



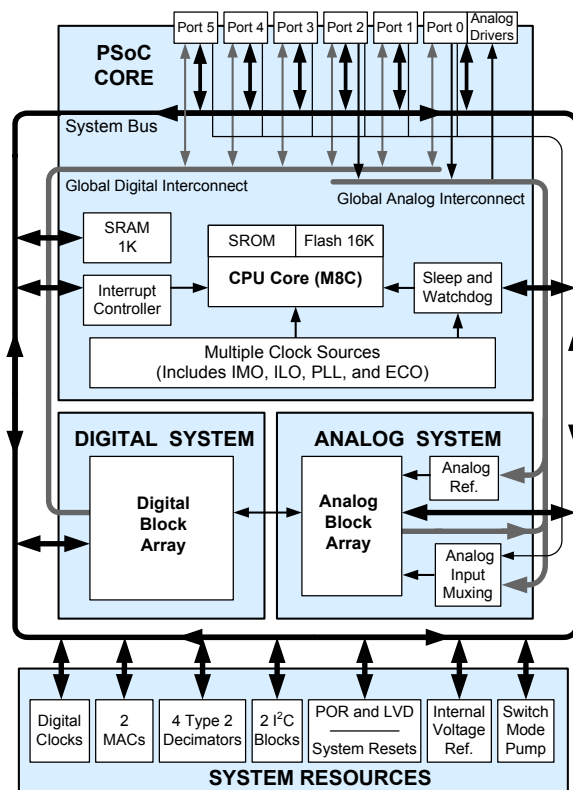
**CY8C28243/CY8C28403/CY8C28413**  
**CY8C28433/CY8C28445/CY8C28452**  
**CY8C28513/CY8C28545**  
**CY8C28623/CY8C28643/CY8C28645**

## PSoC<sup>®</sup> Programmable System-on-Chip<sup>™</sup>

### Features

- Varied resource options within one PSoC<sup>®</sup> device group
- Powerful Harvard-architecture processor
  - M8C processor speeds up to 24 MHz
  - 8 × 8 Multiply, 32-bit accumulate
  - Low power at high speed
  - Operating voltage: 3.0 V to 5.25 V
  - Operating voltages down to 1.5 V Using on-chip switched mode pump (SMP)
  - Industrial temperature range: -40 °C to +85 °C
- Advanced reconfigurable peripherals (PSoC Blocks)
  - Up to 12 rail-to-rail analog PSoC blocks provide:
    - Up to 14-bit ADCs
    - Up to 9-bit DACs
    - Programmable gain amplifiers
    - Programmable filters and comparators
    - Multiple ADC configurations
    - Dedicated SAR ADC, up to 142 ksp/s with sample and hold
    - Up to 4 synchronized or independent delta-sigma ADCs for advanced applications
  - Up to 4 limited type E analog blocks provide:
    - Dual channel capacitive sensing capability
    - Comparators with programmable DAC reference
    - Up to 10-bit single-slope ADCs
  - Up to 12 digital PSoC blocks provide:
    - 8- to 32-bit timers and counters, 8- and 16-bit pulse-width modulators (PWMs)
    - Shift register, CRC, and PRS modules
    - Up to 3 full-duplex UARTs
    - Up to 6 half-duplex UARTs
    - Multiple variable data length SPI<sup>™</sup> masters or slaves
    - Connectable to all GPIOs
  - Complex peripherals by combining blocks
- Precision, programmable clocking
  - Internal ±2.5% 24/48 MHz main oscillator
  - Optional 32.768 kHz crystal for precise on-chip clocks
  - Optional external oscillator, up to 24 MHz
  - Internal low speed, low power oscillator for watchdog and sleep functionality
- Flexible on-chip memory
  - 16 KB flash program storage 50,000 erase/write cycles
  - 1-KB SRAM data storage
  - In-system serial programming (ISSP<sup>™</sup>)
  - Partial flash updates
  - Flexible protection modes
  - EEPROM emulation in flash
- Programmable Pin configurations
  - 25 mA sink, 10 mA drive on all GPIOs
  - Pull-up, pull-down, high Z, strong, or open-drain drive modes on all GPIOs
  - Analog input on all GPIOs
  - 30 mA analog outputs on GPIOs
  - Configurable interrupt on all GPIOs
- Additional system resources
  - Up to two hardware I<sup>2</sup>C resources
    - Each resource implements slave, master, or multi-master modes
    - Operation between 0 and 400 kHz
  - Watchdog and Sleep timers
  - User-configurable low voltage detection
  - Flexible internal voltage references
  - Integrated supervisory circuit
  - On-chip precision voltage reference
- Complete development tools
  - Free development software (PSoC Designer<sup>™</sup>)
  - Full featured in-circuit emulator, and programmer
  - Full speed emulation
  - Flexible and functional breakpoint structure
  - 128 KB trace memory

### Logic Block Diagram



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## More Information

Cypress provides a wealth of data at [www.cypress.com](http://www.cypress.com) to help you to select the right PSoC device for your design, and to help you to quickly and effectively integrate the device into your design. For a comprehensive list of resources, see the knowledge base article “How to Design with PSoC® 1, PowerPSoC®, and PLC – KBA88292”. Following is an abbreviated list for PSoC 1:

- Overview: PSoC Portfolio, PSoC Roadmap
- Product Selectors: [PSoC 1](#), [PSoC 3](#), [PSoC 4](#), [PSoC 5LP](#)
- In addition, PSoC Designer includes a device selection tool.
- Application notes: Cypress offers a large number of PSoC application notes covering a broad range of topics, from basic to advanced level. Recommended application notes for getting started with PSoC 1 are:
  - [Getting Started with PSoC® 1 – AN75320](#)
  - [PSoC® 1 - Getting Started with GPIO – AN2094](#)
  - [PSoC® 1 Analog Structure and Configuration – AN74170](#)
  - [PSoC® 1 Switched Capacitor Analog Blocks – AN2041](#)
  - [Selecting Analog Ground and Reference – AN2219](#)

**Note:** For CY8C28xxx devices related Application note please click [here](#).

- Development Kits:
  - [CY3210-PSocEval1](#) supports all PSoC 1 Mixed-Signal Array families, including automotive, except CY8C25/26xxx devices. The kit includes an LCD module, potentiometer, LEDs, and breadboarding space.
  - [CY3214-PSocEvalUSB](#) features a development board for the CY8C24x94 PSoC device. Special features of the board include USB and CapSense development and debugging support.

**Note:** For CY8C28xxx devices related Development Kits please click [here](#).

The [MiniProg1](#) and [MiniProg3](#) devices provide interfaces for flash programming and debug.

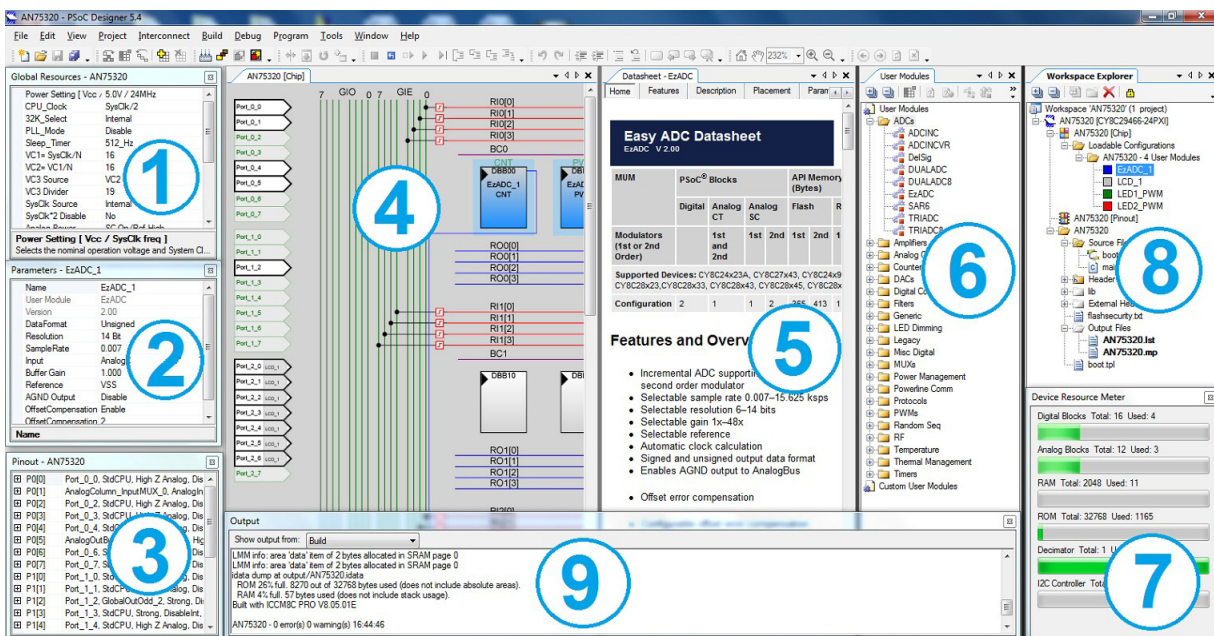
## PSoC Designer

[PSoC Designer](#) is a free Windows-based Integrated Design Environment (IDE). Develop your applications using a library of pre-characterized analog and digital peripherals in a drag-and-drop design environment. Then, customize your design leveraging the dynamically generated API libraries of code. [Figure 1](#) shows PSoC Designer windows. **Note:** This is not the default view.

1. **Global Resources** – all device hardware settings.
2. **Parameters** – the parameters of the currently selected User Modules.
3. **Pinout** – information related to device pins.
4. **Chip-Level Editor** – a diagram of the resources available on the selected chip.
5. **Datasheet** – the datasheet for the currently selected UM
6. **User Modules** – all available User Modules for the selected device.
7. **Device Resource Meter** – device resource usage for the current project configuration.
8. **Workspace** – a tree level diagram of files associated with the project.
9. **Output** – output from project build and debug operations.

**Note:** For detailed information on PSoC Designer, go to PSoC® Designer > Help > Documentation > Designer Specific Documents > IDE User Guide.

**Figure 1. PSoC Designer Layout**



## PSoC Functional Overview

The PSoC family consists of many devices with On-Chip Controllers. These devices are designed to replace multiple traditional MCU based system components with one low cost single chip programmable component. A PSoC device includes configurable analog blocks, digital blocks, and interconnections. This architecture enables the user to create customized peripheral configurations to match the requirements of each individual application. In addition, a fast CPU, Flash program memory, SRAM data memory, and configurable I/O are included in a range of convenient pinouts and packages.

The CY8C28xxx group of PSoC devices described in this datasheet have multiple resource configuration options available. Therefore, not every resource mentioned in this datasheet is available for each CY8C28xxx subgroup. The CY8C28x45 subgroup has a full feature set of all resources described. There are six more segmented subgroups that allow designers to use a device with only the resources and functionality necessary for a specific application. See [Table 2](#) on page 9 to determine the resources available for each CY8C28xxx subgroup. The same information is also presented in more detail in the [Ordering Information](#) section.

The architecture for this specific PSoC device family, as shown in the [Logic Block Diagram](#) on page 1, consists of four main areas: PSoC Core, Digital System, Analog System, and System Resources. The configurable global bus system allows all the device resources to be combined into a complete custom system. PSoC CY8C28xxx family devices have up to six I/O ports that connect to the global digital and analog interconnects, providing access to up to 12 digital blocks and up to 16 analog blocks.

### The PSoC Core

The PSoC Core is a powerful engine that supports a rich feature set. The core includes a CPU, memory, clocks, and configurable general Purpose I/O (GPIO). The M8C CPU core is a powerful processor with speeds up to 24 MHz, providing a four MIPS 8-bit Harvard architecture microcontroller.

Memory encompasses 16K bytes of Flash for program storage, 1K bytes of SRAM for data storage. The PSoC device incorporates flexible internal clock generators, including a 24 MHz internal main oscillator (IMO) accurate to 2.5% over temperature and voltage. A low power 32 kHz internal low speed oscillator (ILO) is provided for the sleep timer and watch dog timer (WDT). The 32.768 kHz external crystal oscillator (ECO) is available for use as a real time clock (RTC) and can optionally generate a crystal-accurate 24 MHz system clock using a PLL.

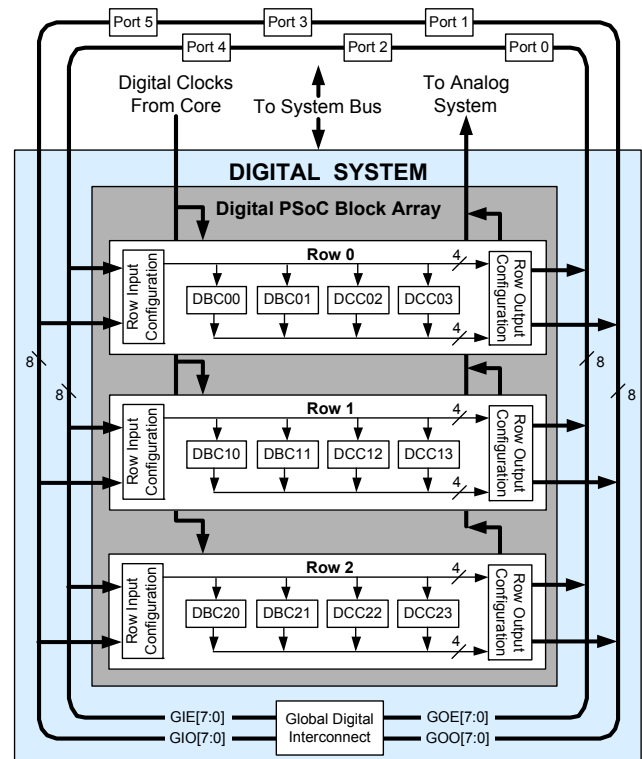
PSoC GPIOs provide connections to the CPU, and digital and analog resources. Each pin's drive mode may be selected from 8 options, which allows great flexibility in external interfacing. Every pin also has the capability to generate a system interrupt on high level, low level, and change from last read.

### The Digital System

The Digital System is composed of up to 12 configurable digital PSoC blocks. Each block is an 8-bit resource that can be used alone or combined with other blocks to create 8, 16, 24, and

32-bit peripherals, which are called user modules. The digital blocks can be connected to any GPIO through a series of global buses that can route any signal to any pin.

**Figure 2. Digital System Block Diagram<sup>[1]</sup>**



Digital peripheral configurations include:

- PWMs (8- and 16-bit, One-shot and Multi-shot capability)
- PWMs with Dead band/Kill (8- and 16-bit)
- Counters (8 to 32 bit)
- Timers (8 to 32 bit)
- Full-duplex 8-bit UARTs (up to 3) with selectable parity
- Half-duplex 8-bit UARTs (up to 6) with selectable parity
- Variable length SPI slave and master
  - Up to 6 total slaves and masters (8-bit)
  - Supports 8 to 16 bit operation
- I<sup>2</sup>C slave, master, or multi-master (up to 2 available as System Resources)
- IrDA (up to 3)
- Pseudo Random Sequence Generators (8 to 32 bit)
- Cyclical Redundancy Checker/Generator (16 bit)
- Shift Register (2 to 32 bit)

#### Note

1. CY8C28x52 devices do not have digital block row 2. They have two digital rows with eight total digital blocks.

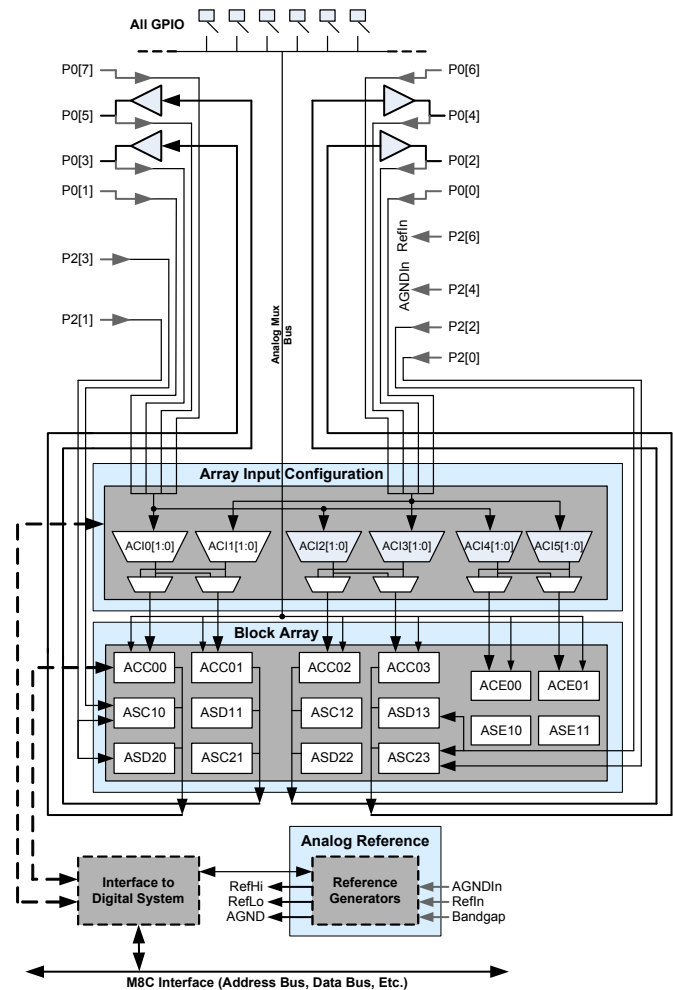
## The Analog System

The Analog System is composed of up to 16 configurable analog blocks, each containing an opamp circuit that allows the creation of complex analog signal flows. Some devices in this PSoC family have an analog multiplex bus that can connect to every GPIO pin. This bus can also connect to the analog system for analysis with comparators and analog-to-digital converters. It can be split into two sections for simultaneous dual-channel processing.

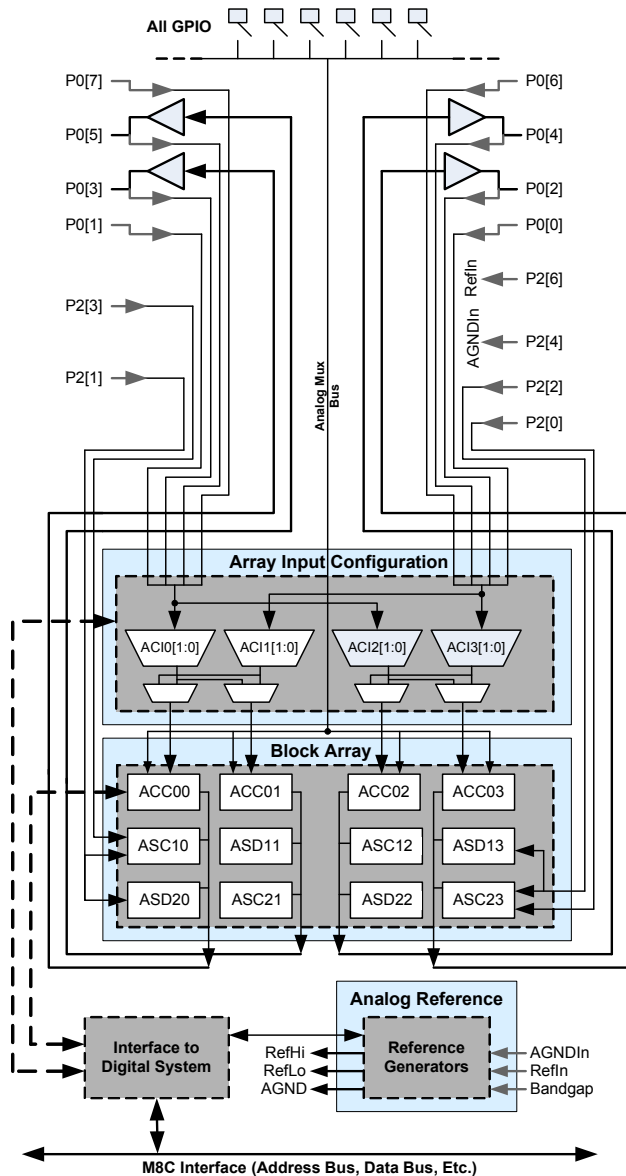
Some of the more common PSoC analog functions (most available as user modules) are:

- Analog-to-digital converters (6 to 14-bit resolution, up to 4, selectable as Incremental or Delta Sigma)
- Dedicated 10-bit SAR ADC with sample rates up to 142 ksps
- Synchronized, simultaneous Delta Sigma ADCs (up to 4)
- Filters (2 to 8 pole band-pass, low pass, and notch)
- Amplifiers (up to 4, with selectable gain to 48x)
- Instrumentation amplifiers (up to 2, with selectable gain to 93x)
- Comparators (up to 6, with 16 selectable thresholds)
- DACs (up to 4, with 6 to 9-bit resolution)
- Multiplying DACs (up to 4, with 6 to 9-bit resolution)
- High current output drivers (up to 4 with 30 mA drive)
- 1.3 V reference (as a System Resource)
- DTMF Dialer
- Modulators
- Correlators
- Peak detectors
- Many other topologies possible

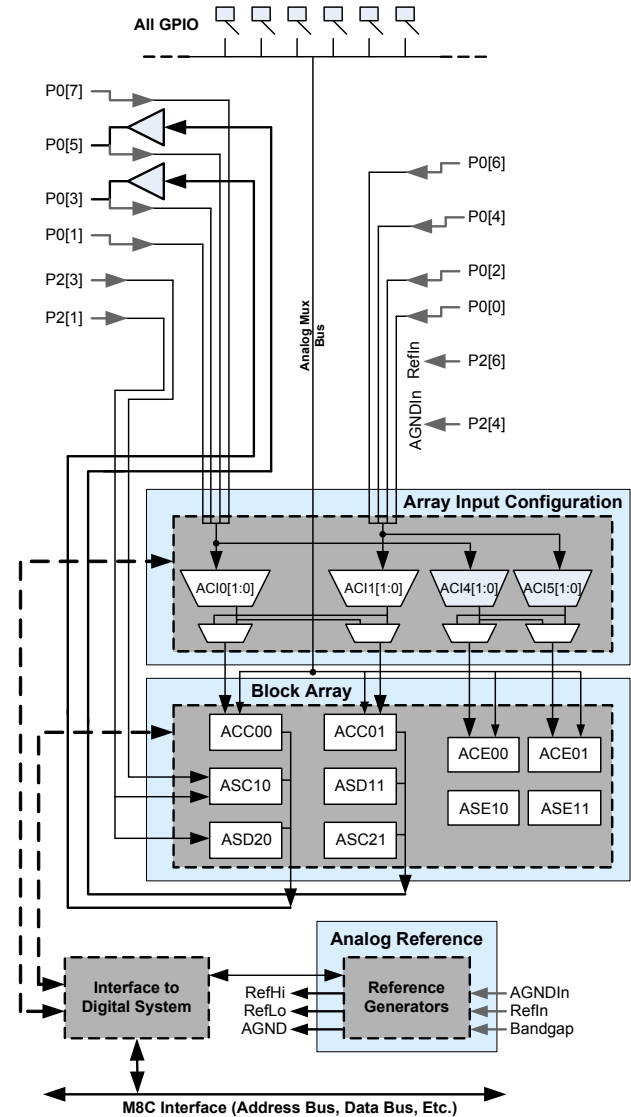
**Figure 3. Analog System Block Diagram for CY8C28x45 and CY8C28x52 Devices**



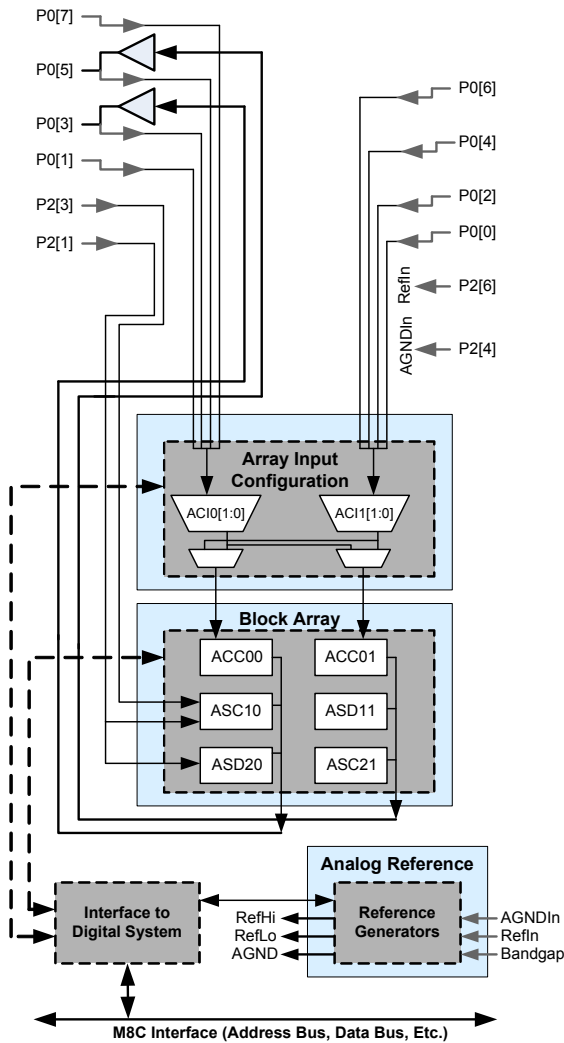
**Figure 4. Analog System Block Diagram for CY8C28x43 Devices**



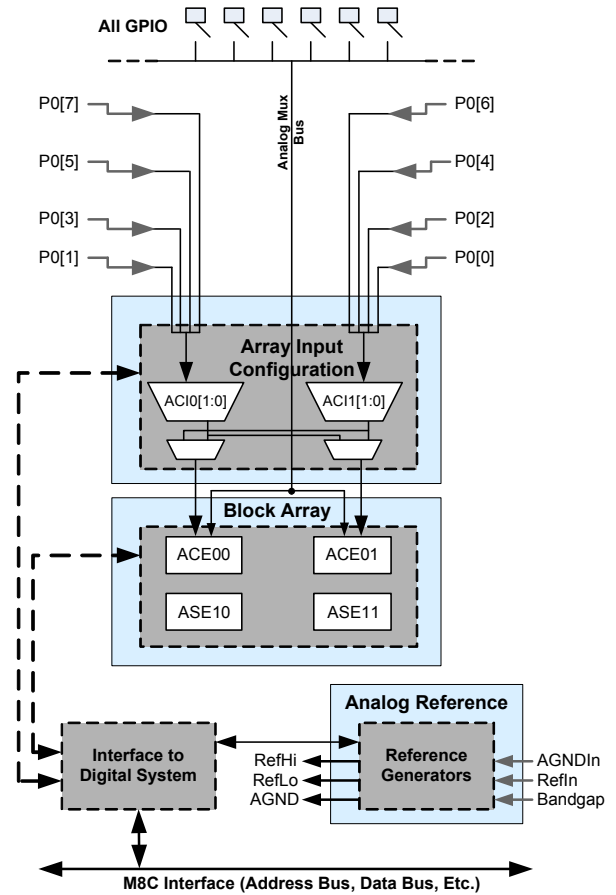
**Figure 5. Analog System Block Diagram for CY8C28x33 Devices**



**Figure 6. Analog System Block Diagram for CY8C28x23 Devices**



**Figure 7. Analog System Block Diagram for CY8C28x13 Devices**



## System Resources

System Resources, some of which are listed in the previous sections, provide additional capability useful to complete systems. Additional resources include a multiplier, multiple decimators, switch mode pump, low voltage detection, and power on reset. Statements describing the merits of each system resource follow:

- Digital clock dividers provide three customizable clock frequencies for use in applications. The clocks can be routed to both the digital and analog systems. Additional clocks can be generated using digital PSoC blocks as clock dividers.
- Multiply accumulate (MAC) provides fast 8-bit multiplier with 32-bit accumulate, to assist in general math and digital filters.
- Up to four decimators provide custom hardware filters for digital signal processing applications such as Delta-Sigma ADCs and CapSense capacitive sensor measurement.
- Up to two I<sup>2</sup>C resources provide 0 to 400 kHz communication over two wires. Slave, master, and multi-master modes are all supported. I<sup>2</sup>C resources have hardware address detection capability.
- Low Voltage Detection (LVD) interrupts can signal the application of falling voltage levels, while the advanced POR (Power On Reset) circuit eliminates the need for a system supervisor.
- An internal 1.3 V reference provides an absolute reference for the analog system, including ADCs and DACs.
- An integrated switch mode pump (SMP) generates normal operating voltages from a single 1.5 V battery cell, providing a low cost boost converter.

## PSoC Device Characteristics

Depending on your PSoC device characteristics, the digital and analog systems can have 16, 8, or 4 digital blocks, and 12, 6, or 4 analog blocks. [Table 1](#) lists the resources available for specific PSoC device groups. The PSoC device covered by this datasheet is highlighted in this table.

**Table 1. PSoC Device Characteristics**

| PSoC Part Number | Digital I/O | Digital Rows | Digital Blocks | Analog Inputs | Analog Outputs | Analog Columns | Analog Blocks               | SRAM Size | Flash Size |
|------------------|-------------|--------------|----------------|---------------|----------------|----------------|-----------------------------|-----------|------------|
| CY8C29x66        | up to 64    | 4            | 16             | up to 12      | 4              | 4              | 12                          | 2 K       | 32 K       |
| CY8C28xxx        | up to 44    | up to 3      | up to 12       | up to 44      | up to 4        | up to 6        | up to 12 + 4 <sup>[2]</sup> | 1 K       | 16 K       |
| CY8C27x43        | up to 44    | 2            | 8              | up to 12      | 4              | 4              | 12                          | 256       | 16 K       |
| CY8C24x94        | up to 56    | 1            | 4              | up to 48      | 2              | 2              | 6                           | 1 K       | 16 K       |
| CY8C24x23A       | up to 24    | 1            | 4              | up to 12      | 2              | 2              | 6                           | 256       | 4 K        |
| CY8C23x33        | up to 26    | 1            | 4              | up to 12      | 2              | 2              | 4                           | 256       | 8 K        |
| CY8C22x45        | up to 38    | 2            | 8              | up to 38      | 0              | 4              | 6 <sup>[2]</sup>            | 1 K       | 16 K       |
| CY8C21x45        | up to 24    | 1            | 4              | up to 24      | 0              | 4              | 6 <sup>[2]</sup>            | 512       | 8 K        |
| CY8C21x34        | up to 28    | 1            | 4              | up to 28      | 0              | 2              | 4 <sup>[2]</sup>            | 512       | 8 K        |
| CY8C21x23        | up to 16    | 1            | 4              | up to 8       | 0              | 2              | 4 <sup>[2]</sup>            | 256       | 4 K        |
| CY8C20x34        | up to 28    | 0            | 0              | up to 28      | 0              | 0              | 3 <sup>[2,3]</sup>          | 512       | 8 K        |
| CY8C20xx6        | up to 36    | 0            | 0              | up to 36      | 0              | 0              | 3 <sup>[2,3]</sup>          | up to 2 K | up to 32 K |

### Notes

2. Limited analog functionality.
3. Two analog blocks and one CapSense®.

The devices covered by this datasheet all have the same architecture, specifications, and ratings. However, the amount of some hardware resources varies from device to device within the group. The following table lists resources available for the specific device subgroups covered by this datasheet.

**Table 2. CY8C28xxx Device Characteristics**

| PSoC Part Number | CapSense | Digital Blocks | Regular Analog Blocks | Limited Analog Blocks | HW I <sup>2</sup> C | Decimators | Digital I/O | Analog Inputs | Analog Outputs | Analog Mux Buses |
|------------------|----------|----------------|-----------------------|-----------------------|---------------------|------------|-------------|---------------|----------------|------------------|
| CY8C28x03        | N        | 12             | 0                     | 0                     | 2                   | 0          | up to 24    | up to 8       | 0              | 0                |
| CY8C28x13        | Y        | 12             | 0                     | 4                     | 1                   | 2          | up to 40    | up to 40      | 0              | 2                |
| CY8C28x23        | N        | 12             | 6                     | 0                     | 2                   | 2          | up to 44    | up to 10      | 2              | 0                |
| CY8C28x33        | Y        | 12             | 6                     | 4                     | 1                   | 4          | up to 40    | up to 40      | 2              | 2                |
| CY8C28x43        | N        | 12             | 12                    | 0                     | 2                   | 4          | up to 44    | up to 44      | 4              | 2                |
| CY8C28x45        | Y        | 12             | 12                    | 4                     | 2                   | 4          | up to 44    | up to 44      | 4              | 2                |
| CY8C28x52        | Y        | 8              | 12                    | 4                     | 1                   | 4          | up to 24    | up to 24      | 4              | 2                |

## 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<sup>2</sup>C 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 analog-to-digital converters (ADCs), digital-to-analog converters (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 lets 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 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 lets 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 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 is:

1. Select [user modules](#).
2. Configure user modules.
3. Organize and connect.
4. Generate, verify, and debug.

### Select User Modules

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

### Configure User Modules

Each user module that 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 eight bits of resolution. Using these parameters, you can 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 of 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 that you may need to successfully implement your design.

### Organize and Connect

Build signal chains at the chip level by interconnecting user modules to each other and the I/O pins. 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, 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 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 lets 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 (accessed 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. It lets you to define complex breakpoint events that include monitoring address and data bus values, memory locations, and external signals.

## Pinouts

This section describes, lists, and illustrates the CY8C28xxx PSoC device pins and pinout configurations.

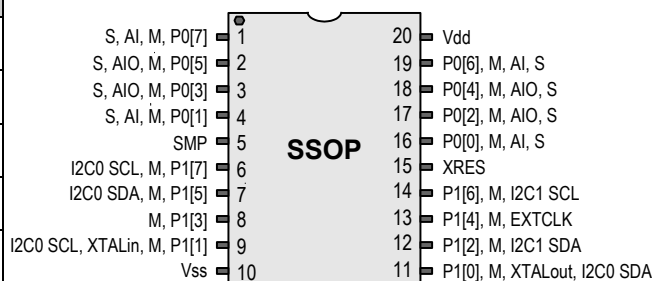
The CY8C28xxx PSoC devices are available in a variety of packages which are listed and illustrated in the following tables. Every port pin (labeled with a “P”) is capable of Digital I/O. However,  $V_{SS}$ ,  $V_{DD}$ , SMP, and XRES are not capable of Digital I/O.

### 20-pin Part Pinout

**Table 3. 20-pin Part Pinout (SSOP)**

| Pin No. | Type    |           | Pin Name | Description                                                                   |
|---------|---------|-----------|----------|-------------------------------------------------------------------------------|
|         | Digital | Analog    |          |                                                                               |
| 1       | I/O     | I, M, S   | P0[7]    | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 2       | I/O     | I/O, M, S | P0[5]    | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 6]</sup>  |
| 3       | I/O     | I/O, M, S | P0[3]    | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 6]</sup>  |
| 4       | I/O     | I, M, S   | P0[1]    | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 5       | Output  |           | SMP      | Switch Mode Pump (SMP) connection to external components.                     |
| 6       | I/O     | M         | P1[7]    | I2C0 Serial Clock (SCL).                                                      |
| 7       | I/O     | M         | P1[5]    | I2C0 Serial Data (SDA).                                                       |
| 8       | I/O     | M         | P1[3]    |                                                                               |
| 9       | I/O     | M         | P1[1]    | Crystal Input (XTALin), I2C0 Serial Clock (SCL), ISSP-SCLK <sup>[4]</sup> .   |
| 10      | Power   |           | $V_{SS}$ | Ground connection.                                                            |
| 11      | I/O     | M         | P1[0]    | Crystal Output (XTALout), I2C0 Serial Data (SDA), ISSP-SDATA <sup>[4]</sup> . |
| 12      | I/O     | M         | P1[2]    | I2C1 Serial Data (SDA). <sup>[7]</sup>                                        |
| 13      | I/O     | M         | P1[4]    | Optional External Clock Input (EXTCLK).                                       |
| 14      | I/O     | M         | P1[6]    | I2C1 Serial Clock (SCL). <sup>[7]</sup>                                       |
| 15      | Input   |           | XRES     | Active high external reset with internal pull-down.                           |
| 16      | I/O     | I, M, S   | P0[0]    | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 17      | I/O     | I/O, M, S | P0[2]    | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 8]</sup>  |
| 18      | I/O     | I/O, M, S | P0[4]    | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 8]</sup>  |
| 19      | I/O     | I, M, S   | P0[6]    | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 20      | Power   |           | $V_{DD}$ | Supply voltage.                                                               |

**CY8C28243 20-pin PSoC Device**



**LEGEND:** A = Analog, I = Input, O = Output, S = SAR ADC Input, and M = Analog Mux Bus Input.

#### Notes

- These are the ISSP pins, which are not High Z at POR (Power On Reset). See the *PSoC Technical Reference Manual* for CY8C28xxx PSoC devices for details.
- CY8C28x52 and CY8C28x23 devices do not have a SAR ADC. Therefore, this pin does not function as a SAR ADC input for these devices.
- CY8C28x13 and CY8C28x03 devices do not have any analog output buffers. Therefore, this pin does not function as an analog column output for these devices.
- CY8C28x52, CY8C28x13, and CY8C28x33 devices only have one I2C block. Therefore, this GPIO does not function as an I2C pin for these devices.
- CY8C28x33, CY8C28x23, CY8C28x13, and CY8C28x03 devices do not have an analog output buffer for this pin. Therefore, this pin does not function as an analog column output for these devices.

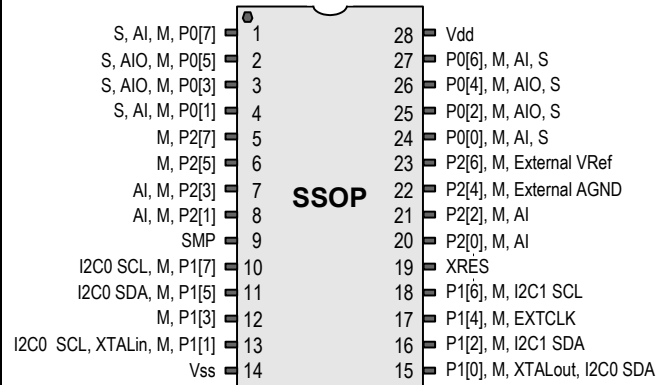
## 28-pin Part Pinout

**Table 4. 28-pin Part Pinout (SSOP)**

| Pin No. | Type    |           | Pin Name        | Description                                                                   |
|---------|---------|-----------|-----------------|-------------------------------------------------------------------------------|
|         | Digital | Analog    |                 |                                                                               |
| 1       | I/O     | I, M, S   | P0[7]           | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 2       | I/O     | I/O, M, S | P0[5]           | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 6]</sup>  |
| 3       | I/O     | I/O, M, S | P0[3]           | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 6]</sup>  |
| 4       | I/O     | I, M, S   | P0[1]           | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 5       | I/O     | M         | P2[7]           |                                                                               |
| 6       | I/O     | M         | P2[5]           |                                                                               |
| 7       | I/O     | I, M      | P2[3]           | Direct switched capacitor block input. <sup>[9]</sup>                         |
| 8       | I/O     | I, M      | P2[1]           | Direct switched capacitor block input. <sup>[9]</sup>                         |
| 9       | Output  |           | SMP             | Switch Mode Pump (SMP) connection to external components.                     |
| 10      | I/O     | M         | P1[7]           | I2C0 Serial Clock (SCL).                                                      |
| 11      | I/O     | M         | P1[5]           | I2C0 Serial Data (SDA).                                                       |
| 12      | I/O     | M         | P1[3]           |                                                                               |
| 13      | I/O     | M         | P1[1]           | Crystal Input (XTALin), I2C0 Serial Clock (SCL), ISSP-SCLK <sup>[4]</sup> .   |
| 14      | Power   |           | V <sub>SS</sub> | Ground connection.                                                            |
| 15      | I/O     | M         | P1[0]           | Crystal Output (XTALout), I2C0 Serial Data (SDA), ISSP-SDATA <sup>[4]</sup> . |
| 16      | I/O     | M         | P1[2]           | I2C1 Serial Data (SDA). <sup>[7]</sup>                                        |
| 17      | I/O     | M         | P1[4]           | Optional External Clock Input (EXTCLK).                                       |
| 18      | I/O     | M         | P1[6]           | I2C1 Serial Clock (SCL). <sup>[7]</sup>                                       |
| 19      | Input   |           | XRES            | Active high external reset with internal pull-down.                           |
| 20      | I/O     | I, M      | P2[0]           | Direct switched capacitor block input. <sup>[10]</sup>                        |
| 21      | I/O     | I, M      | P2[2]           | Direct switched capacitor block input. <sup>[10]</sup>                        |
| 22      | I/O     | M         | P2[4]           | External Analog Ground (AGND).                                                |
| 23      | I/O     | M         | P2[6]           | External Voltage Reference (VRef).                                            |
| 24      | I/O     | I, M, S   | P0[0]           | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 25      | I/O     | I/O, M, S | P0[2]           | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 8]</sup>  |
| 26      | I/O     | I/O, M, S | P0[4]           | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 8]</sup>  |
| 27      | I/O     | I, M, S   | P0[6]           | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 28      | Power   |           | V <sub>DD</sub> | Supply voltage.                                                               |

**LEGEND:** A = Analog, I = Input, O = Output, S = SAR ADC Input, and M = Analog Mux Bus Input

**CY8C28403, CY8C28413, CY8C28433, CY8C28445, and CY8C28452 28-pin PSoc Devices**



### Notes

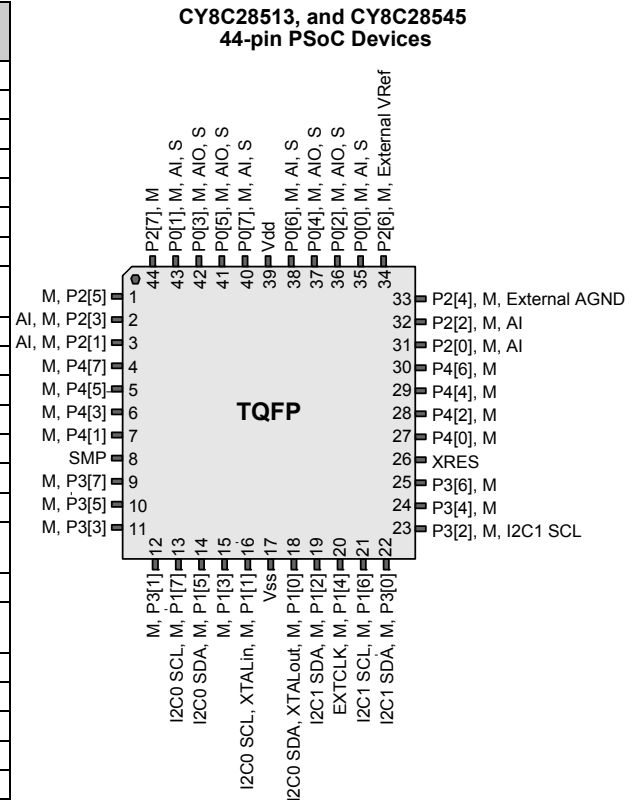
- This pin is not a direct switched capacitor block analog input for CY8C28x03 and CY8C28x13 devices.
- This pin is not a direct switched capacitor block analog input for CY8C28x03, CY8C28x13, CY8C28x23, and CY8C28x33 devices.

