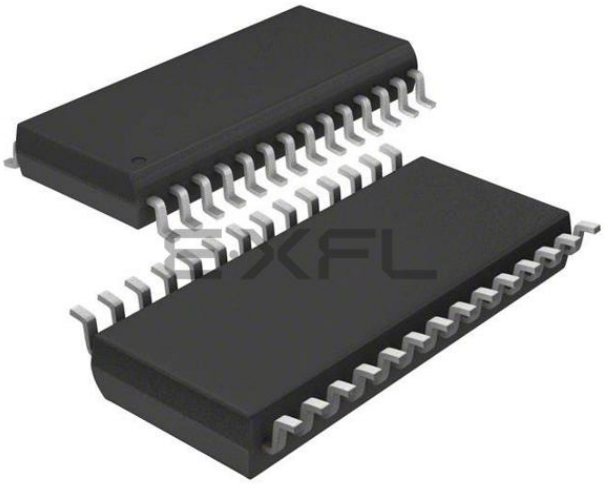

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What Are Embedded - Microcontrollers - Application Specific?

Application-specific microcontrollers are engineered to

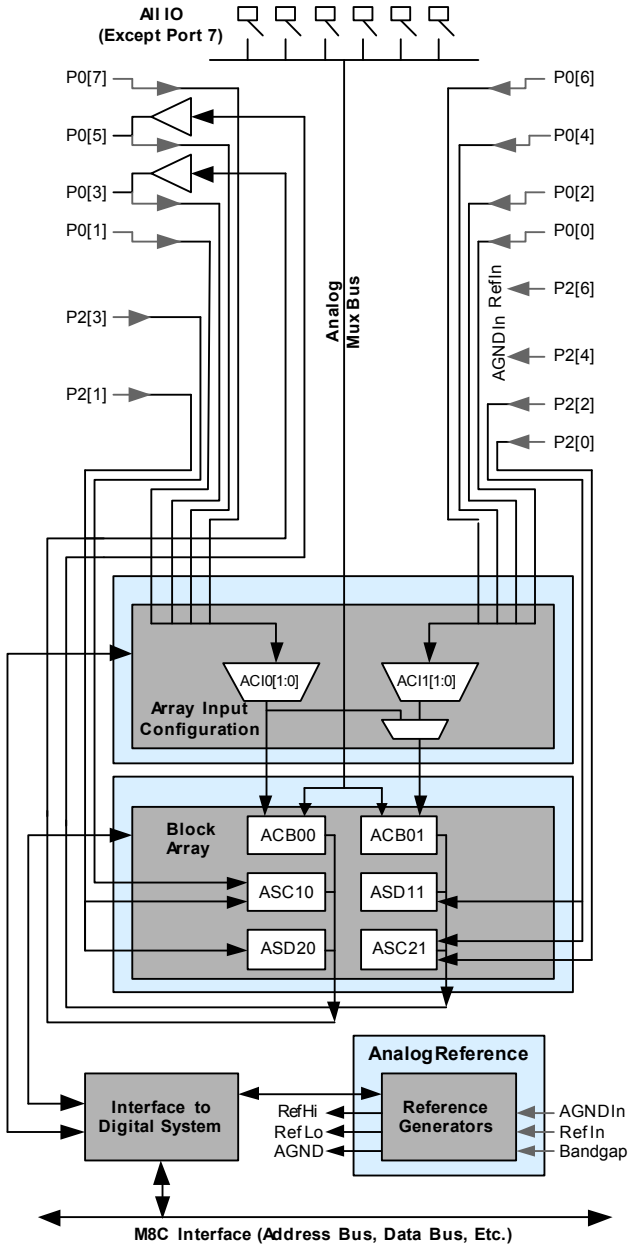
Details	
Product Status	Active
Applications	USB Microcontroller
Core Processor	M8C
Program Memory Type	FLASH (16kB)
Controller Series	CY7C642xx
RAM Size	1K x 8
Interface	I²C, USB
Number of I/O	22
Voltage - Supply	3V ~ 5.25V
Operating Temperature	0°C ~ 70°C
Mounting Type	Surface Mount
Package / Case	28-SSOP (0.209", 5.30mm Width)
Supplier Device Package	28-SSOP
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/cy7c64215-28pvxct

The Analog System

The analog system is composed of six configurable blocks, comprised of an opamp circuit enabling the creation of complex analog signal flows. Analog peripherals are very flexible and are customized to support specific application requirements. enCoRe III analog function supports the Analog-to-digital converters (with 6- to 14-bit resolution, selectable as incremental, and delta-sigma) and programmable threshold comparator).

Analog blocks are arranged in two columns of three, with each column comprising one continuous time (CT) - AC B00 or AC B01 - and two switched capacitor (SC) - ASC10 and ASD20 or ASD11 and ASC21 - blocks, as shown in Figure 2.

Figure 2. Analog System Block Diagram



The Analog Multiplexer System

The analog mux bus can connect to every GPIO pin in ports 0 to 5. Pins are connected to the bus individually or in any combination. The bus also connects to the analog system for analysis with comparators and analog-to-digital converters. It is split into two sections for simultaneous dual-channel processing. An additional 8:1 analog input multiplexer provides a second path to bring Port 0 pins to the analog array.

Additional System Resources

System resources provide additional capability useful to complete systems. Additional resources include a multiplier, decimator, low voltage detection, and power-on reset. Brief statements describing the merits of each resource follow.

- Full-speed USB (12 Mbps) with five configurable endpoints and 256 bytes of RAM. No external components required except two series resistors. Industrial temperature operating range for USB requires an external clock oscillator.
- Two multiply accumulates (MACs) provide fast 8-bit multipliers with 32-bit accumulate, to assist in both general math and digital filters.
- The decimator provides a custom hardware filter for digital signal processing applications including the creation of delta-sigma ADCs.
- Digital clock dividers provide three customizable clock frequencies for use in applications. The clocks are routed to both the digital and analog systems.
- The I^2C module provides 100- and 400-kHz communication over two wires. Slave, master, and multimaster modes are all supported.
- LVD interrupts can signal the application of falling voltage levels, while the advanced power-on reset (POR) circuit eliminates the need for a system supervisor.

enCoRe III Device Characteristics

enCoRe III devices have four digital blocks and six analog blocks. The following table lists the resources available for specific enCoRe III devices.

Table 1. enCoRe III Device Characteristics

Part Number	Digital I/O	Digital Rows	Digital Blocks	Analog Inputs	Analog Outputs	Analog Columns	Analog Blocks	SRAM Size	Flash Size
CY7C64215 28 Pin	up to 22	1	4	22	2	2	6	1K	16K
CY7C64215 56 Pin	up to 50	1	4	48	2	2	6	1K	16K

Getting Started

The quickest path to understanding the enCoRe III silicon is by reading this datasheet and using the PSoC Designer Integrated Development Environment (IDE). This datasheet is an overview of the enCoRe V integrated circuit and presents specific pin, register, and electrical specifications.

For in-depth information, along with detailed programming details, see the *PSoC® Technical Reference Manual*.

For up-to-date ordering, packaging, and electrical specification information, see the latest PSoC device datasheets on the web.

Application Notes

Cypress application notes are an excellent introduction to the wide variety of possible PSoC designs.

Development Kits

PSoC Development Kits are available online from and through a growing number of regional and global distributors, which include Arrow, Avnet, Digi-Key, Farnell, Future Electronics, and Newark.

Training

Free PSoC technical training (on demand, webinars, and workshops), which is available online via www.cypress.com, covers a wide variety of topics and skill levels to assist you in your designs.

CYPros Consultants

Certified PSoC consultants offer everything from technical assistance to completed PSoC designs. To contact or become a PSoC consultant go to the CYPros Consultants web site.

Solutions Library

Visit our growing library of solution focused designs. Here you can find various application designs that include firmware and hardware design files that enable you to complete your designs quickly.

Technical Support

Technical support – including a searchable Knowledge Base articles and technical forums – is also available online. If you cannot find an answer to your question, call our Technical Support hotline at 1-800-541-4736.

