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What is "[Embedded - Microcontrollers](#)"?

"[Embedded - Microcontrollers](#)" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "[Embedded - Microcontrollers](#)"

Details

Product Status	Active
Core Processor	ARM® Cortex®-M0
Core Size	32-Bit Single-Core
Speed	24MHz
Connectivity	I ² C, IrDA, LINbus, Microwire, SmartCard, SPI, SSP, UART/USART
Peripherals	Brown-out Detect/Reset, CapSense, LCD, LVD, POR, PWM, WDT
Number of I/O	36
Program Memory Size	16KB (16K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	4K x 8
Voltage - Supply (Vcc/Vdd)	1.71V ~ 5.5V
Data Converters	A/D 8x12b SAR; D/A 2xIDAC
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	48-LQFP
Supplier Device Package	48-TQFP (7x7)
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/cy8c4124azi-443

More Information

Cypress provides a wealth of data at www.cypress.com to help you to select the right PSoC device for your design, and to help you to quickly and effectively integrate the device into your design. For a comprehensive list of resources, see the knowledge base article [KBA86521](#), [How to Design with PSoC 3](#), [PSoC 4](#), and [PSoC 5LP](#). Following is an abbreviated list for PSoC 4:

- Overview: [PSoC Portfolio](#), [PSoC Roadmap](#)
- Product Selectors: [PSoC 1](#), [PSoC 3](#), [PSoC 4](#), [PSoC 5LP](#)
In addition, PSoC Creator includes a device selection tool.
- Application notes: Cypress offers a large number of PSoC application notes covering a broad range of topics, from basic to advanced level. Recommended application notes for getting started with PSoC 4 are:
 - [AN79953](#): Getting Started With PSoC 4
 - [AN88619](#): PSoC 4 Hardware Design Considerations
 - [AN86439](#): Using PSoC 4 GPIO Pins
 - [AN57821](#): Mixed Signal Circuit Board Layout
 - [AN81623](#): Digital Design Best Practices
 - [AN73854](#): Introduction To Bootloaders
 - [AN89610](#): ARM Cortex Code Optimization
 - [AN90071](#): CY8CMBRxxx CapSense Design Guide
- Technical Reference Manual (TRM) is in two documents:
 - [Architecture TRM](#) details each PSoC 4 functional block.
 - [Registers TRM](#) describes each of the PSoC 4 registers.
- Development Kits:
 - [CY8CKIT-042](#), PSoC 4 Pioneer Kit, is an easy-to-use and inexpensive development platform. This kit includes connectors for Arduino™ compatible shields and Digilent® Pmod™ daughter cards.
 - [CY8CKIT-049](#) is a very low-cost prototyping platform. It is a low-cost alternative to sampling PSoC 4 devices.
 - [CY8CKIT-001](#) is a common development platform for any one of the PSoC 1, PSoC 3, PSoC 4, or PSoC 5LP families of devices.

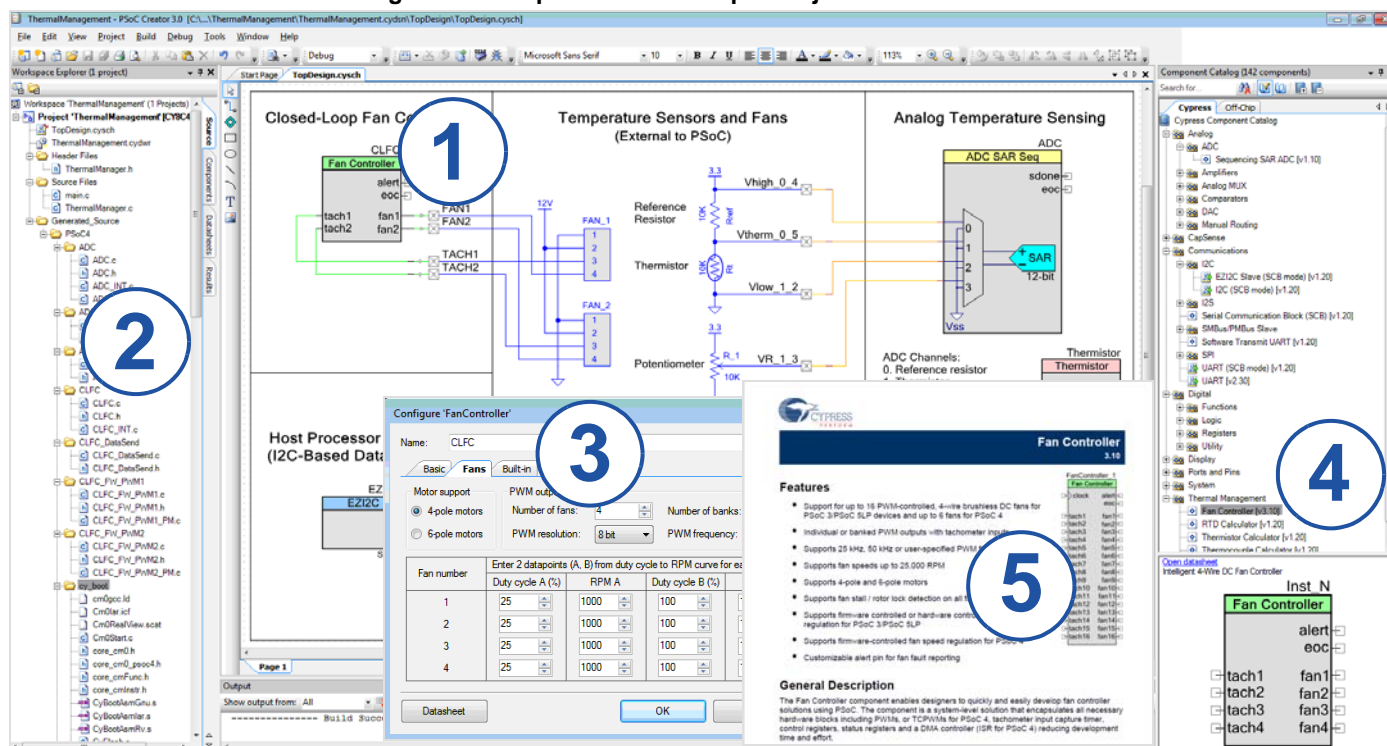
The [MiniProg3](#) device provides an interface for flash programming and debug.

PSoC Creator

[PSoC Creator](#) is a free Windows-based Integrated Design Environment (IDE). It enables concurrent hardware and firmware design of PSoC 3, PSoC 4, and PSoC 5LP based systems. Create designs using classic, familiar schematic capture supported by over 100 pre-verified, production-ready PSoC Components; see the [list of component datasheets](#). With PSoC Creator, you can:

1. Drag and drop component icons to build your hardware system design in the main design workspace
2. Codesign your application firmware with the PSoC hardware, using the PSoC Creator IDE C compiler
3. Configure components using the configuration tools
4. Explore the library of 100+ components
5. Review component datasheets

Figure 1. Multiple-Sensor Example Project in PSoC Creator



Functional Definition

CPU and Memory Subsystem

CPU

The Cortex-M0 CPU in PSoC 4100 is part of the 32-bit MCU subsystem, which is optimized for low power operation with extensive clock gating. It mostly uses 16-bit instructions and executes a subset of the Thumb-2 instruction set. This enables fully compatible binary upward migration of the code to higher performance processors such as the Cortex-M3 and M4, thus enabling upward compatibility. The Cypress implementation includes a hardware multiplier that provides a 32-bit result in one cycle. It includes a nested vectored interrupt controller (NVIC) block with 32 interrupt inputs and also includes a Wakeup Interrupt Controller (WIC), which can wake the processor up from Deep Sleep mode allowing power to be switched off to the main processor when the chip is in Deep Sleep mode. The Cortex-M0 CPU provides a Non-Maskable Interrupt input (NMI), which is made available to the user when it is not in use for system functions requested by the user.

