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What is "Embedded - Microcontrollers"?

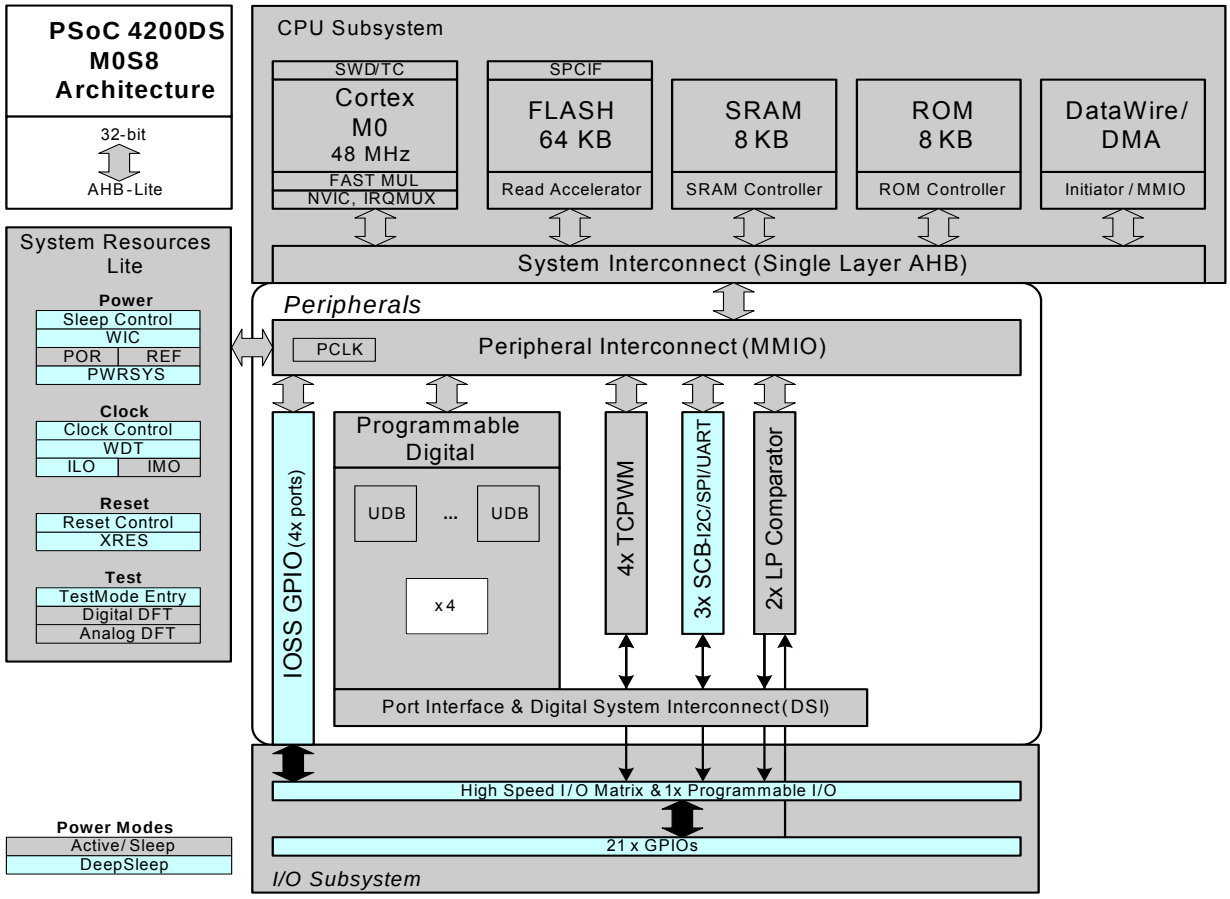
"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" 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	48MHz
Connectivity	I²C, IrDA, LINbus, Microwire, SmartCard, SPI, SSP, UART/USART
Peripherals	Brown-out Detect/Reset, CapSense, LCD, LVD, POR, PWM, WDT
Number of I/O	21
Program Memory Size	32KB (32K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	4K x 8
Voltage - Supply (Vcc/Vdd)	1.7V ~ 5.5V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	25-UFBGA, WLCSP
Supplier Device Package	25-WLCSP (2.07×2.11)
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/cy8c4045fni-ds402t

Contents

PSoC 4200DS Block Diagram



The PSoC 4200DS devices include extensive support for programming, testing, debugging, and tracing both hardware and firmware.

The ARM Serial_Wire Debug (SWD) interface supports all programming and debug features of the device.

Complete debug-on-chip functionality enables full-device debugging in the final system using the standard production device. It does not require special interfaces, debugging pods, simulators, or emulators. Only the standard programming connections are required to fully support debug.

The PSoC Creator Integrated Development Environment (IDE) provides fully integrated programming and debug support for PSoC 4200DS devices. The SWD interface is fully compatible with industry-standard third-party tools. The PSoC 4200DS family provides a level of security not possible with multi-chip application solutions or with microcontrollers. This is due to its ability to disable debug features, robust flash protection, and because it allows customer-proprietary functionality to be implemented in on-chip programmable blocks.

The debug circuits are enabled by default and can only be disabled in firmware. If not enabled, the only way to re-enable them is to erase the entire device, clear flash protection, and reprogram the device with new firmware that enables debugging.