Development Tools

PSoC Designer™ is the revolutionary integrated design environment (IDE) that you can use to customize PSoC to meet your specific application requirements. PSoC Designer software accelerates system design and time to market. Develop your applications using a library of precharacterized analog and digital peripherals (called user modules) in a drag-and-drop design environment. Then, customize your design by leveraging the dynamically generated application programming interface (API) libraries of code. Finally, debug and test your designs with the integrated debug environment, including in-circuit emulation and standard software debug features. PSoC Designer includes:

- Application editor graphical user interface (GUI) for device and user module configuration and dynamic reconfiguration
- Extensive user module catalog
- Integrated source-code editor (C and assembly)
- Free C compiler with no size restrictions or time limits
- Built-in debugger
- In-circuit emulation
- Built-in support for communication interfaces:
  - Hardware and software I^2C slaves and masters
  - Full-speed USB 2.0
  - Up to four full-duplex universal asynchronous receiver/transmitters (UARTs), SPI master and slave, and wireless

PSoC Designer supports the entire library of PSoC 1 devices and runs on Windows XP, Windows Vista, and Windows 7.

PSoC Designer Software Subsystems

Design Entry

In the chip-level view, choose a base device to work with. Then select different onboard analog and digital components that use the PSoC blocks, which are called user modules. Examples of user modules are ADCs, DACs, amplifiers, and filters. Configure the user modules for your chosen application and connect them to each other and to the proper pins. Then generate your project. This prepopulates your project with APIs and libraries that you can use to program your application.

The tool also supports easy development of multiple configurations and dynamic reconfiguration. Dynamic reconfiguration makes it possible to change configurations at run time. In essence, this allows you to use more than 100 percent of PSoC's resources for an application.

Code Generation Tools

The code generation tools work seamlessly within the PSoC Designer interface and have been tested with a full range of debugging tools. You can develop your design in C, assembly, or a combination of the two.

Assemblers. The assemblers allow you to merge assembly code seamlessly with C code. Link libraries automatically use absolute addressing or are compiled in relative mode, and are linked with other software modules to get absolute addressing.

C Language Compilers. C language compilers are available that support the PSoC family of devices. The products allow you to create complete C programs for the PSoC family devices. The optimizing C compilers provide all of the features of C, tailored to the PSoC architecture. They come complete with embedded libraries providing port and bus operations, standard keypad and display support, and extended math functionality.

Debugger

PSoC Designer has a debug environment that provides hardware in-circuit emulation, allowing you to test the program in a physical system while providing an internal view of the PSoC device. Debugger commands allow you to read and program and read and write data memory, and read and write I/O registers. You can read and write CPU registers, set and clear breakpoints,

and provide program run, halt, and step control. The debugger also allows you to create a trace buffer of registers and memory locations of interest.

Online Help System

The online help system displays online, context-sensitive help. Designed for procedural and quick reference, each functional subsystem has its own context-sensitive help. This system also provides tutorials and links to FAQs and an online support Forum to aid the designer.

In-Circuit Emulator

A low-cost, high-functionality in-circuit emulator (ICE) is available for development support. This hardware can program single devices.

The emulator consists of a base unit that connects to the PC using a USB port. The base unit is universal and operates with all PSoC devices. Emulation pods for each device family are available separately. The emulation pod takes the place of the PSoC device in the target board and performs full-speed (24 MHz) operation.

Designing with PSoC Designer

The development process for the PSoC device differs from that of a traditional fixed function microprocessor. The configurable analog and digital hardware blocks give the PSoC architecture a unique flexibility that pays dividends in managing specification change during development and by lowering inventory costs. These configurable resources, called PSoC Blocks, have the ability to implement a wide variety of user-selectable functions.

The PSoC development process can be summarized in the following four steps:

1. Select User Modules
2. Configure User Modules
3. Organize and Connect
4. Generate, Verify, and Debug

Select Components

PSoC Designer provides a library of pre-built, pre-tested hardware peripheral components called “user modules”. User modules make selecting and implementing peripheral devices, both analog and digital, simple.

Configure Components

Each of the User Modules you select establishes the basic register settings that implement the selected function. They also provide parameters and properties that allow you to tailor their precise configuration to your particular application. For example, a PWM User Module configures one or more

digital PSoC blocks, one for each 8 bits of resolution. The user module parameters permit you to establish the pulse width and duty cycle. Configure the parameters and properties to correspond to your chosen application. Enter values directly or by selecting values from drop-down menus. All the user modules are documented in datasheets that may be viewed directly in PSoC Designer or on the Cypress website. These user module datasheets explain the internal operation of the User Module and provide performance specifications. Each datasheet describes the use of each user module parameter, and other information you may need to successfully implement your design.

Organize and Connect

You build signal chains at the chip level by interconnecting user modules to each other and the I/O pins. You perform the selection, configuration, and routing so that you have complete control over all on-chip resources.

Generate, Verify, and Debug

When you are ready to test the hardware configuration or move on to developing code for the project, you perform the "Generate Configuration Files" step. This causes PSoC Designer to generate source code that automatically configures the device to your specification and provides the software for the system. The generated code provides application programming interfaces (APIs) with high-level functions to control and respond to hardware events at run time and interrupt service routines that you can adapt as needed.

A complete code development environment allows you to develop and customize your applications in C, assembly language, or both.

The last step in the development process takes place inside PSoC Designer's Debugger (access by clicking the Connect icon). PSoC Designer downloads the HEX image to the ICE where it runs at full speed. PSoC Designer debugging capabilities rival those of systems costing many times more. In addition

to traditional single-step, run-to-breakpoint and watch-variable features, the debug interface provides a large trace buffer and allows you to define complex breakpoint events that include monitoring address and data bus values, memory locations and external signals.

Pin Information

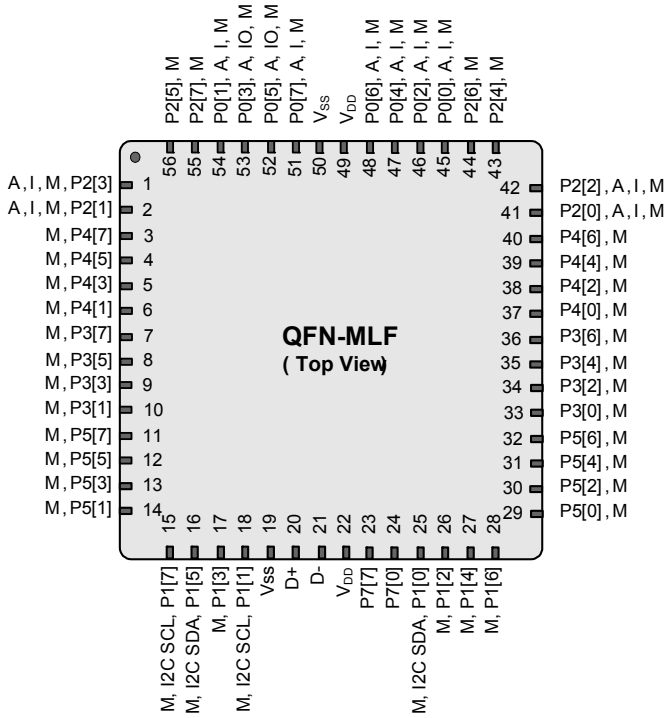
56-Pin Part Pinout

The CY7C64215 enCoRe III device is available in a 56-pin package which is listed and illustrated in the following table. Every port pin (labeled “P”) is capable of digital I/O. However, V_{SS} and V_{DD} are not capable of digital I/O.

Table 2. 56-Pin Part Pinout (QFN-MLF SAWN)[1]