The CPU also includes a debug interface, the serial wire debug (SWD) interface, which is a two-wire form of JTAG; the debug configuration used for PSoC 4100 has four break-point (address) comparators and two watchpoint (data) comparators.

Flash

PSoC 4100 has a flash module with a flash accelerator tightly coupled to the CPU to improve average access times from the flash block. The flash block is designed to deliver 0 wait-state (WS) access time at 24 MHz. Part of the flash module can be used to emulate EEPROM operation if required.

The PSoC 4200 Flash supports the following flash protection modes at the memory subsystem level:

- **Open: No Protection.** Factory default mode in which the product is shipped.
- **Protected: User may change from Open to Protected.** This mode disables Debug interface accesses. The mode can be set back to Open but only after completely erasing the Flash.
- **Kill: User may change from Open to Kill.** This mode disables all Debug accesses. The part cannot be erased externally, thus obviating the possibility of partial erasure by power interruption and potential malfunction and security leaks. This is an irrevocable mode.

In addition, row-level Read/Write protection is also supported to prevent inadvertent Writes as well as selectively block Reads. Flash Read/Write/Erase operations are always available for internal code using system calls.

SRAM

SRAM memory is retained during Hibernate.

SROM

A supervisory ROM that contains boot and configuration routines is provided.

System Resources

Power System

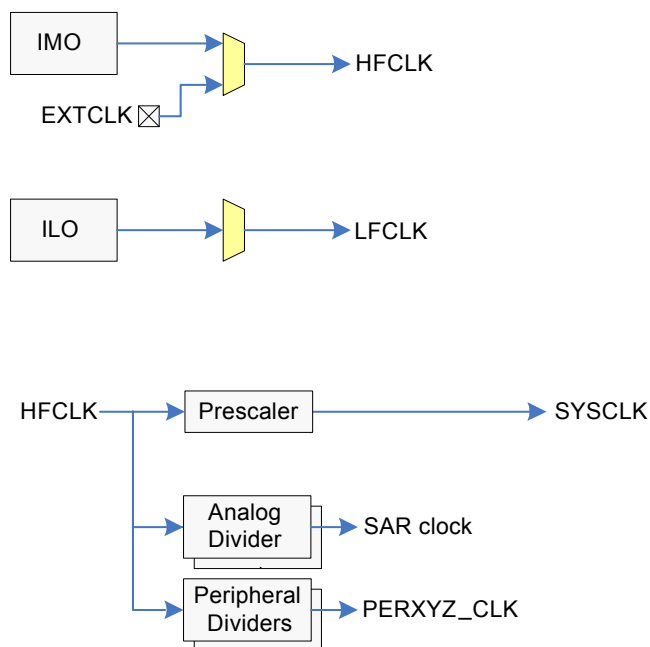
The power system is described in detail in the section [Power on page 15](#). It provides assurance that voltage levels are as required for each respective mode and either delay mode entry (on power-on reset (POR), for example) until voltage levels are as required for proper function or generate resets (brown-out detect (BOD)) or interrupts (low-voltage detect (LVD)). The PSoC 4100 operates with a single external supply over the range of 1.71 V to 5.5 V and has five different power modes, transitions between which are managed by the power system. PSoC 4100 provides Sleep, Deep Sleep, Hibernate, and Stop low-power modes.

Clock System

The PSoC 4100 clock system is responsible for providing clocks to all subsystems that require clocks and for switching between different clock sources without glitching. In addition, the clock system ensures that no metastable conditions occur.

The clock system for PSoC 4100 consists of the internal main oscillator (IMO) and the internal low-power oscillator (ILO) and provision for an external clock.

Figure 3. PSoC 4100 MCU Clocking Architecture



The HFCLK signal can be divided down (see [PSoC 4100 MCU Clocking Architecture](#)) to generate synchronous clocks for the analog and digital peripherals. There are a total of 12 clock dividers for PSoC 4100, each with 16-bit divide capability. The analog clock leads the digital clocks to allow analog events to occur before digital clock-related noise is generated. The 16-bit capability allows a lot of flexibility in generating fine-grained frequency values and is fully supported in PSoC Creator.

IMO Clock Source

The IMO is the primary source of internal clocking in the PSoC 4100. It is trimmed during testing to achieve the specified accuracy. Trim values are stored in nonvolatile latches (NVL). Additional trim settings from flash can be used to compensate for changes. The IMO default frequency is 24 MHz and it can be adjusted between 3 MHz to 24 MHz in steps of 1 MHz. The IMO tolerance with Cypress-provided calibration settings is $\pm 2\%$.

ILO Clock Source

The ILO is a very low power oscillator, which is primarily used to generate clocks for peripheral operation in Deep Sleep mode. ILO-driven counters can be calibrated to the IMO to improve accuracy. Cypress provides a software component, which does the calibration.

Watchdog Timer

A watchdog timer is implemented in the clock block running from the ILO; this allows watchdog operation during Deep Sleep and generates a watchdog reset if not serviced before the timeout occurs. The watchdog reset is recorded in the Reset Cause register.

Reset

PSoC 4100 can be reset from a variety of sources including a software reset. Reset events are asynchronous and guarantee reversion to a known state. The reset cause is recorded in a register, which is sticky through reset and allows software to determine the cause of the reset. An XRES pin is reserved for external reset to avoid complications with configuration and multiple pin functions during power-on or reconfiguration. The XRES pin has an internal pull-up resistor that is always enabled.

Voltage Reference

The PSoC 4100 reference system generates all internally required references. A 1% voltage reference spec is provided for the 12-bit ADC. To allow better signal to noise ratios (SNR) and better absolute accuracy, it is possible to bypass the internal reference using a GPIO pin or to use an external reference for the SAR.

Analog Blocks

12-bit SAR ADC

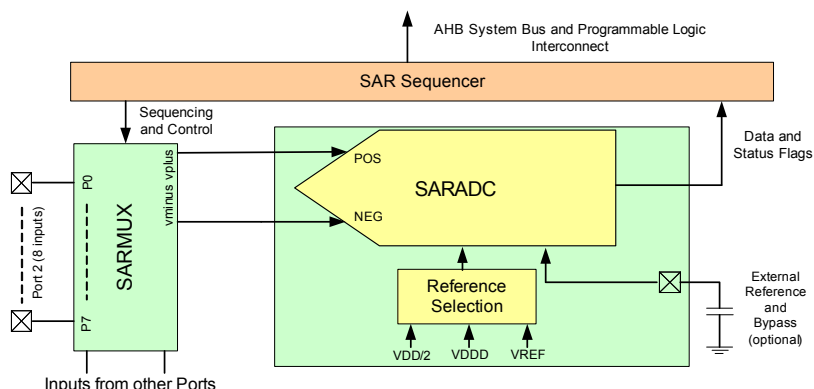
The 12-bit 806 ksp/s SAR ADC can operate at a maximum clock rate of 14.5 MHz and requires a minimum of 18 clocks at that frequency to do a 12-bit conversion.

The block functionality is augmented for the user by adding a reference buffer to it (trimmable to $\pm 1\%$) and by providing the choice (for the PSoC 4100 case) of three internal voltage references: V_{DD} , $V_{DD}/2$, and V_{REF} (nominally 1.024 V) as well as an external reference through a GPIO pin. The sample-and-hold (S/H) aperture is programmable allowing the gain bandwidth requirements of the amplifier driving the SAR inputs, which determine its settling time, to be relaxed if required. System performance will be 65 dB for true 12-bit precision providing appropriate references are used and system noise levels permit. To improve performance in noisy conditions, it is possible to provide an external bypass (through a fixed pin location) for the internal reference amplifier.

