on external compensation capacitor)	No	No	No	No
Driven Shield	Liquid tolerant HMI	**Active Shield Op-amp (for 1.2nF)** Passive shield (Low power)	**Active Shield Comparator**	Needs external op-amps	Yes (Poor, IO Driven Guard)	None
Scan Time (14-bit)	Faster scan rate -> faster response	0.4ms per sensor **0.12ms per sensor (12 bits)** 22us per sensor (10bits)	0.4ms per sensor 22us per sensor (10bits)	0.12ms per sensor (10bits)	0.75ms per sensor	Self: 0.5ms per sensor Mutual: 1.1ms per sensor
Autonomous scan w/DMA	Reduced CPU loading -> lower current	**Scan multiple sensors without CPU (uses DMA)**	-	1 sensor	-	-
Current Consumption	Low average current	< 20uA@10Hz 12-bit scan	< 20uA@10Hz 12-bit scan	<12uA @10Hz 10bit scan	-	-
PSRR	Immunity to power supply variation -> better overall performance	**Integrated LDO** **Multi-Phase Tx/Rx scan mode enables higher PSRR**	External LDO /SBC required Differential scan mode (for self-capacitance) average PSRR	-	-	-
Hardware Filtering	Better SNR (w/lower CPU load)	**2nd order SINC Filter**	1st order CIC Filter	none	1st order IIR Filter	None
Signal Rejection	Reliable EMC	Multi-Phase Scan (MPSC) PRS clocking Freq. Hopping	PRS clocking Freq. Hopping	Freq Hoping, Spread Spectrum (saw tooth variation)	Freq. Hopping (AFA)	None
Stimulation Frequency		45kHz-6MHz (Self) 45kHz-6MHz(Mutual)	45kHz-6MHz (Self) 45kHZ-6MHz(Mutual)	33.33KHz-66.67KHz	< 45kHz	< 2MHz

[1] Data collected based on publicly available datasheets and performance measured based on evaluation boards
[2] HOD: Hands-on detection, POD: Passenger occupancy detection

PSoC™ 4 Application Examples

Infotainment / HVAC

PSoC for Infotainment / HVAC systems

HVAC

Mass production at Europe and Japan OEMs

Infotainment & Navigation

Mass production at Europe and Japan OEMs

Integrated Systems

Capacitive sensing buttons and sliders blend with the design of cars

Why PSoC 4?

#1

OEM proven solution for Infotainment & HVAC

- Touch-sensing buttons/sliders/touchpads with very **thick overlays (>5mm)** can be supported by **CapSense**
- **High refresh rates** to provide intuitive / responsive HMI
- **Support force-sensing** with **CapSense** (capacitive) or **MagSense** (inductive)
- Drive **LEDs brightness / effects** with **PWMs**
- **Scalable solution** from 16KB/2KB (Flash/SRAM) up to 384KB/32KB
- **LIN, CAN, CAN FD** for car communication
- **Single chip integration** of PSoC, LDO and LIN PHY in PSoC 4 HV MS

Automotive interior HMI

PSoC for interior HMI

Interior HMI

Mass production at OEMs in sunroof HMI, light switches

Natural HMI surfaces

- **Touch-sensing with different overlay materials such as plastic, wood, sheet metal**
- **Integration of LEDs for lighting**

Partnering with key suppliers in smart surface design

Demonstrator

Door panel buttons with LED backlight and haptics

Hybrid sensing: capacitive and inductive buttons along with haptics

Why PSoC 4?

