

# Automotive PSoC™ 4: PSoC™ 4100S family

Based on Arm® Cortex®-M0+ CPU

## Functional description

PSoC™ 4 is a scalable and reconfigurable platform architecture for a family of programmable embedded system controllers with an Arm® Cortex®-M0+ CPU, while being AEC-Q100 compliant. It combines programmable and reconfigurable analog and digital blocks with flexible automatic routing. The PSoC™ 4100S product family is a member of the PSoC™ 4 platform architecture. It is a combination of a microcontroller with standard communication and timing peripherals, a capacitive touch-sensing system (CAPSENSE™) with best-in-class performance, programmable general-purpose continuous-time and switched-capacitor analog blocks, and programmable connectivity. PSoC™ 4100S products will be upward compatible with members of the PSoC™ 4 platform for new applications and design needs.

## Features

- Automotive Electronics Council (AEC) AEC-Q100 Qualified
- 32-bit MCU subsystem
  - 48-MHz Arm® Cortex®-M0+ CPU
  - Up to 64 KB of flash with read accelerator
  - Up to 8 KB of SRAM
- Programmable analog
  - Two opamps with reconfigurable high-drive external and high-bandwidth internal drive and Comparator modes and ADC input buffering capability. Opamps can operate in Deep Sleep low-power mode.
  - 12-bit 1-Msps SAR ADC with differential and single-ended modes, and channel sequencer with signal averaging
  - Single-slope 10-bit ADC function provided by a capacitance sensing block
  - Two current DACs (IDACs) for general-purpose or capacitive sensing applications on any pin
  - Two low-power comparators that operate in Deep Sleep low-power mode
- Programmable digital
  - Programmable logic blocks allowing Boolean operations to be performed on port inputs and outputs
- Low-power 1.71-V to 5.5-V operation
  - Deep Sleep mode with operational analog and 2.5-µA digital system current
- Capacitive sensing
  - Capacitive sigma-delta (CSD) provides best-in-class signal-to-noise ratio (SNR) (>5:1) and water tolerance
  - Infineon-supplied software component makes capacitive sensing design easy
  - Automatic hardware tuning (SmartSense)
- LCD drive capability
  - LCD segment drive capability on GPIOs
- Serial communication
  - Three independent run-time reconfigurable serial communication blocks (SCBs) with re-configurable I<sup>2</sup>C, SPI, UART, or LIN slave functionality
- Timing and pulse-width modulation
  - Five 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
- Up to 38 programmable GPIO pins
  - 24-pin QFN, 28-pin SSOP, 40-pin QFN, and 48-pin QFN packages
  - Any GPIO pin can be CapSense, analog, or digital
  - Drive modes, strengths, and slew rates are programmable

## Features

- 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
- Temperature ranges
  - A-grade: -40°C to +85°C
  - S-grade: -40°C to +105°C
  - E-grade: -40°C to +125°C<sup>[1]</sup>

**Note**

1. This device can also operate at temperatures exceeding 125°C (the high temperature of the AEC-Q100 Grade 1 operating range) for a limited amount of time depending on the mission profile of the application. Infineon provides a retention calculator to help estimate the retention lifetime based on the customers' individual temperature profiles for operation throughout the -40°C to +150°C ambient temperature range. Go to the [Infineon community page](#) for more details.

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Logic block diagram

### Logic block diagram

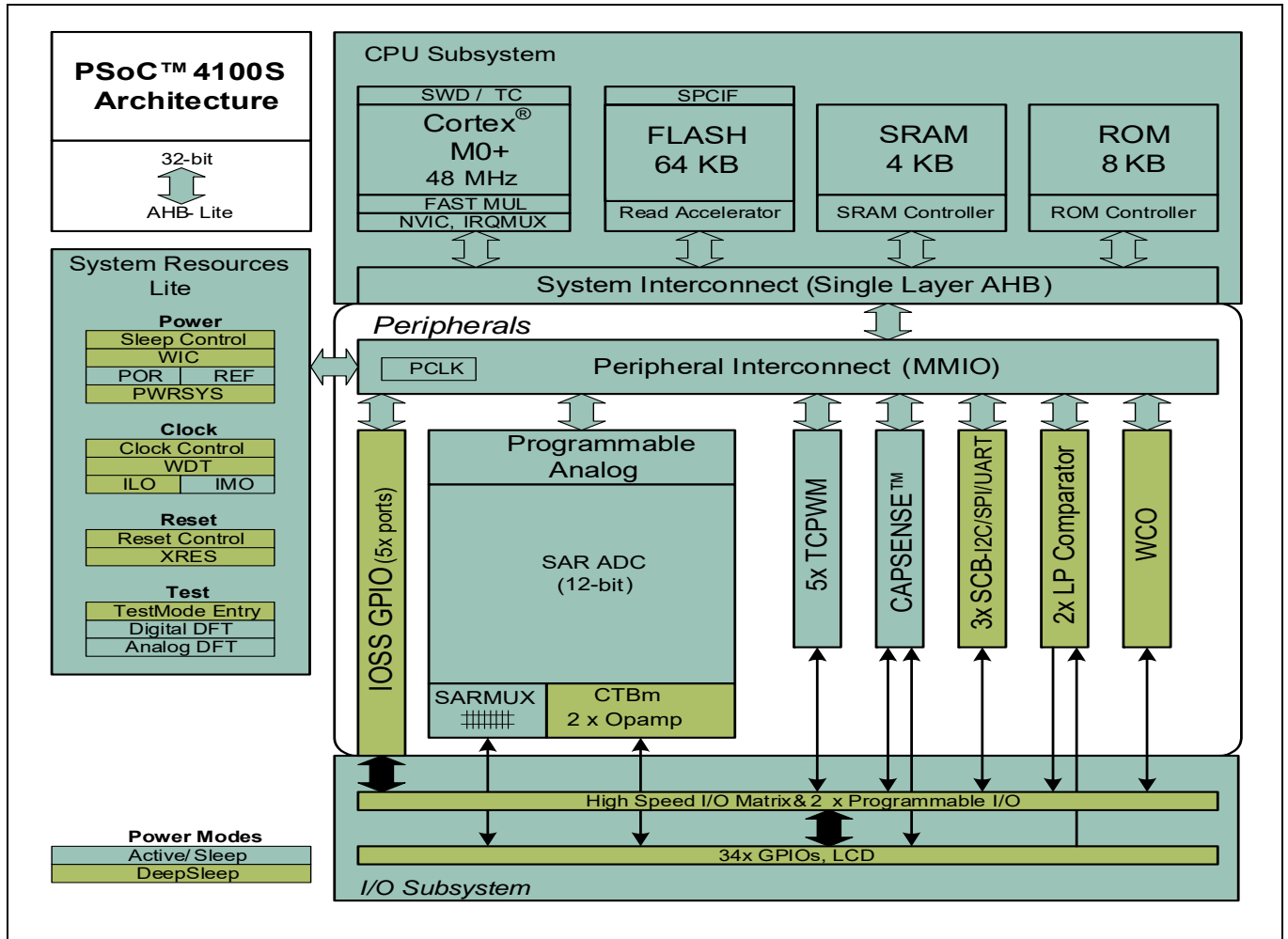


Figure 1 Logic block diagram

## 1 Functional overview

PSoC™ 4100S devices include extensive support for programming, testing, debugging, and tracing both hardware and firmware.

The Arm® 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 the PSoC™ 4100S devices. The SWD interface is fully compatible with industry-standard third-party tools. The PSoC™ 4100S family provides a level of security not possible with multi-chip application solutions or with microcontrollers.

It has the following advantages:

- Allows disabling of debug features
- Robust flash protection
- Allows customer-proprietary functionality to be implemented in on-chip programmable blocks

The debug circuits are enabled by default and can be disabled in firmware. If they are 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. Thus firmware control of debugging cannot be over-ridden without erasing the firmware thus providing security.

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. All programming, debug, and test interfaces are disabled when maximum device security is enabled. Therefore, PSoC™ 4100S, with device security enabled, may not be returned for failure analysis. This is a trade-off the PSoC™ 4100S allows the customer to make.

### 1.1 CPU and memory subsystem

#### 1.1.1 CPU

The Cortex®-M0+ CPU in the PSoC™ 4100S is part of the 32-bit MCU subsystem, which is optimized for low-power operation with extensive clock gating. Most instructions are 16 bits in length and the CPU executes a subset of the Thumb-2 instruction set. It includes a nested vectored interrupt controller (NVIC) block with eight interrupt inputs and also includes a wakeup interrupt controller (WIC). The WIC can wake the processor from Deep Sleep mode, allowing power to be switched off to the main processor when the chip is in Deep Sleep mode.

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

#### 1.1.2 Flash

The PSoC™ 4100S device has a flash module with a flash accelerator, tightly coupled to the CPU to improve average access times from the flash block. The low-power flash block is designed to deliver two wait state (WS) access time at 48 MHz. The flash accelerator delivers 85% of single-cycle SRAM access performance on average.

#### 1.1.3 SRAM

8 KB of SRAM are provided with zero wait state access at 48 MHz.

#### 1.1.4 SROM

An 8 KB supervisory ROM that contains boot and configuration routines is provided.

## 1.2 System resources

### 1.2.1 Power system

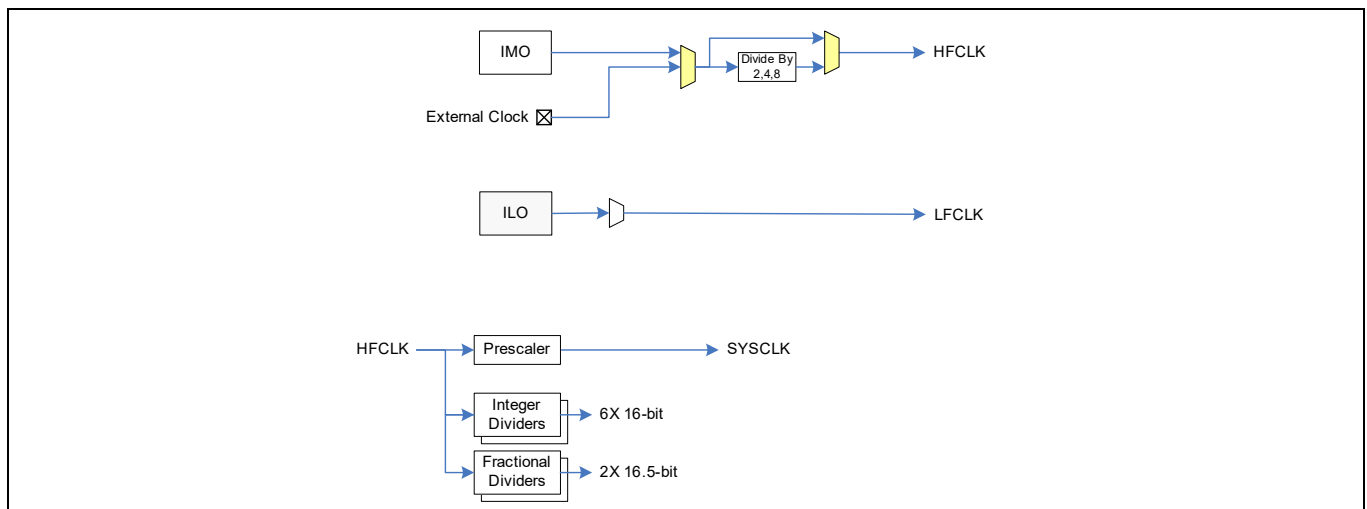
The power system is described in detail in the section “Power” on page 16. It provides assurance that voltage levels are as required for each respective mode and either delays mode entry (for example, on power-on reset (POR)) until voltage levels are as required for proper functionality, or generates resets (for example, on brown-out detection). The PSoC™ 4100S operates with a single external supply over the range of either 1.8 V  $\pm$ 5% (externally regulated) or 1.8 to 5.5 V (internally regulated) and has three different power modes, transitions between which are managed by the power system. The PSoC™ 4100S provides Active, Sleep, and Deep Sleep low-power modes.

All subsystems are operational in Active mode. The CPU subsystem (CPU, flash, and SRAM) is clock-gated off in Sleep mode, while all peripherals and interrupts are active with instantaneous wake-up on a wake-up event. In Deep Sleep mode, the high-speed clock and associated circuitry is switched off; wake-up from this mode takes 35  $\mu$ s. The opamps can remain operational in Deep Sleep mode.

### 1.2.2 Clock system

The PSoC™ 4100S 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 there are no metastable conditions.

The clock system for the PSoC™ 4100S consists of the internal main oscillator (IMO), internal low-speed oscillator (ILO), a 32 kHz watch crystal oscillator (WCO) and provision for an external clock. Clock dividers are provided to generate clocks for peripherals on a fine-grained basis. Fractional dividers are also provided to enable clocking of higher data rates for UARTs.



**Figure 2** Clocking architecture

The HFCLK signal can be divided down to generate synchronous clocks for the analog and digital peripherals. There are eight clock dividers for the PSoC™ 4100S; two of those are fractional dividers. The 16-bit capability allows flexible generation of fine-grained frequency values and is fully supported in PSoC™ Creator

### 1.2.3 IMO clock source

The IMO is the primary source of internal clocking in the PSoC™ 4100S. It is trimmed during testing to achieve the specified accuracy. The IMO default frequency is 24 MHz and it can be adjusted from 24 to 48 MHz in steps of 4 MHz. The IMO tolerance with Infineon-provided calibration settings is  $\pm$ 2%.

### 1.2.4 ILO clock source

The ILO is a very low power, nominally 40-kHz oscillator, which is primarily used to generate clocks for the watchdog timer (WDT) and peripheral operation in Deep Sleep mode. ILO-driven counters can be calibrated to the IMO to improve accuracy. Infineon provides a software component, which does the calibration.

### 1.2.5 Watch crystal oscillator (WCO)

The PSoC™ 4100S clock subsystem also implements a low-frequency (32-kHz watch crystal) oscillator that can be used for precision timing applications.

### 1.2.6 Watchdog timer

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

### 1.2.7 Reset

The PSoC™ 4100S 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 by asserting it active low. The XRES pin has an internal pull-up resistor that is always enabled.

## 1.3 Analog blocks

### 1.3.1 12-bit successive approximation register (SAR) ADC

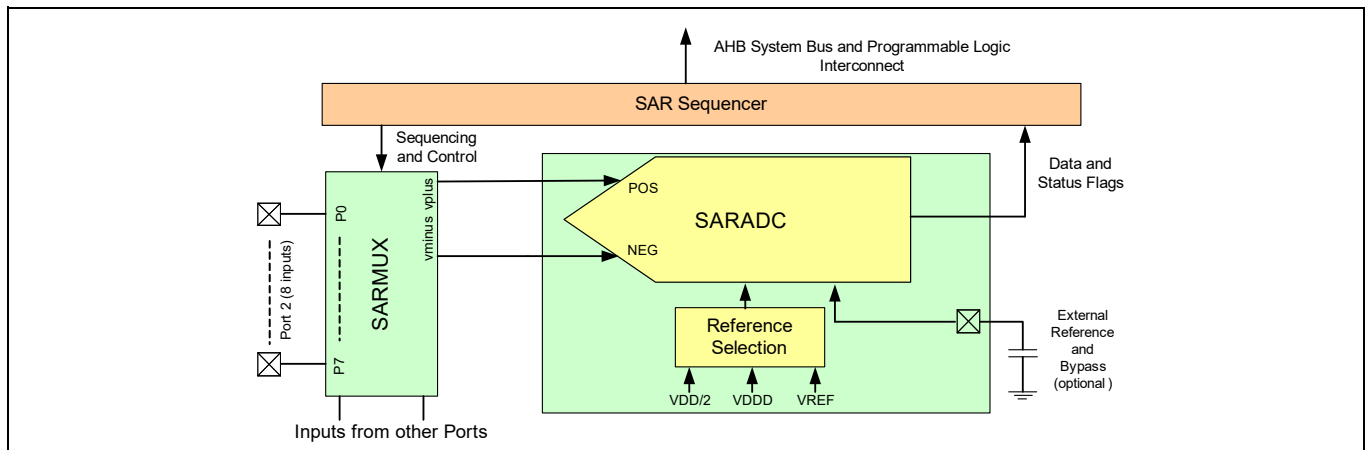
The 12-bit, 1-Msps SAR ADC can operate at a maximum clock rate of 18 MHz and requires a minimum of 18 clocks at that frequency to do a 12-bit conversion.

