Features

32-bit MCU subsystem

- 48 MHz Arm® Cortex®-M0 CPU with single-cycle multiply
- Up to 128 kB of flash with Read Accelerator
- Up to 16 kB of SRAM
- DMA engine

Programmable analog

- Four opamps that operate in Deep Sleep mode at very low current levels
- All opamps have reconfigurable high current pin-drive, high-bandwidth internal drive, ADC input buffering, and Comparator modes with flexible connectivity allowing input connections to any pin
- Four current DACs (IDACs) for general-purpose or capacitive sensing applications on any pin
- Two low-power comparators that operate in Deep Sleep mode
- 12-bit SAR ADC with 1-Msps conversion rate

Programmable digital

- Four programmable logic blocks, each with 8 Macrocells and an 8-bit data path (called universal digital blocks or UDBs)
- Cypress-provided peripheral component library, user-defined state machines, and Verilog input

Low-power 1.71 to 5.5 V operation

- 20-nA Stop Mode with GPIO pin wakeup
- Hibernate and Deep Sleep modes allow wakeup-time vs power trade-offs

Capacitive sensing

- Infineon Capacitive Sigma-Delta (CSD) technique provides best-in-class SNR (>5:1) and water tolerance
- Infineon-supplied software component makes capacitive sensing design easy
- Automatic hardware tuning (SmartSense)

Segment LCD drive

- LCD drive supported on all pins (common or segment)
- Operates in Deep Sleep mode with 4 bits per pin memory

Serial communication

- Four independent run-time reconfigurable serial communication blocks (SCBs) with reconfigurable I2C, SPI, or UART functionality
- Two independent CAN blocks for industrial and automotive networking

Timing and pulse-width modulation

- Eight 16-bit timer/counter pulse-width modulator (TCPWM) blocks
- Center-aligned, Edge, and Pseudo-random modes
- Comparator-based triggering of Kill signals for motor drive and other high-reliability digital logic applications

Package options

- 68-pin QFN, 64-pin TQFP wide and narrow pitch, and 48-pin and 44-pin TQFP packages
- Up to 55 programmable GPIOs
- GPIO pins can be CAPSENSE™, LCD, analog, or digital
- Drive modes, strengths, and slew rates are programmable

Extended industrial temperature operation

- –40°C to +105°C operation

PSoC™ Creator design environment

- Integrated Development Environment (IDE) provides schematic design entry and build (with analog and digital automatic routing)
- Applications Programming Interface (API component) for all fixed-function and programmable peripherals

Industry-standard tool compatibility

- After schematic entry, development can be done with Arm®-based industry-standard development tools

Description

PSoC™ 4 is a scalable and reconfigurable platform architecture for a family of programmable embedded system controllers with an Arm® Cortex®-M0 CPU. It combines programmable and reconfigurable analog and digital blocks with flexible automatic routing. Based on this platform architecture, PSoC™ 4200M is a combination of a microcontroller with digital programmable logic, programmable analog, programmable interconnect, high-performance analog-to-digital conversion, opamps with comparator mode, and standard communication and timing peripherals. The PSoC™ 4200M products will be fully compatible with members of the PSoC™ 4 platform for new applications and design needs. The programmable analog and digital subsystems allow flexibility and in-field tuning of the design.

Table of contents

1 Development ecosystem

1.1 PSoC™ 4 resources

Infineon provides a wealth of data at www.infineon.com to help you select the right PSoC™ device and quickly and effectively integrate it into your design. The following is an abbreviated, hyperlinked list of resources for PSoC™ 4 MCU:

- Overview: PSoC™ portfolio.
- Product selector: PSoC™ 4 MCU
- Application Notes cover a broad range of topics, from basic to advanced level, and include the following:
  - AN79953: Getting Started with PSoC™ 4
  - AN88619: PSoC™ Hardware Design Considerations.
  - AN73854: PSoC™ - Introduction to Bootloaders
  - AN89610: Arm® Cortex® Code Optimization
  - AN86233: PSoC™ 4 MCU Power Reduction Techniques
  - AN57821: Mixed Signal Circuit Board Layout.
  - AN85951: PSoC™ 4 and PSoC™ 6 MCU CapSense Design Guide.
- Code Examples demonstrate product features and usage, and are also available on GitHub repositories
- Technical reference manuals (TRM) provide detailed descriptions of architecture and registers in each device family.
- PSoC™ 4 MCU Programming Specification provides the information necessary to program PSoC™ 4 MCU non-volatile memory.
- Development Tools
  - PSoC™ Creator is a free Windows-based IDE. It enables concurrent hardware and firmware design of PSoC™ 3, PSoC™ 4, PSoC™ 5LP, and PSoC™ 6 MCU based systems. Applications are created using schematic capture and over 150 preverified, production-ready peripheral Components
  - CY8CKIT-044 is a PSoC™ 4 Pioneer kits that is easy-to-use and an inexpensive development platforms. These include connectors for Arduino-compatible shields and Digilent Pmod daughter cards.
  - CY8CKIT-043 is a very low-cost prototyping platform for sampling PSoC™ 4200M device.
  - MiniProg4 and MiniProg3 all-in-one development programmers and debuggers.
  - PSoC™ 4 MCU CAD libraries provide footprint and schematic support for common tools. IBIS models are also available.
- Training videos are available on a wide range of topics including the PSoC™ MCUs.
- Infineon Developer Community enables connection with fellow PSoC™ developers around the world, 24 hours a day, 7 days a week, and hosts a dedicated PSoC™ 4 MCU community.

1.2 PSoC™ Creator

PSoC™ Creator is a free Windows-based Integrated Design Environment (IDE). It enables you to design hardware and firmware systems concurrently, based on PSoC™ 4 MCU. As Figure 1 shows, with PSoC™ Creator you can:

1. Explore the library of 200+ components.
2. Drag and drop component icons to complete your hardware system design in the main design workspace.
3. Configure Components using the Component configuration tools and the Component datasheets.
4. Co-design your application firmware and hardware in the PSoC™ Creator IDE or build a project for a third-party IDE.
5. Prototype your solution with the PSoC™ 4 Pioneer kits. If a design change is needed, PSoC™ Creator and Components enable you to make changes on-the-fly without the need for hardware revisions.

For information on Infineon tools, refer to the documentation delivered with PSoC™ Creator software, and AN79953: Getting started with PSoC™ 4.

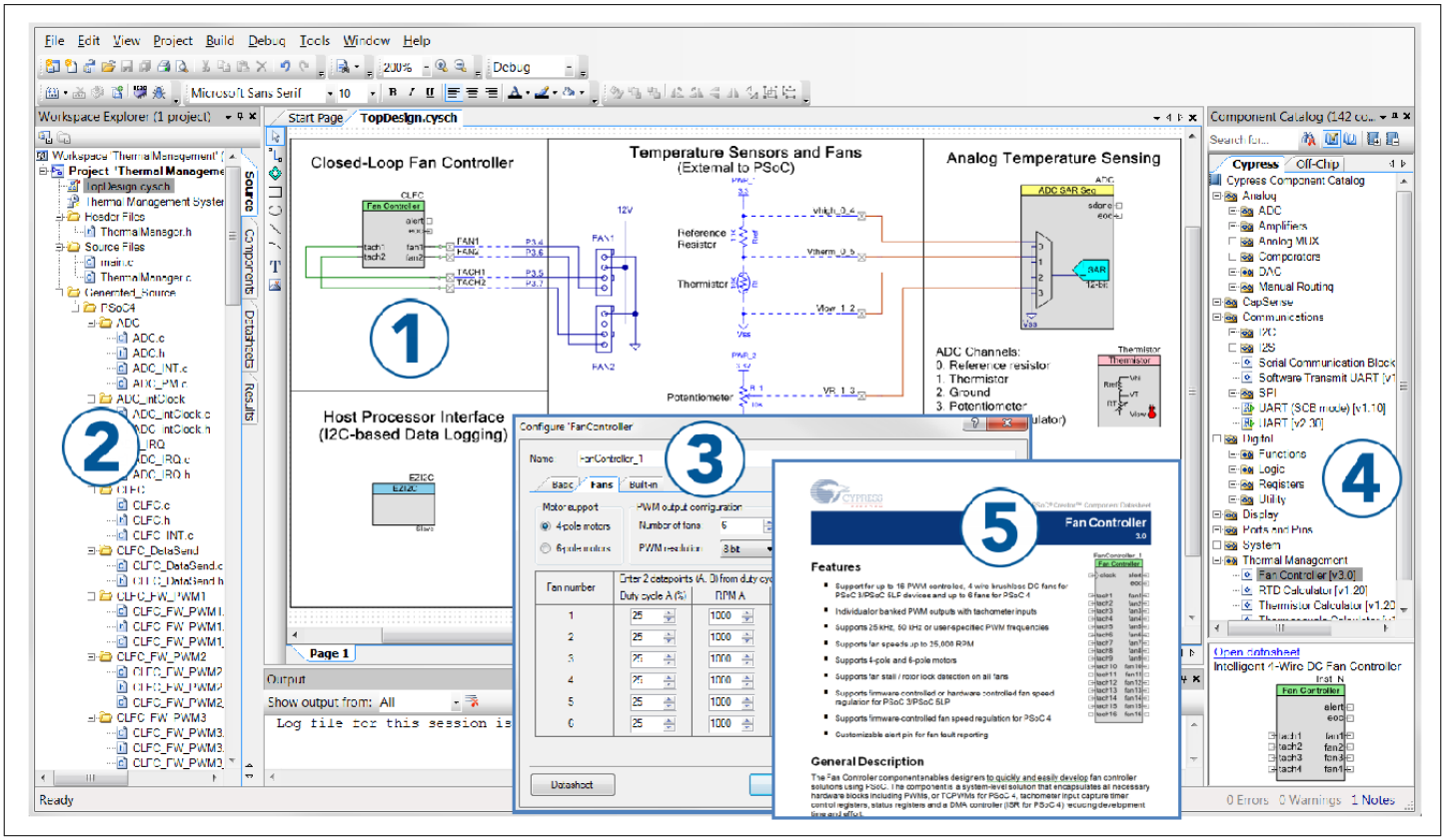


Figure 1 Multiple-sensor example project in PSoC™ Creator

2 Block diagram

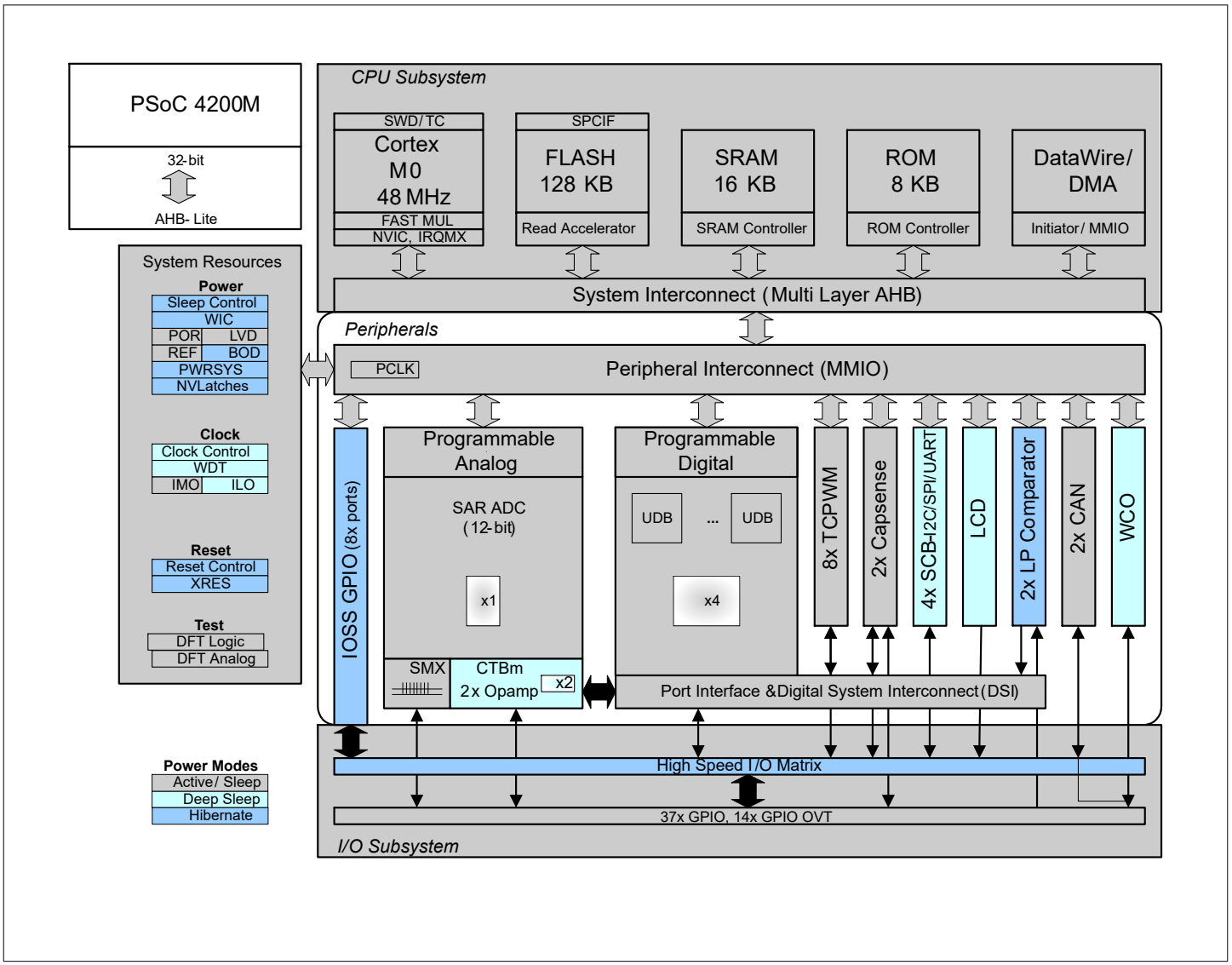


Figure 2 Block diagram

The PSoC™ 4200M 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 IDE provides fully-integrated programming and debug support for PSoC™ 4200M devices. The SWD interface is fully compatible with industry-standard third-party tools. PSoC™ 4200M provides a level of security not possible with multichip 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 the 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™ 4200M with device security enabled may not be returned for failure analysis. This is a trade-off the PSoC™ 4200M allows the customer to make.

3 Functional definition

3.1 CPU and memory subsystem

3.1.1 CPU

The Cortex®-M0 CPU in the PSoC™ 4200M is part of the 32-bit MCU subsystem, which is optimized for low-power operation with an extensive clock gating. Most instructions are 16 bits in length and execute a subset of the Thumb-2 instruction set. The Infineon 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 the Deep Sleep mode allowing power to be switched off to the main processor when the chip is in the Deep Sleep mode. The Cortex®-M0 CPU provides a Non-Maskable Interrupt (NMI) input, 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 2-wire form of JTAG; the debug configuration used for PSoC™ 4200M has four break-point (address) comparators and two watchpoint (data) comparators.

3.1.2 Flash

The PSoC™ 4200M has a flash module with a flash accelerator, tightly coupled to the CPU to improve average access times from the flash block. The flash accelerator delivers 85% of single-cycle SRAM access performance on average. Part of the flash module can be used to emulate EEPROM operation if required.

3.1.3 SRAM

The SRAM memory is retained during Hibernate.

3.1.4 SROM

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

3.1.5 DMA

A DMA engine, with eight channels, is provided that can do 32-bit transfers and has chainable ping-pong descriptors.