## 44-pin Part Pinout

Table 5. 44-pin Part Pinout (TQFP)

| Pin No. | Type    |           | Pin Name        | Description                                                                   |
|---------|---------|-----------|-----------------|-------------------------------------------------------------------------------|
|         | Digital | Analog    |                 |                                                                               |
| 1       | I/O     | M         | P2[5]           |                                                                               |
| 2       | I/O     | I, M      | P2[3]           | Direct switched capacitor block input. <sup>[9]</sup>                         |
| 3       | I/O     | I, M      | P2[1]           | Direct switched capacitor block input. <sup>[9]</sup>                         |
| 4       | I/O     | M         | P4[7]           |                                                                               |
| 5       | I/O     | M         | P4[5]           |                                                                               |
| 6       | I/O     | M         | P4[3]           |                                                                               |
| 7       | I/O     | M         | P4[1]           |                                                                               |
| 8       | Output  |           | SMP             | Switch Mode Pump (SMP) connection to external components.                     |
| 9       | I/O     | M         | P3[7]           |                                                                               |
| 10      | I/O     | M         | P3[5]           |                                                                               |
| 11      | I/O     | M         | P3[3]           |                                                                               |
| 12      | I/O     | M         | P3[1]           |                                                                               |
| 13      | I/O     | M         | P1[7]           | I2C0 Serial Clock (SCL).                                                      |
| 14      | I/O     | M         | P1[5]           | I2C0 Serial Data (SDA).                                                       |
| 15      | I/O     | M         | P1[3]           |                                                                               |
| 16      | I/O     | M         | P1[1]           | Crystal Input (XTALin), I2C0 Serial Clock (SCL), ISSP-SCLK <sup>[4]</sup> .   |
| 17      | Power   |           | V <sub>SS</sub> | Ground connection.                                                            |
| 18      | I/O     | M         | P1[0]           | Crystal Output (XTALout), I2C0 Serial Data (SDA), ISSP-SDATA <sup>[4]</sup> . |
| 19      | I/O     | M         | P1[2]           | I2C1 Serial Data (SDA). <sup>[7]</sup>                                        |
| 20      | I/O     | M         | P1[4]           | Optional External Clock Input (EXTCLK).                                       |
| 21      | I/O     | M         | P1[6]           | I2C1 Serial Clock (SCL). <sup>[7]</sup>                                       |
| 22      | I/O     | M         | P3[0]           | I2C1 Serial Data (SDA). <sup>[7]</sup>                                        |
| 23      | I/O     | M         | P3[2]           | I2C1 Serial Clock (SCL). <sup>[7]</sup>                                       |
| 24      | I/O     | M         | P3[4]           |                                                                               |
| 25      | I/O     | M         | P3[6]           |                                                                               |
| 26      | Input   |           | XRES            | Active high external reset with internal pull-down.                           |
| 27      | I/O     | M         | P4[0]           |                                                                               |
| 28      | I/O     | M         | P4[2]           |                                                                               |
| 29      | I/O     | M         | P4[4]           |                                                                               |
| 30      | I/O     | M         | P4[6]           |                                                                               |
| 31      | I/O     | I, M      | P2[0]           | Direct switched capacitor block input. <sup>[10]</sup>                        |
| 32      | I/O     | I, M      | P2[2]           | Direct switched capacitor block input. <sup>[10]</sup>                        |
| 33      | I/O     | M         | P2[4]           | External Analog Ground (AGND).                                                |
| 34      | I/O     | M         | P2[6]           | External Voltage Reference (VRef).                                            |
| 35      | I/O     | I, M, S   | P0[0]           | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 36      | I/O     | I/O, M, S | P0[2]           | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 8]</sup>  |
| 37      | I/O     | I/O, M, S | P0[4]           | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 8]</sup>  |
| 38      | I/O     | I, M, S   | P0[6]           | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 39      | Power   |           | V <sub>DD</sub> | Supply voltage.                                                               |
| 40      | I/O     | I, M, S   | P0[7]           | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 41      | I/O     | I/O, M, S | P0[5]           | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 6]</sup>  |
| 42      | I/O     | I/O, M, S | P0[3]           | Analog column mux and SAR ADC input. Analog column output. <sup>[5, 6]</sup>  |
| 43      | I/O     | I, M, S   | P0[1]           | Analog column mux and SAR ADC input. <sup>[5]</sup>                           |
| 44      | I/O     |           | P2[7]           |                                                                               |

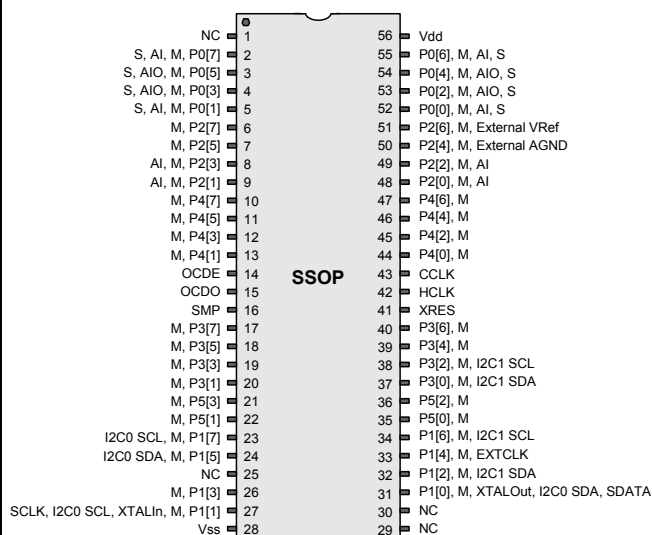
**LEGEND:** A = Analog, I = Input, O = Output, S = SAR ADC Input, and M = Analog Mux Bus Input.





**Note** This part is only used for in-circuit debugging. It is NOT available for production.

| Pin No. | Type    |           | Pin Name        | Description                                                                   |
|---------|---------|-----------|-----------------|-------------------------------------------------------------------------------|
|         | Digital | Analog    |                 |                                                                               |
| 1       |         |           | NC              | No connection.                                                                |
| 2       | I/O     | I, M, S   | P0[7]           | Analog column mux and SAR ADC input.                                          |
| 3       | I/O     | I/O, M, S | P0[5]           | Analog column mux and SAR ADC input.<br>Analog column output.                 |
| 4       | I/O     | I/O, M, S | P0[3]           | Analog column mux and SAR ADC input.<br>Analog column output.                 |
| 5       | I/O     | I, M, S   | P0[1]           | Analog column mux and SAR ADC input.                                          |
| 6       | I/O     | M         | P2[7]           |                                                                               |
| 7       | I/O     | M         | P2[5]           |                                                                               |
| 8       | I/O     | I         | P2[3]           | Direct switched capacitor block input.                                        |
| 9       | I/O     | I         | P2[1]           | Direct switched capacitor block input.                                        |
| 10      | I/O     | M         | P4[7]           |                                                                               |
| 11      | I/O     | M         | P4[5]           |                                                                               |
| 12      | I/O     | I, M      | P4[3]           |                                                                               |
| 13      | I/O     | I, M      | P4[1]           |                                                                               |
| 14      | OCD     | M         | OCDE            | OCD even data I/O.                                                            |
| 15      | OCD     | M         | OCDO            | OCD odd data output.                                                          |
| 16      | Output  |           | SMP             | Switch Mode Pump (SMP) connection to required external components.            |
| 17      | I/O     | M         | P3[7]           |                                                                               |
| 18      | I/O     | M         | P3[5]           |                                                                               |
| 19      | I/O     | M         | P3[3]           |                                                                               |
| 20      | I/O     | M         | P3[1]           |                                                                               |
| 21      | I/O     | M         | P5[3]           |                                                                               |
| 22      | I/O     | M         | P5[1]           |                                                                               |
| 23      | I/O     | M         | P1[7]           | I2C0 Serial Clock (SCL).                                                      |
| 24      | I/O     | M         | P1[5]           | I2C0 Serial Data (SDA).                                                       |
| 25      |         |           | NC              | No connection.                                                                |
| 26      | I/O     | M         | P1[3]           |                                                                               |
| 27      | I/O     | M         | P1[1]           | Crystal Input (XTALin), I2C0 Serial Clock (SCL), ISSP-SCLK <sup>[4]</sup> .   |
| 28      | Power   |           | V <sub>SS</sub> | Ground connection.                                                            |
| 29      |         |           | NC              | No connection.                                                                |
| 30      |         |           | NC              | No connection.                                                                |
| 31      | I/O     | M         | P1[0]           | Crystal Output (XTALout), I2C0 Serial Data (SDA), ISSP-SDATA <sup>[4]</sup> . |
| 32      | I/O     | M         | P1[2]           | I2C1 Serial Data (SDA).                                                       |
| 33      | I/O     | M         | P1[4]           | Optional External Clock Input (EXTCLK).                                       |
| 34      | I/O     | M         | P1[6]           | I2C1 Serial Clock (SCL).                                                      |
| 35      | I/O     | M         | P5[0]           |                                                                               |
| 36      | I/O     | M         | P5[2]           |                                                                               |
| 37      | I/O     | M         | P3[0]           | I2C1 Serial Data (SDA).                                                       |
| 38      | I/O     | M         | P3[2]           | I2C1 Serial Clock (SCL).                                                      |
| 39      | I/O     | M         | P3[4]           |                                                                               |
| 40      | I/O     | M         | P3[6]           |                                                                               |



Not for Production

**Table 7. 56-pin Part Pinout (SSOP) (continued)**

| Pin No. | Type    |           | Pin Name        | Description                                                   |
|---------|---------|-----------|-----------------|---------------------------------------------------------------|
|         | Digital | Analog    |                 |                                                               |
| 41      | Input   |           | XRES            | Active high external reset with internal pull-down.           |
| 42      | OCD     | M         | HCLK            | OCD high speed clock output.                                  |
| 43      | OCD     | M         | CCLK            | OCD CPU clock output.                                         |
| 44      | I/O     | M         | P4[0]           |                                                               |
| 45      | I/O     | M         | P4[2]           |                                                               |
| 46      | I/O     | M         | P4[4]           |                                                               |
| 47      | I/O     | M         | P4[6]           |                                                               |
| 48      | I/O     | I, M      | P2[0]           | Direct switched capacitor block input.                        |
| 49      | I/O     | I, M      | P2[2]           | Direct switched capacitor block input.                        |
| 50      | I/O     | M         | P2[4]           | External Analog Ground (AGND).                                |
| 51      | I/O     | M         | P2[6]           | External Voltage Reference (VRef).                            |
| 52      | I/O     | I, M, S   | P0[0]           | Analog column mux and SAR ADC input.                          |
| 53      | I/O     | I/O, M, S | P0[2]           | Analog column mux and SAR ADC input.<br>Analog column output. |
| 54      | I/O     | I/O, M, S | P0[4]           | Analog column mux and SAR ADC input.<br>Analog column output. |
| 55      | I/O     | I, M, S   | P0[6]           | Analog column mux and SAR ADC input.                          |
| 56      | Power   |           | V <sub>DD</sub> | Supply voltage.                                               |

**LEGEND:** A = Analog, I = Input, O = Output, S = SAR ADC Input, M = Analog Mux Bus Input, and OCD = On-Chip Debug.

## Register Reference

This section lists the registers of the CY8C28xxx PSoC devices. For detailed register information, reference the *PSoC Technical Reference Manual* for CY8C28xxx PSoC devices.

### Register Conventions

The register conventions specific to this section are listed in the following table.

| Convention | Description                  |
|------------|------------------------------|
| R          | Read register or bit(s)      |
| W          | Write register or bit(s)     |
| L          | Logical register or bit(s)   |
| C          | Clearable register or bit(s) |
| #          | Access is bit specific       |

### Register Mapping Tables

CY8C28xxx PSoC devices have a total register address space of 512 bytes. The register space is referred to as I/O space and is divided into two banks. The XIO bit in the Flag register (CPU\_F) determines which bank of registers CPU instructions access. When the XIO bit is set the registers in Bank 1 are accessed by CPU instructions. When the XIO bit is cleared the registers in Bank 0 are accessed by CPU instructions.

**Note** In the following register mapping tables, blank fields are reserved and should not be accessed.

**Table 8. CY8C28x03 Register Map Bank 0 Table: User Space**

| Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name      | Addr (0,Hex) | Access |
|----------|--------------|--------|----------|--------------|--------|----------|--------------|--------|-----------|--------------|--------|
| PRT0DR   | 00           | RW     | DBC20DR0 | 40           | #      |          | 80           |        | RD12RI    | C0           | RW     |
| PRT0IE   | 01           | RW     | DBC20DR1 | 41           | W      |          | 81           |        | RD12SYN   | C1           | RW     |
| PRT0GS   | 02           | RW     | DBC20DR2 | 42           | RW     |          | 82           |        | RD12IS    | C2           | RW     |
| PRT0DM2  | 03           | RW     | DBC20CR0 | 43           | #      |          | 83           |        | RD12LT0   | C3           | RW     |
| PRT1DR   | 04           | RW     | DBC21DR0 | 44           | #      |          | 84           |        | RD12LT1   | C4           | RW     |
| PRT1IE   | 05           | RW     | DBC21DR1 | 45           | W      |          | 85           |        | RD12RO0   | C5           | RW     |
| PRT1GS   | 06           | RW     | DBC21DR2 | 46           | RW     |          | 86           |        | RD12RO1   | C6           | RW     |
| PRT1DM2  | 07           | RW     | DBC21CR0 | 47           | #      |          | 87           |        | RD12DSM   | C7           | RW     |
| PRT2DR   | 08           | RW     | DCC22DR0 | 48           | #      |          | 88           |        |           | C8           |        |
| PRT2IE   | 09           | RW     | DCC22DR1 | 49           | W      |          | 89           |        |           | C9           |        |
| PRT2GS   | 0A           | RW     | DCC22DR2 | 4A           | RW     |          | 8A           |        |           | CA           |        |
| PRT2DM2  | 0B           | RW     | DCC22CR0 | 4B           | #      |          | 8B           |        |           | CB           |        |
| PRT3DR   | 0C           | RW     | DCC23DR0 | 4C           | #      |          | 8C           |        |           | CC           |        |
| PRT3IE   | 0D           | RW     | DCC23DR1 | 4D           | W      |          | 8D           |        |           | CD           |        |
| PRT3GS   | 0E           | RW     | DCC23DR2 | 4E           | RW     |          | 8E           |        |           | CE           |        |
| PRT3DM2  | 0F           | RW     | DCC23CR0 | 4F           | #      |          | 8F           |        |           | CF           |        |
| PRT4DR   | 10           | RW     |          | 50           |        |          | 90           |        | CUR_PP    | D0           | RW     |
| PRT4IE   | 11           | RW     |          | 51           |        |          | 91           |        | STK_PP    | D1           | RW     |
| PRT4GS   | 12           | RW     |          | 52           |        |          | 92           |        |           | D2           |        |
| PRT4DM2  | 13           | RW     |          | 53           |        |          | 93           |        | IDX_PP    | D3           | RW     |
| PRT5DR   | 14           | RW     |          | 54           |        |          | 94           |        | MVR_PP    | D4           | RW     |
| PRT5IE   | 15           | RW     |          | 55           |        |          | 95           |        | MVW_PP    | D5           | RW     |
| PRT5GS   | 16           | RW     |          | 56           |        |          | 96           |        | I2C0_CFG  | D6           | RW     |
| PRT5DM2  | 17           | RW     |          | 57           |        |          | 97           |        | I2C0_SCR  | D7           | #      |
|          | 18           |        |          | 58           |        |          | 98           |        | I2C0_DR   | D8           | RW     |
|          | 19           |        |          | 59           |        |          | 99           |        | I2C0_MSCR | D9           | #      |
|          | 1A           |        |          | 5A           |        |          | 9A           |        | INT_CLR0  | DA           | RW     |
|          | 1B           |        |          | 5B           |        |          | 9B           |        | INT_CLR1  | DB           | RW     |
|          | 1C           |        |          | 5C           |        |          | 9C           |        | INT_CLR2  | DC           | RW     |
|          | 1D           |        |          | 5D           |        |          | 9D           |        | INT_CLR3  | DD           | RW     |
|          | 1E           |        |          | 5E           |        |          | 9E           |        | INT_MSK3  | DE           | RW     |
|          | 1F           |        |          | 5F           |        |          | 9F           |        | INT_MSK2  | DF           | RW     |
| DBC00DR0 | 20           | #      |          | 60           |        |          | A0           |        | INT_MSK0  | E0           | RW     |
| DBC00DR1 | 21           | W      |          | 61           |        |          | A1           |        | INT_MSK1  | E1           | RW     |
| DBC00DR2 | 22           | RW     |          | 62           |        |          | A2           |        | INT_VC    | E2           | RC     |
| DBC00CR0 | 23           | #      |          | 63           |        |          | A3           |        | RES_WDT   | E3           | W      |
| DBC01DR0 | 24           | #      |          | 64           |        |          | A4           |        | I2C1_SCR  | E4           | #      |
| DBC01DR1 | 25           | W      |          | 65           |        |          | A5           |        | I2C1_MSCR | E5           | #      |
| DBC01DR2 | 26           | RW     |          | 66           |        |          | A6           |        |           | E6           |        |
| DBC01CR0 | 27           | #      | I2C1_DR  | 67           | RW     |          | A7           |        |           | E7           |        |
| DCC02DR0 | 28           | #      |          | 68           |        | MUL1_X   | A8           | W      | MUL0_X    | E8           | W      |
| DCC02DR1 | 29           | W      |          | 69           |        | MUL1_Y   | A9           | W      | MUL0_Y    | E9           | W      |
| DCC02DR2 | 2A           | RW     | SADC_DH  | 6A           | RW     | MUL1_DH  | AA           | R      | MUL0_DH   | EA           | R      |
| DCC02CR0 | 2B           | #      | SADC_DL  | 6B           | RW     | MUL1_DL  | AB           | R      | MUL0_DL   | EB           | R      |
| DCC03DR0 | 2C           | #      | TMP_DR0  | 6C           | RW     | ACC1_DR1 | AC           | RW     | ACC0_DR1  | EC           | RW     |
| DCC03DR1 | 2D           | W      | TMP_DR1  | 6D           | RW     | ACC1_DR0 | AD           | RW     | ACC0_DR0  | ED           | RW     |
| DCC03DR2 | 2E           | RW     | TMP_DR2  | 6E           | RW     | ACC1_DR3 | AE           | RW     | ACC0_DR3  | EE           | RW     |
| DCC03CR0 | 2F           | #      | TMP_DR3  | 6F           | RW     | ACC1_DR2 | AF           | RW     | ACC0_DR2  | EF           | RW     |
| DBC10DR0 | 30           | #      |          | 70           |        | RD10RI   | B0           | RW     |           | F0           |        |
| DBC10DR1 | 31           | W      |          | 71           |        | RD10SYN  | B1           | RW     |           | F1           |        |
| DBC10DR2 | 32           | RW     |          | 72           |        | RD10IS   | B2           | RW     |           | F2           |        |
| DBC10CR0 | 33           | #      |          | 73           |        | RD10LT0  | B3           | RW     |           | F3           |        |
| DBC11DR0 | 34           | #      |          | 74           |        | RD10LT1  | B4           | RW     |           | F4           |        |
| DBC11DR1 | 35           | W      |          | 75           |        | RD10RO0  | B5           | RW     |           | F5           |        |
| DBC11DR2 | 36           | RW     |          | 76           |        | RD10RO1  | B6           | RW     |           | F6           |        |
| DBC11CR0 | 37           | #      |          | 77           |        | RD10DSM  | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12DR0 | 38           | #      |          | 78           |        | RD11RI   | B8           | RW     |           | F8           |        |
| DCC12DR1 | 39           | W      |          | 79           |        | RD11SYN  | B9           | RW     |           | F9           |        |
| DCC12DR2 | 3A           | RW     |          | 7A           |        | RD11IS   | BA           | RW     |           | FA           |        |
| DCC12CR0 | 3B           | #      |          | 7B           |        | RD11LT0  | BB           | RW     |           | FB           |        |
| DCC13DR0 | 3C           | #      |          | 7C           |        | RD11LT1  | BC           | RW     |           | FC           |        |
| DCC13DR1 | 3D           | W      |          | 7D           |        | RD11RO0  | BD           | RW     |           | FD           |        |
| DCC13DR2 | 3E           | RW     |          | 7E           |        | RD11RO1  | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR0 | 3F           | #      |          | 7F           |        | RD11DSM  | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 9. CY8C28x03 Register Map Bank 1 Table: Configuration Space**

| Name     | Addr (1,Hex) | Access | Name       | Addr (1,Hex) | Access | Name        | Addr (1,Hex) | Access | Name      | Addr (1,Hex) | Access |
|----------|--------------|--------|------------|--------------|--------|-------------|--------------|--------|-----------|--------------|--------|
| PRT0DM0  | 00           | RW     | DBC20FN    | 40           | RW     |             | 80           |        | RD12RI    | C0           | RW     |
| PRT0DM1  | 01           | RW     | DBC20IN    | 41           | RW     | SADC_TSCMPL | 81           | RW     | RD12SYN   | C1           | RW     |
| PRT0IC0  | 02           | RW     | DBC20OU    | 42           | RW     | SADC_TSCMPH | 82           | RW     | RD12IS    | C2           | RW     |
| PRT0IC1  | 03           | RW     | DBC20CR1   | 43           | RW     |             | 83           |        | RD12LT0   | C3           | RW     |
| PRT1DM0  | 04           | RW     | DBC21FN    | 44           | RW     |             | 84           |        | RD12LT1   | C4           | RW     |
| PRT1DM1  | 05           | RW     | DBC21IN    | 45           | RW     |             | 85           |        | RD12RO0   | C5           | RW     |
| PRT1IC0  | 06           | RW     | DBC21OU    | 46           | RW     |             | 86           |        | RD12RO1   | C6           | RW     |
| PRT1IC1  | 07           | RW     | DBC21CR1   | 47           | RW     |             | 87           |        | RD12DSM   | C7           | RW     |
| PRT2DM0  | 08           | RW     | DCC22FN    | 48           | RW     |             | 88           |        |           | C8           |        |
| PRT2DM1  | 09           | RW     | DCC22IN    | 49           | RW     |             | 89           |        |           | C9           |        |
| PRT2IC0  | 0A           | RW     | DCC22OU    | 4A           | RW     |             | 8A           |        |           | CA           |        |
| PRT2IC1  | 0B           | RW     | DCC22CR1   | 4B           | RW     |             | 8B           |        |           | CB           |        |
| PRT3DM0  | 0C           | RW     | DCC23FN    | 4C           | RW     |             | 8C           |        |           | CC           |        |
| PRT3DM1  | 0D           | RW     | DCC23IN    | 4D           | RW     |             | 8D           |        |           | CD           |        |
| PRT3IC0  | 0E           | RW     | DCC23OU    | 4E           | RW     |             | 8E           |        |           | CE           |        |
| PRT3IC1  | 0F           | RW     | DCC23CR1   | 4F           | RW     |             | 8F           |        |           | CF           |        |
| PRT4DM0  | 10           | RW     |            | 50           |        |             | 90           |        | GDI_O_IN  | D0           | RW     |
| PRT4DM1  | 11           | RW     |            | 51           |        |             | 91           |        | GDI_E_IN  | D1           | RW     |
| PRT4IC0  | 12           | RW     |            | 52           |        |             | 92           |        | GDI_O_OU  | D2           | RW     |
| PRT4IC1  | 13           | RW     |            | 53           |        |             | 93           |        | GDI_E_OU  | D3           | RW     |
| PRT5DM0  | 14           | RW     |            | 54           |        |             | 94           |        |           | D4           |        |
| PRT5DM1  | 15           | RW     |            | 55           |        |             | 95           |        |           | D5           |        |
| PRT5IC0  | 16           | RW     |            | 56           |        |             | 96           |        |           | D6           |        |
| PRT5IC1  | 17           | RW     |            | 57           |        |             | 97           |        |           | D7           |        |
|          | 18           |        |            | 58           |        |             | 98           |        |           | D8           |        |
|          | 19           |        |            | 59           |        |             | 99           |        |           | D9           |        |
|          | 1A           |        |            | 5A           |        |             | 9A           |        |           | DA           |        |
|          | 1B           |        |            | 5B           |        |             | 9B           |        |           | DB           |        |
|          | 1C           |        |            | 5C           |        |             | 9C           |        |           | DC           |        |
|          | 1D           |        |            | 5D           |        |             | 9D           |        | OSC_GO_EN | DD           | RW     |
|          | 1E           |        |            | 5E           |        |             | 9E           |        | OSC_CR4   | DE           | RW     |
|          | 1F           |        |            | 5F           |        |             | 9F           |        | OSC_CR3   | DF           | RW     |
| DBC00FN  | 20           | RW     |            | 60           |        | GDI_O_IN_CR | A0           | RW     | OSC_CR0   | E0           | RW     |
| DBC00IN  | 21           | RW     |            | 61           |        | GDI_E_IN_CR | A1           | RW     | OSC_CR1   | E1           | RW     |
| DBC00OU  | 22           | RW     |            | 62           |        | GDI_O_OU_CR | A2           | RW     | OSC_CR2   | E2           | RW     |
| DBC00CR1 | 23           | RW     |            | 63           |        | GDI_E_OU_CR | A3           | RW     | VLT_CR    | E3           | RW     |
| DBC01FN  | 24           | RW     |            | 64           |        | RTC_H       | A4           | RW     | VLT_CMP   | E4           | RW     |
| DBC01IN  | 25           | RW     |            | 65           |        | RTC_M       | A5           | RW     |           | E5           |        |
| DBC01OU  | 26           | RW     |            | 66           |        | RTC_S       | A6           | RW     |           | E6           |        |
| DBC01CR1 | 27           | RW     |            | 67           |        | RTC_CR      | A7           | RW     |           | E7           |        |
| DCC02FN  | 28           | RW     |            | 68           |        | SADC_CR0    | A8           | RW     | IMO_TR    | E8           | RW     |
| DCC02IN  | 29           | RW     |            | 69           |        | SADC_CR1    | A9           | RW     | ILO_TR    | E9           | RW     |
| DCC02OU  | 2A           | RW     |            | 6A           |        | SADC_CR2    | AA           | RW     | BDG_TR    | EA           | RW     |
| DCC02CR1 | 2B           | RW     | I2C1_CFG   | 6B           | RW     | SADC_CR3    | AB           | RW     | ECO_TR    | EB           | RW     |
| DCC03FN  | 2C           | RW     | TMP_DR0    | 6C           | RW     | SADC_CR4    | AC           | RW     |           | EC           |        |
| DCC03IN  | 2D           | RW     | TMP_DR1    | 6D           | RW     | I2C0_ADDR   | AD           | RW     |           | ED           |        |
| DCC03OU  | 2E           | RW     | TMP_DR2    | 6E           | RW     | I2C1_ADDR   | AE           | RW     |           | EE           |        |
| DCC03CR1 | 2F           | RW     | TMP_DR3    | 6F           | RW     | AMUX_CLK    | AF           | RW     |           | EF           |        |
| DBC10FN  | 30           | RW     |            | 70           |        | RD10RI      | B0           | RW     |           | F0           |        |
| DBC10IN  | 31           | RW     | SADC_TSCR0 | 71           | RW     | RD10SYN     | B1           | RW     |           | F1           |        |
| DBC10OU  | 32           | RW     | SADC_TSCR1 | 72           | RW     | RD10IS      | B2           | RW     |           | F2           |        |
| DBC10CR1 | 33           | RW     |            | 73           |        | RD10LT0     | B3           | RW     |           | F3           |        |
| DBC11FN  | 34           | RW     |            | 74           |        | RD10LT1     | B4           | RW     |           | F4           |        |
| DBC11IN  | 35           | RW     |            | 75           |        | RD10RO0     | B5           | RW     |           | F5           |        |
| DBC11OU  | 36           | RW     |            | 76           |        | RD10RO1     | B6           | RW     |           | F6           |        |
| DBC11CR1 | 37           | RW     |            | 77           |        | RD10DSM     | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12FN  | 38           | RW     |            | 78           |        | RD11RI      | B8           | RW     |           | F8           |        |
| DCC12IN  | 39           | RW     |            | 79           |        | RD11SYN     | B9           | RW     |           | F9           |        |
| DCC12OU  | 3A           | RW     |            | 7A           |        | RD11IS      | BA           | RW     | FLS_PR1   | FA           | RW     |
| DCC12CR1 | 3B           | RW     |            | 7B           |        | RD11LT0     | BB           | RW     |           | FB           |        |
| DCC13FN  | 3C           | RW     |            | 7C           |        | RD11LT1     | BC           | RW     |           | FC           |        |
| DCC13IN  | 3D           | RW     |            | 7D           |        | RD11RO0     | BD           | RW     |           | FD           |        |
| DCC13OU  | 3E           | RW     |            | 7E           |        | RD11RO1     | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR1 | 3F           | RW     |            | 7F           |        | RD11DSM     | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 10. CY8C28x13 Register Map Bank 0 Table: User Space**

| Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name      | Addr (0,Hex) | Access |
|----------|--------------|--------|----------|--------------|--------|----------|--------------|--------|-----------|--------------|--------|
| PRT0DR   | 00           | RW     | DBC20DR0 | 40           | #      |          | 80           |        | RD12RI    | C0           | RW     |
| PRT0IE   | 01           | RW     | DBC20DR1 | 41           | W      |          | 81           |        | RD12SYN   | C1           | RW     |
| PRT0GS   | 02           | RW     | DBC20DR2 | 42           | RW     |          | 82           |        | RD12IS    | C2           | RW     |
| PRT0DM2  | 03           | RW     | DBC20CR0 | 43           | #      |          | 83           |        | RD12LT0   | C3           | RW     |
| PRT1DR   | 04           | RW     | DBC21DR0 | 44           | #      |          | 84           |        | RD12LT1   | C4           | RW     |
| PRT1IE   | 05           | RW     | DBC21DR1 | 45           | W      |          | 85           |        | RD12RO0   | C5           | RW     |
| PRT1GS   | 06           | RW     | DBC21DR2 | 46           | RW     |          | 86           |        | RD12RO1   | C6           | RW     |
| PRT1DM2  | 07           | RW     | DBC21CR0 | 47           | #      |          | 87           |        | RD12DSM   | C7           | RW     |
| PRT2DR   | 08           | RW     | DCC22DR0 | 48           | #      |          | 88           |        |           | C8           |        |
| PRT2IE   | 09           | RW     | DCC22DR1 | 49           | W      |          | 89           |        |           | C9           |        |
| PRT2GS   | 0A           | RW     | DCC22DR2 | 4A           | RW     |          | 8A           |        |           | CA           |        |
| PRT2DM2  | 0B           | RW     | DCC22CR0 | 4B           | #      |          | 8B           |        |           | CB           |        |
| PRT3DR   | 0C           | RW     | DCC23DR0 | 4C           | #      |          | 8C           |        |           | CC           |        |
| PRT3IE   | 0D           | RW     | DCC23DR1 | 4D           | W      |          | 8D           |        |           | CD           |        |
| PRT3GS   | 0E           | RW     | DCC23DR2 | 4E           | RW     |          | 8E           |        |           | CE           |        |
| PRT3DM2  | 0F           | RW     | DCC23CR0 | 4F           | #      |          | 8F           |        |           | CF           |        |
| PRT4DR   | 10           | RW     |          | 50           |        |          | 90           |        | CUR_PP    | D0           | RW     |
| PRT4IE   | 11           | RW     |          | 51           |        |          | 91           |        | STK_PP    | D1           | RW     |
| PRT4GS   | 12           | RW     |          | 52           |        |          | 92           |        |           | D2           |        |
| PRT4DM2  | 13           | RW     |          | 53           |        |          | 93           |        | IDX_PP    | D3           | RW     |
| PRT5DR   | 14           | RW     |          | 54           |        |          | 94           |        | MVR_PP    | D4           | RW     |
| PRT5IE   | 15           | RW     |          | 55           |        |          | 95           |        | MVW_PP    | D5           | RW     |
| PRT5GS   | 16           | RW     |          | 56           |        |          | 96           |        | I2C0_CFG  | D6           | RW     |
| PRT5DM2  | 17           | RW     |          | 57           |        |          | 97           |        | I2C0_SCR  | D7           | #      |
|          | 18           |        |          | 58           |        |          | 98           |        | I2C0_DR   | D8           | RW     |
|          | 19           |        |          | 59           |        |          | 99           |        | I2C0_MSCR | D9           | #      |
|          | 1A           |        |          | 5A           |        |          | 9A           |        | INT_CLR0  | DA           | RW     |
|          | 1B           |        |          | 5B           |        |          | 9B           |        | INT_CLR1  | DB           | RW     |
|          | 1C           |        |          | 5C           |        |          | 9C           |        | INT_CLR2  | DC           | RW     |
|          | 1D           |        |          | 5D           |        |          | 9D           |        | INT_CLR3  | DD           | RW     |
|          | 1E           |        |          | 5E           |        |          | 9E           |        | INT_MSK3  | DE           | RW     |
|          | 1F           |        |          | 5F           |        |          | 9F           |        | INT_MSK2  | DF           | RW     |
| DBC00DR0 | 20           | #      |          | 60           |        | DEC0_DH  | A0           | RC     | INT_MSK0  | E0           | RW     |
| DBC00DR1 | 21           | W      | AMUX_CFG | 61           | RW     | DEC0_DL  | A1           | RC     | INT_MSK1  | E1           | RW     |
| DBC00DR2 | 22           | RW     |          | 62           |        | DEC1_DH  | A2           | RC     | INT_VC    | E2           | RC     |
| DBC00CR0 | 23           | #      |          | 63           |        | DEC1_DL  | A3           | RC     | RES_WDT   | E3           | W      |
| DBC01DR0 | 24           | #      |          | 64           |        |          | A4           |        |           | E4           |        |
| DBC01DR1 | 25           | W      |          | 65           |        |          | A5           |        |           | E5           |        |
| DBC01DR2 | 26           | RW     |          | 66           |        |          | A6           |        | DEC_CR0*  | E6           | RW     |
| DBC01CR0 | 27           | #      |          | 67           |        |          | A7           |        | DEC_CR1*  | E7           | RW     |
| DCC02DR0 | 28           | #      |          | 68           |        | MUL1_X   | A8           | W      | MUL0_X    | E8           | W      |
| DCC02DR1 | 29           | W      |          | 69           |        | MUL1_Y   | A9           | W      | MUL0_Y    | E9           | W      |
| DCC02DR2 | 2A           | RW     | SADC_DH  | 6A           | RW     | MUL1_DH  | AA           | R      | MUL0_DH   | EA           | R      |
| DCC02CR0 | 2B           | #      | SADC_DL  | 6B           | RW     | MUL1_DL  | AB           | R      | MUL0_DL   | EB           | R      |
| DCC03DR0 | 2C           | #      | TMP_DR0  | 6C           | RW     | ACC1_DR1 | AC           | RW     | ACC0_DR1  | EC           | RW     |
| DCC03DR1 | 2D           | W      | TMP_DR1  | 6D           | RW     | ACC1_DR0 | AD           | RW     | ACC0_DR0  | ED           | RW     |
| DCC03DR2 | 2E           | RW     | TMP_DR2  | 6E           | RW     | ACC1_DR3 | AE           | RW     | ACC0_DR3  | EE           | RW     |
| DCC03CR0 | 2F           | #      | TMP_DR3  | 6F           | RW     | ACC1_DR2 | AF           | RW     | ACC0_DR2  | EF           | RW     |
| DBC10DR0 | 30           | #      |          | 70           |        | RD10RI   | B0           | RW     |           | F0           |        |
| DBC10DR1 | 31           | W      |          | 71           |        | RD10SYN  | B1           | RW     |           | F1           |        |
| DBC10DR2 | 32           | RW     |          | 72           |        | RD10IS   | B2           | RW     |           | F2           |        |
| DBC10CR0 | 33           | #      |          | 73           |        | RD10LT0  | B3           | RW     |           | F3           |        |
| DBC11DR0 | 34           | #      |          | 74           |        | RD10LT1  | B4           | RW     |           | F4           |        |
| DBC11DR1 | 35           | W      |          | 75           |        | RD10RO0  | B5           | RW     |           | F5           |        |
| DBC11DR2 | 36           | RW     |          | 76           |        | RD10RO1  | B6           | RW     |           | F6           |        |
| DBC11CR0 | 37           | #      |          | 77           |        | RD10DSM  | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12DR0 | 38           | #      |          | 78           |        | RD11RI   | B8           | RW     |           | F8           |        |
| DCC12DR1 | 39           | W      |          | 79           |        | RD11SYN  | B9           | RW     |           | F9           |        |
| DCC12DR2 | 3A           | RW     |          | 7A           |        | RD11IS   | BA           | RW     |           | FA           |        |
| DCC12CR0 | 3B           | #      |          | 7B           |        | RD11LT0  | BB           | RW     |           | FB           |        |
| DCC13DR0 | 3C           | #      |          | 7C           |        | RD11LT1  | BC           | RW     | DAC1_D    | FC           | RW     |
| DCC13DR1 | 3D           | W      |          | 7D           |        | RD11RO0  | BD           | RW     | DAC0_D    | FD           | RW     |
| DCC13DR2 | 3E           | RW     |          | 7E           |        | RD11RO1  | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR0 | 3F           | #      |          | 7F           |        | RD11DSM  | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 11. CY8C28x13 Register Map Bank 1 Table: Configuration Space**

| Name     | Addr (1,Hex) | Access | Name          | Addr (1,Hex) | Access | Name        | Addr (1,Hex) | Access | Name      | Addr (1,Hex) | Access |
|----------|--------------|--------|---------------|--------------|--------|-------------|--------------|--------|-----------|--------------|--------|
| PRT0DM0  | 00           | RW     | DBC20FN       | 40           | RW     |             | 80           |        | RD12RI    | C0           | RW     |
| PRT0DM1  | 01           | RW     | DBC20IN       | 41           | RW     | SADC_TSCMPL | 81           | RW     | RD12SYN   | C1           | RW     |
| PRT0IC0  | 02           | RW     | DBC20OU       | 42           | RW     | SADC_TSCMPH | 82           | RW     | RD12IS    | C2           | RW     |
| PRT0IC1  | 03           | RW     | DBC20CR1      | 43           | RW     | ACE_AMD_CR1 | 83           | RW     | RD12LT0   | C3           | RW     |
| PRT1DM0  | 04           | RW     | DBC21FN       | 44           | RW     |             | 84           |        | RD12LT1   | C4           | RW     |
| PRT1DM1  | 05           | RW     | DBC21IN       | 45           | RW     | ACE_PWM_CR  | 85           | RW     | RD12RO0   | C5           | RW     |
| PRT1IC0  | 06           | RW     | DBC21OU       | 46           | RW     | ACE_ADC0_CR | 86           | RW     | RD12RO1   | C6           | RW     |
| PRT1IC1  | 07           | RW     | DBC21CR1      | 47           | RW     | ACE_ADC1_CR | 87           | RW     | RD12DSM   | C7           | RW     |
| PRT2DM0  | 08           | RW     | DCC22FN       | 48           | RW     |             | 88           |        |           | C8           |        |
| PRT2DM1  | 09           | RW     | DCC22IN       | 49           | RW     | ACE_CLK_CR0 | 89           | RW     |           | C9           |        |
| PRT2IC0  | 0A           | RW     | DCC22OU       | 4A           | RW     | ACE_CLK_CR1 | 8A           | RW     |           | CA           |        |
| PRT2IC1  | 0B           | RW     | DCC22CR1      | 4B           | RW     | ACE_CLK_CR3 | 8B           | RW     |           | CB           |        |
| PRT3DM0  | 0C           | RW     | DCC23FN       | 4C           | RW     |             | 8C           | RW     |           | CC           |        |
| PRT3DM1  | 0D           | RW     | DCC23IN       | 4D           | RW     | ACE01CR1    | 8D           | RW     |           | CD           |        |
| PRT3IC0  | 0E           | RW     | DCC23OU       | 4E           | RW     | ACE01CR2    | 8E           | RW     |           | CE           |        |
| PRT3IC1  | 0F           | RW     | DCC23CR1      | 4F           | RW     | ASE11CR0    | 8F           | RW     |           | CF           |        |
| PRT4DM0  | 10           | RW     |               | 50           |        |             | 90           |        | GDI_O_IN  | D0           | RW     |
| PRT4DM1  | 11           | RW     |               | 51           |        | DEC0_CR0    | 91           | RW     | GDI_E_IN  | D1           | RW     |
| PRT4IC0  | 12           | RW     |               | 52           |        | DEC_CR3     | 92           | RW     | GDI_O_OU  | D2           | RW     |
| PRT4IC1  | 13           | RW     |               | 53           |        |             | 93           |        | GDI_E_OU  | D3           | RW     |
| PRT5DM0  | 14           | RW     |               | 54           |        |             | 94           |        | DEC0_CR   | D4           | RW     |
| PRT5DM1  | 15           | RW     |               | 55           |        | DEC1_CR0    | 95           | RW     | DEC1_CR   | D5           | RW     |
| PRT5IC0  | 16           | RW     |               | 56           |        |             | 96           |        |           | D6           |        |
| PRT5IC1  | 17           | RW     |               | 57           |        |             | 97           |        |           | D7           |        |
|          | 18           |        |               | 58           |        |             | 98           |        | MUX_CR0   | D8           | RW     |
|          | 19           |        |               | 59           |        |             | 99           |        | MUX_CR1   | D9           | RW     |
|          | 1A           |        |               | 5A           |        | DEC_CR5     | 9A           | RW     | MUX_CR2   | DA           | RW     |
|          | 1B           |        |               | 5B           |        |             | 9B           |        | MUX_CR3   | DB           | RW     |
|          | 1C           |        |               | 5C           |        |             | 9C           |        | IDAC_CR1  | DC           | RW     |
|          | 1D           |        |               | 5D           |        |             | 9D           |        | OSC_GO_EN | DD           | RW     |
|          | 1E           |        |               | 5E           |        |             | 9E           |        | OSC_CR4   | DE           | RW     |
|          | 1F           |        |               | 5F           |        |             | 9F           |        | OSC_CR3   | DF           | RW     |
| DBC00FN  | 20           | RW     |               | 60           |        | GDI_O_IN_CR | A0           | RW     | OSC_CR0   | E0           | RW     |
| DBC00IN  | 21           | RW     |               | 61           |        | GDI_E_IN_CR | A1           | RW     | OSC_CR1   | E1           | RW     |
| DBC00OU  | 22           | RW     |               | 62           |        | GDI_O_OU_CR | A2           | RW     | OSC_CR2   | E2           | RW     |
| DBC00CR1 | 23           | RW     |               | 63           |        | GDI_E_OU_CR | A3           | RW     | VLT_CR    | E3           | RW     |
| DBC01FN  | 24           | RW     |               | 64           |        | RTC_H       | A4           | RW     | VLT_CMP   | E4           | RW     |
| DBC01IN  | 25           | RW     |               | 65           |        | RTC_M       | A5           | RW     | ADC0_TR   | E5           | RW     |
| DBC01OU  | 26           | RW     |               | 66           |        | RTC_S       | A6           | RW     | ADC1_TR   | E6           | RW     |
| DBC01CR1 | 27           | RW     |               | 67           |        | RTC_CR      | A7           | RW     | IDAC_CR2  | E7           | RW     |
| DCC02FN  | 28           | RW     |               | 68           |        | SADC_CR0    | A8           | RW     | IMO_TR    | E8           | RW     |
| DCC02IN  | 29           | RW     |               | 69           |        | SADC_CR1    | A9           | RW     | ILO_TR    | E9           | RW     |
| DCC02OU  | 2A           | RW     | AMUX_CFG1     | 6A           | RW     | SADC_CR2    | AA           | RW     | BDG_TR    | EA           | RW     |
| DCC02CR1 | 2B           | RW     |               | 6B           |        | SADC_CR3    | AB           | RW     | ECO_TR    | EB           | RW     |
| DCC03FN  | 2C           | RW     | TMP_DR0       | 6C           | RW     | SADC_CR4    | AC           | RW     | MUX_CR4   | EC           | RW     |
| DCC03IN  | 2D           | RW     | TMP_DR1       | 6D           | RW     | I2C0_ADDR   | AD           | RW     | MUX_CR5   | ED           | RW     |
| DCC03OU  | 2E           | RW     | TMP_DR2       | 6E           | RW     |             | AE           |        |           | EE           |        |
| DCC03CR1 | 2F           | RW     | TMP_DR3       | 6F           | RW     | AMUX_CLK    | AF           | RW     |           | EF           |        |
| DBC10FN  | 30           | RW     |               | 70           |        | RD10RI      | B0           | RW     |           | F0           |        |
| DBC10IN  | 31           | RW     | SADC_TSCR0    | 71           | RW     | RD10SYN     | B1           | RW     |           | F1           |        |
| DBC10OU  | 32           | RW     | SADC_TSCR1    | 72           | RW     | RD10IS      | B2           | RW     |           | F2           |        |
| DBC10CR1 | 33           | RW     | ACE_AMD_CR0   | 73           | RW     | RD10LT0     | B3           | RW     |           | F3           |        |
| DBC11FN  | 34           | RW     |               | 74           | RW     | RD10LT1     | B4           | RW     |           | F4           |        |
| DBC11IN  | 35           | RW     | ACE_AMX_IN    | 75           | RW     | RD10RO0     | B5           | RW     |           | F5           |        |
| DBC11OU  | 36           | RW     | ACE_CMP_CR0   | 76           | RW     | RD10RO1     | B6           | RW     |           | F6           |        |
| DBC11CR1 | 37           | RW     | ACE_CMP_CR1   | 77           | RW     | RD10DSM     | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12FN  | 38           | RW     |               | 78           |        | RD11RI      | B8           | RW     |           | F8           |        |
| DCC12IN  | 39           | RW     | ACE_CMP_GI_EN | 79           | RW     | RD11SYN     | B9           | RW     |           | F9           |        |
| DCC12OU  | 3A           | RW     | ACE_ALT_CR0   | 7A           | RW     | RD11IS      | BA           | RW     | FLS_PR1   | FA           | RW     |
| DCC12CR1 | 3B           | RW     | ACE_ABF_CR0   | 7B           | RW     | RD11LT0     | BB           | RW     |           | FB           |        |
| DCC13FN  | 3C           | RW     |               | 7C           |        | RD11LT1     | BC           | RW     |           | FC           |        |
| DCC13IN  | 3D           | RW     | ACE0_CR1      | 7D           | RW     | RD11RO0     | BD           | RW     | IDAC_CR0  | FD           | RW     |
| DCC13OU  | 3E           | RW     | ACE0_CR2      | 7E           | RW     | RD11RO1     | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR1 | 3F           | RW     | ACE0_CR3      | 7F           | RW     | RD11DSM     | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 12. CY8C28x23 Register Map Bank 0 Table: User Space**

| Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name      | Addr (0,Hex) | Access |
|----------|--------------|--------|----------|--------------|--------|----------|--------------|--------|-----------|--------------|--------|
| PRT0DR   | 00           | RW     | DBC20DR0 | 40           | #      | ASC10CR0 | 80           | RW     | RD12RI    | C0           | RW     |
| PRT0IE   | 01           | RW     | DBC20DR1 | 41           | W      | ASC10CR1 | 81           | RW     | RD12SYN   | C1           | RW     |
| PRT0GS   | 02           | RW     | DBC20DR2 | 42           | RW     | ASC10CR2 | 82           | RW     | RD12IS    | C2           | RW     |
| PRT0DM2  | 03           | RW     | DBC20CR0 | 43           | #      | ASC10CR3 | 83           | RW     | RD12LT0   | C3           | RW     |
| PRT1DR   | 04           | RW     | DBC21DR0 | 44           | #      | ASD11CR0 | 84           | RW     | RD12LT1   | C4           | RW     |
| PRT1IE   | 05           | RW     | DBC21DR1 | 45           | W      | ASD11CR1 | 85           | RW     | RD12RO0   | C5           | RW     |
| PRT1GS   | 06           | RW     | DBC21DR2 | 46           | RW     | ASD11CR2 | 86           | RW     | RD12RO1   | C6           | RW     |
| PRT1DM2  | 07           | RW     | DBC21CR0 | 47           | #      | ASD11CR3 | 87           | RW     | RD12DSM   | C7           | RW     |
| PRT2DR   | 08           | RW     | DCC22DR0 | 48           | #      |          | 88           |        |           | C8           |        |
| PRT2IE   | 09           | RW     | DCC22DR1 | 49           | W      |          | 89           |        |           | C9           |        |
| PRT2GS   | 0A           | RW     | DCC22DR2 | 4A           | RW     |          | 8A           |        |           | CA           |        |
| PRT2DM2  | 0B           | RW     | DCC22CR0 | 4B           | #      |          | 8B           |        |           | CB           |        |
| PRT3DR   | 0C           | RW     | DCC23DR0 | 4C           | #      |          | 8C           |        |           | CC           |        |
| PRT3IE   | 0D           | RW     | DCC23DR1 | 4D           | W      |          | 8D           |        |           | CD           |        |
| PRT3GS   | 0E           | RW     | DCC23DR2 | 4E           | RW     |          | 8E           |        |           | CE           |        |
| PRT3DM2  | 0F           | RW     | DCC23CR0 | 4F           | #      |          | 8F           |        |           | CF           |        |
| PRT4DR   | 10           | RW     |          | 50           |        | ASD20CR0 | 90           | RW     | CUR_PP    | D0           | RW     |
| PRT4IE   | 11           | RW     |          | 51           |        | ASD20CR1 | 91           | RW     | STK_PP    | D1           | RW     |
| PRT4GS   | 12           | RW     |          | 52           |        | ASD20CR2 | 92           | RW     |           | D2           |        |
| PRT4DM2  | 13           | RW     |          | 53           |        | ASD20CR3 | 93           | RW     | IDX_PP    | D3           | RW     |
| PRT5DR   | 14           | RW     |          | 54           |        | ASC21CR0 | 94           | RW     | MVR_PP    | D4           | RW     |
| PRT5IE   | 15           | RW     |          | 55           |        | ASC21CR1 | 95           | RW     | MVW_PP    | D5           | RW     |
| PRT5GS   | 16           | RW     |          | 56           |        | ASC21CR2 | 96           | RW     | I2C0_CFG  | D6           | RW     |
| PRT5DM2  | 17           | RW     |          | 57           |        | ASC21CR3 | 97           | RW     | I2C0_SCR  | D7           | #      |
|          | 18           |        |          | 58           |        |          | 98           |        | I2C0_DR   | D8           | RW     |
|          | 19           |        |          | 59           |        |          | 99           |        | I2C0_MSCR | D9           | #      |
|          | 1A           |        |          | 5A           |        |          | 9A           |        | INT_CLR0  | DA           | RW     |
|          | 1B           |        |          | 5B           |        |          | 9B           |        | INT_CLR1  | DB           | RW     |
|          | 1C           |        |          | 5C           |        |          | 9C           |        | INT_CLR2  | DC           | RW     |
|          | 1D           |        |          | 5D           |        |          | 9D           |        | INT_CLR3  | DD           | RW     |
|          | 1E           |        |          | 5E           |        |          | 9E           |        | INT_MSK3  | DE           | RW     |
|          | 1F           |        |          | 5F           |        |          | 9F           |        | INT_MSK2  | DF           | RW     |
| DBC00DR0 | 20           | #      | AMX_IN   | 60           | RW     | DEC0_DH  | A0           | RC     | INT_MSK0  | E0           | RW     |
| DBC00DR1 | 21           | W      | AMUX_CFG | 61           | RW     | DEC0_DL  | A1           | RC     | INT_MSK1  | E1           | RW     |
| DBC00DR2 | 22           | RW     | CLK_CR3  | 62           | RW     | DEC1_DH  | A2           | RC     | INT_VC    | E2           | RC     |
| DBC00CR0 | 23           | #      | ARF_CR   | 63           | RW     | DEC1_DL  | A3           | RC     | RES_WDT   | E3           | W      |
| DBC01DR0 | 24           | #      | CMP_CR0  | 64           | #      |          | A4           |        | I2C1_SCR  | E4           | #      |
| DBC01DR1 | 25           | W      | ASY_CR   | 65           | #      |          | A5           |        | I2C1_MSCR | E5           | #      |
| DBC01DR2 | 26           | RW     | CMP_CR1  | 66           | RW     |          | A6           |        | DEC_CR0*  | E6           | RW     |
| DBC01CR0 | 27           | #      | I2C1_DR  | 67           | RW     |          | A7           |        | DEC_CR1*  | E7           | RW     |
| DCC02DR0 | 28           | #      |          | 68           |        | MUL1_X   | A8           | W      | MUL0_X    | E8           | W      |
| DCC02DR1 | 29           | W      |          | 69           |        | MUL1_Y   | A9           | W      | MUL0_Y    | E9           | W      |
| DCC02DR2 | 2A           | RW     |          | 6A           |        | MUL1_DH  | AA           | R      | MUL0_DH   | EA           | R      |
| DCC02CR0 | 2B           | #      |          | 6B           |        | MUL1_DL  | AB           | R      | MUL0_DL   | EB           | R      |
| DCC03DR0 | 2C           | #      | TMP_DR0  | 6C           | RW     | ACC1_DR1 | AC           | RW     | ACC0_DR1  | EC           | RW     |
| DCC03DR1 | 2D           | W      | TMP_DR1  | 6D           | RW     | ACC1_DR0 | AD           | RW     | ACC0_DR0  | ED           | RW     |
| DCC03DR2 | 2E           | RW     | TMP_DR2  | 6E           | RW     | ACC1_DR3 | AE           | RW     | ACC0_DR3  | EE           | RW     |
| DCC03CR0 | 2F           | #      | TMP_DR3  | 6F           | RW     | ACC1_DR2 | AF           | RW     | ACC0_DR2  | EF           | RW     |
| DBC10DR0 | 30           | #      | ACB00CR3 | 70           | RW     | RD10RI   | B0           | RW     |           | F0           |        |
| DBC10DR1 | 31           | W      | ACB00CR0 | 71           | RW     | RD10SYN  | B1           | RW     |           | F1           |        |
| DBC10DR2 | 32           | RW     | ACB00CR1 | 72           | RW     | RD10IS   | B2           | RW     |           | F2           |        |
| DBC10CR0 | 33           | #      | ACB00CR2 | 73           | RW     | RD10LT0  | B3           | RW     |           | F3           |        |
| DBC11DR0 | 34           | #      | ACB01CR3 | 74           | RW     | RD10LT1  | B4           | RW     |           | F4           |        |
| DBC11DR1 | 35           | W      | ACB01CR0 | 75           | RW     | RD10RO0  | B5           | RW     |           | F5           |        |
| DBC11DR2 | 36           | RW     | ACB01CR1 | 76           | RW     | RD10RO1  | B6           | RW     |           | F6           |        |
| DBC11CR0 | 37           | #      | ACB01CR2 | 77           | RW     | RD10DSM  | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12DR0 | 38           | #      |          | 78           |        | RD11RI   | B8           | RW     |           | F8           |        |
| DCC12DR1 | 39           | W      |          | 79           |        | RD11SYN  | B9           | RW     |           | F9           |        |
| DCC12DR2 | 3A           | RW     |          | 7A           |        | RD11IS   | BA           | RW     |           | FA           |        |
| DCC12CR0 | 3B           | #      |          | 7B           |        | RD11LT0  | BB           | RW     |           | FB           |        |
| DCC13DR0 | 3C           | #      |          | 7C           |        | RD11LT1  | BC           | RW     |           | FC           |        |
| DCC13DR1 | 3D           | W      |          | 7D           |        | RD11RO0  | BD           | RW     |           | FD           |        |
| DCC13DR2 | 3E           | RW     |          | 7E           |        | RD11RO1  | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR0 | 3F           | #      |          | 7F           |        | RD11DSM  | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 13. CY8C28x23 Register Map Bank 1 Table: Configuration Space**

| Name     | Addr (1,Hex) | Access | Name      | Addr (1,Hex) | Access | Name        | Addr (1,Hex) | Access | Name      | Addr (1,Hex) | Access |
|----------|--------------|--------|-----------|--------------|--------|-------------|--------------|--------|-----------|--------------|--------|
| PRT0DM0  | 00           | RW     | DBC20FN   | 40           | RW     |             | 80           |        | RD12RI    | C0           | RW     |
| PRT0DM1  | 01           | RW     | DBC20IN   | 41           | RW     |             | 81           |        | RD12SYN   | C1           | RW     |
| PRT0IC0  | 02           | RW     | DBC20OU   | 42           | RW     |             | 82           |        | RD12IS    | C2           | RW     |
| PRT0IC1  | 03           | RW     | DBC20CR1  | 43           | RW     |             | 83           |        | RD12LT0   | C3           | RW     |
| PRT1DM0  | 04           | RW     | DBC21FN   | 44           | RW     |             | 84           |        | RD12LT1   | C4           | RW     |
| PRT1DM1  | 05           | RW     | DBC21IN   | 45           | RW     |             | 85           |        | RD12RO0   | C5           | RW     |
| PRT1IC0  | 06           | RW     | DBC21OU   | 46           | RW     |             | 86           |        | RD12RO1   | C6           | RW     |
| PRT1IC1  | 07           | RW     | DBC21CR1  | 47           | RW     |             | 87           |        | RD12DSM   | C7           | RW     |
| PRT2DM0  | 08           | RW     | DCC22FN   | 48           | RW     |             | 88           |        |           | C8           |        |
| PRT2DM1  | 09           | RW     | DCC22IN   | 49           | RW     |             | 89           |        |           | C9           |        |
| PRT2IC0  | 0A           | RW     | DCC22OU   | 4A           | RW     |             | 8A           |        |           | CA           |        |
| PRT2IC1  | 0B           | RW     | DCC22CR1  | 4B           | RW     |             | 8B           |        |           | CB           |        |
| PRT3DM0  | 0C           | RW     | DCC23FN   | 4C           | RW     |             | 8C           |        |           | CC           |        |
| PRT3DM1  | 0D           | RW     | DCC23IN   | 4D           | RW     |             | 8D           |        |           | CD           |        |
| PRT3IC0  | 0E           | RW     | DCC23OU   | 4E           | RW     |             | 8E           |        |           | CE           |        |
| PRT3IC1  | 0F           | RW     | DCC23CR1  | 4F           | RW     |             | 8F           |        |           | CF           |        |
| PRT4DM0  | 10           | RW     |           | 50           |        |             | 90           |        | GDI_O_IN  | D0           | RW     |
| PRT4DM1  | 11           | RW     |           | 51           |        | DEC0_CR0    | 91           | RW     | GDI_E_IN  | D1           | RW     |
| PRT4IC0  | 12           | RW     |           | 52           |        | DEC_CR3     | 92           | RW     | GDI_O_OU  | D2           | RW     |
| PRT4IC1  | 13           | RW     |           | 53           |        |             | 93           | RW     | GDI_E_OU  | D3           | RW     |
| PRT5DM0  | 14           | RW     |           | 54           |        |             | 94           | RW     | DEC0_CR   | D4           | RW     |
| PRT5DM1  | 15           | RW     |           | 55           |        | DEC1_CR0    | 95           | RW     | DEC1_CR   | D5           | RW     |
| PRT5IC0  | 16           | RW     |           | 56           |        |             | 96           |        |           | D6           |        |
| PRT5IC1  | 17           | RW     |           | 57           |        |             | 97           |        |           | D7           |        |
|          | 18           |        |           | 58           |        |             | 98           |        |           | D8           |        |
|          | 19           |        |           | 59           |        |             | 99           |        |           | D9           |        |
|          | 1A           |        |           | 5A           |        | DEC_CR5     | 9A           | RW     |           | DA           |        |
|          | 1B           |        |           | 5B           |        |             | 9B           |        |           | DB           |        |
|          | 1C           |        |           | 5C           |        |             | 9C           |        |           | DC           |        |
|          | 1D           |        |           | 5D           |        |             | 9D           |        | OSC_GO_EN | DD           | RW     |
|          | 1E           |        |           | 5E           |        |             | 9E           |        | OSC_CR4   | DE           | RW     |
|          | 1F           |        |           | 5F           |        |             | 9F           |        | OSC_CR3   | DF           | RW     |
| DBC00FN  | 20           | RW     | CLK_CR0   | 60           | RW     | GDI_O_IN_CR | A0           | RW     | OSC_CR0   | E0           | RW     |
| DBC00IN  | 21           | RW     | CLK_CR1   | 61           | RW     | GDI_E_IN_CR | A1           | RW     | OSC_CR1   | E1           | RW     |
| DBC00OU  | 22           | RW     | ABF_CR0   | 62           | RW     | GDI_O_OU_CR | A2           | RW     | OSC_CR2   | E2           | RW     |
| DBC00CR1 | 23           | RW     | AMD_CR0   | 63           | RW     | GDI_E_OU_CR | A3           | RW     | VLT_CR    | E3           | RW     |
| DBC01FN  | 24           | RW     | CMP_GO_EN | 64           | RW     | RTC_H       | A4           | RW     | VLT_CMP   | E4           | RW     |
| DBC01IN  | 25           | RW     |           | 65           |        | RTC_M       | A5           | RW     |           | E5           |        |
| DBC01OU  | 26           | RW     | AMD_CR1   | 66           | RW     | RTC_S       | A6           | RW     |           | E6           |        |
| DBC01CR1 | 27           | RW     | ALT_CR0   | 67           | RW     | RTC_CR      | A7           | RW     |           | E7           |        |
| DCC02FN  | 28           | RW     |           | 68           |        |             | A8           |        | IMO_TR    | E8           | RW     |
| DCC02IN  | 29           | RW     | CLK_CR2   | 69           | RW     |             | A9           |        | ILO_TR    | E9           | RW     |
| DCC02OU  | 2A           | RW     |           | 6A           |        |             | AA           |        | BDG_TR    | EA           | RW     |
| DCC02CR1 | 2B           | RW     | I2C1_CFG  | 6B           | RW     |             | AB           |        | ECO_TR    | EB           | RW     |
| DCC03FN  | 2C           | RW     | TMP_DR0   | 6C           | RW     |             | AC           |        |           | EC           |        |
| DCC03IN  | 2D           | RW     | TMP_DR1   | 6D           | RW     | I2C0_ADDR   | AD           | RW     |           | ED           |        |
| DCC03OU  | 2E           | RW     | TMP_DR2   | 6E           | RW     | I2C1_ADDR   | AE           | RW     |           | EE           |        |
| DCC03CR1 | 2F           | RW     | TMP_DR3   | 6F           | RW     | AMUX_CLK    | AF           | RW     |           | EF           |        |
| DBC10FN  | 30           | RW     |           | 70           |        | RD10RI      | B0           | RW     |           | F0           |        |
| DBC10IN  | 31           | RW     |           | 71           |        | RD10SYN     | B1           | RW     |           | F1           |        |
| DBC10OU  | 32           | RW     |           | 72           |        | RD10IS      | B2           | RW     |           | F2           |        |
| DBC10CR1 | 33           | RW     |           | 73           |        | RD10LT0     | B3           | RW     |           | F3           |        |
| DBC11FN  | 34           | RW     |           | 74           |        | RD10LT1     | B4           | RW     |           | F4           |        |
| DBC11IN  | 35           | RW     |           | 75           |        | RD10RO0     | B5           | RW     |           | F5           |        |
| DBC11OU  | 36           | RW     |           | 76           |        | RD10RO1     | B6           | RW     |           | F6           |        |
| DBC11CR1 | 37           | RW     |           | 77           |        | RD10DSM     | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12FN  | 38           | RW     |           | 78           |        | RD11RI      | B8           | RW     |           | F8           |        |
| DCC12IN  | 39           | RW     |           | 79           |        | RD11SYN     | B9           | RW     |           | F9           |        |
| DCC12OU  | 3A           | RW     |           | 7A           |        | RD11IS      | BA           | RW     | FLS_PR1   | FA           | RW     |
| DCC12CR1 | 3B           | RW     |           | 7B           |        | RD11LT0     | BB           | RW     |           | FB           |        |
| DCC13FN  | 3C           | RW     |           | 7C           |        | RD11LT1     | BC           | RW     |           | FC           |        |
| DCC13IN  | 3D           | RW     |           | 7D           |        | RD11RO0     | BD           | RW     |           | FD           |        |
| DCC13OU  | 3E           | RW     |           | 7E           |        | RD11RO1     | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR1 | 3F           | RW     |           | 7F           |        | RD11DSM     | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 14. CY8C28x33 Register Map Bank 0 Table: User Space**

| Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name      | Addr (0,Hex) | Access |
|----------|--------------|--------|----------|--------------|--------|----------|--------------|--------|-----------|--------------|--------|
| PRT0DR   | 00           | RW     | DBC20DR0 | 40           | #      | ASC10CR0 | 80           | RW     | RD12RI    | C0           | RW     |
| PRT0IE   | 01           | RW     | DBC20DR1 | 41           | W      | ASC10CR1 | 81           | RW     | RD12SYN   | C1           | RW     |
| PRT0GS   | 02           | RW     | DBC20DR2 | 42           | RW     | ASC10CR2 | 82           | RW     | RD12IS    | C2           | RW     |
| PRT0DM2  | 03           | RW     | DBC20CR0 | 43           | #      | ASC10CR3 | 83           | RW     | RD12LT0   | C3           | RW     |
| PRT1DR   | 04           | RW     | DBC21DR0 | 44           | #      | ASD11CR0 | 84           | RW     | RD12LT1   | C4           | RW     |
| PRT1IE   | 05           | RW     | DBC21DR1 | 45           | W      | ASD11CR1 | 85           | RW     | RD12RO0   | C5           | RW     |
| PRT1GS   | 06           | RW     | DBC21DR2 | 46           | RW     | ASD11CR2 | 86           | RW     | RD12RO1   | C6           | RW     |
| PRT1DM2  | 07           | RW     | DBC21CR0 | 47           | #      | ASD11CR3 | 87           | RW     | RD12DSM   | C7           | RW     |
| PRT2DR   | 08           | RW     | DCC22DR0 | 48           | #      |          | 88           |        |           | C8           |        |
| PRT2IE   | 09           | RW     | DCC22DR1 | 49           | W      |          | 89           |        |           | C9           |        |
| PRT2GS   | 0A           | RW     | DCC22DR2 | 4A           | RW     |          | 8A           |        |           | CA           |        |
| PRT2DM2  | 0B           | RW     | DCC22CR0 | 4B           | #      |          | 8B           |        |           | CB           |        |
| PRT3DR   | 0C           | RW     | DCC23DR0 | 4C           | #      |          | 8C           |        |           | CC           |        |
| PRT3IE   | 0D           | RW     | DCC23DR1 | 4D           | W      |          | 8D           |        |           | CD           |        |
| PRT3GS   | 0E           | RW     | DCC23DR2 | 4E           | RW     |          | 8E           |        |           | CE           |        |
| PRT3DM2  | 0F           | RW     | DCC23CR0 | 4F           | #      |          | 8F           |        |           | CF           |        |
| PRT4DR   | 10           | RW     |          | 50           |        | ASD20CR0 | 90           | RW     | CUR_PP    | D0           | RW     |
| PRT4IE   | 11           | RW     |          | 51           |        | ASD20CR1 | 91           | RW     | STK_PP    | D1           | RW     |
| PRT4GS   | 12           | RW     |          | 52           |        | ASD20CR2 | 92           | RW     |           | D2           |        |
| PRT4DM2  | 13           | RW     |          | 53           |        | ASD20CR3 | 93           | RW     | IDX_PP    | D3           | RW     |
| PRT5DR   | 14           | RW     |          | 54           |        | ASC21CR0 | 94           | RW     | MVR_PP    | D4           | RW     |
| PRT5IE   | 15           | RW     |          | 55           |        | ASC21CR1 | 95           | RW     | MVW_PP    | D5           | RW     |
| PRT5GS   | 16           | RW     |          | 56           |        | ASC21CR2 | 96           | RW     | I2C0_CFG  | D6           | RW     |
| PRT5DM2  | 17           | RW     |          | 57           |        | ASC21CR3 | 97           | RW     | I2C0_SCR  | D7           | #      |
|          | 18           |        |          | 58           |        |          | 98           |        | I2C0_DR   | D8           | RW     |
|          | 19           |        |          | 59           |        |          | 99           |        | I2C0_MSCR | D9           | #      |
|          | 1A           |        |          | 5A           |        |          | 9A           |        | INT_CLR0  | DA           | RW     |
|          | 1B           |        |          | 5B           |        |          | 9B           |        | INT_CLR1  | DB           | RW     |
|          | 1C           |        |          | 5C           |        |          | 9C           |        | INT_CLR2  | DC           | RW     |
|          | 1D           |        |          | 5D           |        |          | 9D           |        | INT_CLR3  | DD           | RW     |
|          | 1E           |        |          | 5E           |        |          | 9E           |        | INT_MSK3  | DE           | RW     |
|          | 1F           |        |          | 5F           |        |          | 9F           |        | INT_MSK2  | DF           | RW     |
| DBC00DR0 | 20           | #      | AMX_IN   | 60           | RW     | DEC0_DH  | A0           | RC     | INT_MSK0  | E0           | RW     |
| DBC00DR1 | 21           | W      | AMUX_CFG | 61           | RW     | DEC0_DL  | A1           | RC     | INT_MSK1  | E1           | RW     |
| DBC00DR2 | 22           | RW     | CLK_CR3  | 62           | RW     | DEC1_DH  | A2           | RC     | INT_VC    | E2           | RC     |
| DBC00CR0 | 23           | #      | ARF_CR   | 63           | RW     | DEC1_DL  | A3           | RC     | RES_WDT   | E3           | W      |
| DBC01DR0 | 24           | #      | CMP_CR0  | 64           | #      | DEC2_DH  | A4           | RC     |           | E4           |        |
| DBC01DR1 | 25           | W      | ASY_CR   | 65           | #      | DEC2_DL  | A5           | RC     |           | E5           |        |
| DBC01DR2 | 26           | RW     | CMP_CR1  | 66           | RW     | DEC3_DH  | A6           | RC     | DEC_CR0*  | E6           | RW     |
| DBC01CR0 | 27           | #      |          | 67           |        | DEC3_DL  | A7           | RC     | DEC_CR1*  | E7           | RW     |
| DCC02DR0 | 28           | #      |          | 68           |        | MUL1_X   | A8           | W      | MUL0_X    | E8           | W      |
| DCC02DR1 | 29           | W      |          | 69           |        | MUL1_Y   | A9           | W      | MUL0_Y    | E9           | W      |
| DCC02DR2 | 2A           | RW     | SADC_DH  | 6A           | RW     | MUL1_DH  | AA           | R      | MUL0_DH   | EA           | R      |
| DCC02CR0 | 2B           | #      | SADC_DL  | 6B           | RW     | MUL1_DL  | AB           | R      | MUL0_DL   | EB           | R      |
| DCC03DR0 | 2C           | #      | TMP_DR0  | 6C           | RW     | ACC1_DR1 | AC           | RW     | ACC0_DR1  | EC           | RW     |
| DCC03DR1 | 2D           | W      | TMP_DR1  | 6D           | RW     | ACC1_DR0 | AD           | RW     | ACC0_DR0  | ED           | RW     |
| DCC03DR2 | 2E           | RW     | TMP_DR2  | 6E           | RW     | ACC1_DR3 | AE           | RW     | ACC0_DR3  | EE           | RW     |
| DCC03CR0 | 2F           | #      | TMP_DR3  | 6F           | RW     | ACC1_DR2 | AF           | RW     | ACC0_DR2  | EF           | RW     |
| DBC10DR0 | 30           | #      | ACB00CR3 | 70           | RW     | RD10RI   | B0           | RW     |           | F0           |        |
| DBC10DR1 | 31           | W      | ACB00CR0 | 71           | RW     | RD10SYN  | B1           | RW     |           | F1           |        |
| DBC10DR2 | 32           | RW     | ACB00CR1 | 72           | RW     | RD10IS   | B2           | RW     |           | F2           |        |
| DBC10CR0 | 33           | #      | ACB00CR2 | 73           | RW     | RD10LT0  | B3           | RW     |           | F3           |        |
| DBC11DR0 | 34           | #      | ACB01CR3 | 74           | RW     | RD10LT1  | B4           | RW     |           | F4           |        |
| DBC11DR1 | 35           | W      | ACB01CR0 | 75           | RW     | RD10RO0  | B5           | RW     |           | F5           |        |
| DBC11DR2 | 36           | RW     | ACB01CR1 | 76           | RW     | RD10RO1  | B6           | RW     |           | F6           |        |
| DBC11CR0 | 37           | #      | ACB01CR2 | 77           | RW     | RD10DSM  | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12DR0 | 38           | #      |          | 78           |        | RD11RI   | B8           | RW     |           | F8           |        |
| DCC12DR1 | 39           | W      |          | 79           |        | RD11SYN  | B9           | RW     |           | F9           |        |
| DCC12DR2 | 3A           | RW     |          | 7A           |        | RD11IS   | BA           | RW     |           | FA           |        |
| DCC12CR0 | 3B           | #      |          | 7B           |        | RD11LT0  | BB           | RW     |           | FB           |        |
| DCC13DR0 | 3C           | #      |          | 7C           |        | RD11LT1  | BC           | RW     | DAC1_D    | FC           | RW     |
| DCC13DR1 | 3D           | W      |          | 7D           |        | RD11RO0  | BD           | RW     | DAC0_D    | FD           | RW     |
| DCC13DR2 | 3E           | RW     |          | 7E           |        | RD11RO1  | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR0 | 3F           | #      |          | 7F           |        | RD11DSM  | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 15. CY8C28x33 Register Map Bank 1 Table: Configuration Space**

| Name     | Addr (1,Hex) | Access | Name          | Addr (1,Hex) | Access | Name        | Addr (1,Hex) | Access | Name      | Addr (1,Hex) | Access |
|----------|--------------|--------|---------------|--------------|--------|-------------|--------------|--------|-----------|--------------|--------|
| PRT0DM0  | 00           | RW     | DBC20FN       | 40           | RW     |             | 80           |        | RD12RI    | C0           | RW     |
| PRT0DM1  | 01           | RW     | DBC20IN       | 41           | RW     | SADC_TSCMPL | 81           | RW     | RD12SYN   | C1           | RW     |
| PRT0IC0  | 02           | RW     | DBC20OU       | 42           | RW     | SADC_TSCMPH | 82           | RW     | RD12IS    | C2           | RW     |
| PRT0IC1  | 03           | RW     | DBC20CR1      | 43           | RW     | ACE_AMD_CR1 | 83           | RW     | RD12LT0   | C3           | RW     |
| PRT1DM0  | 04           | RW     | DBC21FN       | 44           | RW     |             | 84           |        | RD12LT1   | C4           | RW     |
| PRT1DM1  | 05           | RW     | DBC21IN       | 45           | RW     | ACE_PWM_CR  | 85           | RW     | RD12RO0   | C5           | RW     |
| PRT1IC0  | 06           | RW     | DBC21OU       | 46           | RW     | ACE_ADC0_CR | 86           | RW     | RD12RO1   | C6           | RW     |
| PRT1IC1  | 07           | RW     | DBC21CR1      | 47           | RW     | ACE_ADC1_CR | 87           | RW     | RD12DSM   | C7           | RW     |
| PRT2DM0  | 08           | RW     | DCC22FN       | 48           | RW     |             | 88           | RW     |           | C8           |        |
| PRT2DM1  | 09           | RW     | DCC22IN       | 49           | RW     | ACE_CLK_CR0 | 89           | RW     |           | C9           |        |
| PRT2IC0  | 0A           | RW     | DCC22OU       | 4A           | RW     | ACE_CLK_CR1 | 8A           | RW     |           | CA           |        |
| PRT2IC1  | 0B           | RW     | DCC22CR1      | 4B           | RW     | ACE_CLK_CR3 | 8B           | RW     |           | CB           |        |
| PRT3DM0  | 0C           | RW     | DCC23FN       | 4C           | RW     |             | 8C           |        |           | CC           |        |
| PRT3DM1  | 0D           | RW     | DCC23IN       | 4D           | RW     | ACE01CR1    | 8D           | RW     |           | CD           |        |
| PRT3IC0  | 0E           | RW     | DCC23OU       | 4E           | RW     | ACE01CR2    | 8E           | RW     |           | CE           |        |
| PRT3IC1  | 0F           | RW     | DCC23CR1      | 4F           | RW     | ASE11CR0    | 8F           | RW     |           | CF           |        |
| PRT4DM0  | 10           | RW     |               | 50           |        |             | 90           |        | GDI_O_IN  | D0           | RW     |
| PRT4DM1  | 11           | RW     |               | 51           |        | DEC0_CR0    | 91           | RW     | GDI_E_IN  | D1           | RW     |
| PRT4IC0  | 12           | RW     |               | 52           |        | DEC_CR3     | 92           | RW     | GDI_O_OU  | D2           | RW     |
| PRT4IC1  | 13           | RW     |               | 53           |        |             | 93           |        | GDI_E_OU  | D3           | RW     |
| PRT5DM0  | 14           | RW     |               | 54           |        |             | 94           |        | DEC0_CR   | D4           | RW     |
| PRT5DM1  | 15           | RW     |               | 55           |        | DEC1_CR0    | 95           | RW     | DEC1_CR   | D5           | RW     |
| PRT5IC0  | 16           | RW     |               | 56           |        | DEC_CR4     | 96           | RW     | DEC2_CR   | D6           | RW     |
| PRT5IC1  | 17           | RW     |               | 57           |        |             | 97           |        | DEC3_CR   | D7           | RW     |
|          | 18           |        |               | 58           |        |             | 98           |        | MUX_CR0   | D8           | RW     |
|          | 19           |        |               | 59           |        | DEC2_CR0    | 99           | RW     | MUX_CR1   | D9           | RW     |
|          | 1A           |        |               | 5A           |        | DEC_CR5     | 9A           | RW     | MUX_CR2   | DA           | RW     |
|          | 1B           |        |               | 5B           |        |             | 9B           |        | MUX_CR3   | DB           | RW     |
|          | 1C           |        |               | 5C           |        |             | 9C           |        | IDAC_CR1  | DC           | RW     |
|          | 1D           |        |               | 5D           |        | DEC3_CR0    | 9D           | RW     | OSC_GO_EN | DD           | RW     |
|          | 1E           |        |               | 5E           |        |             | 9E           |        | OSC_CR4   | DE           | RW     |
|          | 1F           |        |               | 5F           |        |             | 9F           |        | OSC_CR3   | DF           | RW     |
| DBC00FN  | 20           | RW     | CLK_CR0       | 60           | RW     | GDI_O_IN_CR | A0           | RW     | OSC_CR0   | E0           | RW     |
| DBC00IN  | 21           | RW     | CLK_CR1       | 61           | RW     | GDI_E_IN_CR | A1           | RW     | OSC_CR1   | E1           | RW     |
| DBC00OU  | 22           | RW     | ABF_CR0       | 62           | RW     | GDI_O_OU_CR | A2           | RW     | OSC_CR2   | E2           | RW     |
| DBC00CR1 | 23           | RW     | AMD_CR0       | 63           | RW     | GDI_E_OU_CR | A3           | RW     | VLT_CR    | E3           | RW     |
| DBC01FN  | 24           | RW     | CMP_GO_EN     | 64           | RW     | RTC_H       | A4           | RW     | VLT_CMP   | E4           | RW     |
| DBC01IN  | 25           | RW     |               | 65           |        | RTC_M       | A5           | RW     | ADC0_TR   | E5           | RW     |
| DBC01OU  | 26           | RW     | AMD_CR1       | 66           | RW     | RTC_S       | A6           | RW     | ADC1_TR   | E6           | RW     |
| DBC01CR1 | 27           | RW     | ALT_CR0       | 67           | RW     | RTC_CR      | A7           | RW     | IDAC_CR2  | E7           | RW     |
| DCC02FN  | 28           | RW     |               | 68           |        | SADC_CR0    | A8           | RW     | IMO_TR    | E8           | RW     |
| DCC02IN  | 29           | RW     | CLK_CR2       | 69           | RW     | SADC_CR1    | A9           | RW     | ILO_TR    | E9           | RW     |
| DCC02OU  | 2A           | RW     | AMUX_CFG1     | 6A           | RW     | SADC_CR2    | AA           | RW     | BDG_TR    | EA           | RW     |
| DCC02CR1 | 2B           | RW     |               | 6B           |        | SADC_CR3    | AB           | RW     | ECO_TR    | EB           | RW     |
| DCC03FN  | 2C           | RW     | TMP_DR0       | 6C           | RW     | SADC_CR4    | AC           | RW     | MUX_CR4   | EC           | RW     |
| DCC03IN  | 2D           | RW     | TMP_DR1       | 6D           | RW     | I2C0_ADDR   | AD           | RW     | MUX_CR5   | ED           | RW     |
| DCC03OU  | 2E           | RW     | TMP_DR2       | 6E           | RW     |             | AE           |        |           | EE           |        |
| DCC03CR1 | 2F           | RW     | TMP_DR3       | 6F           | RW     | AMUX_CLK    | AF           | RW     |           | EF           |        |
| DBC10FN  | 30           | RW     |               | 70           |        | RD10RI      | B0           | RW     |           | F0           |        |
| DBC10IN  | 31           | RW     | SADC_TSCR0    | 71           | RW     | RD10SYN     | B1           | RW     |           | F1           |        |
| DBC10OU  | 32           | RW     | SADC_TSCR1    | 72           | RW     | RD10IS      | B2           | RW     |           | F2           |        |
| DBC10CR1 | 33           | RW     | ACE_AMD_CR0   | 73           | RW     | RD10LT0     | B3           | RW     |           | F3           |        |
| DBC11FN  | 34           | RW     |               | 74           |        | RD10LT1     | B4           | RW     |           | F4           |        |
| DBC11IN  | 35           | RW     | ACE_AMX_IN    | 75           | RW     | RD10RO0     | B5           | RW     |           | F5           |        |
| DBC11OU  | 36           | RW     | ACE_CMP_CR0   | 76           | RW     | RD10RO1     | B6           | RW     |           | F6           |        |
| DBC11CR1 | 37           | RW     | ACE_CMP_CR1   | 77           | RW     | RD10DSM     | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12FN  | 38           | RW     |               | 78           |        | RD11RI      | B8           | RW     |           | F8           |        |
| DCC12IN  | 39           | RW     | ACE_CMP_GI_EN | 79           | RW     | RD11SYN     | B9           | RW     |           | F9           |        |
| DCC12OU  | 3A           | RW     | ACE_ALT_CR0   | 7A           | RW     | RD11IS      | BA           | RW     | FLS_PR1   | FA           | RW     |
| DCC12CR1 | 3B           | RW     | ACE_ABF_CR0   | 7B           | RW     | RD11LT0     | BB           | RW     |           | FB           |        |
| DCC13FN  | 3C           | RW     |               | 7C           |        | RD11LT1     | BC           | RW     |           | FC           |        |
| DCC13IN  | 3D           | RW     | ACE0_CR1      | 7D           | RW     | RD11RO0     | BD           | RW     | IDAC_CR0  | FD           | RW     |
| DCC13OU  | 3E           | RW     | ACE0_CR2      | 7E           | RW     | RD11RO1     | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR1 | 3F           | RW     | ACE0_CR3      | 7F           | RW     | RD11DSM     | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 16. CY8C28x43 Register Map Bank 0 Table: User Space**

| Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name      | Addr (0,Hex) | Access |
|----------|--------------|--------|----------|--------------|--------|----------|--------------|--------|-----------|--------------|--------|
| PRT0DR   | 00           | RW     | DBC20DR0 | 40           | #      | ASC10CR0 | 80           | RW     | RD12RI    | C0           | RW     |
| PRT0IE   | 01           | RW     | DBC20DR1 | 41           | W      | ASC10CR1 | 81           | RW     | RD12SYN   | C1           | RW     |
| PRT0GS   | 02           | RW     | DBC20DR2 | 42           | RW     | ASC10CR2 | 82           | RW     | RD12IS    | C2           | RW     |
| PRT0DM2  | 03           | RW     | DBC20CR0 | 43           | #      | ASC10CR3 | 83           | RW     | RD12LT0   | C3           | RW     |
| PRT1DR   | 04           | RW     | DBC21DR0 | 44           | #      | ASD11CR0 | 84           | RW     | RD12LT1   | C4           | RW     |
| PRT1IE   | 05           | RW     | DBC21DR1 | 45           | W      | ASD11CR1 | 85           | RW     | RD12RO0   | C5           | RW     |
| PRT1GS   | 06           | RW     | DBC21DR2 | 46           | RW     | ASD11CR2 | 86           | RW     | RD12RO1   | C6           | RW     |
| PRT1DM2  | 07           | RW     | DBC21CR0 | 47           | #      | ASD11CR3 | 87           | RW     | RD12DSM   | C7           | RW     |
| PRT2DR   | 08           | RW     | DCC22DR0 | 48           | #      | ASC12CR0 | 88           | RW     |           | C8           |        |
| PRT2IE   | 09           | RW     | DCC22DR1 | 49           | W      | ASC12CR1 | 89           | RW     |           | C9           |        |
| PRT2GS   | 0A           | RW     | DCC22DR2 | 4A           | RW     | ASC12CR2 | 8A           | RW     |           | CA           |        |
| PRT2DM2  | 0B           | RW     | DCC22CR0 | 4B           | #      | ASC12CR3 | 8B           | RW     |           | CB           |        |
| PRT3DR   | 0C           | RW     | DCC23DR0 | 4C           | #      | ASD13CR0 | 8C           | RW     |           | CC           |        |
| PRT3IE   | 0D           | RW     | DCC23DR1 | 4D           | W      | ASD13CR1 | 8D           | RW     |           | CD           |        |
| PRT3GS   | 0E           | RW     | DCC23DR2 | 4E           | RW     | ASD13CR2 | 8E           | RW     |           | CE           |        |
| PRT3DM2  | 0F           | RW     | DCC23CR0 | 4F           | #      | ASD13CR3 | 8F           | RW     |           | CF           |        |
| PRT4DR   | 10           | RW     |          | 50           |        | ASD20CR0 | 90           | RW     | CUR_PP    | D0           | RW     |
| PRT4IE   | 11           | RW     |          | 51           |        | ASD20CR1 | 91           | RW     | STK_PP    | D1           | RW     |
| PRT4GS   | 12           | RW     |          | 52           |        | ASD20CR2 | 92           | RW     |           | D2           |        |
| PRT4DM2  | 13           | RW     |          | 53           |        | ASD20CR3 | 93           | RW     | IDX_PP    | D3           | RW     |
| PRT5DR   | 14           | RW     |          | 54           |        | ASC21CR0 | 94           | RW     | MVR_PP    | D4           | RW     |
| PRT5IE   | 15           | RW     |          | 55           |        | ASC21CR1 | 95           | RW     | MVW_PP    | D5           | RW     |
| PRT5GS   | 16           | RW     |          | 56           |        | ASC21CR2 | 96           | RW     | I2C0_CFG  | D6           | RW     |
| PRT5DM2  | 17           | RW     |          | 57           |        | ASC21CR3 | 97           | RW     | I2C0_SCR  | D7           | #      |
|          | 18           |        |          | 58           |        | ASD22CR0 | 98           | RW     | I2C0_DR   | D8           | RW     |
|          | 19           |        |          | 59           |        | ASD22CR1 | 99           | RW     | I2C0_MSCR | D9           | #      |
|          | 1A           |        |          | 5A           |        | ASD22CR2 | 9A           | RW     | INT_CLR0  | DA           | RW     |
|          | 1B           |        |          | 5B           |        | ASD22CR3 | 9B           | RW     | INT_CLR1  | DB           | RW     |
|          | 1C           |        |          | 5C           |        | ASC23CR0 | 9C           | RW     | INT_CLR2  | DC           | RW     |
|          | 1D           |        |          | 5D           |        | ASC23CR1 | 9D           | RW     | INT_CLR3  | DD           | RW     |
|          | 1E           |        |          | 5E           |        | ASC23CR2 | 9E           | RW     | INT_MSK3  | DE           | RW     |
|          | 1F           |        |          | 5F           |        | ASC23CR3 | 9F           | RW     | INT_MSK2  | DF           | RW     |
| DBC00DR0 | 20           | #      | AMX_IN   | 60           | RW     | DEC0_DH  | A0           | RC     | INT_MSK0  | E0           | RW     |
| DBC00DR1 | 21           | W      | AMUX_CFG | 61           | RW     | DEC0_DL  | A1           | RC     | INT_MSK1  | E1           | RW     |
| DBC00DR2 | 22           | RW     | CLK_CR3  | 62           | RW     | DEC1_DH  | A2           | RC     | INT_VC    | E2           | RC     |
| DBC00CR0 | 23           | #      | ARF_CR   | 63           | RW     | DEC1_DL  | A3           | RC     | RES_WDT   | E3           | W      |
| DBC01DR0 | 24           | #      | CMP_CR0  | 64           | #      | DEC2_DH  | A4           | RC     | I2C1_SCR  | E4           | #      |
| DBC01DR1 | 25           | W      | ASY_CR   | 65           | #      | DEC2_DL  | A5           | RC     | I2C1_MSCR | E5           | #      |
| DBC01DR2 | 26           | RW     | CMP_CR1  | 66           | RW     | DEC3_DH  | A6           | RC     | DEC_CR0*  | E6           | RW     |
| DBC01CR0 | 27           | #      | I2C1_DR  | 67           | RW     | DEC3_DL  | A7           | RC     | DEC_CR1*  | E7           | RW     |
| DCC02DR0 | 28           | #      |          | 68           |        | MUL1_X   | A8           | W      | MUL0_X    | E8           | W      |
| DCC02DR1 | 29           | W      |          | 69           |        | MUL1_Y   | A9           | W      | MUL0_Y    | E9           | W      |
| DCC02DR2 | 2A           | RW     | SADC_DH  | 6A           | RW     | MUL1_DH  | AA           | R      | MUL0_DH   | EA           | R      |
| DCC02CR0 | 2B           | #      | SADC_DL  | 6B           | RW     | MUL1_DL  | AB           | R      | MUL0_DL   | EB           | R      |
| DCC03DR0 | 2C           | #      | TMP_DR0  | 6C           | RW     | ACC1_DR1 | AC           | RW     | ACC0_DR1  | EC           | RW     |
| DCC03DR1 | 2D           | W      | TMP_DR1  | 6D           | RW     | ACC1_DR0 | AD           | RW     | ACC0_DR0  | ED           | RW     |
| DCC03DR2 | 2E           | RW     | TMP_DR2  | 6E           | RW     | ACC1_DR3 | AE           | RW     | ACC0_DR3  | EE           | RW     |
| DCC03CR0 | 2F           | #      | TMP_DR3  | 6F           | RW     | ACC1_DR2 | AF           | RW     | ACC0_DR2  | EF           | RW     |
| DBC10DR0 | 30           | #      | ACB00CR3 | 70           | RW     | RD10RI   | B0           | RW     |           | F0           |        |
| DBC10DR1 | 31           | W      | ACB00CR0 | 71           | RW     | RD10SYN  | B1           | RW     |           | F1           |        |
| DBC10DR2 | 32           | RW     | ACB00CR1 | 72           | RW     | RD10IS   | B2           | RW     |           | F2           |        |
| DBC10CR0 | 33           | #      | ACB00CR2 | 73           | RW     | RD10LT0  | B3           | RW     |           | F3           |        |
| DBC11DR0 | 34           | #      | ACB01CR3 | 74           | RW     | RD10LT1  | B4           | RW     |           | F4           |        |
| DBC11DR1 | 35           | W      | ACB01CR0 | 75           | RW     | RD10RO0  | B5           | RW     |           | F5           |        |
| DBC11DR2 | 36           | RW     | ACB01CR1 | 76           | RW     | RD10RO1  | B6           | RW     |           | F6           |        |
| DBC11CR0 | 37           | #      | ACB01CR2 | 77           | RW     | RD10DSM  | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12DR0 | 38           | #      | ACB02CR3 | 78           | RW     | RD11RI   | B8           | RW     |           | F8           |        |
| DCC12DR1 | 39           | W      | ACB02CR0 | 79           | RW     | RD11SYN  | B9           | RW     |           | F9           |        |
| DCC12DR2 | 3A           | RW     | ACB02CR1 | 7A           | RW     | RD11IS   | BA           | RW     |           | FA           |        |
| DCC12CR0 | 3B           | #      | ACB02CR2 | 7B           | RW     | RD11LT0  | BB           | RW     |           | FB           |        |
| DCC13DR0 | 3C           | #      | ACB03CR3 | 7C           | RW     | RD11LT1  | BC           | RW     |           | FC           |        |
| DCC13DR1 | 3D           | W      | ACB03CR0 | 7D           | RW     | RD11RO0  | BD           | RW     |           | FD           |        |
| DCC13DR2 | 3E           | RW     | ACB03CR1 | 7E           | RW     | RD11RO1  | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR0 | 3F           | #      | ACB03CR2 | 7F           | RW     | RD11DSM  | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 17. CY8C28x43 Register Map Bank 1 Table: Configuration Space**

| Name     | Addr (1,Hex) | Access | Name       | Addr (1,Hex) | Access | Name        | Addr (1,Hex) | Access | Name      | Addr (1,Hex) | Access |
|----------|--------------|--------|------------|--------------|--------|-------------|--------------|--------|-----------|--------------|--------|
| PRT0DM0  | 00           | RW     | DBC20FN    | 40           | RW     |             | 80           |        | RD12RI    | C0           | RW     |
| PRT0DM1  | 01           | RW     | DBC20IN    | 41           | RW     | SADC_TSCMPL | 81           | RW     | RD12SYN   | C1           | RW     |
| PRT0IC0  | 02           | RW     | DBC20OU    | 42           | RW     | SADC_TSCMPH | 82           | RW     | RD12IS    | C2           | RW     |
| PRT0IC1  | 03           | RW     | DBC20CR1   | 43           | RW     |             | 83           |        | RD12LT0   | C3           | RW     |
| PRT1DM0  | 04           | RW     | DBC21FN    | 44           | RW     |             | 84           |        | RD12LT1   | C4           | RW     |
| PRT1DM1  | 05           | RW     | DBC21IN    | 45           | RW     |             | 85           |        | RD12RO0   | C5           | RW     |
| PRT1IC0  | 06           | RW     | DBC21OU    | 46           | RW     |             | 86           |        | RD12RO1   | C6           | RW     |
| PRT1IC1  | 07           | RW     | DBC21CR1   | 47           | RW     |             | 87           |        | RD12DSM   | C7           | RW     |
| PRT2DM0  | 08           | RW     | DCC22FN    | 48           | RW     |             | 88           |        |           | C8           |        |
| PRT2DM1  | 09           | RW     | DCC22IN    | 49           | RW     |             | 89           |        |           | C9           |        |
| PRT2IC0  | 0A           | RW     | DCC22OU    | 4A           | RW     |             | 8A           |        |           | CA           |        |
| PRT2IC1  | 0B           | RW     | DCC22CR1   | 4B           | RW     |             | 8B           |        |           | CB           |        |
| PRT3DM0  | 0C           | RW     | DCC23FN    | 4C           | RW     |             | 8C           |        |           | CC           |        |
| PRT3DM1  | 0D           | RW     | DCC23IN    | 4D           | RW     |             | 8D           |        |           | CD           |        |
| PRT3IC0  | 0E           | RW     | DCC23OU    | 4E           | RW     |             | 8E           |        |           | CE           |        |
| PRT3IC1  | 0F           | RW     | DCC23CR1   | 4F           | RW     |             | 8F           |        |           | CF           |        |
| PRT4DM0  | 10           | RW     |            | 50           |        |             | 90           |        | GDI_O_IN  | D0           | RW     |
| PRT4DM1  | 11           | RW     |            | 51           |        | DEC0_CR0    | 91           | RW     | GDI_E_IN  | D1           | RW     |
| PRT4IC0  | 12           | RW     |            | 52           |        | DEC_CR3     | 92           | RW     | GDI_O_OU  | D2           | RW     |
| PRT4IC1  | 13           | RW     |            | 53           |        |             | 93           |        | GDI_E_OU  | D3           | RW     |
| PRT5DM0  | 14           | RW     |            | 54           |        |             | 94           |        | DEC0_CR   | D4           | RW     |
| PRT5DM1  | 15           | RW     |            | 55           |        | DEC1_CR0    | 95           | RW     | DEC1_CR   | D5           | RW     |
| PRT5IC0  | 16           | RW     |            | 56           |        | DEC_CR4     | 96           | RW     | DEC2_CR   | D6           | RW     |
| PRT5IC1  | 17           | RW     |            | 57           |        |             | 97           |        | DEC3_CR   | D7           | RW     |
|          | 18           |        |            | 58           |        |             | 98           |        | MUX_CR0   | D8           | RW     |
|          | 19           |        |            | 59           |        | DEC2_CR0    | 99           | RW     | MUX_CR1   | D9           | RW     |
|          | 1A           |        |            | 5A           |        | DEC_CR5     | 9A           | RW     | MUX_CR2   | DA           | RW     |
|          | 1B           |        |            | 5B           |        |             | 9B           |        | MUX_CR3   | DB           | RW     |
|          | 1C           |        |            | 5C           |        |             | 9C           |        |           | DC           |        |
|          | 1D           |        |            | 5D           |        | DEC3_CR0    | 9D           | RW     | OSC_GO_EN | DD           | RW     |
|          | 1E           |        |            | 5E           |        |             | 9E           |        | OSC_CR4   | DE           | RW     |
|          | 1F           |        |            | 5F           |        |             | 9F           |        | OSC_CR3   | DF           | RW     |
| DBC00FN  | 20           | RW     | CLK_CR0    | 60           | RW     | GDI_O_IN_CR | A0           | RW     | OSC_CR0   | E0           | RW     |
| DBC00IN  | 21           | RW     | CLK_CR1    | 61           | RW     | GDI_E_IN_CR | A1           | RW     | OSC_CR1   | E1           | RW     |
| DBC00OU  | 22           | RW     | ABF_CR0    | 62           | RW     | GDI_O_OU_CR | A2           | RW     | OSC_CR2   | E2           | RW     |
| DBC00CR1 | 23           | RW     | AMD_CR0    | 63           | RW     | GDI_E_OU_CR | A3           | RW     | VLT_CR    | E3           | RW     |
| DBC01FN  | 24           | RW     | CMP_GO_EN  | 64           | RW     | RTC_H       | A4           | RW     | VLT_CMP   | E4           | RW     |
| DBC01IN  | 25           | RW     | CMP_GO_EN1 | 65           | RW     | RTC_M       | A5           | RW     |           | E5           |        |
| DBC01OU  | 26           | RW     | AMD_CR1    | 66           | RW     | RTC_S       | A6           | RW     |           | E6           |        |
| DBC01CR1 | 27           | RW     | ALT_CR0    | 67           | RW     | RTC_CR      | A7           | RW     |           | E7           |        |
| DCC02FN  | 28           | RW     | ALT_CR1    | 68           | RW     | SADC_CR0    | A8           | RW     | IMO_TR    | E8           | RW     |
| DCC02IN  | 29           | RW     | CLK_CR2    | 69           | RW     | SADC_CR1    | A9           | RW     | ILO_TR    | E9           | RW     |
| DCC02OU  | 2A           | RW     | AMUX_CFG1  | 6A           | RW     | SADC_CR2    | AA           | RW     | BDG_TR    | EA           | RW     |
| DCC02CR1 | 2B           | RW     | I2C1_CFG   | 6B           | RW     | SADC_CR3    | AB           | RW     | EDO_TR    | EB           | RW     |
| DCC03FN  | 2C           | RW     | TMP_DR0    | 6C           | RW     | SADC_CR4    | AC           | RW     | MUX_CR4   | EC           | RW     |
| DCC03IN  | 2D           | RW     | TMP_DR1    | 6D           | RW     | I2C0_ADDR   | AD           | RW     | MUX_CR5   | ED           | RW     |
| DCC03OU  | 2E           | RW     | TMP_DR2    | 6E           | RW     | I2C1_ADDR   | AE           | RW     |           | EE           |        |
| DCC03CR1 | 2F           | RW     | TMP_DR3    | 6F           | RW     | AMUX_CLK    | AF           | RW     |           | EF           |        |
| DBC10FN  | 30           | RW     |            | 70           |        | RD10RI      | B0           | RW     |           | F0           |        |
| DBC10IN  | 31           | RW     | SADC_TSCR0 | 71           | RW     | RD10SYN     | B1           | RW     |           | F1           |        |
| DBC10OU  | 32           | RW     | SADC_TSCR1 | 72           | RW     | RD10IS      | B2           | RW     |           | F2           |        |
| DBC10CR1 | 33           | RW     |            | 73           |        | RD10LT0     | B3           | RW     |           | F3           |        |
| DBC11FN  | 34           | RW     |            | 74           |        | RD10LT1     | B4           | RW     |           | F4           |        |
| DBC11IN  | 35           | RW     |            | 75           |        | RD10RO0     | B5           | RW     |           | F5           |        |
| DBC11OU  | 36           | RW     |            | 76           |        | RD10RO1     | B6           | RW     |           | F6           |        |
| DBC11CR1 | 37           | RW     |            | 77           |        | RD10DSM     | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12FN  | 38           | RW     |            | 78           |        | RD11RI      | B8           | RW     |           | F8           |        |
| DCC12IN  | 39           | RW     |            | 79           |        | RD11SYN     | B9           | RW     |           | F9           |        |
| DCC12OU  | 3A           | RW     |            | 7A           |        | RD11IS      | BA           | RW     | FLS_PR1   | FA           | RW     |
| DCC12CR1 | 3B           | RW     |            | 7B           |        | RD11LT0     | BB           | RW     |           | FB           |        |
| DCC13FN  | 3C           | RW     |            | 7C           |        | RD11LT1     | BC           | RW     |           | FC           |        |
| DCC13IN  | 3D           | RW     |            | 7D           |        | RD11RO0     | BD           | RW     |           | FD           |        |
| DCC13OU  | 3E           | RW     |            | 7E           |        | RD11RO1     | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR1 | 3F           | RW     |            | 7F           |        | RD11DSM     | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 18. CY8C28x45 Register Map Bank 0 Table: User Space**

| Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name      | Addr (0,Hex) | Access |
|----------|--------------|--------|----------|--------------|--------|----------|--------------|--------|-----------|--------------|--------|
| PRT0DR   | 00           | RW     | DBC20DR0 | 40           | #      | ASC10CR0 | 80           | RW     | RD12RI    | C0           | RW     |
| PRT0IE   | 01           | RW     | DBC20DR1 | 41           | W      | ASC10CR1 | 81           | RW     | RD12SYN   | C1           | RW     |
| PRT0GS   | 02           | RW     | DBC20DR2 | 42           | RW     | ASC10CR2 | 82           | RW     | RD12IS    | C2           | RW     |
| PRT0DM2  | 03           | RW     | DBC20CR0 | 43           | #      | ASC10CR3 | 83           | RW     | RD12LT0   | C3           | RW     |
| PRT1DR   | 04           | RW     | DBC21DR0 | 44           | #      | ASD11CR0 | 84           | RW     | RD12LT1   | C4           | RW     |
| PRT1IE   | 05           | RW     | DBC21DR1 | 45           | W      | ASD11CR1 | 85           | RW     | RD12RO0   | C5           | RW     |
| PRT1GS   | 06           | RW     | DBC21DR2 | 46           | RW     | ASD11CR2 | 86           | RW     | RD12RO1   | C6           | RW     |
| PRT1DM2  | 07           | RW     | DBC21CR0 | 47           | #      | ASD11CR3 | 87           | RW     | RD12DSM   | C7           | RW     |
| PRT2DR   | 08           | RW     | DCC22DR0 | 48           | #      | ASC12CR0 | 88           | RW     |           | C8           |        |
| PRT2IE   | 09           | RW     | DCC22DR1 | 49           | W      | ASC12CR1 | 89           | RW     |           | C9           |        |
| PRT2GS   | 0A           | RW     | DCC22DR2 | 4A           | RW     | ASC12CR2 | 8A           | RW     |           | CA           |        |
| PRT2DM2  | 0B           | RW     | DCC22CR0 | 4B           | #      | ASC12CR3 | 8B           | RW     |           | CB           |        |
| PRT3DR   | 0C           | RW     | DCC23DR0 | 4C           | #      | ASD13CR0 | 8C           | RW     |           | CC           |        |
| PRT3IE   | 0D           | RW     | DCC23DR1 | 4D           | W      | ASD13CR1 | 8D           | RW     |           | CD           |        |
| PRT3GS   | 0E           | RW     | DCC23DR2 | 4E           | RW     | ASD13CR2 | 8E           | RW     |           | CE           |        |
| PRT3DM2  | 0F           | RW     | DCC23CR0 | 4F           | #      | ASD13CR3 | 8F           | RW     |           | CF           |        |
| PRT4DR   | 10           | RW     |          | 50           |        | ASD20CR0 | 90           | RW     | CUR_PP    | D0           | RW     |
| PRT4IE   | 11           | RW     |          | 51           |        | ASD20CR1 | 91           | RW     | STK_PP    | D1           | RW     |
| PRT4GS   | 12           | RW     |          | 52           |        | ASD20CR2 | 92           | RW     |           | D2           |        |
| PRT4DM2  | 13           | RW     |          | 53           |        | ASD20CR3 | 93           | RW     | IDX_PP    | D3           | RW     |
| PRT5DR   | 14           | RW     |          | 54           |        | ASC21CR0 | 94           | RW     | MVR_PP    | D4           | RW     |
| PRT5IE   | 15           | RW     |          | 55           |        | ASC21CR1 | 95           | RW     | MVW_PP    | D5           | RW     |
| PRT5GS   | 16           | RW     |          | 56           |        | ASC21CR2 | 96           | RW     | I2C0_CFG  | D6           | RW     |
| PRT5DM2  | 17           | RW     |          | 57           |        | ASC21CR3 | 97           | RW     | I2C0_SCR  | D7           | #      |
|          | 18           |        |          | 58           |        | ASD22CR0 | 98           | RW     | I2C0_DR   | D8           | RW     |
|          | 19           |        |          | 59           |        | ASD22CR1 | 99           | RW     | I2C0_MSCR | D9           | #      |
|          | 1A           |        |          | 5A           |        | ASD22CR2 | 9A           | RW     | INT_CLR0  | DA           | RW     |
|          | 1B           |        |          | 5B           |        | ASD22CR3 | 9B           | RW     | INT_CLR1  | DB           | RW     |
|          | 1C           |        |          | 5C           |        | ASC23CR0 | 9C           | RW     | INT_CLR2  | DC           | RW     |
|          | 1D           |        |          | 5D           |        | ASC23CR1 | 9D           | RW     | INT_CLR3  | DD           | RW     |
|          | 1E           |        |          | 5E           |        | ASC23CR2 | 9E           | RW     | INT_MSK3  | DE           | RW     |
|          | 1F           |        |          | 5F           |        | ASC23CR3 | 9F           | RW     | INT_MSK2  | DF           | RW     |
| DBC00DR0 | 20           | #      | AMX_IN   | 60           | RW     | DEC0_DH  | A0           | RC     | INT_MSK0  | E0           | RW     |
| DBC00DR1 | 21           | W      | AMUX_CFG | 61           | RW     | DEC0_DL  | A1           | RC     | INT_MSK1  | E1           | RW     |
| DBC00DR2 | 22           | RW     | CLK_CR3  | 62           | RW     | DEC1_DH  | A2           | RC     | INT_VC    | E2           | RC     |
| DBC00CR0 | 23           | #      | ARF_CR   | 63           | RW     | DEC1_DL  | A3           | RC     | RES_WDT   | E3           | W      |
| DBC01DR0 | 24           | #      | CMP_CR0  | 64           | #      | DEC2_DH  | A4           | RC     | I2C1_SCR  | E4           | #      |
| DBC01DR1 | 25           | W      | ASY_CR   | 65           | #      | DEC2_DL  | A5           | RC     | I2C1_MSCR | E5           | #      |
| DBC01DR2 | 26           | RW     | CMP_CR1  | 66           | RW     | DEC3_DH  | A6           | RC     | DEC_CR0*  | E6           | RW     |
| DBC01CR0 | 27           | #      | I2C1_DR  | 67           | RW     | DEC3_DL  | A7           | RC     | DEC_CR1*  | E7           | RW     |
| DCC02DR0 | 28           | #      |          | 68           |        | MUL1_X   | A8           | W      | MUL0_X    | E8           | W      |
| DCC02DR1 | 29           | W      |          | 69           |        | MUL1_Y   | A9           | W      | MUL0_Y    | E9           | W      |
| DCC02DR2 | 2A           | RW     | SADC_DH  | 6A           | RW     | MUL1_DH  | AA           | R      | MUL0_DH   | EA           | R      |
| DCC02CR0 | 2B           | #      | SADC_DL  | 6B           | RW     | MUL1_DL  | AB           | R      | MUL0_DL   | EB           | R      |
| DCC03DR0 | 2C           | #      | TMP_DR0  | 6C           | RW     | ACC1_DR1 | AC           | RW     | ACC0_DR1  | EC           | RW     |
| DCC03DR1 | 2D           | W      | TMP_DR1  | 6D           | RW     | ACC1_DR0 | AD           | RW     | ACC0_DR0  | ED           | RW     |
| DCC03DR2 | 2E           | RW     | TMP_DR2  | 6E           | RW     | ACC1_DR3 | AE           | RW     | ACC0_DR3  | EE           | RW     |
| DCC03CR0 | 2F           | #      | TMP_DR3  | 6F           | RW     | ACC1_DR2 | AF           | RW     | ACC0_DR2  | EF           | RW     |
| DBC10DR0 | 30           | #      | ACB00CR3 | 70           | RW     | RD10RI   | B0           | RW     |           | F0           |        |
| DBC10DR1 | 31           | W      | ACB00CR0 | 71           | RW     | RD10SYN  | B1           | RW     |           | F1           |        |
| DBC10DR2 | 32           | RW     | ACB00CR1 | 72           | RW     | RD10IS   | B2           | RW     |           | F2           |        |
| DBC10CR0 | 33           | #      | ACB00CR2 | 73           | RW     | RD10LT0  | B3           | RW     |           | F3           |        |
| DBC11DR0 | 34           | #      | ACB01CR3 | 74           | RW     | RD10LT1  | B4           | RW     |           | F4           |        |
| DBC11DR1 | 35           | W      | ACB01CR0 | 75           | RW     | RD10RO0  | B5           | RW     |           | F5           |        |
| DBC11DR2 | 36           | RW     | ACB01CR1 | 76           | RW     | RD10RO1  | B6           | RW     |           | F6           |        |
| DBC11CR0 | 37           | #      | ACB01CR2 | 77           | RW     | RD10DSM  | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12DR0 | 38           | #      | ACB02CR3 | 78           | RW     | RD11RI   | B8           | RW     |           | F8           |        |
| DCC12DR1 | 39           | W      | ACB02CR0 | 79           | RW     | RD11SYN  | B9           | RW     |           | F9           |        |
| DCC12DR2 | 3A           | RW     | ACB02CR1 | 7A           | RW     | RD11IS   | BA           | RW     |           | FA           |        |
| DCC12CR0 | 3B           | #      | ACB02CR2 | 7B           | RW     | RD11LT0  | BB           | RW     |           | FB           |        |
| DCC13DR0 | 3C           | #      | ACB03CR3 | 7C           | RW     | RD11LT1  | BC           | RW     | DAC1_D    | FC           | RW     |
| DCC13DR1 | 3D           | W      | ACB03CR0 | 7D           | RW     | RD11RO0  | BD           | RW     | DAC0_D    | FD           | RW     |
| DCC13DR2 | 3E           | RW     | ACB03CR1 | 7E           | RW     | RD11RO1  | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR0 | 3F           | #      | ACB03CR2 | 7F           | RW     | RD11DSM  | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 19. CY8C28x45 Register Map Bank 1 Table: Configuration Space**

| Name     | Addr (1,Hex) | Access | Name          | Addr (1,Hex) | Access | Name        | Addr (1,Hex) | Access | Name      | Addr (1,Hex) | Access |
|----------|--------------|--------|---------------|--------------|--------|-------------|--------------|--------|-----------|--------------|--------|
| PRT0DM0  | 00           | RW     | DBC20FN       | 40           | RW     |             | 80           | RW     | RD12RI    | C0           | RW     |
| PRT0DM1  | 01           | RW     | DBC20IN       | 41           | RW     | SADC_TSCMPL | 81           | RW     | RD12SYN   | C1           | RW     |
| PRT0IC0  | 02           | RW     | DBC20OU       | 42           | RW     | SADC_TSCMPH | 82           | RW     | RD12IS    | C2           | RW     |
| PRT0IC1  | 03           | RW     | DBC20CR1      | 43           | RW     | ACE_AMD_CR1 | 83           | RW     | RD12LT0   | C3           | RW     |
| PRT1DM0  | 04           | RW     | DBC21FN       | 44           | RW     |             | 84           | RW     | RD12LT1   | C4           | RW     |
| PRT1DM1  | 05           | RW     | DBC21IN       | 45           | RW     | ACE_PWM_CR  | 85           | RW     | RD12RO0   | C5           | RW     |
| PRT1IC0  | 06           | RW     | DBC21OU       | 46           | RW     | ACE_ADC0_CR | 86           | RW     | RD12RO1   | C6           | RW     |
| PRT1IC1  | 07           | RW     | DBC21CR1      | 47           | RW     | ACE_ADC1_CR | 87           | RW     | RD12DSM   | C7           | RW     |
| PRT2DM0  | 08           | RW     | DCC22FN       | 48           | RW     |             | 88           | RW     |           | C8           |        |
| PRT2DM1  | 09           | RW     | DCC22IN       | 49           | RW     | ACE_CLK_CR0 | 89           | RW     |           | C9           |        |
| PRT2IC0  | 0A           | RW     | DCC22OU       | 4A           | RW     | ACE_CLK_CR1 | 8A           | RW     |           | CA           |        |
| PRT2IC1  | 0B           | RW     | DCC22CR1      | 4B           | RW     | ACE_CLK_CR3 | 8B           | RW     |           | CB           |        |
| PRT3DM0  | 0C           | RW     | DCC23FN       | 4C           | RW     |             | 8C           | RW     |           | CC           |        |
| PRT3DM1  | 0D           | RW     | DCC23IN       | 4D           | RW     | ACE01CR1    | 8D           | RW     |           | CD           |        |
| PRT3IC0  | 0E           | RW     | DCC23OU       | 4E           | RW     | ACE01CR2    | 8E           | RW     |           | CE           |        |
| PRT3IC1  | 0F           | RW     | DCC23CR1      | 4F           | RW     | ASE11CR0    | 8F           | RW     |           | CF           |        |
| PRT4DM0  | 10           | RW     |               | 50           |        |             | 90           |        | GDI_O_IN  | D0           | RW     |
| PRT4DM1  | 11           | RW     |               | 51           |        | DEC0_CR0    | 91           | RW     | GDI_E_IN  | D1           | RW     |
| PRT4IC0  | 12           | RW     |               | 52           |        | DEC_CR3     | 92           | RW     | GDI_O_OU  | D2           | RW     |
| PRT4IC1  | 13           | RW     |               | 53           |        |             | 93           |        | GDI_E_OU  | D3           | RW     |
| PRT5DM0  | 14           | RW     |               | 54           |        |             | 94           |        | DEC0_CR   | D4           | RW     |
| PRT5DM1  | 15           | RW     |               | 55           |        | DEC1_CR0    | 95           | RW     | DEC1_CR   | D5           | RW     |
| PRT5IC0  | 16           | RW     |               | 56           |        | DEC_CR4     | 96           | RW     | DEC2_CR   | D6           | RW     |
| PRT5IC1  | 17           | RW     |               | 57           |        |             | 97           |        | DEC3_CR   | D7           | RW     |
|          | 18           |        |               | 58           |        |             | 98           |        | MUX_CR0   | D8           | RW     |
|          | 19           |        |               | 59           |        | DEC2_CR0    | 99           | RW     | MUX_CR1   | D9           | RW     |
|          | 1A           |        |               | 5A           |        | DEC_CR5     | 9A           | RW     | MUX_CR2   | DA           | RW     |
|          | 1B           |        |               | 5B           |        |             | 9B           |        | MUX_CR3   | DB           | RW     |
|          | 1C           |        |               | 5C           |        |             | 9C           |        | IDAC_CR1  | DC           | RW     |
|          | 1D           |        |               | 5D           |        | DEC3_CR0    | 9D           | RW     | OSC_GO_EN | DD           | RW     |
|          | 1E           |        |               | 5E           |        |             | 9E           |        | OSC_CR4   | DE           | RW     |
|          | 1F           |        |               | 5F           |        |             | 9F           |        | OSC_CR3   | DF           | RW     |
| DBC00FN  | 20           | RW     | CLK_CR0       | 60           | RW     | GDI_O_IN_CR | A0           | RW     | OSC_CR0   | E0           | RW     |
| DBC00IN  | 21           | RW     | CLK_CR1       | 61           | RW     | GDI_E_IN_CR | A1           | RW     | OSC_CR1   | E1           | RW     |
| DBC00OU  | 22           | RW     | ABF_CR0       | 62           | RW     | GDI_O_OU_CR | A2           | RW     | OSC_CR2   | E2           | RW     |
| DBC00CR1 | 23           | RW     | AMD_CR0       | 63           | RW     | GDI_E_OU_CR | A3           | RW     | VLT_CR    | E3           | RW     |
| DBC01FN  | 24           | RW     | CMP_GO_EN     | 64           | RW     | RTC_H       | A4           | RW     | VLT_CMP   | E4           | RW     |
| DBC01IN  | 25           | RW     | CMP_GO_EN1    | 65           | RW     | RTC_M       | A5           | RW     | ADC0_TR   | E5           | RW     |
| DBC01OU  | 26           | RW     | AMD_CR1       | 66           | RW     | RTC_S       | A6           | RW     | ADC1_TR   | E6           | RW     |
| DBC01CR1 | 27           | RW     | ALT_CR0       | 67           | RW     | RTC_CR      | A7           | RW     | IDAC_CR2  | E7           | RW     |
| DCC02FN  | 28           | RW     | ALT_CR1       | 68           | RW     | SADC_CR0    | A8           | RW     | IMO_TR    | E8           | RW     |
| DCC02IN  | 29           | RW     | CLK_CR2       | 69           | RW     | SADC_CR1    | A9           | RW     | ILO_TR    | E9           | RW     |
| DCC02OU  | 2A           | RW     | AMUX_CFG1     | 6A           | RW     | SADC_CR2    | AA           | RW     | BDG_TR    | EA           | RW     |
| DCC02CR1 | 2B           | RW     | I2C1_CFG      | 6B           | RW     | SADC_CR3    | AB           | RW     | ECO_TR    | EB           | RW     |
| DCC03FN  | 2C           | RW     | TMP_DR0       | 6C           | RW     | SADC_CR4    | AC           | RW     | MUX_CR4   | EC           | RW     |
| DCC03IN  | 2D           | RW     | TMP_DR1       | 6D           | RW     | I2C0_ADDR   | AD           | RW     | MUX_CR5   | ED           | RW     |
| DCC03OU  | 2E           | RW     | TMP_DR2       | 6E           | RW     | I2C1_ADDR   | AE           | RW     |           | EE           |        |
| DCC03CR1 | 2F           | RW     | TMP_DR3       | 6F           | RW     | AMUX_CLK    | AF           | RW     |           | EF           |        |
| DBC10FN  | 30           | RW     |               | 70           |        | RD10RI      | B0           | RW     |           | F0           |        |
| DBC10IN  | 31           | RW     | SADC_TSCR0    | 71           | RW     | RD10SYN     | B1           | RW     |           | F1           |        |
| DBC10OU  | 32           | RW     | SADC_TSCR1    | 72           | RW     | RD10IS      | B2           | RW     |           | F2           |        |
| DBC10CR1 | 33           | RW     | ACE_AMD_CR0   | 73           | RW     | RD10LT0     | B3           | RW     |           | F3           |        |
| DBC11FN  | 34           | RW     |               | 74           |        | RD10LT1     | B4           | RW     |           | F4           |        |
| DBC11IN  | 35           | RW     | ACE_AMX_IN    | 75           | RW     | RD10RO0     | B5           | RW     |           | F5           |        |
| DBC11OU  | 36           | RW     | ACE_CMP_CR0   | 76           | RW     | RD10RO1     | B6           | RW     |           | F6           |        |
| DBC11CR1 | 37           | RW     | ACE_CMP_CR1   | 77           | RW     | RD10DSM     | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12FN  | 38           | RW     |               | 78           |        | RD11RI      | B8           | RW     |           | F8           |        |
| DCC12IN  | 39           | RW     | ACE_CMP_GI_EN | 79           | RW     | RD11SYN     | B9           | RW     |           | F9           |        |
| DCC12OU  | 3A           | RW     | ACE_ALT_CR0   | 7A           | RW     | RD11IS      | BA           | RW     | FLS_PR1   | FA           | RW     |
| DCC12CR1 | 3B           | RW     | ACE_ABF_CR0   | 7B           | RW     | RD11LT0     | BB           | RW     |           | FB           |        |
| DCC13FN  | 3C           | RW     |               | 7C           |        | RD11LT1     | BC           | RW     |           | FC           |        |
| DCC13IN  | 3D           | RW     | ACE0_CR1      | 7D           | RW     | RD11RO0     | BD           | RW     | IDAC_CR0  | FD           | RW     |
| DCC13OU  | 3E           | RW     | ACE0_CR2      | 7E           | RW     | RD11RO1     | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR1 | 3F           | RW     | ACE0_CR3      | 7F           | RW     | RD11DSM     | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 20. CY8C28x52 Register Map Bank 0 Table: User Space**

| Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name     | Addr (0,Hex) | Access | Name      | Addr (0,Hex) | Access |
|----------|--------------|--------|----------|--------------|--------|----------|--------------|--------|-----------|--------------|--------|
| PRT0DR   | 00           | RW     |          | 40           |        | ASC10CR0 | 80           | RW     |           | C0           |        |
| PRT0IE   | 01           | RW     |          | 41           |        | ASC10CR1 | 81           | RW     |           | C1           |        |
| PRT0GS   | 02           | RW     |          | 42           |        | ASC10CR2 | 82           | RW     |           | C2           |        |
| PRT0DM2  | 03           | RW     |          | 43           |        | ASC10CR3 | 83           | RW     |           | C3           |        |
| PRT1DR   | 04           | RW     |          | 44           |        | ASD11CR0 | 84           | RW     |           | C4           |        |
| PRT1IE   | 05           | RW     |          | 45           |        | ASD11CR1 | 85           | RW     |           | C5           |        |
| PRT1GS   | 06           | RW     |          | 46           |        | ASD11CR2 | 86           | RW     |           | C6           |        |
| PRT1DM2  | 07           | RW     |          | 47           |        | ASD11CR3 | 87           | RW     |           | C7           |        |
| PRT2DR   | 08           | RW     |          | 48           |        | ASC12CR0 | 88           | RW     |           | C8           |        |
| PRT2IE   | 09           | RW     |          | 49           |        | ASC12CR1 | 89           | RW     |           | C9           |        |
| PRT2GS   | 0A           | RW     |          | 4A           |        | ASC12CR2 | 8A           | RW     |           | CA           |        |
| PRT2DM2  | 0B           | RW     |          | 4B           |        | ASC12CR3 | 8B           | RW     |           | CB           |        |
| PRT3DR   | 0C           | RW     |          | 4C           |        | ASD13CR0 | 8C           | RW     |           | CC           |        |
| PRT3IE   | 0D           | RW     |          | 4D           |        | ASD13CR1 | 8D           | RW     |           | CD           |        |
| PRT3GS   | 0E           | RW     |          | 4E           |        | ASD13CR2 | 8E           | RW     |           | CE           |        |
| PRT3DM2  | 0F           | RW     |          | 4F           |        | ASD13CR3 | 8F           | RW     |           | CF           |        |
| PRT4DR   | 10           | RW     |          | 50           |        | ASD20CR0 | 90           | RW     | CUR_PP    | D0           | RW     |
| PRT4IE   | 11           | RW     |          | 51           |        | ASD20CR1 | 91           | RW     | STK_PP    | D1           | RW     |
| PRT4GS   | 12           | RW     |          | 52           |        | ASD20CR2 | 92           | RW     |           | D2           |        |
| PRT4DM2  | 13           | RW     |          | 53           |        | ASD20CR3 | 93           | RW     | IDX_PP    | D3           | RW     |
| PRT5DR   | 14           | RW     |          | 54           |        | ASC21CR0 | 94           | RW     | MVR_PP    | D4           | RW     |
| PRT5IE   | 15           | RW     |          | 55           |        | ASC21CR1 | 95           | RW     | MVW_PP    | D5           | RW     |
| PRT5GS   | 16           | RW     |          | 56           |        | ASC21CR2 | 96           | RW     | I2C0_CFG  | D6           | RW     |
| PRT5DM2  | 17           | RW     |          | 57           |        | ASC21CR3 | 97           | RW     | I2C0_SCR  | D7           | #      |
|          | 18           |        |          | 58           |        | ASD22CR0 | 98           | RW     | I2C0_DR   | D8           | RW     |
|          | 19           |        |          | 59           |        | ASD22CR1 | 99           | RW     | I2C0_MSCR | D9           | #      |
|          | 1A           |        |          | 5A           |        | ASD22CR2 | 9A           | RW     | INT_CLR0  | DA           | RW     |
|          | 1B           |        |          | 5B           |        | ASD22CR3 | 9B           | RW     | INT_CLR1  | DB           | RW     |
|          | 1C           |        |          | 5C           |        | ASC23CR0 | 9C           | RW     | INT_CLR2  | DC           | RW     |
|          | 1D           |        |          | 5D           |        | ASC23CR1 | 9D           | RW     | INT_CLR3  | DD           | RW     |
|          | 1E           |        |          | 5E           |        | ASC23CR2 | 9E           | RW     | INT_MSK3  | DE           | RW     |
|          | 1F           |        |          | 5F           |        | ASC23CR3 | 9F           | RW     | INT_MSK2  | DF           | RW     |
| DBC00DR0 | 20           | #      | AMX_IN   | 60           | RW     | DEC0_DH  | A0           | RC     | INT_MSK0  | E0           | RW     |
| DBC00DR1 | 21           | W      | AMUX_CFG | 61           | RW     | DEC0_DL  | A1           | RC     | INT_MSK1  | E1           | RW     |
| DBC00DR2 | 22           | RW     | CLK_CR3  | 62           | RW     | DEC1_DH  | A2           | RC     | INT_VC    | E2           | RC     |
| DBC00CR0 | 23           | #      | ARF_CR   | 63           | RW     | DEC1_DL  | A3           | RC     | RES_WDT   | E3           | W      |
| DBC01DR0 | 24           | #      | CMP_CR0  | 64           | #      | DEC2_DH  | A4           | RC     |           | E4           |        |
| DBC01DR1 | 25           | W      | ASY_CR   | 65           | #      | DEC2_DL  | A5           | RC     |           | E5           |        |
| DBC01DR2 | 26           | RW     | CMP_CR1  | 66           | RW     | DEC3_DH  | A6           | RC     | DEC_CR0*  | E6           | RW     |
| DBC01CR0 | 27           | #      |          | 67           |        | DEC3_DL  | A7           | RC     | DEC_CR1*  | E7           | RW     |
| DCC02DR0 | 28           | #      |          | 68           |        | MUL1_X   | A8           | W      | MUL0_X    | E8           | W      |
| DCC02DR1 | 29           | W      |          | 69           |        | MUL1_Y   | A9           | W      | MUL0_Y    | E9           | W      |
| DCC02DR2 | 2A           | RW     |          | 6A           |        | MUL1_DH  | AA           | R      | MUL0_DH   | EA           | R      |
| DCC02CR0 | 2B           | #      |          | 6B           |        | MUL1_DL  | AB           | R      | MUL0_DL   | EB           | R      |
| DCC03DR0 | 2C           | #      | TMP_DR0  | 6C           | RW     | ACC1_DR1 | AC           | RW     | ACC0_DR1  | EC           | RW     |
| DCC03DR1 | 2D           | W      | TMP_DR1  | 6D           | RW     | ACC1_DR0 | AD           | RW     | ACC0_DR0  | ED           | RW     |
| DCC03DR2 | 2E           | RW     | TMP_DR2  | 6E           | RW     | ACC1_DR3 | AE           | RW     | ACC0_DR3  | EE           | RW     |
| DCC03CR0 | 2F           | #      | TMP_DR3  | 6F           | RW     | ACC1_DR2 | AF           | RW     | ACC0_DR2  | EF           | RW     |
| DBC10DR0 | 30           | #      | ACB00CR3 | 70           | RW     | RD10RI   | B0           | RW     |           | F0           |        |
| DBC10DR1 | 31           | W      | ACB00CR0 | 71           | RW     | RD10SYN  | B1           | RW     |           | F1           |        |
| DBC10DR2 | 32           | RW     | ACB00CR1 | 72           | RW     | RD10IS   | B2           | RW     |           | F2           |        |
| DBC10CR0 | 33           | #      | ACB00CR2 | 73           | RW     | RD10LT0  | B3           | RW     |           | F3           |        |
| DBC11DR0 | 34           | #      | ACB01CR3 | 74           | RW     | RD10LT1  | B4           | RW     |           | F4           |        |
| DBC11DR1 | 35           | W      | ACB01CR0 | 75           | RW     | RD10RO0  | B5           | RW     |           | F5           |        |
| DBC11DR2 | 36           | RW     | ACB01CR1 | 76           | RW     | RD10RO1  | B6           | RW     |           | F6           |        |
| DBC11CR0 | 37           | #      | ACB01CR2 | 77           | RW     | RD10DSM  | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12DR0 | 38           | #      | ACB02CR3 | 78           | RW     | RD11RI   | B8           | RW     |           | F8           |        |
| DCC12DR1 | 39           | W      | ACB02CR0 | 79           | RW     | RD11SYN  | B9           | RW     |           | F9           |        |
| DCC12DR2 | 3A           | RW     | ACB02CR1 | 7A           | RW     | RD11IS   | BA           | RW     |           | FA           |        |
| DCC12CR0 | 3B           | #      | ACB02CR2 | 7B           | RW     | RD11LT0  | BB           | RW     |           | FB           |        |
| DCC13DR0 | 3C           | #      | ACB03CR3 | 7C           | RW     | RD11LT1  | BC           | RW     | DAC1_D    | FC           | RW     |
| DCC13DR1 | 3D           | W      | ACB03CR0 | 7D           | RW     | RD11RO0  | BD           | RW     | DAC0_D    | FD           | RW     |
| DCC13DR2 | 3E           | RW     | ACB03CR1 | 7E           | RW     | RD11RO1  | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR0 | 3F           | #      | ACB03CR2 | 7F           | RW     | RD11DSM  | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