Additionally, all device interfaces can be permanently disabled (device security) for applications concerned about phishing attacks due to a maliciously reprogrammed device or attempts to defeat security by starting and interrupting flash programming sequences. Because all programming, debug, and test interfaces are disabled when maximum device security is enabled, PSoC 4200DS with device security enabled may not be returned for failure analysis. This is a trade-off the PSoC 4200DS allows the customer to make.

Reset

The PSoC 4200DS 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.

Analog Block

Low-power Comparators

The PSoC 4200DS has a pair of low-power comparators, with two different power modes allowing trade-off of power versus response time.

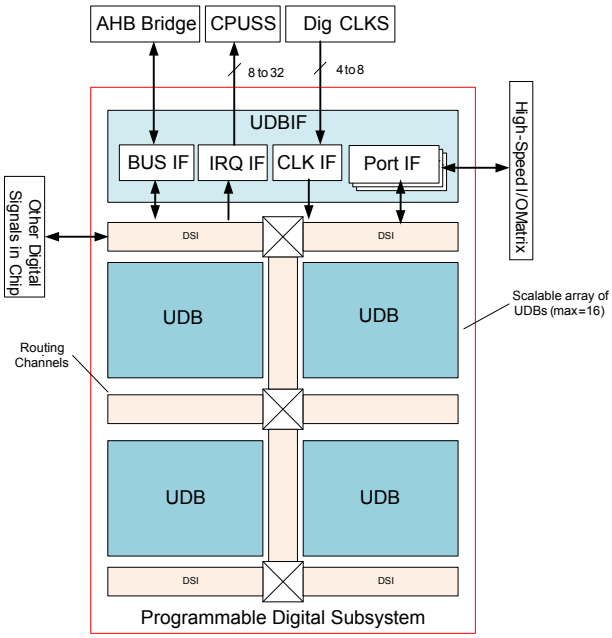
Programmable Digital

Universal Digital Blocks (UDBs) and Port Interfaces

The PSoC 4200DS has four UDBs; the UDB array also provides a switched Digital System Interconnect (DSI) fabric that allows signals from peripherals and ports to be routed to and through the UDBs for communication and control. The UDB array is shown in the following figure.

UDBs can be clocked from a clock divider block, from a port interface (required for peripherals such as SPI), and from the DSI network directly or after synchronization.

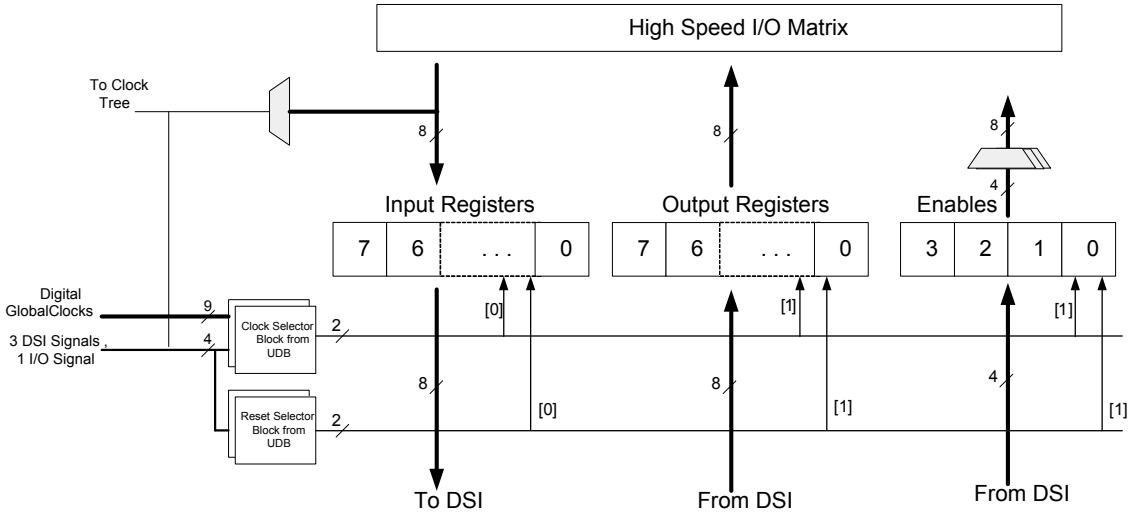
Figure 3. UDB Array



A port interface is defined, which acts as a register that can be clocked with the same source as the PLDs inside the UDB array. This allows faster operation because the inputs and outputs can be registered at the port interface close to the I/O pins and at the edge of the array. The port interface registers can be clocked by one of the I/Os from the same port. This allows interfaces such as SPI to operate at higher clock speeds by eliminating the delay for the port input to be routed over DSI and used to register other inputs. The port interface is shown in Figure 4.

The UDBs can generate interrupts (one UDB at a time) to the interrupt controller. The UDBs retain the ability to connect to any pin on the chip through the DSI.

Figure 4. Port Interface



Fixed Function Digital

Timer/Counter/PWM (TCPWM) Block

The TCPWM block uses a16-bit counter 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. The PSoC 4200D has four TCPWM blocks.

Serial Communication Blocks (SCB)

The PSoC 4200D has three SCBs, which can each implement an I^2C, UART, or SPI interface.