The SAR is connected to a fixed set of pins through an 8-input sequencer. The sequencer cycles through selected channels autonomously (sequencer scan) and does so with zero switching overhead (that is, aggregate sampling bandwidth is equal to 806 ksp/s whether it is for a single channel or distributed over several channels). The sequencer switching is effected through a state machine or through firmware driven switching. A feature provided by the sequencer is buffering of each channel to reduce CPU interrupt service requirements. To accommodate signals with varying source impedance and frequency, it is possible to have different sample times programmable for each channel. Also, signal range specification through a pair of range registers (low and high range values) is implemented with a corresponding out-of-range interrupt if the digitized value exceeds the programmed range; this allows fast detection of out-of-range values without the necessity of having to wait for a sequencer scan to be completed and the CPU to read the values and check for out-of-range values in software.

The SAR is able to digitize the output of the on-board temperature sensor for calibration and other temperature-dependent functions. The SAR is not available in Deep Sleep and Hibernate modes as it requires a high-speed clock (up to 18 MHz). The SAR operating range is 1.71 V to 5.5 V.

Figure 4. SAR ADC System Diagram



Two Opamps (CTBm Block)

PSoC 4100 has two opamps with Comparator modes which allow most common analog functions to be performed on-chip eliminating external components; PGAs, voltage buffers, filters, trans-impedance amplifiers, and other functions can be realized with external passives saving power, cost, and space. The on-chip opamps are designed with enough bandwidth to drive the S/H circuit of the ADC without requiring external buffering.

Temperature Sensor

PSoC 4100 has one on-chip temperature sensor. This consists of a diode, which is biased by a current source that can be disabled to save power. The temperature sensor is connected to the ADC, which digitizes the reading and produces a temperature value using Cypress supplied software that includes calibration and linearization.

Low-power Comparators

PSoC 4100 has a pair of low-power comparators, which can also operate in the Deep Sleep and Hibernate modes. This allows the analog system blocks to be disabled while retaining the ability to monitor external voltage levels during low-power modes. The comparator outputs are normally synchronized to avoid metastability unless operating in an asynchronous power mode (Hibernate) where the system wake-up circuit is activated by a comparator switch event.

Fixed Function Digital

Timer/Counter/PWM Block (TCPWM)

The TCPWM block consists of four 16-bit counters with user-programmable period length. There is a Capture register to record the count value at the time of an event (which may be an I/O event), a period register which is used to either stop or auto-reload the counter when its count is equal to the period register, and compare registers to generate compare value signals which are used as PWM duty cycle outputs. The block also provides true and complementary outputs with programmable offset between them to allow use as deadband programmable complementary PWM outputs. It also has a Kill input to force outputs to a predetermined state; for example, this is used in motor drive systems when an overcurrent state is indicated and the PWMs driving the FETs need to be shut off immediately with no time for software intervention.

Serial Communication Blocks (SCB)

The PSoC 4100 has two SCBs, which can each implement an I²C, UART, or SPI interface.

I²C Mode: The hardware I²C block implements a full multi-master and slave interface (it is capable of multimaster arbitration). This block is capable of operating at speeds of up to 1 Mbps (Fast Mode Plus) and has flexible buffering options to reduce interrupt overhead and latency for the CPU. The FIFO mode is available in all channels and is very useful in the absence of DMA.

The I²C peripheral is compatible with the I²C Standard-mode, Fast-mode, and Fast-Mode Plus devices as defined in the NXP I²C-bus specification and user manual (UM10204). The I²C bus I/O is implemented with GPIO in open-drain modes. The I²C bus uses open-drain drivers for clock and data with pull-up resistors on the bus for clock and data connected to all nodes. The required Rise and Fall times for different I²C speeds are guaranteed by using appropriate pull-up resistor values depending on VDD, Bus Capacitance, and resistor tolerance. For detailed information on how to calculate the optimum pull-up resistor value for your design, refer to the UM10204 I²C bus specification and user manual (the latest revision is available at www.nxp.com).

PSoC 4100 is not completely compliant with the I²C spec in the following respects:

- GPIO cells are not overvoltage-tolerant and, therefore, cannot be hot-swapped or powered up independently of the rest of the I²C system.
- Fast-mode Plus has an I_{OL} specification of 20 mA at a V_{OL} of 0.4 V. The GPIO cells can sink a maximum of 8-mA I_{OL} with a V_{OL} maximum of 0.6 V.
- Fast-mode and Fast-mode Plus specify minimum Fall times, which are not met with the GPIO cell; Slow strong mode can help meet this spec depending on the Bus Load.
- When the SCB is an I²C master, it interposes an IDLE state between NACK and Repeated Start; the I²C spec defines Bus free as following a Stop condition so other Active Masters do not intervene but a Master that has just become activated may start an Arbitration cycle.
- When the SCB is in I²C slave mode, and Address Match on External Clock is enabled (EC_AM = 1) along with operation in the internally clocked mode (EC_OP = 0), then its I²C address must be even.

UART Mode: This is a full-feature UART operating at up to 1 Mbps. It supports automotive single-wire interface (LIN), infrared interface (IrDA), and SmartCard (ISO7816) protocols, all of which are minor variants of the basic UART protocol. In addition, it supports the 9-bit multiprocessor mode that allows addressing of peripherals connected over common RX and TX lines. Common UART functions such as parity error, break detect, and frame error are supported. An 8-deep FIFO allows much greater CPU service latencies to be tolerated.

SPI Mode: The SPI mode supports full Motorola SPI, TI SSP (essentially adds a start pulse used to synchronize SPI Codecs), and National Microwire (half-duplex form of SPI). The SPI block can use the FIFO.

The following is the pin-list for the PSoC 4100 (35-WLCSP).