The 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. It is possible to provide an external bypass (through a fixed pin location) for the internal reference amplifier.

The SAR is connected to a fixed set of pins through an 8-input sequencer. The sequencer cycles through selected channels autonomously (sequencer scan) with zero switching overhead (that is, 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. Also, signal range specification through a pair of range registers (low and high range values) is implemented with a corresponding out-of-range interrupt if the digitized value exceeds the programmed range; this allows fast detection of out-of-range values without the necessity of having to wait for a sequencer scan to be completed and the CPU to read the values and check for out-of-range values in software.

The SAR is not available in Deep Sleep mode as it requires a high-speed clock (up to 18 MHz). The SAR operating range is 1.71 V to 5.5 V.

## Functional overview



**Figure 3 SAR ADC**

### 1.3.2 Two opamps (Continuous-time block; CTB)

The PSoC™ 4100S has two opamps with Comparator modes which allow most common analog functions to be performed on-chip eliminating external components; PGAs, Voltage Buffers, Filters, Trans-Impedance Amplifiers, and other functions can be realized, in some cases 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.

### 1.3.3 Low-power comparators (LPC)

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

### 1.3.4 Current DACs

The PSoC™ 4100S has two IDACs, which can drive any of the pins on the chip. These IDACs have programmable current ranges.

### 1.3.5 Analog multiplexed buses

The PSoC™ 4100S has two concentric independent buses that go around the periphery of the chip. These buses (called amux buses) are connected to firmware-programmable analog switches that allow the chip's internal resources (IDACs, comparator) to connect to any pin on the I/O Ports.

### 1.3.6 Programmable digital blocks

The Programmable I/O (Smart I/O) block is a fabric of switches and LUTs that allows Boolean functions to be performed in signals being routed to the pins of a GPIO port. The Smart I/O can perform logical operations on input pins to the chip and on signals going out as outputs.



## 1.4 Fixed function digital

### 1.4.1 Timer/counter/PWM (TCPWM) block

The TCPWM block consists of a 16-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 that 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 that are used as PWM duty cycle outputs. The block also provides true and complementary outputs with programmable offset between them to allow use as dead-band 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 over-current state is indicated and the PWM driving the FETs needs to be shut off immediately with no time for software intervention. There are five TCPWM blocks in the PSoC™ 4100S.

### 1.4.2 Serial communication block (SCB)

The PSoC™ 4100S has three serial communication blocks, which can be programmed to have SPI, I2C, UART or LIN Slave functionality.

**I<sup>2</sup>C Mode:** The hardware I<sup>2</sup>C block implements a full multi-master and slave interface (it is capable of multi-master 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 EZI2C that creates a mailbox address range in the memory of the PSoC™ 4100S and effectively reduces I<sup>2</sup>C 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 I<sup>2</sup>C peripheral is compatible with the I<sup>2</sup>C Standard-mode and Fast-mode devices as defined in the NXP I<sup>2</sup>C-bus specification and user manual (UM10204). The I<sup>2</sup>C bus I/O is implemented with GPIO in open-drain modes.

The PSoC™ 4100S is not completely compliant with the I<sup>2</sup>C spec in the following respect:

- GPIO cells are not overvoltage tolerant and, therefore, cannot be hot-swapped or powered up independently of the rest of the I<sup>2</sup>C system.

**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 (adds a start pulse used to synchronize SPI Codecs), and National Microwire (half-duplex form of SPI). The SPI block can use the FIFO.

## 1.5 LIN slave mode

The LIN Slave mode uses the SCB hardware block and implements a full LIN slave interface. This LIN Slave is compliant with LIN v1.3, v2.1/2.2, ISO 17987-6, and SAE J2602-2 specification standards. It is certified by C&S GmbH based on the standard protocol and data link layer conformance tests. LIN slave can be operated at baud rates of up to ~20 Kbps with a maximum of 40-meter cable length. PSoC™ Creator software supports up to two LIN slave interfaces in the PSoC™ 4 device, providing built-in application programming interfaces (APIs) based on the LIN specification standard.

## 1.6 GPIO

The PSoC™ 4100S has up to 38 GPIOs.

The GPIO block implements the following:

- Eight drive modes:
  - Analog input mode (input and output buffers disabled)
  - Input only
  - Weak pull-up with strong pull-down
  - Strong pull-up with weak pull-down
  - Open drain with strong pull-down
  - Open drain with strong pull-up
  - Strong pull-up with strong pull-down
  - Weak pull-up with weak pull-down
- Input threshold select (CMOS or LVTTL).
- Individual control of input and output buffer enabling/disabling in addition to the drive strength 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 disabled 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.

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 (5 for PSoC™ 4100S).

## **1.7 Special function peripherals**

### **1.7.1 CAPSENSE™**

CAPSENSE™ is supported in the PSoC™ 4100S through a CSD block that can be connected to any pins through an analog multiplex bus via analog switches. CAPSENSE™ function can thus be provided on any available pin or group of pins in a system under software control. A PSoC™ Creator component is provided for the CAPSENSE™ block to make it easy for the user.

Shield voltage can be driven on another analog multiplex 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. Proximity sensing can also be implemented.

The CAPSENSE™ 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 CAPSENSE™ block also provides a 10-bit Slope ADC function which can be used in conjunction with the CAPSENSE™ function.

The CAPSENSE™ block is an advanced, low-noise, programmable block with programmable voltage references and current source ranges for improved sensitivity and flexibility. It can also use an external reference voltage. It has a full-wave CSD mode that alternates sensing to VDDA and ground to null out power-supply related noise.

### **1.7.2 LCD segment drive**

The PSoC™ 4100S has an LCD controller, which can drive up to 4 commons and up to 32 segments. 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 drive 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 to 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. LCD operation is supported during Deep Sleep refreshing a small display buffer (4 bits; 1 32-bit register per port).

## 2 Pinouts

**Table 1** provides the pin list for PSoC™ 4100S for the for the 8-pin QFN, 40-pin QFN, 28-pin SSOP, and 24-pin QFN packages. All port pins support GPIO.

**Table 1** Pin list

48-QFN-Auto		40-QFN-Auto		28-SSOP-Auto		24-QFN-Auto-2	
Pin	Name	Pin	Name	Pin	Name	Pin	Name
28	P0.0	22	P0.0	19	P0.0	13	P0.0
29	P0.1	23	P0.1	20	P0.1	14	P0.1
30	P0.2	24	P0.2	21	P0.2		
31	P0.3	25	P0.3	22	P0.3		
32	P0.4	26	P0.4			15	P0.4
33	P0.5	27	P0.5			16	P0.5
34	P0.6	28	P0.6	23	P0.6	17	P0.6
35	P0.7	29	P0.7	24	P0.7		
36	XRES	30	XRES	25	XRES	18	XRES
37	VCCD	31	VCCD	26	VCCD	19	VCCD
38	VSSD	32	VSSD	27	VSS	20	VSSD
39	VDDD	33	VDD	28	VDD	21	VDD
40	VDDA	33	VDD				
41	VSSA	34	VSSA			22	VSSA
42	P1.0	35	P1.0	1	P1.0		
43	P1.1	36	P1.1	2	P1.1		
44	P1.2	37	P1.2	3	P1.2	23	P1.2
45	P1.3	38	P1.3	4	P1.3	24	P1.3
46	P1.4	39	P1.4	5	P1.4		
47	P1.5						
48	P1.6						
1	P1.7/VREF	40	P1.7/VREF	6	P1.7/VREF	1	P1.7/VREF
2	P2.0	1	P2.0			2	P2.0
3	P2.1	2	P2.1			3	P2.1
4	P2.2	3	P2.2				
5	P2.3	4	P2.3				
6	P2.4	5	P2.4	7	P2.4		
7	P2.5	6	P2.5	8	P2.5		
8	P2.6	7	P2.6	9	P2.6	4	P2.6
9	P2.7	8	P2.7	10	P2.7	5	P2.7
12	VSSD	9	VSSD				
13	P3.0	10	P3.0	11	P3.0	6	P3.0
14	P3.1	11	P3.1	12	P3.1		
15	P3.2	12	P3.2	13	P3.2	7	P3.2
16	P3.3	13	P3.3	14	P3.3	8	P3.3

## Pinouts

**Table 1** Pin list (continued)

48-QFN-Auto		40-QFN-Auto		28-SSOP-Auto		24-QFN-Auto-2	
Pin	Name	Pin	Name	Pin	Name	Pin	Name
17	P3.4	14	P3.4				
18	P3.5	15	P3.5				
19	P3.6	16	P3.6				
20	P3.7	17	P3.7				
21	VDDD						
22	P4.0	18	P4.0	15	P4.0	9	P4.0
23	P4.1	19	P4.1	16	P4.1	10	P4.1
24	P4.2	20	P4.2	17	P4.2	11	P4.2
25	P4.3	21	P4.3	18	P4.3	12	P4.3
10	NC						
11	NC						
26	NC						
27	NC						

**The power pins description is as follows:**

VDDD: Power supply for the digital section.

VDDA: Power supply for the analog section.

VSSD, VSSA: Ground pins for the digital and analog sections respectively.

VCCD: Regulated digital supply (1.8 V ± 5%)

VDD: On some packages, VDDA and VDDD are shorted inside and brought out as a single power supply

NC: No connection

## 2.1 Alternate pin functions

Each port pin has can be assigned to one of multiple functions. For example, it can be an analog I/O, a digital peripheral function, an LCD pin, or a CAPSENSE™ pin.

**Table 2** provides the pin assignments.

**Table 2** Alternate pin functions

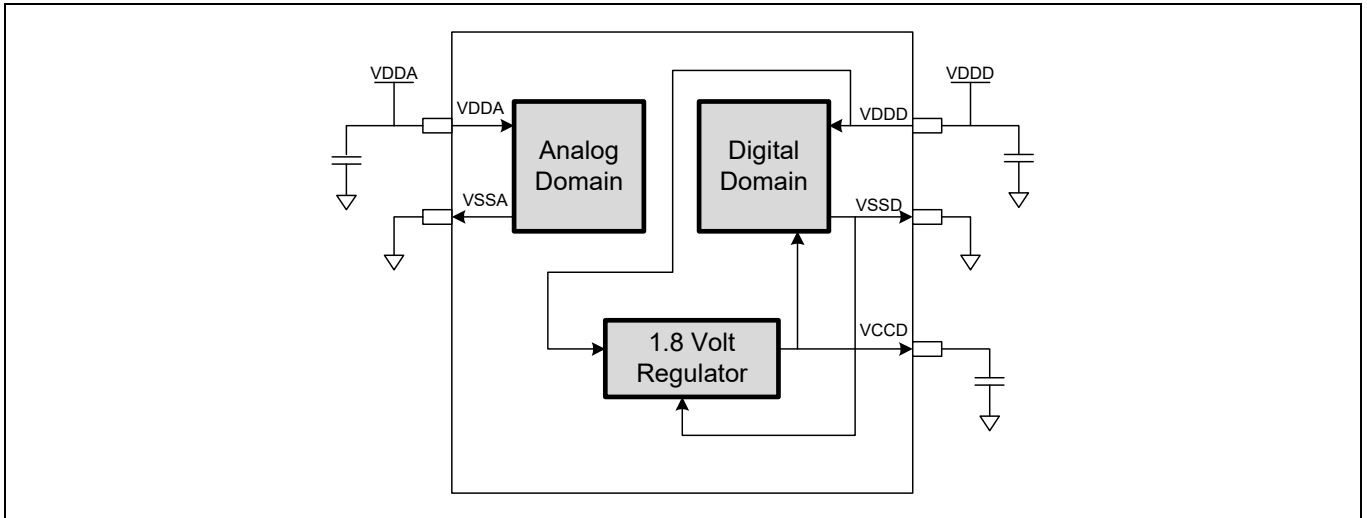
Name	Analog	Smart I/O	Alternate Function 1	Alternate Function 2	Alternate Function 3	Deep Sleep 1	Deep Sleep 2	Deep Sleep 3	Deelp Sleep 4
P0.0	lpcomp.in_p[0]			scb[2].uart_cts:0	tcpwm.tr_in[0]	lcd.com[0]	lcd.seg[0]	scb[2].i2c_scl:0	scb[0].spi_select1:0
P0.1	lpcomp.in_n[0]			scb[2].uart_rts:0	tcpwm.tr_in[1]	lcd.com[1]	lcd.seg[1]	scb[2].i2c_sda:0	scb[0].spi_select2:0
P0.2	lpcomp.in_p[1]					lcd.com[2]	lcd.seg[2]		scb[0].spi_select3:0
P0.3	lpcomp.in_n[1]					lcd.com[3]	lcd.seg[3]		scb[2].spi_select0
P0.4	wco.wco_in			scb[1].uart_rx:0	scb[2].uart_rx:0	lcd.com[4]	lcd.seg[4]	scb[1].i2c_scl:0	scb[1].spi_mosi:1
P0.5	wco.wco_out			scb[1].uart_tx:0	scb[2].uart_tx:0	lcd.com[5]	lcd.seg[5]	scb[1].i2c_sda:0	scb[1].spi_miso:1
P0.6	srss.adft_por_pad_hv		srss.ext_clk	scb[1].uart_cts:0	scb[2].uart_tx:1	lcd.com[6]	lcd.seg[6]		scb[1].spi_clk:1
P0.7			tcpwm.line[0]:2	scb[1].uart_rts:0		lcd.com[7]	lcd.seg[7]		scb[1].spi_select0:1
P1.0	pass.ctb0_pads[0]		tcpwm.line[2]:1	scb[0].uart_rx:1		lcd.com[8]	lcd.seg[8]	scb[0].i2c_scl:0	scb[0].spi_mosi:1
P1.1	pass.ctb0_pads[1]		tcpwm.line_- compl[2]:1	scb[0].uart_tx:1		lcd.com[9]	lcd.seg[9]	scb[0].i2c_sda:0	scb[0].spi_miso:1
P1.2	pass.ctb0_pads[2] pass.ctb0_oa0_out_10x		tcpwm.line[3]:1	scb[0].uart_cts:1	tcpwm.tr_in[2]	lcd.com[10]	lcd.seg[10]	scb[2].i2c_scl:1	scb[0].spi_clk:1
P1.3	pass.ctb0_pads[3] pass.ctb0_oa1_out_10x		tcpwm.line_- compl[3]:1	scb[0].uart_rts:1	tcpwm.tr_in[3]	lcd.com[11]	lcd.seg[11]	scb[2].i2c_sda:1	scb[0].spi_select0:1
P1.4	pass.ctb0_pads[4]					lcd.com[12]	lcd.seg[12]		scb[0].spi_select1:1
P1.5	pass.ctb0_pads[5]					lcd.com[13]	lcd.seg[13]		scb[0].spi_select2:1
P1.6	pass.ctb0_pads[6]					lcd.com[14]	lcd.seg[14]		scb[0].spi_select3:1
P1.7	pass.ctb0_pads[7] pass.sar_ext_vref0 pass.sar_ext_vref1					lcd.com[15]	lcd.seg[15]		scb[2].spi_clk
P2.0	pass.sarmux_pads[0]	prgio[0].io[0]	tcpwm.line[4]:0	csd.comp	tcpwm.tr_in[4]	lcd.com[16]	lcd.seg[16]	scb[1].i2c_scl:1	scb[1].spi_mosi:2
P2.1	pass.sarmux_pads[1]	prgio[0].io[1]	tcpwm.line_- compl[4]:0		tcpwm.tr_in[5]	lcd.com[17]	lcd.seg[17]	scb[1].i2c_sda:1	scb[1].spi_miso:2
P2.2	pass.sarmux_pads[2]	prgio[0].io[2]				lcd.com[18]	lcd.seg[18]		scb[1].spi_clk:2