I^2C Mode: The hardware I^2C 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. It also supports EzI^2C that creates a mailbox address range in the memory of the PSoC 4200D and effectively reduces I^2C communication to reading from and writing to an array in memory. In addition, the block supports an 8-deep FIFO for receive and transmit which, by increasing the time given for the CPU to read data, greatly reduces the need for clock stretching caused by the CPU not having read data on time. The FIFO mode is available in all channels and is very useful in the absence of DMA.

The I^2C peripheral is compatible with the I^2C Standard-mode, Fast-mode, and Fast-mode Plus devices as defined in the NXP I^2C-bus specification and user manual (UM10204). The I^2C bus I/O is implemented with GPIO in open-drain modes.

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. Note that hardware handshaking is not supported. This is not commonly used and can be implemented with a UDB-based UART in the system, if required.

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 to buffer transfers.

GPIO

The PSoC 4200DS has 21 GPIOs in the 25-ball CSP package. The GPIO block implements the following:

- Eight drive strength modes including strong push-pull, resistive pull-up and pull-down, weak (resistive) pull-up and pull-down, open drain and open source, input only, and disabled
- Input threshold select (CMOS or LVTTL)
- Individual control of input and output disables
- Hold mode for latching previous state (used for retaining I/O state in Deep Sleep mode)
- Selectable slew rates for dV/dt related noise control to improve EMI

The pins are organized in logical entities called ports, which are 8-bit in width. During power-on and reset, the blocks are forced to the disable state so as not to crowbar any inputs and/or cause excess turn-on current. A multiplexing network known as a high-speed I/O matrix is used to multiplex between various signals that may connect to an I/O pin. Pin locations for fixed-function peripherals are also fixed to reduce internal multiplexing complexity (these signals do not go through the DSI network). DSI signals are not affected by this and any pin may be routed to any UDB through the DSI network.

Data output and pin state registers store, respectively, the values to be driven on the pins and the states of the pins themselves.

Every I/O pin can generate an interrupt if so enabled and each I/O port has an interrupt request (IRQ) and interrupt service routine (ISR) vector associated with it (4 for the PSoC 4200DS).

Pinouts

The following is the pin list for the PSoC 4200DS. Pins 16, 17, and 18 are No-Connects in the 28-pin SSOP package.

Table 1. PSoC 4200DS Pin Description

28-Pin SSOP		25-Ball CSP		Alternate Functions for Pins						Pin Description
Pin	Name	Pin	Name	Analog	PRGIO	Alt 1	Alt 2	Alt 3	Alt 4	
19	P0.0	E4	P0.0	lpcomp.in_p[0]		tcpwm.line[2]			scb[0].spi_select1	P0.0, LPC0, TCPWM2, SCB0
20	P0.1	E3	P0.1	lpcomp.in_n[0]		tcpwm.line_compl[2]			scb[0].spi_select2	P0.1, LPC0, TCPWM2, SCB0
21	P0.2	D3	P0.2			tcpwm.line[3]			scb[0].spi_select3	P0.2, TCPWM3, SCB0
22	P0.4	E2	P0.4				scb[1].uart_rx	scb[1].i2c_scl	scb[1].spi_mosi	P0.4, SCB1
23	P0.5	C4	P0.5				scb[1].uart_tx	scb[1].i2c_sda	scb[1].spi_miso	P0.5, SCB1
24	P0.6	C3	P0.6			ext_clk	scb[1].uart_cts		scb[1].spi_clk	P0.6, Ext Clock, SCB1
25	XRES	D2	XRES							XRES
26	VCCD	E1	VCCD							Regulator Output
28	VSSD	D1	VSSD							Power Supply
27	VDDD	C1	VDDD							Ground
1	P1.0	C2	P1.0			tcpwm.line[2]	scb[0].uart_rx	scb[0].i2c_scl	scb[0].spi_mosi	P1.0, TCPWM2, SCB0
2	P1.1	B2	P1.1			tcpwm.line_compl[2]	scb[0].uart_tx	scb[0].i2c_sda	scb[0].spi_miso	P1.1, TCPWM2, SCB0
3	P1.2	B1	P1.2			tcpwm.line[3]	scb[0].uart_cts		scb[0].spi_clk	P1.2, TCPWM3, SCB0
4	P1.3	A1	P1.3			tcpwm.line_compl[3]	scb[0].uart_rts		scb[0].spi_select0	P1.3, TCPWM3, SCB0
5	P2.2	B3	P2.2		prgio[0].io[2]		scb[2].uart_rx	scb[2].i2c_scl	scb[2].spi_mosi	P2.2, PRG, SCB2
6	P2.3	A2	P2.3		prgio[0].io[3]		scb[2].uart_tx	scb[2].i2c_sda	scb[2].spi_miso	P2.3, PRG. SCB2
7	P2.4	B4	P2.4		prgio[0].io[4]	tcpwm.line[0]	scb[2].uart_cts	lpcomp.comp[0]	scb[2].spi_clk	P2.4, PRG, TCPWM0, SCB2, LPC0
8	P2.5	A4	P2.5		prgio[0].io[5]	tcpwm.line_compl[0]	scb[2].uart_rts		scb[2].spi_select0	P2.5, PRG, TCPWM0, SCB2
9	P2.6	A3	P2.6		prgio[0].io[6]	tcpwm.line[1]			scb[2].spi_select1	P2.6, PRG, TCPWM1, SCB2
10	P2.7	A5	P2.7		prgio[0].io[7]	tcpwm.line_compl[1]			scb[2].spi_select2	P2.7, PRG, TCPWM1, SCB2