3.2 System resources

3.2.1 Power system

The power system is described in detail in the section Power. It provides assurance that voltage levels are as required for each respective mode and either delay mode entry (for example, on power-on reset (POR)) until voltage levels are as required for proper function or generate resets (brownout detect (BOD)) or interrupts (low voltage detect (LVD)). The PSoC™ 4200M operates with a single external supply over the range of 1.71 to 5.5 V and has five different power modes, transitions between which are managed by the power system. The PSoC™ 4200M provides Sleep, Deep Sleep, Hibernate, and Stop low-power modes.

3.2.2 Clock system

The PSoC™ 4200M 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 meta-stable conditions occur.

The clock system for the PSoC™ 4200M consists of a Watch Crystal Oscillator (WCO) running at 32 kHz, the IMO (3 to 48 MHz) and the ILO (32-kHz nominal) internal oscillators, and provision for an external clock.

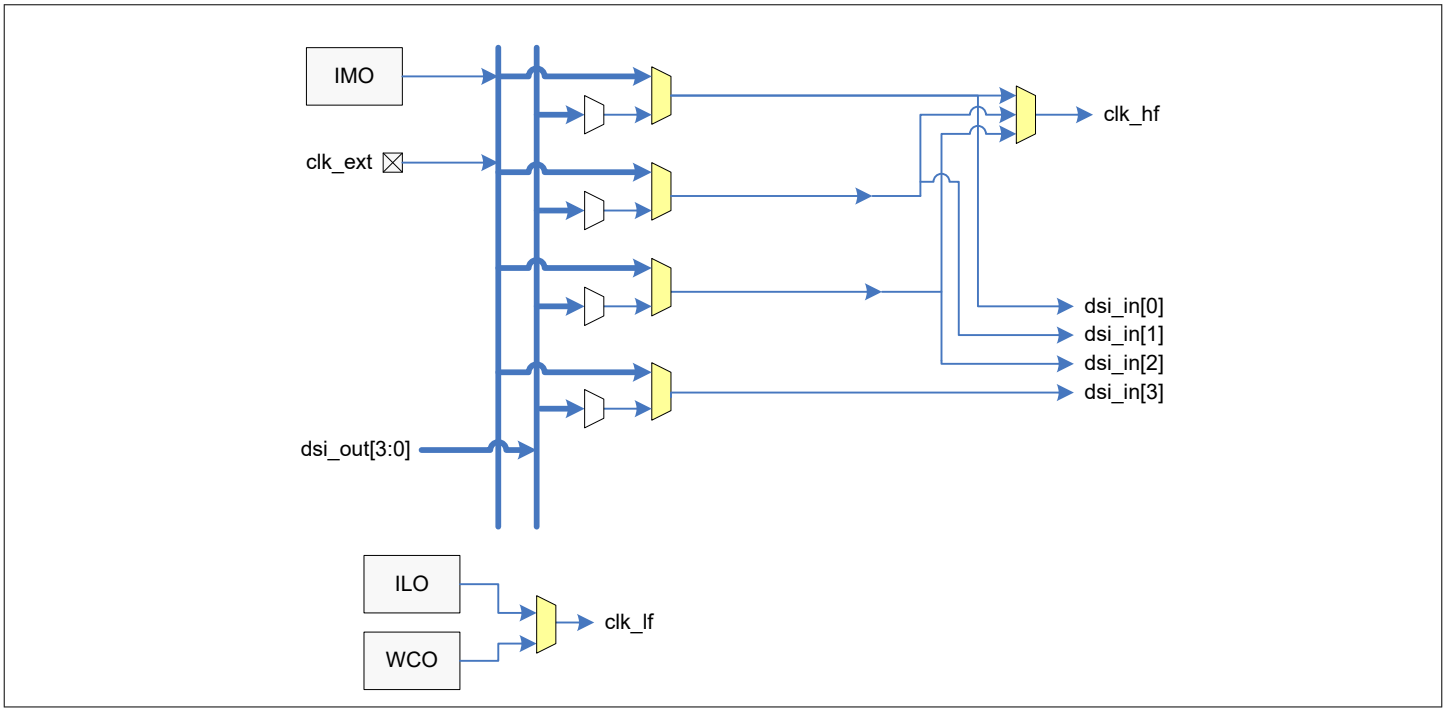


Figure 3 PSoC™ 4200M MCU clocking architecture

The clk_hf signal can be divided down to generate synchronous clocks for the UDBs, and the analog and digital peripherals. There are a total of 16 clock dividers for the PSoC™ 4200M, each with 16-bit divide capability; this allows 12 to be used for the fixed-function blocks and four for the UDBs. 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.

3.2.3 IMO clock source

The IMO is the primary source of internal clocking in the PSoC™ 4200M. It is trimmed during testing to achieve the specified accuracy. Trim values are stored in non-volatile memory. Trimming can also be done on the fly to allow in-field calibration. The IMO default frequency is 24 MHz and it can be adjusted between 3 to 48 MHz in steps of 1 MHz. The IMO tolerance with Infineon-provided calibration settings is ±2%.

3.2.4 ILO clock source

The ILO is a very low-power oscillator, nominally 32 kHz, which is primarily used to generate clocks for peripheral operation in Deep Sleep mode. The ILO-driven counters can be calibrated to the IMO to improve accuracy. Infineon provides a software component, which does the calibration.

3.2.5 Crystal oscillator

The PSoC™ 4200M clock subsystem also includes a low-frequency crystal oscillator (32-kHz WCO) that is available during the Deep Sleep mode and can be used for Real-Time Clock (RTC) and Watchdog Timer applications.

3.2.6 Watchdog timer

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

3.2.7 Reset

The PSoC™ 4200M can be reset from a variety of sources including a software reset. The 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.

3.2.8 Voltage reference

The PSoC™ 4200M 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 add an external bypass capacitor to the internal reference using a GPIO pin or to use an external reference for the SAR.

3.3 Analog blocks

3.3.1 12-bit SAR ADC

The 12-bit 1 MSample/second SAR ADC can operate at a maximum clock rate of 18 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 ±1%) and by providing the choice 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. The system performance will be 65 dB for true 12-bit precision if 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 (expandable to 16 inputs). The sequencer cycles through selected channels autonomously (sequencer scan) and does so with zero switching overhead (that is, the aggregate sampling bandwidth is equal to 1 Msps, 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. In addition, the 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 to 5.5 V.

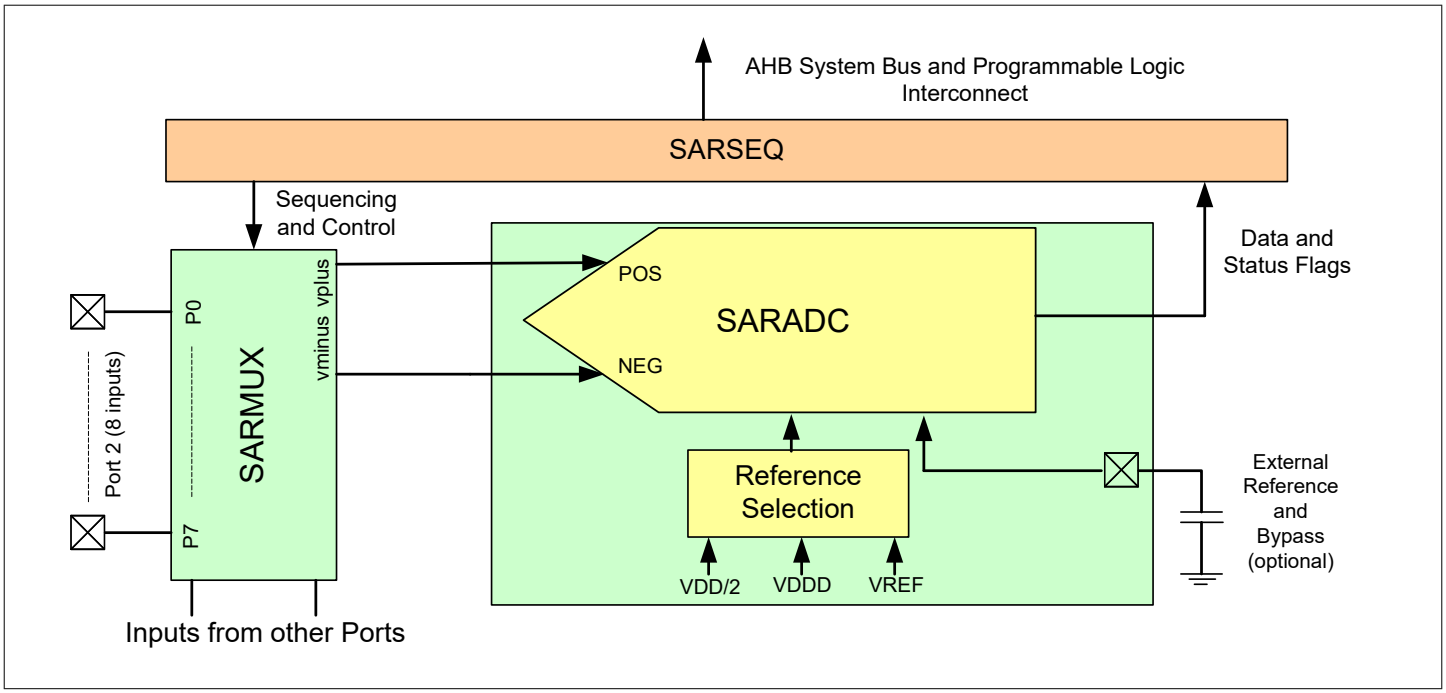


Figure 4 SAR ADC system diagram

3.3.2 Analog multiplex bus

The PSoC™ 4200M has two concentric analog buses (Analog Mux Bus A and Analog Mux Bus B) that circumnavigate the periphery of the chip. These buses can transport analog signals from any pin to various analog blocks (including the opamps) and to the CAPSENSE™ blocks allowing, for instance, the ADC to monitor any pin on the chip. These buses are independent and can also be split into three independent sections. This allows one section to be used for CAPSENSE™ purposes, one for general analog signal processing, and the third for general-purpose digital peripherals and GPIO.

3.3.3 Four opamps

The PSoC™ 4200M has four 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 Sample-and-Hold circuit of the ADC without requiring external buffering. The opamps can operate in the Deep Sleep mode at very low power levels. The following diagram shows one of two identical opamp pairs of the opamp subsystem.

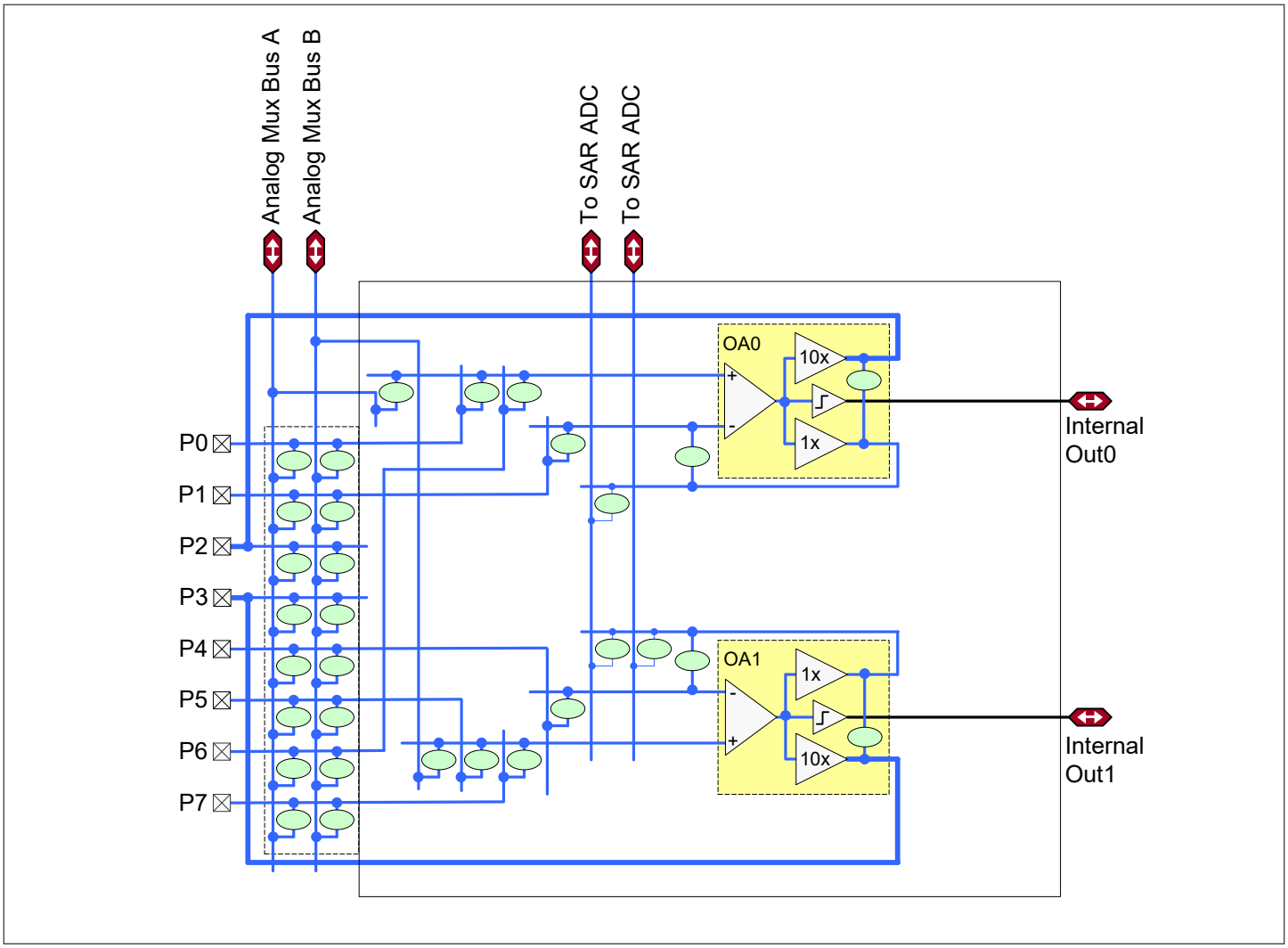


Figure 5 Identical opamp pairs in opamp subsystem

The ovals in Figure 5 represent analog switches, which may be controlled via user firmware, the SAR sequencer, or user-defined programmable logic. The opamps (OA0 and OA1) are programmable and reconfigurable to provide standard opamp functionality via switchable feedback components, unity gain functionality for driving pins directly, or for internal use (such as buffering SAR ADC inputs as indicated in the diagram), or as true comparators.

The opamp inputs provide highly flexible connectivity and can connect directly to dedicated pins or, via the analog mux buses, to any pin on the chip. Analog switch connectivity is controllable by user firmware as well as user-defined programmable digital state machines (implemented via UDBs).

The opamps operate in Deep Sleep mode at very low currents allowing analog circuits to remain operational during Deep Sleep.

3.3.4 Temperature sensor

The PSoC™ 4200M 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 Infineon-supplied software that includes calibration and linearization.

3.3.5 Low-power comparators

The PSoC™ 4200M 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 meta-stability unless operating in an asynchronous power mode (Hibernate) where the system wake-up circuit is activated by a comparator switch event.

3.4 Programmable digital

3.4.1 Universal digital blocks (UDBs) and port interfaces

The PSoC™ 4200M 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.