Pin No.	Type		Name	Description
	Digital	Analog		
1	I/O	I, M	P2[3]	Direct switched capacitor block input.
2	I/O	I, M	P2[1]	Direct switched capacitor block input.
3	I/O	M	P4[7]	
4	I/O	M	P4[5]	
5	I/O	M	P4[3]	
6	I/O	M	P4[1]	
7	I/O	M	P3[7]	
8	I/O	M	P3[5]	
9	I/O	M	P3[3]	
10	I/O	M	P3[1]	
11	I/O	M	P5[7]	
12	I/O	M	P5[5]	
13	I/O	M	P5[3]	
14	I/O	M	P5[1]	
15	I/O	M	P1[7]	I^2C serial clock (SCL).
16	I/O	M	P1[5]	I^2C serial data (SDA).
17	I/O	M	P1[3]	
18	I/O	M	P1[1]	I^2C SCL, ISSP-SCLK.
19	Power		V_{SS}	Ground connection.
20	USB		D+	
21	USB		D-	
22	Power		V_{DD}	Supply voltage.
23	I/O		P7[7]	
24	I/O		P7[0]	
25	I/O	M	P1[0]	I^2C SDA, ISSP-SDATA.
26	I/O	M	P1[2]	
27	I/O	M	P1[4]	Optional external clock input EXTCLK.
28	I/O	M	P1[6]	
29	I/O	M	P5[0]	
30	I/O	M	P5[2]	
31	I/O	M	P5[4]	
32	I/O	M	P5[6]	
33	I/O	M	P3[0]	
34	I/O	M	P3[2]	
35	I/O	M	P3[4]	
36	I/O	M	P3[6]	
37	I/O	M	P4[0]	
38	I/O	M	P4[2]	
39	I/O	M	P4[4]	
40	I/O	M	P4[6]	
41	I/O	I, M	P2[0]	Direct switched capacitor block input.
42	I/O	I, M	P2[2]	Direct switched capacitor block input.
43	I/O	M	P2[4]	External analog ground (AGND) input.
44	I/O	M	P2[6]	External voltage reference (VREF) input.
45	I/O	I, M	P0[0]	Analog column mux input.
46	I/O	I, M	P0[2]	Analog column mux input and column output.
47	I/O	I, M	P0[4]	Analog column mux input and column output.
48	I/O	I, M	P0[6]	Analog column mux input.
49	Power		V_{DD}	Supply voltage.
50	Power		V_{SS}	Ground connection.
51	I/O	I, M	P0[7]	Analog column mux input.
52	I/O	I/O, M	P0[5]	Analog column mux input and column output
53	I/O	I/O, M	P0[3]	Analog column mux input and column output.
54	I/O	I, M	P0[1]	Analog column mux input.
55	I/O	M	P2[7]	
56	I/O	M	P2[5]	

Figure 3. CY7C64215 56-Pin enCoRe III Device



LEGEND A = Analog, I = Input, O = Output, and M = Analog Mux Input.

Note
1. The center pad on the QFN-MLF package should be connected to ground (V_{SS}) for best mechanical, thermal, and electrical performance. If not connected to ground, it should be electrically floated and not connected to any other signal.

28-Pin Part Pinout

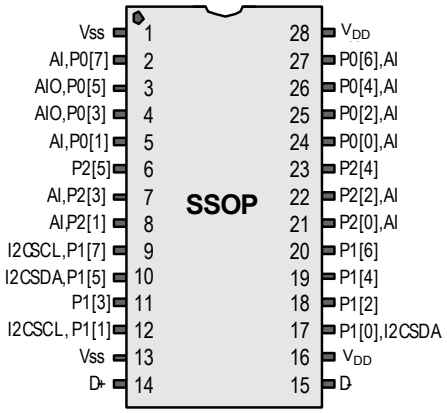
The CY7C64215 enCoRe III device is available in a 28-pin package which is listed and illustrated in the following table. Every port pin (labeled with a “P”) is capable of digital I/O. However, V_{SS} and V_{DD} are not capable of digital I/O.

Table 3. 28-Pin Part Pinout (SSOP)

Pin No.	Type		Name	Description
	Digital	Analog		
1	Power		GND	Ground connection.
2	I/O	I, M	P0[7]	Analog column mux input.
3	I/O	I/O,M	P0[5]	Analog column mux input and column output.
4	I/O	I/O,M	P0[3]	Analog column mux input and column output.
5	I/O	I,M	P0[1]	Analog column mux input.
6	I/O	M	P2[5]	
7	I/O	M	P2[3]	Direct switched capacitor block input.
8	I/O	M	P2[1]	Direct switched capacitor block input.
9	I/O	M	P1[7]	I^2C SCL
10	I/O	M	P1[5]	I^2C SDA
11	I/O	M	P1[3]	
12	I/O	M	P1[1]	I^2C SCL, ISSP-SCLK.
13	Power		GND	Ground connection.
14	USB		D+	
15	USB		D-	
16	Power		V_{DD}	Supply voltage.
17	I/O	M	P1[0]	I^2C SCL, ISSP-SDATA.
18	I/O	M	P1[2]	
19	I/O	M	P1[4]	
20	I/O	M	P1[6]	
21	I/O	M	P2[0]	Direct switched capacitor block input.
22	I/O	M	P2[2]	Direct switched capacitor block input.
23	I/O	M	P2[4]	External analog ground (AGND) input.
24	I/O	M	P0[0]	Analog column mux input.
25	I/O	M	P0[2]	Analog column mux input and column output.
26	I/O	M	P0[4]	Analog column mux input and column output.
27	I/O	M	P0[6]	Analog column mux input.
28	Power		V_{DD}	Supply voltage.

LEGEND A = Analog, I = Input, O = Output, and M = Analog Mux Input.

Figure 4. CY7C64215 28-Pin enCoRe III Device

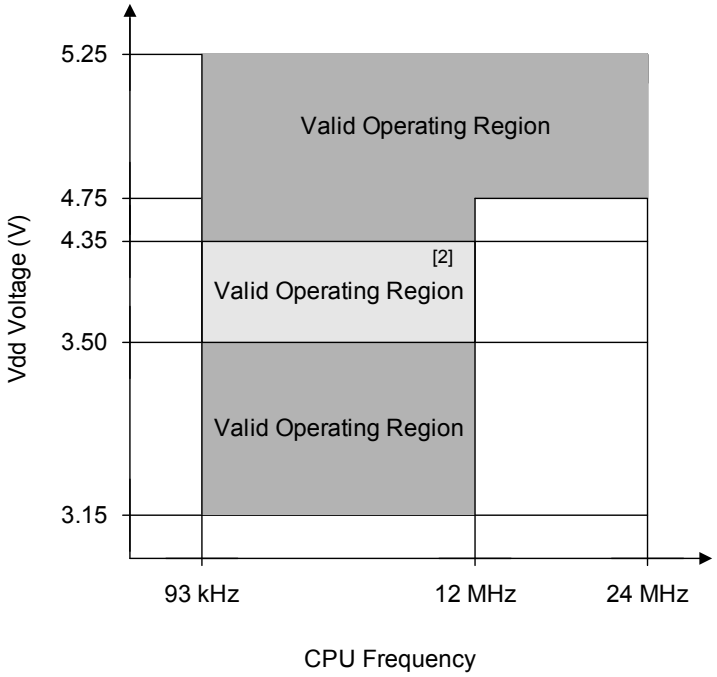


Electrical Specifications

This section presents the DC and AC electrical specifications of the CY7C64215 enCoRe III. For the most up-to-date electrical specifications, confirm that you have the most recent datasheet by going to the web at http://www.cypress.com/go/usb.

Specifications are valid for –40 °C ≤ T_A ≤ 85 °C and T_J ≤ 100 °C, except where noted. Specifications for devices running at greater than 12 MHz are valid for –40 °C ≤ T_A ≤ 70°C and T_J ≤ 82 °C.

Figure 5. Voltage versus CPU Frequency



Note
2. This is a valid operating region for the CPU, but USB hardware is non functional in the voltage range from 3.50 V to 4.35 V.

DC Electrical Characteristics

DC Chip-Level Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and –40 °C ≤ T_A ≤ 85 °C, or 3.15 V to 3.5 V and –40 °C ≤ T_A ≤ 85 °C, respectively. Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

Table 7. DC Chip-Level Specifications

Parameter	Description	Min	Typ	Max	Unit	Notes
V_{DD}	Supply voltage	3.0	–	5.25	V	See DC POR and LVD specifications, Table 15 on page 22. USB hardware is not functional when V_{DD} is between 3.5 V to 4.35 V.
I_{DD5}	Supply current, IMO = 24 MHz (5 V)	–	14	27	mA	Conditions are V_{DD} = 5.0 V, T_A = 25 °C, CPU = 3 MHz, SYSCLK doubler disabled, VC1 = 1.5 MHz, VC2 = 93.75 kHz, VC3 = 93.75 kHz, analog power = off.
I_{DD3}	Supply current, IMO = 24 MHz (3.3 V)	–	8	14	mA	Conditions are V_{DD} = 3.3 V, T_A = 25 °C, CPU = 3 MHz, SYSCLK doubler disabled, VC1 = 1.5 MHz, VC2 = 93.75 kHz, VC3 = 0.367 kHz, analog power = off.
I_{SB}	Sleep [3] (mode) current with POR, LVD, sleep timer, and WDT [4].	–	3	6.5	µA	Conditions are with internal slow speed oscillator, V_{DD} = 3.3 V, 0 °C ≤ T_A ≤ 55 °C, analog power = off.
I_{SBH}	Sleep (mode) current with POR, LVD, sleep timer, and WDT at high temperature [4] .	–	4	25	µA	Conditions are with internal slow speed oscillator, V_{DD} = 3.3 V, 55 °C < T_A ≤ 70 °C, analog power = off.