Table 1. PSoC 4200DS Pin Description *(continued)*

28-Pin SSOP		25-Ball CSP		Alternate Functions for Pins						Pin Description
Pin	Name	Pin	Name	Analog	PRGIO	Alt 1	Alt 2	Alt 3	Alt 4	
11	P3.0	D5	P3.0			tcpwm.line[0]	scb[1].uart_rx	scb[1].i2c_scl	scb[1].spi_mosi	P3.0, TCPWM0, SCB1
12	P3.1	C5	P3.1			tcpwm.line_compl[0]	scb[1].uart_tx	scb[1].i2c_sda	scb[1].spi_miso	P3.1, TCPWM0, SCB1
13	P3.2	E5	P3.2			tcpwm.line[1]	scb[1].uart_cts	swd_data	scb[1].spi_clk	P3.2, TCPWM1, SCB1, SWD_IO
14	P3.3	B5	P3.3			tcpwm.line_compl[1]	scb[1].uart_rts	swd_clk	scb[1].spi_select0	P3.3, TCPWM1, SCB1, SWD_CLK
15	P3.4	D4	P3.4						scb[1].spi_select1	P3.4, SCB1

Descriptions of the power pin functions are as follows:

VDDD: Power supply for the chip.

VSSD: Ground pin.

VCCD: Regulated digital supply (1.8 V ±5% if supplied externally).

Power

The supply voltage range is 1.71 to 5.5 V with all functions and circuits operating over that range.

The PSoC 4200DS family allows two distinct modes of power supply operation: Unregulated External Supply and Regulated External Supply modes.

Unregulated External Supply

In this mode, the PSoC 4200DS is powered by an External Power Supply that can be anywhere in the range of 1.8 to 5.5 V. This range is also designed for battery-powered operation, for instance, the chip can be powered from a battery system that starts at 3.5V and works down to 1.8 V. In this mode, the internal regulator of the PSoC 4200DS supplies the internal logic and the VCCD output of the PSoC 4200DS must be bypassed to ground via an external capacitor.

Bypass capacitors must be used from VDDD to ground, typical practice for systems in this frequency range is to use a capacitor in the 1 µF range in parallel with a smaller capacitor (0.1 µF, for example). Note that these are simply rules of thumb and that, for critical applications, the PCB layout, lead inductance, and the Bypass capacitor parasitic should be simulated to design and obtain optimal bypassing.

Power Supply	Typical Bypass Capacitors
VDDD–VSS	0.1-µF ceramic at each pin plus bulk capacitor 1 to 10 µF.
VCCD–VSS	0.1-µF ceramic capacitor at the VCCD pin

Regulated External Supply

In this mode, the PSoC 4200DS is powered by an external power supply that must be within the range of 1.71 to 1.89 V (1.8 ±5%); note that this range needs to include power supply ripple. In this mode, VCCD and VDDD pins are shorted together and bypassed. The internal regulator should be disabled in firmware.

Development Support

The PSoC 4200DS 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 4200DS 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.

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 4200DS 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.

Table 5. GPIO DC Specifications *(continued)*

Spec ID#	Parameter	Description	Min	Typ	Max	Units	Details/ Conditions
SID62	V_{OL}	Output voltage low level	–	–	0.6	V	I_{OL} = 8 mA at 3 V V_{DDD}
SID62A	V_{OL}	Output voltage low level	–	–	0.4	V	I_{OL} = 3 mA at 3 V V_{DDD}
SID63	R_{PULLUP}	Pull-up resistor	3.5	5.6	8.5	kΩ	
SID64	$R_{PULLDOWN}$	Pull-down resistor	3.5	5.6	8.5	kΩ	
SID65	I_{IL}	Input leakage current (absolute value)	–	–	2	nA	25 °C, V_{DDD} = 3.0 V
SID66	C_{IN}	Input capacitance	–	–	7	pF	
SID67	V_{HYSTTL}	Input hysteresis LVTTL	25	40	–	mV	$V_{DDD} \geq 2.7$ V
SID68	$V_{HYSCMOS}$	Input hysteresis CMOS	0.05 × V_{DDD}	–	–	mV	
SID69	I_{DIODE}	Current through protection diode to V_{DD}/Vss	–	–	100	µA	Guaranteed by characterization
SID69A	I_{TOT_GPIO}	Maximum Total Source or Sink Chip Current	–	–	200	mA	Guaranteed by characterization

Table 6. GPIO AC Specifications

(Guaranteed by Characterization)[3]