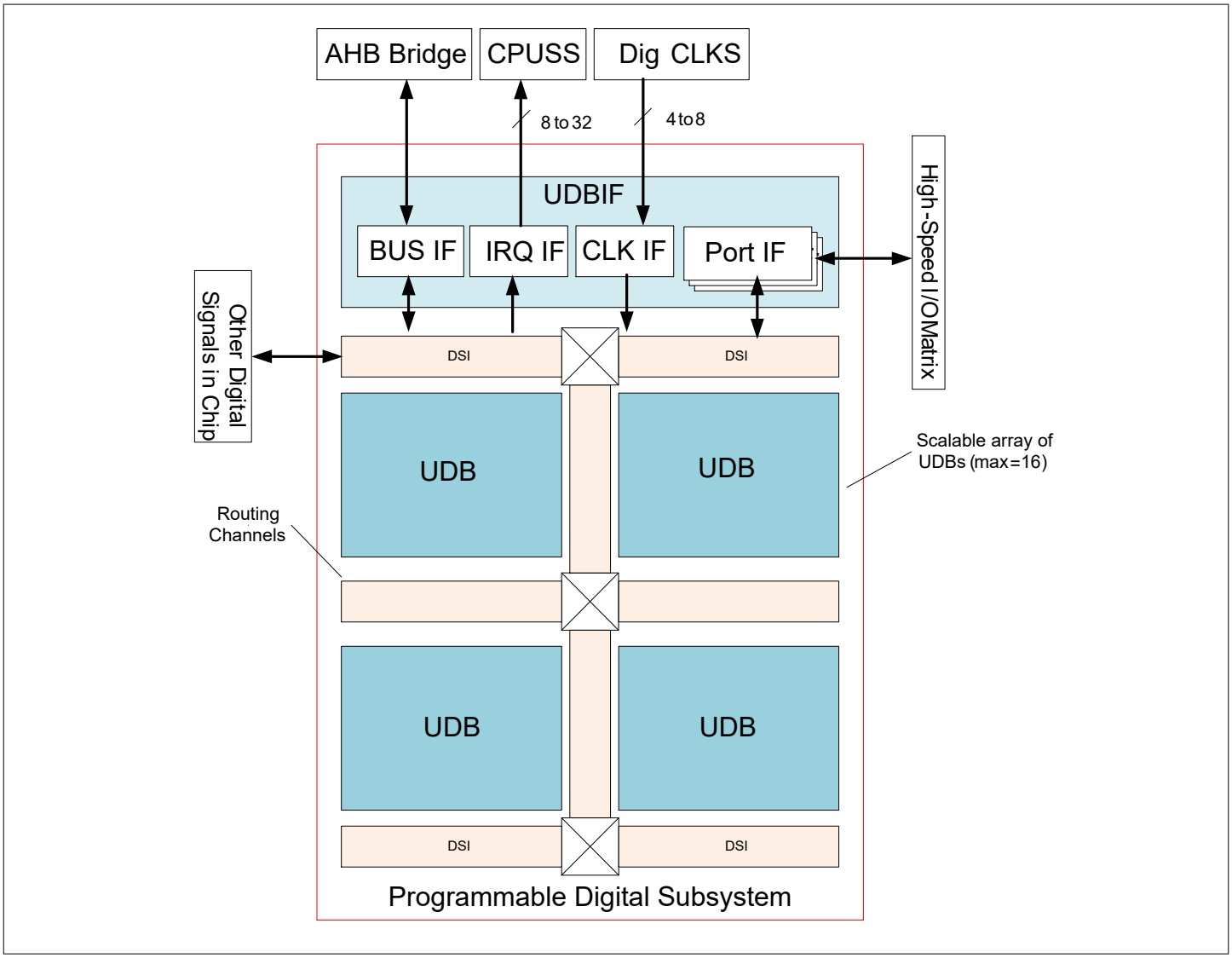


Figure 6 UDB array

The 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.

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 7.

The UDBs can generate interrupts (one UDB at a time) to the interrupt controller. The UDBs can connect to any pin on Ports 0, 1, 2, and 3 (each port interconnect requires one UDB) through the DSI.

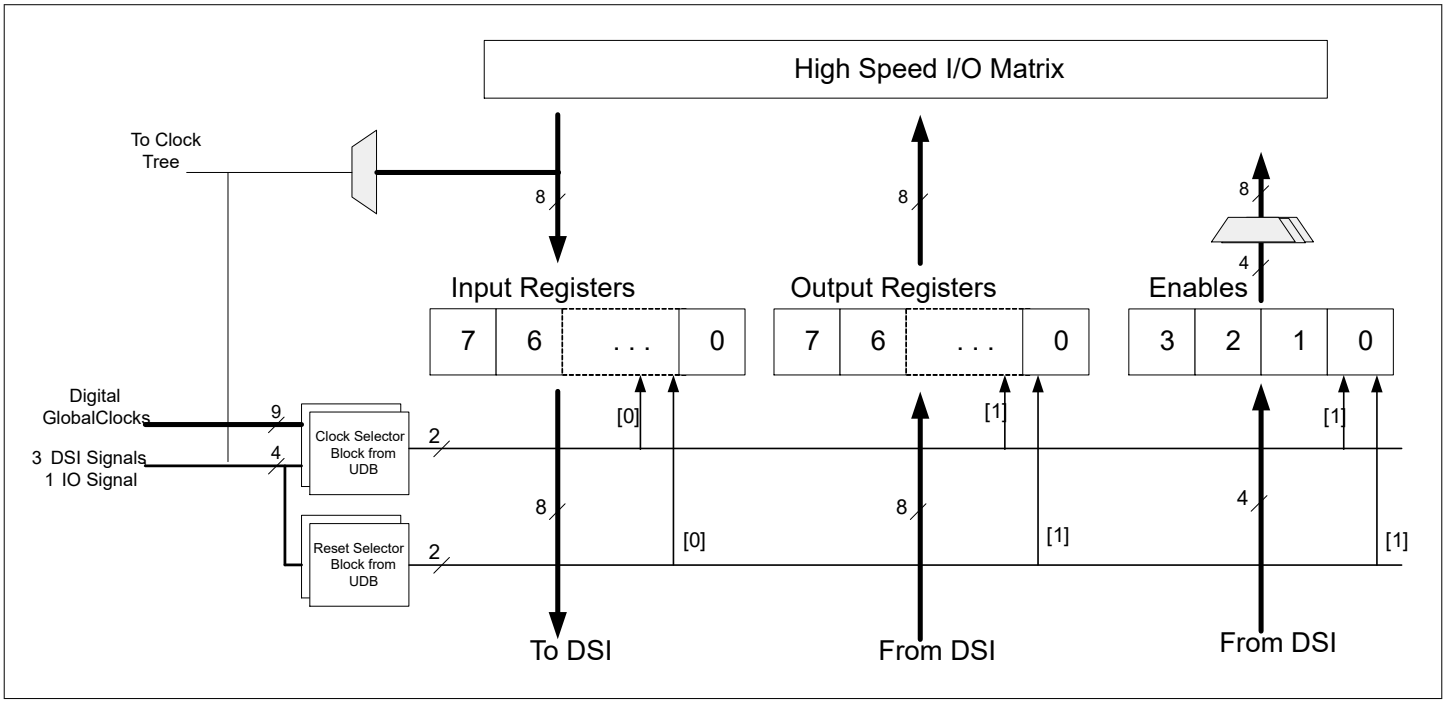


Figure 7 Port interface

3.5 Fixed function digital

3.5.1 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™ 4200M has eight TCPWM blocks.

3.5.2 Serial communication blocks (SCB)

The PSoC™ 4200M has four 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™ 4200M 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.

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 and also supports an EzSPI mode in which data interchange is reduced to reading and writing an array in memory.

3.5.3 CAN blocks

There are two independent CAN 2.0B blocks, which are certified CAN conformant.

3.6 GPIO

The PSoC™ 4200M has 55 GPIOs in the 68-pin QFN 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 and Hibernate modes)
- 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 on Ports 0, 1, 2, and 3 may be routed to any UDB through the DSI network. Only pins on Ports 0, 1, 2, and 3 may be routed through DSI signals.

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 (8 for PSoC™ 4200M).

The Pins of Port 6 (up to 6 depending on the package) are overvoltage tolerant (V_{IN} can exceed V_{DD}). The overvoltage cells will not sink more than 10 µA when their inputs exceed V_{DDIO} in compliance with I^2C specifications.

3.7 Special function peripherals

3.7.1 LCD segment drive

The PSoC™ 4200M has an LCD controller, which can drive up to eight commons and up to 49 segments. Any pin can be either a common or a segment pin. It uses full digital methods to drive the LCD segments requiring no generation of internal LCD voltages. The two methods used are referred to as digital correlation and PWM.

Digital correlation pertains to modulating the frequency and levels of the common and segment signals to generate the highest RMS voltage across a segment to light it up or to keep the RMS signal zero. This method is good for STN displays but may result in reduced contrast with TN (cheaper) displays.

PWM pertains to driving the panel with PWM signals to effectively use the capacitance of the panel to provide the integration of the modulated pulse-width to generate the desired LCD voltage. This method results in higher power consumption but can result in better results when driving TN displays.

3.7.2 CAPSENSE™

CAPSENSE™ is supported on all pins in the PSoC™ 4200M through a Capacitive Sigma-Delta (CSD) block that can be connected to any pin through an analog mux bus that any GPIO pin can be connected to via an Analog switch. CAPSENSE™ functionality can thus be provided on any pin or group of pins in a system under software control. A component is provided for the CAPSENSE™ block, which provides automatic hardware tuning (Infineon SmartSense), to make it easy for the user.

Shield voltage can be driven on another Mux Bus to provide water tolerance capability. Water tolerance is provided by driving the shield electrode in phase with the sense electrode to keep the shield capacitance from attenuating the sensed input.

Each CSD block has two IDACs which can be used for general purposes if CAPSENSE™ is not being used.(both IDACs are available in that case) or if CAPSENSE™ is used without water tolerance (one IDAC is available). The PSoC™ 4200M has two CSD blocks which can be used independently; one for CAPSENSE™ and one providing two IDACs.

The two CAPSENSE™ blocks are referred to as CSD0 and CSD1. Capacitance sensing inputs on Ports 0, 1, 2, 3, 4, 6, and 7 are sensed by CSD0. Capacitance sensing inputs on Port 5 are sensed by CSD1.

4 Pinouts

The following is the pin list for the PSoC™ 4200M. This shows the power supply and port pins (for example, P0.0 is Pin 0 of Port 0).

68-QFN		64-TQFP		48-TQFP		44-TQFP	
Pin	**Name**	**Pin**	**Name**	**Pin**	**Name**	**Pin**	**Name**
42	P0.0	39	P0.0	28	P0.0	24	P0.0
43	P0.1	40	P0.1	29	P0.1	25	P0.1
44	P0.2	41	P0.2	30	P0.2	26	P0.2
45	P0.3	42	P0.3	31	P0.3	27	P0.3
46	P0.4	43	P0.4	32	P0.4	28	P0.4
47	P0.5	44	P0.5	33	P0.5	29	P0.5
48	P0.6	45	P0.6	34	P0.6	30	P0.6
49	P0.7	46	P0.7	35	P0.7	31	P0.7
50	XRES	47	XRES	36	XRES	32	XRES
51	VCCD	48	VCCD	37	VCCD	33	VCCD
52	VSSD	49	VSSD	38	VSSD	–	–
53	VDDD	50	VDDD	39	VDDD	34	VDDD
–	–	–	–	40	VDDA	35	VDDA
62	P1.0	58	P1.0	42	P1.0	37	P1.0
63	P1.1	59	P1.1	43	P1.1	38	P1.1
64	P1.2	60	P1.2	44	P1.2	39	P1.2
65	P1.3	61	P1.3	45	P1.3	40	P1.3
66	P1.4	62	P1.4	46	P1.4	41	P1.4
67	P1.5	63	P1.5	47	P1.5	42	P1.5
68	P1.6	64	P1.6	48	P1.6	43	P1.6
1	P1.7/VREF	1	P1.7/VREF	1	P1.7/VREF	44	P1.7/VREF
–	–	–	–	–	–	1	VSSD
2	P2.0	2	P2.0	2	P2.0	2	P2.0
3	P2.1	3	P2.1	3	P2.1	3	P2.1
4	P2.2	4	P2.2	4	P2.2	4	P2.2
5	P2.3	5	P2.3	5	P2.3	5	P2.3
6	P2.4	6	P2.4	6	P2.4	6	P2.4
7	P2.5	7	P2.5	7	P2.5	7	P2.5
8	P2.6	8	P2.6	8	P2.6	8	P2.6
9	P2.7	9	P2.7	9	P2.7	9	P2.7
10	VSSA	10	VSSA	10	VSSD	10	VSSD
11	VDDA	11	VDDA	–	–	–	–

68-QFN		64-TQFP		48-TQFP		44-TQFP	
Pin	Name	Pin	Name	Pin	Name	Pin	Name
19	P3.0	18	P3.0	12	P3.0	11	P3.0
20	P3.1	19	P3.1	13	P3.1	12	P3.1
21	P3.2	20	P3.2	14	P3.2	13	P3.2
22	P3.3	21	P3.3	16	P3.3	14	P3.3
23	P3.4	22	P3.4	17	P3.4	15	P3.4
24	P3.5	23	P3.5	18	P3.5	16	P3.5
25	P3.6	24	P3.6	19	P3.6	17	P3.6
26	P3.7	25	P3.7	20	P3.7	18	P3.7
27	VDDIO	26	VDDIO	21	VDDIO	19	VDDD
28	P4.0	27	P4.0	22	P4.0	20	P4.0
29	P4.1	28	P4.1	23	P4.1	21	P4.1
30	P4.2	29	P4.2	24	P4.2	22	P4.2
31	P4.3	30	P4.3	25	P4.3	23	P4.3
32	P4.4	31	P4.4	–	–	–	–
33	P4.5	32	P4.5	–	–	–	–
34	P4.6	33	P4.6	–	–	–	–
35	P4.7	–	–	–	–	–	–
54	P5.0	51	P5.0	–	–	–	–
55	P5.1	52	P5.1	–	–	–	–
56	P5.2	53	P5.2	–	–	–	–
57	P5.3	54	P5.3	–	–	–	–
58	P5.4	–	–	–	–	–	–
59	P5.5	55	P5.5	–	–	–	–
60	VDDA	56	VDDA	40	VDDA	35	VDDA
61	VSSA	57	VSSA	41	VSSA	36	VSSA
12	P6.0	12	P6.0	–	–	–	–
13	P6.1	13	P6.1	–	–	–	–
14	P6.2	14	P6.2	–	–	–	–
15	P6.3	–	–	–	–	–	–
16	P6.4	15	P6.4	–	–	–	–
17	P6.5	16	P6.5	–	–	–	–
18	VSSIO	17	VSSIO	10	VSSD	10	VSSD
39	P7.0	37	P7.0	26	P7.0	–	–
40	P7.1	38	P7.1	27	P7.1	–	–

68-QFN		64-TQFP		48-TQFP		44-TQFP	
Pin	Name	Pin	Name	Pin	Name	Pin	Name
41	P7.2	–	–	–	–	–	–

The pins of Port 6 are overvoltage-tolerant. Pins 36, 37, and 38 are No-Connects on the 68-pin QFN. Pins 34, 35, and 36 are No-Connects on the 64-pin TQFP. Pins 11 and 15 are No-connects in the 48-pin TQFP. All VSS pins must be tied together.

The output drivers of I/O Ports P0 and P7 are connected to VDDD. Output drivers of I/O Ports 1, 2, and 5 are connected to VDDA. Output drivers of I/O Ports 3, 4, and 6 are connected to VDDIO.

Each of the pins shown in the previous table can have multiple programmable functions as shown in the following table. Column headings refer to Analog and Alternate pin functions.