35-Ball CSP		Alternate Functions for Pins					Pin Description
Pin	Name	Analog	Alt 1	Alt 2	Alt 3	Alt 4	
D3	P2.2	sarmux.2	–	–	–	–	Port 2 Pin 2: gpio, lcd, csd, sarmux
E4	P2.3	sarmux.3	–	–	–	–	Port 2 Pin 3: gpio, lcd, csd, sarmux
E5	P2.4	sarmux.4	tcpwm0_p[1]	–	–	–	Port 2 Pin 4: gpio, lcd, csd, sarmux, pwm
E6	P2.5	sarmux.5	tcpwm0_n[1]	–	–	–	Port 2 Pin 5: gpio, lcd, csd, sarmux, pwm
E3	P2.6	sarmux.6	tcpwm1_p[1]	–	–	–	Port 2 Pin 6: gpio, lcd, csd, sarmux, pwm
E2	P2.7	sarmux.7	tcpwm1_n[1]	–	–	–	Port 2 Pin 7: gpio, lcd, csd, sarmux, pwm
E1	P3.0	–	tcpwm0_p[0]	scb1_uart_rx[0]	scb1_i2c_scl[0]	scb1_spi_mosi[0]	Port 3 Pin 0: gpio, lcd, csd, pwm, scb1
D2	P3.1	–	tcpwm0_n[0]	scb1_uart_tx[0]	scb1_i2c_sda[0]	scb1_spi_miso[0]	Port 3 Pin 1: gpio, lcd, csd, pwm, scb1
D1	P3.2	–	tcpwm1_p[0]	–	swd_io[0]	scb1_spi_clk[0]	Port 3 Pin 2: gpio, lcd, csd, pwm, scb1, swd
B7	VSS	–	–	–	–	–	Ground
C1	P3.3	–	tcpwm1_n[0]	–	swd_clk[0]	scb1_spi_ssel_0[0]	Port 3 Pin 3: gpio, lcd, csd, pwm, scb1, swd
C2	P3.4	–	tcpwm2_p[0]	–	–	scb1_spi_ssel_1	Port 3 Pin 4: gpio, lcd, csd, pwm, scb1
B1	P4.0	–	–	scb0_uart_rx	scb0_i2c_scl	scb0_spi_mosi	Port 4 Pin 0: gpio, lcd, csd, scb0
B2	P4.1	–	–	scb0_uart_tx	scb0_i2c_sda	scb0_spi_miso	Port 4 Pin 1: gpio, lcd, csd, scb0
A2	P4.2	csd_c_mod	–	–	–	scb0_spi_clk	Port 4 Pin 2: gpio, lcd, csd, scb0
A1	P4.3	csd_c_sh_tank	–	–	–	scb0_spi_ssel_0	Port 4 Pin 3: gpio, lcd, csd, scb0
C3	P0.0	comp1_inp	–	–	–	scb0_spi_ssel_1	Port 0 Pin 0: gpio, lcd, csd, scb0, comp
A5	P0.1	comp1_inn	–	–	–	scb0_spi_ssel_2	Port 0 Pin 1: gpio, lcd, csd, scb0, comp
A4	P0.2	comp2_inp	–	–	–	scb0_spi_ssel_3	Port 0 Pin 2: gpio, lcd, csd, scb0, comp
A3	P0.3	comp2_inn	–	–	–	–	Port 0 Pin 3: gpio, lcd, csd, comp
B3	P0.4	–	–	scb1_uart_rx[1]	scb1_i2c_scl[1]	scb1_spi_mosi[1]	Port 0 Pin 4: gpio, lcd, csd, scb1
A6	P0.5	–	–	scb1_uart_tx[1]	scb1_i2c_sda[1]	scb1_spi_miso[1]	Port 0 Pin 5: gpio, lcd, csd, scb1
B4	P0.6	–	ext_clk	–	–	scb1_spi_clk[1]	Port 0 Pin 6: gpio, lcd, csd, scb1, ext_clk
B5	P0.7	–	–	–	wakeup	scb1_spi_ssel_0[1]	Port 0 Pin 7: gpio, lcd, csd, scb1, wakeup
B6	XRES	–	–	–	–	–	Chip reset, active low
A7	VCCD	–	–	–	–	–	Regulated supply, connect to 1µF cap or 1.8V
C7	VDD	–	–	–	–	–	Supply, 1.8 - 5.5V
C4	P1.0	ctb.oa0.inp	tcpwm2_p[1]	–	–	–	Port 1 Pin 0: gpio, lcd, csd, ctb, pwm
C5	P1.1	ctb.oa0.inm	tcpwm2_n[1]	–	–	–	Port 1 Pin 1: gpio, lcd, csd, ctb, pwm

Figure 7. 40-Pin QFN Pinout

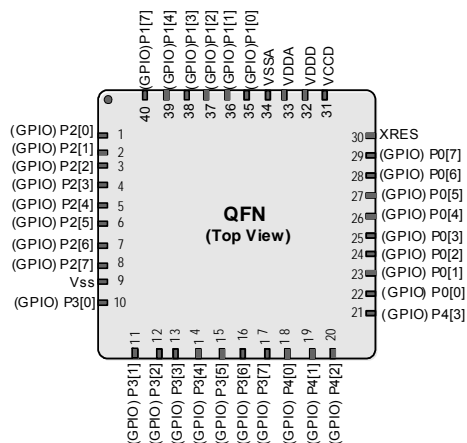


Figure 8. 35-Ball WLCSP

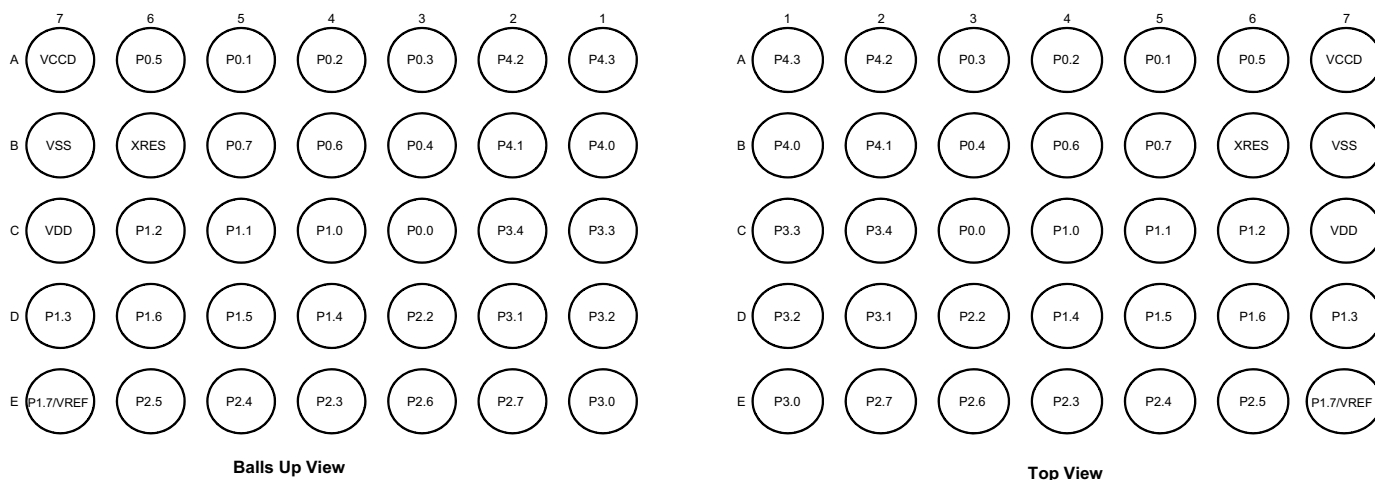
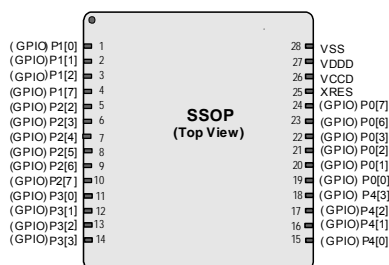


Figure 9. 28-Pin SSOP Pinout



Note It is good practice to check the datasheets for your bypass capacitors, specifically the working voltage and the DC bias specifications. With some capacitors, the actual capacitance can decrease considerably when the DC bias (V_{DDA} , V_{DDD} , or V_{CCD}) is a significant percentage of the rated working voltage. V_{DDA} must be equal to or higher than the V_{DDD} supply when powering up.