**Table 2** Alternate pin functions (continued)

Name	Analog	Smart I/O	Alternate Function 1	Alternate Function 2	Alternate Function 3	Deep Sleep 1	Deep Sleep 2	Deep Sleep 3	Deep Sleep 4
P2.3	pass.sarmux_pads[3]	prgio[0].io[3]				lcd.com[19]	lcd.seg[19]		scb[1].spi_select0:2
P2.4	pass.sarmux_pads[4]	prgio[0].io[4]	tcpwm.line[0]:1			lcd.com[20]	lcd.seg[20]		scb[1].spi_select1:1
P2.5	pass.sarmux_pads[5]	prgio[0].io[5]	tcpwm.line_- compl[0]:1			lcd.com[21]	lcd.seg[21]		scb[1].spi_select2:1
P2.6	pass.sarmux_pads[6]	prgio[0].io[6]	tcpwm.line[1]:1			lcd.com[22]	lcd.seg[22]		scb[1].spi_select3:1
P2.7	pass.sarmux_pads[7]	prgio[0].io[7]	tcpwm.line_- compl[1]:1			lcd.com[23]	lcd.seg[23]	lpcomp.comp[0]:1	scb[2].spi_mosi
P3.0		prgio[1].io[0]	tcpwm.line[0]:0	scb[1].uart_rx:1		lcd.com[24]	lcd.seg[24]	scb[1].i2c_scl:2	scb[1].spi_mosi:0
P3.1		prgio[1].io[1]	tcpwm.line_- compl[0]:0	scb[1].uart_tx:1		lcd.com[25]	lcd.seg[25]	scb[1].i2c_sda:2	scb[1].spi_miso:0
P3.2		prgio[1].io[2]	tcpwm.line[1]:0	scb[1].uart_cts:1		lcd.com[26]	lcd.seg[26]	cpuss.swd_data	scb[1].spi_clk:0
P3.3		prgio[1].io[3]	tcpwm.line_- compl[1]:0	scb[1].uart_rts:1		lcd.com[27]	lcd.seg[27]	cpuss.swd_clk	scb[1].spi_select0:0
P3.4		prgio[1].io[4]	tcpwm.line[2]:0		tcpwm.tr_in[6]	lcd.com[28]	lcd.seg[28]		scb[1].spi_select1:0
P3.5		prgio[1].io[5]	tcpwm.line_- compl[2]:0			lcd.com[29]	lcd.seg[29]		scb[1].spi_select2:0
P3.6		prgio[1].io[6]	tcpwm.line[3]:0			lcd.com[30]	lcd.seg[30]		scb[1].spi_select3:0
P3.7		prgio[1].io[7]	tcpwm.line_- compl[3]:0			lcd.com[31]	lcd.seg[31]	lpcomp.comp[1]:1	scb[2].spi_miso
P4.0	csd.vref_ext			scb[0].uart_rx:0		lcd.com[32]	lcd.seg[32]	scb[0].i2c_scl:1	scb[0].spi_mosi:0
P4.1	csd.cshieldpads			scb[0].uart_tx:0		lcd.com[33]	lcd.seg[33]	scb[0].i2c_sda:1	scb[0].spi_miso:0
P4.2	csd.cmodpads csd.cmodpadd			scb[0].uart_cts:0		lcd.com[34]	lcd.seg[34]	lpcomp.comp[0]:0	scb[0].spi_clk:0
P4.3	csd.csh_tankpads csd.csh_tankpadd			scb[0].uart_rts:0		lcd.com[35]	lcd.seg[35]	lpcomp.comp[1]:0	scb[0].spi_select0:0

### 3 Power

**Figure 4** illustrates the set of power supply pins as implemented for the PSoC™ 4100S. The system has one regulator in Active mode for the digital circuitry. There is no analog regulator; the analog circuits run directly from the  $V_{DDA}$  input.



**Figure 4** Power supply connections

There are two distinct modes of operation. In Mode 1, the supply voltage range is 1.8 V to 5.5 V (unregulated externally; internal regulator operational). In Mode 2, the supply range is  $1.8 \text{ V} \pm 5\%$  (externally regulated; 1.71 to 1.89, internal regulator bypassed).

#### 3.1 Mode 1: 1.8 V to 5.5 V external supply

In this mode, the PSoC™ 4100S 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 example, the chip can be powered from a battery system that starts at 3.5 V and works down to 1.8 V. In this mode, the internal regulator of the PSoC™ 4100S supplies the internal logic and its output is connected to the VCCD pin. The VCCD pin must be bypassed to ground via an external capacitor (0.1  $\mu\text{F}$ ; X5R ceramic or better) and must not be connected to anything else.

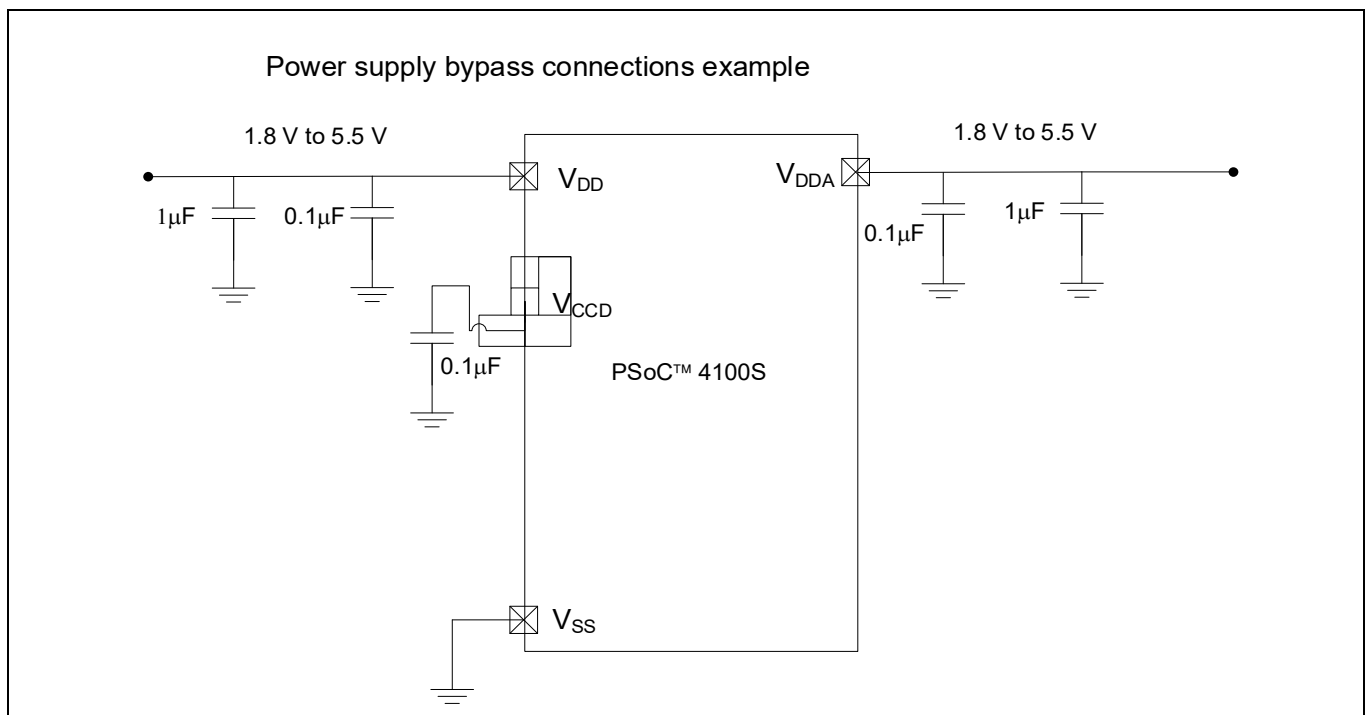


### 3.2 Mode 2: 1.8 V $\pm$ 5% external supply

In this mode, the PSoC™ 4100S is powered by an external power supply that must be within the range of 1.71 to 1.89 V; note that this range needs to include the power supply ripple too. In this mode, the VDD and VCCD pins are shorted together and bypassed.

Bypass capacitors must be used from VDDD to ground. The typical practice for systems in this frequency range is to use a capacitor in the 1- $\mu$ F range, in parallel with a smaller capacitor (0.1  $\mu$ F, 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.

On some packages, V<sub>DDD</sub> and V<sub>DDA</sub> pins are shorted inside the package and brought out as a generic V<sub>DD</sub> pin. In that case, only 0.1  $\mu$ F and 1  $\mu$ F decoupling capacitors are required on the V<sub>DD</sub> pin. [Figure 5](#) illustrates an example of a bypass scheme.



**Figure 5** External supply range from 1.8 V to 5.5 V with internal regulator active

## 4 Development support

The PSoC™ 4100S family has a rich set of documentation, development tools, and online resources to assist you during your development process. Visit [www.infineon.com/psoc4](http://www.infineon.com/psoc4) to find out more.

### 4.1 Documentation

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

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

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

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

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

### 4.2 Online

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

### 4.3 Tools

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

## 5 Electrical specifications

### 5.1 Absolute maximum ratings

Table 3 Absolute maximum ratings<sup>[2]</sup>

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/ conditions
SID1	V <sub>DDD_ABS</sub>	Digital supply relative to V <sub>SS</sub>	-0.5	-	6	V	-
SID2	V <sub>CCD_ABS</sub>	Direct digital core voltage input relative to V <sub>SS</sub>	-0.5	-	1.95		-
SID3	V <sub>GPIO_ABS</sub>	GPIO voltage	-0.5	-	V <sub>DD</sub> +0.5		-
SID4	I <sub>GPIO_ABS</sub>	Maximum current per GPIO	-25	-	25	mA	-
SID5	I <sub>GPIO_injection</sub>	GPIO injection current, Max for V <sub>IH</sub> > V <sub>DDD</sub> , and Min for V <sub>IL</sub> < V <sub>SS</sub>	-0.5	-	0.5		Current injected per pin
BID44	ESD_HBM	Electrostatic discharge human body model	2200	-	-	V	-
BID45	ESD_CDM	Electrostatic discharge charged device model	500	-	-		-
BID46	LU	Pin current for latch-up	-140	-	140	mA	-

#### Note

- Usage above the absolute maximum conditions listed in [Table 3](#) 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.

## Electrical specifications

## 5.2 Device-level specifications

All specifications are valid for  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$  for Grade-A devices,  $-40^{\circ}\text{C} \leq T_A \leq 105^{\circ}\text{C}$  for Grade-S devices, and  $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$  for Grade-E devices. Specifications are valid for 1.71 V to 5.5 V, except where noted.<sup>[3]</sup>

### 5.2.1 DC specifications

**Table 4 DC specifications**

Typical values measured at  $V_{DD} = 3.3\text{ V}$  and  $25^{\circ}\text{C}$ .

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/ conditions
SID53	$V_{DD}$	Power supply input voltage	1.8	–	5.5	V	Internally regulated supply
SID255	$V_{DD}$	Power supply input voltage ( $V_{CCD} = V_{DDD} = V_{DDA}$ )	1.71	–	1.89		Internally unregulated supply
SID54	$V_{CCD}$	Output voltage (for core logic)	–	1.8	–		–
SID55	$C_{EFC}$	External regulator voltage bypass	–	0.1	–	$\mu\text{F}$	X5R ceramic or better
SID56	$C_{EXC}$	Power supply bypass capacitor	–	1	–		X5R ceramic or better

#### Active Mode, $V_{DD} = 1.8\text{ V to }5.5\text{ V}$ . Typical values measured at $V_{DD} = 3.3\text{ V}$ and $25^{\circ}\text{C}$ .

SID10	$I_{DD5}$	Execute from flash; CPU at 6 MHz	–	1.8	2.7	mA	Max is at $125^{\circ}\text{C}$ and $5.5\text{ V}$
SID16	$I_{DD8}$	Execute from flash; CPU at 24 MHz	–	3.0	4.75		Max is at $125^{\circ}\text{C}$ and $5.5\text{ V}$
SID19	$I_{DD11}$	Execute from flash; CPU at 48 MHz	–	5.4	6.85		Max is at $125^{\circ}\text{C}$ and $5.5\text{ V}$

#### Sleep Mode, $V_{DDD} = 1.8\text{ V to }5.5\text{ V}$ (Regulator on)

SID22	$I_{DD17}$	$I^2\text{C}$ wakeup WDT, and Comparators on	–	1.7	2.2	mA	6 MHz. Max is at $125^{\circ}\text{C}$ and $5.5\text{ V}$ .
SID25	$I_{DD20}$	$I^2\text{C}$ wakeup, WDT, and Comparators on.	–	2.2	2.5		12 MHz. Max is at $125^{\circ}\text{C}$ and $5.5\text{ V}$ .

#### Sleep Mode, $V_{DDD} = 1.71\text{ V to }1.89\text{ V}$ (Regulator bypassed)

SID28	$I_{DD23}$	$I^2\text{C}$ wakeup, WDT, and Comparators on	–	0.7	0.9	mA	6 MHz. Max is at $125^{\circ}\text{C}$ and $5.5\text{ V}$ .
SID28A	$I_{DD23A}$	$I^2\text{C}$ wakeup, WDT, and Comparators on	–	1.0	1.2	mA	12 MHz. Max is at $125^{\circ}\text{C}$ and $5.5\text{ V}$ .

#### Deep Sleep Mode, $V_{DD} = 1.8\text{ V to }3.6\text{ V}$ (Regulator on)

SID31	$I_{DD26}$	$I^2\text{C}$ wakeup and WDT on	–	2.5	150	$\mu\text{A}$	Max is at $3.6\text{ V}$ and $125^{\circ}\text{C}$ .
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#### Note

3. This device is not AEC-Q100 Grade 0 qualified, so Infineon does not guarantee performance at  $+150^{\circ}\text{C}$ . The specifications for  $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$  are best estimates of the performance.

## Electrical specifications

**Table 4** DC specifications (continued)Typical values measured at  $V_{DD} = 3.3\text{ V}$  and  $25^\circ\text{C}$ .

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/ conditions
<b>Deep Sleep Mode, <math>V_{DD} = 3.6\text{ V}</math> to <math>5.5\text{ V}</math> (Regulator on)</b>							
SID34	$I_{DD29}$	I <sup>2</sup> C wakeup and WDT on	–	2.5	150	μA	Max is at 5.5 V and 125°C.
<b>Deep Sleep Mode, <math>V_{DD} = V_{CCD} = 1.71\text{ V}</math> to <math>1.89\text{ V}</math> (Regulator bypassed)</b>							
SID37	$I_{DD32}$	I <sup>2</sup> C wakeup and WDT on	–	2.5	160	μA	Max is at 1.89 V and 125°C.
<b>XRES Current</b>							
SID307	$I_{DD\_XR}$	Supply current while XRES asserted	–	2	5	mA	–

**5.2.2 AC specifications****Table 5** AC specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/ conditions
SID48	$F_{CPU}$	CPU frequency	DC	–	48	MHz	$1.71 \leq V_{DD} \leq 5.5$
SID49 <sup>[4]</sup>	$T_{SLEEP}$	Wakeup from Sleep mode	–	0	–	μs	–
SID50 <sup>[4]</sup>	$T_{DEEPSLEEP}$	Wakeup from Deep Sleep mode	–	35	–		–