Port/ Pin	Analog	Alt. Function 1	Alt. Function 2	Alt. Function 3	Alt. Function 4	Alt. Function 5
P0.0	lpcomp.in_p[0]	–	–	can[1].can_rx:0	–	scb[0].spi_select 1:0
P0.1	lpcomp.in_n[0]	–	–	can[1].can_tx:0	–	scb[0].spi_select 2:0
P0.2	lpcomp.in_p[1]	–	–	–	–	scb[0].spi_select 3:0
P0.3	lpcomp.in_n[1]	–	–	–	–	–
P0.4	wco_in	–	scb[1].uart_rx:0	–	scb[1].i2c_scl:0	scb[1].spi_mosi: 1
P0.5	wco_out	–	scb[1].uart_tx:0	–	scb[1].i2c_sda:0	scb[1].spi_miso: 1
P0.6	–	ext_clk:0	scb[1].uart_cts:0	–	–	scb[1].spi_clk:1
P0.7	–	–	scb[1].uart_rts:0	can[1].can_tx_enb_n:0	wakeup	scb[1].spi_select 0:1
P5.0	ctb1.oa0.inp	tcpwm.line[4]	scb[2].uart_rx:0	–	scb[2].i2c_scl:0	scb[2].spi_mosi: 0
P5.1	ctb1.oa0.inm	tcpwm.line_compl[4]	scb[2].uart_tx:0	–	scb[2].i2c_sda:0	scb[2].spi_miso: 0
P5.2	ctb1.oa0.out	tcpwm.line[5]	scb[2].uart_cts:0	–	lpcomp.comp[0]:1	scb[2].spi_clk:0
P5.3	ctb1.oa1.out	tcpwm.line_compl[5]	scb[2].uart_rts:0	–	lpcomp.comp[1]:1	scb[2].spi_select 0:0
P5.4	ctb1.oa1.inm	tcpwm.line[6]	–	–	–	scb[2].spi_select 1:0
P5.5	ctb1.oa1.inp	tcpwm.line_compl[6]	–	–	–	scb[2].spi_select 2:0
P5.6	ctb1.oa0.inp_alt	tcpwm.line[7]	–	–	–	scb[2].spi_select 3:0
P5.7	ctb1.oa1.inp_alt	tcpwm.line_compl[7]	–	–	–	–

Port/ Pin	Analog	Alt. Function 1	Alt. Function 2	Alt. Function 3	Alt. Function 4	Alt. Function 5
P1.0	ctb0.oa0.inp	tcpwm.line[2]	scb[0].uart_rx:1	–	scb[0].i2c_scl:0	scb[0].spi_mosi:1
P1.1	ctb0.oa0.inm	tcpwm.line_compl[2]	scb[0].uart_tx:1	–	scb[0].i2c_sda:0	scb[0].spi_miso:1
P1.2	ctb0.oa0.out	tcpwm.line[3]	scb[0].uart_cts:1	–	–	scb[0].spi_clk:1
P1.3	ctb0.oa1.out	tcpwm.line_compl[3]	scb[0].uart_rts:1	–	–	scb[0].spi_select0:1
P1.4	ctb0.oa1.inm	tcpwm.line[6]	–	–	–	scb[0].spi_select1:1
P1.5	ctb0.oa1.inp	tcpwm.line_compl[6]	–	–	–	scb[0].spi_select2:1
P1.6	ctb0.oa0.inp_alt	tcpwm.line[7]	–	–	–	scb[0].spi_select3:1
P1.7	ctb0.oa1.inp_alt	tcpwm.line_compl[7]	–	–	–	–
P2.0	sarmux.0	tcpwm.line[4]	–	–	scb[1].i2c_scl:1	scb[1].spi_mosi:2
P2.1	sarmux.1	tcpwm.line_compl[4]	–	–	scb[1].i2c_sda:1	scb[1].spi_miso:2
P2.2	sarmux.2	tcpwm.line[5]	–	–	–	scb[1].spi_clk:2
P2.3	sarmux.3	tcpwm.line_compl[5]	–	–	–	scb[1].spi_select0:2
P2.4	sarmux.4	tcpwm.line[0]	–	–	–	scb[1].spi_select1:1
P2.5	sarmux.5	tcpwm.line_compl[0]	–	–	–	scb[1].spi_select2:1
P2.6	sarmux.6	tcpwm.line[1]	–	–	–	scb[1].spi_select3:1
P2.7	sarmux.7	tcpwm.line_compl[1]	–	–	–	scb[3].spi_select0:1
P6.0	–	tcpwm.line[4]	scb[3].uart_rx:0	can[0].can_tx_enb_n:0	scb[3].i2c_scl:0	scb[3].spi_mosi:0
P6.1	–	tcpwm.line_compl[4]	scb[3].uart_tx:0	can[0].can_rx:0	scb[3].i2c_sda:0	scb[3].spi_miso:0
P6.2	–	tcpwm.line[5]	scb[3].uart_cts:0	can[0].can_tx:0	–	scb[3].spi_clk:0
P6.3	–	tcpwm.line_compl[5]	scb[3].uart_rts:0	–	–	scb[3].spi_select0:0
P6.4	–	tcpwm.line[6]	–	–	–	scb[3].spi_select1:0

Port/ Pin	Analog	Alt. Function 1	Alt. Function 2	Alt. Function 3	Alt. Function 4	Alt. Function 5
P6.5	–	tcpwm.line_compl[6]	–	–	–	scb[3].spi_select2:0
P3.0	–	tcpwm.line[0]	scb[1].uart_rx:1	–	scb[1].i2c_scl:2	scb[1].spi_mosi:0
P3.1	–	tcpwm.line_compl[0]	scb[1].uart_tx:1	–	scb[1].i2c_sda:2	scb[1].spi_miso:0
P3.2	–	tcpwm.line[1]	scb[1].uart_cts:1	–	swd_data	scb[1].spi_clk:0
P3.3	–	tcpwm.line_compl[1]	scb[1].uart_rts:1	–	swd_clk	scb[1].spi_select0:0
P3.4	–	tcpwm.line[2]	–	–	–	scb[1].spi_select1:0
P3.5	–	tcpwm.line_compl[2]	–	–	–	scb[1].spi_select2:0
P3.6	–	tcpwm.line[3]	–	–	–	scb[1].spi_select3:0
P3.7	–	tcpwm.line_compl[3]	–	–	–	–
P4.0	–	–	scb[0].uart_rx:0	can[0].can_rx:1	scb[0].i2c_scl:1	scb[0].spi_mosi:0
P4.1	–	–	scb[0].uart_tx:0	can[0].can_tx:1	scb[0].i2c_sda:1	scb[0].spi_miso:0
P4.2	csd[0].c_mod	–	scb[0].uart_cts:0	can[0].can_tx_enb_n:1	lpcomp.comp[0]:0	scb[0].spi_clk:0
P4.3	csd[0].c_sh_tank	–	scb[0].uart_rts:0	–	lpcomp.comp[1]:0	scb[0].spi_select0:0
P4.4	–	–	–	can[1].can_tx_enb_n:1	–	scb[0].spi_select1:2
P4.5	–	–	–	can[1].can_rx:1	–	scb[0].spi_select2:2
P4.6	–	–	–	can[1].can_tx:1	–	scb[0].spi_select3:2
P4.7	–	–	–	–	–	–
P7.0	–	tcpwm.line[0]	scb[3].uart_rx:1	–	scb[3].i2c_scl:1	scb[3].spi_mosi:1
P7.1	–	tcpwm.line_compl[0]	scb[3].uart_tx:1	–	scb[3].i2c_sda:1	scb[3].spi_miso:1
P7.2	–	tcpwm.line[1]	scb[3].uart_cts:1	–	–	scb[3].spi_clk:1

Descriptions of the power pin functions are as follows:

VDDD: Power supply for both analog and digital sections (where there is no V_{DDA} pin).

VDDA: Analog V_{DD} pin where package pins allow; shorted to V_{DDD} otherwise.

VDDIO: I/O pin power domain.

VSSA: Analog ground pin where package pins allow; shorted to VSS otherwise

VSS: Ground pin.

VCCD: Regulated Digital supply (1.8 V ±5%).

Port Pins can all be used as LCD Commons, LCD Segment drivers, or CSD sense and shield pins can be connected to AMUXBUS A or B or can all be used as GPIO pins that can be driven by firmware or DSI signals.

5 Power

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

PSoC™ 4200M allows two distinct modes of power supply operation: Unregulated External Supply and Regulated External Supply modes.

5.1 Unregulated external supply

In this mode, the PSoC™ 4200M 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™ 4200M supplies the internal logic and the VCCD output of the PSoC™ 4200M must be bypassed to ground via an external Capacitor (in the range of 1 to 1.6 µF; X5R ceramic or better).

The grounds, VSSA and VSS, must be shorted together. Bypass capacitors must be used from VDDD and VDDA 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	Bypass Capacitors
VDDD–VSS and VDDIO-VSS	0.1 µF ceramic at each pin plus bulk capacitor 1 to 10 µF
VDDA–VSSA	0.1 µF ceramic at pin. Additional 1 µF to 10 µF bulk capacitor
VCCD–VSS	1 µF ceramic capacitor at the VCCD pin
VREF–VSSA (optional)	The internal bandgap may be bypassed with a 1 µF to 10 µF capacitor for better ADC performance

5.2 Regulated external supply

In this mode, the PSoC™ 4200M 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. VCCD and VDDD pins are shorted together and bypassed. The internal regulator is disabled in firmware.

6 Electrical specifications

6.1 Absolute maximum ratings

Table 1 Absolute maximum ratings

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID1	V_{DD_ABS}	Analog or digital supply relative to V_{SS} ($V_{SSD} = V_{SSA}$)	–0.5	–	6	V	Absolute maximum
SID2	V_{CCD_ABS}	Direct digital core voltage input relative to V_{SSD}	–0.5	–	1.95	V	Absolute maximum
SID3	V_{GPIO_ABS}	GPIO voltage; V_{DDD} or V_{DDA}	–0.5	–	V_{DD}+0.5	V	Absolute maximum
SID4	I_{GPIO_ABS}	Current per GPIO	–25	–	25	mA	Absolute maximum
SID5	$I_{G\text{-}PIO\_injection}$	GPIO injection current per pin	–0.5	–	0.5	mA	Absolute maximum
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	–140	–	140	mA	–

***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.*

6.2 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	Unit	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	–

(table continues...)

Table 2 (continued) DC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID55	C_{EFC}	External Regulator voltage bypass	1	1.3	1.6	µF	X5R ceramic or better
SID56	C_{EXC}	Power supply decoupling capacitor	–	1	–	µF	X5R ceramic or better
Active Mode, VDD = 1.71 V to 5.5 V, –40°C to +105°C							
SID6	I_{DD1}	Execute from Flash; CPU at 6 MHz	–	2.2	2.8	mA	–
SID7	I_{DD2}	Execute from Flash; CPU at 12 MHz	–	3.7	4.2	mA	–
SID8	I_{DD3}	Execute from Flash; CPU at 24 MHz	–	6.7	7.2	mA	–
SID9	I_{DD4}	Execute from Flash; CPU at 48 MHz	–	13	13.8	mA	–
Sleep Mode, –40°C to +105°C							
SID21	I_{DD16}	I^2C wakeup, WDT, and Comparators on. Regulator Off	–	1.75	2.1	mA	V_{DD} = 1.71 to 1.89, 6 MHz
SID22	I_{DD17}	I^2C wakeup, WDT, and Comparators on	–	1.7	2.1	mA	V_{DD} = 1.8 to 5.5, 6 MHz
SID23	I_{DD18}	I^2C wakeup, WDT, and Comparators on. Regulator Off	–	2.35	2.8	mA	V_{DD} = 1.71 to 1.89, 12 MHz
SID24	I_{DD19}	I^2C wakeup, WDT, and Comparators on	–	2.25	2.8	mA	V_{DD} = 1.8 to 5.5, 12 MHz
Deep Sleep Mode, –40°C to + 60°C							
SID30	I_{DD25}	I^2C wakeup and WDT on. Regulator Off	–	1.55	20	µA	V_{DD} = 1.71 to 1.89
SID31	I_{DD26}	I^2C wakeup and WDT on	–	1.35	15	µA	V_{DD} = 1.8 to 3.6
SID32	I_{DD27}	I^2C wakeup and WDT on	–	1.5	15	µA	V_{DD} = 3.6 to 5.5
Deep Sleep Mode, +85°C							
SID33	I_{DD28}	I^2C wakeup and WDT on. Regulator Off	–	–	60	µA	V_{DD} = 1.71 to 1.89
SID34	I_{DD29}	I^2C wakeup and WDT on	–	–	45	µA	V_{DD} = 1.8 to 3.6
SID35	I_{DD30}	I^2C wakeup and WDT on	–	–	30	µA	V_{DD} = 3.6 to 5.5
Deep Sleep Mode, +105°C							
SID33Q	I_{DD28Q}	I^2C wakeup and WDT on. Regulator Off	–	–	135	µA	V_{DD} = 1.71 to 1.89
SID34Q	I_{DD29Q}	I^2C wakeup and WDT on	–	–	180	µA	V_{DD} = 1.8 to 3.6
SID35Q	I_{DD30Q}	I^2C wakeup and WDT on	–	–	140	µA	V_{DD} = 3.6 to 5.5
Hibernate Mode, –40°C to + 60°C							
SID39	I_{DD34}	Regulator Off	–	150	3000	nA	V_{DD} = 1.71 to 1.89

(table continues...)

Table 2 (continued) DC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID40	I_{DD35}	–	–	150	1000	nA	V_{DD} = 1.8 to 3.6
SID41	I_{DD36}	–	–	150	1100	nA	V_{DD} = 3.6 to 5.5
Hibernate Mode, +85°C							
SID42	I_{DD37}	Regulator Off	–	–	4500	nA	V_{DD} = 1.71 to 1.89
SID43	I_{DD38}	–	–	–	3500	nA	V_{DD} = 1.8 to 3.6
SID44	I_{DD39}	–	–	–	3500	nA	V_{DD} = 3.6 to 5.5
Hibernate Mode, +105°C							
SID42Q	I_{DD37Q}	Regulator Off	–	–	19.4	µA	V_{DD} = 1.71 to 1.89
SID43Q	I_{DD38Q}	–	–	–	17	µA	V_{DD} = 1.8 to 3.6
SID44Q	I_{DD39Q}	–	–	–	16	µA	V_{DD} = 3.6 to 5.5
Stop Mode							
SID304	I_{DD43A}	Stop Mode current; V_{DD} = 3.6 V	–	35	85	nA	T = –40°C to +60°C
SID304A	I_{DD43B}	Stop Mode current; V_{DD} = 3.6 V	–	–	1450	nA	T = +85°C
Stop Mode, +105°C							
SID304Q	I_{DD43AQ}	Stop Mode current; V_{DD} = 3.6 V	–	–	5645	nA	–
XRES current							
SID307	I_{DD_XR}	Supply current while XRES asserted	–	2	5	mA	–

Table 3 AC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID48	F_{CPU}	CPU frequency	DC	–	48	MHz	$1.71 \le V_{DD} \le 5.5$
SID49[1)]	T_{SLEEP}	Wakeup from sleep mode	–	0	–	µs	–
SID50[1)]	$T_{DEEPSLEEP}$	Wakeup from Deep Sleep mode	–	–	25	µs	24 MHz IMO
SID51[1)]	$T_{HIBERNATE}$	Wakeup from Hibernate mode	–	–	0.7	ms	–
SID51A[1)]	T_{STOP}	Wakeup from Stop mode	–	–	2	ms	–
SID52[1)]	$T_{RESETWIDTH}$	External reset pulse width	1	–	–	µs	–

1) Guaranteed by characterization.