Notes

3. Errata: When the device operates at4.75 V to 5.25 V and the 3.3-V regulator is enabled, a short low pulse may be created on the DP signal line during device wakeup. The 15- to 20-µs low pulse of the DP line may be interpreted by the host computer as a deattach or the beginning of a wakeup. For more details refer to Errata on page 40.
4. Standby current includes all functions (POR, LVD, WDT, sleep time) needed for reliable system operation. This should be compared with devices that have similar functions enabled.

DC GPIO Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and –40 °C ≤ T_A ≤ 85 °C, or 3.15 V to 3.5 V and –40 °C ≤ T_A ≤ 85 °C, respectively. Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

Table 8. DC GPIO Specifications

Parameter	Description	Min	Typ	Max	Unit	Notes
R_{PU}	Pull-up resistor	4	5.6	8	kΩ	–
R_{PD}	Pull-down resistor	4	5.6	8	kΩ	–
V_{OH}	High output level	V_{DD} – 1.0	–	–	V	I_{OH} = 10 mA, V_{DD} = 4.75 to 5.25 V (8 total loads, 4 on even port pins (for example, P0[2], P1[4]), 4 on odd port pins (for example, P0[3], P1[5])). 80 mA maximum combined I_{OH} budget.
V_{OL}	Low output level	–	–	0.75	V	I_{OL} = 25 mA, V_{DD} = 4.75 to 5.25 V (8 total loads, 4 on even port pins (for example, P0[2], P1[4]), 4 on odd port pins (for example, P0[3], P1[5])). 150 mA maximum combined I_{OL} budget.
I_{OH}	High-level source current	10	–	–	mA	–
I_{OL}	Low-level sink current	25	–	–	mA	–
V_{IL}	Input low level	–	–	0.8	V	V_{DD} = 3.15 to 5.25.
V_{IH}	Input high level	2.1	–		V	V_{DD} = 3.15 to 5.25.
V_H	Input hysteresis	–	60	–	mV	–
I_{IL}	Input leakage (absolute value)	–	1	–	nA	Gross tested to 1 µA.
C_{IN}	Capacitive load on pins as input	–	3.5	10	pF	Package and pin dependent. Temp = 25 °C.
C_{OUT}	Capacitive load on pins as output	–	3.5	10	pF	Package and pin dependent. Temp = 25 °C.

DC Full-Speed USB Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges when the IMO is selected as system clock: 4.75 V to 5.25 V and 0 °C ≤ T_A ≤ 70 °C, or 3.15 V to 3.5 V and 0 °C ≤ T_A ≤ 70 °C, respectively.

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges when an external clock is selected as the system clock: 4.75 V to 5.25 V and –40 °C ≤ T_A ≤ 85 °C, or 3.15 V to 3.5 V and –40 °C ≤ T_A ≤ 85 °C.

Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

Table 9. DC Full Speed (12 Mbps) USB Specifications

Parameter	Description	Min	Typ	Max	Unit	Notes
USB Interface						
V_{DI}	Differential input sensitivity	0.2	–	–	V	| (D+) – (D–) |
V_{CM}	Differential input common mode range	0.8	–	2.5	V	–
V_{SE}	Single-ended receiver threshold	0.8	–	2.0	V	–
C_{IN}	Transceiver capacitance	–	–	20	pF	–
I_{IO}	High Z state data line leakage	–10	–	10	µA	0 V < V_{IN} < 3.3 V.
R_{EXT}	External USB series resistor	23	–	25	Ω	In series with each USB pin.
V_{UOH}	Static output high, driven	2.8	–	3.6	V	15 kΩ ± 5% to ground. Internal pull-up enabled.
V_{UOHI}	Static output high, idle	2.7	–	3.6	V	15 kΩ ± 5% to ground. Internal pull-up enabled.
V_{UOL}	Static output low	–	–	0.3	V	15 kΩ ± 5% to ground. Internal pull-up enabled.
Z_O	USB driver output impedance	28	–	44	Ω	Including R_{EXT} resistor.
V_{CRS}	D+/D– crossover voltage	1.3	–	2.0	V	–

DC Analog Reference Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and –40 °C ≤ T_A ≤ 85 °C, or 3.15 V to 3.5 V and –40 °C ≤ T_A ≤ 85 °C, respectively. Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

The guaranteed specifications are measured through the analog continuous time PSoC blocks. The power levels for AGND refer to the power of the Analog Continuous Time PSoC block. The power levels for RefHi and RefLo refer to the Analog Reference Control register. The limits stated for AGND include the offset error of the AGND buffer local to the Analog Continuous Time PSoC block. Reference control power is high.

Table 12. 5-V DC Analog Reference Specifications

Reference ARF_CR [5:3]	Reference Power Settings	Symbol	Reference	Description	Min	Typ	Max	Units
0b000	RefPower = high Opamp bias = high	V_{REFHI}	Ref High	$V_{DD}/2$ + Bandgap	$V_{DD}/2$ + 1.229	$V_{DD}/2$ + 1.290	$V_{DD}/2$ + 1.346	V
		V_{AGND}	AGND	$V_{DD}/2$	$V_{DD}/2$ – 0.038	$V_{DD}/2$	$V_{DD}/2$ + 0.040	V
		V_{REFLO}	Ref Low	$V_{DD}/2$ – Bandgap	$V_{DD}/2$ – 1.356	$V_{DD}/2$ – 1.295	$V_{DD}/2$ – 1.218	V
	RefPower = high Opamp bias = low	V_{REFHI}	Ref High	$V_{DD}/2$ + Bandgap	$V_{DD}/2$ + 1.220	$V_{DD}/2$ + 1.292	$V_{DD}/2$ + 1.348	V
		V_{AGND}	AGND	$V_{DD}/2$	$V_{DD}/2$ – 0.036	$V_{DD}/2$	$V_{DD}/2$ + 0.036	V
		V_{REFLO}	Ref Low	$V_{DD}/2$ – Bandgap	$V_{DD}/2$ – 1.357	$V_{DD}/2$ – 1.297	$V_{DD}/2$ – 1.225	V
	RefPower = medium Opamp bias = high	V_{REFHI}	Ref High	$V_{DD}/2$ + Bandgap	$V_{DD}/2$ + 1.221	$V_{DD}/2$ + 1.293	$V_{DD}/2$ + 1.351	V
		V_{AGND}	AGND	$V_{DD}/2$	$V_{DD}/2$ – 0.036	$V_{DD}/2$	$V_{DD}/2$ + 0.036	V
		V_{REFLO}	Ref Low	$V_{DD}/2$ – Bandgap	$V_{DD}/2$ – 1.357	$V_{DD}/2$ – 1.298	$V_{DD}/2$ – 1.228	V
	RefPower = medium Opamp bias = low	V_{REFHI}	Ref High	$V_{DD}/2$ + Bandgap	$V_{DD}/2$ + 1.219	$V_{DD}/2$ + 1.293	$V_{DD}/2$ + 1.353	V
		V_{AGND}	AGND	$V_{DD}/2$	$V_{DD}/2$ – 0.037	$V_{DD}/2$ – 0.001	$V_{DD}/2$ + 0.036	V
		V_{REFLO}	Ref Low	$V_{DD}/2$ – Bandgap	$V_{DD}/2$ – 1.359	$V_{DD}/2$ – 1.299	$V_{DD}/2$ – 1.229	V
0b001	RefPower = high Opamp bias = high	V_{REFHI}	Ref High	P2[4]+P2[6] (P2[4] = $V_{DD}/2$, P2[6] = 1.3 V)	P2[4] + P2[6] – 0.092	P2[4] + P2[6] – 0.011	P2[4] + P2[6] + 0.064	V
		V_{AGND}	AGND	P2[4]	P2[4]	P2[4]	P2[4]	–
		V_{REFLO}	Ref Low	P2[4]–P2[6] (P2[4] = $V_{DD}/2$, P2[6] = 1.3 V)	P2[4] – P2[6] – 0.031	P2[4] – P2[6] + 0.007	P2[4] – P2[6] + 0.056	V
	RefPower = high Opamp bias = low	V_{REFHI}	Ref High	P2[4]+P2[6] (P2[4] = $V_{DD}/2$, P2[6] = 1.3 V)	P2[4] + P2[6] – 0.078	P2[4] + P2[6] – 0.008	P2[4] + P2[6] + 0.063	V
		V_{AGND}	AGND	P2[4]	P2[4]	P2[4]	P2[4]	–
		V_{REFLO}	Ref Low	P2[4]–P2[6] (P2[4] = $V_{DD}/2$, P2[6] = 1.3 V)	P2[4] – P2[6] – 0.031	P2[4] – P2[6] + 0.004	P2[4] – P2[6] + 0.043	V
	RefPower = medium Opamp bias = high	V_{REFHI}	Ref High	P2[4]+P2[6] (P2[4] = $V_{DD}/2$, P2[6] = 1.3 V)	P2[4] + P2[6] – 0.073	P2[4] + P2[6] – 0.006	P2[4] + P2[6] + 0.062	V
		V_{AGND}	AGND	P2[4]	P2[4]	P2[4]	P2[4]	–
		V_{REFLO}	Ref Low	P2[4]–P2[6] (P2[4] = $V_{DD}/2$, P2[6] = 1.3 V)	P2[4] – P2[6] – 0.032	P2[4] – P2[6] + 0.003	P2[4] – P2[6] + 0.038	V
	RefPower = medium Opamp bias = low	V_{REFHI}	Ref High	P2[4]+P2[6] (P2[4] = $V_{DD}/2$, P2[6] = 1.3 V)	P2[4] + P2[6] – 0.073	P2[4] + P2[6] – 0.006	P2[4] + P2[6] + 0.062	V
		V_{AGND}	AGND	P2[4]	P2[4]	P2[4]	P2[4]	–
		V_{REFLO}	Ref Low	P2[4]–P2[6] (P2[4] = $V_{DD}/2$, P2[6] = 1.3 V)	P2[4] – P2[6] – 0.034	P2[4] – P2[6] + 0.002	P2[4] – P2[6] + 0.037	V