\*Address has a dual purpose, see "Mapping Exceptions" on page 251

**Table 21. CY8C28x52 Register Map Bank 1 Table: Configuration Space**

| Name     | Addr (1,Hex) | Access | Name          | Addr (1,Hex) | Access | Name        | Addr (1,Hex) | Access | Name      | Addr (1,Hex) | Access |
|----------|--------------|--------|---------------|--------------|--------|-------------|--------------|--------|-----------|--------------|--------|
| PRT0DM0  | 00           | RW     |               | 40           |        |             | 80           |        |           | C0           |        |
| PRT0DM1  | 01           | RW     |               | 41           |        |             | 81           |        |           | C1           |        |
| PRT0IC0  | 02           | RW     |               | 42           |        |             | 82           |        |           | C2           |        |
| PRT0IC1  | 03           | RW     |               | 43           |        | ACE_AMD_CR1 | 83           | RW     |           | C3           |        |
| PRT1DM0  | 04           | RW     |               | 44           |        |             | 84           |        |           | C4           |        |
| PRT1DM1  | 05           | RW     |               | 45           |        | ACE_PWM_CR  | 85           | RW     |           | C5           |        |
| PRT1IC0  | 06           | RW     |               | 46           |        | ACE_ADC0_CR | 86           | RW     |           | C6           |        |
| PRT1IC1  | 07           | RW     |               | 47           |        | ACE_ADC1_CR | 87           | RW     |           | C7           |        |
| PRT2DM0  | 08           | RW     |               | 48           |        |             | 88           |        |           | C8           |        |
| PRT2DM1  | 09           | RW     |               | 49           |        | ACE_CLK_CR0 | 89           | RW     |           | C9           |        |
| PRT2IC0  | 0A           | RW     |               | 4A           |        | ACE_CLK_CR1 | 8A           | RW     |           | CA           |        |
| PRT2IC1  | 0B           | RW     |               | 4B           |        | ACE_CLK_CR3 | 8B           | RW     |           | CB           |        |
| PRT3DM0  | 0C           | RW     |               | 4C           |        |             | 8C           |        |           | CC           |        |
| PRT3DM1  | 0D           | RW     |               | 4D           |        | ACE01CR1    | 8D           | RW     |           | CD           |        |
| PRT3IC0  | 0E           | RW     |               | 4E           |        | ACE01CR2    | 8E           | RW     |           | CE           |        |
| PRT3IC1  | 0F           | RW     |               | 4F           |        | ASE11CR0    | 8F           | RW     |           | CF           |        |
| PRT4DM0  | 10           | RW     |               | 50           |        |             | 90           |        | GDI_O_IN  | D0           | RW     |
| PRT4DM1  | 11           | RW     |               | 51           |        | DEC0_CR0    | 91           | RW     | GDI_E_IN  | D1           | RW     |
| PRT4IC0  | 12           | RW     |               | 52           |        | DEC_CR3     | 92           | RW     | GDI_O_OU  | D2           | RW     |
| PRT4IC1  | 13           | RW     |               | 53           |        |             | 93           |        | GDI_E_OU  | D3           | RW     |
| PRT5DM0  | 14           | RW     |               | 54           |        |             | 94           |        | DEC0_CR   | D4           | RW     |
| PRT5DM1  | 15           | RW     |               | 55           |        | DEC1_CR0    | 95           | RW     | DEC1_CR   | D5           | RW     |
| PRT5IC0  | 16           | RW     |               | 56           |        | DEC_CR4     | 96           | RW     | DEC2_CR   | D6           | RW     |
| PRT5IC1  | 17           | RW     |               | 57           |        |             | 97           |        | DEC3_CR   | D7           | RW     |
|          | 18           |        |               | 58           |        |             | 98           |        | MUX_CR0   | D8           | RW     |
|          | 19           |        |               | 59           |        | DEC2_CR0    | 99           | RW     | MUX_CR1   | D9           | RW     |
|          | 1A           |        |               | 5A           |        | DEC_CR5     | 9A           | RW     | MUX_CR2   | DA           | RW     |
|          | 1B           |        |               | 5B           |        |             | 9B           |        | MUX_CR3   | DB           | RW     |
|          | 1C           |        |               | 5C           |        |             | 9C           |        | IDAC_CR1  | DC           | RW     |
|          | 1D           |        |               | 5D           |        | DEC3_CR0    | 9D           | RW     | OSC_GO_EN | DD           | RW     |
|          | 1E           |        |               | 5E           |        |             | 9E           |        | OSC_CR4   | DE           | RW     |
|          | 1F           |        |               | 5F           |        |             | 9F           |        | OSC_CR3   | DF           | RW     |
| DBC00FN  | 20           | RW     | CLK_CR0       | 60           | RW     | GDI_O_IN_CR | A0           | RW     | OSC_CR0   | E0           | RW     |
| DBC00IN  | 21           | RW     | CLK_CR1       | 61           | RW     | GDI_E_IN_CR | A1           | RW     | OSC_CR1   | E1           | RW     |
| DBC00OU  | 22           | RW     | ABF_CR0       | 62           | RW     | GDI_O_OU_CR | A2           | RW     | OSC_CR2   | E2           | RW     |
| DBC00CR1 | 23           | RW     | AMD_CR0       | 63           | RW     | GDI_E_OU_CR | A3           | RW     | VLT_CR    | E3           | RW     |
| DBC01FN  | 24           | RW     | CMP_GO_EN     | 64           | RW     | RTC_H       | A4           | RW     | VLT_CMP   | E4           | RW     |
| DBC01IN  | 25           | RW     | CMP_GO_EN1    | 65           | RW     | RTC_M       | A5           | RW     | ADC0_TR   | E5           | RW     |
| DBC01OU  | 26           | RW     | AMD_CR1       | 66           | RW     | RTC_S       | A6           | RW     | ADC1_TR   | E6           | RW     |
| DBC01CR1 | 27           | RW     | ALT_CR0       | 67           | RW     | RTC_CR      | A7           | RW     | IDAC_CR2  | E7           | RW     |
| DCC02FN  | 28           | RW     | ALT_CR1       | 68           | RW     |             | A8           |        | IMO_TR    | E8           | RW     |
| DCC02IN  | 29           | RW     | CLK_CR2       | 69           | RW     |             | A9           |        | ILO_TR    | E9           | RW     |
| DCC02OU  | 2A           | RW     | AMUX_CFG1     | 6A           | RW     |             | AA           |        | BDG_TR    | EA           | RW     |
| DCC02CR1 | 2B           | RW     |               | 6B           |        |             | AB           |        | ECO_TR    | EB           | RW     |
| DCC03FN  | 2C           | RW     | TMP_DR0       | 6C           | RW     |             | AC           |        | MUX_CR4   | EC           | RW     |
| DCC03IN  | 2D           | RW     | TMP_DR1       | 6D           | RW     | I2C0_ADDR   | AD           | RW     | MUX_CR5   | ED           | RW     |
| DCC03OU  | 2E           | RW     | TMP_DR2       | 6E           | RW     |             | AE           |        |           | EE           |        |
| DCC03CR1 | 2F           | RW     | TMP_DR3       | 6F           | RW     | AMUX_CLK    | AF           | RW     |           | EF           |        |
| DBC10FN  | 30           | RW     |               | 70           |        | RD10RI      | B0           | RW     |           | F0           |        |
| DBC10IN  | 31           | RW     |               | 71           |        | RD10SYN     | B1           | RW     |           | F1           |        |
| DBC10OU  | 32           | RW     |               | 72           |        | RD10IS      | B2           | RW     |           | F2           |        |
| DBC10CR1 | 33           | RW     | ACE_AMD_CR0   | 73           | RW     | RD10LT0     | B3           | RW     |           | F3           |        |
| DBC11FN  | 34           | RW     |               | 74           |        | RD10LT1     | B4           | RW     |           | F4           |        |
| DBC11IN  | 35           | RW     | ACE_AMX_IN    | 75           | RW     | RD10RO0     | B5           | RW     |           | F5           |        |
| DBC11OU  | 36           | RW     | ACE_CMP_CR0   | 76           | RW     | RD10RO1     | B6           | RW     |           | F6           |        |
| DBC11CR1 | 37           | RW     | ACE_CMP_CR1   | 77           | RW     | RD10DSM     | B7           | RW     | CPU_F     | F7           | RL     |
| DCC12FN  | 38           | RW     |               | 78           |        | RD11RI      | B8           | RW     |           | F8           |        |
| DCC12IN  | 39           | RW     | ACE_CMP_GI_EN | 79           | RW     | RD11SYN     | B9           | RW     |           | F9           |        |
| DCC12OU  | 3A           | RW     | ACE_ALT_CR0   | 7A           | RW     | RD11IS      | BA           | RW     | FLS_PR1   | FA           | RW     |
| DCC12CR1 | 3B           | RW     | ACE_ABF_CR0   | 7B           | RW     | RD11LT0     | BB           | RW     |           | FB           |        |
| DCC13FN  | 3C           | RW     |               | 7C           |        | RD11LT1     | BC           | RW     |           | FC           |        |
| DCC13IN  | 3D           | RW     | ACE0_CR1      | 7D           | RW     | RD11RO0     | BD           | RW     | IDAC_CR0  | FD           | RW     |
| DCC13OU  | 3E           | RW     | ACE0_CR2      | 7E           | RW     | RD11RO1     | BE           | RW     | CPU_SCR1  | FE           | #      |
| DCC13CR1 | 3F           | RW     | ACE0_CR3      | 7F           | RW     | RD11DSM     | BF           | RW     | CPU_SCR0  | FF           | #      |

Blank fields are Reserved and should not be accessed.

# Access is bit specific.

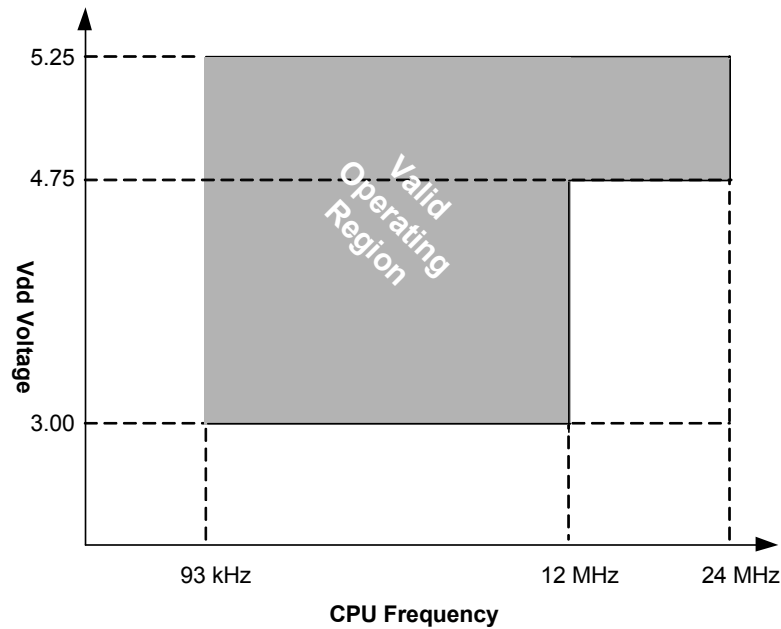
\*Address has a dual purpose, see "Mapping Exceptions" on page 251

## Electrical Specifications

This section presents the DC and AC electrical specifications of the CY8C28xxx PSoC devices. 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>.

Specifications are valid for  $-40\text{ }^{\circ}\text{C} \leq T_A \leq 85\text{ }^{\circ}\text{C}$  and  $T_J \leq 100\text{ }^{\circ}\text{C}$ , except where noted. Specifications for devices running at greater than 12 MHz are valid for  $-40\text{ }^{\circ}\text{C} \leq T_A \leq 70\text{ }^{\circ}\text{C}$  and  $T_J \leq 82\text{ }^{\circ}\text{C}$ .

**Figure 8. Voltage versus CPU Frequency**



## Absolute Maximum Ratings

Table 22. Absolute Maximum Ratings

| Symbol                | Description                                                   | Min                   | Typ | Max                   | Units | Notes                                                                                                                                                                           |
|-----------------------|---------------------------------------------------------------|-----------------------|-----|-----------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| T <sub>STG</sub>      | Storage temperature                                           | -55                   | 25  | +100                  | °C    | Higher storage temperatures reduce data retention time. Recommended storage temperature is +25°C ± 25°C. Extended duration storage temperatures above 65°C degrade reliability. |
| T <sub>BAKETEMP</sub> | Bake temperature                                              | –                     | 125 | See Package label     | °C    |                                                                                                                                                                                 |
| t <sub>BAKETIME</sub> | Bake time                                                     | See package label     | –   | 72                    | Hours |                                                                                                                                                                                 |
| T <sub>A</sub>        | Ambient temperature with power applied                        | -40                   | –   | +85                   | °C    |                                                                                                                                                                                 |
| V <sub>DD</sub>       | Supply voltage on V <sub>DD</sub> relative to V <sub>SS</sub> | -0.5                  | –   | +6.0                  | V     |                                                                                                                                                                                 |
| V <sub>IO</sub>       | DC input voltage                                              | V <sub>SS</sub> – 0.5 | –   | V <sub>DD</sub> + 0.5 | V     |                                                                                                                                                                                 |
| V <sub>IOZ</sub>      | DC voltage applied to tri-state                               | V <sub>SS</sub> – 0.5 | –   | V <sub>DD</sub> + 0.5 | V     |                                                                                                                                                                                 |
| I <sub>MIO</sub>      | Maximum current into any port pin                             | -25                   | –   | +50                   | mA    |                                                                                                                                                                                 |
| I <sub>MAIO</sub>     | Maximum current into any port pin configured as analog driver | -50                   | –   | +50                   | mA    |                                                                                                                                                                                 |
| ESD                   | Electro static discharge voltage                              | 2000                  | –   | –                     | V     | Human Body Model ESD.                                                                                                                                                           |
| LU                    | Latch up current                                              | –                     | –   | 200                   | mA    |                                                                                                                                                                                 |

## Operating Temperature

Table 23. Operating Temperature

| Symbol         | Description          | Min | Typ | Max  | Units | Notes                                                                                                                                                                                            |
|----------------|----------------------|-----|-----|------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| T <sub>A</sub> | Ambient temperature  | -40 | –   | +85  | °C    |                                                                                                                                                                                                  |
| T <sub>J</sub> | Junction temperature | -40 | –   | +100 | °C    | The temperature rise from ambient to junction is package specific. See <a href="#">Thermal Impedances</a> on page 72. The user must limit the power consumption to comply with this requirement. |

## 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  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 24. DC Chip Level Specifications**

| Symbol       | Description                                                                                                     | Min   | Typ   | Max   | Units         | Notes                                                                                                                                                            |
|--------------|-----------------------------------------------------------------------------------------------------------------|-------|-------|-------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $V_{DD}$     | Supply voltage                                                                                                  | 3.00  | –     | 5.25  | V             |                                                                                                                                                                  |
| $I_{DD}$     | Supply current                                                                                                  | –     | 8     | 14    | mA            | Conditions are $V_{DD} = 5.0\text{ V}$ , $T_A = 25^{\circ}\text{C}$ , CPU = 3 MHz, SYSCLK doubler disabled. VC1 = 1.5 MHz, VC2 = 93.75 kHz, VC3 = 93.75 kHz.     |
| $I_{DD3}$    | Supply current                                                                                                  | –     | 5     | 9     | mA            | Conditions are $V_{DD} = 3.3\text{ V}$ , $T_A = 25^{\circ}\text{C}$ , CPU = 3 MHz, SYSCLK doubler disabled. VC1 = 1.5 MHz, VC2 = 93.75 kHz, VC3 = 93.75 kHz.     |
| $I_{DDP}$    | Supply current when IMO = 6 MHz using SLIMO mode=1                                                              | –     | 2     | 3     | mA            | Conditions are $V_{DD} = 3.3\text{ V}$ , $T_A = 25^{\circ}\text{C}$ , CPU = 0.75 MHz, SYSCLK doubler disabled, VC1 = 0.375 MHz, VC2 = 23.44 kHz, VC3 = 0.09 kHz. |
| $I_{SB}$     | Sleep (Mode) current with POR, LVD, sleep timer, and WDT. <sup>[12]</sup>                                       | –     | 3     | 10    | $\mu\text{A}$ | Conditions are with internal slow speed oscillator, $V_{DD} = 3.3\text{ V}$ , $-40^{\circ}\text{C} \leq T_A \leq 55^{\circ}\text{C}$ .                           |
| $I_{SBH}$    | Sleep (Mode) current with POR, LVD, sleep timer, and WDT at high temperature. <sup>[12]</sup>                   | –     | 4     | 25    | $\mu\text{A}$ | Conditions are with internal slow speed oscillator, $V_{DD} = 3.3\text{ V}$ , $55^{\circ}\text{C} < T_A \leq 85^{\circ}\text{C}$ .                               |
| $I_{SBXTL}$  | Sleep (Mode) Current with POR, LVD, sleep timer, WDT, and external crystal. <sup>[12]</sup>                     | –     | 4     | 13    | $\mu\text{A}$ | Conditions are with properly loaded, 1 $\mu\text{W}$ max, 32.768 kHz crystal. $V_{DD} = 3.3\text{ V}$ , $-40^{\circ}\text{C} \leq T_A \leq 55^{\circ}\text{C}$ . |
| $I_{SBXTLH}$ | Sleep (Mode) current with POR, LVD, sleep timer, WDT, and external crystal at high temperature. <sup>[12]</sup> | –     | 5     | 26    | $\mu\text{A}$ | Conditions are with properly loaded, 1 $\mu\text{W}$ max, 32.768 kHz crystal. $V_{DD} = 3.3\text{ V}$ , $55^{\circ}\text{C} < T_A \leq 85^{\circ}\text{C}$ .     |
| $I_{SBRTC}$  | Current consumed by RTC during sleep                                                                            | –     | 0.5   | 1     | $\mu\text{A}$ | Extra current consumed by the RTC during sleep. This number is typical at $25^{\circ}\text{C}$ and 5 V.                                                          |
| $V_{REF}$    | Reference voltage (Bandgap)                                                                                     | 1.280 | 1.300 | 1.320 | V             | Trimmed for appropriate $V_{DD}$ .                                                                                                                               |
| $I_{SXRES}$  | Supply current with XRES asserted 5 V                                                                           | –     | 0.65  | 3     | mA            | Max is peak current after XRES;                                                                                                                                  |
|              | Supply current with XRES asserted 3.3 V                                                                         | –     | 0.4   | 1.5   | mA            | Typical value is the steady state current value. $T_A = 25^{\circ}\text{C}$ .                                                                                    |

#### Note

12. Standby (sleep) current includes all functions (POR, LVD, WDT, Sleep Timer) 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  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 25. DC GPIO Specifications**

| Symbol    | Description                       | Min            | Typ | Max  | Units     | Notes                                                                                                                                                                                                                        |
|-----------|-----------------------------------|----------------|-----|------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $R_{PU}$  | Pull-up resistor                  | 4              | 5.6 | 8    | $k\Omega$ |                                                                                                                                                                                                                              |
| $R_{PD}$  | Pull-down resistor                | 4              | 5.6 | 8    | $k\Omega$ |                                                                                                                                                                                                                              |
| $V_{OH}$  | High output level                 | $V_{DD} - 1.0$ | —   | —    | V         | $I_{OH} = 10\text{ mA}$ , $V_{DD} = 4.75\text{ to }5.25\text{ V}$ (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         | $I_{OL} = 25\text{ mA}$ , $V_{DD} = 4.75\text{ to }5.25\text{ V}$ (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        | $V_{OH} = V_{DD} - 1.0\text{ V}$ , see the limitations of the total current in the note for $V_{OH}$ .                                                                                                                       |
| $I_{OL}$  | Low level sink current            | 25             | —   | —    | mA        | $V_{OL} = 0.75\text{ V}$ , see the limitations of the total current in the note for $V_{OL}$ .                                                                                                                               |
| $V_{IL}$  | Input low level                   | —              | —   | 0.8  | V         | $V_{DD} = 3.0\text{ to }5.25$ .                                                                                                                                                                                              |
| $V_{IH}$  | Input high level                  | 2.1            | —   | —    | V         | $V_{DD} = 3.0\text{ to }5.25$ .                                                                                                                                                                                              |
| $V_H$     | Input hysteresis                  | —              | 60  | —    | mV        |                                                                                                                                                                                                                              |
| $I_{IL}$  | Input leakage (absolute value)    | —              | 1   | —    | nA        | Gross tested to $1\text{ }\mu\text{A}$ .                                                                                                                                                                                     |
| $C_{IN}$  | Capacitive load on pins as input  | —              | 3.5 | 10   | pF        | Package and pin dependent. Temp = $25^{\circ}\text{C}$ .                                                                                                                                                                     |
| $C_{OUT}$ | Capacitive load on pins as output | —              | 3.5 | 10   | pF        | Package and pin dependent. Temp = $25^{\circ}\text{C}$ .                                                                                                                                                                     |

### DC Operational Amplifier Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only. The Operational Amplifiers covered by these specifications are components of both the Analog Continuous Time PSoC blocks and the Analog Switched Cap PSoC blocks. The guaranteed specifications are measured in the Analog Continuous Time PSoC block.

**Table 26. 5 V DC Operational Amplifier Specifications**

| Symbol                     | Description                                                                      | Min                   | Typ  | Max                   | Units                          | Notes                                                                                                                                                                                   |
|----------------------------|----------------------------------------------------------------------------------|-----------------------|------|-----------------------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $V_{\text{OSOACT}}$        | Input Offset Voltage CT Block (absolute value)<br>Power = Low, Opamp bias = High | –                     | 1.6  | 8                     | mV                             |                                                                                                                                                                                         |
|                            | Power = Medium, Opamp bias = High                                                | –                     | 1.3  | 8                     | mV                             |                                                                                                                                                                                         |
|                            | Power = High, Opamp bias = High                                                  | –                     | 1.2  | 8                     | mV                             |                                                                                                                                                                                         |
| $V_{\text{OSOA}}$          | Input Offset Voltage SC and AGND Opamps (absolute value)                         | –                     | 1    | 6                     | mV                             | Applies to High and Low Opamp bias.                                                                                                                                                     |
| $\text{TCV}_{\text{OSOA}}$ | Average Input Offset Voltage Drift                                               | –                     | 7.0  | 35.0                  | $\mu\text{V}/^{\circ}\text{C}$ |                                                                                                                                                                                         |
| $I_{\text{EBOA}}$          | Input Leakage Current (Port 0 Analog Pins)                                       | –                     | 200  | –                     | pA                             | Gross tested to $1\ \mu\text{A}$ .                                                                                                                                                      |
| $C_{\text{INOA}}$          | Input Capacitance (Port 0 Analog Pins)                                           | –                     | 4.5  | 9.5                   | pF                             | Package and pin dependent.<br>Temp = $25^{\circ}\text{C}$ .                                                                                                                             |
| $V_{\text{CMOA}}$          | Common Mode Voltage Range                                                        | 0.0                   | –    | $V_{\text{DD}}$       | V                              | The common-mode input voltage range is measured through an analog output buffer. The specification includes the limitations imposed by the characteristics of the analog output buffer. |
|                            | Common Mode Voltage Range (high power or high Opamp bias)                        | 0.5                   | –    | $V_{\text{DD}} - 0.5$ | V                              |                                                                                                                                                                                         |
| $\text{CMRR}_{\text{OA}}$  | Common Mode Rejection Ratio<br>Power = Low                                       | 60                    | –    | –                     | dB                             |                                                                                                                                                                                         |
|                            | Power = Medium                                                                   | 60                    | –    | –                     | dB                             |                                                                                                                                                                                         |
|                            | Power = High                                                                     | 60                    | –    | –                     | dB                             |                                                                                                                                                                                         |
| $G_{\text{OLOA}}$          | Open Loop Gain<br>Power = Low                                                    | 60                    | –    | –                     | dB                             |                                                                                                                                                                                         |
|                            | Power = Medium                                                                   | 60                    | –    | –                     | dB                             |                                                                                                                                                                                         |
|                            | Power = High                                                                     | 80                    | –    | –                     | dB                             |                                                                                                                                                                                         |
| $V_{\text{OHIGHOA}}$       | High Output Voltage Swing (internal signals)<br>Power = Low                      | $V_{\text{DD}} - 0.2$ | –    | –                     | V                              |                                                                                                                                                                                         |
|                            | Power = Medium                                                                   | $V_{\text{DD}} - 0.2$ | –    | –                     | V                              |                                                                                                                                                                                         |
|                            | Power = High                                                                     | $V_{\text{DD}} - 0.5$ | –    | –                     | V                              |                                                                                                                                                                                         |
| $V_{\text{OLOWA}}$         | Low Output Voltage Swing (internal signals)<br>Power = Low                       | –                     | –    | 0.2                   | V                              |                                                                                                                                                                                         |
|                            | Power = Medium                                                                   | –                     | –    | 0.2                   | V                              |                                                                                                                                                                                         |
|                            | Power = High                                                                     | –                     | –    | 0.5                   | V                              |                                                                                                                                                                                         |
| $I_{\text{SOA}}$           | Supply Current (including associated AGND buffer)                                | –                     | –    | –                     | –                              |                                                                                                                                                                                         |
|                            | Power = Low, Opamp bias = Low                                                    | –                     | 200  | 300                   | $\mu\text{A}$                  |                                                                                                                                                                                         |
|                            | Power = Low, Opamp bias = High                                                   | –                     | 400  | 600                   | $\mu\text{A}$                  |                                                                                                                                                                                         |
|                            | Power = Medium, Opamp bias = Low                                                 | –                     | 700  | 1100                  | $\mu\text{A}$                  |                                                                                                                                                                                         |
|                            | Power = Medium, Opamp bias = High                                                | –                     | 1400 | 2000                  | $\mu\text{A}$                  |                                                                                                                                                                                         |
|                            | Power = High, Opamp bias = Low                                                   | –                     | 2400 | 3600                  | $\mu\text{A}$                  |                                                                                                                                                                                         |
|                            | Power = High, Opamp bias = High                                                  | –                     | 4600 | 7700                  | $\mu\text{A}$                  |                                                                                                                                                                                         |
| $\text{PSRR}_{\text{OA}}$  | Supply Voltage Rejection Ratio                                                   | 60                    | –    | –                     | dB                             | $V_{\text{SS}} \leq V_{\text{IN}} \leq (V_{\text{DD}} - 2.25)$ or $(V_{\text{DD}} - 1.25\text{ V}) \leq V_{\text{IN}} \leq V_{\text{DD}}$ .                                             |

**Table 27. 3.3 V DC Operational Amplifier Specifications**

| Symbol        | Description                                       | Min            | Typ  | Max            | Units             | Notes                                                                                                                                                                                   |
|---------------|---------------------------------------------------|----------------|------|----------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $V_{OSOACT}$  | Input Offset Voltage CT Blocks (absolute value)   | –              | 1.65 | 8              | mV                |                                                                                                                                                                                         |
|               | Power = Low, Opamp bias = High                    | –              | 1.32 | 8              | mV                |                                                                                                                                                                                         |
|               | Power = Medium, Opamp bias = High                 | –              | –    | –              | mV                |                                                                                                                                                                                         |
| $V_{OSOA}$    | Input Offset Voltage SC and AGND (absolute value) | –              | 1    | 6              | mV                | Applies to High and Low Opamp bias.                                                                                                                                                     |
| $TCV_{OSOA}$  | Average Input Offset Voltage Drift                | –              | 7.0  | 35.0           | $\mu V/^{\circ}C$ |                                                                                                                                                                                         |
| $I_{EBOA}$    | Input Leakage Current (Port 0 Analog Pins)        | –              | 200  | –              | pA                | Gross tested to 1 $\mu A$ .                                                                                                                                                             |
| $C_{INOA}$    | Input Capacitance (Port 0 Analog Pins)            | –              | 4.5  | 9.5            | pF                | Package and pin dependent. Temp = 25 $^{\circ}C$ .                                                                                                                                      |
| $V_{CMOA}$    | Common Mode Voltage Range                         | 0.2            | –    | $V_{DD} - 0.2$ | V                 | The common-mode input voltage range is measured through an analog output buffer. The specification includes the limitations imposed by the characteristics of the analog output buffer. |
| $CMRR_{OA}$   | Common Mode Rejection Ratio                       | 50             | –    | –              | dB                |                                                                                                                                                                                         |
|               | Power = Low                                       | 50             | –    | –              | dB                |                                                                                                                                                                                         |
|               | Power = Medium                                    | 50             | –    | –              | dB                |                                                                                                                                                                                         |
| $G_{OLOA}$    | Open Loop Gain                                    | 60             | –    | –              | dB                |                                                                                                                                                                                         |
|               | Power = Low                                       | 60             | –    | –              | dB                |                                                                                                                                                                                         |
|               | Power = Medium                                    | 80             | –    | –              | dB                |                                                                                                                                                                                         |
| $V_{OHIGHOA}$ | High Output Voltage Swing (internal signals)      | $V_{DD} - 0.2$ | –    | –              | V                 |                                                                                                                                                                                         |
|               | Power = Low                                       | $V_{DD} - 0.2$ | –    | –              | V                 |                                                                                                                                                                                         |
|               | Power = Medium                                    | $V_{DD} - 0.2$ | –    | –              | V                 |                                                                                                                                                                                         |
| $V_{OLOWA}$   | Low Output Voltage Swing (internal signals)       | –              | –    | 0.2            | V                 |                                                                                                                                                                                         |
|               | Power = Low                                       | –              | –    | 0.2            | V                 |                                                                                                                                                                                         |
|               | Power = Medium                                    | –              | –    | 0.2            | V                 |                                                                                                                                                                                         |
| $I_{SOA}$     | Supply Current (including associated AGND buffer) | –              | 200  | 300            | $\mu A$           |                                                                                                                                                                                         |
|               | Power = Low, Opamp bias = Low                     | –              | 400  | 600            | $\mu A$           |                                                                                                                                                                                         |
|               | Power = Low, Opamp bias = High                    | –              | 700  | 1000           | $\mu A$           |                                                                                                                                                                                         |
|               | Power = Medium, Opamp bias = Low                  | –              | 1400 | 2000           | $\mu A$           |                                                                                                                                                                                         |
|               | Power = Medium, Opamp bias = High                 | –              | 2400 | 3600           | $\mu A$           |                                                                                                                                                                                         |
|               | Power = High, Opamp bias = Low                    | –              | 4600 | 7500           | $\mu A$           |                                                                                                                                                                                         |
| $PSRR_{OA}$   | Supply Voltage Rejection Ratio                    | 50             | 80   | –              | dB                | $V_{SS} \leq V_{IN} \leq (V_{DD} - 2.25 V)$ or $(V_{DD} - 1.25 V) \leq V_{IN} \leq V_{DD}$ .                                                                                            |

### DC Type-E Operational Amplifier Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only. The Operational Amplifiers covered by these specifications are components of the Limited Type E Analog PSoC blocks.

**Table 28. 5 V DC Type-E Operational Amplifier Specifications**

| Symbol                     | Description                                | Min | Typ | Max             | Units                          | Notes                                                                                          |
|----------------------------|--------------------------------------------|-----|-----|-----------------|--------------------------------|------------------------------------------------------------------------------------------------|
| $V_{\text{OSOA}}$          | Input offset voltage (absolute value)      | –   | 2.5 | 15              | mV                             | For $0.2\text{ V} < V_{\text{IN}} < V_{\text{DD}} - 1.2\text{ V}$ .                            |
|                            |                                            | –   | 2.5 | 20              | mV                             | For $V_{\text{IN}} = 0$ to $0.2\text{ V}$ and $V_{\text{IN}} > V_{\text{DD}} - 1.2\text{ V}$ . |
| $\text{TCV}_{\text{OSOA}}$ | Average input offset voltage drift         | –   | 10  | –               | $\mu\text{V}/^{\circ}\text{C}$ |                                                                                                |
| $I_{\text{EBOA}}^{[13]}$   | Input leakage current (Port 0 Analog Pins) | –   | 200 | –               | nA                             | Gross tested to $1\text{ }\mu\text{A}$ .                                                       |
| $C_{\text{INOA}}$          | Input capacitance (Port 0 Analog Pins)     | –   | 4.5 | 9.5             | pF                             | Package and pin dependent. Temp = $25^{\circ}\text{C}$ .                                       |
| $V_{\text{CMOA}}$          | Common mode voltage range                  | 0.0 | –   | $V_{\text{DD}}$ | V                              |                                                                                                |
| $I_{\text{SOA}}$           | Amplifier supply current                   | –   | 10  | 30              | $\mu\text{A}$                  |                                                                                                |

**Table 29. 3.3 V DC Type-E Operational Amplifier Specifications**

| Symbol                     | Description                                | Min | Typ | Max             | Units                          | Notes                                                                                          |
|----------------------------|--------------------------------------------|-----|-----|-----------------|--------------------------------|------------------------------------------------------------------------------------------------|
| $V_{\text{OSOA}}$          | Input offset voltage (absolute value)      | –   | 2.5 | 15              | mV                             | For $0.2\text{ V} < V_{\text{IN}} < V_{\text{DD}} - 1.2\text{ V}$ .                            |
|                            |                                            | –   | 2.5 | 20              | mV                             | For $V_{\text{IN}} = 0$ to $0.2\text{ V}$ and $V_{\text{IN}} > V_{\text{DD}} - 1.2\text{ V}$ . |
| $\text{TCV}_{\text{OSOA}}$ | Average input offset voltage drift         | –   | 10  | –               | $\mu\text{V}/^{\circ}\text{C}$ |                                                                                                |
| $I_{\text{EBOA}}^{[13]}$   | Input leakage current (Port 0 Analog Pins) | –   | 200 | –               | nA                             | Gross tested to $1\text{ }\mu\text{A}$ .                                                       |
| $C_{\text{INOA}}$          | Input capacitance (Port 0 Analog Pins)     | –   | 4.5 | 9.5             | pF                             | Package and pin dependent. Temp = $25^{\circ}\text{C}$ .                                       |
| $V_{\text{CMOA}}$          | Common mode voltage range                  | 0   | –   | $V_{\text{DD}}$ | V                              |                                                                                                |
| $I_{\text{SOA}}$           | Amplifier supply current                   | –   | 10  | 30              | $\mu\text{A}$                  |                                                                                                |

### DC Low Power Comparator Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 2.4 V to 3.0 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 30. DC Low Power Comparator Specifications**

| Symbol              | Description                                        | Min | Typ | Max                 | Units         | Notes |
|---------------------|----------------------------------------------------|-----|-----|---------------------|---------------|-------|
| $V_{\text{REFLPC}}$ | Low power comparator (LPC) reference voltage range | 0.2 | –   | $V_{\text{DD}} - 1$ | V             |       |
| $V_{\text{OSLPC}}$  | LPC voltage offset                                 | –   | 2.5 | 30                  | mV            |       |
| $I_{\text{SLPC}}$   | LPC supply current                                 | –   | 10  | 40                  | $\mu\text{A}$ |       |

#### Note

13. Atypical behavior:  $I_{\text{EBOA}}$  of Port 0 Pin 0 is below 1 nA at  $25^{\circ}\text{C}$ ; 50 nA over temperature. Use Port 0 Pins 1-7 for the lowest leakage of 200 nA.

### DC 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  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 31. 5 V DC Analog Output Buffer Specifications**

| Symbol        | Description                                                                                  | Min                                                    | Typ        | Max                                                    | Units                          | Notes                                                                                                |
|---------------|----------------------------------------------------------------------------------------------|--------------------------------------------------------|------------|--------------------------------------------------------|--------------------------------|------------------------------------------------------------------------------------------------------|
| $C_L$         | Load capacitance                                                                             | –                                                      | –          | 200                                                    | pF                             | This specification applies to the external circuit that is being driven by the analog output buffer. |
| $V_{OSOB}$    | Input offset voltage (Absolute Value)                                                        | –                                                      | 3          | 12                                                     | mV                             |                                                                                                      |
| $TCV_{OSOB}$  | Average input offset voltage drift                                                           | –                                                      | +6         | 20                                                     | $\mu\text{V}/^{\circ}\text{C}$ |                                                                                                      |
| $V_{CMOB}$    | Common-mode input voltage range                                                              | 0.5                                                    | –          | $V_{DD} - 1.0$                                         | V                              |                                                                                                      |
| $R_{OUTOB}$   | Output resistance<br>Power = Low<br>Power = High                                             | –<br>–                                                 | 1<br>1     | –<br>–                                                 | $\Omega$<br>$\Omega$           |                                                                                                      |
| $V_{OHIGHOB}$ | High output voltage swing (Load = 32 $\Omega$ to $V_{DD}/2$ )<br>Power = Low<br>Power = High | $0.5 \times V_{DD} + 1.3$<br>$0.5 \times V_{DD} + 1.3$ | –<br>–     | –<br>–                                                 | V<br>V                         |                                                                                                      |
| $V_{LOWOB}$   | Low output voltage swing (Load = 32 $\Omega$ to $V_{DD}/2$ )<br>Power = Low<br>Power = High  | –<br>–                                                 | –<br>–     | $0.5 \times V_{DD} - 1.3$<br>$0.5 \times V_{DD} - 1.3$ | V<br>V                         |                                                                                                      |
| $I_{SOB}$     | Supply current including bias cell (No Load)<br>Power = Low<br>Power = High                  | –<br>–                                                 | 1.1<br>2.6 | 5.1<br>8.8                                             | mA<br>mA                       |                                                                                                      |
| $PSRR_{OB}$   | Supply voltage rejection ratio                                                               | 53                                                     | 64         | –                                                      | dB                             | $(0.5 \times V_{DD} - 1.0) \leq V_{OUT} \leq (0.5 \times V_{DD} + 0.9)$ .                            |

**Table 32. 3.3 V DC Analog Output Buffer Specifications**

| Symbol        | Description                                                                                   | Min                                                    | Typ        | Max                                                    | Units                | Notes                                                                                                |
|---------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------|------------|--------------------------------------------------------|----------------------|------------------------------------------------------------------------------------------------------|
| $C_L$         | Load Capacitance                                                                              | –                                                      | –          | 200                                                    | pF                   | This specification applies to the external circuit that is being driven by the analog output buffer. |
| $V_{OSOB}$    | Input Offset Voltage (Absolute Value)                                                         | –                                                      | 3          | 12                                                     | mV                   |                                                                                                      |
| $TCV_{OSOB}$  | Average Input Offset Voltage Drift                                                            | –                                                      | +6         | 20                                                     | $\mu V/^{\circ}C$    |                                                                                                      |
| $V_{CMOB}$    | Common-Mode Input Voltage Range                                                               | 0.5                                                    | –          | $V_{DD} - 1.0$                                         | V                    |                                                                                                      |
| $R_{OUTOB}$   | Output Resistance<br>Power = Low<br>Power = High                                              | –<br>–                                                 | 1<br>1     | –<br>–                                                 | $\Omega$<br>$\Omega$ |                                                                                                      |
| $V_{OHIGHOB}$ | High Output Voltage Swing (Load = 1 k $\Omega$ to $V_{DD}/2$ )<br>Power = Low<br>Power = High | $0.5 \times V_{DD} + 1.0$<br>$0.5 \times V_{DD} + 1.0$ | –<br>–     | –<br>–                                                 | V<br>V               |                                                                                                      |
| $V_{OLOWOB}$  | Low Output Voltage Swing (Load = 1 k $\Omega$ to $V_{DD}/2$ )<br>Power = Low<br>Power = High  | –<br>–                                                 | –<br>–     | $0.5 \times V_{DD} - 1.0$<br>$0.5 \times V_{DD} - 1.0$ | V<br>V               |                                                                                                      |
| $I_{SOB}$     | Supply current including bias cell (No Load)<br>Power = Low<br>Power = High                   | –<br>–                                                 | 0.8<br>2.0 | 2.0<br>4.3                                             | mA<br>mA             |                                                                                                      |
| $PSRR_{OB}$   | Supply voltage rejection ratio                                                                | 47                                                     | 64         | –                                                      | dB                   | $(0.5 \times V_{DD} - 1.0) \leq V_{OUT} \leq (0.5 \times V_{DD} + 0.9)$ .                            |

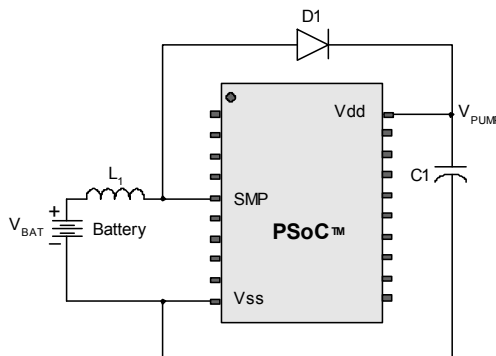
### DC Switch Mode Pump Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 33. DC Switch Mode Pump (SMP) Specifications**

| Symbol                           | Description                                                                                                                                                           | Min    | Typ    | Max    | Units    | Notes                                                                                                                                                                                                     |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------|--------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $V_{\text{PUMP } 5\text{ V}}$    | 5 V output voltage                                                                                                                                                    | 4.75   | 5.0    | 5.25   | V        | Configuration of footnote. <sup>[14]</sup> Average, neglecting ripple. SMP trip voltage is set to 5.0 V.                                                                                                  |
| $V_{\text{PUMP } 3\text{ V}}$    | 3 V output voltage                                                                                                                                                    | 3.00   | 3.25   | 3.60   | V        | Configuration of footnote. <sup>[14]</sup> Average, neglecting ripple. SMP trip voltage is set to 3.25 V.                                                                                                 |
| $I_{\text{PUMP}}$                | Available output current<br>$V_{\text{BAT}} = 1.5\text{ V}$ , $V_{\text{PUMP}} = 3.25\text{ V}$<br>$V_{\text{BAT}} = 1.8\text{ V}$ , $V_{\text{PUMP}} = 5.0\text{ V}$ | 8<br>5 | —<br>— | —<br>— | mA<br>mA | Configuration of footnote. <sup>[14]</sup><br>SMP trip voltage is set to 3.25 V.<br>SMP trip voltage is set to 5.0 V.                                                                                     |
| $V_{\text{BAT } 5\text{ V}}$     | Input voltage range from battery                                                                                                                                      | 1.8    | —      | 5.0    | V        | Configuration of footnote. <sup>[14]</sup> SMP trip voltage is set to 5.0 V.                                                                                                                              |
| $V_{\text{BAT } 3\text{ V}}$     | Input voltage range from battery                                                                                                                                      | 1.5    | —      | 3.3    | V        | Configuration of footnote. <sup>[14]</sup> SMP trip voltage is set to 3.25 V.                                                                                                                             |
| $V_{\text{BATSTART}}$            | Minimum input voltage from battery to start pump                                                                                                                      | 2.6    | —      | —      | V        | Configuration of footnote. <sup>[14]</sup>                                                                                                                                                                |
| $\Delta V_{\text{PUMP\_Line}}$   | Line regulation (over $V_{\text{BAT}}$ range)                                                                                                                         | —      | 5      | —      | % $V_O$  | Configuration of footnote. <sup>[14]</sup> $V_O$ is the “ $V_{\text{DD}}$ Value for PUMP Trip” specified by the VM[2:0] setting in the DC POR and LVD Specification, <a href="#">Table 40</a> on page 52. |
| $\Delta V_{\text{PUMP\_Load}}$   | Load regulation                                                                                                                                                       | —      | 5      | —      | % $V_O$  | Configuration of footnote. <sup>[14]</sup> $V_O$ is the “ $V_{\text{DD}}$ Value for PUMP Trip” specified by the VM[2:0] setting in the DC POR and LVD Specification, <a href="#">Table 40</a> on page 52. |
| $\Delta V_{\text{PUMP\_Ripple}}$ | Output voltage ripple (depends on capacitor/load)                                                                                                                     | —      | 100    | —      | mVpp     | Configuration of footnote. <sup>[14]</sup> Load is 5mA.                                                                                                                                                   |
| $E_3$                            | Efficiency                                                                                                                                                            | 35     | 50     | —      | %        | Configuration of footnote. <sup>[14]</sup> Load is 5 mA. SMP trip voltage is set to 3.25 V.                                                                                                               |
| $F_{\text{PUMP}}$                | Switching frequency                                                                                                                                                   | —      | 1.3    | —      | MHz      |                                                                                                                                                                                                           |
| $\text{DC}_{\text{PUMP}}$        | Switching duty cycle                                                                                                                                                  | —      | 50     | —      | %        |                                                                                                                                                                                                           |

**Figure 9. Basic Switch Mode Pump Circuit**



**Note**

14.  $L_1 = 2\text{ }\mu\text{H}$  inductor,  $C_1 = 10\text{ }\mu\text{F}$  capacitor,  $D_1 =$  Schottky diode. See [Figure 9](#).