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_{DDD}, Cload = 25 pF
SID71	T_{FALLF}	Fall time in fast strong mode	2	–	12	ns	3.3 V V_{DDD}, Cload = 25 pF
SID72	T_{RISES}	Rise time in slow strong mode	10	–	60	ns	3.3 V V_{DDD}, Cload = 25 pF
SID73	T_{FALLS}	Fall time in slow strong mode	10	–	60	ns	3.3 V V_{DDD}, Cload = 25 pF
SID74	$F_{GPIOUT1}$	GPIO Fout;3.3 V ≤ V_{DDD} ≤ 5.5 V. Fast strong mode.	–	–	33	MHz	90/10%, 25 pF load, 60/40 duty cycle
SID75	$F_{GPIOUT2}$	GPIO Fout;1.7 V≤ V_{DDD}≤ 3.3 V. Fast strong mode.	–	–	16.7	MHz	90/10%, 25 pF load, 60/40 duty cycle
SID76	$F_{GPIOUT3}$	GPIO Fout;3.3 V ≤ V_{DDD} ≤ 5.5 V. Slow strong mode.	–	–	7	MHz	90/10%, 25 pF load, 60/40 duty cycle
SID245	$F_{GPIOUT4}$	GPIO Fout;1.7 V ≤ V_{DDD} ≤ 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 ≤ V_{DDD} ≤ 5.5 V	–	–	48	MHz	90/10% V_{IO}

Note
3. Simultaneous switching transitions on many fully-loaded GPIO pins may cause ground perturbations depending on several factors including PCB and decoupling capacitor design. For applications that are very sensitive to ground perturbations, the slower GPIO slew rate setting may be used.

Digital Peripherals

The following specifications apply to the Timer/Counter/PWM peripheral in timer mode.

Timer/Counter/PWM

Table 11. TCPWM Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.TCPWM.1	ITCPWM1	Block current consumption at 3 MHz	–	–	45	µA	All modes (Timer/Counter/PWM)
SID.TCPWM.2	ITCPWM2	Block current consumption at 12 MHz	–	–	155	µA	All modes (Timer/Counter/PWM)
SID.TCPWM.2A	ITCPWM3	Block current consumption at 48 MHz	–	–	650	µA	All modes (Timer/Counter/PWM)
SID.TCPWM.3	TCPWMFREQ	Operating frequency	–	–	Fc	MHz	Fc max = Fcpu. Maximum = 48 MHz
SID.TCPWM.4	TPWMENEXT	Input Trigger Pulse Width for all Trigger Events	2/Fc	–	–	ns	Trigger Events can be Stop, Start, Reload, Count, Capture, or Kill depending on which mode of operation is selected.
SID.TCPWM.5	TPWMEXT	Output Trigger Pulse widths	2/Fc	–	–	ns	Minimum possible width of Overflow, Underflow, and CC (Counter equals Compare value) trigger outputs
SID.TCPWM.5A	TCRES	Resolution of Counter	1/Fc	–	–	ns	Minimum time between successive counts
SID.TCPWM.5B	PWMRES	PWM Resolution	1/Fc	–	–	ns	Minimum pulse width of PWM Output
SID.TCPWM.5C	QRES	Quadrature inputs resolution	1/Fc	–	–	ns	Minimum pulse width between Quadrature phase inputs.

I^2C

Table 12. Fixed I^2C DC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID149	I_{I2C1}	Block current consumption at 100 kHz	–	–	50	µA	
SID150	I_{I2C2}	Block current consumption at 400 kHz	–	–	135	µA	
SID151	I_{I2C3}	Block current consumption at 1 Mbps	–	–	310	µA	
SID152	I_{I2C4}	I^2C enabled in Deep Sleep mode	–	–	1.4	µA	

Table 13. Fixed I^2C AC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID153	F_{I2C1}	Bit rate	–	–	1	Mbps	

Table 19. Fixed SPI Slave mode AC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units
SID170	T_{DMI}	MOSI valid before Sclock capturing edge	40	–	–	ns
SID171	T_{DSO}	MISO valid after Sclock driving edge	–	–	42 + 3 × (1/FCPU)	ns
SID171A	T_{DSO_ext}	MISO valid after Sclock driving edge in Ext. Clock mode	–	–	48	ns
SID172	T_{HSO}	Previous MISO data hold time	0	–	–	ns
SID172A	$T_{SSELSCK}$	SSEL Valid to first SCK Valid edge	100	–	–	ns

Memory

Table 20. Flash DC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID173	V_{PE}	Erase and program voltage	1.71	–	5.5	V	

Table 21. Flash AC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID174	$T_{ROWWRITE}$	Row (block) write time (erase and program)	–	–	20	ms	Row (block) = 256 bytes
SID175	$T_{ROWERASE}$	Row erase time	–	–	13	ms	
SID176	$T_{ROWPROGRAM}$	Row program time after erase	–	–	7	ms	
SID178	$T_{BULKERASE}$	Bulk erase time (64 KB)	–	–	35	ms	
SID180	$T_{DEVPROG}$	Total device program time	–	–	15	seconds	Guaranteed by characterization
SID181	F_{END}	Flash endurance	100 K	–	–	cycles	Guaranteed by characterization
SID182	F_{RET}	Flash retention. $T_A \leq 55$ °C, 100 K P/E cycles	20	–	–	years	Guaranteed by characterization
SID182A		Flash retention. $T_A \leq 85$ °C, 10 K P/E cycles	10	–	–	years	Guaranteed by characterization

System Resources

Power-on-Reset and Brown-out Detect (BOD) Specifications

Table 22. Power On Reset

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.CLK#6	SR_POWER_UP	Power supply slew rate	1	–	67	V/ms	At power-up
SID185	$V_{RISEIPOR}$	Rising trip voltage	0.80	–	1.45	V	Guaranteed by characterization
SID186	$V_{FALLIPOR}$	Falling trip voltage	0.75	–	1.4	V	Guaranteed by characterization
BID51	Twupo	Initialization after Power-On	–	–	3	ms	