Table 12. 5-V DC Analog Reference Specifications (continued)

Reference ARF_CR [5:3]	Reference Power Settings	Symbol	Reference	Description	Min	Typ	Max	Units
0b010	RefPower = high Opamp bias = high	V_{REFHI}	Ref High	V_{DD}	V_{DD} – 0.037	V_{DD} – 0.007	V_{DD}	V
		V_{AGND}	AGND	$V_{DD}/2$	$V_{DD}/2$ – 0.036	$V_{DD}/2$ – 0.001	$V_{DD}/2$ + 0.036	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.005	V_{SS} + 0.029	V
	RefPower = high Opamp bias = low	V_{REFHI}	Ref High	V_{DD}	V_{DD} – 0.034	V_{DD} – 0.006	V_{DD}	V
		V_{AGND}	AGND	$V_{DD}/2$	$V_{DD}/2$ – 0.036	$V_{DD}/2$ – 0.001	$V_{DD}/2$ + 0.035	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.004	V_{SS} + 0.024	V
	RefPower = medium Opamp bias = high	V_{REFHI}	Ref High	V_{DD}	V_{DD} – 0.032	V_{DD} – 0.005	V_{DD}	V
		V_{AGND}	AGND	$V_{DD}/2$	$V_{DD}/2$ – 0.036	$V_{DD}/2$ – 0.001	$V_{DD}/2$ + 0.035	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.003	V_{SS} + 0.022	V
	RefPower = medium Opamp bias = low	V_{REFHI}	Ref High	V_{DD}	V_{DD} – 0.031	V_{DD} – 0.005	V_{DD}	V
		V_{AGND}	AGND	$V_{DD}/2$	$V_{DD}/2$ – 0.037	$V_{DD}/2$ – 0.001	$V_{DD}/2$ + 0.035	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.003	V_{SS} + 0.020	V
0b011	RefPower = high Opamp bias = high	V_{REFHI}	Ref High	3 × Bandgap	3.760	3.884	4.006	V
		V_{AGND}	AGND	2 × Bandgap	2.522	2.593	2.669	V
		V_{REFLO}	Ref Low	Bandgap	1.252	1.299	1.342	V
	RefPower = high Opamp bias = low	V_{REFHI}	Ref High	3 × Bandgap	3.766	3.887	4.010	V
		V_{AGND}	AGND	2 × Bandgap	2.523	2.594	2.670	V
		V_{REFLO}	Ref Low	Bandgap	1.252	1.297	1.342	V
	RefPower = medium Opamp bias = high	V_{REFHI}	Ref High	3 × Bandgap	3.769	3.888	4.013	V
		V_{AGND}	AGND	2 × Bandgap	2.523	2.594	2.671	V
		V_{REFLO}	Ref Low	Bandgap	1.251	1.296	1.343	V
	RefPower = medium Opamp bias = low	V_{REFHI}	Ref High	3 × Bandgap	3.769	3.889	4.015	V
		V_{AGND}	AGND	2 × Bandgap	2.523	2.595	2.671	V
		V_{REFLO}	Ref Low	Bandgap	1.251	1.296	1.344	V
0b100	RefPower = high Opamp bias = high	V_{REFHI}	Ref High	2 × Bandgap + P2[6] (P2[6] = 1.3 V)	2.483 – P2[6]	2.582 – P2[6]	2.674 – P2[6]	V
		V_{AGND}	AGND	2 × Bandgap	2.522	2.593	2.669	V
		V_{REFLO}	Ref Low	2 × Bandgap – P2[6] (P2[6] = 1.3 V)	2.524 – P2[6]	2.600 – P2[6]	2.676 – P2[6]	V
	RefPower = high Opamp bias = low	V_{REFHI}	Ref High	2 × Bandgap + P2[6] (P2[6] = 1.3 V)	2.490 – P2[6]	2.586 – P2[6]	2.679 – P2[6]	V
		V_{AGND}	AGND	2 × Bandgap	2.523	2.594	2.669	V
		V_{REFLO}	Ref Low	2 × Bandgap – P2[6] (P2[6] = 1.3 V)	2.523 – P2[6]	2.598 – P2[6]	2.675 – P2[6]	V
	RefPower = medium Opamp bias = high	V_{REFHI}	Ref High	2 × Bandgap + P2[6] (P2[6] = 1.3 V)	2.493 – P2[6]	2.588 – P2[6]	2.682 – P2[6]	V
		V_{AGND}	AGND	2 × Bandgap	2.523	2.594	2.670	V
		V_{REFLO}	Ref Low	2 × Bandgap – P2[6] (P2[6] = 1.3 V)	2.523 – P2[6]	2.597 – P2[6]	2.675 – P2[6]	V
	RefPower = medium Opamp bias = low	V_{REFHI}	Ref High	2 × Bandgap + P2[6] (P2[6] = 1.3 V)	2.494 – P2[6]	2.589 – P2[6]	2.685 – P2[6]	V
		V_{AGND}	AGND	2 × Bandgap	2.523	2.595	2.671	V
		V_{REFLO}	Ref Low	2 × Bandgap – P2[6] (P2[6] = 1.3 V)	2.522 – P2[6]	2.596 – P2[6]	2.676 – P2[6]	V

Table 12. 5-V DC Analog Reference Specifications (continued)