### 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  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

The guaranteed specifications for RefHi and RefLo are measured through the Analog Continuous Time PSoC blocks. The power levels for RefHi and RefLo refer to the Analog Reference Control register. AGND is measured at P2[4] in AGND bypass mode. Each Analog Continuous Time PSoC block adds a maximum of 10mV additional offset error to guaranteed AGND specifications from the local AGND buffer. Reference control power can be set to medium or high unless otherwise noted.

**Note** Avoid using P2[4] for digital signaling when using an analog resource that depends on the Analog Reference. Some coupling of the digital signal may appear on the AGND.

**Table 34. 5-V DC Analog Reference Specifications**

| Reference ARF_CR [5:3] | Reference Power Settings               | Symbol             | Reference | Description                  | Min                        | Typ                        | Max                        | Units |
|------------------------|----------------------------------------|--------------------|-----------|------------------------------|----------------------------|----------------------------|----------------------------|-------|
| 0b000                  | RefPower = High<br>Opamp bias = High   | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub> /2 + Bandgap | V <sub>DD</sub> /2 + 1.214 | V <sub>DD</sub> /2 + 1.279 | V <sub>DD</sub> /2 + 1.341 | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2           | V <sub>DD</sub> /2 – 0.018 | V <sub>DD</sub> /2 – 0.004 | V <sub>DD</sub> /2 + 0.01  | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>DD</sub> /2 – Bandgap | V <sub>DD</sub> /2 – 1.328 | V <sub>DD</sub> /2 – 1.301 | V <sub>DD</sub> /2 – 1.273 | V     |
|                        | RefPower = High<br>Opamp bias = Low    | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub> /2 + Bandgap | V <sub>DD</sub> /2 + 0.228 | V <sub>DD</sub> /2 + 1.284 | V <sub>DD</sub> /2 + 1.344 | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2           | V <sub>DD</sub> /2 – 0.015 | V <sub>DD</sub> /2 – 0.002 | V <sub>DD</sub> /2 + 0.011 | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>DD</sub> /2 – Bandgap | V <sub>DD</sub> /2 – 1.329 | V <sub>DD</sub> /2 – 1.303 | V <sub>DD</sub> /2 – 1.275 | V     |
|                        | RefPower = Medium<br>Opamp bias = High | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub> /2 + Bandgap | V <sub>DD</sub> /2 + 1.224 | V <sub>DD</sub> /2 + 1.287 | V <sub>DD</sub> /2 + 1.345 | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2           | V <sub>DD</sub> /2 – 0.014 | V <sub>DD</sub> /2 – 0.001 | V <sub>DD</sub> /2 + 0.012 | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>DD</sub> /2 – Bandgap | V <sub>DD</sub> /2 – 1.328 | V <sub>DD</sub> /2 – 1.304 | V <sub>DD</sub> /2 – 1.275 | V     |
|                        | RefPower = Medium<br>Opamp bias = Low  | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub> /2 + Bandgap | V <sub>DD</sub> /2 + 1.226 | V <sub>DD</sub> /2 + 1.288 | V <sub>DD</sub> /2 + 1.346 | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2           | V <sub>DD</sub> /2 – 0.014 | V <sub>DD</sub> /2 – 0.001 | V <sub>DD</sub> /2 + 0.012 | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>DD</sub> /2 – Bandgap | V <sub>DD</sub> /2 – 1.328 | V <sub>DD</sub> /2 – 1.304 | V <sub>DD</sub> /2 – 1.276 | V     |

**Note**

15. AGND tolerance includes the offsets of the local buffer in the PSoC block.

**Table 34. 5-V DC Analog Reference Specifications** (continued)

| Reference<br>ARF_CR<br>[5:3] | Reference Power<br>Settings               | Symbol             | Reference | Description                                                | Min                           | Typ                           | Max                           | Units |
|------------------------------|-------------------------------------------|--------------------|-----------|------------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------|-------|
| 0b001                        | RefPower = High<br>Opamp bias = High      | V <sub>REFHI</sub> | Ref high  | P2[4]+P2[6] (P2[4] =<br>V <sub>DD</sub> /2, P2[6] = 1.3 V) | P2[4] + P2[6]<br>– 0.055      | P2[4] + P2[6]<br>– 0.019      | P2[4] + P2[6]<br>+ 0.019      | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | P2[4]                                                      | P2[4]                         | P2[4]                         | P2[4]                         | –     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | P2[4]–P2[6] (P2[4] =<br>V <sub>DD</sub> /2, P2[6] = 1.3 V) | P2[4] – P2[6]<br>– 0.030      | P2[4] – P2[6]<br>+ 0.005      | P2[4] – P2[6]<br>+ 0.035      | V     |
|                              | RefPower = High<br>Opamp bias = Low       | V <sub>REFHI</sub> | Ref high  | P2[4]+P2[6] (P2[4] =<br>V <sub>DD</sub> /2, P2[6] = 1.3 V) | P2[4] + P2[6]<br>– 0.05       | P2[4] + P2[6]<br>– 0.015      | P2[4] + P2[6]<br>+ 0.021      | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | P2[4]                                                      | P2[4]                         | P2[4]                         | P2[4]                         | –     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | P2[4]–P2[6] (P2[4] =<br>V <sub>DD</sub> /2, P2[6] = 1.3 V) | P2[4] – P2[6]<br>– 0.033      | P2[4] – P2[6]<br>+ 0.001      | P2[4] – P2[6]<br>+ 0.031      | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = High | V <sub>REFHI</sub> | Ref high  | P2[4]+P2[6] (P2[4] =<br>V <sub>DD</sub> /2, P2[6] = 1.3 V) | P2[4] + P2[6]<br>– 0.048      | P2[4] + P2[6]<br>– 0.013      | P2[4] + P2[6]<br>+ 0.022      | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | P2[4]                                                      | P2[4]                         | P2[4]                         | P2[4]                         | –     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | P2[4]–P2[6] (P2[4] =<br>V <sub>DD</sub> /2, P2[6] = 1.3 V) | P2[4] – P2[6]<br>– 0.034      | P2[4] – P2[6]<br>– 0.001      | P2[4] – P2[6]<br>+ 0.031      | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = Low  | V <sub>REFHI</sub> | Ref high  | P2[4]+P2[6] (P2[4] =<br>V <sub>DD</sub> /2, P2[6] = 1.3 V) | P2[4] + P2[6]<br>– 0.047      | P2[4] + P2[6]<br>– 0.012      | P2[4] + P2[6]<br>+ 0.023      | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | P2[4]                                                      | P2[4]                         | P2[4]                         | P2[4]                         | –     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | P2[4]–P2[6] (P2[4] =<br>V <sub>DD</sub> /2, P2[6] = 1.3 V) | P2[4] – P2[6]<br>– 0.036      | P2[4] – P2[6]<br>– 0.002      | P2[4] – P2[6]<br>+ 0.030      | V     |
| 0b010                        | RefPower = High<br>Opamp bias = High      | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub>                                            | V <sub>DD</sub> – 0.028       | V <sub>DD</sub> – 0.010       | V <sub>DD</sub>               | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2                                         | V <sub>DD</sub> /2 –<br>0.014 | V <sub>DD</sub> /2 –<br>0.002 | V <sub>DD</sub> /2 +<br>0.012 | V     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                            | V <sub>SS</sub>               | V <sub>SS</sub> + 0.004       | V <sub>SS</sub> + 0.008       | V     |
|                              | RefPower = High<br>Opamp bias = Low       | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub>                                            | V <sub>DD</sub> – 0.021       | V <sub>DD</sub> – 0.007       | V <sub>DD</sub>               | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2                                         | V <sub>DD</sub> /2 –<br>0.014 | V <sub>DD</sub> /2 –<br>0.001 | V <sub>DD</sub> /2 +<br>0.012 | V     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                            | V <sub>SS</sub>               | V <sub>SS</sub> + 0.002       | V <sub>SS</sub> + 0.005       | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = High | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub>                                            | V <sub>DD</sub> – 0.019       | V <sub>DD</sub> – 0.006       | V <sub>DD</sub>               | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2                                         | V <sub>DD</sub> /2 –<br>0.014 | V <sub>DD</sub> /2 –<br>0.001 | V <sub>DD</sub> /2 +<br>0.012 | V     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                            | V <sub>SS</sub>               | V <sub>SS</sub> + 0.002       | V <sub>SS</sub> + 0.004       | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = Low  | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub>                                            | V <sub>DD</sub> – 0.017       | V <sub>DD</sub> – 0.005       | V <sub>DD</sub>               | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2                                         | V <sub>DD</sub> /2 –<br>0.014 | V <sub>DD</sub> /2 –<br>0.001 | V <sub>DD</sub> /2 +<br>0.013 | V     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                            | V <sub>SS</sub>               | V <sub>SS</sub> + 0.001       | V <sub>SS</sub> + 0.003       | V     |

**Table 34. 5-V DC Analog Reference Specifications** (continued)

| Reference<br>ARF_CR<br>[5:3] | Reference Power<br>Settings            | Symbol             | Reference | Description                            | Min           | Typ           | Max           | Units |
|------------------------------|----------------------------------------|--------------------|-----------|----------------------------------------|---------------|---------------|---------------|-------|
| 0b011                        | RefPower = High<br>Opamp bias = High   | V <sub>REFHI</sub> | Ref high  | 3 × Bandgap                            | 3.736         | 3.887         | 4.030         | V     |
|                              |                                        | V <sub>AGND</sub>  | AGND      | 2 × Bandgap                            | 2.525         | 2.598         | 2.667         | V     |
|                              |                                        | V <sub>REFLO</sub> | Ref low   | Bandgap                                | 1.265         | 1.302         | 1.335         | V     |
|                              | RefPower = High<br>Opamp bias = Low    | V <sub>REFHI</sub> | Ref high  | 3 × Bandgap                            | 3.747         | 3.894         | 4.034         | V     |
|                              |                                        | V <sub>AGND</sub>  | AGND      | 2 × Bandgap                            | 2.528         | 2.601         | 2.668         | V     |
|                              |                                        | V <sub>REFLO</sub> | Ref low   | Bandgap                                | 1.264         | 1.302         | 1.335         | V     |
|                              | RefPower = Medium<br>Opamp bias = High | V <sub>REFHI</sub> | Ref high  | 3 × Bandgap                            | 3.749         | 3.897         | 4.035         | V     |
|                              |                                        | V <sub>AGND</sub>  | AGND      | 2 × Bandgap                            | 2.529         | 2.602         | 2.668         | V     |
|                              |                                        | V <sub>REFLO</sub> | Ref low   | Bandgap                                | 1.264         | 1.302         | 1.335         | V     |
| 0b100                        | RefPower = High<br>Opamp bias = High   | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap + P2[6]<br>(P2[6] = 1.3 V) | 2.483 – P2[6] | 2.578 – P2[6] | 2.669 – P2[6] | V     |
|                              |                                        | V <sub>AGND</sub>  | AGND      | 2 × Bandgap                            | 2.525         | 2.598         | 2.666         | V     |
|                              |                                        | V <sub>REFLO</sub> | Ref low   | 2 × Bandgap – P2[6]<br>(P2[6] = 1.3 V) | 2.512 – P2[6] | 2.602 – P2[6] | 2.684 – P2[6] | V     |
|                              | RefPower = High<br>Opamp bias = Low    | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap + P2[6]<br>(P2[6] = 1.3 V) | 2.495 – P2[6] | 2.586 – P2[6] | 2.673 – P2[6] | V     |
|                              |                                        | V <sub>AGND</sub>  | AGND      | 2 × Bandgap                            | 2.528         | 2.601         | 2.668         | V     |
|                              |                                        | V <sub>REFLO</sub> | Ref low   | 2 × Bandgap – P2[6]<br>(P2[6] = 1.3 V) | 2.510 – P2[6] | 2.602 – P2[6] | 2.685 – P2[6] | V     |
|                              | RefPower = Medium<br>Opamp bias = High | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap + P2[6]<br>(P2[6] = 1.3 V) | 2.498 – P2[6] | 2.589 – P2[6] | 2.674 – P2[6] | V     |
|                              |                                        | V <sub>AGND</sub>  | AGND      | 2 × Bandgap                            | 2.529         | 2.601         | 2.668         | V     |
|                              |                                        | V <sub>REFLO</sub> | Ref low   | 2 × Bandgap – P2[6]<br>(P2[6] = 1.3 V) | 2.509 – P2[6] | 2.601 – P2[6] | 2.685 – P2[6] | V     |
|                              | RefPower = Medium<br>Opamp bias = Low  | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap + P2[6]<br>(P2[6] = 1.3 V) | 2.500 – P2[6] | 2.591 – P2[6] | 2.675 – P2[6] | V     |
|                              |                                        | V <sub>AGND</sub>  | AGND      | 2 × Bandgap                            | 2.530         | 2.603         | 2.669         | V     |
|                              |                                        | V <sub>REFLO</sub> | Ref low   | 2 × Bandgap – P2[6]<br>(P2[6] = 1.3 V) | 2.508 – P2[6] | 2.601 – P2[6] | 2.686 – P2[6] | V     |

**Table 34. 5-V DC Analog Reference Specifications** (continued)

| Reference<br>ARF_CR<br>[5:3] | Reference Power<br>Settings               | Symbol             | Reference | Description                                     | Min             | Typ                     | Max                     | Units |
|------------------------------|-------------------------------------------|--------------------|-----------|-------------------------------------------------|-----------------|-------------------------|-------------------------|-------|
| 0b101                        | RefPower = High<br>Opamp bias = High      | V <sub>REFHI</sub> | Ref high  | P2[4] + Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] + 1.218   | P2[4] + 1.283           | P2[4] + 1.344           | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | P2[4]                                           | P2[4]           | P2[4]                   | P2[4]                   | –     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | P2[4] – Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] – 1.329   | P2[4] – 1.297           | P2[4] – 1.265           | V     |
|                              | RefPower = High<br>Opamp bias = Low       | V <sub>REFHI</sub> | Ref high  | P2[4] + Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] + 1.225   | P2[4] + 1.287           | P2[4] + 1.346           | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | P2[4]                                           | P2[4]           | P2[4]                   | P2[4]                   | –     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | P2[4] – Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] – 1.330   | P2[4] – 1.301           | P2[4] – 1.271           | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = High | V <sub>REFHI</sub> | Ref high  | P2[4] + Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] + 1.226   | P2[4] + 1.288           | P2[4] + 1.346           | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | P2[4]                                           | P2[4]           | P2[4]                   | P2[4]                   | –     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | P2[4] – Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] – 1.330   | P2[4] – 1.302           | P2[4] – 1.272           | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = Low  | V <sub>REFHI</sub> | Ref high  | P2[4] + Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] + 1.227   | P2[4] + 1.289           | P2[4] + 1.347           | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | P2[4]                                           | P2[4]           | P2[4]                   | P2[4]                   | –     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | P2[4] – Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] – 1.331   | P2[4] – 1.303           | P2[4] – 1.273           | V     |
| 0b110                        | RefPower = High<br>Opamp bias = High      | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap                                     | 2.506           | 2.597                   | 2.674                   | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | Bandgap                                         | 1.263           | 1.302                   | 1.336                   | V     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                 | V <sub>SS</sub> | V <sub>SS</sub> + 0.006 | V <sub>SS</sub> + 0.014 | V     |
|                              | RefPower = High<br>Opamp bias = Low       | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap                                     | 2.508           | 2.595                   | 2.675                   | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | Bandgap                                         | 1.263           | 1.302                   | 1.336                   | V     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                 | V <sub>SS</sub> | V <sub>SS</sub> + 0.003 | V <sub>SS</sub> + 0.008 | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = High | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap                                     | 2.508           | 2.595                   | 2.676                   | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | Bandgap                                         | 1.263           | 1.302                   | 1.336                   | V     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                 | V <sub>SS</sub> | V <sub>SS</sub> + 0.002 | V <sub>SS</sub> + 0.005 | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = Low  | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap                                     | 2.508           | 2.596                   | 2.677                   | V     |
|                              |                                           | V <sub>AGND</sub>  | AGND      | Bandgap                                         | 1.263           | 1.302                   | 1.336                   | V     |
|                              |                                           | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                 | V <sub>SS</sub> | V <sub>SS</sub> + 0.001 | V <sub>SS</sub> + 0.003 | V     |

**Table 34. 5-V DC Analog Reference Specifications (continued)**

| Reference ARF_CR [5:3] | Reference Power Settings               | Symbol             | Reference | Description     | Min             | Typ                     | Max                     | Units |
|------------------------|----------------------------------------|--------------------|-----------|-----------------|-----------------|-------------------------|-------------------------|-------|
| 0b111                  | RefPower = High<br>Opamp bias = High   | V <sub>REFHI</sub> | Ref high  | 3.2 × Bandgap   | 4.056           | 4.155                   | 4.222                   | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | 1.6 × Bandgap   | 2.012           | 2.083                   | 2.168                   | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub> | V <sub>SS</sub> | V <sub>SS</sub> + 0.01  | V <sub>SS</sub> + 0.035 | V     |
|                        | RefPower = High<br>Opamp bias = Low    | V <sub>REFHI</sub> | Ref high  | 3.2 × Bandgap   | 4.061           | 4.153                   | 4.223                   | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | 1.6 × Bandgap   | 2.023           | 2.082                   | 2.145                   | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub> | V <sub>SS</sub> | V <sub>SS</sub> + 0.006 | V <sub>SS</sub> + 0.022 | V     |
|                        | RefPower = Medium<br>Opamp bias = High | V <sub>REFHI</sub> | Ref high  | 3.2 × Bandgap   | 4.063           | 4.154                   | 4.224                   | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | 1.6 × Bandgap   | 2.020           | 2.083                   | 2.152                   | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub> | V <sub>SS</sub> | V <sub>SS</sub> + 0.006 | V <sub>SS</sub> + 0.024 | V     |
|                        | RefPower = Medium<br>Opamp bias = Low  | V <sub>REFHI</sub> | Ref high  | 3.2 × Bandgap   | 4.061           | 4.154                   | 4.225                   | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | 1.6 × Bandgap   | 2.026           | 2.081                   | 2.140                   | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub> | V <sub>SS</sub> | V <sub>SS</sub> + 0.004 | V <sub>SS</sub> + 0.017 | V     |

**Table 35. 3.3-V DC Analog Reference Specifications**

| Reference ARF_CR [5:3] | Reference Power Settings               | Symbol             | Reference | Description                  | Min                        | Typ                        | Max                        | Units |
|------------------------|----------------------------------------|--------------------|-----------|------------------------------|----------------------------|----------------------------|----------------------------|-------|
| 0b000                  | RefPower = High<br>Opamp bias = High   | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub> /2 + Bandgap | V <sub>DD</sub> /2 + 1.223 | V <sub>DD</sub> /2 + 1.283 | V <sub>DD</sub> /2 + 1.343 | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2           | V <sub>DD</sub> /2 – 0.013 | V <sub>DD</sub> /2 – 0.003 | V <sub>DD</sub> /2 + 0.005 | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>DD</sub> /2 – Bandgap | V <sub>DD</sub> /2 – 1.322 | V <sub>DD</sub> /2 – 1.297 | V <sub>DD</sub> /2 – 1.270 | V     |
|                        | RefPower = High<br>Opamp bias = Low    | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub> /2 + Bandgap | V <sub>DD</sub> /2 + 1.228 | V <sub>DD</sub> /2 + 1.288 | V <sub>DD</sub> /2 + 1.345 | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2           | V <sub>DD</sub> /2 – 0.008 | V <sub>DD</sub> /2 – 0.002 | V <sub>DD</sub> /2 + 0.005 | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>DD</sub> /2 – Bandgap | V <sub>DD</sub> /2 – 1.322 | V <sub>DD</sub> /2 – 1.298 | V <sub>DD</sub> /2 – 1.271 | V     |
|                        | RefPower = Medium<br>Opamp bias = High | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub> /2 + Bandgap | V <sub>DD</sub> /2 + 1.232 | V <sub>DD</sub> /2 + 1.290 | V <sub>DD</sub> /2 + 1.346 | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2           | V <sub>DD</sub> /2 – 0.008 | V <sub>DD</sub> /2 – 0.001 | V <sub>DD</sub> /2 + 0.006 | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>DD</sub> /2 – Bandgap | V <sub>DD</sub> /2 – 1.322 | V <sub>DD</sub> /2 – 1.299 | V <sub>DD</sub> /2 – 1.272 | V     |
|                        | RefPower = Medium<br>Opamp bias = Low  | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub> /2 + Bandgap | V <sub>DD</sub> /2 + 1.233 | V <sub>DD</sub> /2 + 1.291 | V <sub>DD</sub> /2 + 1.347 | V     |
|                        |                                        | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2           | V <sub>DD</sub> /2 – 0.006 | V <sub>DD</sub> /2         | V <sub>DD</sub> /2 + 0.006 | V     |
|                        |                                        | V <sub>REFLO</sub> | Ref low   | V <sub>DD</sub> /2 – Bandgap | V <sub>DD</sub> /2 – 1.322 | V <sub>DD</sub> /2 – 1.299 | V <sub>DD</sub> /2 – 1.272 | V     |

**Table 35. 3.3-V DC Analog Reference Specifications** (continued)

| Reference<br>ARF_CR<br>[5:3] | Reference Power<br>Settings                      | Symbol             | Reference | Description                                             | Min                        | Typ                        | Max                        | Units |
|------------------------------|--------------------------------------------------|--------------------|-----------|---------------------------------------------------------|----------------------------|----------------------------|----------------------------|-------|
| 0b001                        | RefPower = High<br>Opamp bias = High             | V <sub>REFHI</sub> | Ref high  | P2[4]+P2[6] (P2[4] = V <sub>DD</sub> /2, P2[6] = 0.5 V) | P2[4] + P2[6] – 0.045      | P2[4] + P2[6] – 0.017      | P2[4] + P2[6] + 0.016      | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | P2[4]                                                   | P2[4]                      | P2[4]                      | P2[4]                      | –     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | P2[4]–P2[6] (P2[4] = V <sub>DD</sub> /2, P2[6] = 0.5 V) | P2[4] – P2[6] – 0.019      | P2[4] – P2[6] + 0.004      | P2[4] – P2[6] + 0.023      | V     |
|                              | RefPower = High<br>Opamp bias = Low              | V <sub>REFHI</sub> | Ref high  | P2[4]+P2[6] (P2[4] = V <sub>DD</sub> /2, P2[6] = 0.5 V) | P2[4] + P2[6] – 0.036      | P2[4] + P2[6] – 0.012      | P2[4] + P2[6] + 0.013      | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | P2[4]                                                   | P2[4]                      | P2[4]                      | P2[4]                      | –     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | P2[4]–P2[6] (P2[4] = V <sub>DD</sub> /2, P2[6] = 0.5 V) | P2[4] – P2[6] – 0.021      | P2[4] – P2[6] – 0.001      | P2[4] – P2[6] + 0.021      | V     |
|                              | RefPower = Medium<br>Opamp bias = High           | V <sub>REFHI</sub> | Ref high  | P2[4]+P2[6] (P2[4] = V <sub>DD</sub> /2, P2[6] = 0.5 V) | P2[4] + P2[6] – 0.034      | P2[4] + P2[6] – 0.011      | P2[4] + P2[6] + 0.013      | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | P2[4]                                                   | P2[4]                      | P2[4]                      | P2[4]                      | –     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | P2[4]–P2[6] (P2[4] = V <sub>DD</sub> /2, P2[6] = 0.5 V) | P2[4] – P2[6] – 0.023      | P2[4] – P2[6] – 0.002      | P2[4] – P2[6] + 0.016      | V     |
|                              | RefPower = Medium<br>Opamp bias = Low            | V <sub>REFHI</sub> | Ref high  | P2[4]+P2[6] (P2[4] = V <sub>DD</sub> /2, P2[6] = 0.5 V) | P2[4] + P2[6] – 0.033      | P2[4] + P2[6] – 0.009      | P2[4] + P2[6] + 0.014      | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | P2[4]                                                   | P2[4]                      | P2[4]                      | P2[4]                      | –     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | P2[4]–P2[6] (P2[4] = V <sub>DD</sub> /2, P2[6] = 0.5 V) | P2[4] – P2[6] – 0.024      | P2[4] – P2[6] – 0.003      | P2[4] – P2[6] + 0.020      | V     |
| 0b010                        | RefPower = High<br>Opamp bias = High             | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub>                                         | V <sub>DD</sub> – 0.042    | V <sub>DD</sub> – 0.008    | V <sub>DD</sub>            | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2                                      | V <sub>DD</sub> /2 – 0.035 | V <sub>DD</sub> /2 – 0.001 | V <sub>DD</sub> /2 + 0.031 | V     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                         | V <sub>SS</sub>            | V <sub>SS</sub> + 0.003    | V <sub>SS</sub> + 0.0165   | V     |
|                              | RefPower = High<br>Opamp bias = Low              | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub>                                         | V <sub>DD</sub> – 0.035    | V <sub>DD</sub> – 0.005    | V <sub>DD</sub>            | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2                                      | V <sub>DD</sub> /2 – 0.031 | V <sub>DD</sub> /2 – 0.001 | V <sub>DD</sub> /2 + 0.028 | V     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                         | V <sub>SS</sub>            | V <sub>SS</sub> + 0.002    | V <sub>SS</sub> + 0.012    | V     |
|                              | RefPower = Medium<br>Opamp bias = High           | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub>                                         | V <sub>DD</sub> – 0.044    | V <sub>DD</sub> – 0.005    | V <sub>DD</sub>            | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2                                      | V <sub>DD</sub> /2 – 0.052 | V <sub>DD</sub> /2         | V <sub>DD</sub> /2 + 0.046 | V     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                         | V <sub>SS</sub>            | V <sub>SS</sub> + 0.002    | V <sub>SS</sub> + 0.014    | V     |
|                              | RefPower = Medium<br>Opamp bias = Low            | V <sub>REFHI</sub> | Ref high  | V <sub>DD</sub>                                         | V <sub>DD</sub> – 0.036    | V <sub>DD</sub> – 0.004    | V <sub>DD</sub>            | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | V <sub>DD</sub> /2                                      | V <sub>DD</sub> /2 – 0.032 | V <sub>DD</sub> /2         | V <sub>DD</sub> /2 + 0.029 | V     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                         | V <sub>SS</sub>            | V <sub>SS</sub> + 0.001    | V <sub>SS</sub> + 0.012    | V     |
| 0b011                        | All power settings.<br>Not allowed for<br>3.3 V. | –                  | –         | –                                                       | –                          | –                          | –                          | –     |
| 0b100                        | All power settings.<br>Not allowed for<br>3.3 V. | –                  | –         | –                                                       | –                          | –                          | –                          | –     |

**Table 35. 3.3-V DC Analog Reference Specifications** (continued)

| Reference<br>ARF_CR<br>[5:3] | Reference Power<br>Settings                      | Symbol             | Reference | Description                                     | Min             | Typ                     | Max                     | Units |
|------------------------------|--------------------------------------------------|--------------------|-----------|-------------------------------------------------|-----------------|-------------------------|-------------------------|-------|
| 0b101                        | RefPower = High<br>Opamp bias = High             | V <sub>REFHI</sub> | Ref high  | P2[4] + Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] + 1.226   | P2[4] + 1.286           | P2[4] + 1.343           | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | P2[4]                                           | P2[4]           | P2[4]                   | P2[4]                   | –     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | P2[4] – Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] – 1.323   | P2[4] – 1.293           | P2[4] – 1.262           | V     |
|                              | RefPower = High<br>Opamp bias = Low              | V <sub>REFHI</sub> | Ref high  | P2[4] + Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] + 1.232   | P2[4] + 1.29            | P2[4] + 1.344           | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | P2[4]                                           | P2[4]           | P2[4]                   | P2[4]                   | –     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | P2[4] – Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] – 1.324   | P2[4] – 1.296           | P2[4] – 1.267           | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = High        | V <sub>REFHI</sub> | Ref high  | P2[4] + Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] + 1.233   | P2[4] + 1.291           | P2[4] + 1.345           | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | P2[4]                                           | P2[4]           | P2[4]                   | P2[4]                   | –     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | P2[4] – Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] – 1.324   | P2[4] – 1.298           | P2[4] – 1.269           | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = Low         | V <sub>REFHI</sub> | Ref high  | P2[4] + Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] + 1.234   | P2[4] + 1.292           | P2[4] + 1.345           | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | P2[4]                                           | P2[4]           | P2[4]                   | P2[4]                   | –     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | P2[4] – Bandgap<br>(P2[4] = V <sub>DD</sub> /2) | P2[4] – 1.324   | P2[4] – 1.299           | P2[4] – 1.270           | V     |
| 0b110                        | RefPower = High<br>Opamp bias = High             | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap                                     | 2.504           | 2.595                   | 2.672                   | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | Bandgap                                         | 1.262           | 1.301                   | 1.336                   | V     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                 | V <sub>SS</sub> | V <sub>SS</sub> + 0.006 | V <sub>SS</sub> + 0.013 | V     |
|                              | RefPower = High<br>Opamp bias = Low              | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap                                     | 2.506           | 2.593                   | 2.674                   | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | Bandgap                                         | 1.262           | 1.301                   | 1.336                   | V     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                 | V <sub>SS</sub> | V <sub>SS</sub> + 0.003 | V <sub>SS</sub> + 0.008 | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = High        | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap                                     | 2.506           | 2.594                   | 2.675                   | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | Bandgap                                         | 1.262           | 1.301                   | 1.335                   | V     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                 | V <sub>SS</sub> | V <sub>SS</sub> + 0.002 | V <sub>SS</sub> + 0.007 | V     |
|                              | RefPower =<br>Medium<br>Opamp bias = Low         | V <sub>REFHI</sub> | Ref high  | 2 × Bandgap                                     | 2.507           | 2.595                   | 2.675                   | V     |
|                              |                                                  | V <sub>AGND</sub>  | AGND      | Bandgap                                         | 1.262           | 1.301                   | 1.335                   | V     |
|                              |                                                  | V <sub>REFLO</sub> | Ref low   | V <sub>SS</sub>                                 | V <sub>SS</sub> | V <sub>SS</sub> + 0.001 | V <sub>SS</sub> + 0.005 | V     |
| 0b111                        | All power settings.<br>Not allowed for<br>3.3 V. | –                  | –         | –                                               | –               | –                       | –                       | –     |

### DC Analog PSoC Block Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 36. DC Analog PSoC Block Specifications**

| Symbol   | Description                           | Min | Typ   | Max | Units      | Notes |
|----------|---------------------------------------|-----|-------|-----|------------|-------|
| $R_{CT}$ | Resistor Unit Value (Continuous Time) | –   | 12.24 | –   | k $\Omega$ |       |
| $C_{SC}$ | Capacitor Unit Value (Switch Cap)     | –   | 80    | –   | fF         |       |

### DC Analog Mux Bus Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 37. DC Analog Mux Bus Specifications**

| Symbol    | Description                                     | Min | Typ | Max | Units    | Notes                      |
|-----------|-------------------------------------------------|-----|-----|-----|----------|----------------------------|
| $R_{SW}$  | Switch Resistance to Common Analog Bus          | –   | –   | 400 | $\Omega$ | $V_{DD} \geq 3.0\text{ V}$ |
| $R_{VSS}$ | Resistance of Initialization Switch to $V_{SS}$ | –   | –   | 800 | $\Omega$ |                            |

### DC SAR10 ADC Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 38. DC SAR10 ADC Specifications**

| Symbol          | Description                                                                                     | Min  | Typ  | Max                     | Units      | Notes                                                                                                                                                                                                                                                                       |
|-----------------|-------------------------------------------------------------------------------------------------|------|------|-------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $INL_{SAR10}$   | Integral nonlinearity for $V_{REF} \geq 3\text{ V}$                                             | –2.5 | –    | 2.5                     | LSB        | 10-bit resolution                                                                                                                                                                                                                                                           |
|                 | Integral nonlinearity for $V_{REF} < 3\text{ V}$                                                | –5   | –    | 5                       | LSB        | 10-bit resolution                                                                                                                                                                                                                                                           |
| $DNL_{SAR10}$   | Differential nonlinearity for $V_{REF} \geq 3\text{ V}$                                         | –1.5 | –    | 1.5                     | LSB        | 10-bit resolution                                                                                                                                                                                                                                                           |
|                 | Differential nonlinearity for $V_{REF} < 3\text{ V}$                                            | –4   | –    | 4                       | LSB        | 10-bit resolution                                                                                                                                                                                                                                                           |
| $I_{SAR10}$     | Active current consumption                                                                      | 0.08 | 0.5  | 0.497                   | mA         |                                                                                                                                                                                                                                                                             |
| $I_{VREFSAR10}$ | Input current into P2[5] when configured as the SAR10 ADC's $V_{REF}$ input.                    | –    | –    | 0.5                     | mA         | The internal voltage reference buffer is disabled in this configuration.                                                                                                                                                                                                    |
| $V_{VREFSAR10}$ | Input reference voltage at P2[5] when configured as the SAR10 ADC's external voltage reference. | 2.7  | –    | $V_{DD} - 0.3\text{ V}$ | V          | When $V_{REF}$ is buffered inside the SAR10 ADC, the voltage level at P2[5] (when configured as the external reference voltage) must always be at least 300 mV less than the chip supply voltage level on the $V_{DD}$ pin. ( $V_{VREFSAR10} < (V_{DD} - 300\text{ mV})$ ). |
| $V_{OSSAR10}$   | Offset voltage                                                                                  | 5    | 7.7  | 10                      | mV         |                                                                                                                                                                                                                                                                             |
| $SAR_{IMP}$     | SAR input impedance                                                                             | –    | 1.64 | –                       | M $\Omega$ | Frequency dependant = $1/F_s$ °C. 142.9 kHz (maximum) and $C_{in} = 4.28\text{ pF}$ (typical)                                                                                                                                                                               |

# DC IDAC Specifications

**Table 39. DC IDAC Specifications**

| Symbol     | Description                                           | Min  | Typ  | Max  | Units | Notes                                                         |
|------------|-------------------------------------------------------|------|------|------|-------|---------------------------------------------------------------|
| IDAC_DNL   | Differential nonlinearity                             | –5.0 | 2.0  | 5.0  | LSB   | Valid for all 3 current ranges                                |
| IDAC_INL   | Integral nonlinearity                                 | –5.0 | 2.0  | 5.0  | LSB   | Valid for all 3 current ranges                                |
| IDAC_Gain  | Gain per bit – Range 1 (91 $\mu$ A)                   | 283  | 357  | 447  | nA    | Measured at full scale                                        |
|            | Gain per bit – Range 2 (318 $\mu$ A)                  | 985  | 1250 | 1532 | nA    |                                                               |
|            | Gain per bit – Range 3 (637 $\mu$ A)                  | 1959 | 2500 | 3056 | nA    |                                                               |
| IDACOffset | Offset at Code 0 vs LSB Ideal – Range 1 (91 $\mu$ A)  |      | 2.0% | 20%  | %     | Measured as a % of LSB (Current @ Code 0)/(LSB Ideal Current) |
|            | Offset at Code 0 vs LSB Ideal – Range 2 (318 $\mu$ A) |      | 1.0% | 10%  | %     |                                                               |
|            | Offset at Code 0 vs LSB Ideal – Range 3 (637 $\mu$ A) |      | 1.0% | 10%  | %     |                                                               |

### DC POR and LVD Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Note** The bits PORLEV and VM in the table below refer to bits in the VLT\_CR register. See the *PSoC Technical Reference Manual* for CY8C28xxx PSoC devices, for more information on the VLT\_CR register.

**Table 40. DC POR and LVD Specifications**

| Symbol              | Description                                         | Min  | Typ  | Max                  | Units | Notes                                                                                                                   |
|---------------------|-----------------------------------------------------|------|------|----------------------|-------|-------------------------------------------------------------------------------------------------------------------------|
| V <sub>PPOR0R</sub> | V <sub>DD</sub> Value for PPOR Trip (positive ramp) | —    | 2.91 | 2.985                | V     | V <sub>DD</sub> must be greater than or equal to 2.5 V during startup, reset from the XRES pin, or reset from Watchdog. |
| V <sub>PPOR1R</sub> | PORLEV[1:0] = 00b                                   | —    | 4.39 | 4.49                 | V     |                                                                                                                         |
| V <sub>PPOR2R</sub> | PORLEV[1:0] = 01b                                   | —    | 4.55 | 4.65                 | V     |                                                                                                                         |
| V <sub>PPOR0</sub>  | V <sub>DD</sub> Value for PPOR Trip (negative ramp) | —    | 2.82 | 2.90                 | V     | V <sub>DD</sub> must be greater than or equal to 2.5 V during startup, reset from the XRES pin, or reset from Watchdog. |
| V <sub>PPOR1</sub>  | PORLEV[1:0] = 00b                                   | —    | 4.39 | 4.49                 | V     |                                                                                                                         |
| V <sub>PPOR2</sub>  | PORLEV[1:0] = 01b                                   | —    | 4.55 | 4.64                 | V     |                                                                                                                         |
| V <sub>PH0</sub>    | PPOR Hysteresis                                     | —    | 92   | —                    | mV    |                                                                                                                         |
| V <sub>PH1</sub>    | PORLEV[1:0] = 00b                                   | —    | 0    | —                    | mV    |                                                                                                                         |
| V <sub>PH2</sub>    | PORLEV[1:0] = 01b                                   | —    | 0    | —                    | mV    |                                                                                                                         |
| V <sub>LVD0</sub>   | V <sub>DD</sub> Value for LVD Trip                  | 2.83 | 2.91 | 3.00 <sup>[16]</sup> | V     |                                                                                                                         |
| V <sub>LVD1</sub>   | VM[2:0] = 000b                                      | 2.93 | 3.01 | 3.10                 | V     |                                                                                                                         |
| V <sub>LVD2</sub>   | VM[2:0] = 001b                                      | 3.04 | 3.12 | 3.21                 | V     |                                                                                                                         |
| V <sub>LVD3</sub>   | VM[2:0] = 010b                                      | 3.90 | 3.99 | 4.09                 | V     |                                                                                                                         |
| V <sub>LVD4</sub>   | VM[2:0] = 011b                                      | 4.38 | 4.47 | 4.58                 | V     |                                                                                                                         |
| V <sub>LVD5</sub>   | VM[2:0] = 100b                                      | 4.54 | 4.63 | 4.74 <sup>[17]</sup> | V     |                                                                                                                         |
| V <sub>LVD6</sub>   | VM[2:0] = 101b                                      | 4.62 | 4.71 | 4.83                 | V     |                                                                                                                         |
| V <sub>LVD7</sub>   | VM[2:0] = 110b                                      | 4.71 | 4.80 | 4.92                 | V     |                                                                                                                         |
| V <sub>PUMP0</sub>  | V <sub>DD</sub> Value for PUMP Trip                 | 2.93 | 3.01 | 3.10                 | V     |                                                                                                                         |
| V <sub>PUMP1</sub>  | VM[2:0] = 000b                                      | 3.00 | 3.08 | 3.17                 | V     |                                                                                                                         |
| V <sub>PUMP2</sub>  | VM[2:0] = 001b                                      | 3.16 | 3.24 | 3.33                 | V     |                                                                                                                         |
| V <sub>PUMP3</sub>  | VM[2:0] = 010b                                      | 4.09 | 4.17 | 4.28                 | V     |                                                                                                                         |
| V <sub>PUMP4</sub>  | VM[2:0] = 011b                                      | 4.53 | 4.62 | 4.74                 | V     |                                                                                                                         |
| V <sub>PUMP5</sub>  | VM[2:0] = 100b                                      | 4.61 | 4.71 | 4.82                 | V     |                                                                                                                         |
| V <sub>PUMP6</sub>  | VM[2:0] = 101b                                      | 4.70 | 4.80 | 4.91                 | V     |                                                                                                                         |
| V <sub>PUMP7</sub>  | VM[2:0] = 110b                                      | 4.88 | 4.98 | 5.10                 | V     |                                                                                                                         |

#### Notes

16. Always greater than 50 mV above PPOR (PORLEV = 00) for falling supply.  
 17. Always greater than 50 mV above PPOR (PORLEV = 10) for falling supply.

### 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  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 41. DC Programming Specifications**

| Symbol                | Description                                                                                 | Min                    | Typ | Max             | Units | Notes                                                                                   |
|-----------------------|---------------------------------------------------------------------------------------------|------------------------|-----|-----------------|-------|-----------------------------------------------------------------------------------------|
| V <sub>DDP</sub>      | V <sub>DD</sub> for programming and erase                                                   | 4.5                    | 5   | 5.5             | V     | This specification applies to the functional requirements of external programmer tools. |
| V <sub>DDL</sub>      | Low V <sub>DD</sub> for verify                                                              | 3                      | 3.1 | 3.2             | V     | This specification applies to the functional requirements of external programmer tools. |
| V <sub>DDH</sub>      | High V <sub>DD</sub> for verify                                                             | 5.1                    | 5.2 | 5.3             | V     | This specification applies to the functional requirements of external programmer tools. |
| V <sub>DDIWRITE</sub> | Supply Voltage for Flash write operation                                                    | 3                      | —   | 5.25            | V     | This specification applies to this device when it is executing internal flash writes.   |
| I <sub>DDP</sub>      | Supply Current During Programming or Verify                                                 | —                      | 5   | 25              | mA    |                                                                                         |
| V <sub>ILP</sub>      | Input Low Voltage During Programming or Verify                                              | —                      | —   | 0.8             | V     |                                                                                         |
| V <sub>IHP</sub>      | Input High Voltage During Programming or Verify                                             | 2.2                    | —   | —               | V     |                                                                                         |
| I <sub>ILP</sub>      | Input Current when Applying V <sub>ilp</sub> to P1[0] or P1[1] During Programming or Verify | —                      | —   | 0.21            | mA    | Driving internal pull-down resistor.                                                    |
| I <sub>IHP</sub>      | Input Current when Applying V <sub>ihp</sub> to P1[0] or P1[1] During Programming or Verify | —                      | —   | 1.5             | mA    | Driving internal pull-down resistor.                                                    |
| V <sub>OLV</sub>      | Output Low Voltage During Programming or Verify                                             | —                      | —   | 0.75            | V     |                                                                                         |
| V <sub>OHV</sub>      | Output High Voltage During Programming or Verify                                            | V <sub>DD</sub> – 1.0  | —   | V <sub>DD</sub> | V     |                                                                                         |
| Flash <sub>ENPB</sub> | Flash Endurance (per block)                                                                 | 50,000 <sup>[18]</sup> | —   | —               | —     | Erase/write cycles per block.                                                           |
| Flash <sub>ENT</sub>  | Flash Endurance (total) <sup>[19]</sup>                                                     | 1,800,000              | —   | —               | —     | Erase/write cycles. Must be programmed and read at the same voltage to meet this.       |
| Flash <sub>DR</sub>   | Flash Data Retention                                                                        | 10                     | —   | —               | Years |                                                                                         |

### Notes

18. The 50,000 cycle Flash endurance per block will only be guaranteed if the Flash is operating within one voltage range. Voltage ranges are 3.0 V to 3.6 V and 4.75 V to 5.25 V.