Figure 13. 40-pin QFN Example

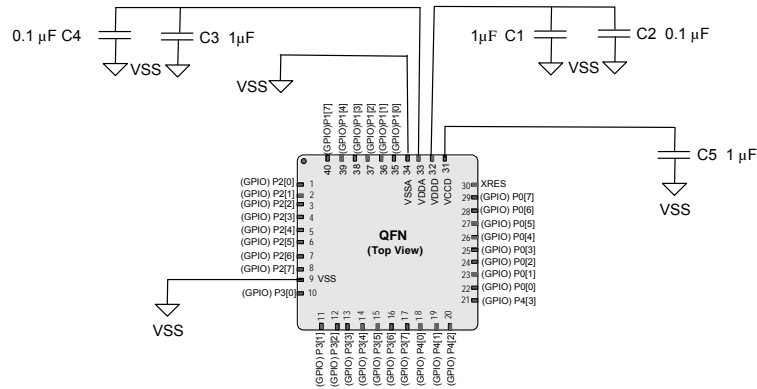
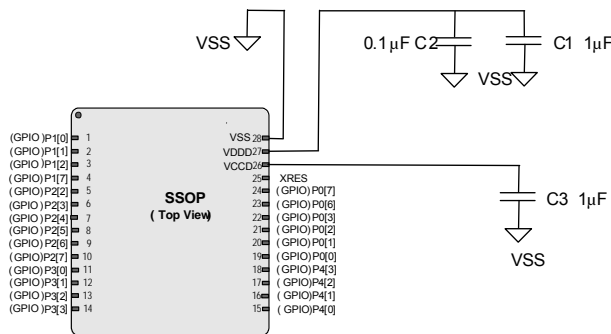


Figure 14. 28-SSOP Example



Regulated External Supply

In this mode, the PSoC 4100 is powered by an external power supply that must be within the range of 1.71 V to 1.89 V (1.8 ±5%); note that this range needs to include power supply ripple too. In this mode, V_{CCD} , V_{DDA} , and V_{DDD} pins are all shorted together and bypassed. The internal regulator is disabled in firmware.

Development Support

The PSoC 4100 family has a rich set of documentation, development tools, and online resources to assist you during your development process. Visit www.cypress.com/go/psoc4 to find out more.

Documentation

A suite of documentation supports the PSoC 4100 family to ensure that you can find answers to your questions quickly. This section contains a list of some of the key documents.

Software User Guide: A step-by-step guide for using PSoC Creator. The software user guide shows you how the PSoC Creator build process works in detail, how to use source control with PSoC Creator, and much more.

Component Datasheets: The flexibility of PSoC allows the creation of new peripherals (components) long after the device has gone into production. Component data sheets provide all of the information needed to select and use a particular component, including a functional description, API documentation, example code, and AC/DC specifications.

Application Notes: PSoC application notes discuss a particular application of PSoC in depth; examples include brushless DC motor control and on-chip filtering. Application notes often include example projects in addition to the application note document.

Technical Reference Manual: The Technical Reference Manual (TRM) contains all the technical detail you need to use a PSoC device, including a complete description of all PSoC registers. The TRM is available in the Documentation section at www.cypress.com/psoc4.

Online

In addition to print documentation, the Cypress PSoC forums connect you with fellow PSoC users and experts in PSoC from around the world, 24 hours a day, 7 days a week.

Tools

With industry standard cores, programming, and debugging interfaces, the PSoC 4100 family is part of a development tool ecosystem. Visit us at www.cypress.com/go/psoccreator for the latest information on the revolutionary, easy to use PSoC Creator IDE, supported third party compilers, programmers, debuggers, and development kits.

Electrical Specifications

Absolute Maximum Ratings

Table 1. Absolute Maximum Ratings^[1]

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID1	V _{DDD_ABS}	Digital supply relative to V _{SSD}	-0.5	–	6	V	Absolute max
SID2	V _{CCD_ABS}	Direct digital core voltage input relative to V _{SSD}	-0.5	–	1.95	V	Absolute max
SID3	V _{GPIO_ABS}	GPIO voltage	-0.5	–	V _{DD} +0.5	V	Absolute max
SID4	I _{GPIO_ABS}	Maximum current per GPIO	-25	–	25	mA	Absolute max
SID5	I _{GPIO_injection}	GPIO injection current, Max for V _{IH} > V _{DDD} , and Min for V _{IL} < V _{SS}	-0.5	–	0.5	mA	Absolute max, current injected per pin
BID44	ESD_HBM	Electrostatic discharge human body model	2200	–	–	V	
BID45	ESD_CDM	Electrostatic discharge charged device model	500	–	–	V	
BID46	LU	Pin current for latch-up	-200	–	200	mA	

Device-Level Specifications

All specifications are valid for -40 °C ≤ TA ≤ 105 °C and TJ ≤ 125 °C, except where noted. Specifications are valid for 1.71 V to 5.5 V, except where noted.

Table 2. DC Specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID53	V _{DD}	Power Supply Input Voltage (V _{DDA} = V _{DDD} = V _{DD})	1.8	–	5.5	V	With regulator enabled
SID255	V _{DDD}	Power Supply Input Voltage unregulated	1.71	1.8	1.89	V	Internally unregulated Supply
SID54	V _{CCD}	Output voltage (for core logic)	–	1.8	–	V	
SID55	CEFC	External Regulator voltage bypass	1	1.3	1.6	μF	X5R ceramic or better
SID56	CEXC	Power supply decoupling capacitor	–	1	–	μF	X5R ceramic or better
Active Mode, V_{DD} = 1.71 V to 5.5 V. Typical Values measured at V_{DD} = 3.3 V							
SID9	IDD4	Execute from Flash; CPU at 6 MHz	–	–	2.8	mA	
SID10	IDD5	Execute from Flash; CPU at 6 MHz	–	2.2	–	mA	T = 25 °C
SID12	IDD7	Execute from Flash; CPU at 12 MHz,	–	–	4.2	mA	
SID13	IDD8	Execute from Flash; CPU at 12 MHz	–	3.7	–	mA	T = 25 °C
SID16	IDD11	Execute from Flash; CPU at 24 MHz	–	6.7	–	mA	T = 25 °C
SID17	IDD12	Execute from Flash; CPU at 24 MHz	–	–	7.2	mA	
Sleep Mode, V_{DD} = 1.7 V to 5.5 V							
SID25	IDD20	I ² C wakeup, WDT, and Comparators on. 6 MHz.	–	1.3	1.8	mA	V _{DD} = 1.71 to 5.5 V
SID25A	IDD20A	I ² C wakeup, WDT, and Comparators on. 12 MHz.	–	1.7	2.2	mA	V _{DD} = 1.71 to 5.5 V
Deep Sleep Mode, V_{DD} = 1.8 V to 3.6 V (Regulator on)							
SID31	IDD26	I ² C wakeup and WDT on.	–	1.3	–	μA	T = 25 °C
SID32	IDD27	I ² C wakeup and WDT on.	–	–	45	μA	T = 85 °C

Note

- Usage above the absolute maximum conditions listed in Table 1 may cause permanent damage to the device. Exposure to absolute maximum conditions for extended periods of time may affect device reliability. The maximum storage temperature is 150 °C in compliance with JEDEC Standard JESD22-A103, High Temperature Storage Life. When used below absolute maximum conditions but above normal operating conditions, the device may not operate to specification.

Table 5. GPIO AC Specifications (Guaranteed by Characterization)

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/ Conditions
SID70	T_{RISEF}	Rise time in fast strong mode	2	–	12	ns	3.3-V V_{DD} , Clload = 25 pF
SID71	T_{FALLF}	Fall time in fast strong mode	2	–	12	ns	3.3-V V_{DD} , Clload = 25 pF
SID72	T_{RISES}	Rise time in slow strong mode	10	–	60	ns	3.3-V V_{DD} , Clload = 25 pF
SID73	T_{FALLS}	Fall time in slow strong mode	10	–	60	ns	3.3-V V_{DD} , Clload = 25 pF
SID74	$F_{GPIOOUT1}$	GPIO Fout; 3.3 V $\leq V_{DD} \leq 5.5$ V. Fast strong mode.	–	–	24	MHz	90/10%, 25-pF load, 60/40 duty cycle
SID75	$F_{GPIOOUT2}$	GPIO Fout; 1.7 V $\leq V_{DD} \leq 3.3$ V. Fast strong mode.	–	–	16.7	MHz	90/10%, 25-pF load, 60/40 duty cycle
SID76	$F_{GPIOOUT3}$	GPIO Fout; 3.3 V $\leq V_{DD} \leq 5.5$ V. Slow strong mode.	–	–	7	MHz	90/10%, 25-pF load, 60/40 duty cycle
SID245	$F_{GPIOOUT4}$	GPIO Fout; 1.7 V $\leq V_{DD} \leq 3.3$ V. Slow strong mode.	–	–	3.5	MHz	90/10%, 25-pF load, 60/40 duty cycle
SID246	F_{GPIOIN}	GPIO input operating frequency; 1.71 V $\leq V_{DD} \leq 5.5$ V	–	–	24	MHz	90/10% V_{IO}