Reference ARF_CR [5:3]	Reference Power Settings	Symbol	Reference	Description	Min	Typ	Max	Units
0b101	RefPower = high Opamp bias = high	V_{REFHI}	Ref High	P2[4] + Bandgap (P2[4] = V_{DD}/2)	P2[4] + 1.218	P2[4] + 1.291	P2[4] + 1.354	V
		V_{AGND}	AGND	P2[4]	P2[4]	P2[4]	P2[4]	–
		V_{REFLO}	Ref Low	P2[4] – Bandgap (P2[4] = V_{DD}/2)	P2[4] – 1.335	P2[4] – 1.294	P2[4] – 1.237	V
	RefPower = high Opamp bias = low	V_{REFHI}	Ref High	P2[4] + Bandgap (P2[4] = V_{DD}/2)	P2[4] + 1.221	P2[4] + 1.293	P2[4] + 1.358	V
		V_{AGND}	AGND	P2[4]	P2[4]	P2[4]	P2[4]	–
		V_{REFLO}	Ref Low	P2[4] – Bandgap (P2[4] = V_{DD}/2)	P2[4] – 1.337	P2[4] – 1.297	P2[4] – 1.243	V
	RefPower = medium Opamp bias = high	V_{REFHI}	Ref High	P2[4] + Bandgap (P2[4] = V_{DD}/2)	P2[4] + 1.222	P2[4] + 1.294	P2[4] + 1.360	V
		V_{AGND}	AGND	P2[4]	P2[4]	P2[4]	P2[4]	–
		V_{REFLO}	Ref Low	P2[4] – Bandgap (P2[4] = V_{DD}/2)	P2[4] – 1.338	P2[4] – 1.298	P2[4] – 1.245	V
	RefPower = medium Opamp bias = low	V_{REFHI}	Ref High	P2[4] + Bandgap (P2[4] = V_{DD}/2)	P2[4] + 1.221	P2[4] + 1.294	P2[4] + 1.362	V
		V_{AGND}	AGND	P2[4]	P2[4]	P2[4]	P2[4]	–
		V_{REFLO}	Ref Low	P2[4] – Bandgap (P2[4] = V_{DD}/2)	P2[4] – 1.340	P2[4] – 1.298	P2[4] – 1.245	V
0b110	RefPower = high Opamp bias = high	V_{REFHI}	Ref High	2 × Bandgap	2.513	2.593	2.672	V
		V_{AGND}	AGND	Bandgap	1.264	1.302	1.340	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.008	V_{SS} + 0.038	V
	RefPower = high Opamp bias = low	V_{REFHI}	Ref High	2 × Bandgap	2.514	2.593	2.674	V
		V_{AGND}	AGND	Bandgap	1.264	1.301	1.340	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.005	V_{SS} + 0.028	V
	RefPower = medium Opamp bias = high	V_{REFHI}	Ref High	2 × Bandgap	2.514	2.593	2.676	V
		V_{AGND}	AGND	Bandgap	1.264	1.301	1.340	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.004	V_{SS} + 0.024	V
	RefPower = medium Opamp bias = low	V_{REFHI}	Ref High	2 × Bandgap	2.514	2.593	2.677	V
		V_{AGND}	AGND	Bandgap	1.264	1.300	1.340	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.003	V_{SS} + 0.021	V
0b111	RefPower = high Opamp bias = high	V_{REFHI}	Ref High	3.2 × Bandgap	4.028	4.144	4.242	V
		V_{AGND}	AGND	1.6 × Bandgap	2.028	2.076	2.125	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.008	V_{SS} + 0.034	V
	RefPower = high Opamp bias = low	V_{REFHI}	Ref High	3.2 × Bandgap	4.032	4.142	4.245	V
		V_{AGND}	AGND	1.6 × Bandgap	2.029	2.076	2.126	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.005	V_{SS} + 0.025	V
	RefPower = medium Opamp bias = high	V_{REFHI}	Ref High	3.2 × Bandgap	4.034	4.143	4.247	V
		V_{AGND}	AGND	1.6 × Bandgap	2.029	2.076	2.126	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.004	V_{SS} + 0.021	V
	RefPower = medium Opamp bias = low	V_{REFHI}	Ref High	3.2 × Bandgap	4.036	4.144	4.249	V
		V_{AGND}	AGND	1.6 × Bandgap	2.029	2.076	2.126	V
		V_{REFLO}	Ref Low	V_{SS}	V_{SS}	V_{SS} + 0.003	V_{SS} + 0.019	V

DC Programming Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and –40 °C ≤ T_A ≤ 85 °C, or 3.15 V to 3.5 V and –40 °C ≤ T_A ≤ 85 °C, respectively. Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

Table 16. DC Programming Specifications

Parameter	Description	Min	Typ	Max	Unit	Notes
V_{DDP}	V_{DD} for programming and erase	4.5	5.0	5.5	V	This specification applies to the functional requirements of external programmer tools
V_{DDLV}	Low V_{DD} for verify	3.0	3.1	3.2	V	This specification applies to the functional requirements of external programmer tools
V_{DDHV}	High V_{DD} for verify	5.1	5.2	5.3	V	This specification applies to the functional requirements of external programmer tools
$V_{DDIWRITE}$	Supply voltage for flash write operation	3.15	–	5.25	V	This specification applies to this device when it is executing internal flash writes
I_{DDP}	Supply current during programming or verify	–	15	30	mA	–
V_{ILP}	Input low voltage during programming or verify	–	–	0.8	V	–
V_{IHP}	Input high voltage during programming or Verify	2.1	–	–	V	–
I_{ILP}	Input current when applying Vilp to P1[0] or P1[1] during programming or verify	–	–	0.2	mA	Driving internal pull-down resistor.
I_{IHP}	Input current when applying Vihp to P1[0] or P1[1] during programming or verify	–	–	1.5	mA	Driving internal pull-down resistor.
V_{OLV}	Output low voltage during programming or verify	–	–	V_{SS} + 0.75	V	–
V_{OHV}	Output high voltage during programming or verify	V_{DD} – 1.0	–	V_{DD}	V	–
$Flash_{ENPB}$	Flash endurance (per block)	50,000[8]	–	–	–	Erase/write cycles per block.
$Flash_{ENT}$	Flash endurance (total)[9]	1,800,000	–	–	–	Erase/write cycles.
$Flash_{DR}$	Flash data retention	10	–	–	Years	–

DC I^2C Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and –40 °C ≤ T_A ≤ 85 °C, or 3.15 V to 3.5 V and –40 °C ≤ T_A ≤ 85 °C, respectively. Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

Table 17. DC I^2C Specifications [10]

Symbol	Description	Min	Typ	Max	Units	Notes
V_{ILI2C}	Input low level	–	–	0.3 × V_{DD}	V	3.15 V ≤ V_{DD} ≤ 3.6 V
		–	–	0.25 × V_{DD}	V	4.75 V ≤ V_{DD} ≤ 5.25 V
V_{IHI2C}	Input high level	0.7 × V_{DD}	–	–	V	3.15 V ≤ V_{DD} ≤ 5.25 V

Notes

8. The 50,000 cycle Flash endurance per block will only be guaranteed if the Flash is operating within one voltage range. Voltage ranges are 3.0V to 3.6V and 4.75V to 5.25V.
9. A maximum of 36 x 50,000 block endurance cycles is allowed. This may be balanced between operations on 36x1 blocks of 50,000 maximum cycles each, 36x2 blocks of 25,000 maximum cycles each, or 36x4 blocks of 12,500 maximum cycles each (to limit the total number of cycles to 36x50,000 and that no single block ever sees more than 50,000 cycles).
   For the full industrial range, the user must employ a temperature sensor user module (FlashTemp) and feed the result to the temperature argument before writing. Refer to the Flash APIs application note AN2015 for more information.
10. All GPIOs meet the DC GPIO V_{IL} and V_{IH} specifications found in the DC GPIO Specifications sections. The I^2C GPIO pins also meet the mentioned specifications.

AC External Clock Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and –40 °C ≤ T_A ≤ 85 °C, or 3.15 V to 3.5 V and –40 °C ≤ T_A ≤ 85 °C, respectively. Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

Table 22. AC External Clock Specifications

Parameter	Description	Min	Typ	Max	Unit	Notes
F_{OSCEXT}	Frequency for USB applications	23.94	24	24.06	MHz	USB operation in the extended Industrial temperature range (–40 °C ≤ T_A ≤ 85 °C) requires that the system clock is sourced from an external clock oscillator.
–	Duty cycle	47	50	53	%	–
–	Power-up to IMO switch	150	–	–	µs	–

AC Analog Output Buffer Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and –40 °C ≤ T_A ≤ 85 °C, or 3.15 V to 3.5 V and –40 °C ≤ T_A ≤ 85 °C, respectively. Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

Table 23. 5 V AC Analog Output Buffer Specifications

Parameter	Description	Min	Typ	Max	Unit	Notes
T_{ROB}	Rising settling time to 0.1%, 1 V Step, 100-pF load Power = low Power = high	 – –	 – –	 2.5 2.5	 µs µs	–
T_{SOB}	Falling settling time to 0.1%, 1 V Step, 100-pF load Power = low Power = high	 – –	 – –	 2.2 2.2	 µs µs	–
SR_{ROB}	Rising slew rate (20% to 80%), 1 V Step, 100-pF load Power = low Power = high	 0.65 0.65	 – –	 – –	 V/µs V/µs	–
SR_{FOB}	Falling slew rate (80% to 20%), 1 V Step, 100-pF load Power = low Power = high	 0.65 0.65	 – –	 – –	 V/µs V/µs	–
BW_{OBSS}	Small signal bandwidth, 20 mV_{pp}, 3-dB BW, 100-pF load Power = low Power = high	 0.8 0.8	 – –	 – –	 MHz MHz	–
BW_{OBLS}	Large signal bandwidth, 1 V_{pp}, 3-dB BW, 100-pF load Power = low Power = high	 300 300	 – –	 – –	 kHz kHz	–