#1

OEM proven solution for interior HMI

- Touch-sensing buttons/sliders/touchpads with very **thick overlays (>5mm)** can be supported by **CapSense**
- **High refresh rates** to provide intuitive / responsive HMI
- **Support force-sensing** with **CapSense** (capacitive) or **MagSense** (inductive)
- **Metal touch** surfaces can be enabled by MagSense
- Drive **LEDs brightness / effects** with **PWMs**
- **Scalable solution** from 16KB/2KB (Flash/SRAM) up to 384KB/32KB
- **LIN, CAN, CAN FD** for car communication
- **Single chip integration** of PSoC, LDO and LIN PHY in PSoC 4 HV MS
- **Full ISO 26262** support up to **ASIL B** with PSoC 4 HV MS (PSoC 4 ASIL B Ready)

Automotive exterior HMI

PSoC for automotive exterior HMI

Door lock / unlock

Mass production at US and Japan OEMs

Foot-kick, emblem touch

Mass production at Japan OEMs

Demonstrator

Door handle touch demo w/ water tolerance

Robust water tolerance performance with CapSense!

Why PSoC 4?

#1

OEM proven solution for Exterior HMI

- **Robust grounded-water rejection** for reliable functioning of automotive exterior HMI designs such as door handles
- **Scalable solution** from 16KB/2KB (Flash/SRAM) up to 384KB/32KB
- **LIN, CAN, CAN FD** for car communication
- **Single chip integration** of PSoC, LDO and LIN PHY in PSoC 4 HV MS

Steering wheel HMI

PSoC for Steering Wheel HMI

Buttons/Sliders/TP

- **CapSense for touch**
- **HMI to control infotainment system / cluster setting**
- **Cruise control settings as well**

Mass production at US and Europe OEMs
Multiple DWINs across the world

Force-sensing, haptics

- **Force-sensing, haptics to avoid accidental touches and provide mechanical button-like feedback**

Mass production at US
Partner support for reference designs

Infineon @ EW 2020

Steering wheel demo with PSoC 4100S Max

Integration of MCU, Flash, Analog Frontend, Car Communication

Why PSoC 4?

#1

OEM proven solution for HMI in steering wheels

- Touch-sensing buttons/sliders/touchpads with very **thick overlays (>5mm)** can be supported by **CapSense**
- **High refresh rates** to provide intuitive / responsive HMI
- **Support force-sensing** with **CapSense** (capacitive) or **MagSense** (inductive)
- Drive **haptics** motors with **PWMs** or in somecases integrated **DACs**
- **Scalable solution** from 16KB/2KB (Flash/SRAM) up to 384KB/32KB
- **LIN, CAN, CAN FD** for car communication
- **Single chip integration** of PSoC, LDO and LIN PHY in PSoC 4 HV MS
- **Full ISO 26262** support up to **ASIL B** with PSoC 4 HV MS (PSoC 4 ASIL B Ready)

Passenger Occupant Detection (POD)/Hands-on-Detection (HOD)

PSoC for Passenger Occupant and Hands-on-Detection

POD

- **Heating element as POD sensor**
- **HMI features for seat control as buttons and sliders can also be done by PSoC**

Mass production at US OEM

HOD

- **Heating element as HOD sensor**
- **HMI features for steering wheel controls can also be done by PSoC**

Mass production at US and Japan OEM‘s

Infineon @ CES 2020

Retrofit of an after-market Seat Heater

Control panel with occupant detection LED

Integration of MCU, Flash, Analog Frontend, Car Communication

Why PSoC 4?

#1

OEM proven solution for POD and HOD beyond HMI

- **High parasitic capacitance** from the sensor of **~150-250 pF** can be scanned by PSoC
- **Ratiometric capacitive sensing** to measure the absolute value of high parasitic capacitances
- **Standard heating element** can be used as sensors
- **Scalable solution** from 16KB/2KB (Flash/SRAM) up to 384KB/32KB
- **Analog Frontend** including CapSense or Multisense Converter (MSC), operational amplifiers and comparators
- **LIN, CAN, CAN FD** for car communication
- **Single chip integration** of PSoC, LDO and LIN PHY in PSoC 4 HV MS
- **Full ISO 26262** support up to **ASIL B** with PSoC 4 HV MS (PSoC 4 ASIL B Ready)