**Note**

4. Guaranteed by characterization.

## Electrical specifications

## 5.2.3 GPIO

Table 6 GPIO DC specifications

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions	
SID57	$V_{IH}^{[5]}$	Input voltage high threshold	$0.7 \times V_{DDD}$	-	-	V	CMOS Input	
SID58	$V_{IL}$	Input voltage low threshold	-	-	$0.3 \times V_{DDD}$		CMOS Input	
SID241	$V_{IH}^{[5]}$	LVTTL input, $V_{DDD} < 2.7 V$	$0.7 \times V_{DDD}$	-	-		-	
SID242	$V_{IL}$	LVTTL input, $V_{DDD} < 2.7 V$	-	-	$0.3 \times V_{DDD}$		-	
SID243	$V_{IH}^{[5]}$	LVTTL input, $V_{DDD} \geq 2.7 V$	2.0	-	-		-	
SID244	$V_{IL}$	LVTTL input, $V_{DDD} \geq 2.7 V$	-	-	0.8		-	
SID59	$V_{OH}$	Output voltage high level	$V_{DDD} - 0.6$	-	-		$I_{OH} = 4 \text{ mA at } 3 V V_{DDD}$	
SID60	$V_{OH}$	Output voltage high level	$V_{DDD} - 0.5$	-	-		$I_{OH} = 1 \text{ mA at } 1.8 V V_{DDD}$	
SID61	$V_{OL}$	Output voltage low level	-	-	0.6		$I_{OL} = 4 \text{ mA at } 1.8 V V_{DDD}$	
SID62	$V_{OL}$	Output voltage low level	-	-	0.6		$I_{OL} = 10 \text{ mA at } 3 V V_{DDD}$	
SID62A	$V_{OL}$	Output voltage low level	-	-	0.4		$I_{OL} = 3 \text{ mA at } 3 V V_{DDD}$	
SID63	$R_{PULLUP}$	Pull-up resistor	3.5	5.6	8.5		kΩ	$-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$
SID63A	$R_{PULLUP}$	Pull-up resistor	3	-	-			$125^\circ\text{C} < T_A \leq 150^\circ\text{C}$
SID64	$R_{PULLDOWN}$	Pull-down resistor	3.5	5.6	8.5			$-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$
SID64A	$R_{PULLDOWN}$	Pull-down resistor	3	-	-	$125^\circ\text{C} < T_A \leq 150^\circ\text{C}$		
SID65	$I_{IL}$	Input leakage current (absolute value)	-	-	2	nA	$25^\circ\text{C}, V_{DDD} = 3.0 V$	
SID66	$C_{IN}$	Input capacitance	-	-	7	pF	-	
SID67 <sup>[6]</sup>	$V_{HYSTTL}$	Input hysteresis LVTTL	25	40	-	mV	$V_{DDD} \geq 2.7 V, -40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$	
SID67A <sup>[6]</sup>	$V_{HYSTTL}$	Input hysteresis LVTTL	7.5	-	-		$125^\circ\text{C} < T_A \leq 150^\circ\text{C}$	
SID68 <sup>[6]</sup>	$V_{HYSCMOS}$	Input hysteresis CMOS	$0.05 \times V_{DDD}$	-	-		$V_{DD} < 4.5 V$	
SID68A <sup>[6]</sup>	$V_{HYSCMOS5V5}$	Input hysteresis CMOS	200	-	-		$V_{DD} > 4.5 V$	
SID69 <sup>[6]</sup>	$I_{DIODE}$	Current through protection diode to $V_{DD}/V_{SS}$	-	-	100	μA	-	
SID69A <sup>[6]</sup>	$I_{TOT\_GPIO}$	Maximum total source or sink chip current	-	-	200	mA	-	

## Notes

5.  $V_{IH}$  must not exceed  $V_{DDD} + 0.2 V$ .

6. Guaranteed by characterization.

## Electrical specifications

**Table 7 GPIO AC Specifications**

(Guaranteed by Characterization)

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, $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$
SID70A	$T_{RISEF}$	Rise time in fast strong mode	-	-	25		3.3 V $V_{DDD}$ , Cload = 25 pF, $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$
SID71	$T_{FALLF}$	Fall time in fast strong mode	2	-	12		3.3 V $V_{DDD}$ , Cload = 25 pF, $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$
SID71A	$T_{FALLF}$	Fall time in fast strong mode	-	-	25		3.3 V $V_{DDD}$ , Cload = 25 pF, $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$
SID72	$T_{RISES}$	Rise time in slow strong mode	10	-	60	-	3.3 V $V_{DDD}$ , Cload = 25 pF, $-4^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$
SID72A	$T_{RISES}$	Rise time in slow strong mode	-	-	130	ns	3.3 V $V_{DDD}$ , Cload = 25 pF, $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$
SID73	$T_{FALLS}$	Fall time in slow strong mode	10	-	60	-	3.3 V $V_{DDD}$ , Cload = 25 pF, $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$
SID73A	$T_{FALLS}$	Fall time in slow strong mode	-	-	130	ns	3.3 V $V_{DDD}$ , Cload = 25 pF, $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$
SID74	$F_{GPIOOUT1}$	GPIO $F_{OUT}$ ; $3.3\text{ V} \leq V_{DDD} \leq 5.5\text{ V}$ Fast strong mode	-	-	33	MHz	90/10%, 25-pF load, 60/40 duty cycle
SID75	$F_{GPIOOUT2}$	GPIO $F_{OUT}$ ; $1.71\text{ V} \leq V_{DDD} \leq 3.3\text{ V}$ Fast strong mode	-	-	16.7		90/10%, 25-pF load, 60/40 duty cycle
SID76	$F_{GPIOOUT3}$	GPIO $F_{OUT}$ ; $3.3\text{ V} \leq V_{DDD} \leq 5.5\text{ V}$ Slow strong mode	-	-	7		90/10%, 25-pF load, 60/40 duty cycle
SID245	$F_{GPIOOUT4}$	GPIO $F_{OUT}$ ; $1.71\text{ V} \leq V_{DDD} \leq 3.3\text{ V}$ Slow strong mode.	-	-	3.5		90/10%, 25-pF load, 60/40 duty cycle
SID246	$F_{GPIOIN}$	GPIO input operating frequency; $1.71\text{ V} \leq V_{DDD} \leq 5.5\text{ V}$	-	-	48		90/10% $V_{IO}$

Electrical specifications

## 5.2.4 XRES

**Table 8 XRES DC specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID77	V <sub>IH</sub>	Input voltage high threshold	0.7 × V <sub>DDD</sub>	–	–	V	CMOS Input
SID78	V <sub>IL</sub>	Input voltage low threshold	–	–	0.3 × V <sub>DDD</sub>		
SID79	R <sub>PULLUP</sub>	Pull-up resistor	–	60	–	kΩ	–
SID80	C <sub>IN</sub>	Input capacitance	–	–	7	pF	–
SID81 <sup>[7]</sup>	V <sub>HYSXRES</sub>	Input voltage hysteresis	–	100	–	mV	Typical hysteresis is 200 mV for V <sub>DD</sub> > 4.5 V
SID82	I <sub>DIODE</sub>	Current through protection diode to V <sub>DD</sub> /V <sub>SS</sub>	–	–	100	μA	–

**Table 9 XRES AC specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID83 <sup>[7]</sup>	T <sub>RESETWIDTH</sub>	Reset pulse width	1	–	–	μs	–
BID194 <sup>[7]</sup>	T <sub>RESETWAKE</sub>	Wake-up time from reset release	–	–	2.7	ms	–

**Note**

7. Guaranteed by characterization.



Electrical specifications

**5.3 Analog peripherals**

**5.3.1 CTBm opamp**

**Table 10 CTBm opamp specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions	
	$I_{DD}$	Opamp block current, External load						
SID269	$I_{DD\_HI}$	power = hi	-	1100	1850	μA	-	
SID270	$I_{DD\_MED}$	power = med	-	550	950		$-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$	
SID270A	$I_{DD\_MED}$	power = med	-	-	1075		$125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$	
SID271	$I_{DD\_LOW}$	power = lo	-	150	350		$-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$	
SID271A	$I_{DD\_LOW}$	power = lo	-	-	500		$125^{\circ}\text{C} < T_A \leq 15^{\circ}\text{C}$	
	$G_{BW}$	Load = 20 pF, 0.1 mA $V_{DDA} = 2.7\text{ V}$						
SID272	$G_{BW\_HI}$	power = hi	6	-	-	MHz	Input and output are 0.2 V to $V_{DDA}-0.2\text{ V}$ , $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$	
SID272A	$G_{BW\_HI}$	power = hi	4.5	-	-		$125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$	
SID273	$G_{BW\_MED}$	power = med	3	-	-		Input and output are 0.2 V to $V_{DDA}-0.2\text{ V}$ , $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$	
SID273A	$G_{BW\_MED}$	power = med	-	3	-		$125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$	
SID274	$G_{BW\_LO}$	power = lo	-	1	-		Input and output are 0.2 V to $V_{DDA}-0.2\text{ V}$	
	$I_{OUT\_MAX}$	$V_{DDA} = 2.7\text{ V}$ , 500 mV from rail						
SID275	$I_{OUT\_MAX\_HI}$	power = hi	10	-	-	mA	Output is 0.5 V, $V_{DDA}-0.5\text{ V}$	
SID276	$I_{OUT\_MAX\_MID}$	power = mid	10	-	-		Output is 0.5 V, $V_{DDA}-0.5\text{ V}$	
SID277	$I_{OUT\_MAX\_LO}$	power = lo	-	5	-		Output is 0.5 V, $V_{DDA}-0.5\text{ V}$	
	$I_{OUT}$	$V_{DDA} = 1.71\text{ V}$ , 500 mV from rail						
SID278	$I_{OUT\_MAX\_HI}$	power = hi	4	-	-	mA	Output is 0.5 V, $V_{DDA}-0.5\text{ V}$	
SID279	$I_{OUT\_MAX\_MID}$	power = mid	4	-	-		Output is 0.5 V, $V_{DDA}-0.5\text{ V}$	
SID280	$I_{OUT\_MAX\_LO}$	power = lo	-	2	-		Output is 0.5 V, $V_{DDA}-0.5\text{ V}$	
	$I_{DD\_Int}$	Opamp block current Internal Load						

## Electrical specifications

Table 10 CTBm opamp specifications (continued)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID269_I	I <sub>DD_HI_Int</sub>	power = hi	-	1500	1700	μA	-
SID270_I	I <sub>DD_MED_Int</sub>	power = med	-	700	900		-
SID271_I	I <sub>DD_LOW_Int</sub>	power = lo	-	-	-		-
	G <sub>BW</sub>	V <sub>DDA</sub> = 2.7 V					
SID272_I	G <sub>BW_HI_Int</sub>	power = hi	8	-	-	MHz	Output is 0.25 V to V <sub>DDA</sub> -0.25 V
		General opamp specs for both internal and external modes					
SID281	V <sub>IN</sub>	Charge-pump on, V <sub>DDA</sub> = 2.7 V	-0.05	-	V <sub>DDA</sub> -0.2	V	-
SID282	V <sub>CM</sub>	Charge-pump on, V <sub>DDA</sub> = 2.7 V	-0.05	-	V <sub>DDA</sub> -0.2		-
	V <sub>OUT</sub>	V <sub>DDA</sub> = 2.7 V					
SID283	V <sub>OUT_1</sub>	power = hi, Iload = 10 mA	0.5	-	V <sub>DDA</sub> -0.5	V	-
SID284	V <sub>OUT_2</sub>	power = hi, Iload = 1 mA	0.2	-	V <sub>DDA</sub> -0.2		-
SID285	V <sub>OUT_3</sub>	power = med, Iload = 1 mA	0.2	-	V <sub>DDA</sub> -0.2		-
SID286	V <sub>OUT_4</sub>	power = lo, Iload = 0.1 mA	0.2	-	V <sub>DDA</sub> -0.2		-
SID288	V <sub>OS_TR</sub>	Offset voltage, trimmed	-1.0	±0.5	1.0	mV	High mode, input 0 V to V <sub>DDA</sub> -0.2 V, -40°C ≤ T <sub>A</sub> ≤ 125°C
SID288C	V <sub>OS_TR</sub>	Offset voltage, trimmed	-1.3	-	1.3		High mode, input 0 V to V <sub>DDA</sub> -0.2 V, 125°C < T <sub>A</sub> ≤ 150°C
SID288A	V <sub>OS_TR</sub>	Offset voltage, trimmed	-	±1	-		Medium mode, input 0 V to V <sub>DDA</sub> -0.2 V
SID288B	V <sub>OS_TR</sub>	Offset voltage, trimmed	-	±2	-		Low mode, input 0 V to V <sub>DDA</sub> -0.2 V

## Electrical specifications

**Table 10** CTBm opamp specifications (continued)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID290	$V_{OS\_DR\_TR}$	Offset voltage drift, trimmed	-10	$\pm 3$	10	$\mu V/^{\circ}C$	High mode, $-40^{\circ}C \leq T_A \leq 125^{\circ}C$
SID290C	$V_{OS\_DR\_TR}$	Offset voltage drift, trimmed	-15	-	15		High mode, $125^{\circ}C < T_A \leq 150^{\circ}C$
SID290A	$V_{OS\_DR\_TR}$	Offset voltage drift, trimmed	-	$\pm 10$	-		Medium mode, $-40^{\circ}C \leq T_A \leq 125^{\circ}C$
SID290D	$V_{OS\_DR\_TR}$	Offset voltage drift, trimmed	-	$\pm 15$	-		Medium mode, $125^{\circ}C < T_A \leq 150^{\circ}C$
SID290B	$V_{OS\_DR\_TR}$	Offset voltage drift, trimmed	-	$\pm 10$	-		Low mode, $-40^{\circ}C \leq T_A \leq 125^{\circ}C$
SID290E	$V_{OS\_DR\_TR}$	Offset voltage drift, trimmed	-	$\pm 15$	-		Low mode, $125^{\circ}C < T_A \leq 150^{\circ}C$
SID291	CMRR	DC	70	80	-	dB	Input is 0 V to $V_{DDA}-0.2$ V, Output is 0.2 V to $V_{DDA}-0.2$ V
SID292	PSRR	At 1 kHz, 10-mV ripple	70	85	-		$V_{DD} = 3.6$ V, high-power mode, input is 0.2 V to $V_{DDA}-0.2$ V

## Electrical specifications

Table 10 CTBm opamp specifications (continued)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
		Noise					
SID294	VN2	Input-referred, 1 kHz, power = Hi	-	72	-	nV/rtHz	Input and output are at 0.2 V to $V_{DDA}-0.2$ V
SID295	VN3	Input-referred, 10 kHz, power = Hi	-	28	-		Input and output are at 0.2 V to $V_{DDA}-0.2$ V
SID296	VN4	Input-referred, 100 kHz, power = Hi	-	15	-		Input and output are at 0.2 V to $V_{DDA}-0.2$ V
SID297	$C_{LOAD}$	Stable up to max. load. Performance specs at 50 pF.	-	-	125	pF	-
SID298	SLEW_RATE	Clod = 50 pF, Power = High, $V_{DDA} = 2.7$ V	6	-	-	V/ $\mu$ s	-
SID299	T_OP_WAKE	From disable to enable, no external RC dominating	-	-	25	$\mu$ s	-
SID299A	OL_GAIN	Open Loop Gain	-	90	-	dB	-
	COMP_MODE	Comparator mode; 50 mV drive, $T_{rise} = T_{fall}$ (approx.)					
SID300	TPD1	Response time; power = hi	-	150	-	ns	Input is 0.2 V to $V_{DDA}-0.2$ V
SID301	TPD2	Response time; power = med	-	500	-		Input is 0.2 V to $V_{DDA}-0.2$ V
SID302	TPD3	Response time; power = lo	-	2500	-		Input is 0.2 V to $V_{DDA}-0.2$ V
SID303	VHYST_OP	Hysteresis	-	10	-	mV	-
SID304	WUP_CTB	Wake-up time from Enabled to Usable	-	-	25	$\mu$ s	-
	Deep Sleep Mode	Mode 2 is lowest current range. Mode 1 has higher GBW.					