19. A maximum of  $36 \times 50,000$  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 at <http://www.cypress.com> under Application Notes for more information.

### DC I<sup>2</sup>C Specifications

Table 42 lists the guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

**Table 42. DC I<sup>2</sup>C Specifications**<sup>[20]</sup>

| Symbol                           | Description      | Min                 | Typ | Max                  | Units | Notes                                          |
|----------------------------------|------------------|---------------------|-----|----------------------|-------|------------------------------------------------|
| V <sub>IL</sub> I <sub>2</sub> C | Input low level  | –                   | –   | $0.3 \times V_{DD}$  | V     | $3.0\text{ V} \leq V_{DD} \leq 3.6\text{ V}$   |
|                                  |                  | –                   | –   | $0.25 \times V_{DD}$ | V     | $4.75\text{ V} \leq V_{DD} \leq 5.25\text{ V}$ |
| V <sub>IH</sub> I <sub>2</sub> C | Input high level | $0.7 \times V_{DD}$ | –   | –                    | V     | $3.0\text{ V} \leq V_{DD} \leq 5.25\text{ V}$  |
| V <sub>OL</sub> I <sub>2</sub> C | Output low level | –                   | –   | 0.4                  | V     | at sink current of 3 mA                        |
|                                  |                  | –                   | –   | 0.6                  | V     | at sink current of 6 mA                        |

#### Note

20. All GPIOs meet the DC GPIO V<sub>IL</sub> and V<sub>IH</sub> specifications found in the DC GPIO Specifications sections. The I<sup>2</sup>C GPIO pins also meet the above specs.

## AC Electrical Characteristics

### AC 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  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 43. AC Chip-Level Specifications**

| Symbol                   | Description                                       | Min   | Typ    | Max                      | Units | Notes                                                                                                                                                                                                                                                                                                 |
|--------------------------|---------------------------------------------------|-------|--------|--------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| F <sub>IMO</sub>         | Internal Main Oscillator Frequency                | 23.4  | 24     | 24.6 <sup>[21]</sup>     | MHz   | Trimmed. Utilizing factory trim values. SLIMO Mode = 0.                                                                                                                                                                                                                                               |
| F <sub>IMO6</sub>        | Internal Main Oscillator Frequency for 6 MHz      | 5.5   | 6      | 6.5 <sup>[21]</sup>      | MHz   | Trimmed for 5 V or 3.3 V operation using factory trim values. SLIMO Mode = 1.                                                                                                                                                                                                                         |
| F <sub>CPU1</sub>        | CPU Frequency (5 V Nominal)                       | 0.091 | 24     | 24.6 <sup>[21]</sup>     | MHz   | Trimmed. Utilizing factory trim values. SLIMO mode = 0.                                                                                                                                                                                                                                               |
| F <sub>CPU2</sub>        | CPU Frequency (3.3 V Nominal)                     | 0.091 | 12     | 12.3 <sup>[22]</sup>     | MHz   | Trimmed. Utilizing factory trim values. SLIMO mode = 0.                                                                                                                                                                                                                                               |
| F <sub>BLK5</sub>        | Digital PSoC Block Frequency                      | 0     | –      | 49.2 <sup>[21, 23]</sup> | MHz   | 4.75 V < V <sub>DD</sub> < 5.25 V                                                                                                                                                                                                                                                                     |
| F <sub>BLK33</sub>       | Digital PSoC Block Frequency                      | 0     | 24     | 24.6 <sup>[23]</sup>     | MHz   | 3.0 V < V <sub>DD</sub> < 3.6 V                                                                                                                                                                                                                                                                       |
| F <sub>32K1</sub>        | Internal Low Speed Oscillator Frequency           | 15    | 32     | 64                       | kHz   | Trimmed. Utilizing factory trim values.                                                                                                                                                                                                                                                               |
| F <sub>32K2</sub>        | External Crystal Oscillator                       | –     | 32.768 | –                        | kHz   | Accuracy is capacitor and crystal dependent. 50% duty cycle.                                                                                                                                                                                                                                          |
| F <sub>32K_U</sub>       | Internal Low Speed Oscillator Untrimmed Frequency | 5     | –      | 100                      | kHz   | After a reset and before the m8c starts to run, the ILO is not trimmed. See the System Resets section of the PSoC Technical Reference manual for details on timing this.                                                                                                                              |
| F <sub>PLL</sub>         | PLL Frequency                                     | –     | 23.986 | –                        | MHz   | Multiple (x732) of crystal frequency.                                                                                                                                                                                                                                                                 |
| t <sub>PLLSLEW</sub>     | PLL Lock Time                                     | 0.5   | –      | 10                       | ms    |                                                                                                                                                                                                                                                                                                       |
| t <sub>PLLSLEWSLOW</sub> | PLL Lock Time for Low Gain Setting                | 0.5   | –      | 50                       | ms    |                                                                                                                                                                                                                                                                                                       |
| T <sub>OS</sub>          | External Crystal Oscillator Startup to 1%         | –     | 1700   | 2620                     | ms    |                                                                                                                                                                                                                                                                                                       |
| T <sub>OSACC</sub>       | External Crystal Oscillator Startup to 100 ppm    | –     | 2800   | 3800                     | ms    | The crystal oscillator frequency is within 100 ppm of its final value by the end of the T <sub>OSACC</sub> period. Correct operation assumes a properly loaded 1 μW maximum drive level 32.768 kHz crystal. 3.0 V ≤ V <sub>DD</sub> ≤ 5.5 V, $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ . |

#### Notes

21. 4.75 V < V<sub>DD</sub> < 5.25 V.

22. 3.0 V < V<sub>DD</sub> < 3.6 V. See application note Adjusting PSoC® Trims for 3.3 V and 2.7 V Operation – AN2012 for information on trimming for operation at 3.3 V.

23. See the individual user module datasheets for information on maximum frequencies for user modules.

**Table 43. AC Chip-Level Specifications** *(continued)*

| Symbol                         | Description                                             | Min  | Typ  | Max                     | Units   | Notes                                   |
|--------------------------------|---------------------------------------------------------|------|------|-------------------------|---------|-----------------------------------------|
| $t_{XRST}$                     | External Reset Pulse Width                              | 10   | —    | —                       | $\mu$ s |                                         |
| DC24M                          | 24 MHz Duty Cycle                                       | 40   | 50   | 60                      | %       |                                         |
| DC <sub>ILO</sub>              | Internal Low Speed Oscillator Duty Cycle                | 20   | 50   | 80                      | %       |                                         |
| F <sub>out48M</sub>            | 48 MHz Output Frequency                                 | 46.8 | 48.0 | 49.2 <sup>[24,25]</sup> | MHz     | Trimmed. Utilizing factory trim values. |
| F <sub>MAX</sub>               | Maximum Frequency of Signal on Row Input or Row Output. | —    | —    | 12.3                    | MHz     |                                         |
| SR <sub>POWERUP</sub>          | Supply Ramp Time                                        | 0    | —    | —                       | $\mu$ s |                                         |
| $t_{POWERUP}$                  | Time for POR Release to Code Execution                  | —    | 16   | 100                     | ms      |                                         |
| $t_{jit\_IMO}$ <sup>[26]</sup> | 24 MHz IMO cycle-to-cycle jitter (RMS)                  | —    | 200  | 1300                    | ps      |                                         |
|                                | 24 MHz IMO long term N cycle-to-cycle jitter (RMS)      | —    | 300  | 1300                    | ps      | N = 32                                  |
|                                | 24 MHz IMO period jitter (RMS)                          | —    | 200  | 800                     | ps      |                                         |
| $t_{jit\_PLL}$ <sup>[26]</sup> | 24 MHz IMO cycle-to-cycle jitter (RMS)                  | —    | 200  | 1100                    | ps      |                                         |
|                                | 24 MHz IMO long term N cycle-to-cycle jitter (RMS)      | —    | 400  | 2800                    | ps      | N = 32                                  |
|                                | 24 MHz IMO period jitter (RMS)                          | —    | 200  | 1400                    | ps      |                                         |

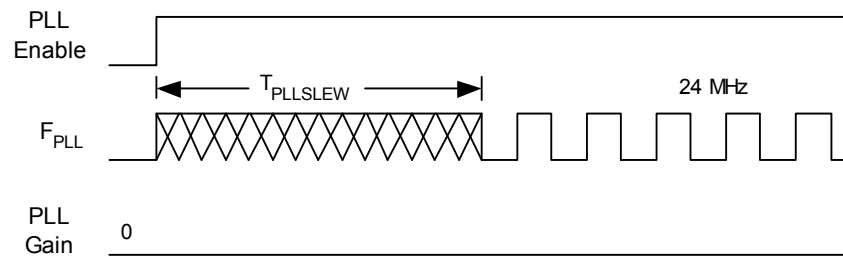
**Notes**

 24. 4.75 V < V<sub>DD</sub> < 5.25 V.

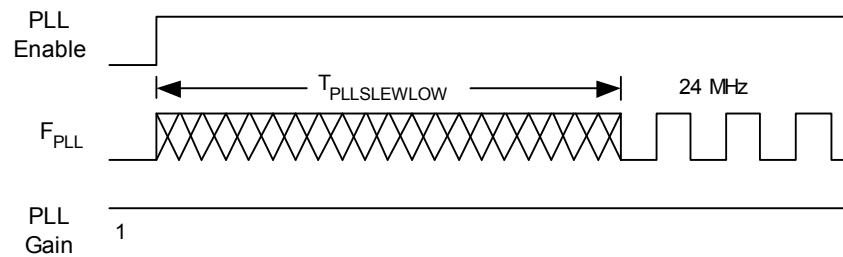
 25. 3.0 V < V<sub>DD</sub> < 3.6 V. See application note Adjusting PSoC® Trims for 3.3 V and 2.7 V Operation – AN2012 for information on trimming for operation at 3.3 V.

 26. Refer to Cypress Jitter Specifications application note, [Understanding Datasheet Jitter Specifications for Cypress Timing Products – AN5054](#) for more information.

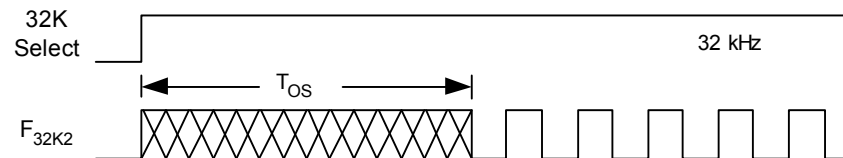
**Figure 10. PLL Lock Timing Diagram**



**Figure 11. PLL Lock for Low Gain Setting Timing Diagram**



**Figure 12. External Crystal Oscillator Startup Timing Diagram**



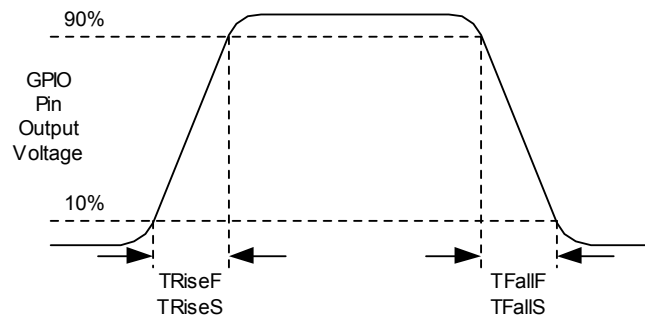
### AC GPIO Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 44. AC GPIO Specifications**

| Symbol             | Description                                 | Min | Typ | Max  | Units | Notes                                        |
|--------------------|---------------------------------------------|-----|-----|------|-------|----------------------------------------------|
| $F_{\text{GPIO}}$  | GPIO Operating Frequency                    | 0   | —   | 12.3 | MHz   | Normal Strong Mode                           |
| $t_{\text{RiseF}}$ | Rise Time, Normal Strong Mode, Load = 50 pF | 3   | —   | 18   | ns    | $V_{\text{DD}} = 4.5$ to $5.25$ V, 10% – 90% |
| $t_{\text{FallF}}$ | Fall Time, Normal Strong Mode, Load = 50 pF | 2   | —   | 18   | ns    | $V_{\text{DD}} = 4.5$ to $5.25$ V, 10% – 90% |
| $t_{\text{RiseS}}$ | Rise Time, Slow Strong Mode, Load = 50 pF   | 10  | 27  | —    | ns    | $V_{\text{DD}} = 3$ to $5.25$ V, 10% – 90%   |
| $t_{\text{FallS}}$ | Fall Time, Slow Strong Mode, Load = 50 pF   | 10  | 22  | —    | ns    | $V_{\text{DD}} = 3$ to $5.25$ V, 10% – 90%   |

**Figure 13. GPIO Timing Diagram**



### AC Operational Amplifier Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only. The Operational Amplifiers covered by these specifications are components of both the Analog Continuous Time PSoC blocks and the Analog Switched Cap PSoC blocks. Settling times, slew rates, and gain bandwidth are based on the Analog Continuous Time PSoC block.

Power = High and Opamp bias = High is not supported at 3.3 V.

**Table 45. 5 V AC Operational Amplifier Specifications**

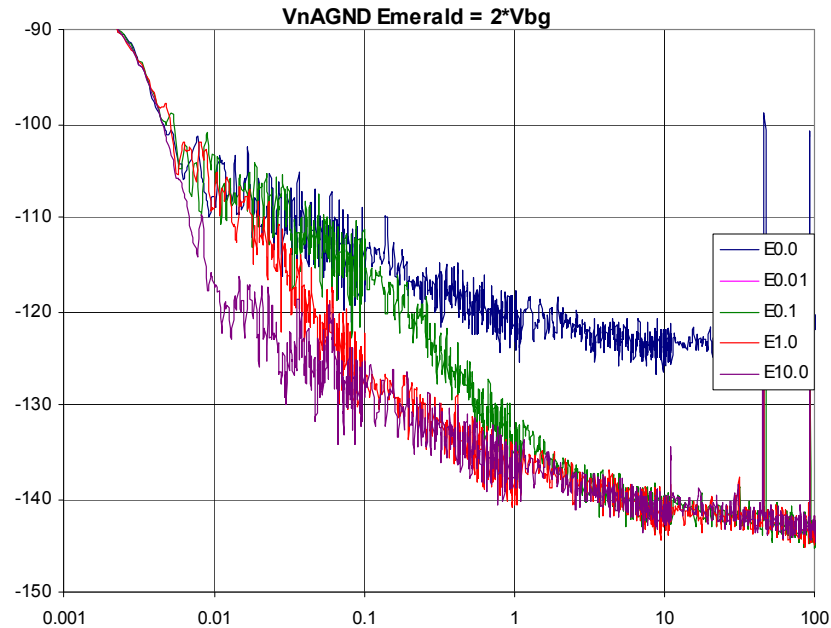
| Symbol                   | Description                                                                                           | Min  | Typ | Max  | Units                    | Notes |
|--------------------------|-------------------------------------------------------------------------------------------------------|------|-----|------|--------------------------|-------|
| $t_{\text{ROA}}$         | Rising Settling Time from 80% of $\Delta V$ to 0.1% of $\Delta V$ (Active Probe Loading, Unity Gain)  |      |     |      |                          |       |
|                          | Power = Low, Opamp bias = Low                                                                         | —    | —   | 3.9  | $\mu\text{s}$            |       |
|                          | Power = Medium, Opamp bias = High                                                                     | —    | —   | 0.72 | $\mu\text{s}$            |       |
|                          | Power = High, Opamp bias = High                                                                       | —    | —   | 0.62 | $\mu\text{s}$            |       |
| $t_{\text{SOA}}$         | Falling Settling Time from 20% of $\Delta V$ to 0.1% of $\Delta V$ (Active Probe Loading, Unity Gain) |      |     |      |                          |       |
|                          | Power = Low, Opamp bias = Low                                                                         | —    | —   | 5.9  | $\mu\text{s}$            |       |
|                          | Power = Medium, Opamp bias = High                                                                     | —    | —   | 0.92 | $\mu\text{s}$            |       |
|                          | Power = High, Opamp bias = High                                                                       | —    | —   | 0.72 | $\mu\text{s}$            |       |
| $\text{SR}_{\text{ROA}}$ | Rising Slew Rate (20% to 80%)(Active Probe Loading, Unity Gain)                                       |      |     |      |                          |       |
|                          | Power = Low, Opamp bias = Low                                                                         | 0.15 | —   | —    | $\text{V}/\mu\text{s}$   |       |
|                          | Power = Medium, Opamp bias = High                                                                     | 1.7  | —   | —    | $\text{V}/\mu\text{s}$   |       |
|                          | Power = High, Opamp bias = High                                                                       | 6.5  | —   | —    | $\text{V}/\mu\text{s}$   |       |
| $\text{SR}_{\text{FOA}}$ | Falling Slew Rate (80% to 20%)(Active Probe Loading, Unity Gain)                                      |      |     |      |                          |       |
|                          | Power = Low, Opamp bias = Low                                                                         | 0.01 | —   | —    | $\text{V}/\mu\text{s}$   |       |
|                          | Power = Medium, Opamp bias = High                                                                     | 0.5  | —   | —    | $\text{V}/\mu\text{s}$   |       |
|                          | Power = High, Opamp bias = High                                                                       | 4.0  | —   | —    | $\text{V}/\mu\text{s}$   |       |
| $\text{BW}_{\text{OA}}$  | Gain Bandwidth Product                                                                                |      |     |      |                          |       |
|                          | Power = Low, Opamp bias = Low                                                                         | 0.75 | —   | —    | MHz                      |       |
|                          | Power = Medium, Opamp bias = High                                                                     | 3.1  | —   | —    | MHz                      |       |
|                          | Power = High, Opamp bias = High                                                                       | 5.4  | —   | —    | MHz                      |       |
| $E_{\text{NOA}}$         | Noise at 1 kHz                                                                                        | —    | 100 | —    | $\text{nV}/\text{rt-Hz}$ |       |
|                          | Power = Medium, Opamp bias = High                                                                     |      |     |      |                          |       |

**Table 46. 3.3 V AC Operational Amplifier Specifications**

| Symbol     | Description                                                                                                                                                                 | Min         | Typ    | Max          | Units                  | Notes |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------|--------------|------------------------|-------|
| $t_{ROA}$  | Rising Settling Time from 80% of $\Delta V$ to 0.1% of $\Delta V$ (Active Probe Loading, Unity Gain)<br>Power = Low, Opamp bias = Low<br>Power = Low, Opamp bias = High     | —<br>—      | —<br>— | 3.92<br>0.72 | $\mu s$<br>$\mu s$     |       |
| $t_{SOA}$  | Falling Settling Time from 20% of $\Delta V$ to 0.1% of $\Delta V$ (Active Probe Loading, Unity Gain)<br>Power = Low, Opamp bias = Low<br>Power = Medium, Opamp bias = High | —<br>—      | —<br>— | 5.41<br>0.72 | $\mu s$<br>$\mu s$     |       |
| $SR_{ROA}$ | Rising Slew Rate (20% to 80%)(Active Probe Loading, Unity Gain)<br>Power = Low, Opamp bias = Low<br>Power = Medium, Opamp bias = High                                       | 0.31<br>2.7 | —<br>— | —<br>—       | $V/\mu s$<br>$V/\mu s$ |       |
| $SR_{FOA}$ | Falling Slew Rate (80% to 20%)(Active Probe Loading, Unity Gain)<br>Power = Low, Opamp bias = Low<br>Power = Medium, Opamp bias = High                                      | 0.24<br>1.8 | —<br>— | —<br>—       | $V/\mu s$<br>$V/\mu s$ |       |
| $BW_{OA}$  | Gain Bandwidth Product<br>Power = Low, Opamp bias = Low<br>Power = Medium, Opamp bias = High                                                                                | 0.67<br>2.8 | —<br>— | —<br>—       | MHz<br>MHz             |       |
| $E_{NOA}$  | Noise at 1 kHz<br>Power = Medium, Opamp bias = High                                                                                                                         | —           | 100    | —            | nV/rt-Hz               |       |

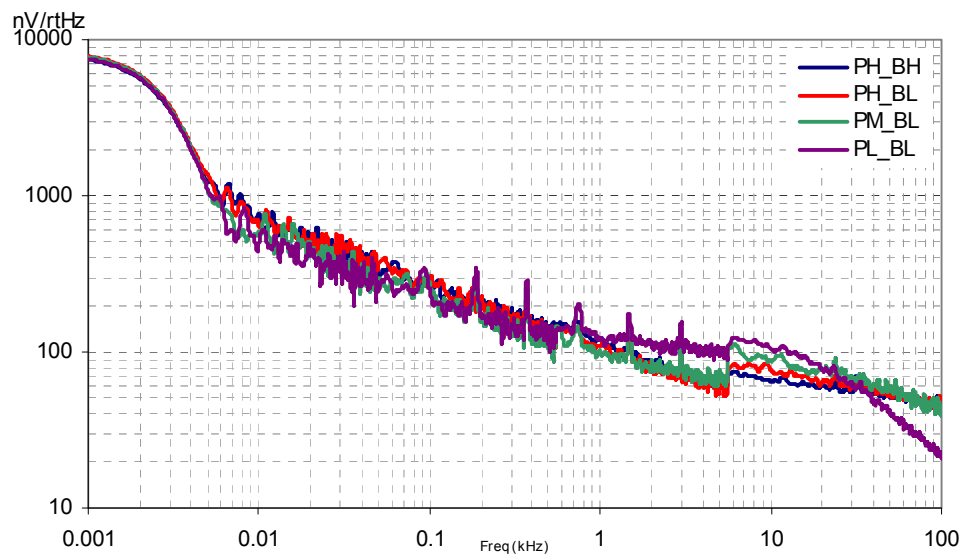
When bypassed by a capacitor on P2[4], the noise of the analog ground signal distributed to each block is reduced by a factor of up to 5 (14 dB). This is at frequencies above the corner frequency defined by the on-chip 8.1k resistance and the external capacitor.

**Figure 14. Typical AGND Noise with P2[4] Bypass**



At low frequencies, the opamp noise is proportional to  $1/f$ , power independent, and determined by device geometry. At high frequencies, increased power level reduces the noise spectrum level.

**Figure 15. Typical Opamp Noise**



### AC Type-E Operational Amplifier Specifications

Table 47 lists the guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 2.4 V to 3.0 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V, 3.3 V, or 2.7 V at  $25^{\circ}\text{C}$  and are for design guidance only. The Operational Amplifiers covered by these specifications are components of the Limited Type E Analog PSoC blocks.

**Table 47. AC Type-E Operational Amplifier Specifications**

| Symbol            | Description                   | Min | Typ | Max | Units | Notes            |
|-------------------|-------------------------------|-----|-----|-----|-------|------------------|
| $t_{\text{COMP}}$ | Comparator Mode Response Time | –   | 75  | 100 | ns    | 50 mV overdrive. |

### AC Low Power Comparator Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 2.4 V to 3.0 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 48. AC Low Power Comparator Specifications**

| Symbol            | Description       | Min | Typ | Max | Units         | Notes                   |
|-------------------|-------------------|-----|-----|-----|---------------|-------------------------|
| $t_{\text{RLPC}}$ | LPC Response Time | –   | –   | 50  | $\mu\text{s}$ | $\geq 50$ mV overdrive. |

### AC Digital Block Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 49. AC Digital Block Specifications**

| Function          | Description                                  | Min                | Typ | Max | Units | Notes                                                                                     |
|-------------------|----------------------------------------------|--------------------|-----|-----|-------|-------------------------------------------------------------------------------------------|
| All functions     | Block Input Clock Frequency                  |                    |     |     |       |                                                                                           |
|                   | $V_{DD} \geq 4.75\text{ V}$                  | –                  | –   | 49  | MHz   |                                                                                           |
|                   | $V_{DD} < 4.75\text{ V}$                     | –                  | –   | 25  | MHz   |                                                                                           |
| Timer             | Input Clock Frequency                        |                    |     |     |       |                                                                                           |
|                   | No Capture, $V_{DD} \geq 4.75\text{ V}$      | –                  | –   | 49  | MHz   |                                                                                           |
|                   | No Capture, $V_{DD} < 4.75\text{ V}$         | –                  | –   | 25  | MHz   |                                                                                           |
|                   | With Capture                                 | –                  | –   | 25  | MHz   |                                                                                           |
|                   | Capture Pulse Width                          | 50 <sup>[27]</sup> | –   | –   | ns    |                                                                                           |
| Counter           | Input Clock Frequency                        |                    |     |     |       |                                                                                           |
|                   | No Enable Input, $V_{DD} \geq 4.75\text{ V}$ | –                  | –   | 49  | MHz   |                                                                                           |
|                   | No Enable Input, $V_{DD} < 4.75\text{ V}$    | –                  | –   | 25  | MHz   |                                                                                           |
|                   | With Enable Input                            | –                  | –   | 25  | MHz   |                                                                                           |
|                   | Enable Input Pulse Width                     | 50 <sup>[27]</sup> | –   | –   | ns    |                                                                                           |
| Dead Band         | Kill Pulse Width                             |                    |     |     |       |                                                                                           |
|                   | Asynchronous Restart Mode                    | 20                 | –   | –   | ns    |                                                                                           |
|                   | Synchronous Restart Mode                     | 50 <sup>[27]</sup> | –   | –   | ns    |                                                                                           |
|                   | Disable Mode                                 | 50 <sup>[27]</sup> | –   | –   | ns    |                                                                                           |
|                   | Input Clock Frequency                        |                    |     |     |       |                                                                                           |
|                   | $V_{DD} \geq 4.75\text{ V}$                  | –                  | –   | 49  | MHz   |                                                                                           |
|                   | $V_{DD} < 4.75\text{ V}$                     | –                  | –   | 25  | MHz   |                                                                                           |
| CRCPRS (PRS Mode) | Input Clock Frequency                        |                    |     |     |       |                                                                                           |
|                   | $V_{DD} \geq 4.75\text{ V}$                  | –                  | –   | 49  | MHz   |                                                                                           |
|                   | $V_{DD} < 4.75\text{ V}$                     | –                  | –   | 25  | MHz   |                                                                                           |
| CRCPRS (CRC Mode) | Input Clock Frequency                        | –                  | –   | 25  | MHz   |                                                                                           |
| SPIM              | Input Clock Frequency                        | –                  | –   | 8.2 | MHz   | The SPI serial clock (SCLK) frequency is equal to the input clock frequency divided by 2. |
| SPIS              | Input Clock (SCLK) Frequency                 | –                  | –   | 4.1 | MHz   | The input clock is the SPI SCLK in SPIS mode.                                             |
|                   | Width of SS_Negated Between Transmissions    | 50 <sup>[13]</sup> | –   | –   | ns    |                                                                                           |
| Transmitter       | Input Clock Frequency                        |                    |     |     |       | The baud rate is equal to the input clock frequency divided by 8.                         |
|                   | $V_{DD} \geq 4.75\text{ V}$ , 2 Stop Bits    | –                  | –   | 49  | MHz   |                                                                                           |
|                   | $V_{DD} \geq 4.75\text{ V}$ , 1 Stop Bit     | –                  | –   | 25  | MHz   |                                                                                           |
|                   | $V_{DD} < 4.75\text{ V}$                     | –                  | –   | 25  | MHz   |                                                                                           |
| Receiver          | Input Clock Frequency                        |                    |     |     |       | The baud rate is equal to the input clock frequency divided by 8.                         |
|                   | $V_{DD} \geq 4.75\text{ V}$ , 2 Stop Bits    | –                  | –   | 49  | MHz   |                                                                                           |
|                   | $V_{DD} \geq 4.75\text{ V}$ , 1 Stop Bit     | –                  | –   | 25  | MHz   |                                                                                           |
|                   | $V_{DD} < 4.75\text{ V}$                     | –                  | –   | 25  | MHz   |                                                                                           |

**Note**

27. 50 ns minimum input pulse width is based on the input synchronizers running at 24 MHz (42 ns nominal period).

### 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  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 50. 5 V AC Analog Output Buffer Specifications**

| Symbol                   | Description                                                                                     | Min          | Typ    | Max        | Units                                            | Notes |
|--------------------------|-------------------------------------------------------------------------------------------------|--------------|--------|------------|--------------------------------------------------|-------|
| $t_{\text{ROB}}$         | Rising Settling Time to 0.1%, 1 V Step, 100 pF Load<br>Power = Low<br>Power = High              | —<br>—       | —<br>— | 2.5<br>2.9 | $\mu\text{s}$<br>$\mu\text{s}$                   |       |
| $t_{\text{SOB}}$         | Falling Settling Time to 0.1%, 1 V Step, 100 pF Load<br>Power = Low<br>Power = High             | —<br>—       | —<br>— | 2.3<br>2.3 | $\mu\text{s}$<br>$\mu\text{s}$                   |       |
| $\text{SR}_{\text{ROB}}$ | Rising Slew Rate (20% to 80%), 1 V Step, 100 pF Load<br>Power = Low<br>Power = High             | 0.65<br>0.65 | —<br>— | —<br>—     | $\text{V}/\mu\text{s}$<br>$\text{V}/\mu\text{s}$ |       |
| $\text{SR}_{\text{FOB}}$ | Falling Slew Rate (80% to 20%), 1 V Step, 100 pF Load<br>Power = Low<br>Power = High            | 0.65<br>0.65 | —<br>— | —<br>—     | $\text{V}/\mu\text{s}$<br>$\text{V}/\mu\text{s}$ |       |
| $\text{BW}_{\text{OB}}$  | Small Signal Bandwidth, 20mV <sub>pp</sub> , 3dB BW, 100 pF Load<br>Power = Low<br>Power = High | 0.8<br>0.8   | —<br>— | —<br>—     | MHz<br>MHz                                       |       |
| $\text{BW}_{\text{OB}}$  | Large Signal Bandwidth, 1 V <sub>pp</sub> , 3dB BW, 100 pF Load<br>Power = Low<br>Power = High  | 300<br>300   | —<br>— | —<br>—     | kHz<br>kHz                                       |       |

**Table 51. 3.3 V AC Analog Output Buffer Specifications**

| Symbol                   | Description                                                                                     | Min          | Typ    | Max        | Units                                            | Notes |
|--------------------------|-------------------------------------------------------------------------------------------------|--------------|--------|------------|--------------------------------------------------|-------|
| $t_{\text{ROB}}$         | Rising Settling Time to 0.1%, 1 V Step, 100 pF Load<br>Power = Low<br>Power = High              | —<br>—       | —<br>— | 3.8<br>3.8 | $\mu\text{s}$<br>$\mu\text{s}$                   |       |
| $t_{\text{SOB}}$         | Falling Settling Time to 0.1%, 1 V Step, 100 pF Load<br>Power = Low<br>Power = High             | —<br>—       | —<br>— | 3.2<br>2.9 | $\mu\text{s}$<br>$\mu\text{s}$                   |       |
| $\text{SR}_{\text{ROB}}$ | Rising Slew Rate (20% to 80%), 1 V Step, 100 pF Load<br>Power = Low<br>Power = High             | 0.5<br>0.5   | —<br>— | —<br>—     | $\text{V}/\mu\text{s}$<br>$\text{V}/\mu\text{s}$ |       |
| $\text{SR}_{\text{FOB}}$ | Falling Slew Rate (80% to 20%), 1 V Step, 100 pF Load<br>Power = Low<br>Power = High            | 0.5<br>0.5   | —<br>— | —<br>—     | $\text{V}/\mu\text{s}$<br>$\text{V}/\mu\text{s}$ |       |
| $\text{BW}_{\text{OB}}$  | Small Signal Bandwidth, 20mV <sub>pp</sub> , 3dB BW, 100 pF Load<br>Power = Low<br>Power = High | 0.64<br>0.64 | —<br>— | —<br>—     | MHz<br>MHz                                       |       |
| $\text{BW}_{\text{OB}}$  | Large Signal Bandwidth, 1 V <sub>pp</sub> , 3dB BW, 100 pF Load<br>Power = Low<br>Power = High  | 200<br>200   | —<br>— | —<br>—     | kHz<br>kHz                                       |       |

### AC SAR10 ADC Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 52. AC SAR10 ADC Specifications**

| Symbol               | Description                                                 | Min | Typ | Max   | Units | Notes                                                                          |
|----------------------|-------------------------------------------------------------|-----|-----|-------|-------|--------------------------------------------------------------------------------|
| $F_{\text{INSAR10}}$ | Input clock frequency for SAR10 ADC                         | –   | –   | 2.0   | MHz   |                                                                                |
| $F_{\text{SSAR10}}$  | Sample rate for SAR10 ADC<br>SAR10 ADC Resolution = 10 bits | –   | –   | 142.9 | ksps  | For 10-bit resolution, the sample rate is the ADC's input clock divided by 14. |

### 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  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 53. 5 V AC External Clock Specifications**

| Symbol              | Description            | Min   | Typ | Max  | Units         | Notes |
|---------------------|------------------------|-------|-----|------|---------------|-------|
| $F_{\text{OSCEXT}}$ | Frequency              | 0.093 | –   | 24.6 | MHz           |       |
| –                   | High Period            | 20.6  | –   | 5300 | ns            |       |
| –                   | Low Period             | 20.6  | –   | –    | ns            |       |
| –                   | Power-up IMO to Switch | 150   | –   | –    | $\mu\text{s}$ |       |

**Table 54. 3.3 V AC External Clock Specifications**

| Symbol              | Description                                                     | Min   | Typ | Max  | Units         | Notes |
|---------------------|-----------------------------------------------------------------|-------|-----|------|---------------|-------|
| $F_{\text{OSCEXT}}$ | Frequency with CPU Clock divide by 1 <sup>[28]</sup>            | 0.093 | –   | 12.3 | MHz           |       |
| $F_{\text{OSCEXT}}$ | Frequency with CPU Clock divide by 2 or greater <sup>[29]</sup> | 0.186 | –   | 24.6 | MHz           |       |
| –                   | High Period with CPU Clock divide by 1                          | 41.7  | –   | 5300 | ns            |       |
| –                   | Low Period with CPU Clock divide by 1                           | 41.7  | –   | –    | ns            |       |
| –                   | Power-up IMO to Switch                                          | 150   | –   | –    | $\mu\text{s}$ |       |

### Notes

28. Maximum CPU frequency is 12 MHz at 3.3 V. With the CPU clock divider set to 1, the external clock must adhere to the maximum frequency and duty cycle requirements.  
 29. If the frequency of the external clock is greater than 12 MHz, the CPU clock divider must be set to 2 or greater. In this case, the CPU clock divider ensures that the fifty percent duty cycle requirement is met.

### 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  $-40\text{ }^{\circ}\text{C} \leq T_A \leq 85\text{ }^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40\text{ }^{\circ}\text{C} \leq T_A \leq 85\text{ }^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at 25 °C and are for design guidance only.

**Table 55. AC Programming Specifications**

| Symbol                     | Description                                | Min | Typ | Max                 | Units | Notes                                                                 |
|----------------------------|--------------------------------------------|-----|-----|---------------------|-------|-----------------------------------------------------------------------|
| $t_{\text{RCLK}}$          | Rise Time of SCLK                          | 1   | –   | 20                  | ns    |                                                                       |
| $t_{\text{FCLK}}$          | Fall Time of SCLK                          | 1   | –   | 20                  | ns    |                                                                       |
| $t_{\text{SSCLK}}$         | Data Setup Time to Falling Edge of SCLK    | 40  | –   | –                   | ns    |                                                                       |
| $t_{\text{HCLK}}$          | Data Hold Time from Falling Edge of SCLK   | 40  | –   | –                   | ns    |                                                                       |
| $F_{\text{SCLK}}$          | Frequency of SCLK                          | 0   | –   | 8                   | MHz   |                                                                       |
| $t_{\text{ERASEB}}$        | Flash Erase Time (Block)                   | –   | 10  | –                   | ms    |                                                                       |
| $t_{\text{WRITE}}$         | Flash Block Write Time                     | –   | 40  | –                   | ms    |                                                                       |
| $t_{\text{DSCLK}}$         | Data Out Delay from Falling Edge of SCLK   | –   | –   | 55                  | ns    | $V_{\text{DD}} > 3.6$                                                 |
| $t_{\text{DSCLK3}}$        | Data Out Delay from Falling Edge of SCLK   | –   | –   | 75                  | ns    | $3.0 \leq V_{\text{DD}} \leq 3.6$                                     |
| $t_{\text{ERASEALL}}$      | Flash Erase Time (Bulk)                    | –   | 40  | –                   | ms    | Erase all blocks and protection fields at once.                       |
| $t_{\text{PROGRAM\_HOT}}$  | Flash Block Erase + Flash Block Write Time | –   | –   | 100 <sup>[30]</sup> | ms    | $0\text{ }^{\circ}\text{C} \leq T_j \leq 100\text{ }^{\circ}\text{C}$ |
| $t_{\text{PROGRAM\_COLD}}$ | Flash Block Erase + Flash Block Write Time | –   | –   | 200 <sup>[30]</sup> | ms    | $-40\text{ }^{\circ}\text{C} \leq T_j \leq 0\text{ }^{\circ}\text{C}$ |

#### Note

30. 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 at <http://www.cypress.com> under Application Notes for more information.

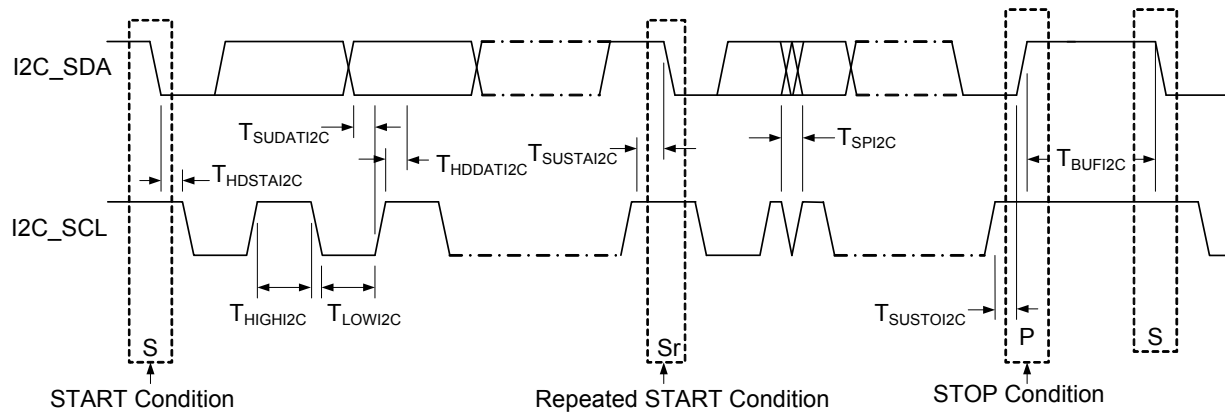
### AC I<sup>2</sup>C Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75 V to 5.25 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 3.0 V to 3.6 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , respectively. Typical parameters apply to 5 V and 3.3 V at  $25^{\circ}\text{C}$  and are for design guidance only.

**Table 56. AC Characteristics of the I<sup>2</sup>C SDA and SCL Pins**

| Symbol                       | Description                                                                                  | Standard Mode |     | Fast Mode           |     | Units         | Notes |
|------------------------------|----------------------------------------------------------------------------------------------|---------------|-----|---------------------|-----|---------------|-------|
|                              |                                                                                              | Min           | Max | Min                 | Max |               |       |
| $F_{\text{SCL}2\text{C}}$    | SCL clock frequency                                                                          | 0             | 100 | 0                   | 400 | kHz           |       |
| $t_{\text{HDSTA}2\text{C}}$  | Hold time (repeated) START condition. After this period, the first clock pulse is generated. | 4.0           | –   | 0.6                 | –   | $\mu\text{s}$ |       |
| $t_{\text{LOW}2\text{C}}$    | LOW period of the SCL clock                                                                  | 4.7           | –   | 1.3                 | –   | $\mu\text{s}$ |       |
| $t_{\text{HIGH}2\text{C}}$   | HIGH period of the SCL clock                                                                 | 4.0           | –   | 0.6                 | –   | $\mu\text{s}$ |       |
| $t_{\text{SUSTA}2\text{C}}$  | Setup time for a repeated START condition                                                    | 4.7           | –   | 0.6                 | –   | $\mu\text{s}$ |       |
| $t_{\text{HDDAT}2\text{C}}$  | Data hold time                                                                               | 0             | –   | 0                   | –   | $\mu\text{s}$ |       |
| $t_{\text{SUDAT}2\text{C}}$  | Data setup time                                                                              | 250           | –   | 100 <sup>[31]</sup> | –   | ns            |       |
| $t_{\text{SUSTOI}2\text{C}}$ | Setup time for STOP condition                                                                | 4.0           | –   | 0.6                 | –   | $\mu\text{s}$ |       |
| $t_{\text{BUFI}2\text{C}}$   | Bus free time between a STOP and START condition                                             | 4.7           | –   | 1.3                 | –   | $\mu\text{s}$ |       |
| $t_{\text{SPI}2\text{C}}$    | Pulse width of spikes are suppressed by the input filter.                                    | –             | –   | 0                   | 50  | ns            |       |

**Figure 16. Definition for Timing for Fast/Standard Mode on the I<sup>2</sup>C Bus**



#### Note

31. A Fast-Mode I<sup>2</sup>C-bus device can be used in a Standard-Mode I<sup>2</sup>C-bus system, but the requirement  $T_{\text{SUDAT}2\text{C}} \geq 250$  ns must then be met. This is automatically 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  $t_{\text{max}} + T_{\text{SUDAT}2\text{C}} = 1000 + 250 = 1250$  ns (according to the Standard-Mode I<sup>2</sup>C-bus specification) before the SCL line is released.