6.2.1 GPIO

Table 4 GPIO DC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID57	V_{IH} [1]	Input voltage high threshold	0.7 × V_{DDD}	–	–	V	CMOS Input
SID57A	IIHS	Input current when Pad > V_{DDIO} for OVT inputs	–	–	10	µA	Per I^2C Spec
SID58	V_{IL}	Input voltage low threshold	–	–	0.3 × V_{DDD}	V	CMOS Input
SID241	V_{IH} [1]	LVTTL input, V_{DDD} < 2.7 V	0.7× V_{DDD}	–	–	V	–
SID242	V_{IL}	LVTTL input, V_{DDD} < 2.7 V	–	–	0.3 × V_{DDD}	V	–
SID243	V_{IH} [1]	LVTTL input, V_{DDD} ≥ 2.7 V	2.0	–	–	V	–
SID244	V_{IL}	LVTTL input, V_{DDD} ≥ 2.7 V	–	–	0.8	V	–
SID59	V_{OH}	Output voltage high level	V_{DDD} –0.6	–	–	V	I_{OH} = 4 mA, V_{DDD} ≥ 3 V
SID60	V_{OH}	Output voltage high level	V_{DDD} –0.5	–	–	V	I_{OH} = 1 mA at 1.8-V V_{DDD}
SID61	V_{OL}	Output voltage low level	–	–	0.6	V	I_{OL} = 4 mA at 1.8-V V_{DDD}
SID62	V_{OL}	Output voltage low level	–	–	0.6	V	I_{OL} = 8 mA, V_{DDD} ≥ 3 V
SID62A	V_{OL}	Output voltage low level	–	–	0.4	V	I_{OL} = 3 mA, V_{DDD} ≥ 3 V
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 [2]	I_{IL}	Input leakage current (absolute value)	–	–	2	nA	25 °C, V_{DDD} = 3.0 V
SID65A [2]	I_{IL_CTBM}	Input leakage current (absolute value) for CTBM pins	–	–	4	nA	–
SID66	C_{IN}	Input capacitance	–	–	7	pF	–
SID67	V_{HYSTTL}	Input hysteresis LVTTL	25	40	–	mV	V_{DDD} ≥ 2.7 V
SID68	$V_{HYSCMOS}$	Input hysteresis CMOS	0.05 × V_{DDD}	–	–	mV	–
SID69 [2]	I_{DIODE}	Current through protection diode to V_{DD}/Vss	–	–	100	µA	–
SID69A [2]	I_{TOT_GPIO}	Maximum Total Source or Sink Chip Current	–	–	200	mA	–

1) V_{IH} must not exceed V_{DDD} + 0.2 V.
2) Guaranteed by characterization.

Table 5 GPIO AC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	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**: 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.*

6.2.2 XRES

Table 6 XRES DC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID77	V_{IH}	Input voltage high threshold	0.7 × V_{DDD}	–	–	V	CMOS Input
SID78	V_{IL}	Input voltage low threshold	–	–	0.3 × V_{DDD}	V	CMOS Input
SID79	R_{PULLUP}	Pull-up resistor	3.5	5.6	8.5	kΩ	–
SID80	C_{IN}	Input capacitance	–	3	–	pF	–
SID81[1)]	$V_{HYSXRES}$	Input voltage hysteresis	–	100	–	mV	–
SID82[1)]	I_{DIODE}	Current through protection diode to V_{DDD}/V_{SS}	–	–	100	µA	–

1) Guaranteed by characterization.

Table 7 XRES AC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID83[1)]	$T_{RESETWIDTH}$	Reset pulse width	1	–	–	µs	–

1) Guaranteed by characterization.

6.3 Analog peripherals

6.3.1 Opamp

Table 8 Opamp specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details/ conditions
–	I_{DD}	Opamp block current. No load	–	–	–	–	–
SID269	I_{DD_HI}	Power = high	–	1100	1850	µA	–
SID270	I_{DD_MED}	Power = medium	–	550	950	µA	–
SID271	I_{DD_LOW}	Power = low	–	150	350	µA	–
–	GBW	Load = 20 pF, 0.1 mA. V_{DDA} = 2.7 V	–	–	–	–	–
SID272	GBW_HI	Power = high	6	–	–	MHz	–
SID273	GBW_MED	Power = medium	4	–	–	MHz	–
SID274	GBW_LO	Power = low	–	1	–	MHz	–
–	I_{OUT_MAX}	$V_{DDA} \geq 2.7$ V, 500 mV from rail	–	–	–	–	–
SID275	$I_{OUT\_MAX\_HI}$	Power = high	10	–	–	mA	–
SID276	$I_{OUT\_MAX\_MID}$	Power = medium	10	–	–	mA	–
SID277	$I_{OUT\_MAX\_LO}$	Power = low	–	5	–	mA	–
–	I_{OUT}	V_{DDA} = 1.71 V, 500 mV from rail	–	–	–	–	–
SID278	$I_{OUT\_MAX\_HI}$	Power = high	4	–	–	mA	–

(table continues...)

Table 8 (continued) Opamp specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details/ conditions
SID279	$I_{OUT\_MAX\_MID}$	Power = medium	4	–	–	mA	–
SID280	$I_{OUT\_MAX\_LO}$	Power = low	–	2	–	mA	–
SID281	V_{IN}	Input voltage range	–0.05	–	VDDA – 0.2	V	Charge-pump on, $V_{DDA} \geq 2.7$ V
SID282	V_{CM}	Input common mode voltage	–0.05	–	VDDA – 0.2	V	Charge-pump on, $V_{DDA} \geq 2.7$ V
–	V_{OUT}	$V_{DDA} \geq 2.7$ V	–	–	–		–
SID283	V_{OUT_1}	Power = high, Iload = 10 mA	0.5	–	VDDA – 0.5	V	–
SID284	V_{OUT_2}	Power = high, Iload = 1 mA	0.2	–	VDDA – 0.2	V	–
SID285	V_{OUT_3}	Power = medium, Iload = 1 mA	0.2	–	VDDA – 0.2	V	–
SID286	V_{OUT_4}	Power = low, Iload = 0.1 mA	0.2	–	VDDA – 0.2	V	–
SID288	V_{OS_TR}	Offset voltage, trimmed	1	±0.5	1	mV	High mode
SID288A	V_{OS_TR}	Offset voltage, trimmed	–	±1	–	mV	Medium mode
SID288B	V_{OS_TR}	Offset voltage, trimmed	–	±2	–	mV	Low mode
SID290	$V_{OS\_DR\_TR}$	Offset voltage drift, trimmed	–10	±3	10	µV/°C	High mode. $T_A \leq 85$°C.
SID290Q	$V_{OS\_DR\_TR}$	Offset voltage drift, trimmed	15	±3	15	µV/°C	High mode. $T_A \leq 105$°C

(table continues...)

Table 8 (continued) Opamp specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details/ conditions
SID290A	$V_{OS\_DR\_TR}$	Offset voltage drift, trimmed	–	±10	–	µV/°C	Medium mode
SID290B	$V_{OS\_DR\_TR}$	Offset voltage drift, trimmed	–	±10	–	µV/°C	Low mode
SID291	CMRR	DC Common mode rejection ratio. High-power mode. Common Model voltage range from 0.5 V to V_{DDA} - 0.5 V.	60	70	–	dB	V_{DDD} = 3.6 V
SID292	PSRR	At 1 kHz, 100-mV ripple	70	85	–	dB	V_{DDD} = 3.6 V
–	Noise		–	–	–	–	–
SID293	V_{N1}	Input referred, 1 Hz - 1 GHz, power = high	–	94	–	µVrms	–
SID294	V_{N2}	Input referred, 1 kHz, power = high	–	72	–	nV/rtHz	–
SID295	V_{N3}	Input referred, 10 kHz, power = high	–	28	–	nV/rtHz	–
SID296	V_{N4}	Input referred, 100 kHz, power = high	–	15	–	nV/rtHz	–

(table continues...)

Table 8 (continued) Opamp specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	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} ≥ 2.7 V	6	–	–	V/µs	–
SID299	T_op_wake	From disable to enable, no external RC dominating	–	25	–	µs	–
SID299A	OL_GAIN	Open Loop Gain	–	90	–	dB	–
–	Comp_mode	Comparator mode; 50 mV drive, Trise = Tfall (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	–
Deep Sleep Mode		Mode 2 is lowest current range. Mode 1 has higher GBW.					Deep Sleep mode. V_{DDA} ≥ 2.7 V
SID_DS_1	IDD_HI_M1	Mode 1, High current	–	1400	–	uA	25°C

(table continues...)

Table 8 (continued) Opamp specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details/ conditions
SID_DS_2	IDD_MED_M1	Mode 1, Medium current	–	700	–	uA	25°C
SID_DS_3	IDD_LOW_M1	Mode 1, Low current	–	200	–	uA	25°C
SID_DS_4	IDD_HI_M2	Mode 2, High current	–	120	–	uA	25°C
SID_DS_5	IDD_MED_M2	Mode 2, Medium current	–	60	–	uA	25°C
SID_DS_6	IDD_LOW_M2	Mode 2, Low current	–	15	–	uA	25°C
SID_DS_7	GBW_HI_M1	Mode 1, High current	–	4	–	MHz	25°C
SID_DS_8	GBW_MED_M1	Mode 1, Medium current	–	2	–	MHz	25°C
SID_DS_9	GBW_LOW_M1	Mode 1, Low current	–	0.5	–	MHz	25°C
SID_DS_10	GBW_HI_M2	Mode 2, High current	–	0.5	–	MHz	20-pF load, no DC load 0.2 V to V_{DDA}-1.5 V
SID_DS_11	GBW_MED_M2	Mode 2, Medium current	–	0.2	–	MHz	20-pF load, no DC load 0.2 V to V_{DDA}-1.5 V
SID_DS_12	GBW_LOW_M2	Mode 2, Low current	–	0.1	–	MHz	20-pF load, no DC load 0.2 V to V_{DDA}-1.5 V
SID_DS_13	VOS_HI_M1	Mode 1, High current	–	5	–	mV	With trim 25°C, 0.2 V to V_{DDA}-1.5 V
SID_DS_14	VOS_MED_M1	Mode 1, Medium current	–	5	–	mV	With trim 25°C, 0.2 V to V_{DDA}-1.5 V
SID_DS_15	VOS_LOW_M1	Mode 1, Low current	–	5	–	mV	With trim 25°C, 0.2 V to V_{DDA}-1.5 V

(table continues...)

Table 8 (continued) Opamp specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details/ conditions
SID_DS_16	VOS_HI_M2	Mode 2, High current	–	5	–	mV	With trim 25°C, 0.2 V to V_{DDA}-1.5 V
SID_DS_17	VOS_MED_M2	Mode 2, Medium current	–	5	–	mV	With trim 25°C, 0.2 V to V_{DDA}-1.5 V
SID_DS_18	VOS_LOW_M2	Mode 2, Low current	–	5	–	mV	With trim 25°C, 0.2 V to V_{DDA}-1.5 V
SID_DS_19	IOUT_HI_M1	Mode 1, High current	–	10	–	mA	Output is 0.5 V to V_{DDA}-0.5 V
SID_DS_20	IOUT_MED_M1	Mode 1, Medium current	–	10	–	mA	Output is 0.5 V to V_{DDA}-0.5 V
SID_DS_21	IOUT_LOW_M1	Mode 1, Low current	–	4	–	mA	Output is 0.5 V to V_{DDA}-0.5 V
SID_DS_22	IOUT_HI_M2	Mode 2, High current	–	1	–	mA	Output is 0.5 V to V_{DDA}-0.5 V
SID_DS_23	IOUT_MED_M2	Mode 2, Medium current	–	1	–	mA	Output is 0.5 V to V_{DDA}-0.5 V
SID_DS_24	IOUT_LOW_M2	Mode 2, Low current	–	0.5	–	mA	Output is 0.5 V to V_{DDA}-0.5 V

6.3.2 Comparator

Table 9 Comparator DC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	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} ≥ 2.2 V for Temp < 0°C, V_{DDD} ≥ 1.8 V for Temp > 0°C)	–	±12	–	mV	–

(table continues...)

Table 9 (continued) Comparator DC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID86[1)]	V_{HYST}	Hysteresis when enabled, Common Mode voltage range from 0 to V_{DD} -1	–	10	35	mV	–
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} ≥ 2.2 V for Temp < 0°C, V_{DDD} ≥ 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[1)]	CMRR	Common mode rejection ratio	50	–	–	dB	V_{DDD} ≥ 2.7 V
SID88A[1)]	CMRR	Common mode rejection ratio	42	–	–	dB	V_{DDD}< 2.7 V
SID89[1)]	I_{CMP1}	Block current, normal mode	–	–	400	µA	–
SID248[1)]	I_{CMP2}	Block current, low power mode	–	–	100	µA	–
SID259[1)]	I_{CMP3}	Block current, ultra low power mode (V_{DDD} ≥ 2.2 V for Temp < 0°C, V_{DDD} ≥ 1.8 V for Temp > 0°C)	–	6	28	µA	–
SID90[1)]	Z_{CMP}	DC input impedance of comparator	35	–	–	MΩ	–

1) Guaranteed by characterization.

Table 10 Comparator AC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	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_{DDD} ≥ 2.2 V for Temp < 0°C, V_{DDD} ≥ 1.8 V for Temp > 0°C)	–	–	15	µs	200-mV overdrive

6.3.3 Temperature sensor

Table 11 Temperature sensor specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID93	$T_{SENSACC}$	Temperature sensor accuracy	–5	±1	+5	°C	–40°C to +85°C

6.3.4 SAR ADC

Table 12 SAR ADC DC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID94	A_RES	Resolution	–	–	12	bits	–
SID95	A_CHNIS_S	Number of channels - single ended	–	–	16		–
SID96	A-CHNKS_D	Number of channels - differential	–	–	8		Diff inputs use neighboring I/O
SID97[1)]	A-MONO	Monotonicity	Yes				–
SID98	A_GAINERR	Gain error	–	–	±0.1	%	With external reference
SID99	A_OFFSET	Input offset voltage	–	–	2	mV	Measured with 1-V V_{REF}
SID100	A_ISAR	Current consumption	–	–	1	mA	–
SID101[1)]	A_VINS	Input voltage range - single ended	V_{SS}	–	V_{DDA}	V	–
SID102[1)]	A_VIND	Input voltage range - differential	V_{SS}	–	V_{DDA}	V	–
SID103[1)]	A_INRES	Input resistance	–	–	2.2	KΩ	–
SID104[1)]	A_INCAP	Input capacitance	–	–	10	pF	–

1) Guaranteed by characterization.

Table 13 SAR ADC AC specifications

(Guaranteed by characterization)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID106	A_PSRR	Power supply rejection ratio	70	–	–	dB	–
SID107	A_CMRR	Common mode rejection ratio	66	–	–	dB	Measured at 1 V
SID108	A_SAMP_1	Sample rate with external reference bypass cap	–	–	1	Msps	–
SID108A	A_SAMP_2	Sample rate with no bypass cap. Reference = V_{DD}	–	–	1	Msps	–
SID108B	A_SAMP_3	Sample rate with no bypass cap. Internal reference	–	–	100	Ksps	–
SID109	A_SNDR	Signal-to-noise and distortion ratio (SINAD)	66	–	–	dB	F_{IN} = 10 kHz
SID111	A_INL	Integral non linearity	–1.4	–	+1.4	LSB	V_{DD} = 1.71 to 5.5, 1 Msps, Vref = 1 to 5.5

(table continues...)