Liquid Level & Quality Sensing

PSoC for Liquid Level Sensing

AdBlue

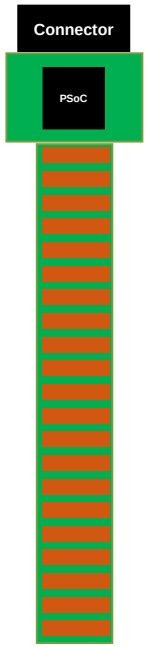
Mass production at premium OEM

Water & Fuel, Quality

- **Different liquids**
  - AdBlue
  - Windscreen wiper fluid
  - Gasoline/Diesel
  - ...
- **Quality**
  - Analog Front End (AFE) can be used to implement quality sensing

Scalable solution (different liquids) with value add (quality sensing)

Smart Sensor



Integration of MCU, Flash, Analog Frontend, Car Communication

Why PSoC 4?

#1

OEM proven solution for AdBlue and going beyond

- **Proven OEM solution in mass production** supporting different sensor lengths to accomodate various tank sizes and shapes
- **Refill on ice detection and air bubble proof** with level detection in any condition
- **Accuracy up to +/- 1.5mm**
- **Scalable solution** from 16KB/2KB (Flash/SRAM) up to 384KB/32KB
- **Analog Frontend** including CapSense or Multisense Converter (MSC), operational amplifiers and comparators
- **SENT, LIN, CAN, CAN FD** for car communication
- **Single chip integration** of PSoC, LDO and LIN PHY in PSoC 4 HV MS
- **Full ISO 26262** support up to **ASIL B** with PSoC 4 HV MS (PSoC 4 ASIL B Ready)

Ecosystem

Automotive PSoC 4 & PSoC 4 HV Ecosystem

Tool Category	Tool Vendor	PSoC 4	PSoC 4 HV	Notes
Compilers	IAR SYSTEMS	✓	✓	PSoC 4 HV: SDL and AutoPDL supported in IAR
	Green Hills SOFTWARE			PSoC 4 HV: Currently no support planned, considered as a concept for future
	arm	✓		PSoC 4 HV: Currently no support planned, considered as a concept for future
IDE	IAR SYSTEMS	✓	✓	PSoC 4 HV: SDL and AutoPDL supported in IAR
	Green Hills SOFTWARE			PSoC 4 HV: Currently no support planned, considered as a concept for future
	KEIL µVision5	✓		PSoC 4 HV: Currently no support planned, considered as a concept for future
	PSoC Creator	✓		PSoC 4: Established (= legacy) IFX tool chain for all devices up to 4100S Plus (128 KB)
	ModusToolbox	✓		PSoC 4: New IFX tool chain for 4100S Plus/Max now (128-384 KB), smaller devices in 2021
	Infineon CapSense Tuner	✓	✓	PSoC 4 HV: Stand-alone GUI tool | PSoC 4: Integrated in PSoC Creator/ModusToolBox
Debugger / Programmer	Infineon	✓	✓	MiniProg4 CY8CKIT-005
	Infineon	✓	✓	Auto Flash Utility Programmer
	IAR SYSTEMS	✓	✓	
	Green Hills SOFTWARE			PSoC 4 HV: Currently no support planned, considered as a concept for future
	LAUTERBACH	✓		
	KEIL Tools by ARM	✓		PSoC 4 HV: Currently no support planned, considered as a concept for future
	Z SYSTEM	✓	✓	
Protocol SW Driver				
LIN	Infineon	✓	✓	PSoC 4: PSoC Creator Component | PSoC 4 HV: SDL, AutoPDL
	VECTOR	✓		PSoC 4: CANbedded LIN available incl. LIN Bootloader (IFX: Example code)
CAN/CAN FD	Infineon	✓		
	VECTOR			PSoC 4: Currently no support from Vector; PDL via Modus Toolbox in 2021