XRES

Table 6. XRES DC Specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/ Conditions
SID77	V_{IH}	Input voltage high threshold	$0.7 \times V_{DD}$	–	–	V	CMOS Input
SID78	V_{IL}	Input voltage low threshold	–	–	$0.3 \times V_{DD}$	V	CMOS Input
SID79	R_{PULLUP}	Pull-up resistor	3.5	5.6	8.5	k Ω	
SID80	C_{IN}	Input capacitance	–	3	–	pF	
SID81	$V_{HYSXRES}$	Input voltage hysteresis	–	100	–	mV	Guaranteed by characterization
SID82	I_{DIODE}	Current through protection diode to V_{DD}/V_{SS}	–	–	100	μ A	Guaranteed by characterization

Table 7. XRES AC Specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/ Conditions
SID83	$T_{RESETWIDTH}$	Reset pulse width	1	–	–	μ s	Guaranteed by characterization

Table 8. Opamp Specifications (Guaranteed by Characterization) (continued)

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/ Conditions
SID297	Cload	Stable up to maximum load. Performance specs at 50 pF.	–	–	125	pF	
SID298	Slew_rate	Cload = 50 pF, Power = High, $V_{DDA} \geq 2.7$ V	6	–	–	V/ μ s	
SID299	T_op_wake	From disable to enable, no external RC dominating	–	300	–	μ s	
SID299A	OL_GAIN	Open Loop Gain	–	90	–	dB	Guaranteed by design
	Comp_mode	Comparator mode; 50-mV drive, $T_{rise} = T_{fall}$ (approx)	–	–	–		
SID300	T _{PD1}	Response time; power = high	–	150	–	ns	
SID301	T _{PD2}	Response time; power = medium	–	400	–	ns	
SID302	T _{PD3}	Response time; power = low	–	2000	–	ns	
SID303	Vhyst_op	Hysteresis	–	10	–	mV	

Comparator

Table 9. Comparator DC Specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/ Conditions
SID85	V _{OFFSET2}	Input offset voltage, Common Mode voltage range from 0 to $V_{DD}-1$	–	–	± 4	mV	
SID85A	V _{OFFSET3}	Input offset voltage. Ultra low-power mode ($V_{DDD} \geq 2.2$ V for Temp < 0 °C, $V_{DDD} \geq 1.8$ V for Temp > 0 °C)	–	± 12	–	mV	
SID86	V _{HYST}	Hysteresis when enabled, Common Mode voltage range from 0 to $V_{DD}-1$.	–	10	35	mV	Guaranteed by characterization
SID87	V _{ICM1}	Input common mode voltage in normal mode	0	–	$V_{DDD} - 0.1$	V	Modes 1 and 2.
SID247	V _{ICM2}	Input common mode voltage in low power mode ($V_{DDD} \geq 2.2$ V for Temp < 0 °C, $V_{DDD} \geq 1.8$ V for Temp > 0 °C)	0	–	V_{DDD}	V	
SID247A	V _{ICM3}	Input common mode voltage in ultra low power mode	0	–	$V_{DDD} - 1.15$	V	
SID88	CMRR	Common mode rejection ratio	50	–	–	dB	$V_{DDD} \geq 2.7$ V. Guaranteed by characterization
SID88A	CMRR	Common mode rejection ratio	42	–	–	dB	$V_{DDD} < 2.7$ V. Guaranteed by characterization
SID89	I _{CMP1}	Block current, normal mode	–	–	400	μ A	Guaranteed by characterization
SID248	I _{CMP2}	Block current, low power mode	–	–	100	μ A	Guaranteed by characterization
SID259	I _{CMP3}	Block current, ultra low power mode ($V_{DDD} \geq 2.2$ V for Temp < 0 °C, $V_{DDD} \geq 1.8$ V for Temp > 0 °C)	–	6	28	μ A	Guaranteed by characterization
SID90	Z _{CMP}	DC input impedance of comparator	35	–	–	M Ω	Guaranteed by characterization

Table 10. Comparator AC Specifications

(Guaranteed by Characterization)

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID91	T _{RESP1}	Response time, normal mode	–	–	110	ns	50-mV overdrive
SID258	T _{RESP2}	Response time, low power mode	–	–	200	ns	50-mV overdrive
SID92	T _{RESP3}	Response time, ultra low power mode (V _{DD} ≥ 2.2 V for Temp < 0 °C, V _{DD} ≥ 1.8 V for Temp > 0 °C)	–	–	15	µs	200-mV overdrive

Temperature Sensor

Table 11. Temperature Sensor Specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID93	T _{SENSACC}	Temperature sensor accuracy	–5	±1	+5	°C	–40 to +85 °C

SAR ADC

Table 12. SAR ADC DC Specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID94	A_RES	Resolution	–	–	12	bits	
SID95	A_CHNIS_S	Number of channels - single ended	–	–	8		8 full speed
SID96	A-CHNKS_D	Number of channels - differential	–	–	4		Diff inputs use neighboring I/O
SID97	A-MONO	Monotonicity	–	–	–		Yes. Based on characterization
SID98	A_GAINERR	Gain error	–	–	±0.1	%	With external reference. Guaranteed by characterization
SID99	A_OFFSET	Input offset voltage	–	–	2	mV	Measured with 1-V V _{REF} . Guaranteed by characterization
SID100	A_ISAR	Current consumption	–	–	1	mA	
SID101	A_VINS	Input voltage range - single ended	V _{SS}	–	V _{DDA}	V	Based on device characterization
SID102	A_VIND	Input voltage range - differential	V _{SS}	–	V _{DDA}	V	Based on device characterization
SID103	A_INRES	Input resistance	–	–	2.2	KΩ	Based on device characterization
SID104	A_INCAP	Input capacitance	–	–	10	pF	Based on device characterization
SID106	A_PSR	Power supply rejection ratio	70	–	–	dB	
SID107	A_CMRR	Common mode rejection ratio	66	–	–	dB	Measured at 1 V
SID111	A_INL	Integral non linearity	–1.7	–	+2	LSB	V _{DD} = 1.71 to 5.5, 806 ksp, V _{REF} = 1 to 5.5.
SID111A	A_INL	Integral non linearity	–1.5	–	+1.7	LSB	V _{DD} = 1.71 to 3.6, 806 ksp, V _{REF} = 1.71 to V _{DD} .