Table 23. Brown-out Detect (BOD) for V_{CCD}

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID190	$V_{FALLPPOR}$	BOD trip voltage in active and sleep modes	1.48	-	1.62	V	Guaranteed by characterization
SID192	$V_{FALLDPSLP}$	BOD trip voltage in Deep Sleep	1.11	-	1.5	V	Guaranteed by characterization

SWD Interface

Table 24. SWD Interface Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID213	F_SWDCLK1	$3.3\ V \le V_{DD} \le 5.5\ V$	–	–	14	MHz	SWDCLK ≤ 1/3 CPU clock frequency
SID214	F_SWDCLK2	$1.71\ V \le V_{DD} \le 3.3\ V$	–	–	7	MHz	SWDCLK ≤ 1/3 CPU clock frequency
SID215	T_SWDI_SETUP	T = 1/f SWDCLK	0.25*T	–	–	ns	Guaranteed by characterization
SID216	T_SWDI_HOLD	T = 1/f SWDCLK	0.25*T	–	–	ns	Guaranteed by characterization
SID217	T_SWDO_VALID	T = 1/f SWDCLK	–	–	0.5*T	ns	Guaranteed by characterization
SID217A	T_SWDO_HOLD	T = 1/f SWDCLK	1	–	–	ns	Guaranteed by characterization

Internal Main Oscillator

Table 25. IMO DC Specifications

(Guaranteed by Design)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID218	I_{IMO1}	IMO operating current at 48 MHz	–	–	250	µA	
SID219	I_{IMO2}	IMO operating current at 24 MHz	–	–	180	µA	

Table 26. IMO AC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID223	$F_{IMOTOL1}$	Frequency variation	–	–	±2	%	
SID226	$T_{STARTIMO}$	IMO startup time	–	–	7	µs	
SID228	$T_{JITRMSIMO2}$	RMS Jitter at 24 MHz	–	145	–	ps	

Internal Low-Speed Oscillator

Table 27. ILO DC Specifications

(Guaranteed by Design)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID231	I_{ILO1}	ILO operating current	–	0.3	1.05	µA	Guaranteed by Characterization

Table 28. ILO AC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID234	$T_{STARTILO1}$	ILO startup time	–	–	2	ms	Guaranteed by characterization
SID236	$T_{ILODUTY}$	ILO duty cycle	40	50	60	%	Guaranteed by characterization
SID237	$F_{ILOTRIM1}$	Operating frequency	20	40	80	kHz	

Table 29. External Clock Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID305	ExtClkFreq	External clock input frequency	0	–	48	MHz	Guaranteed by characterization
SID306	ExtClkDuty	Duty cycle; Measured at $V_{DD/2}$	45	–	55	%	Guaranteed by characterization

Table 30. UDB AC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
Datapath performance							
SID249	$F_{MAX-TIMER}$	Max frequency of 16-bit timer in a UDB pair	–	–	48	MHz	
SID250	$F_{MAX-ADDER}$	Max frequency of 16-bit adder in a UDB pair	–	–	48	MHz	
SID251	F_{MAX_CRC}	Max frequency of 16-bit CRC/PRS in a UDB pair	–	–	48	MHz	
PLD Performance in UDB							
SID252	F_{MAX_PLD}	Max frequency of 2-pass PLD function in a UDB pair	–	–	48	MHz	
Clock to Output Performance							
SID253	$T_{CLK\_OUT\_UDB1}$	Prop. delay for clock in to data out at 25 °C, Typ.	–	15	–	ns	
SID254	$T_{CLK\_OUT\_UDB2}$	Prop. delay for clock in to data out, Worst case.	–	25	–	ns	

Table 31. Block Specs

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID256*	T_{WS48}*	Number of wait states at 48 MHz	2	–	–		CPU execution from Flash
SID257	T_{WS24}*	Number of wait states at 24 MHz	1	–	–		CPU execution from Flash
* Tws48 and Tws24 are guaranteed by Design							

Ordering Information

The PSoC 4200DS family part numbers and features are listed in the following table.

Table 32. PSoC 4200DS Ordering Information

Category	Marketing Part Number (MPN)	MAX. CPU Speed (MHz)	No. of DMA Channels	Flash (KB)	SRAM (KB)	Low-power Comparators	No. of Universal Digital Blocks (UDB)	Timer/Counter/PWM Blocks (TCPWM)	No. of Serial Communication Blocks (SCB)	PRGIO	No. of GPIOs	Package Type
4045	CY8C4045PVI-DS402	48	8	32	4	2	-	4	3	1	21	28-pin SSOP
	CY8C4045FNI-DS402	48	8	32	4	2	-	4	3	1	21	25-ball WLCSP
4245	CY8C4245PVI-DS402	48	8	32	4	2	4	4	3	1	21	28-pin SSOP
	CY8C4245FNI-DS402	48	8	32	4	2	4	4	3	1	21	25-ball WLCSP
4246	CY8C4246PVI-DS402	48	8	64	8	2	4	4	3	1	21	28-pin SSOP
	CY8C4246FNI-DS402	48	8	64	8	2	4	4	3	1	21	25-ball WLCSP

The nomenclature used in the preceding table is based on the following part numbering convention:

Field	Description	Values	Meaning
CY8C	Cypress Prefix		
4	Architecture	4	PSoC 4
A	Family	2	4200 Family
B	CPU Speed	4	48 MHz
C	Flash Capacity	5	32 KB
		6	64 KB
DE	Package Code	PV	SSOP
		FN	CSP
F	Temperature Range	I	Industrial
S	Silicon Family	D	PSoC 4D
XYZ	Attributes Code	000-999	Code of feature set in the specific family

Packaging

The description of the PSoC 4200D package dimensions follows.