Design Partners and Ecosystem

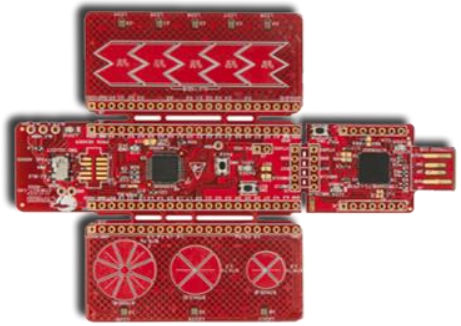
Injection Molded Structural Electronics	Carbon NanoBud (CNB) transparent films and sensors	Haptic Feedback
TACTOTEK	CANATU®	Greous

Preferred Design House (PDH)	
CLICK TOUCH	SemsoTec
Touch Sensors & Electronics PSoC & TrueTouch	**Displays, Touch, Electronics PSoC, TrueTouch & Traveo**

Getting Started / References

Getting started

PSoC® 4000S CapSense Prototyping Kit



CY8CKIT-145-40XX
32 kB Flash

About the kit: This kit enables you to evaluate and develop with Cypress's fourth-generation, low-power CapSense® solution using the PSoC 4000S device.

Price: $15.00

Availability: In Stock

PSoC® 4 Pioneer Kit

CY8CKIT-042
32 kB Flash

About the kit: This is an easy-to-use and inexpensive development platform enabling you to create unique designs with the flexibility of PSoC®4.

Price: $30.00

Availability: In Stock

PSoC 4100S CapSense Pioneer Kit

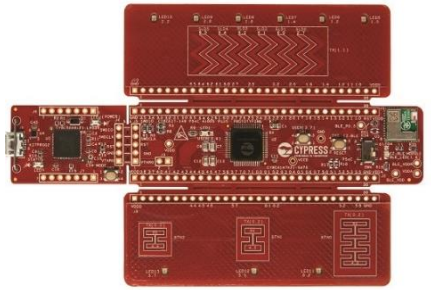
CY8CKIT-041-41XX
64 kB Flash

About the kit: This kit enables you to evaluate and develop with Cypress's fourth-generation, low-power CapSense® solution using the PSoC 4100S device.

Price: $49.00

Availability: In Stock

PSoC® 4100S Plus Prototyping Kit



CY8CKIT-149
128 kB Flash

About the kit: This kit enables you to evaluate the PSoC 4100S Plus device and develop with Cypress's fourth-generation, low-power CapSense® solution.

Price: $20.00

Availability: Going to be replenished soon

PSoC 4100S Max Pioneer Kit

CY8CKIT-041S-Max
256/384 kB Flash

About the kit: This is a low-cost hardware platform that enables design and debug of the PSoC 4100S Max device

Price: Coming Soon

Availability: Coming Soon

Documentation/Materials

Documentation

- PSoC™ 4 Product Overview
- PSoC™ 4 Product Brochures
- PSoC™ 4 Datasheets
- PSoC™ 4 Technical Documentation
- PSoC™ 4 CAD Librairies
- PSoC™ 4 Application notes
- PSoC™ 4 Programming Specifications
- PSoC™ 4 Product Roadmap
- PSoC™ 4 News Releases
- PSoC™ 4 Blogs
- TrueTouch Tools
- PSoC™ Software
- PSoC™ Programming Solutions

PSoC™ 4 Datasheets

Documentation	Family		Level of security
Datasheet	PSoC™ 4000	PSoC® 4: PSoC 4000 Family Datasheet	Public
	PSoC™ 4000S	PSoC 4: PSoC 4000S Family Datasheet	Public
	PSoC™ 4100	PSoC® 4: PSoC 4100 Family Datasheet	Public
	PSoC™ 4100S	PSoC 4: PSoC 4100S Datasheet	Public
	PSoC™ 4100S PLUS	PSoC 4: PSoC 4100S Plus Datasheet	Public
	PSoC™ 4100M	PSoC® 4: PSoC 4100M Family Datasheet	Public
	PSoC™ 4200	PSoC® 4: PSoC 4200 Family Datasheet	Public
	PSoC™ 4200M	PSoC® 4: PSoC 4200M Datasheet	Public
	PSoC™ 4200L (Industrial version, Automotive coming soon)	PSoC™ 4: PSoC 4200L Datasheet	Public
	PSoC™ 4700S (Industrial version, Automotive coming soon)	PSoC 4: PSoC 4700S Family Datasheet	Public