Table 13 (continued) SAR ADC AC specifications

(Guaranteed by characterization)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID111A	A_INL	Integral non linearity	–1.4	–	+1.4	LSB	V_{DDD} = 1.71 to 3.6, 1 Msps, Vref = 1.71 to V_{DDD}
SID111B	A_INL	Integral non linearity	–1.4	–	+1.4	LSB	V_{DDD} = 1.71 to 5.5, 500 ksps, Vref = 1 to 5.5
SID112	A_DNL	Differential non linearity	–0.9	–	+1.35	LSB	V_{DDD} = 1.71 to 5.5, 1 Msps, Vref = 1 to 5.5
SID112A	A_DNL	Differential non linearity	–0.9	–	+1.35	LSB	V_{DDD} = 1.71 to 3.6, 1 Msps, Vref = 1.71 to V_{DDD}
SID112B	A_DNL	Differential non linearity	–0.9	–	+1.35	LSB	V_{DDD} = 1.71 to 5.5, 500 ksps, Vref = 1 to 5.5
SID113	A_THD	Total harmonic distortion	–	–	–65	dB	F_{IN} = 10 kHz.

6.3.5 CSD

Table 14 CSD block specification

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
CSD specification							
SID308	VCSD	Voltage range of operation	1.71	–	5.5	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[1)]	SNR	Ratio of counts of finger to noise	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	–	µA	–
SID314A	IDAC1_CRT2	Output current of Idac1 (8-bits) in Low range	–	306	–	µA	–
SID315	IDAC2_CRT1	Output current of Idac2 (7-bits) in High range	–	304.8	–	µA	–

(table continues...)

Table 14 (continued) CSD block specification

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID315A	IDAC2_CRT2	Output current of Idac2 (7-bits) in Low range	–	152.4	–	µA	–

1) Guaranteed by characterization.

6.4 Digital peripherals

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

6.4.1 Timer/Counter/PWM

Table 15 TCPWM specifications

(Guaranteed by characterization.)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	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 = 24 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

(table continues...)

Table 15 (continued) TCPWM specifications

(Guaranteed by characterization.)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
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.

6.4.2 I2C

Table 16 Fixed I^2C DC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	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 17 Fixed I^2C AC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID153	F_{I2C1}	Bit rate	–	–	1	Mbps	–

6.4.3 LCD direct drive

Table 18 LCD direct drive DC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID154	I_{LCDLOW}	Operating current in low power mode	–	5	–	µA	16 × 4 small segment disp. at 50 Hz
SID155[1)]	C_{LCDCAP}	LCD capacitance per segment/ common driver	–	500	5000	pF	–
SID156	LCD_{OFFSET}	Long-term segment offset	–	20	–	mV	–
SID157	I_{LCDOP1}	PWM Mode current. 5-V bias. 24-MHz IMO	–	0.6	–	mA	32 × 4 segments. 50 Hz, 25 °C
SID158	I_{LCDOP2}	PWM Mode current. 3.3-V bias. 24-MHz IMO.	–	0.5	–	mA	32 × 4 segments. 50 Hz, 25 °C

1) Guaranteed by design.

Table 19 LCD direct drive AC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID159	F_{LCD}	LCD frame rate	10	50	150	Hz	–

Table 20 Fixed UART DC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID160	I_{UART1}	Block current consumption at 100 Kbps	–	–	55	µA	–
SID161	I_{UART2}	Block current consumption at 1000 Kbps	–	–	312	µA	–

Table 21 Fixed UART AC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID162	F_{UART}	Bit rate	–	–	1	Mbps	–

6.4.4 SPI specifications

Table 22 Fixed SPI DC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID163	I_{SPI1}	Block current consumption at 1 Mbps	–	–	360	µA	–
SID164	I_{SPI2}	Block current consumption at 4 Mbps	–	–	560	µA	–
SID165	I_{SPI3}	Block current consumption at 8 Mbps	–	–	600	µA	–

Table 23 Fixed SPI AC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID166	F_{SPI}	SPI operating frequency (master; 6X oversampling)	–	–	8	MHz	–

Table 24 Fixed SPI Master mode AC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID167	T_{DMO}	MOSI valid after Sclock driving edge	–	–	15	ns	–
SID168	T_{DSI}	MISO valid before Sclock capturing edge. Full clock, late MISO Sampling used	20	–	–	ns	–
SID169	T_{HMO}	Previous MOSI data hold time with respect to capturing edge at Slave	0	–	–	ns	–

Table 25 Fixed SPI Slave mode AC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
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	–

6.5 Memory

Table 26 Flash DC specifications

(Guaranteed by characterization.)

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

Table 27 Flash AC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID174	$T_{ROWWRITE}$	Row (block) write time (erase and program)	–	–	20	ms	Row (block) = 128 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 (128 KB)	–	–	35	ms	–
SID179	$T_{SECTORERASE}$	Sector erase time (8 KB)	–	–	15	ms	–
SID180[1)]	$T_{DEVPROG}$	Total device program time	–	–	15	seconds	–
SID181[1)]	F_{END}	Flash endurance	100 K	–	–	cycles	–
SID182[1)]	F_{RET}	Flash retention. $T_A \leq 55°C$, 100 K P/E cycles	20	–	–	years	–
SID182A[1)]	–	Flash retention. $T_A \leq 85°C$, 10 K P/E cycles	10	–	–	years	–
SID182B[1)]	F_{RETQ}	Flash retention. $T_A \leq 105°C$, 10 K P/E cycles, ≤ three years at $T_A \geq 85°C$	10	20	–	years	–

1) Guaranteed by characterization.

6.6 System resources

6.6.1 Power-on reset (POR) with Brown Out

Table 28 Imprecise Power-on reset (PRES)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID185[1)]	$V_{RISEIPOR}$	Rising trip voltage	0.80	–	1.45	V	–
SID186[1)]	$V_{FALLIPOR}$	Falling trip voltage	0.75	–	1.4	V	–
SID187[1)]	$V_{IPORHYST}$	Hysteresis	15	–	200	mV	–

1) Guaranteed by characterization.

Table 29 Precise Power-on reset (POR)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID190[1)]	$V_{FALLPPOR}$	BOD trip voltage in active and sleep modes	1.64	–	–	V	–
SID192[1)]	$V_{FALLDPSLP}$	BOD trip voltage in Deep Sleep	1.4	–	–	V	–

1) Guaranteed by characterization.

6.6.2 Voltage monitors

Table 30 Voltage monitors DC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID195	V_{LVI1}	LVI_A/D_SEL[3:0] = 0000b	1.71	1.75	1.79	V	–
SID196	V_{LVI2}	LVI_A/D_SEL[3:0] = 0001b	1.76	1.80	1.85	V	–
SID197	V_{LVI3}	LVI_A/D_SEL[3:0] = 0010b	1.85	1.90	1.95	V	–
SID198	V_{LVI4}	LVI_A/D_SEL[3:0] = 0011b	1.95	2.00	2.05	V	–
SID199	V_{LVI5}	LVI_A/D_SEL[3:0] = 0100b	2.05	2.10	2.15	V	–
SID200	V_{LVI6}	LVI_A/D_SEL[3:0] = 0101b	2.15	2.20	2.26	V	–
SID201	V_{LVI7}	LVI_A/D_SEL[3:0] = 0110b	2.24	2.30	2.36	V	–
SID202	V_{LVI8}	LVI_A/D_SEL[3:0] = 0111b	2.34	2.40	2.46	V	–
SID203	V_{LVI9}	LVI_A/D_SEL[3:0] = 1000b	2.44	2.50	2.56	V	–
SID204	V_{LVI10}	LVI_A/D_SEL[3:0] = 1001b	2.54	2.60	2.67	V	–
SID205	V_{LVI11}	LVI_A/D_SEL[3:0] = 1010b	2.63	2.70	2.77	V	–
SID206	V_{LVI12}	LVI_A/D_SEL[3:0] = 1011b	2.73	2.80	2.87	V	–
SID207	V_{LVI13}	LVI_A/D_SEL[3:0] = 1100b	2.83	2.90	2.97	V	–
SID208	V_{LVI14}	LVI_A/D_SEL[3:0] = 1101b	2.93	3.00	3.08	V	–
SID209	V_{LVI15}	LVI_A/D_SEL[3:0] = 1110b	3.12	3.20	3.28	V	–
SID210	V_{LVI16}	LVI_A/D_SEL[3:0] = 1111b	4.39	4.50	4.61	V	–
SID211[1)]	LVI_IDD	Block current	–	–	100	µA	–

1) Guaranteed by characterization.

Table 31 Voltage monitors AC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID212[1)]	$T_{MONTRIP}$	Voltage monitor trip time	–	–	1	µs	–

1) Guaranteed by characterization.

6.6.3 SWD interface

Table 32 SWD interface specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID213	F_SWDCLK1	3.3 V ≤ V_{DD} ≤ 5.5 V	–	–	14	MHz	SWDCLK ≤ 1/3 CPU clock frequency
SID214	F_SWDCLK2	1.71 V ≤ V_{DD} ≤ 3.3 V	–	–	7	MHz	SWDCLK ≤ 1/3 CPU clock frequency
SID215[1)]	T_SWDI_SETUP	T = 1/f SWDCLK	0.25*T	–	–	ns	–
SID216[1)]	T_SWDI_HOLD	T = 1/f SWDCLK	0.25*T	–	–	ns	–
SID217[1)]	T_SWDO_VALID	T = 1/f SWDCLK	–	–	0.5*T	ns	–
SID217A[1)]	T_SWDO_HOLD	T = 1/f SWDCLK	1	–	–	ns	–

1) Guaranteed by characterization.

6.6.4 Internal main oscillator

Table 33 IMO DC specifications

(Guaranteed by design.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID218	I_{IMO1}	IMO operating current at 48 MHz	–	–	1000	µA	–
SID219	I_{IMO2}	IMO operating current at 24 MHz	–	–	325	µA	–
SID220	I_{IMO3}	IMO operating current at 12 MHz	–	–	225	µA	–
SID221	I_{IMO4}	IMO operating current at 6 MHz	–	–	180	µA	–
SID222	I_{IMO5}	IMO operating current at 3 MHz	–	–	150	µA	–

Table 34 IMO AC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID223	$F_{IMOTOL1}$	Frequency variation from 3 to 48 MHz	–	–	±2	%	±3% if T_A > 85 °C and IMO frequency < 24 MHz
SID226	$T_{STARTIMO}$	IMO startup time	–	–	12	µs	–
SID227	$T_{JITRMSIMO1}$	RMS Jitter at 3 MHz	–	156	–	ps	–

(table continues...)

Table 34 (continued) IMO AC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID228	$T_{JITRMSIMO2}$	RMS Jitter at 24 MHz	–	145	–	ps	–
SID229	$T_{JITRMSIMO3}$	RMS Jitter at 48 MHz	–	139	–	ps	–

6.6.5 Internal low-speed oscillator

Table 35 ILO DC specifications

(Guaranteed by design.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID231[1)]	I_{ILO1}	ILO operating current at 32 kHz	–	0.3	1.05	µA	–
SID233[2)]	$I_{ILOLEAK}$	ILO leakage current	–	2	15	nA	–

1) Guaranteed by characterization.
2) Guaranteed by design.

Table 36 ILO AC specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID234[1)]	$T_{STARTILO1}$	ILO startup time	–	–	2	ms	–
SID236[1)]	$T_{ILODUTY}$	ILO duty cycle	40	50	60	%	–
SID237	$F_{ILOTRIM1}$	32 kHz trimmed frequency	15	32	50	kHz	Max ILO frequency is 70 kHz if T_A > 85 °C

1) Guaranteed by characterization.

Table 37 External clock specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID305[1)]	ExtClkFreq	External Clock input Frequency	0	–	48	MHz	–
SID306[1)]	ExtClkDuty	Duty cycle; Measured at $V_{DD/2}$	45	–	55	%	–

1) Guaranteed by characterization.

Table 38 Watch crystal oscillator (WCO) specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
IMO WCO-PLL calibrated mode							
SID330	IMO_{WCO1}	Frequency variation with IMO set to 3 MHz	–0.6	–	0.6	%	Does not include WCO tolerance
SID331	IMO_{WCO2}	Frequency variation with IMO set to 5 MHz	–0.4	–	0.4	%	Does not include WCO tolerance
SID332	IMO_{WCO3}	Frequency variation with IMO set to 7 MHz or 9 MHz	–0.3	–	0.3	%	Does not include WCO tolerance
SID333	IMO_{WCO4}	All other IMO frequency settings	–0.2	–	0.2	%	Does not include WCO tolerance
WCO specifications							
SID398	F_{WCO}	Crystal frequency	–	32.768	–	kHz	–
SID399	F_{TOL}	Frequency tolerance	–	50	250	ppm	With 20-ppm crystal.
SID400	ESR	Equivalent series resistance	–	50	–	kΩ	–
SID401	PD	Drive level	–	–	1	µW	–
SID402	T_{START}	Startup time	–	–	500	ms	–
SID403	C_L	Crystal load capacitance	6	–	12.5	pF	–
SID404	C_0	Crystal shunt capacitance	–	1.35	–	pF	–
SID405	I_{WCO1}	Operating current (high power mode)	–	–	8	uA	–

Table 39 UDB AC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	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							

(table continues...)

Table 39 (continued) UDB AC specifications

(Guaranteed by characterization.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
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 40 Block specs

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	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
SID260[1)]	V_{REFSAR}	Trimmed internal reference to SAR	–1	–	+1	%	Percentage of Vbg (1.024 V).
SID261[1)]	$F_{SARINTREF}$	SAR operating speed without external reference bypass	–	–	100	ksps	12-bit resolution.
SID262[2)]	$T_{CLKSWITCH}$	Clock switching from clk1 to clk2 in clk1 periods	3	–	4	Periods	–

* Tws48 and Tws24 are guaranteed by Design

1) Guaranteed by characterization.
2) Guaranteed by design.

Table 41 UDB port adaptor specifications

(Based on LPC Component Specs, Guaranteed by Characterization -10-pF load, 3-V V_{DDIO} and V_{DDD}.)

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID263	T_{LCLKDO}	LCLK to output delay	–	–	18	ns	–
SID264	$T_{DINLCLK}$	Input setup time to LCLCK rising edge	–	–	7	ns	–
SID265	$T_{DINLCLKHLD}$	Input hold time from LCLK rising edge	0	–	–	ns	–
SID266	$T_{LCLKHIZ}$	LCLK to output tristated	–	–	28	ns	–
SID267	T_{FLCLK}	LCLK frequency	–	–	33	MHz	–
SID268	$T_{LCLKDUTY}$	LCLK duty cycle (percentage high)	40	–	60	%	–

Table 42 CAN specifications

Spec ID#	Parameter	Description	Min	Typ	Max	Unit	Details / conditions
SID420	IDD_CAN	Block current consumption	–	–	200	uA	–
SID421	CAN_bits	CAN Bit rate (Min 8-MHZ clock)	–	–	1	Mbps	–

7 Ordering information

The PSoC™ 4200M part numbers and features are listed in the Table 43.