## Electrical specifications

Table 10 CTBm opamp specifications (continued)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID_DS_1	I <sub>DD_HI_M1</sub>	Mode 1, High current	-	1400	-	μA	25°C
SID_DS_2	I <sub>DD_MED_M1</sub>	Mode 1, Medium current	-	700	-		25°C
SID_DS_3	I <sub>DD_LOW_M1</sub>	Mode 1, Low current	-	200	-		25°C
SID_DS_4	I <sub>DD_HI_M2</sub>	Mode 2, High current	-	120	-		25°C
SID_DS_5	I <sub>DD_MED_M2</sub>	Mode 2, Medium current	-	60	-		25°C
SID_DS_6	I <sub>DD_LOW_M2</sub>	Mode 2, Low current	-	15	-		25°C
SID_DS_7	G <sub>BW_HI_M1</sub>	Mode 1, High current	-	4	-	MHz	20-pF load, no DC load 0.2 V to V <sub>DDA</sub> -0.2 V
SID_DS_8	G <sub>BW_MED_M1</sub>	Mode 1, Medium current	-	2	-		20-pF load, no DC load 0.2 V to V <sub>DDA</sub> -0.2 V
SID_DS_9	G <sub>BW_LOW_M1</sub>	Mode 1, Low current	-	0.5	-		20-pF load, no DC load 0.2 V to V <sub>DDA</sub> -0.2 V
SID_DS_10	G <sub>BW_HI_M2</sub>	Mode 2, High current	-	0.5	-		20-pF load, no DC load 0.2 V to V <sub>DDA</sub> -0.2 V
SID_DS_11	G <sub>BW_MED_M2</sub>	Mode 2, Medium current	-	0.2	-		20-pF load, no DC load 0.2 V to V <sub>DDA</sub> -0.2 V
SID_DS_12	G <sub>BW_LOW_M2</sub>	Mode 2, Low current	-	0.1	-		20-pF load, no DC load 0.2 V to V <sub>DDA</sub> -0.2 V
SID_DS_13	V <sub>OS_HI_M1</sub>	Mode 1, High current	-	5	-	mV	With trim 25°C, 0.2 V to V <sub>DDA</sub> -0.2 V
SID_DS_14	V <sub>OS_MED_M1</sub>	Mode 1, Medium current	-	5	-		With trim 25°C, 0.2 V to V <sub>DDA</sub> -0.2 V
SID_DS_15	V <sub>OS_LOW_M2</sub>	Mode 1, Low current	-	5	-		With trim 25°C, 0.2 V to V <sub>DDA</sub> -0.2 V
SID_DS_16	V <sub>OS_HI_M2</sub>	Mode 2, High current	-	5	-		With trim 25°C, 0.2V to V <sub>DDA</sub> -0.2 V
SID_DS_17	V <sub>OS_MED_M2</sub>	Mode 2, Medium current	-	5	-		With trim 25°C, 0.2 V to V <sub>DDA</sub> -0.2 V
SID_DS_18	V <sub>OS_LOW_M2</sub>	Mode 2, Low current	-	5	-		With trim 25°C, 0.2 V to V <sub>DDA</sub> -0.2 V

## Electrical specifications

**Table 10** CTBm opamp specifications (continued)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID_DS_19	I <sub>OUT_HI_M1</sub>	Mode 1, High current	-	10	-	mA	Output is 0.5 V to V <sub>DDA</sub> -0.5 V
SID_DS_20	I <sub>OUT_MED_M1</sub>	Mode 1, Medium current	-	10	-		Output is 0.5 V to V <sub>DDA</sub> -0.5 V
SID_DS_21	I <sub>OUT_LOW_M1</sub>	Mode 1, Low current	-	4	-		Output is 0.5 V to V <sub>DDA</sub> -0.5 V
SID_DS_22	I <sub>OUT_HI_M2</sub>	Mode 2, High current	-	1	-		-
SID_DS_23	I <sub>OU_MED_M2</sub>	Mode 2, Medium current	-	1	-		-
SID_DS_24	I <sub>OU_LOW_M2</sub>	Mode 2, Low current	-	0.5	-		-

## Electrical specifications

## 5.3.2 Comparator

Table 11 Comparator DC specifications

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID84	V <sub>OFFSET1</sub>	Input offset voltage, Factory trim	-	-	±10	mV	Normal mode, -40°C ≤ T <sub>A</sub> ≤ 125°C
SID84A	V <sub>OFFSET1</sub>	Input offset voltage, Factory trim	-	±15	-		125°C < T <sub>A</sub> ≤ 150°C, normal mode
SID85	V <sub>OFFSET2</sub>	Input offset voltage, Custom trim	-	-	±4		Low power mode, -40°C ≤ T <sub>A</sub> ≤ 125°C
SID85A	V <sub>OFFSET2</sub>	Input offset voltage, Custom trim	-	±4	-		125°C < T <sub>A</sub> ≤ 150°C, low power mode
SID86	V <sub>HYST</sub>	Hysteresis when enabled	-	10	35		-40°C ≤ T <sub>A</sub> ≤ 125°C
SID86A	V <sub>HYST</sub>	Hysteresis when enabled	-	-	40		125°C < T <sub>A</sub> ≤ 150°C
SID87	V <sub>ICM1</sub>	Input common mode voltage in normal mode	0	-	V <sub>DDD</sub> -0.1	V	Modes 1 and 2
SID247	V <sub>ICM2</sub>	Input common mode voltage in low power mode	0	-	V <sub>DDD</sub>		-
SID247A	V <sub>ICM3</sub>	Input common mode voltage in ultra low power mode	0	-	V <sub>DDD</sub> -1.15		V <sub>DDD</sub> ≥ 2.2 V at -40°C
SID88	CMRR	Common mode rejection ratio	50	-	-	dB	V <sub>DDD</sub> ≥ 2.7 V, -40°C ≤ T <sub>A</sub> ≤ 125°C
SID88B	CMRR	Common mode rejection ratio	-	50	-		V <sub>DDD</sub> ≥ 2.7 V; 125°C < T <sub>A</sub> ≤ 150°C
SID88A	CMRR	Common mode rejection ratio	42	-	-		V <sub>DDD</sub> ≤ 2.7 V, -40°C ≤ T <sub>A</sub> ≤ 125°C
SID88C	CMRR	Common mode rejection ratio	-	42	-		V <sub>DDD</sub> ≤ 2.7 V; 125°C < T <sub>A</sub> ≤ 150°C
SID89	I <sub>CMP1</sub>	Block current, normal mode	-	-	400	μA	-
SID248	I <sub>CMP2</sub>	Block current, low power mode	-	-	100		-
SID259	I <sub>CMP3</sub>	Block current in ultra low-power mode	-	-	6		V <sub>DDD</sub> ≥ 2.2 V at -40°C
SID90	Z <sub>CMP</sub>	DC Input impedance of comparator	35	-	-	MΩ	-

Table 12 Comparator AC specifications

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID91	T <sub>RESP1</sub>	Response time, normal mode, 50 mV overdrive	-	38	110	ns	-
SID258	T <sub>RESP2</sub>	Response time, low power mode, 50 mV overdrive	-	70	200		-
SID92	T <sub>RESP3</sub>	Response time, ultra-low power mode, 200 mV overdrive	-	2.3	15	μs	V <sub>DDD</sub> ≥ 2.2 V at -40°C

## Electrical specifications

### 5.3.3 Temperature sensor

**Table 13 Temperature sensor specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID93	T <sub>SENSACC</sub>	Temperature sensor accuracy	-5	±1	5	°C	-40°C to +85°C
SID93A	T <sub>SENSACC</sub>	Temperature sensor accuracy	-15	-	+15	°C	-85°C to +150°C

### 5.3.4 SAR ADC

**Table 14 SAR ADC DC specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID94	A_RES	Resolution	-	-	12	bits	-
SID95	A_CHNLS_S	Number of channels - single ended	-	-	8		8 full speed.
SID96	A-CHNKS_D	Number of channels - differential	-	-	4		Diff inputs use neighboring I/O
SID97	A-MONO	Monotonicity	-	-	-		Yes.
SID98	A_GAINERR	Gain error	-	-	±0.1	%	With external reference.
SID99	A_OFFSET	Input offset voltage	-	-	2	mV	Measured with 1-V reference, -40°C ≤ T <sub>A</sub> ≤ 125°C
SID99A	A_OFFSET	Input offset voltage	-	-	2.7	mV	125°C < T <sub>A</sub> ≤ 150°C
SID100	A_ISAR	Current consumption	-	-	1	mA	-
SID101	A_VINS	Input voltage range - single ended	V <sub>SS</sub>	-	V <sub>DDA</sub>	V	-
SID102	A_VIND	Input voltage range - differential	V <sub>SS</sub>	-	V <sub>DDA</sub>	V	-
SID103	A_INRES	Input resistance	-	-	2.2	KΩ	-
SID104	A_INCAP	Input capacitance	-	-	10	pF	-
SID260	VREFSAR	Trimmed internal reference to SAR	-	-	TBD	V	-

**Table 15 SAR ADC AC Specifications**

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, -40°C ≤ T <sub>A</sub> ≤ 125°C
SID107A	A_CMRR	Common mode rejection ratio	-	66	-	dB	125°C < T <sub>A</sub> ≤ 150°C
SID108	A_SAMP	Sample rate	-	-	1	Msp/s	-40°C ≤ T <sub>A</sub> ≤ 125°C
SID108A	A_SAMP	Sample rate	-	-	0.375	Msp/s	125°C < T <sub>A</sub> ≤ 150°C
SID109	A_SNR	Signal-to-noise and distortion ratio (SINAD)	65	-	-	dB	F <sub>IN</sub> = 10 kHz, -40°C ≤ T <sub>A</sub> ≤ 125°C
SID109A	A_SNR	Signal-to-noise and distortion ratio (SINAD)	-	65	-	dB	125°C ≤ T <sub>A</sub> ≤ 150°C
SID110	A_BW	Input bandwidth without aliasing	-	-	A <sub>samp</sub> /2	kHz	-
SID111	A_INL	Integral non linearity. V <sub>DD</sub> = 1.71 to 5.5, 1 Msp/s	-1.7	-	2	LSB	V <sub>REF</sub> = 1 to V <sub>DD</sub> , -40°C ≤ T <sub>A</sub> ≤ 125°C



## Electrical specifications

**Table 15 SAR ADC AC Specifications** (continued)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID111A	A_INL	Integral non linearity. $V_{DD} = 1.71$ to $3.6$ , $1$ Msps	-1.5	-	1.7	LSB	$V_{REF} = 1.71$ to $V_{DD}$ , $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$
SID111B	A_INL	Integral non linearity. $V_{DD} = 1.71$ to $5.5$ , $500$ ksps	-1.5	-	1.7	LSB	$V_{REF} = 1$ to $V_{DD}$ , $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$
SID111C	A_INL	Integral non linearity. $V_{DD} = 4.5$ to $5.5$ V, $375$ ksps	-4.5	-	3.3	LSB	$V_{REF} = 1$ to $V_{DD}$ , $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$
SID111D	A_INL	Integral non linearity. $V_{DD} = 3$ to $4.5$ V, $300$ ksps	-4.5	-	3.3	LSB	$V_{REF} = 1$ to $V_{DD}$ , $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$
SID111E	A_INL	Integral non linearity. $V_{DD} = 1.71$ to $3$ V, $150$ ksps	-4.5	-	3.4	LSB	$V_{REF} = 1$ to $V_{DD}$ , $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$
SID112	A_DNL	Differential non linearity. $V_{DD} = 1.71$ to $5.5$ , $1$ Msps	-1	-	2.2	LSB	$V_{REF} = 1$ to $V_{DD}$ , $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$
SID112A	A_DNL	Differential non linearity. $V_{DD} = 1.71$ to $3.6$ , $1$ Msps	-1	-	2	LSB	$V_{REF} = 1.71$ to $V_{DD}$ , $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$
SID112B	A_DNL	Differential non linearity. $V_{DD} = 1.71$ to $5.5$ , $500$ ksps	-1	-	2.2	LSB	$V_{REF} = 1$ to $V_{DD}$ , $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$
SID112C	A_DNL	Differential non linearity. $V_{DD} = 4.5$ to $5.5$ V, $375$ ksps	-1	-	3.2	LSB	$V_{REF} = 1$ to $V_{DD}$ , $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$
SID112D	A_DNL	Differential non linearity. $V_{DD} = 3$ to $4.5$ V, $300$ ksps	-1	-	3.2	LSB	$V_{REF} = 1$ to $V_{DD}$ , $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$
SID112E	A_DNL	Differential non linearity. $V_{DD} = 1.71$ to $3$ V, $150$ ksps	-1	-	3.3	LSB	$V_{REF} = 1$ to $V_{DD}$ , $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$
SID113	A_THD	Total harmonic distortion	-	-	-65	dB	$f_{in} = 10$ kHz
SID113A	A_THD	Total harmonic distortion	-	-65	-	dB	$f_{in} = 10$ kHz, $125^{\circ}\text{C} < T_A \leq 150^{\circ}\text{C}$
SID261	FSAR <sub>INTREF</sub>	SAR operating speed without external reference bypass	-	-	100	ksps	12-bit resolution

**5.3.5 CSD and IDAC****Table 16 CSD and IDAC specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SYS.PER#3	$V_{DD\_RIPPLE}$	Max allowed ripple on power supply, DC to $10$ MHz	-	-	$\pm 50$	mV	$V_{DD} > 2$ V (with ripple), $25^{\circ}\text{C}$ $T_A$ , Sensitivity = $0.1$ pF
SYS.PER#16	$V_{DD\_RIPPLE\_1.8}$	Max allowed ripple on power supply, DC to $10$ MHz	-	-	$\pm 25$	mV	$V_{DD} > 1.75$ V (with ripple), $25^{\circ}\text{C}$ $T_A$ , Parasitic Capacitance ( $C_P$ ) $< 20$ pF, Sensitivity $\geq 0.4$ pF
SID.CSD.BLK	$I_{CSD}$	Maximum block current	-	-	4000	$\mu\text{A}$	Maximum block current for both IDACs in dynamic (switching) mode including comparators, buffer, and reference generator.

## Electrical specifications

Table 16 CSD and IDAC specifications (continued)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID.CSD#15	V <sub>REF</sub>	Voltage reference for CSD and Comparator	0.6	1.2	V <sub>DDA</sub> - 0.6	V	V <sub>DDA</sub> - 0.06 or 4.4, whichever is lower
SID.CSD#15A	V <sub>REF_EXT</sub>	External Voltage reference for CSD and Comparator	0.6		V <sub>DDA</sub> - 0.6		V <sub>DDA</sub> - 0.06 or 4.4, whichever is lower
SID.CSD#16	IDAC1 <sub>IDD</sub>	IDAC1 (7 bits) block current	-	-	1750	μA	-
SID.CSD#17	IDAC2 <sub>IDD</sub>	IDAC2 (7 bits) block current	-	-	1750		-
SID308	V <sub>CSD</sub>	Voltage range of operation	1.71	-	5.5	V	1.8 V ±5% or 1.8 V to 5.5 V
SID308A	V <sub>COMPIDAC</sub>	Voltage compliance range of IDAC	0.6	-	V <sub>DDA</sub> - 0.6		V <sub>DDA</sub> - 0.06 or 4.4, whichever is lower
SID309	IDAC1 <sub>DNL</sub>	DNL	-1	-	1	LSB	
SID310	IDAC1 <sub>INL</sub>	INL	-3	-	3		INL is ±5 LSB for V <sub>DDA</sub> < 2 V
SID311	IDAC2 <sub>DNL</sub>	DNL	-1	-	1		
SID312	IDAC2 <sub>INL</sub>	INL	-3	-	3		INL is ±5 LSB for V <sub>DDA</sub> < 2 V, -40°C ≤ T <sub>A</sub> ≤ 125°C
SID312A	IDAC2 <sub>INL</sub>	INL	-	-	7		125°C < T <sub>A</sub> ≤ 150°C
SID313	SNR	Ratio of counts of finger to noise. Guaranteed by characterization	5	-	-	-	Capacitance range of 5 to 35 pF, 0.1-pF sensitivity. All use cases. V <sub>DDA</sub> > 2 V
SID314	IDAC1 <sub>CRT1</sub>	Output current of IDAC1 (7 bits) in low range	4.2	-	5.2	μA	LSB = 37.5-nA typ
SID314A	IDAC1 <sub>CRT2</sub>	Output current of IDAC1(7 bits) in medium range	34	-	41		LSB = 300-nA typ
SID314B	IDAC1 <sub>CRT3</sub>	Output current of IDAC1(7 bits) in high range	275	-	330		LSB = 2.4-μA typ
SID314C	IDAC1 <sub>CRT12</sub>	Output current of IDAC1 (7 bits) in low range, 2X mode	8	-	10.5		LSB = 37.5-nA typ. 2X output stage
SID314D	IDAC1 <sub>CRT22</sub>	Output current of IDAC1(7 bits) in medium range, 2X mode	69	-	82		LSB = 300-nA typ. 2X output stage
SID314E	IDAC1 <sub>CRT32</sub>	Output current of IDAC1(7 bits) in high range, 2X mode	540	-	660		LSB = 2.4-μA typ.2X output stage
SID315	IDAC2 <sub>CRT1</sub>	Output current of IDAC2 (7 bits) in low range	4.2	-	5.2		LSB = 37.5-nA typ.