Spec Id#	Package	Description	Package Dwg #
PKG_1	28-pin SSOP	28-pin SSOP, 8 mm × 10 mm × 2.0 mm height with 0.65-mm pitch	51-85079
PKG_2	25-ball CSP	25-ball CSP, 2.07 mm × 2.11 mm × 0.55 mm height with 0.4-mm pitch	001-97945

Table 33. Package Characteristics

Parameter	Description	Conditions	Min	Typ	Max	Units
T_A	Operating ambient temperature		–40	25	85	°C
T_J	Operating junction temperature		–40		100	°C
T_{JA}	Package θ_{JA} (28-pin SSOP)		–	67	–	°C/Watt
T_{JC}	Package θ_{JC} (28-pin SSOP)		–	26	–	°C/Watt
T_{JA}	Package θ_{JA} (25-ball CSP)		–	48	–	°C/Watt
T_{JC}	Package θ_{JC} (25-ball CSP)		–	0.47	–	°C/Watt

Table 34. Solder Reflow Peak Temperature

Package	Maximum Peak Temperature	Maximum Time at Peak Temperature
All packages	260 °C	30 seconds

Table 35. Package Moisture Sensitivity Level (MSL), IPC/JEDEC J-STD-2

Package	MSL
28-pin SSOP	MSL 3
25-ball CSP	MSL 1

Figure 5. 28-Pin SSOP Package Outline

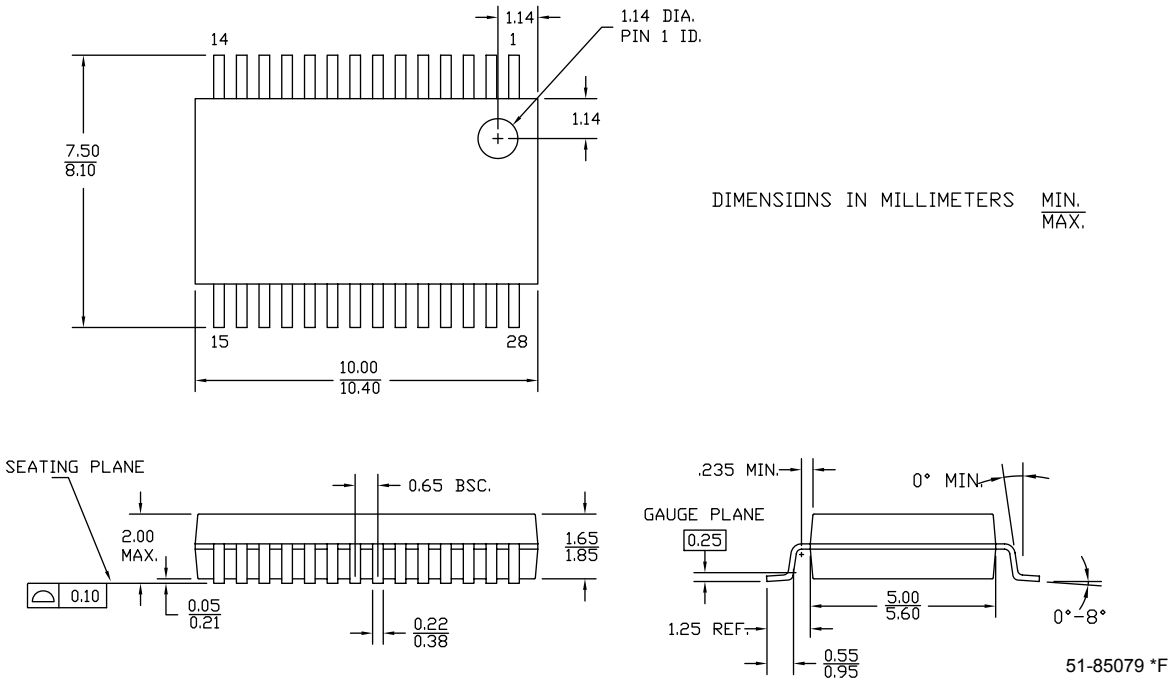
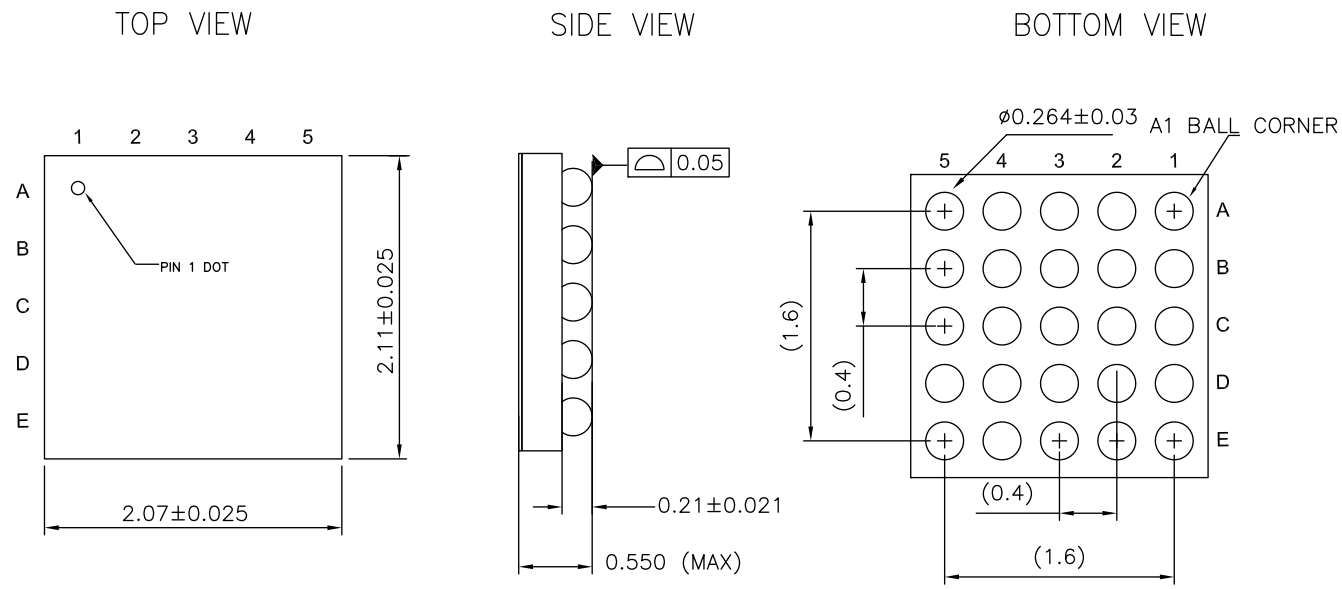