CSD
Table 14. CSD Specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/ Conditions
SID.CSD#16	IDAC1IDD	IDAC1 (8 bits) block current	–	–	1125	μA	
SID.CSD#17	IDAC2IDD	IDAC2 (7 bits) block current	–	–	1125	μA	
SID308	VCSD	Voltage range of operation	1.71	–	5.5	V	
SID308A	VCOMPIDAC	Voltage compliance range of IDAC for S0	0.8	–	V _{DD} -0.8	V	
SID309	IDAC1	DNL for 8-bit resolution	–1	–	1	LSB	
SID310	IDAC1	INL for 8-bit resolution	–3	–	3	LSB	
SID311	IDAC2	DNL for 7-bit resolution	–1	–	1	LSB	
SID312	IDAC2	INL for 7-bit resolution	–3	–	3	LSB	
SID313	SNR	Ratio of counts of finger to noise, 0.1-pF sensitivity	5	–	–	Ratio	Capacitance range of 9 to 35 pF, 0.1-pF sensitivity
SID314	IDAC1_CRT1	Output current of IDAC1 (8 bits) in High range	–	612	–	uA	
SID314A	IDAC1_CRT2	Output current of IDAC1 (8 bits) in Low range	–	306	–	uA	
SID315	IDAC2_CRT1	Output current of IDAC2 (7 bits) in High range	–	304.8	–	uA	
SID315A	IDAC2_CRT2	Output current of IDAC2 (7 bits) in Low range	–	152.4	–	uA	
SID320	IDACOFFSET	All zeroes input	–	–	±1	LSB	
SID321	IDACGAIN	Full-scale error less offset	–	–	±10	%	
SID322	IDACMISMATCH	Mismatch between IDACs	–	–	7	LSB	
SID323	IDACSET8	Settling time to 0.5 LSB for 8-bit IDAC	–	–	10	μs	Full-scale transition. No external load.
SID324	IDACSET7	Settling time to 0.5 LSB for 7-bit IDAC	–	–	10	μs	Full-scale transition. No external load.
SID325	CMOD	External modulator capacitor	–	2.2	–	nF	5-V rating, X7R or NP0 cap.

Ordering Information

The PSoC 4100 part numbers and features are listed in the following table.

Table 39. PSoC 4100 Family Ordering Information

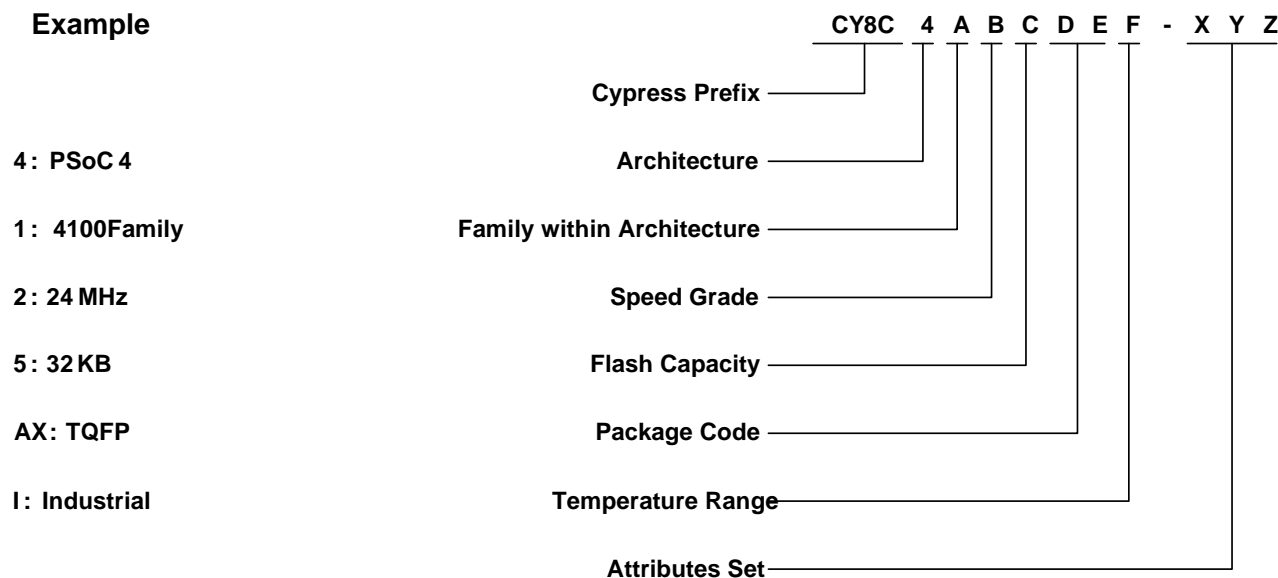
Family	MPN	Features												Package				
		Max CPU Speed (MHz)	Flash (KB)	SRAM (KB)	UDB	Op-amp (CTBm)	CapSense	Direct LCD Drive	12-bit SAR ADC	LP Comparators	TCPWM Blocks	SCB Blocks	GPIO	28-SSOP	35-WLCSP	40-QFN	44-TQFP	48-TQFP
4100	CY8C4124PVI-432	24	16	4	-	1	-	-	806 ksps	2	4	2	24	√				
	CY8C4124PVI-442	24	16	4	-	1	√	√	806 ksps	2	4	2	24	√				
	CY8C4124PVQ-432	24	16	4	-	1	-	-	806 ksps	2	4	2	24	√				
	CY8C4124PVQ-442	24	16	4	-	1	√	√	806 ksps	2	4	2	24	√				
	CY8C4124FNI-443	24	16	4	-	2	√	√	806 ksps	2	4	2	31		√			
	CY8C4124LQI-443	24	16	4	-	2	√	√	806 ksps	2	4	2	34			√		
	CY8C4124AXI-443	24	16	4	-	2	√	√	806 ksps	2	4	2	36				√	
	CY8C4124LQQ-443	24	16	4	-	2	√	√	806 ksps	2	4	2	34			√		
	CY8C4124AXQ-443	24	16	4	-	2	√	√	806 ksps	2	4	2	36				√	
	CY8C4124AZI-443	24	16	4	-	2	√	√	806 ksps	2	4	2	36					√
	CY8C4125AXI-473	24	32	4	-	2	-	-	806 ksps	2	4	2	36				√	
	CY8C4125AXQ-473	24	32	4	-	2	-	-	806 ksps	2	4	2	36				√	
	CY8C4125AZI-473	24	32	4	-	2	-	-	806 ksps	2	4	2	36					√
	CY8C4125PVI-482	24	32	4	-	1	√	√	806 ksps	2	4	2	24	√				
	CY8C4125PVQ-482	24	32	4	-	1	√	√	806 ksps	2	4	2	24	√				
	CY8C4125FNI-483(T)	24	32	4	-	2	√	√	806 ksps	2	4	2	31		√			
	CY8C4125LQI-483	24	32	4	-	2	√	√	806 ksps	2	4	2	34			√		
	CY8C4125AXI-483	24	32	4	-	2	√	√	806 ksps	2	4	2	36				√	
	CY8C4125LQQ-483	24	32	4	-	2	√	√	806 ksps	2	4	2	34			√		
	CY8C4125AXQ-483	24	32	4	-	2	√	√	806 ksps	2	4	2	36				√	
	CY8C4125AZI-483	24	32	4	-	2	√	√	806 ksps	2	4	2	36					√

Part Numbering Conventions

PSoC 4 devices follow the part numbering convention described in the following table. All fields are single-character alphanumeric (0, 1, 2, ..., 9, A, B, ..., Z) unless stated otherwise.

The part numbers are of the form CY8C4ABCDEF-XYZ where the fields are defined as follows.

Example



The Field Values are listed in the following table.