## Electrical specifications

Table 16 CSD and IDAC specifications (continued)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID315A	IDAC <sub>2</sub> CRT2	Output current of IDAC2 (7 bits) in medium range	34	–	41	μA	LSB = 300-nA typ.
SID315B	IDAC <sub>2</sub> CRT3	Output current of IDAC2 (7 bits) in high range	275	–	330		LSB = 2.4-μA typ.
SID315C	IDAC <sub>2</sub> CRT12	Output current of IDAC2 (7 bits) in low range, 2X mode	8	–	10.5		LSB = 37.5-nA typ. 2X output stage
SID315D	IDAC <sub>2</sub> CRT22	Output current of IDAC2(7 bits) in medium range, 2X mode	69	–	82		LSB = 300-nA typ. 2X output stage
SID315E	IDAC <sub>2</sub> CRT32	Output current of IDAC2(7 bits) in high range, 2X mode	540	–	660		LSB = 2.4-μA typ. 2X output stage
SID315F	IDAC <sub>3</sub> CRT13	Output current of IDAC in 8-bit mode in low range	8	–	10.5		LSB = 37.5-nA typ
SID315G	IDAC <sub>3</sub> CRT23	Output current of IDAC in 8-bit mode in medium range	69	–	82		LSB = 300-nA typ
SID315H	IDAC <sub>3</sub> CRT33	Output current of IDAC in 8-bit mode in high range	540	–	660		LSB = 2.4-μA typ
SID320	IDAC <sub>OFFSET</sub>	All zeros input	–	–	1	LSB	Polarity set by Source or Sink. Offset is 2 LSBs for 37.5 nA/LSB mode
SID321	IDAC <sub>GAIN</sub>	Full-scale error less offset	–	–	±10	%	–40°C ≤ T <sub>A</sub> ≤ 125°C
SID321A	IDAC <sub>GAIN</sub>	Full-scale error less offset	–	–	±11		125°C < T <sub>A</sub> ≤ 150°C
SID322	IDAC <sub>MIS-MATCH1</sub>	Mismatch between IDAC1 and IDAC2 in Low mode	–	–	9.2	LSB	LSB = 37.5-nA typ.
SID322A	IDAC <sub>MIS-MATCH2</sub>	Mismatch between IDAC1 and IDAC2 in Medium mode	–	–	4.6		LSB = 300-nA typ.
SID322B	IDAC <sub>MIS-MATCH3</sub>	Mismatch between IDAC1 and IDAC2 in High mode	–	–	2.3		LSB = 2.4 μA typ, –40°C ≤ T <sub>A</sub> ≤ 125°C
SID322C	IDAC <sub>MIS-MATCH4</sub>	Mismatch between IDAC1 and IDAC2 in High mode	–	–	6.3		125°C < T <sub>A</sub> ≤ 150°C
SID323	IDAC <sub>SET8</sub>	Settling time to 0.5 LSB for 8-bit IDAC	–	–	10	μs	Full-scale transition. No external load.
SID324	IDAC <sub>SET7</sub>	Settling time to 0.5 LSB for 7-bit IDAC	–	–	10		Full-scale transition. No external load.
SID325	CMOD	External modulator capacitor	–	2.2	–	nF	5-V rating, X7R or NP0 cap

## Electrical specifications

## 5.3.6 10-bit CAPSENSE™ ADC

Table 17 10-bit CAPSENSE™ ADC specifications

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SIDA94	A_RES	Resolution	–	–	10	bits	Auto-zeroing is required every milli-second
SIDA95	A_CHNLS_S	Number of channels - single ended	–	–	16		Defined by AMUX Bus.
SIDA97	A-MONO	Monotonicity	–	–	–	Yes	–
SIDA98	A_GAINERR	Gain error	–	–	±2	%	In V <sub>REF</sub> (2.4 V) mode with V <sub>DDA</sub> bypass capacitance of 10 µF
SIDA99	A_OFFSET	Input offset voltage	–	–	3	mV	In V <sub>REF</sub> (2.4 V) mode with V <sub>DDA</sub> bypass capacitance of 10 µF
SIDA100	A_ISAR	Current consumption	–	–	0.25	mA	–
SIDA101	A_VINS	Input voltage range - single ended	V <sub>SSA</sub>	–	V <sub>DDA</sub>	V	–
SIDA103	A_INRES	Input resistance	–	2.2	–	KΩ	–
SIDA104	A_INCAP	Input capacitance	–	20	–	pF	–
SIDA106	A_PSRR	Power supply rejection ratio	–	60	–	dB	In V <sub>REF</sub> (2.4 V) mode with V <sub>DDA</sub> bypass capacitance of 10 µF
SIDA107	A_TACQ	Sample acquisition time	–	1	–	µs	–
SIDA108	A_CONV8	Conversion time for 8-bit resolution at conversion rate = F <sub>clk</sub> /(2 <sup>N+2</sup> ). Clock frequency = 48 MHz.	–	–	21.3	µs	Does not include acquisition time. Equivalent to 44.8 ksp/s including acquisition time.
SIDA108A	A_CONV10	Conversion time for 10-bit resolution at conversion rate = F <sub>clk</sub> /(2 <sup>N+2</sup> ). Clock frequency = 48 MHz.	–	–	85.3	µs	Does not include acquisition time. Equivalent to 11.6 ksp/s including acquisition time.
SIDA109	A_SND	Signal-to-noise and Distortion ratio (SINAD)	61	–	–	dB	With 10-Hz input sine wave, external 2.4-V reference, V <sub>REF</sub> (2.4 V) mode
SIDA110	A_BW	Input bandwidth without aliasing	–	–	22.4	kHz	8-bit resolution
SIDA111	A_INL	Integral Non Linearity. 1 ksp/s	–	–	2	LSB	V <sub>REF</sub> = 2.4 V or greater
SIDA112	A_DNL	Differential Non Linearity. 1 ksp/s	–	–	1	LSB	–

## Electrical specifications

## 5.4 Digital peripherals

## 5.4.1 Timer counter pulse-width modulator (TCPWM)

Table 18 TCPWM specifications

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID.TCPWM.1	$I_{TCPWM1}$	Block current consumption at 3 MHz	-	-	45	μA	All modes (TCPWM)
SID.TCPWM.2	$I_{TCPWM2}$	Block current consumption at 12 MHz	-	-	155		All modes (TCPWM)
SID.TCPWM.2A	$I_{TCPWM3}$	Block current consumption at 48 MHz	-	-	650		All modes (TCPWM)
SID.TCPWM.3	$TCPWM_{FREQ}$	Operating frequency	-	-	$F_c$	MHz	$F_c$ max = CLK_SYS Maximum = 48 MHz
SID.TCPWM.4	$TPWM_{ENEXT}$	Input trigger pulse width	$2/F_c$	-	-	ns	For all trigger events <sup>[8]</sup>
SID.TCPWM.5	$TPWM_{EXT}$	Output trigger pulse widths	$2/F_c$	-	-		Minimum possible width of Overflow, Underflow, and CC (Counter equals Compare value) outputs
SID.TCPWM.5A	$TC_{RES}$	Resolution of counter	$1/F_c$	-	-		Minimum time between successive counts
SID.TCPWM.5B	$PWM_{RES}$	PWM resolution	$1/F_c$	-	-		Minimum pulse width of PWM Output
SID.TCPWM.5C	$Q_{RES}$	Quadrature inputs resolution	$1/F_c$	-	-		Minimum pulse width between Quadrature phase inputs

**Note**

8. Trigger events can be Stop, Start, Reload, Count, Capture, or Kill depending on which mode of operation is selected.

## Electrical specifications

5.4.2 I<sup>2</sup>CTable 19 Fixed I<sup>2</sup>C DC specifications<sup>[9]</sup>

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID149	I <sub>I2C1</sub>	Block current consumption at 100 kHz	-	-	50	μA	-
SID150	I <sub>I2C2</sub>	Block current consumption at 400 kHz	-	-	135		-
SID151	I <sub>I2C3</sub>	Block current consumption at 1 Mbps	-	-	310		-
SID152	I <sub>I2C4</sub>	I <sup>2</sup> C enabled in Deep Sleep mode	-	-	1.4		-

Table 20 Fixed I<sup>2</sup>C AC Specifications<sup>[9]</sup>

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID153	F <sub>I2C1</sub>	Bit rate	-	-	1	Mbps	-

## 5.4.3 SPI

Table 21 SPI DC Specifications<sup>[10]</sup>

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID163	ISPI1	Block current consumption at 1 Mbps	-	-	360	μA	-
SID164	ISPI2	Block current consumption at 4 Mbps	-	-	560		-
SID165	ISPI3	Block current consumption at 8 Mbps	-	-	600		-

Table 22 SPI AC Specifications<sup>[10]</sup>

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID166	FSPI	SPI Operating frequency (Master; 6X Oversampling)	-	-	8	MHz	

## Fixed SPI Master Mode AC Specifications

SID167	TDMO	MOSI Valid after SClk driving edge	-	-	15	ns	-
SID168	TDSI	MISO Valid before SClk capturing edge	20	-	-		Full clock, late MISO sampling
SID169	THMO	Previous MOSI data hold time	0	-	-		Referred to Slave capturing edge

## Note

9. Guaranteed by characterization.

## Electrical specifications

**Table 22** SPI AC Specifications<sup>[10]</sup> (continued)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
<b>Fixed SPI Slave Mode AC Specifications</b>							
SID170	TDMI	MOSI Valid before Sclock Capturing edge	40	-	-	ns	-
SID171	TDSO	MISO Valid after Sclock driving edge	-	-	42 + 3*Tcpu		$T_{CPU} = 1/F_{CPU}$
SID171A	TDSO_EXT	MISO Valid after Sclock driving edge in Ext. Clk mode	-	-	48		-
SID172	THSO	Previous MISO data hold time	0	-	-		-
SID172A	TSSELSSCK	SSEL Valid to first SCK valid edge	-	-	100	ns	-

**5.4.4** UART**Table 23** UART DC specifications<sup>[11]</sup>

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID160	I <sub>UART1</sub>	Block current consumption at 100 Kbps	-	-	55	μA	-
SID161	I <sub>UART2</sub>	Block current consumption at 1000 Kbps	-	-	312	μA	-

**Table 24** UART AC specifications<sup>[11]</sup>

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID162	F <sub>UART</sub>	Bit rate	-	-	1	Mbps	-

**Note**

10. Guaranteed by characterization.

Electrical specifications

### 5.4.5 LCD

**Table 25 LCD Direct Drive DC specifications<sup>[11]</sup>**

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	$C_{LCDCAP}$	LCD capacitance per segment/common driver	–	500	5000	pF	–
SID156	$LCD_{OFFSET}$	Long-term segment offset	–	20	–	mV	–
SID157	$I_{LCDOP1}$	LCD system operating current V <sub>bias</sub> = 5 V	–	2	–	mA	32 × 4 segments. 50 Hz. 25°C
SID158	$I_{LCDOP2}$	LCD system operating current V <sub>bias</sub> = 3.3 V	–	2	–		32 × 4 segments. 50 Hz. 25°C

**Table 26 LCD Direct Drive AC specifications<sup>[11]</sup>**

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

**Note**

11. Guaranteed by characterization.



## Electrical specifications

## 5.5 Memory

### 5.5.1 Flash

**Table 27 Flash DC specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID173	V <sub>PE</sub>	Erase and program voltage	1.71	–	5.5	V	–

**Table 28 Flash AC Specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID174	T <sub>ROWWRITE</sub> <sup>[12]</sup>	Row (block) write time (erase and program)	–	–	20	ms	Row (block) = 128 bytes
SID175	T <sub>ROWERASE</sub> <sup>[12]</sup>	Row erase time	–	–	16		–
SID176	T <sub>ROWPROGRAM</sub> <sup>[12]</sup>	Row program time after erase	–	–	4		–
SID178	T <sub>BULKERASE</sub> <sup>[12]</sup>	Bulk erase time (64 KB)	–	–	35		–
SID180 <sup>[13]</sup>	T <sub>DEVPROG</sub> <sup>[12]</sup>	Total device program time	–	–	7	Seconds	–
SID181 <sup>[13]</sup>	F <sub>END</sub>	Flash endurance	100 K	–	–	Cycles	–
SID182 <sup>[13, 14]</sup>	F <sub>RET</sub>	Flash retention. T <sub>A</sub> ≤ 55 °C, 100 K P/E cycles	20	–	–	Years	–
SID182A <sup>[13, 14]</sup>	F <sub>RET</sub>	Flash retention. T <sub>A</sub> ≤ 85 °C, 10 K P/E cycles	10	–	–		–
SID256	TWS48	Number of Wait states at 48 MHz	2	–	–	–	CPU execution from Flash
SID257	TWS24	Number of Wait states at 24 MHz	1	–	–	–	CPU execution from Flash

#### Notes

12. It can take as much as 20 milliseconds to write to Flash. During this time the device should not be Reset, or Flash operations will be interrupted and cannot be relied on to have completed. Reset sources include the XRES pin, software resets, CPU lockup states and privilege violations, improper power supply levels, and watchdogs. Make certain that these are not inadvertently activated.

13. Guaranteed by characterization.

14. Infineon provides a retention calculator to calculate the retention lifetime based on the customers' individual temperature profiles for operation over the –40 °C to +150 °C ambient temperature range. For more information, visit the [Infineon community page](#).

Electrical specifications

## 5.6 System resources

### 5.6.1 Power-on reset (POR)

**Table 29** Power-on reset (PRES)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID.CLK#6	SR_POWER	Power supply slew rate	1 <sup>[15]</sup>	-	67	V/ms	On power-up & power-down
SID185 <sup>[16]</sup>	V <sub>RISEIPOR</sub>	Rising trip voltage	0.80	-	1.5	V	-
SID186 <sup>[16]</sup>	V <sub>FALLIPOR</sub>	Falling trip voltage	0.70	-	1.4		-

**Table 30** Brown-out detect (BOD) for V<sub>CCD</sub>

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID190 <sup>[16]</sup>	V <sub>FALLPPOR</sub>	BOD trip voltage in active and sleep modes	1.48	-	1.62	V	-
SID192 <sup>[16]</sup>	V <sub>FALLDPSLP</sub>	BOD trip voltage in Deep Sleep	1.11	-	1.5		-

### 5.6.2 SWD interface

**Table 31** SWD interface specifications

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID213	F_SWDCCLK1	$3.3\text{ V} \leq V_{DD} \leq 5.5\text{ V}$	-	-	14	MHz	SWDCCLK ≤ 1/3 CPU clock frequency
SID214	F_SWDCCLK2	$1.71\text{ V} \leq V_{DD} \leq 3.3\text{ V}$	-	-	7		SWDCCLK ≤ 1/3 CPU clock frequency
SID215 <sup>[17]</sup>	T_SWDI_SETUP	$T = 1/f\text{ SWDCCLK}$	$0.25 \cdot T$	-	-	ns	-
SID216 <sup>[17]</sup>	T_SWDI_HOLD	$T = 1/f\text{ SWDCCLK}$	$0.25 \cdot T$	-	-		-
SID217 <sup>[17]</sup>	T_SWDO_VALID	$T = 1/f\text{ SWDCCLK}$	-	-	$0.5 \cdot T$		-
SID217A <sup>[17]</sup>	T_SWDO_HOLD	$T = 1/f\text{ SWDCCLK}$	1	-	-		-

#### Notes

15.If minimum ramp rate cannot be met, XRES should be asserted during voltage ramp ( $1.5\text{ V} > V_{DD} > 1.0\text{ V}$  for ramp-down or until voltage is stable for ramp-up). Note that a glitch on the I2C bus could occur during voltage ramp in this case.

16.Guaranteed by characterization.