Table 24. 3.3 V AC Analog Output Buffer Specifications

Parameter	Description	Min	Typ	Max	Unit	Notes
T_{ROB}	Rising settling time to 0.1%, 1 V Step, 100-pF load Power = low Power = high	 – –	 – –	 3.8 3.8	 µs µs	–
T_{SOB}	Falling settling time to 0.1%, 1 V Step, 100-pF load Power = low Power = high	 – –	 – –	 2.6 2.6	 µs µs	–
SR_{ROB}	Rising slew rate (20% to 80%), 1 V Step, 100-pF load Power = low Power = high	 0.5 0.5	 – –	 – –	 V/µs V/µs	–
SR_{FOB}	Falling slew rate (80% to 20%), 1 V Step, 100-pF load Power = low Power = high	 0.5 0.5	 – –	 – –	 V/µs V/µs	–
BW_{OBSS}	Small signal bandwidth, 20 mV_{pp}, 3dB BW, 100-pF load Power = low Power = high	 0.7 0.7	 – –	 – –	 MHz MHz	–
BW_{OBLS}	Large signal bandwidth, 1 V_{pp}, 3dB BW, 100-pF load Power = low Power = high	 200 200	 – –	 – –	 kHz kHz	–

AC Programming Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and –40 °C ≤ T_A ≤ 85 °C, or 3.15 V to 3.5 V and –40 °C ≤ T_A ≤ 85 °C, respectively. Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

Table 25. AC Programming Specifications

Parameter	Description	Min	Typ	Max	Unit	Notes
T_{RSCLK}	Rise time of SCLK	1	–	20	ns	–
T_{FSCLK}	Fall time of SCLK	1	–	20	ns	–
T_{SSCLK}	Data setup time to falling edge of SCLK	40	–	–	ns	–
T_{HSCLK}	Data hold time from falling edge of SCLK	40	–	–	ns	–
F_{SCLK}	Frequency of SCLK	0	–	8	MHz	–
T_{ERASEB}	Flash erase time (block)	–	10	–	ms	–
T_{WRITE}	Flash block write time	–	40	–	ms	–
T_{DSCLK}	Data out delay from falling edge of SCLK	–	–	45	ns	$V_{DD} > 3.6$
T_{DSCLK3}	Data out delay from falling edge of SCLK	–	–	50	ns	$3.15 \leq V_{DD} \leq 3.5$
$T_{ERASEALL}$	Flash erase time (bulk)	–	40	–	ms	Erase all blocks and protection fields at once.
$T_{PROGRAM\_HOT}$	Flash block erase + flash block write time	–	–	100	ms	0 °C ≤ T_J ≤ 100 °C
$T_{PROGRAM\_COLD}$	Flash block erase + flash block write time	–	–	200	ms	–40 °C ≤ T_J ≤ 0 °C

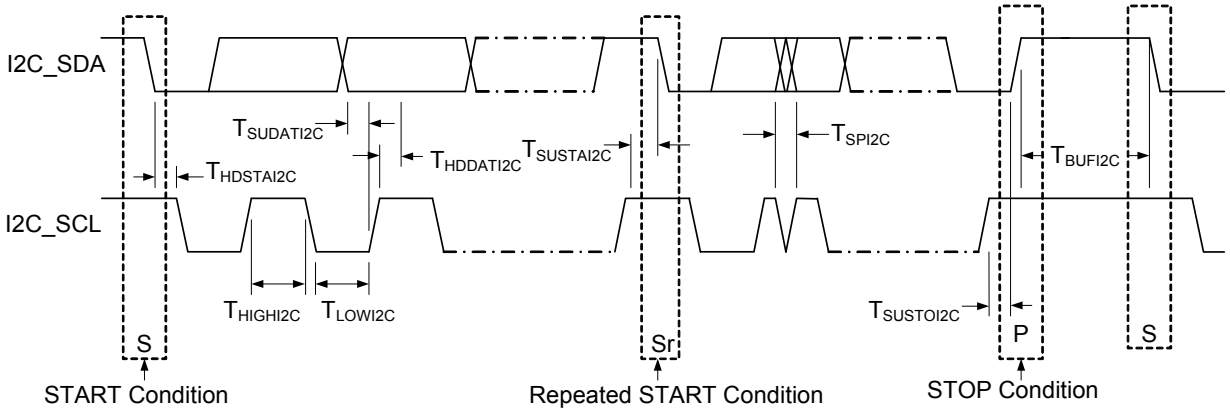
AC I²C Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and –40 °C ≤ T_A ≤ 85 °C, or 3.15 V to 3.5 V and –40 °C ≤ T_A ≤ 85 °C, respectively. Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

Table 26. AC Characteristics of the I²C SDA and SCL Pins for V_{DD}

Parameter	Description	Standard-Mode		Fast-Mode		Unit	Notes
		Min	Max	Min	Max		
F_{SCLI2C}	SCL clock frequency	0	100	0	400	kHz	–
$T_{HDSTAI2C}$	Hold time (repeated) START condition. After this period, the first clock pulse is generated.	4.0	–	0.6	–	µs	–
T_{LOWI2C}	LOW period of the SCL clock	4.7	–	1.3	–	µs	–
$T_{HIGHI2C}$	HIGH period of the SCL clock	4.0	–	0.6	–	µs	–
$T_{SUSTAI2C}$	Setup time for a repeated START condition	4.7	–	0.6	–	µs	–
$T_{HDDATI2C}$	Data hold time	0	–	0	–	µs	–
$T_{SUDATI2C}$	Data setup time	250	–	100[17]	–	ns	–
$T_{SUSTOI2C}$	Setup time for STOP condition	4.0	–	0.6	–	µs	–
T_{BUFI2C}	Bus free time between a STOP and START condition	4.7	–	1.3	–	µs	–
T_{SPI2C}	Pulse width of spikes are suppressed by the input filter.	–	–	0	50	ns	–

Figure 7. Definition for Timing for Fast-/Standard-Mode on the I²C Bus



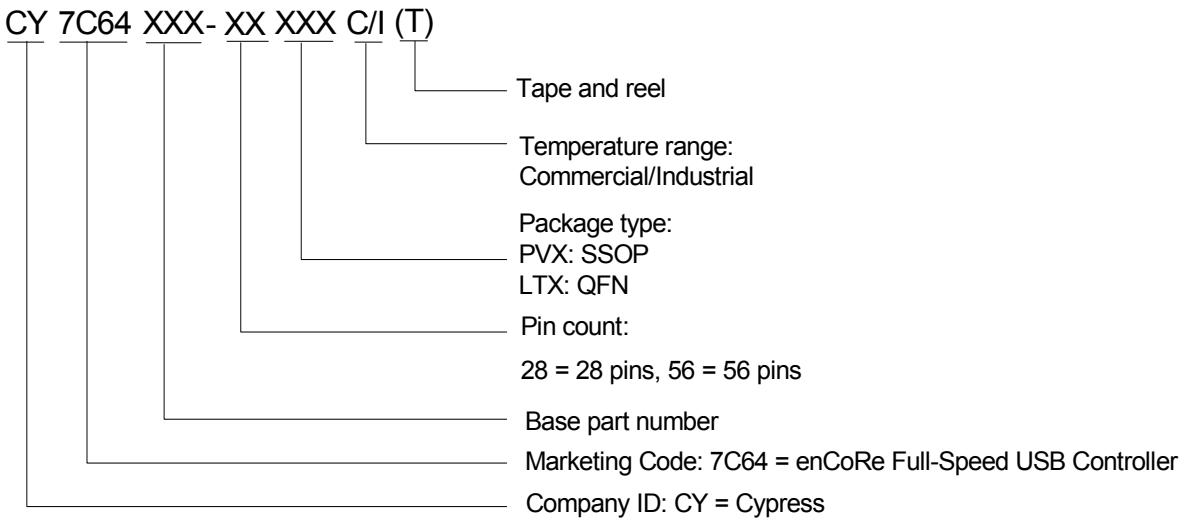
Note

17. A Fast-Mode I²C-bus device can be used in a Standard-Mode I²C-bus system, but the requirement $T_{SUDATI2C} \geq 250$ ns must then be met. This automatically is the case if the device does not stretch the LOW period of the SCL signal. If such device does stretch the LOW period of the SCL signal, it must output the next data bit to the SDA line $t_{rmax} + T_{SUDATI2C} = 1000 + 250 = 1250$ ns (according to the Standard-Mode I²C-bus specification) before the SCL line is released.