Figure 6. 25-ball CSP 2.07 × 2.11 × 0.55 mm



Note: 1. REFERENCE JEDEC PUBLICATION 95, DESIGN GUIDE 4.18
2. ALL DIMENSIONS ARE IN MILLIMETER

001-97945 **

Acronyms

Table 36. 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 36. 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^2C, 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
LVTTL	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
PC	program counter
PCB	printed circuit board

Table 36. Acronyms Used in this Document *(continued)*

Acronym	Description
PGA	programmable gain amplifier
PHUB	peripheral hub
PHY	physical layer
PICU	port interrupt control unit
PLA	programmable logic array
PLD	programmable logic device, see also PAL
PLL	phase-locked loop
PMDD	package material declaration data sheet
POR	power-on reset
PRES	precise power-on reset
PRS	pseudo random sequence
PS	port read data register
PSoC®	Programmable System-on-Chip™
PSRR	power supply rejection ratio
PWM	pulse-width modulator
RAM	random-access memory
RISC	reduced-instruction-set computing
RMS	root-mean-square
RTC	real-time clock
RTL	register transfer language
RTR	remote transmission request
RX	receive
SAR	successive approximation register
SC/CT	switched capacitor/continuous time
SCL	I^2C serial clock
SDA	I^2C serial data
S/H	sample and hold
SINAD	signal to noise and distortion ratio
SIO	special input/output, GPIO with advanced features. See GPIO.
SOC	start of conversion
SOF	start of frame
SPI	Serial Peripheral Interface, a communications protocol
SR	slew rate
SRAM	static random access memory
SRES	software reset
SWD	serial wire debug, a test protocol
SWV	single-wire viewer
TD	transaction descriptor, see also DMA

Table 36. Acronyms Used in this Document *(continued)*

Acronym	Description
THD	total harmonic distortion
TIA	transimpedance amplifier
TRM	technical reference manual
TTL	transistor-transistor logic
TX	transmit
UART	Universal Asynchronous Transmitter Receiver, a communications protocol
UDB	universal digital block
USB	Universal Serial Bus
USBIO	USB input/output, PSoC pins used to connect to a USB port
VDAC	voltage DAC, see also DAC, IDAC
WDT	watchdog timer
WOL	write once latch, see also NVL
WRES	watchdog timer reset
XRES	external reset I/O pin
XTAL	crystal

Document Conventions

Units of Measure

Table 37. 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 4200DS Family Datasheet Programmable System-on-Chip (PSoC®) Document Number: 001-98044				
Revision	**ECN**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	4795389	WKA	06/23/2015	New datasheet
*A	4931127	WKA	09/23/2015	Removed 28-pin SSOP package. Updated Pinouts. Updated DC Specifications. Removed SID85A, SID247A, SID259, and SID92. Added BID51.
*B	4958966	WKA	10/12/2015	Updated package dimensions. Updated bulk erase time to 64 KB. Changed SID226 max to 7. Updated T_{JA} typ to 48 and T_{JC} typ to 0.47.
*C	5759255	WKA	05/31/2017	Added 28-pin SSOP package. Updated to new template.
*D	5825921	WKA	07/20/2017	Updated Document Title to read as “PSoC® 4: PSoC 4200DS Family Datasheet Programmable System-on-Chip (PSoC®)”. Replaced “PSoC 4200D” with “PSoC 4200DS” in all instances across the document.

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