PSoC™ 4 Product Roadmap

Documentation	Level of security
Automotive HMI Solutions and PSoC (Q4 2020)	Public
Automotive HMI Solutions and PSoC (NDA)	Confidential (NDA needed)

The confidential material can be found at the myInfineon Collaboration Platform (myICP) after an NDA has been signed:

- PSoC documentation
- TrueTouch tools under NDA restriction

1.1. Datasheet - PSoC
1.2 Datasheet - TrueTouch
10. Programming Specifications
11. Technical Reference Manuals
12. News Releases
13. Safety Documents
2. App Notes
3. New Product Introduction
4. CAD Resources
5. Design Guides
6. Product Brochures
7. Blogs
8. Product Overview
9. Product Roadmap

39 Application notes
15 Data Sheets
7 CAD Resources
5 Safety Documents
4 NPIs

For more details, please visit: www.infineon.com/cms/en/product/promopages/MyICP-platform-for-Microcontroller/#PSoC-4-Documentation

Videos

Microcontroller Video Hub

AURIX™ Video Hub › Explore now

Traveo™ II Video Hub › Explore now

PSoC™ Video Hub › Explore now

What can you find:
By clicking on the PSoC Video Hub tab, you will be redirected to the Online Video Training adn Tutotials from Cypress page where you will find all PSoC 4 videos.

Coming Soon:
A dedicated page with PSoC 4 videos will be launching soon on our Microcontroller Video Hub

Free Online Video Training and Tutorials from Cypress

Watch short 3-6 minute video tutorials to quickly learn how to use Cypress Arm Cortex-M0 based PSoC, Bluetooth Low Energy products, kits and software. Each video tutorial series includes 5- 15 videos designed to reduce your learning curve by providing you practical experience on how to use each product. Each video in the series teaches a specific feature of the product. Videos and tutorial projects are available for free download.

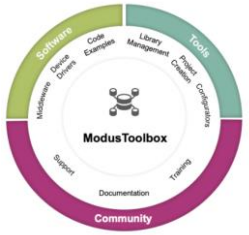
Video Training is available for the following product families:

Arm® Cortex®-M4-based PSoC 6
Arm® Cortex®-M0-based PSoC 4
Arm® Cortex®-M0-based PSoC 4 Bluetooth Low Energy
PSoC® Creator™ Integrated Design Environment (IDE)

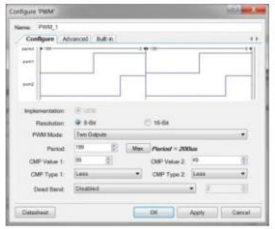
For more details, please visit: www.infineon.com/cms/en/product/promopages/aurix-video-hub/

Tools & Softwares

ModusToolbox™ Software and Tools



PSoC® Creator™ Integrated Design Environment (IDE)



References and links

PSoC 4 Product Webpage	www.cypress.com/PSoC4
Automotive Product Roadmap	www.cypress.com/Automotive/Roadmap
PSoC Creator IDE	www.cypress.com/PSoCCreator
Documentation	www.infineon.com/cms/en/product/promopages/MyICP-platform-for-Microcontroller/#PSoC-4-Documentation
PSoC Programmer	www.cypress.com/products/psoc-programming-solutions

Infineon & Cypress systems should be **merged by 2022**

Part of your life. Part of tomorrow.