Table 43 PSoC™ 4200M ordering information

		Features															Packages			
Category	Product	Max CPU speed (MHz)	Flash (KB)	SRAM (KB)	UDB	Opamp (CTBm)	CSD	IDAC (1X7-Bit, 1-8-Bit)	Direct LCD drive	12-bit SAR ADC	LP comparators	TCPWM blocks	SCB blocks	CAN	GPIO	44-TQFP	48-TQFP	64-TQFP (0.5-mm pitch)	64-TQFP (0.8-mm pitch)	68-QFN
4245	CY8C4245AZI-M433	48	32	4	4	2	–	–	–	1000 ksps	2	8	3	–	38	–	✓	–	–	–
	CY8C4245AZI-M443	48	32	4	4	2	1	–	✓	1000 ksps	2	8	3	–	38	–	✓	–	–	–
	CY8C4245AZI-M445	48	32	4	4	2	1	–	✓	1000 ksps	2	8	4	–	51	–	–	✓	–	–
	CY8C4245LTI-M445	48	32	4	4	2	1	–	✓	1000 ksps	2	8	4	–	55	–	–	–	–	✓
	CY8C4245LTI-DM405	48	32	4	4	–	–	–	–	–	2	8	4	–	55	–	–	–	–	✓
	CY8C4245AXI-M445	48	32	4	4	2	1	–	✓	1000 ksps	2	8	4	–	51	–	–	–	✓	–
4246	CY8C4246AXI-M443	48	64	8	4	2	1	–	✓	1000 ksps	2	8	2	–	36	✓	–	–	–	–
	CY8C4246AZI-M443	48	64	8	4	2	1	–	✓	1000 ksps	2	8	3	–	38	–	✓	–	–	–
	CY8C4246AZI-M445	48	64	8	4	2	1	–	✓	1000 ksps	2	8	4	–	51	–	–	✓	–	–
	CY8C4246AZI-M475	48	64	8	4	4	–	2	–	1000 ksps	2	8	4	–	51	–	–	✓	–	–
	CY8C4246LTI-M445	48	64	8	4	2	1	–	✓	1000 ksps	2	8	4	–	55	–	–	–	–	✓
	CY8C4246LTI-M475	48	64	8	4	4	–	2	–	1000 ksps	2	8	4	–	55	–	–	–	–	✓
	CY8C4246LTI-DM405	48	64	8	4	–	–	–	–	–	2	8	4	–	55	–	–	–	–	✓
	CY8C4246AXI-M445	48	64	8	4	2	1	–	✓	1000 ksps	2	8	4	–	51	–	–	–	✓	–
	CY8C4246AZQ-M443	48	64	8	4	2	1	–	✓	1000 ksps	2	8	3	–	38	–	✓	–	–	–
4247	CY8C4247LTI-M475	48	128	16	4	4	2	4	–	1000 ksps	2	8	4	–	55	–	–	–	–	✓
	CY8C4247AZI-M475	48	128	16	4	4	–	4	–	1000 ksps	2	8	4	–	51	–	–	✓	–	–
	CY8C4247AZI-M485	48	128	16	4	4	2	4	✓	1000 ksps	2	8	4	✓	51	–	–	✓	–	–
	CY8C4247AXI-M485	48	128	16	4	4	2	4	✓	1000 ksps	2	8	4	✓	51	–	–	–	✓	–
	CY8C4247LTQ-M475	48	128	16	4	4	2	4	✓	1000 ksps	2	8	4	–	55	–	–	–	–	✓
	CY8C4247AZQ-M485	48	128	16	4	4	2	4	✓	1000 ksps	2	8	4	✓	51	–	–	✓	–	–
	CY8C4247AXQ-M485	48	128	16	4	4	2	4	✓	1000 ksps	2	8	4	✓	51	–	–	–	✓	–

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

Table 44 MPN nomenclature

Field	Description	Values	Meaning
CY8C	Infineon prefix		
4	Architecture	4	PSoC™ 4
A	Family	2	4200 Family
B	CPU speed	4	48 MHz
C	Flash capacity	4	16 KB
		5	32 KB
		6	64 KB
		7	128 KB
DE	Package code	AX, AZ	TQFP
		LT	QFN
		BU	BGA
		FD	CSP
F	Temperature range	I	Industrial
		Q	Extended Industrial
S	Series designator	N/A	PSoC™ 4 Base Series
		L	PSoC™ 4 L-Series
		BL	PSoC™ 4 BLE
		M	PSoC™ 4 M-Series
XYZ	Attributes code	000-999	Code of feature set in the specific family

7.1 Part numbering conventions

The part number fields are defined as follows.

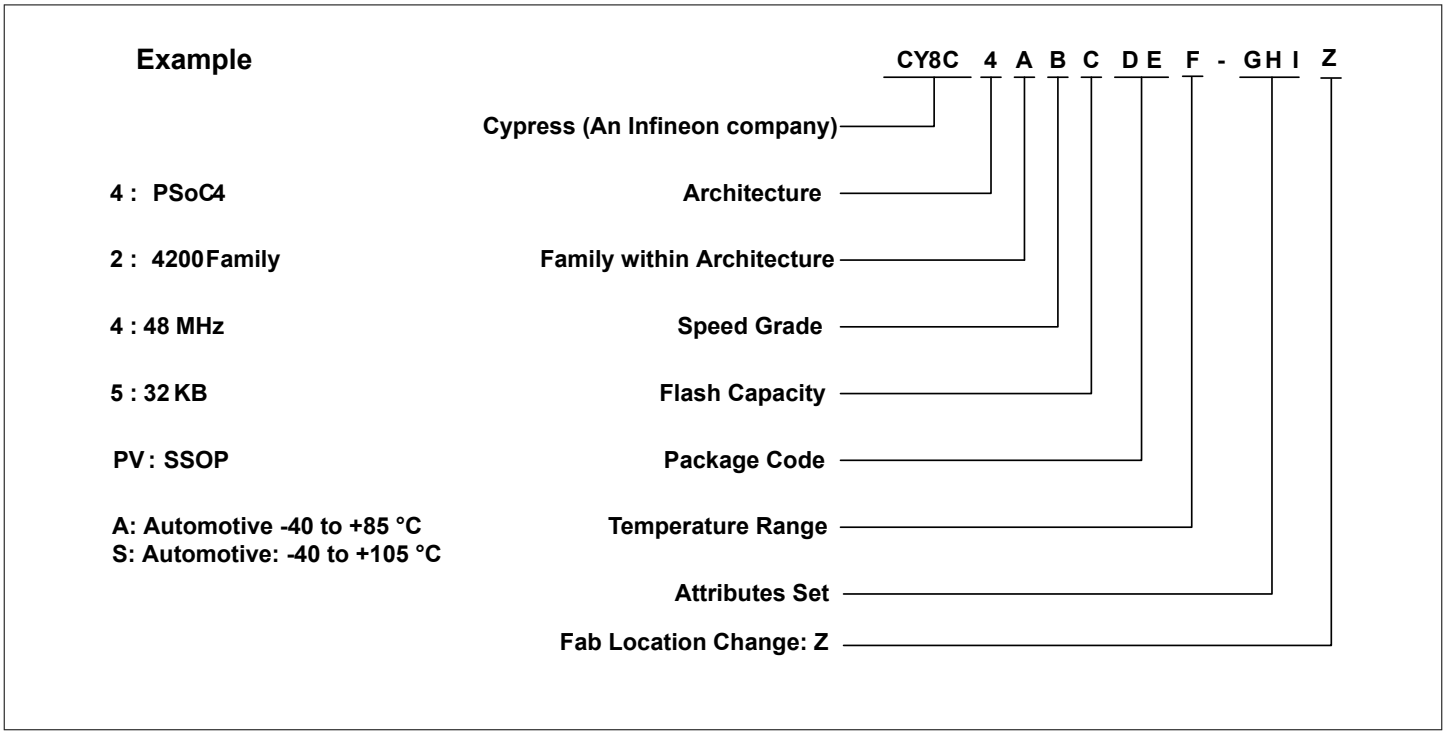


Figure 8 Part numbering conventions

8 Packaging

Table 45 Package dimensions

Spec ID#	Package	Description	Package Dwg #
PKG_1	68-pin QFN	68-pin QFN, 8 mm x 8 mm x 1.0 mm height with 0.4 mm pitch	001-09618
PKG_2	64-pin TQFP	64-pin TQFP, 10 mm x 10 mm x 1.4 mm height with 0.5 mm pitch	51-85051
PKG_4	64-pin TQFP	64-pin TQFP, 14 mm x 14 mm x 1.4 mm height with 0.8 mm pitch	51-85046
PKG_5	48-pin TQFP	48-pin TQFP, 7 mm x 7 mm x 1.4 mm height with 0.5 mm pitch	51-85135
PKG_6	44-pin TQFP	44-pin TQFP, 10 mm x 10 mm x 1.4 mm height with 0.8 mm pitch	51-85064

Table 46 Package characteristics

Parameter	Description	Conditions	Min	Typ	Max	Unit
T_A	Operating ambient temperature	–	–40	25	85	°C
T_J	Operating junction temperature	–	–40	–	100	°C
T_{JA}	Package θ_{JA} (68-pin QFN)	–	–	16.8	–	°C/Watt
T_{JC}	Package θ_{JC} (68-pin QFN)	–	–	2.9	–	°C/Watt
T_{JA}	Package θ_{JA} (64-pin TQFP, 0.5 mm pitch)	–	–	56	–	°C/Watt
T_{JC}	Package θ_{JC} (64-pin TQFP, 0.5 mm pitch)	–	–	19.5	–	°C/Watt
T_{JA}	Package θ_{JA} (64-pin TQFP, 0.8 mm pitch)	–	–	66.4	–	°C/Watt
T_{JC}	Package θ_{JC} (64-pin TQFP, 0.8 mm pitch)	–	–	18.2	–	°C/Watt
T_{JA}	Package θ_{JA} (48-pin TQFP, 0.5 mm pitch)	–	–	67.3	–	°C/Watt
T_{JC}	Package θ_{JC} (48-pin TQFP, 0.5 mm pitch)	–	–	30.4	–	°C/Watt
T_{JA}	Package θ_{JA} (44-pin TQFP, 0.8 mm pitch)	–	–	57	–	°C/Watt
T_{JC}	Package θ_{JC} (44-pin TQFP, 0.8 mm pitch)	–	–	25.9	–	°C/Watt

***Note**: All Theta$_{JA}$ and Theta$_{JC}$ values are simulated, not characterized.*

Table 47 Solder reflow peak temperature

Package	Maximum peak temperature	Maximum time at peak temperature
All packages	260°C	30 seconds

Table 48 Package moisture sensitivity level (MSL), IPC/JEDEC J-STD-2

Package	MSL
All packages	MSL 3

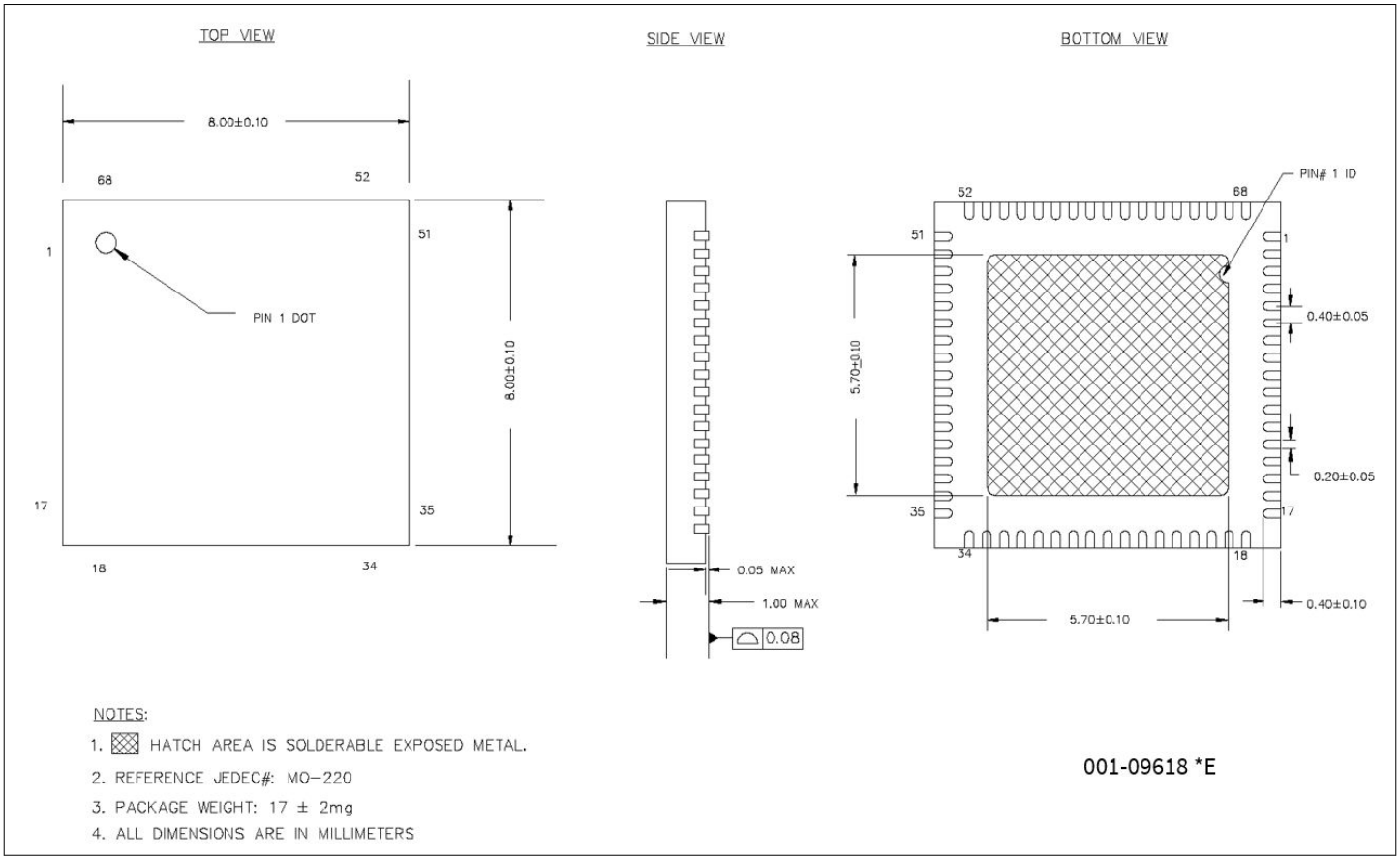


Figure 9 68-Pin QFN 8 × 8 × 1.0 mm package outline (PG-VQFN-68)

***Note**: The center pad on the QFN package should be connected to ground (VSS) for best mechanical, thermal, and electrical performance. If not connected to ground, it should be electrically floating and not connected to any other signal.*