## Electrical specifications

### 5.6.3 Internal main oscillator

**Table 32 IMO DC specifications**

(Guaranteed by design)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID218	I <sub>IMO1</sub>	IMO operating current at 48 MHz	–	–	250	μA	–
SID219	I <sub>IMO2</sub>	IMO operating current at 24 MHz	–	–	180	μA	–

**Table 33 IMO AC specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID223	F <sub>IMOTOL1</sub>	Frequency variation at 24, 32, and 48 MHz (trimmed)	–	–	±2	%	–40°C ≤ T <sub>A</sub> ≤ 125°C
SID223A	F <sub>IMOTOL1</sub>	Frequency variation at 24, 32, and 48 MHz (trimmed)	–	–	±4	%	125°C ≤ T <sub>A</sub> ≤ 150°C
SID226	T <sub>STARTIMO</sub>	IMO startup time	–	–	7	μs	–
SID228	T <sub>JITRMSIMO2</sub>	RMS jitter at 24 MHz	–	145	–	ps	–

### 5.6.4 Internal low-speed oscillator

**Table 34 ILO DC specifications**

(Guaranteed by Design)

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID231 <sup>[17]</sup>	I <sub>ILO1</sub>	ILO operating current <sup>[17]</sup>	–	0.3	1.05	μA	–

**Table 35 ILO AC specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID234 <sup>[17]</sup>	T <sub>STARTILO1</sub>	ILO startup time	–	–	2	ms	–
SID236 <sup>[17]</sup>	T <sub>ILODUTY</sub>	ILO duty cycle	40	50	60	%	–
SID237	F <sub>ILOTRIM1</sub>	ILO frequency range	20	40	80	kHz	–

### 5.6.5 Watch crystal oscillator

**Table 36 Watch crystal oscillator specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID398	F <sub>WCO</sub>	Crystal frequency	–	32.768	–	kHz	–
SID399	F <sub>TOL</sub>	Frequency tolerance	–	50	250	ppm	With 20-ppm crystal
SID400	ESR	Equivalent series resistance	–	50	–	kΩ	–
SID401	PD	Drive Level	–	–	1	μW	–

**Note**

17. Guaranteed by characterization.

Electrical specifications

**Table 36 Watch crystal oscillator specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
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	$\mu$ A	–
SID406	$I_{WCO2}$	Operating current (low power mode)	–	–	1	$\mu$ A	–

### 5.6.6 External clock

**Table 37 External clock specifications**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID305 <sup>[18]</sup>	ExtClk <sub>Freq</sub>	External clock input frequency	0	–	48	MHz	–
SID306 <sup>[18]</sup>	ExtClk <sub>Duty</sub>	Duty cycle; measured at $V_{DD/2}$	45	–	55	%	–

### 5.6.7 Block

**Table 38 Block specs**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID262 <sup>[18]</sup>	$T_{CLKSWITCH}$	System clock source switching time	3	–	4	Periods	–

### 5.6.8 PRGIO pass-through time

**Table 39 PRGIO pass-through time (Delay in bypass mode)**

Spec ID	Parameter	Description	Min	Typ	Max	Unit	Details/conditions
SID252	PRG_BYPASS	Max. delay added by PRGIO in bypass mode	–	–	1.6	ns	–

**Note**

18. Guaranteed by characterization.



# 6 Ordering information

Table 40 lists the marketing part numbers for the PSoC™ 4100S family.

**Table 40** Ordering information

MPN	Features													Packages				Operating temperature		
	Max CPU Speed (MHz)	Flash (KB)	SRAM (KB)	UDB	Op-amp (CTBm)	CapSense	Direct LCD Drive	12-bit SAR ADC	LP Comparators	TCPWM Blocks	SCB Blocks	Smart IOs	GPIO	24-QFN	28-SSOP	40-QFN	48-QFN	-40 to +85C	-40 to +105C	-40 to +125C
CY8C4124PVA-S412	24	16	4	-	2	X	X	-	2	5	2	16	24	X				X		
CY8C4124LQA-S413	24	16	4	-	2	X	X	-	2	5	2	16	34		X			X		
CY8C4124PVA-S422	24	16	4	-	2	-	X	806 Ksps	2	5	2	16	24	X				X		
CY8C4124LQA-S423	24	16	4	-	2	-	X	806 Ksps	2	5	2	16	34		X			X		
CY8C4124PVA-S432	24	16	4	-	2	X	X	806 Ksps	2	5	2	16	24	X				X		
CY8C4124LQA-S433	24	16	4	-	2	X	X	806 Ksps	2	5	2	16	34		X			X		
CY8C4125PVA-S412	24	32	4	-	2	X	X	-	2	5	2	16	24	X				X		
CY8C4125LQA-S413	24	32	4	-	2	X	X	-	2	5	2	16	34		X			X		
CY8C4125PVA-S422	24	32	4	-	2	-	X	806 Ksps	2	5	2	16	24	X				X		
CY8C4125LQA-S423	24	32	4	-	2	-	X	806 Ksps	2	5	2	16	34		X			X		
CY8C4125PVA-S432	24	32	4	-	2	X	X	806 Ksps	2	5	2	16	24	X				X		
CY8C4125LQA-S433	24	32	4	-	2	X	X	806 Ksps	2	5	2	16	34		X			X		
CY8C4146PVA-S422	48	64	8	-	2	-	X	1000 Ksps	2	5	2	16	24	X				X		
CY8C4146LQA-S423	48	64	8	-	2	-	X	1000 Ksps	2	5	3	16	34		X			X		
CY8C4146PVA-S432	48	64	8	-	2	X	X	1000 Ksps	2	5	3	16	24	X				X		
CY8C4146LQA-S433	48	64	8	-	2	X	X	1000 Ksps	2	5	3	16	34		X			X		
CY8C4124PVS-S412	24	16	4	-	2	X	X	-	2	5	2	16	24	X					X	
CY8C4124LQS-S413	24	16	4	-	2	X	X	-	2	5	2	16	34		X				X	

**Note**  
19. Alternate fab available.



**Table 40** Ordering information (continued)

MPN	Features												Packages				Operating temperature			
	Max CPU Speed (MHz)	Flash (KB)	SRAM (KB)	UDB	Op-amp (CTBm)	CapSense	Direct LCD Drive	12-bit SAR ADC	LP Comparators	TCPWM Blocks	SCB Blocks	Smart I/Os	GPIO	24-QFN	28-SSOP	40-QFN	48-QFN	-40 to +85C	-40 to +105C	-40 to +125C
CY8C4124PVS-S422	24	16	4	-	2	-	X	806 Ksps	2	5	2	16	24	X				X		
CY8C4124LQS-S423	24	16	4	-	2	-	X	806 Ksps	2	5	2	16	34		X			X		
CY8C4124PVS-S432	24	16	4	-	2	X	X	806 Ksps	2	5	2	16	24	X				X		
CY8C4124LQS-S433	24	16	4	-	2	X	X	806 Ksps	2	5	2	16	34			X		X		
CY8C4125PVS-S412	24	32	4	-	2	X	X	-	2	5	2	16	24	X				X		
CY8C4125LQS-S413	24	32	4	-	2	X	X	-	2	5	2	16	34			X		X		
CY8C4125PVS-S422	24	32	4	-	2	-	X	806 Ksps	2	5	2	16	24	X				X		
CY8C4125LQS-S423	24	32	4	-	2	-	X	806 Ksps	2	5	2	16	34			X		X		
CY8C4125PVS-S432	24	32	4	-	2	X	X	806 Ksps	2	5	2	16	24	X				X		
CY8C4125LQS-S433	24	32	4	-	2	X	X	806 Ksps	2	5	2	16	34			X		X		
CY8C4146PVS-S422	48	64	8	-	2	-	X	1000 Ksps	2	5	2	16	24	X				X		
CY8C4146LQS-S423	48	64	8	-	2	-	X	1000 Ksps	2	5	3	16	34			X		X		
CY8C4146PVS-S432	48	64	8	-	2	X	X	1000 Ksps	2	5	3	16	24	X				X		
CY8C4146LQS-S433 <sup>[19]</sup>	48	64	8	-	2	X	X	1000 Ksps	2	5	3	16	34			X		X		
CY8C4124PVE-S412	24	16	4	-	2	X	X	-	2	5	2	16	24	X						X
CY8C4124LQE-S413	24	16	4	-	2	X	X	-	2	5	2	16	34			X				X
CY8C4124PVE-S422 <sup>[19]</sup>	24	16	4	-	2	-	X	806 Ksps	2	5	2	16	24	X						X
CY8C4124LQE-S423	24	16	4	-	2	-	X	806 Ksps	2	5	2	16	34			X				X
CY8C4124PVE-S432	24	16	4	-	2	X	X	806 Ksps	2	5	2	16	24	X						X
CY8C4124LQE-S433	24	16	4	-	2	X	X	806 Ksps	2	5	2	16	34			X				X
CY8C4125PVE-S412	24	32	4	-	2	X	X	-	2	5	2	16	24	X						X
CY8C4125LQE-S413	24	32	4	-	2	X	X	-	2	5	2	16	34			X				X

**Note**  
19. Alternate fab available.

**Table 40** Ordering information (continued)

MPN	Features												Packages				Operating temperature			
	Max CPU Speed (MHz)	Flash (KB)	SRAM (KB)	UDB	Op-amp (CTBm)	CapSense	Direct LCD Drive	12-bit SAR ADC	LP Comparators	TCPWM Blocks	SCB Blocks	Smart I/Os	GPIO	24-QFN	28-SSOP	40-QFN	48-QFN	-40 to +85C	-40 to +105C	-40 to +125C
CY8C4125PVE-S422 <sup>[19]</sup>	24	32	4	-	2	-	X	806 Ksps	2	5	2	16	24	X						X
CY8C4125LQE-S423	24	32	4	-	2	-	X	806 Ksps	2	5	2	16	34		X					X
CY8C4125PVE-S432	24	32	4	-	2	X	X	806 Ksps	2	5	2	16	24	X						X
CY8C4125LQE-S433	24	32	4	-	2	X	X	806 Ksps	2	5	2	16	34		X					X
CY8C4146PVE-S422	48	64	8	-	2	-	X	1000 Ksps	2	5	2	16	24	X						X
CY8C4146LQE-S423 <sup>[19]</sup>	48	64	8	-	2	-	X	1000 Ksps	2	5	3	16	34		X					X
CY8C4146PVE-S432	48	64	8	-	2	X	X	1000 Ksps	2	5	3	16	24	X						X
CY8C4146LQE-S433	48	64	8	-	2	X	X	1000 Ksps	2	5	3	16	34		X					X

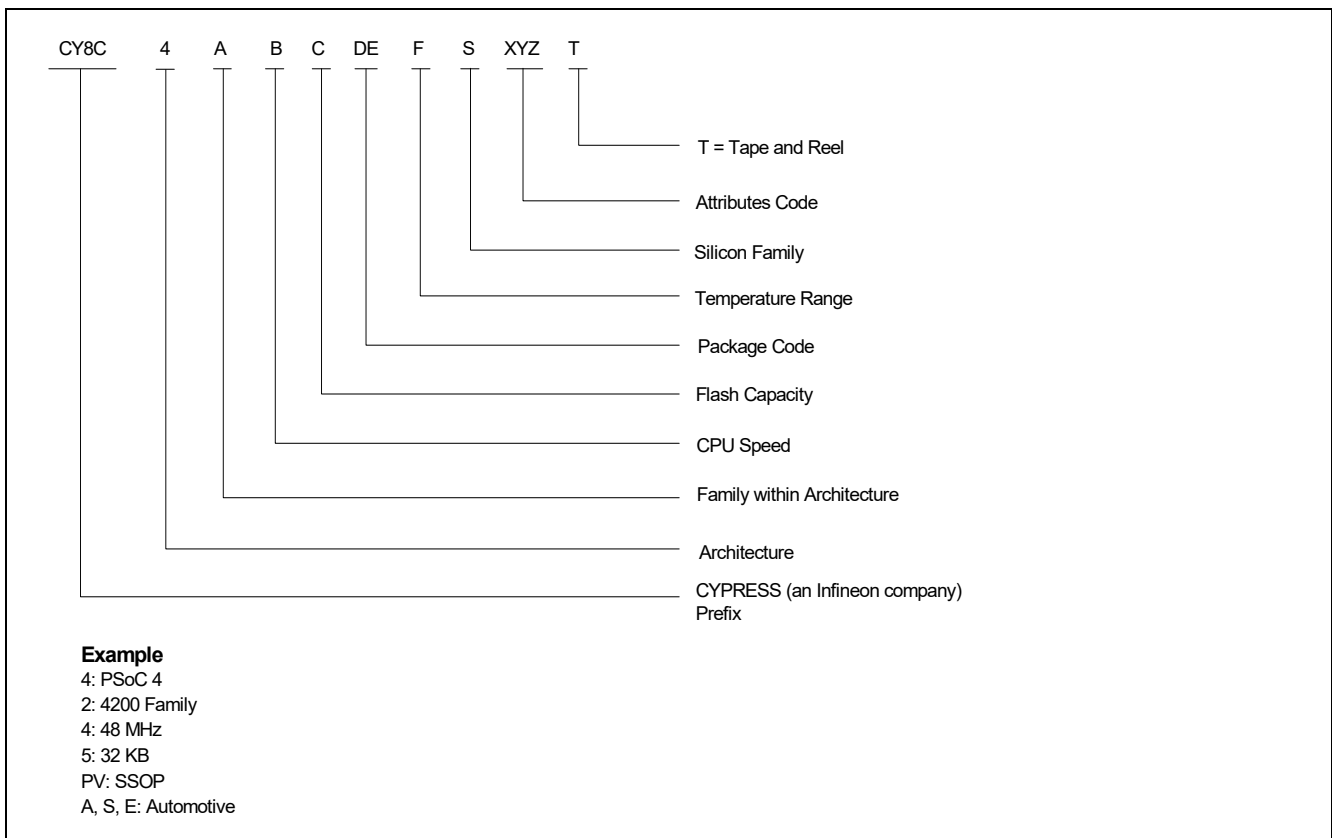
**Note**  
19. Alternate fab available.

Ordering information

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

Field	Description	Values	Meaning
CY8C	Cypress (an Infineon company) Prefix		
4	Architecture	4	PSoC™ 4
A	Family	0	4000 family
B	CPU speed	2	24 MHz
		4	48 MHz
C	Flash capacity	4	16 KB
		5	32 KB
		6	64 KB
DE	Package code	LQ	QFN
		PV	SSOP
F	Temperature range	A	Automotive (AEC-Q100: -40°C to +85°C)
		S	Automotive (AEC-Q100: -40 °C to +105 °C)
		E	Automotive (AEC-Q100: -40°C to +125°C)
S	Silicon family	S	PSoC™ 4A-S1, PSoC™ 4A-S2
		M	PSoC™ 4A-M
XYZ	Attributes code	000-999	Code of feature set in the specific family

The following is an example of a part number:





## 7 Packaging information

The PSoC™ 4100S will be offered in 24-pin QFN, 28-pin SSOP, 40 pin QFN, and 48-pin QFN packages.