Field	Description	Values	Meaning
CY8C	Cypress Prefix		
4	Architecture	4	PSoC 4
A	Family within architecture	1	4100 Family
		2	4200 Family
B	CPU Speed	2	24 MHz
		4	48 MHz
C	Flash Capacity	4	16 KB
		5	32 KB
DE	Package Code	AX, AZ	TQFP
		LQ	QFN
		PV	SSOP
		FN	WLCSP
F	Temperature Range	I	Industrial
		Q	Extended Industrial
XYZ	Attributes Code	000-999	Code of feature set in specific family

Packaging

Table 40. Package Characteristics

Parameter	Description	Conditions	Min	Typ	Max	Units
T _A	Operating ambient temperature		–40	25.00	105	°C
T _J	Operating junction temperature		–40	–	125	°C
T _{JA}	Package θ_{JA} (28-pin SSOP)		–	66.58	–	°C/Watt
T _{JA}	Package θ_{JA} (35-ball WLCSP)		–	28.00	–	°C/Watt
T _{JA}	Package θ_{JA} (40-pin QFN)		–	15.34	–	°C/Watt
T _{JA}	Package θ_{JA} (44-pin TQFP)		–	57.16	–	°C/Watt
T _{JA}	Package θ_{JA} (48-pin TQFP)		–	67.30	–	°C/Watt
T _{JC}	Package θ_{JC} (28-pin SSOP)		–	26.28	–	°C/Watt
T _{JC}	Package θ_{JC} (35-ball WLCSP)		–	00.40	–	°C/Watt
T _{JC}	Package θ_{JC} (40-pin QFN)		–	2.50	–	°C/Watt
T _{JC}	Package θ_{JC} (44-pin TQFP)		–	17.47	–	°C/Watt
T _{JC}	Package θ_{JC} (48-pin TQFP)		–	27.60	–	°C/Watt

Table 41. Solder Reflow Peak Temperature

Package	Maximum Peak Temperature	Maximum Time at Peak Temperature
28-pin SSOP	260 °C	30 seconds
35-ball WLCSP	260 °C	30 seconds
40-pin QFN	260 °C	30 seconds
44-pin TQFP	260 °C	30 seconds
48-pin TQFP	260 °C	30 seconds

Table 42. Package Moisture Sensitivity Level (MSL), IPC/JEDEC J-STD-2

Package	MSL
28-pin SSOP	MSL 3
35-ball WLCSP	MSL 3
40-pin QFN	MSL 3
44-pin TQFP	MSL 3
48-pin TQFP	MSL 3

PSoC 4 CAB Libraries with Schematics Symbols and PCB Footprints are on the Cypress web site at http://www.cypress.com/cad-resources/psoc-4-cad-libraries?source=search&cat=technical_documents.

Acronyms

Table 43. Acronyms Used in this Document

Acronym	Description
abus	analog local bus
ADC	analog-to-digital converter
AG	analog global
AHB	AMBA (advanced microcontroller bus architecture) high-performance bus, an ARM data transfer bus
ALU	arithmetic logic unit
AMUXBUS	analog multiplexer bus
API	application programming interface
APSR	application program status register
ARM®	advanced RISC machine, a CPU architecture
ATM	automatic thump mode
BW	bandwidth
CAN	Controller Area Network, a communications protocol
CMRR	common-mode rejection ratio
CPU	central processing unit
CRC	cyclic redundancy check, an error-checking protocol
DAC	digital-to-analog converter, see also IDAC, VDAC
DFB	digital filter block
DIO	digital input/output, GPIO with only digital capabilities, no analog. See GPIO.
DMIPS	Dhrystone million instructions per second
DMA	direct memory access, see also TD
DNL	differential nonlinearity, see also INL
DNU	do not use
DR	port write data registers
DSI	digital system interconnect
DWT	data watchpoint and trace
ECC	error correcting code
ECO	external crystal oscillator
EEPROM	electrically erasable programmable read-only memory
EMI	electromagnetic interference
EMIF	external memory interface
EOC	end of conversion
EOF	end of frame
EPSR	execution program status register
ESD	electrostatic discharge

Table 43. Acronyms Used in this Document *(continued)*

Acronym	Description
ETM	embedded trace macrocell
FIR	finite impulse response, see also IIR
FPB	flash patch and breakpoint
FS	full-speed
GPIO	general-purpose input/output, applies to a PSoC pin
HVI	high-voltage interrupt, see also LVI, LVD
IC	integrated circuit
IDAC	current DAC, see also DAC, VDAC
IDE	integrated development environment
I ² C, or IIC	Inter-Integrated Circuit, a communications protocol
IIR	infinite impulse response, see also FIR
ILO	internal low-speed oscillator, see also IMO
IMO	internal main oscillator, see also ILO
INL	integral nonlinearity, see also DNL
I/O	input/output, see also GPIO, DIO, SIO, USBIO
IPOR	initial power-on reset
IPSR	interrupt program status register
IRQ	interrupt request
ITM	instrumentation trace macrocell
LCD	liquid crystal display
LIN	Local Interconnect Network, a communications protocol.
LR	link register
LUT	lookup table
LVD	low-voltage detect, see also LVI
LVI	low-voltage interrupt, see also HVI
LVTTTL	low-voltage transistor-transistor logic
MAC	multiply-accumulate
MCU	microcontroller unit
MISO	master-in slave-out
NC	no connect
NMI	nonmaskable interrupt
NRZ	non-return-to-zero
NVIC	nested vectored interrupt controller
NVL	nonvolatile latch, see also WOL
opamp	operational amplifier
PAL	programmable array logic, see also PLD

Document Conventions

Units of Measure

Table 44. Units of Measure

Symbol	Unit of Measure
°C	degrees Celsius
dB	decibel
fF	femto farad
Hz	hertz
KB	1024 bytes
kbps	kilobits per second
Khr	kilohour
kHz	kilohertz
kΩ	kilo ohm
ksps	kilosamples per second
LSB	least significant bit
Mbps	megabits per second
MHz	megahertz
MΩ	mega-ohm
Msps	megasamples per second
μA	microampere
μF	microfarad
μH	microhenry
μs	microsecond
μV	microvolt
μW	microwatt
mA	milliampere
ms	millisecond
mV	millivolt
nA	nanoampere
ns	nanosecond
nV	nanovolt
Ω	ohm
pF	picofarad
ppm	parts per million
ps	picosecond
s	second
sps	samples per second
sqrtHz	square root of hertz
V	volt

Revision History

Description Title: PSoC® 4: PSoC 4100 Family Datasheet Programmable System-on-Chip (PSoC®) Document Number:001-87220				
Revision	ECN	Orig. of Change	Submission Date	Description of Change
*B	4108562	WKA	08/29/2013	Added clarifying note about the XRES pin in the Reset section. Added a link reference to the PSoC 4 TRM. Updated the footnote in Absolute Maximum Ratings . Updated Sleep Mode IDD specs in DC Specifications . Updated Comparator DC Specifications Updated SAR ADC AC Specifications (Guaranteed by Characterization) Updated LCD Direct Drive DC Specifications (Guaranteed by Characterization) Updated the number of GPIOs in Ordering Information .
*C	4568937	WKA	11/19/2014	Added 48-pin TQFP pin and package details. Added SID308A spec details. Updated Ordering Information .
*D	4617283	WKA	01/08/2015	Corrected typo in the ordering information table. Updated 28-pin SSOP package diagram.
*E	4643655	WKA	04/29/2015	Added 35 WLCSP pinout and package detail information. Updated CSD specifications.
*F	5287114	WKA	06/09/2016	Corrected typo in the Features section. Added reference to AN90071 in the More Information section. Updated Flash section with details of flash protection modes. Added notes in the Pinouts section. Updated 40-pin QFN and 28-pin SSOP pin diagrams. Added PSoC 4 Power Supply diagram. Updated the Bypass Capacitors column in the Power Supply table. Updated values for SID32, SID34, SID38, SID269, SID270, SID271. Added SID299A. Updated Comparator Specifications. Updated TCPWM Specifications. Updated values for SID149, SID160, SID171. Updated Conditions for SID190. Added BID55. Removed Conditions for SID237. Added reference to PSoC 4 CAB Libraries with Schematics Symbols and PCB Footprints in the Packaging section.
*G	5327384	WKA	06/28/2016	Removed the capacitor connection for Pin 15 in Figure 11.
*H	5704046	GNKK	04/26/2017	Updated the Cypress logo and copyright information.

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