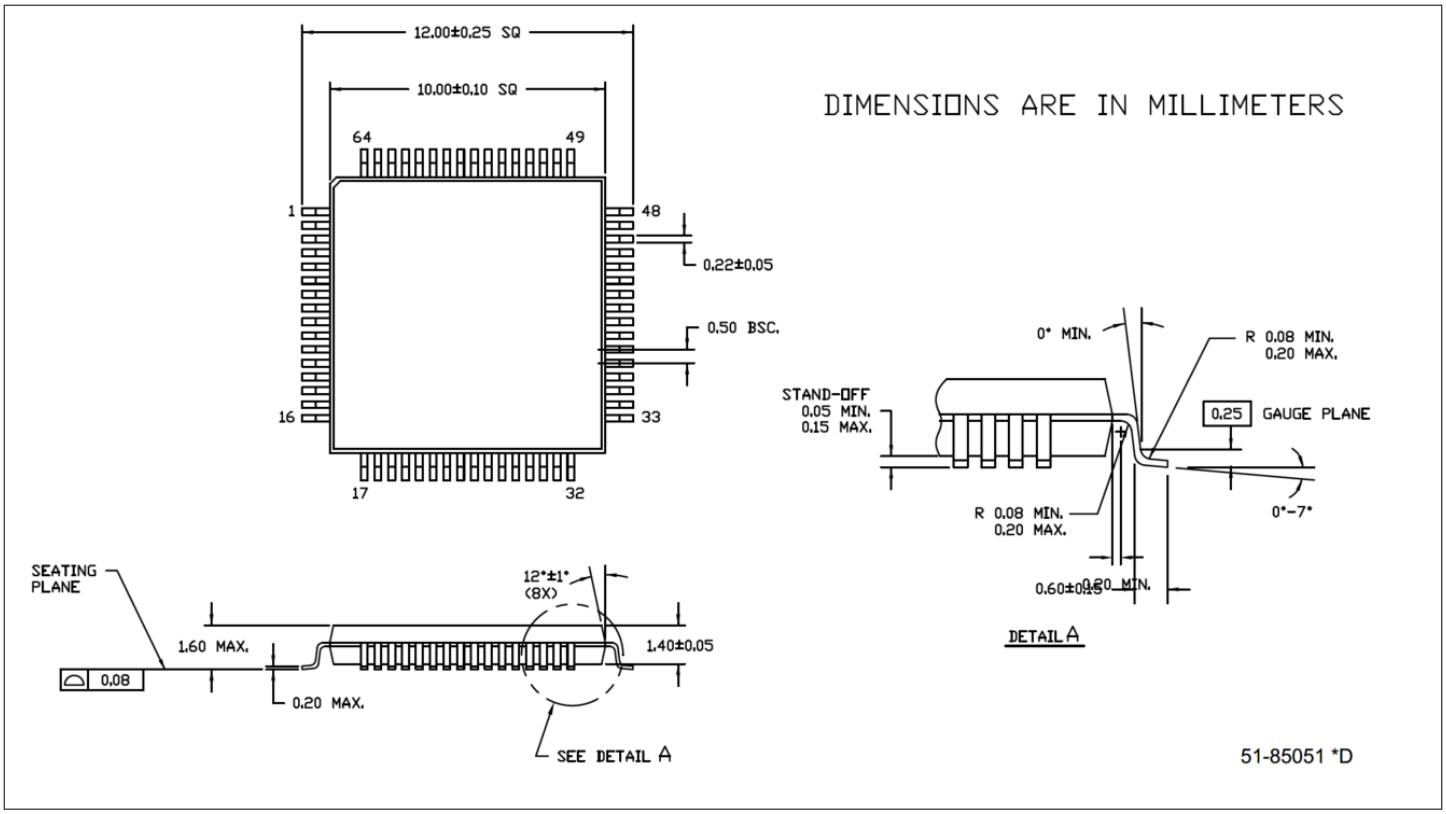
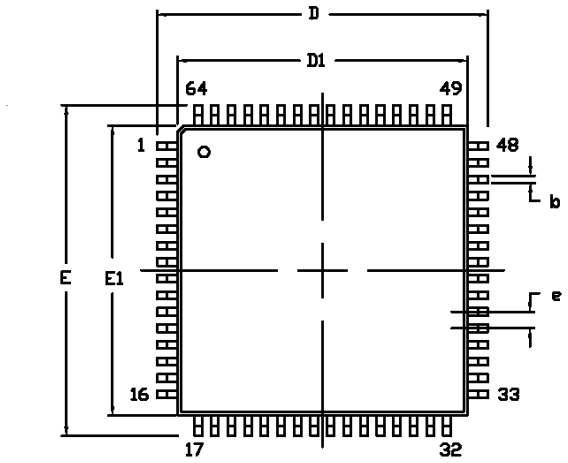
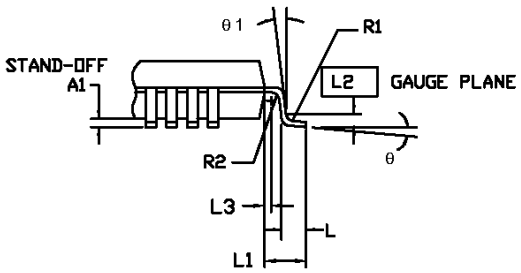


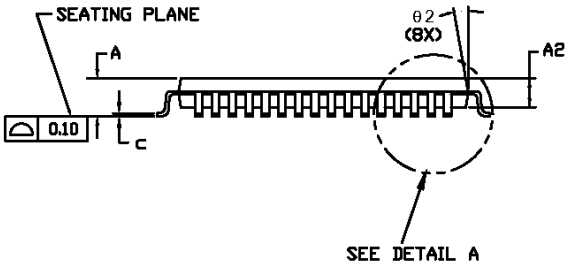
Figure 10 64-Pin TQFP 10 × 10 × 1.4 mm package outline (PG-TQFP-64)



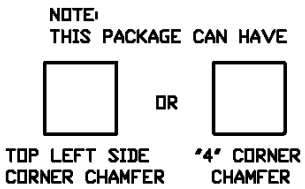
TOP VIEW



DETAIL A



SIDE VIEW



SYMBOL	DIMENSIONS		
	MIN.	NOM.	MAX.
A	—	—	1.60
A1	0.05	—	0.15
A2	1.35	1.40	1.45
D	15.75	16.00	16.25
D1	13.95	14.00	14.05
E	15.75	16.00	16.25
E1	13.95	14.00	14.05
R1	0.08	—	0.20
R2	0.08	—	0.20
θ	0°	—	7°
θ1	0°	—	—
θ2	11°	12°	13°
c	—	—	0.20
b	0.30	0.35	0.40
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
L3	0.20	—	—
e	0.80 TYP		

NOTE:
1. JEDEC STD REF MS-026
2. BODY LENGTH DIMENSION DOES NOT INCLUDE MOLD PROTRUSION/END FLASH MOLD PROTRUSION/END FLASH SHALL NOT EXCEED 0.0098 in (0.25 mm) PER SIDE BODY LENGTH DIMENSIONS ARE MAX PLASTIC BODY SIZE INCLUDING MOLD MISMATCH
3. DIMENSIONS IN MILLIMETERS

51-85046 *H

Figure 11 64-Pin 14 × 14 × 1.4 mm TQFP package outline (PG-TQFP-64)

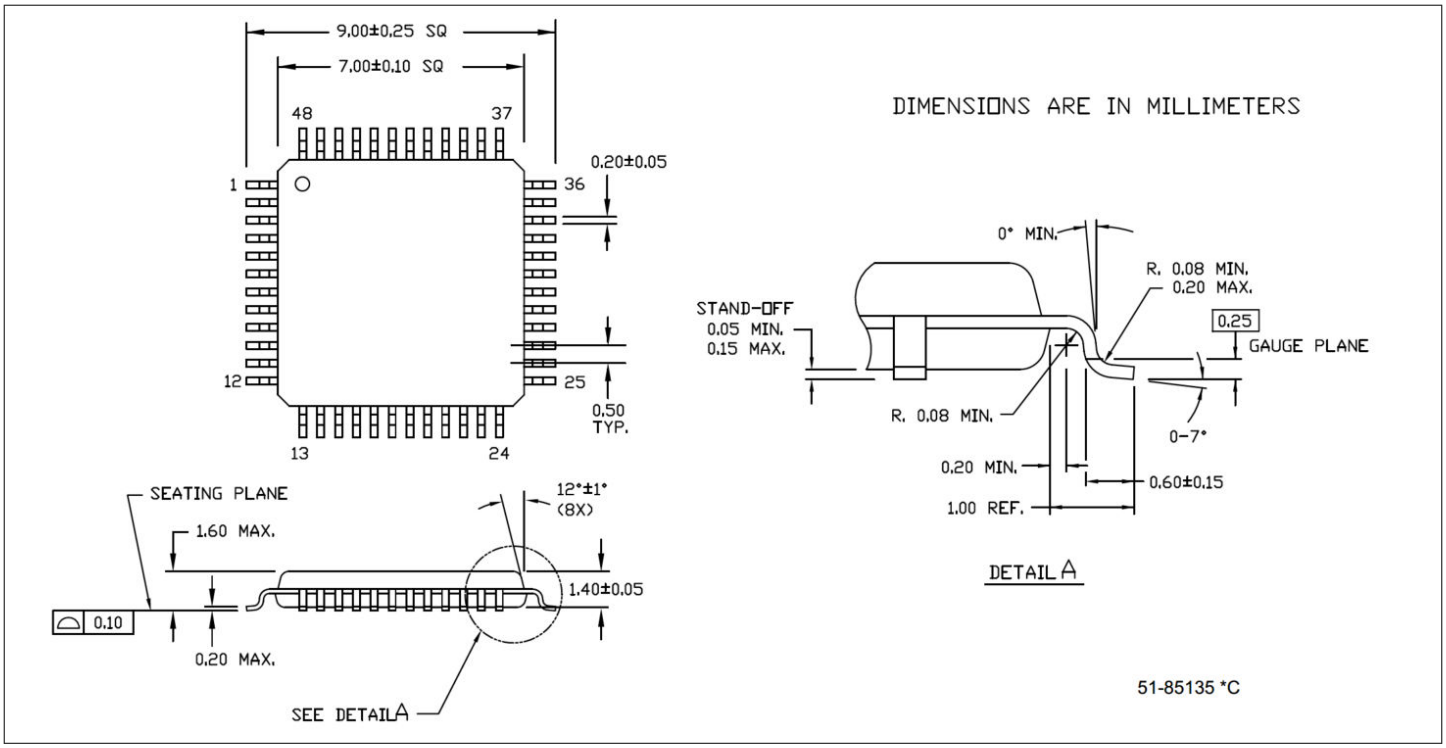


Figure 12 48-Pin 7 × 7 × 1.4 mm TQFP package outline (PG-TQFP-48)

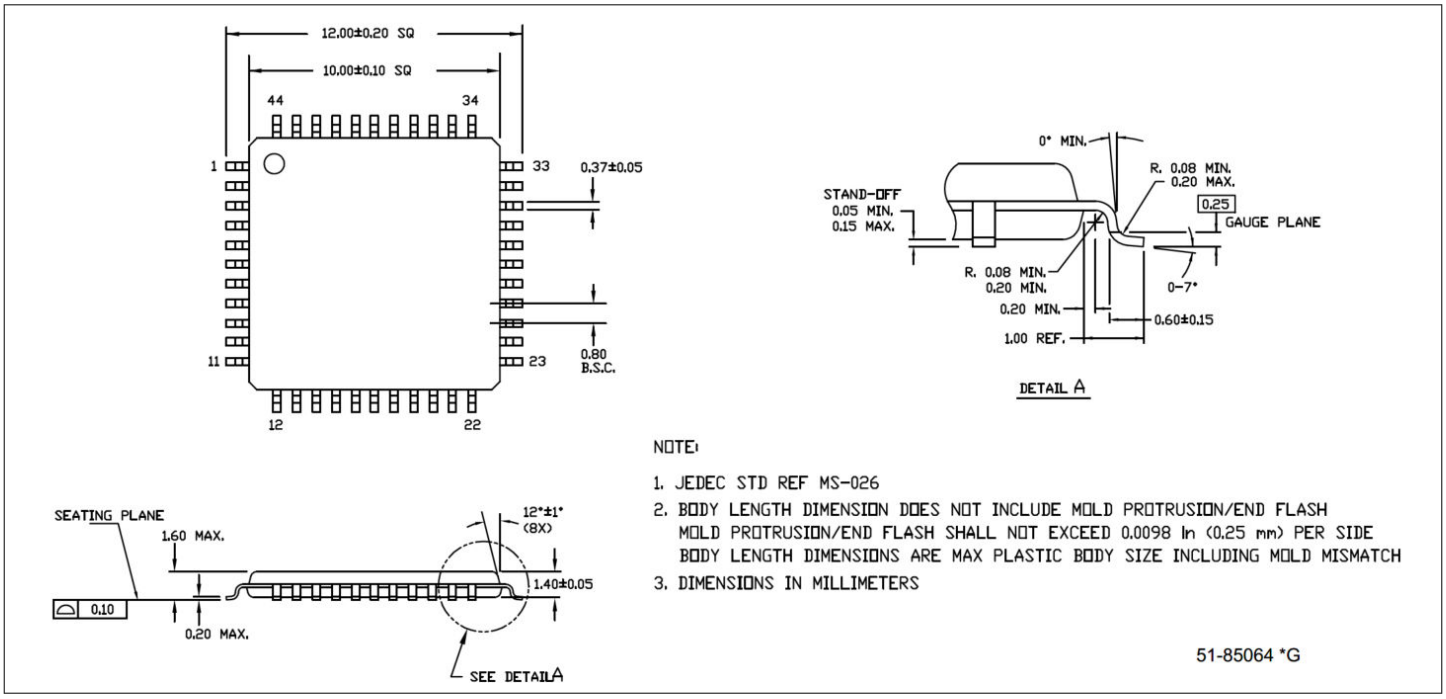


Figure 13 44-Pin 10 × 10 × 1.4 mm TQFP package outline (PG-TQFP-44)

9 Acronyms

Table 49 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

(table continues...)

Table 49 (continued) Acronyms used in this document

Acronym	Description
EPSR	execution program status register
ESD	electrostatic discharge
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

(table continues...)

Table 49 (continued) Acronyms used in this document

Acronym	Description
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
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	I2C serial clock
SDA	I2C serial data

(table continues...)

Table 49 (continued) Acronyms used in this document

Acronym	Description
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
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

10 Document conventions

10.1 Units of measure

Table 50 Unit 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

(table continues...)

Table 50 (continued) Unit of measure

Symbol	Unit of measure
s	second
sps	samples per second
sqrtHz	square root of hertz
V	volt

11 Revision history

Document revision	Date	Description of changes
*B	2015-06-03	Release to web.
*C	2015-06-29	Removed note regarding hardware handshaking in the UART Mode section. Changed max value of SID51A to 2 ms. Added “Guaranteed by characterization” note for SID65 and SID65A Updated Ordering Information. Removed the Errata section.
*D	2015-07-08	Corrected Block Diagram
*E	2015-09-30	Updated CAPSENSE™ section. Updated the note at the end of the Pinout table. Removed Conditions for spec SID237. Updated Ordering Information.
*F	2015-11-25	Added Comparator ULP mode range restrictions and corrected typos.
*G	2016-08-19	Added extended industrial temperature range. Added specs SID290Q, SID182A, and SID299A. Updated conditions for SID290, SID223, and SID237. Added 44-pin TQFP package details. Updated Ordering Information.
*H	2016-10-21	Added back CY8C4245LTI-DM405 and CY8C4246LTI-DM405 parts.
*I	2017-10-23	Updated the Cypress logo and copyright information. Added CY8C4246AXI-M443 in Ordering Information. Updated 64-pin TQFP package diagram (spec 51-85046) to current revision.
*J	2018-03-28	Corrected MPN Table to show three SCBs for 48 TQFP packages and two SCBs for 44 TQFP package.
*K	2018-04-24	Corrected MPN Table to show three SCBs for 48 TQFP packages and two SCBs for 44 TQFP package.
*L	2019-06-28	Added CY8C4246AZQ-M443, CY8C4247AZQ-M485, and CY8C4247AXQ-M485 in Ordering Information.
*M	2024-02-16	Migrated to IFX template. Deleted DN VSSD pins from Pinout. Added Note in Packaging. Updated Development ecosystem Deleted Reference section

Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

Edition 2024-02-16

Published by

Infineon Technologies AG

81726 Munich, Germany

Do you have a question about any aspect of this document?

Email: erratum@infineon.com

Document reference
IFX-cua1691739763189

Important notice

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffenheitsgarantie").

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's products and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

Warnings

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.