**Table 41** provides the package dimensions and Infineon drawing numbers.

**Table 41 Package list**

Spec ID	Package	Description	Package drawing
BID27	40-pin QFN	6 × 6 × 0.6 mm height with 0.5-mm pitch	002-16818
BID28	28-pin SSOP	28LD SSOP 210 MILS O28.21	51-85079
BID29	24-pin QFN	4.0 × 4.0 × 0.6 mm (Wettable flank)	002-18982

**Table 42 Package thermal characteristics**

Parameter	Description	Package	Conditions	Min	Typ	Max	Unit
T <sub>A</sub>	Operating Ambient temperature	–	For A-grade devices	–40	25	85	°C
		–	For S-grade devices	–40	25	105	°C
		–	For E-grade devices	–40	25	125	°C
T <sub>J</sub>	Operating Junction temperature	–	For A-grade devices	–40	–	100	°C
		–	For S-grade devices	–40	–	120	°C
		–	For E-grade devices	–40	–	140	°C
T <sub>JA</sub>	Package $\theta_{JA}$	40-pin QFN	–	–	25	–	°C/Watt
T <sub>JC</sub>	Package $\theta_{JC}$	40-pin QFN	–	–	3	–	°C/Watt
T <sub>JA</sub>	Package $\theta_{JA}$	28-pin SSOP	–	–	66.58	–	°C/Watt
T <sub>JC</sub>	Package $\theta_{JC}$	28-pin SSOP	–	–	46.28	–	°C/Watt

**Table 43 Solder reflow peak temperature**

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

**Table 44 Package moisture sensitivity level (MSL), IPC/JEDEC J-STD-020**

Package	MSL
All	MSL 3

Packaging information

7.1 Package diagrams

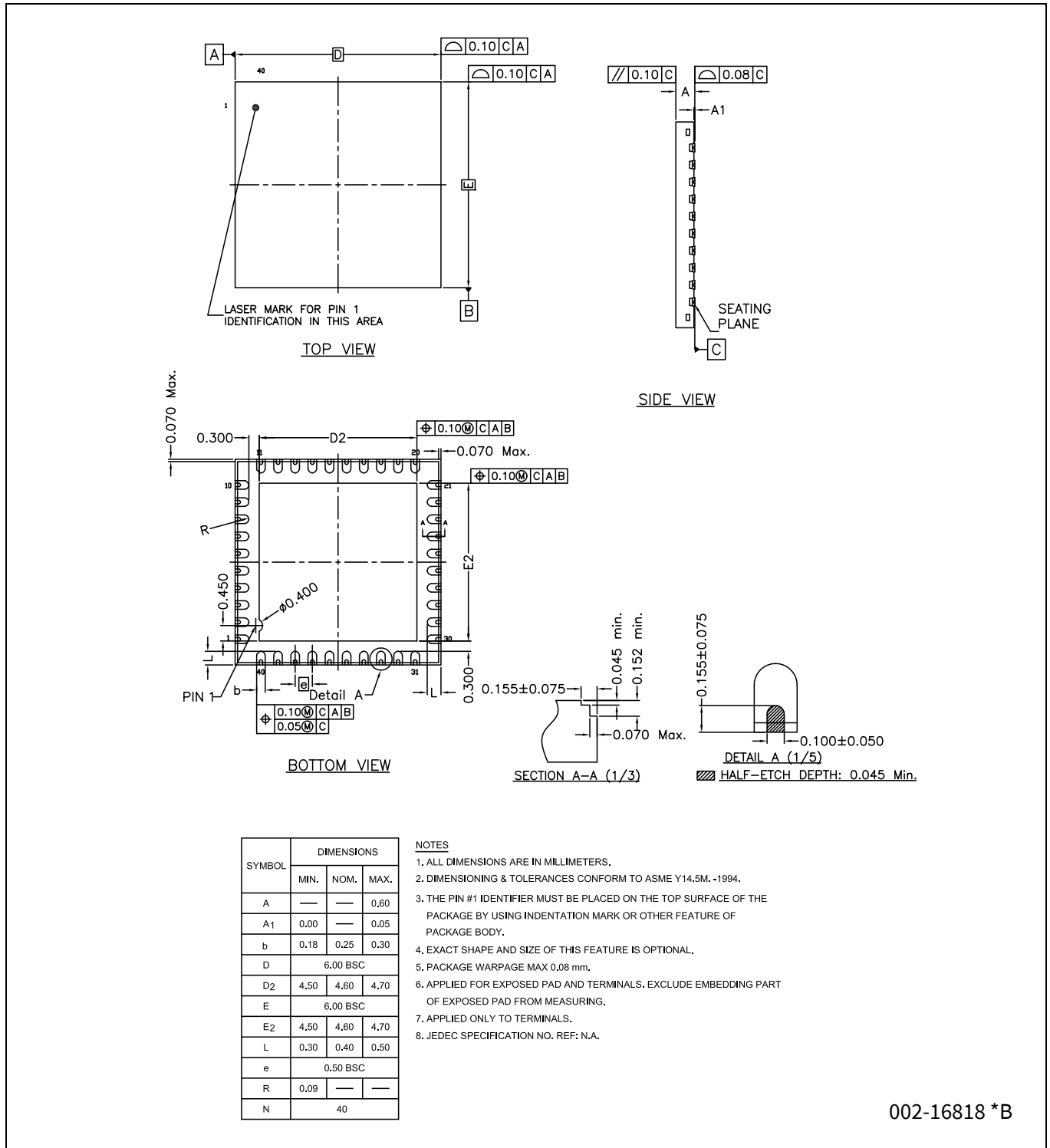


Figure 6 40-pin QFN (6.0 × 6.0 × 0.6 mm) LD40A 4.6 × 4.6 mm E-Pad (Sawn) package outline

Packaging information

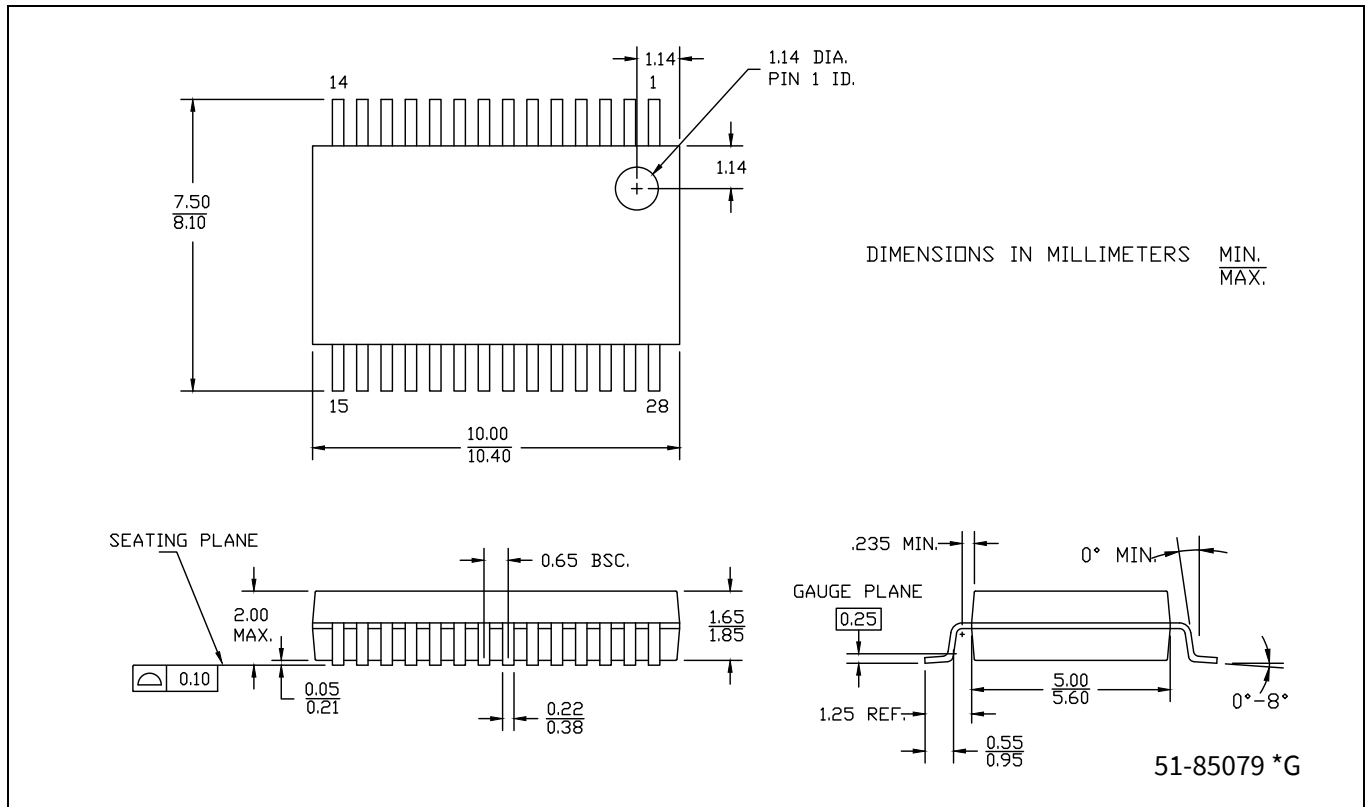


Figure 7 28-pin SSOP (210 Mils) package outline

Packaging information

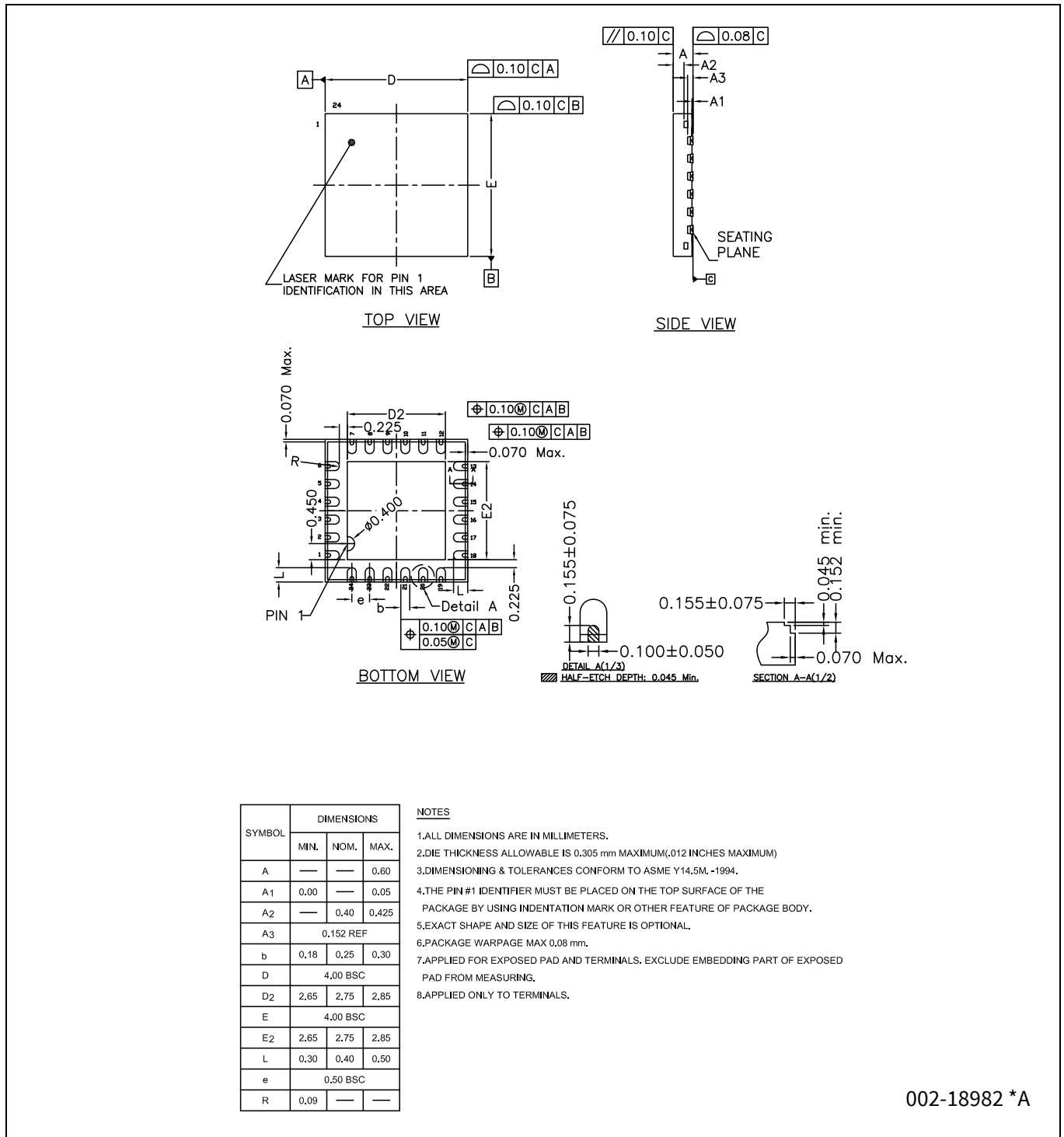


Figure 8 24-pin QFN 4.0 x 4.0 x 0.6 mm package outline (wettable flank)

## 8 Acronyms

**Table 45 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
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
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
ETM	embedded trace macrocell
FPB	flash patch and breakpoint
GPIO	general-purpose input/output, applies to a PSoC™ pin
HVI	high-voltage interrupt, see also LVI, LVD

## Acronyms

**Table 45** Acronyms Used in this Document *(continued)*

Acronym	Description
IC	integrated circuit
IDAC	current DAC, see also DAC, VDAC
IDE	integrated development environment
I <sup>2</sup> C, or IIC	Inter-Integrated Circuit, a communications protocol
ILO	internal low-speed oscillator, see also IMO
IMO	internal main oscillator, see also ILO
INL	integral nonlinearity, see also DNL
I/O	input/output, see also GPIO, DIO, SIO, USBIO
IPOR	initial power-on reset
IPSR	interrupt program status register
IRQ	interrupt request
ITM	instrumentation trace macrocell
LCD	liquid crystal display
LIN	Local Interconnect Network, a communications protocol.
LR	link register
LUT	lookup table
LVD	low-voltage detect, see also LVI
LVI	low-voltage interrupt, see also HVI
LVTTTL	low-voltage transistor-transistor logic
MAC	multiply-accumulate
MCU	microcontroller unit
MISO	master-in slave-out
NC	no connect
NMI	nonmaskable interrupt
NRZ	non-return-to-zero
NVIC	nested vectored interrupt controller
NVL	nonvolatile latch, see also WOL
opamp	operational amplifier
PC	program counter
PCB	printed circuit board
PGA	programmable gain amplifier
PHUB	peripheral hub
PHY	physical layer
PICU	port interrupt control unit
PLL	phase-locked loop
PMDD	package material declaration data sheet
POR	power-on reset
PRES	precise power-on reset

## Acronyms

**Table 45** Acronyms Used in this Document *(continued)*

Acronym	Description
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 <sup>2</sup> C serial clock
SDA	I <sup>2</sup> C 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
THD	total harmonic distortion
TIA	transimpedance amplifier
TRM	technical reference manual
TTL	transistor-transistor logic
TX	transmit
UART	Universal Asynchronous Receiver-Transmitter, 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

## Acronyms

**Table 45** Acronyms Used in this Document *(continued)*

Acronym	Description
WDT	watchdog timer
WOL	write once latch, see also NVL
WRES	watchdog timer reset
XRES	external reset I/O pin
XTAL	crystal



## 9 Document conventions

### 9.1 Units of measure

**Table 46** 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

Document revision	Date	Description of changes
**	2016-07-18	New data sheet.
*A	2016-11-18	Updated <b>Logic block diagram</b> . Updated <b>Figure 1</b> . Updated <b>Packaging information</b> : Updated <b>Package diagrams</b> : Removed spec 001-80659 *A. Added spec 002-16818 **.
*B	2017-02-06	Changed status from Advance to Preliminary. Updated to new template.
*C	2017-05-30	Changed datasheet status to Final. Added Note 1 for E-grade temperature range. Added new specs for the device usage at 150C temperature range. Added SID67A, SID277A, SID107A, SID108A, SID111C, SID111D, SID111E, SID112C, SID112D, SID112E, SID113A Removed SID93A Updated max value for SID321A
*D	2018-04-09	Updated Note 1. Updated <b>DC specifications</b> - Updated typ and max values for SID10, SID16, SID19, SID22, SID25, SID28, SID28A, SID31, SID34, SID37, and SID307. Added Note 3 under <b>Device-level specifications</b> . Updated <b>Ordering information</b> .
*E	2018- 05-23	Added Errata. Updated SID64A, SID113, and SID113A specs.
*F	2019-04-24	Removed Errata.
*G	2020-05-04	Updated <b>Ordering information</b> . Updated and Copyright year.
*H	2020-09-29	Updated SID.CLK#6 parameter. Updated conditions for <b>Device-level specifications</b> . Refer to Product Information Notice #6965423.
*I	2021-12-01	Updated GPIO count. Updated <b>Pinouts</b> . Updated max values for SID31, SID34, and SID37. Added footnote for SID.CLK#6. Updated <b>Ordering information</b> and <b>Packaging information</b> . Converted to Infineon template.
*J	2023-02-21	Updated <b>Ordering information</b> Changed Cypress references to Infineon. Removed package diagram 002-23807.