Ordering Information

Package	Ordering Code	Flash Size	SRAM (Bytes)	Temperature Range
28-pin SSOP	CY7C64215-28PVXC	16K	1K	Commercial, 0 °C to 70 °C
28-pin SSOP (Tape and Reel)	CY7C64215-28PVXCT	16K	1K	Commercial, 0 °C to 70 °C
28-pin SSOP	CY7C64215-28PVXI	16 K	1K	Industrial, –40 °C to 85 °C
28-pin SSOP (Tape and Reel)	CY7C64215-28PVXIT	16 K	1K	Industrial, –40 °C to 85 °C
56-pin QFN (Sawn)	CY7C64215-56LTXC	16K	1K	Commercial, 0 °C to 70 °C
56-pin QFN (Sawn) (Tape and Reel)	CY7C64215-56LTXCT	16K	1K	Commercial, 0 °C to 70 °C
56-pin QFN (Sawn)	CY7C64215-56LTXI	16K	1K	Industrial, –40 °C to 85 °C
56-pin QFN (Sawn) (Tape and Reel)	CY7C64215-56LTXIT	16K	1K	Industrial, –40 °C to 85 °C

Ordering Code Definitions



buffer	1. A storage area for data that is used to compensate for a speed difference, when transferring data from one device to another. Usually refers to an area reserved for IO operations, into which data is read, or from which data is written. 2. A portion of memory set aside to store data, often before it is sent to an external device or as it is received from an external device. 3. An amplifier used to lower the output impedance of a system.
bus	1. A named connection of nets. Bundling nets together in a bus makes it easier to route nets with similar routing patterns. 2. A set of signals performing a common function and carrying similar data. Typically represented using vector notation; for example, address[7:0]. 3. One or more conductors that serve as a common connection for a group of related devices.
clock	The device that generates a periodic signal with a fixed frequency and duty cycle. A clock is sometimes used to synchronize different logic blocks.
comparator	An electronic circuit that produces an output voltage or current whenever two input levels simultaneously satisfy predetermined amplitude requirements.
compiler	A program that translates a high level language, such as C, into machine language.
configuration space	In PSoC devices, the register space accessed when the XIO bit, in the CPU_F register, is set to ‘1’.
crystal oscillator	An oscillator in which the frequency is controlled by a piezoelectric crystal. Typically a piezoelectric crystal is less sensitive to ambient temperature than other circuit components.
cyclic redundancy check (CRC)	A calculation used to detect errors in data communications, typically performed using a linear feedback shift register. Similar calculations may be used for a variety of other purposes such as data compression.
data bus	A bi-directional set of signals used by a computer to convey information from a memory location to the central processing unit and vice versa. More generally, a set of signals used to convey data between digital functions.
debugger	A hardware and software system that allows the user to analyze the operation of the system under development. A debugger usually allows the developer to step through the firmware one step at a time, set break points, and analyze memory.
dead band	A period of time when neither of two or more signals are in their active state or in transition.
digital blocks	The 8-bit logic blocks that can act as a counter, timer, serial receiver, serial transmitter, CRC generator, pseudo-random number generator, or SPI.
digital-to-analog (DAC)	A device that changes a digital signal to an analog signal of corresponding magnitude. The analog-to-digital (ADC) converter performs the reverse operation.
duty cycle	The relationship of a clock period high time to its low time, expressed as a percent.
emulator	Duplicates (provides an emulation of) the functions of one system with a different system, so that the second system appears to behave like the first system.
external reset (XRES)	An active high signal that is driven into the PSoC device. It causes all operation of the CPU and blocks to stop and return to a pre-defined state.

Errata

This section describes the errata for the enCoRe III CY7C64215 device. The information in this document describes hardware issues associated with Silicon Revision A.

Contact your local Cypress sales representative if you have questions.

Part Numbers Affected

Part Number	Silicon Revision
CY7C64215	A

CY7C64215 Qualification Status

Product Status: In Production

CY7C64215 Errata Summary

This table defines the errata applicability to available enCoRe III CY7C64215 family devices.

Items	Part Number	Silicon Revision	Fix Status
USB interface DP line pulses low when the enCoRe III device wakes from sleep.	CY7C64215	A	No silicon fix planned. Use workaround.
Invalid flash reads may occur if V_{DD} is pulled to –0.5 V just before power on.	CY7C64215	A	
PMA Index Register fails to auto-increment with CPU_Clock set to SysClk/1 (24 MHz).	CY7C64215	A	

1. USB interface DP line pulses low when the enCoRe III device wakes from sleep

■ Problem Definition

When the device operates at 4.75 V to 5.25 V and the 3.3-V regulator is enabled, a short low pulse may be created on the DP signal line during device wakeup. The 15- to 20-µs low pulse of the DP line may be interpreted by the host computer as a deattach or the beginning of a wakeup.

■ Parameters Affected

The bandgap reference voltage used by the 3.3-V regulator decreases during sleep due to leakage. Upon device wakeup, the bandgap is re-enabled and, after a delay for settling, the 3.3-V regulator is enabled. On some devices the 3.3-V regulator used to generate the USB DP signal may be enabled before the bandgap is fully stabilized. This can cause a low pulse on the regulator output and DP signal line until the bandgap stabilizes. In applications where V_{DD} is 3.3 V, the regulator is not used and, therefore, the DP low pulse is not generated.

■ Trigger Condition

N/A

■ Scope of Impact

N/A

■ Workaround

To prevent the DP signal from pulsing low, keep the bandgap enabled during sleep. The most efficient method is to set the No Buzz bit in the OSC_CR0 register. The No Buzz bit keeps the bandgap powered and output stable during sleep. Setting the No Buzz bit results in a nominal 100 µA increase in sleep current. Leaving the analog reference block enabled during sleep also resolves this issue because it forces the bandgap to remain enabled. The following example shows how to disable the No Buzz bit:

Assembly

```
M8C_SetBank1
or    reg[OSC_CR0], 0x20
M8C_SetBank0
```

C

```
OSC_CR0 |= 0x20;
```

■ **WORKAROUND**

To make certain that the index register properly increments, set the CPU_Clock to SysClk/2 (12 MHz) during the read of the PMA buffer. An example for the clock adjustment method follows:

PSoC Designer 4.3 User Module workaround: PSoC Designer Release 4.3 and subsequent releases include a revised full-speed USB User Module with the revised firmware workaround included (see the following example).

24-Mhz read PMA workaround

```
;;
M8C_SetBank1
mov A, reg[OSC_CR0]
push A
and A, 0xf8 ;clear the clock bits (briefly chg the cpu_clk to 3Mhz)
or A, 0x02 ;will set clk to 12Mhz

mov reg[OSC_CR0],A ;clk is now set at 12Mhz
M8C_SetBank0
.loop:
   mov A, reg[PMA0_DR] ; Get the data from the PMA space
   mov [X], A ; save it in data array
   inc X ; increment the pointer
   dec [USB_APITemp+1] ; decrement the counter
   jnz .loop ; wait for count to zero out
;;
;; 24Mhz read PMA workaround (back to previous clock speed)
;;
pop A ;recover previous reg[OSC_CR0] value
M8C_SetBank1
mov reg[OSC_CR0],A ;clk is now set at previous value
M8C_SetBank0
;;
;; end 24Mhz read PMA workaround
```

■ **Fix Status**

There is no planned silicon fix; use workaround.

Document History Page (continued)

Description Title: CY7C64215, enCoRe™ III Full-Speed USB Controller
Document Number: 38-08036

Rev.	ECN No.	Submission Date	Orig. of Change	Description of Change
*J	3995635	05/09/2013	CSAI	Updated Packaging Information: spec 001-12921 – Changed revision from *A to *B. spec 001-53450 – Changed revision from *B to *C. spec 51-85079 – Changed revision from *D to *E. Added Errata.
*K	4080167	07/29/2013	CSAI	Added Errata footnotes (Note 3, 5). Updated Electrical Specifications: Updated DC Electrical Characteristics: Updated DC Chip-Level Specifications: Added Note 3 and referred the same note in “Sleep Mode” in description of I_{SB} parameter in Table 7. Updated DC POR and LVD Specifications: Added Note 5 and referred the same note in V_{PPOR0}, V_{PPOR1}, V_{PPOR2} parameters in Table 15. Updated Reference Documents: Removed references of spec 001-17397 and spec 001-14503 as these specs are obsolete. Updated in new template.
*L	4247931	01/16/2014	CSAI	Updated Packaging Information: spec 001-53450 – Changed revision from *C to *D. Completing Sunset Review.
*M	4481449	08/28/2014	MVTA	Updated Packaging Information: spec 001-12921 – Changed revision from *B to *C. Updated Ordering Information (Updated part numbers). Updated in new template.