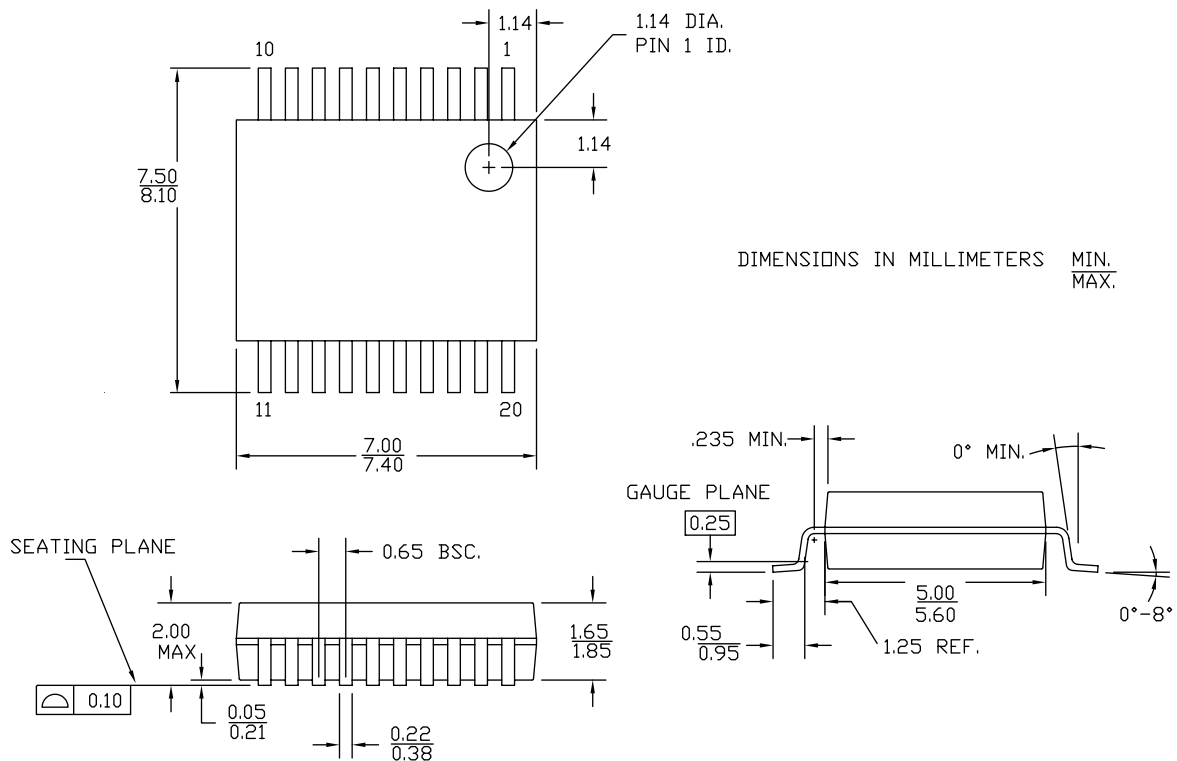
## Packaging Information

This section illustrates the packaging specifications for the CY8C28xxx PSoC devices, along with the thermal impedances for each package and the typical package capacitance on crystal pins.

**Important Note** Emulation tools may require a larger area on the target PCB than the chip's footprint. For a detailed description of the emulation tools' dimensions, refer to the Emulator Pod Dimension drawings at <http://www.cypress.com>.

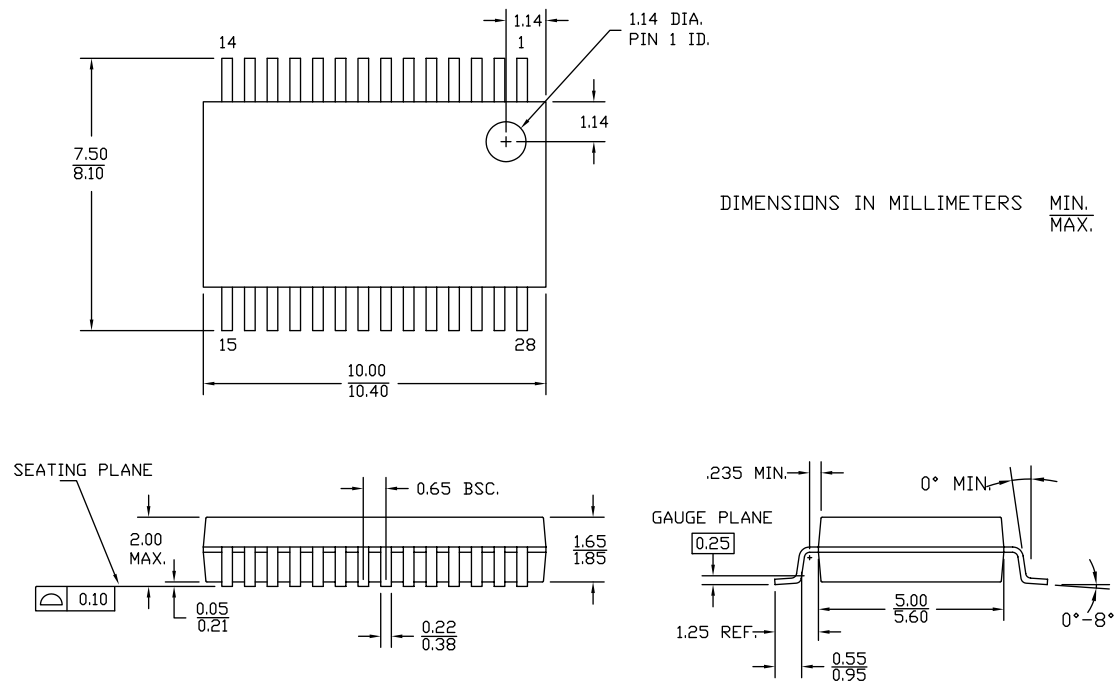
### Packaging Dimensions

**Figure 17. 20-pin SSOP (210 Mils) Package Outline O20.21, 51-85077**



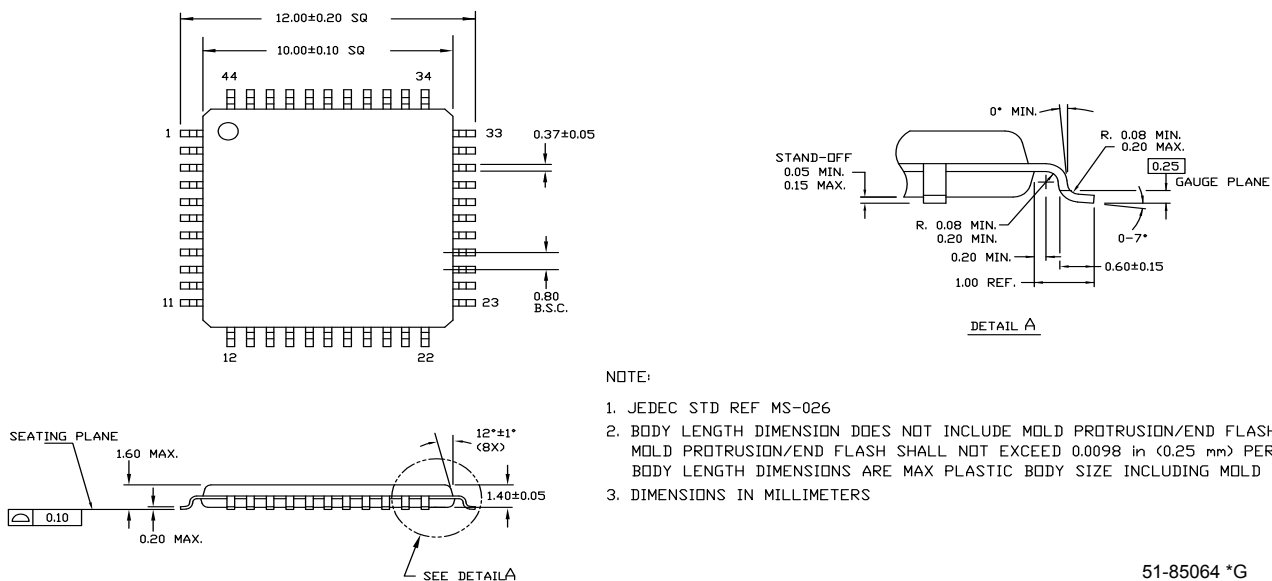
51-85077 \*F

Figure 18. 28-pin SSOP (210 Mils) O28.21 Package Outline, 51-85079



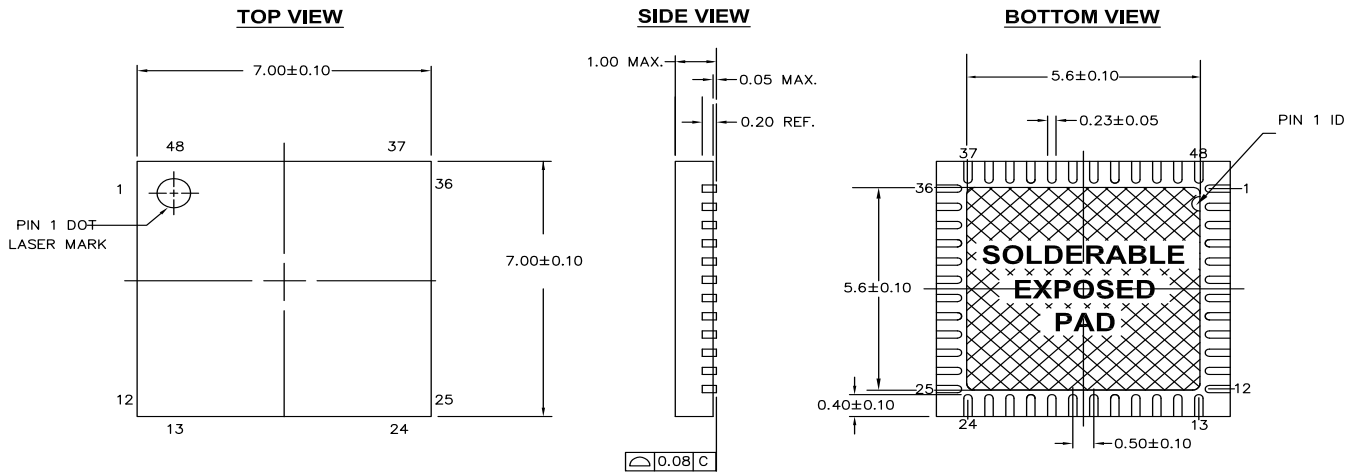
51-85079 \*F

Figure 19. 44-pin TQFP (10 × 10 × 1.4 mm) A44S Package Outline, 51-85064



51-85064 \*G

Figure 20. 48-pin QFN (7 × 7 × 1.0 mm) LT48D 5.6 × 5.6 E-Pad (Sawn Type) Package Outline, 001-45616



NOTES:

1.  HATCH AREA IS SOLDERABLE EXPOSED METAL.
2. REFERENCE JEDEC#: MO-220
3. PACKAGE WEIGHT: REFER TO PMDD SPEC.
4. ALL DIMENSIONS ARE IN MM [MIN/MAX]
5. PACKAGE CODE

| PART # | DESCRIPTION |
|--------|-------------|
| LT48D  | LEAD FREE   |

001-45616 \*F

**Important Note** For information on the preferred dimensions for mounting QFN packages, see the following application note, *Design Guidelines for Cypress Quad Flat No Extended Lead (QFN) Packaged Devices* – AN72845 available at <http://www.cypress.com>.

NOTE:

1. PACKAGE WEIGHT : REFER TO PMDD SPEC.
2. DIMENSIONS IN INCHES MIN.  
MAX.

The drawing includes three views of a PMDD package:

- Top View:** Shows a rectangular package with 28 pins on the left, 56 pins on the right, and 1 pin on the top. Dimensions include a width of 0.395 (min) to 0.420 (max) and a height of 0.292 (min) to 0.299 (max). A pin 1 indicator is shown.
- Side View:** Shows the package height with dimensions 0.088 (min) to 0.092 (max) and a total height of 0.720 (min) to 0.730 (max). It also shows a 0.025 BSC dimension for the pin pitch.
- Cross-sectional View:** Shows the internal structure with dimensions for the seating plane (0.095 to 0.110), gauge plane (0.010), and a 0°-8° angle. Other dimensions include 0.008 (min) to 0.0135 (max) for the pin height, 0.008 (min) to 0.016 (max) for the pin width, and 0.024 (min) to 0.040 (max) for the pin length.

51-85062 \*F

## Thermal Impedances

**Table 57. Thermal Impedances per Package**

| Package                    | Typical $\theta_{JA}$ <sup>[32]</sup> |
|----------------------------|---------------------------------------|
| 20-pin SSOP                | 80.8 °C/W                             |
| 28-pin SSOP                | 45.4 °C/W                             |
| 44-pin TQFP                | 24.0 °C/W                             |
| 48-pin QFN <sup>[33]</sup> | 16.7 °C/W                             |
| 56-pin SSOP                | 67.5 °C/W                             |

## Capacitance on Crystal Pins

**Table 58. Typical Package Capacitance on Crystal Pins**

| Package     | Package Capacitance                        |
|-------------|--------------------------------------------|
| 20-pin SSOP | Pin9 = 0.0056 pF<br>Pin11 = 0.006048 pF    |
| 28-pin SSOP | Pin13 = 0.006796 pF<br>Pin15 = 0.006755 pF |
| 44-pin TQFP | Pin16 = 0.009428 pF<br>Pin18 = 0.008635 pF |
| 48-pin QFN  | Pin17 = 0.008493 pF<br>Pin19 = 0.008742 pF |
| 56-pin SSOP | Pin27 = 0.007916 pF<br>Pin31 = 0.007132 pF |

## Solder Reflow Specifications

Table 59 shows the solder reflow temperature limits that must not be exceeded.

**Table 59. Solder Reflow Specifications**

| Package     | Maximum Peak Temperature ( $T_C$ ) | Maximum Time above $T_C - 5\text{ °C}$ |
|-------------|------------------------------------|----------------------------------------|
| 20-pin SSOP | 260 °C                             | 30 seconds                             |
| 28-pin SSOP | 260 °C                             | 30 seconds                             |
| 44-pin TQFP | 260 °C                             | 30 seconds                             |
| 48-pin QFN  | 260 °C                             | 30 seconds                             |
| 56-pin SSOP | 260 °C                             | 30 seconds                             |

### Notes

32.  $T_J = T_A + \text{POWER} \times \theta_{JA}$

33. To achieve the thermal impedance specified for the QFN package, refer to *Design Guidelines for Cypress Quad Flat No Extended Lead (QFN) Packaged Devices – AN72845* available at <http://www.cypress.com> for PCB requirements.

34. Higher temperatures may be required based on the solder melting point. Typical temperatures for solder are  $220 \pm 5\text{ °C}$  with Sn-Pb or  $245 \pm 5\text{ °C}$  with Sn-Ag-Cu paste. Refer to the solder manufacturer specifications.

## Development Tool Selection

This section presents the development tools available for all current PSoC device families including the CY8C28xxx family.

### Software

#### *PSoC Designer*

At the core of the PSoC development software suite is PSoC Designer. Utilized by thousands of PSoC developers, this robust software has been facilitating PSoC designs for over half a decade. PSoC Designer is available free of charge at <http://www.cypress.com>.

#### *PSoC Programmer*

Flexible enough to be used on the bench in development, yet suitable for factory programming, PSoC Programmer works either as a standalone programming application or it can operate directly from PSoC Designer. PSoC Programmer software is compatible with both PSoC ICE-Cube In-Circuit Emulator and PSoC MiniProg. PSoC Programmer is available free of charge at <http://www.cypress.com>.

### Development Kits

All development kits can be purchased from the Cypress Online Store.

#### *CY3215-DK Basic Development Kit*

The CY3215-DK is for prototyping and development with PSoC Designer. This kit supports in-circuit emulation and the software interface allows users to run, halt, and single step the processor and view the content of specific memory locations. Advanced emulation features are supported in PSoC Designer. The kit includes:

- PSoC Designer Software CD
- ICE-Cube In-Circuit Emulator
- Pod kit for CY8C29x66 PSoC Family
- Cat-5 Adapter
- Mini-Eval Programming Board
- 110 ~ 240 V Power Supply, Euro-Plug Adapter
- ISSP Cable
- USB 2.0 Cable and Blue Cat-5 Cable
- 2 CY8C29466-24PXI 28-PDIP Chip Samples

### Evaluation Tools

All evaluation tools can be purchased from the Cypress Online Store.

#### *CY3210-MiniProg1*

The CY3210-MiniProg1 kit allows a user to program PSoC devices via the MiniProg1 programming unit. The MiniProg is a small, compact prototyping programmer that connects to the PC via a provided USB 2.0 cable. The kit includes:

- MiniProg Programming Unit
- MiniEval Socket Programming and Evaluation Board
- 28-Pin CY8C29466-24PXI PDIP PSoC Device Sample
- 28-Pin CY8C27443-24PXI PDIP PSoC Device Sample
- PSoC Designer Software CD
- Getting Started Guide
- USB 2.0 Cable

#### *CY3210-PSoCEval1*

The CY3210-PSoCEval1 kit features an evaluation board and the MiniProg1 programming unit. The evaluation board includes an LCD module, potentiometer, LEDs, and plenty of bread-boarding space to meet all of your evaluation needs. The kit includes:

- Evaluation Board with LCD Module
- MiniProg Programming Unit
- 28-Pin CY8C29466-24PXI PDIP PSoC Device Sample (2)
- PSoC Designer Software CD
- Getting Started Guide
- USB 2.0 Cable

## Device Programmers

All device programmers can be purchased from the Cypress Online Store.

### *CY3207ISSP In-System Serial Programmer (ISSP)*

The CY3207ISSP is a production programmer. It includes protection circuitry and an industrial case that is more robust than the MiniProg in a production-programming environment.

**Note** The CY3207ISSP programmer needs the PSoC ISSP software. It is not compatible with the PSoC Programmer

software. The latest PSoC ISSP software for this kit can be downloaded from <http://www.cypress.com>. The kit includes:

- CY3207 Programmer Unit
- PSoC ISSP Software CD
- 110 ~ 240 V Power Supply, Euro-Plug Adapter
- USB 2.0 Cable

## Accessories (Emulation and Programming)

**Table 60. Emulation and Programming Accessories**

| Part #           | Pin Package | Pod Kit <sup>[35]</sup> | Foot Kit <sup>[36]</sup> | Adapter <sup>[37]</sup>                                                                    |
|------------------|-------------|-------------------------|--------------------------|--------------------------------------------------------------------------------------------|
| CY8C28243-24PVXI | 20-SSOP     | CY3250-28XXX            | CY3250-20SSOP-FK         | Adapters can be found at <a href="http://www.emulation.com">http://www.emulation.com</a> . |
| CY8C28403-24PVXI | 28-SSOP     | CY3250-28XXX            | CY3250-28SSOP-FK         |                                                                                            |
| CY8C28413-24PVXI |             |                         |                          |                                                                                            |
| CY8C28433-24PVXI |             |                         |                          |                                                                                            |
| CY8C28445-24PVXI |             |                         |                          |                                                                                            |
| CY8C28452-24PVXI |             |                         |                          |                                                                                            |
| CY8C28513-24AXI  | 44-TQFP     | CY3250-28XXX            | CY3250-44TQFP-FK         |                                                                                            |
| CY8C28545-24AXI  |             |                         |                          |                                                                                            |
| CY8C28623-24LTXI | 48-QFN      | CY3250-28XXXQFN         | CY3250-48QFN-FK          |                                                                                            |
| CY8C28643-24LTXI |             |                         |                          |                                                                                            |
| CY8C28645-24LTXI |             |                         |                          |                                                                                            |

### Notes

35. Pod kit contains an emulation pod, a flex-cable (connects the pod to the ICE), two feet, and device samples.

36. Foot kit includes surface mount feet that can be soldered to the target PCB.

37. Programming adapter converts non-DIP package to DIP footprint. Specific details and ordering information for each of the adapters can be found at <http://www.emulation.com>.

## Ordering Information

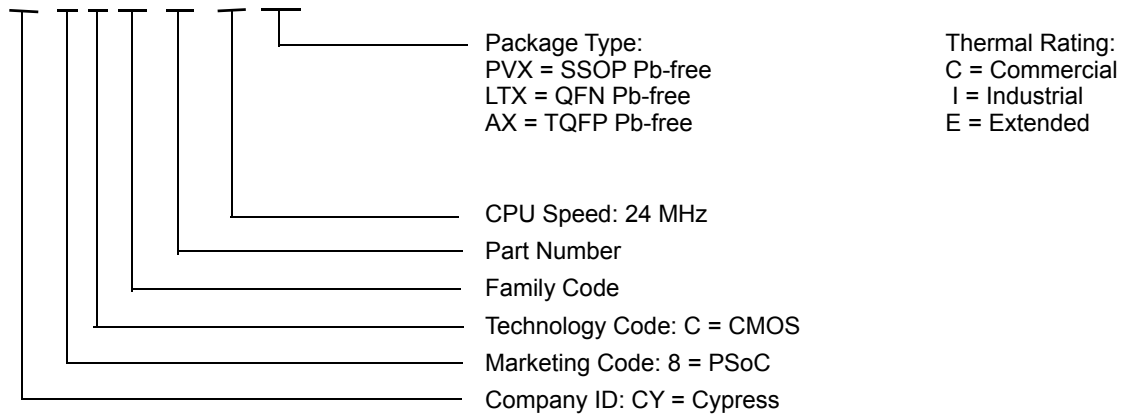
The following table lists the CY8C28xxx PSoC devices key package features and ordering codes.

| Package                               | Ordering Code     | Temperature Range | CapSense | Digital Blocks | Regular Analog Blocks | Limited Analog Blocks | HW I <sup>2</sup> C | Decimators | 10-bit SAR ADC | Digital I/O Pins | Analog Inputs | Analog Outputs | Flash (KBytes) | RAM (KBytes) | XRES Pin |
|---------------------------------------|-------------------|-------------------|----------|----------------|-----------------------|-----------------------|---------------------|------------|----------------|------------------|---------------|----------------|----------------|--------------|----------|
| 28-Pin (210-Mil) SSOP                 | CY8C28403-24PVXI  | –40 °C to 85 °C   | N        | 12             | 0                     | 0                     | 2                   | 0          | Y              | 24               | 8             | 0              | 16             | 1            | Y        |
| 28-Pin (210-Mil) SSOP (Tape and Reel) | CY8C28403-24PVXIT | –40 °C to 85 °C   | N        | 12             | 0                     | 0                     | 2                   | 0          | Y              | 24               | 8             | 0              | 16             | 1            | Y        |
| 28-Pin (210-Mil) SSOP                 | CY8C28413-24PVXI  | –40 °C to 85 °C   | Y        | 12             | 0                     | 4                     | 1                   | 2          | Y              | 24               | 24            | 0              | 16             | 1            | Y        |
| 28-Pin (210-Mil) SSOP (Tape and Reel) | CY8C28413-24PVXIT | –40 °C to 85 °C   | Y        | 12             | 0                     | 4                     | 1                   | 2          | Y              | 24               | 24            | 0              | 16             | 1            | Y        |
| 44-Pin TQFP                           | CY8C28513-24AXI   | –40 °C to 85 °C   | Y        | 12             | 0                     | 4                     | 1                   | 2          | Y              | 40               | 40            | 0              | 16             | 1            | Y        |
| 44-Pin TQFP (Tape and Reel)           | CY8C28513-24AXIT  | –40 °C to 85 °C   | Y        | 12             | 0                     | 4                     | 1                   | 2          | Y              | 40               | 40            | 0              | 16             | 1            | Y        |
| 48-Pin Sawn QFN                       | CY8C28623-24LTXI  | –40 °C to 85 °C   | N        | 12             | 6                     | 0                     | 2                   | 2          | N              | 44               | 10            | 2              | 16             | 1            | Y        |
| 48-Pin Sawn QFN (Tape and Reel)       | CY8C28623-24LTXIT | –40 °C to 85 °C   | N        | 12             | 6                     | 0                     | 2                   | 2          | N              | 44               | 10            | 2              | 16             | 1            | Y        |
| 28-Pin (210-Mil) SSOP                 | CY8C28433-24PVXI  | –40 °C to 85 °C   | Y        | 12             | 6                     | 4                     | 1                   | 4          | Y              | 24               | 24            | 2              | 16             | 1            | Y        |
| 28-Pin (210-Mil) SSOP (Tape and Reel) | CY8C28433-24PVXIT | –40 °C to 85 °C   | Y        | 12             | 6                     | 4                     | 1                   | 4          | Y              | 24               | 24            | 2              | 16             | 1            | Y        |
| 20-Pin (210-Mil) SSOP                 | CY8C28243-24PVXI  | –40 °C to 85 °C   | N        | 12             | 12                    | 0                     | 2                   | 4          | Y              | 16               | 16            | 4              | 16             | 1            | Y        |
| 20-Pin (210-Mil) SSOP (Tape and Reel) | CY8C28243-24PVXIT | –40 °C to 85 °C   | N        | 12             | 12                    | 0                     | 2                   | 4          | Y              | 16               | 16            | 4              | 16             | 1            | Y        |
| 48-Pin Sawn QFN                       | CY8C28643-24LTXI  | –40 °C to 85 °C   | N        | 12             | 12                    | 0                     | 2                   | 4          | Y              | 44               | 44            | 4              | 16             | 1            | Y        |
| 48-Pin Sawn QFN (Tape and Reel)       | CY8C28643-24LTXIT | –40 °C to 85 °C   | N        | 12             | 12                    | 0                     | 2                   | 4          | Y              | 44               | 44            | 4              | 16             | 1            | Y        |
| 28-Pin (210-Mil) SSOP                 | CY8C28445-24PVXI  | –40 °C to 85 °C   | Y        | 12             | 12                    | 4                     | 2                   | 4          | Y              | 24               | 24            | 4              | 16             | 1            | Y        |
| 28-Pin (210-Mil) SSOP (Tape and Reel) | CY8C28445-24PVXIT | –40 °C to 85 °C   | Y        | 12             | 12                    | 4                     | 2                   | 4          | Y              | 24               | 24            | 4              | 16             | 1            | Y        |
| 44-Pin TQFP                           | CY8C28545-24AXI   | –40 °C to 85 °C   | Y        | 12             | 12                    | 4                     | 2                   | 4          | Y              | 40               | 40            | 4              | 16             | 1            | Y        |
| 44-Pin TQFP (Tape and Reel)           | CY8C28545-24AXIT  | –40 °C to 85 °C   | Y        | 12             | 12                    | 4                     | 2                   | 4          | Y              | 40               | 40            | 4              | 16             | 1            | Y        |
| 48-Pin Sawn QFN                       | CY8C28645-24LTXI  | –40 °C to 85 °C   | Y        | 12             | 12                    | 4                     | 2                   | 4          | Y              | 44               | 44            | 4              | 16             | 1            | Y        |
| 48-Pin Sawn QFN (Tape and Reel)       | CY8C28645-24LTXIT | –40 °C to 85 °C   | Y        | 12             | 12                    | 4                     | 2                   | 4          | Y              | 44               | 44            | 4              | 16             | 1            | Y        |
| 28-Pin (210-Mil) SSOP                 | CY8C28452-24PVXI  | –40 °C to 85 °C   | Y        | 8              | 12                    | 4                     | 1                   | 4          | N              | 24               | 24            | 4              | 16             | 1            | Y        |
| 28-Pin (210-Mil) SSOP (Tape and Reel) | CY8C28452-24PVXIT | –40 °C to 85 °C   | Y        | 8              | 12                    | 4                     | 1                   | 4          | N              | 24               | 24            | 4              | 16             | 1            | Y        |
| 56-Pin SSOP OCD                       | CY8C28000-24PVXI  | –40 °C to 85 °C   | Y        | 12             | 12                    | 4                     | 2                   | 4          | Y              | 44               | 44            | 4              | 16             | 1            | Y        |

**Note** For Die sales information, contact a local Cypress sales office or Field Applications Engineer (FAE).

### Ordering Code Definitions

CY 8 C 28 xxx - SP xxxx



## Acronyms

### Acronyms Used

Table 61 lists the acronyms that are used in this document.

**Table 61. Acronyms Used in this Datasheet**

| Acronym | Description                                         | Acronym | Description                                   |
|---------|-----------------------------------------------------|---------|-----------------------------------------------|
| AC      | alternating current                                 | MIPS    | million instructions per second               |
| ADC     | analog-to-digital converter                         | OCD     | on-chip debug                                 |
| API     | application programming interface                   | PCB     | printed circuit board                         |
| CMOS    | complementary metal oxide semiconductor             | PDIP    | plastic dual-in-line package                  |
| CPU     | central processing unit                             | PGA     | programmable gain amplifier                   |
| CRC     | cyclic redundancy check                             | PLL     | phase-locked loop                             |
| CT      | continuous time                                     | POR     | power on reset                                |
| DAC     | digital-to-analog converter                         | PPOR    | precision power on reset                      |
| DC      | direct current                                      | PRS     | pseudo-random sequence                        |
| DTMF    | dual-tone multi-frequency                           | PSoC®   | Programmable System-on-Chip                   |
| ECO     | external crystal oscillator                         | PWM     | pulse width modulator                         |
| EEPROM  | electrically erasable programmable read-only memory | QFN     | quad flat no leads                            |
| GPIO    | general purpose I/O                                 | RTC     | real time clock                               |
| ICE     | in-circuit emulator                                 | SAR     | successive approximation                      |
| IDE     | integrated development environment                  | SC      | switched capacitor                            |
| ILO     | internal low speed oscillator                       | SLIMO   | slow IMO                                      |
| IMO     | internal main oscillator                            | SMP     | switch mode pump                              |
| I/O     | input/output                                        | SOIC    | small-outline integrated circuit              |
| IrDA    | infrared data association                           | SPI™    | serial peripheral interface                   |
| ISSP    | in-system serial programming                        | SRAM    | static random access memory                   |
| LCD     | liquid crystal display                              | SROM    | supervisory read only memory                  |
| LED     | light-emitting diode                                | SSOP    | shrink small-outline package                  |
| LPC     | low power comparator                                | UART    | universal asynchronous receiver / transmitter |
| LVD     | low voltage detect                                  | USB     | universal serial bus                          |
| MAC     | multiply-accumulate                                 | WDT     | watchdog timer                                |
| MCU     | microcontroller unit                                | XRES    | external reset                                |

## Reference Documents

CY8CPLC20, CY8CLED16P01, CY8C29x66, CY8C27x43, CY8C24x94, CY8C24x23, CY8C24x23A, CY8C22x13, CY8C21x34, CY8C21x23, CY7C64215, CY7C603xx, CY8CNP1xx, and CYWUSB6953 PSoC® Programmable System-on-Chip Technical Reference Manual (TRM) (001-14463)

Design Aids – Reading and Writing PSoC® Flash – AN2015 (001-40459)

Design Guidelines for Cypress Quad Flat No Extended Lead (QFN) Packaged Devices – AN72845 available at <http://www.cypress.com>.

## Document Conventions

### Units of Measure

Table 62 lists the unit sof measures.

**Table 62. Units of Measure**

| Symbol | Unit of Measure | Symbol | Unit of Measure         |
|--------|-----------------|--------|-------------------------|
| kB     | 1024 bytes      | μs     | microsecond             |
| dB     | decibels        | ms     | millisecond             |
| °C     | degree Celsius  | ns     | nanosecond              |
| fF     | femto farad     | ps     | picosecond              |
| pF     | picofarad       | μV     | microvolts              |
| kHz    | kilohertz       | mV     | millivolts              |
| MHz    | megahertz       | mVpp   | millivolts peak-to-peak |
| rt-Hz  | root hertz      | nV     | nanovolts               |
| kΩ     | kilohm          | V      | volts                   |
| Ω      | ohm             | μW     | microwatts              |
| μA     | microampere     | W      | watt                    |
| mA     | milliampere     | mm     | millimeter              |
| nA     | nanoampere      | ppm    | parts per million       |
| pA     | pikoampere      | %      | percent                 |
| mH     | millihenry      |        |                         |

### Numeric Conventions

Hexadecimal numbers are represented with all letters in uppercase with an appended lowercase 'h' (for example, '14h' or '3Ah'). Hexadecimal numbers may also be represented by a '0x' prefix, the C coding convention. Binary numbers have an appended lowercase 'b' (for example, 01010100b' or '01000011b'). Numbers not indicated by an 'h' or 'b' are decimals.

## Glossary

|                                         |                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| active high                             | 5. A logic signal having its asserted state as the logic 1 state.<br>6. A logic signal having the logic 1 state as the higher voltage of the two states.                                                                                                                                        |
| analog blocks                           | The basic programmable opamp circuits. These are SC (switched capacitor) and CT (continuous time) blocks. These blocks can be interconnected to provide ADCs, DACs, multi-pole filters, gain stages, and much more.                                                                             |
| analog-to-digital (ADC)                 | A device that changes an analog signal to a digital signal of corresponding magnitude. Typically, an ADC converts a voltage to a digital number. The digital-to-analog (DAC) converter performs the reverse operation.                                                                          |
| API (Application Programming Interface) | A series of software routines that comprise an interface between a computer application and lower level services and functions (for example, user modules and libraries). APIs serve as building blocks for programmers that create software applications.                                      |
| asynchronous                            | A signal whose data is acknowledged or acted upon immediately, irrespective of any clock signal.                                                                                                                                                                                                |
| Bandgap reference                       | A stable voltage reference design that matches the positive temperature coefficient of VT with the negative temperature coefficient of VBE, to produce a zero temperature coefficient (ideally) reference.                                                                                      |
| bandwidth                               | 1. The frequency range of a message or information processing system measured in hertz.<br>2. The width of the spectral region over which an amplifier (or absorber) has substantial gain (or loss); it is sometimes represented more specifically as, for example, full width at half maximum. |

## Glossary *(continued)*

|                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| bias                          | <ol style="list-style-type: none"> <li>1. A systematic deviation of a value from a reference value.</li> <li>2. The amount by which the average of a set of values departs from a reference value.</li> <li>3. The electrical, mechanical, magnetic, or other force (field) applied to a device to establish a reference level to operate the device.</li> </ol>                                                                                                                                                               |
| block                         | <ol style="list-style-type: none"> <li>1. A functional unit that performs a single function, such as an oscillator.</li> <li>2. A functional unit that may be configured to perform one of several functions, such as a digital PSoC block or an analog PSoC block.</li> </ol>                                                                                                                                                                                                                                                 |
| buffer                        | <ol style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>3. An amplifier used to lower the output impedance of a system.</li> </ol> |
| bus                           | <ol style="list-style-type: none"> <li>1. A named connection of nets. Bundling nets together in a bus makes it easier to route nets with similar routing patterns.</li> <li>2. A set of signals performing a common function and carrying similar data. Typically represented using vector notation; for example, address[7:0].</li> <li>3. One or more conductors that serve as a common connection for a group of related devices.</li> </ol>                                                                                |
| 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.                                                                                                                                                                                                                                                                                                                                                                   |

## Glossary (continued)

|                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| flash                           | An electrically programmable and erasable, non-volatile technology that provides users with the programmability and data storage of EPROMs, plus in-system erasability. Non-volatile means that the data is retained when power is off.                                                                                                                                                                                                                                                                                                                                                             |
| Flash block                     | The smallest amount of Flash ROM space that may be programmed at one time and the smallest amount of Flash space that may be protected. A Flash block holds 64 bytes.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| frequency                       | The number of cycles or events per unit of time, for a periodic function.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| gain                            | The ratio of output current, voltage, or power to input current, voltage, or power, respectively. Gain is usually expressed in dB.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| I <sup>2</sup> C                | A two-wire serial computer bus by Philips Semiconductors (now NXP Semiconductors). I <sup>2</sup> C is an Inter-Integrated Circuit. It is used to connect low-speed peripherals in an embedded system. The original system was created in the early 1980s as a battery control interface, but it was later used as a simple internal bus system for building control electronics. I <sup>2</sup> C uses only two bi-directional pins, clock and data, both running at +5 V and pulled high with resistors. The bus operates at 100 kbits/second in standard mode and 400 kbits/second in fast mode. |
| ICE                             | The in-circuit emulator that allows users to test the project in a hardware environment, while viewing the debugging device activity in a software environment (PSoC Designer).                                                                                                                                                                                                                                                                                                                                                                                                                     |
| input/output (I/O)              | A device that introduces data into or extracts data from a system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| interrupt                       | A suspension of a process, such as the execution of a computer program, caused by an event external to that process, and performed in such a way that the process can be resumed.                                                                                                                                                                                                                                                                                                                                                                                                                   |
| interrupt service routine (ISR) | A block of code that normal code execution is diverted to when the M8C receives a hardware interrupt. Many interrupt sources may each exist with its own priority and individual ISR code block. Each ISR code block ends with the RETI instruction, returning the device to the point in the program where it left normal program execution.                                                                                                                                                                                                                                                       |
| jitter                          | <ol style="list-style-type: none"> <li>1. A misplacement of the timing of a transition from its ideal position. A typical form of corruption that occurs on serial data streams.</li> <li>2. The abrupt and unwanted variations of one or more signal characteristics, such as the interval between successive pulses, the amplitude of successive cycles, or the frequency or phase of successive cycles.</li> </ol>                                                                                                                                                                               |
| low-voltage detect (LVD)        | A circuit that senses V <sub>DD</sub> and provides an interrupt to the system when V <sub>DD</sub> falls lower than a selected threshold.                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| M8C                             | An 8-bit Harvard-architecture microprocessor. The microprocessor coordinates all activity inside a PSoC by interfacing to the Flash, SRAM, and register space.                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| master device                   | A device that controls the timing for data exchanges between two devices. Or when devices are cascaded in width, the master device is the one that controls the timing for data exchanges between the cascaded devices and an external interface. The controlled device is called the <b>slave device</b> .                                                                                                                                                                                                                                                                                         |

## Glossary *(continued)*

|                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| microcontroller             | An integrated circuit chip that is designed primarily for control systems and products. In addition to a CPU, a microcontroller typically includes memory, timing circuits, and IO circuitry. The reason for this is to permit the realization of a controller with a minimal quantity of chips, thus achieving maximal possible miniaturization. This in turn, reduces the volume and the cost of the controller. The microcontroller is normally not used for general-purpose computation as is a microprocessor. |
| mixed-signal                | The reference to a circuit containing both analog and digital techniques and components.                                                                                                                                                                                                                                                                                                                                                                                                                            |
| modulator                   | A device that imposes a signal on a carrier.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| noise                       | <ol style="list-style-type: none"> <li>1. A disturbance that affects a signal and that may distort the information carried by the signal.</li> <li>2. The random variations of one or more characteristics of any entity such as voltage, current, or data.</li> </ol>                                                                                                                                                                                                                                              |
| oscillator                  | A circuit that may be crystal controlled and is used to generate a clock frequency.                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| parity                      | A technique for testing transmitting data. Typically, a binary digit is added to the data to make the sum of all the digits of the binary data either always even (even parity) or always odd (odd parity).                                                                                                                                                                                                                                                                                                         |
| phase-locked loop (PLL)     | An electronic circuit that controls an <b>oscillator</b> so that it maintains a constant phase angle relative to a reference signal.                                                                                                                                                                                                                                                                                                                                                                                |
| pinouts                     | The pin number assignment: the relation between the logical inputs and outputs of the PSoC device and their physical counterparts in the printed circuit board (PCB) package. Pinouts involve pin numbers as a link between schematic and PCB design (both being computer generated files) and may also involve pin names.                                                                                                                                                                                          |
| port                        | A group of pins, usually eight.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| power on reset (POR)        | A circuit that forces the PSoC device to reset when the voltage is lower than a pre-set level. This is one type of hardware reset.                                                                                                                                                                                                                                                                                                                                                                                  |
| PSoC®                       | Cypress Semiconductor's PSoC® is a registered trademark and Programmable System-on-Chip™ is a trademark of Cypress.                                                                                                                                                                                                                                                                                                                                                                                                 |
| PSoC Designer™              | The software for Cypress' Programmable System-on-Chip technology.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| pulse width modulator (PWM) | An output in the form of duty cycle which varies as a function of the applied measurand                                                                                                                                                                                                                                                                                                                                                                                                                             |
| RAM                         | An acronym for random access memory. A data-storage device from which data can be read out and new data can be written in.                                                                                                                                                                                                                                                                                                                                                                                          |
| register                    | A storage device with a specific capacity, such as a bit or byte.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| reset                       | A means of bringing a system back to a know state. See hardware reset and software reset.                                                                                                                                                                                                                                                                                                                                                                                                                           |
| ROM                         | An acronym for read only memory. A data-storage device from which data can be read out, but new data cannot be written in.                                                                                                                                                                                                                                                                                                                                                                                          |
| serial                      | <ol style="list-style-type: none"> <li>1. Pertaining to a process in which all events occur one after the other.</li> <li>2. Pertaining to the sequential or consecutive occurrence of two or more related activities in a single device or channel.</li> </ol>                                                                                                                                                                                                                                                     |
| settling time               | The time it takes for an output signal or value to stabilize after the input has changed from one value to another.                                                                                                                                                                                                                                                                                                                                                                                                 |

## Glossary *(continued)*

|                 |                                                                                                                                                                                                                                                                                                                                                     |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| shift register  | A memory storage device that sequentially shifts a word either left or right to output a stream of serial data.                                                                                                                                                                                                                                     |
| slave device    | A device that allows another device to control the timing for data exchanges between two devices. Or when devices are cascaded in width, the slave device is the one that allows another device to control the timing of data exchanges between the cascaded devices and an external interface. The controlling device is called the master device. |
| SRAM            | An acronym for static random access memory. A memory device allowing users to store and retrieve data at a high rate of speed. The term static is used because, after a value has been loaded into an SRAM cell, it remains unchanged until it is explicitly altered or until power is removed from the device.                                     |
| SROM            | An acronym for supervisory read only memory. The SROM holds code that is used to boot the device, calibrate circuitry, and perform Flash operations. The functions of the SROM may be accessed in normal user code, operating from Flash.                                                                                                           |
| stop bit        | A signal following a character or block that prepares the receiving device to receive the next character or block.                                                                                                                                                                                                                                  |
| synchronous     | <ol style="list-style-type: none"> <li>1. A signal whose data is not acknowledged or acted upon until the next active edge of a clock signal.</li> <li>2. A system whose operation is synchronized by a clock signal.</li> </ol>                                                                                                                    |
| tri-state       | A function whose output can adopt three states: 0, 1, and Z (high-impedance). The function does not drive any value in the Z state and, in many respects, may be considered to be disconnected from the rest of the circuit, allowing another output to drive the same net.                                                                         |
| UART            | A UART or universal asynchronous receiver-transmitter translates between parallel bits of data and serial bits.                                                                                                                                                                                                                                     |
| user modules    | Pre-build, pre-tested hardware/firmware peripheral functions that take care of managing and configuring the lower level Analog and Digital PSoC Blocks. User Modules also provide high level <b>API (Application Programming Interface)</b> for the peripheral function.                                                                            |
| user space      | The bank 0 space of the register map. The registers in this bank are more likely to be modified during normal program execution and not just during initialization. Registers in bank 1 are most likely to be modified only during the initialization phase of the program.                                                                         |
| V <sub>DD</sub> | A name for a power net meaning “voltage drain.” The most positive power supply signal. Usually 5 V or 3.3 V.                                                                                                                                                                                                                                        |
| V <sub>SS</sub> | A name for a power net meaning “voltage source.” The most negative power supply signal.                                                                                                                                                                                                                                                             |
| watchdog timer  | A timer that must be serviced periodically. If it is not serviced, the CPU resets after a specified period of time.                                                                                                                                                                                                                                 |

## Errata

This section describes the errata for CY8C28243, CY8C28403, CY8C28413, CY8C28433, CY8C28445, CY8C28452, CY8C28513, CY8C28545, CY8C28623, CY8C28643, CY8C28645 PSoC devices. Details include errata trigger conditions, scope of impact, available workarounds, and silicon revision applicability.

Please contact your local Cypress Sales Representative if you have questions.

### Part Numbers Affected

| Part Number | Device Characteristics |
|-------------|------------------------|
| CY8C28403   | All Variants           |
| CY8C28243   | All Variants           |
| CY8C28413   | All Variants           |
| CY8C28433   | All Variants           |
| CY8C28445   | All Variants           |
| CY8C28513   | All Variants           |
| CY8C28545   | All Variants           |
| CY8C28643   | All Variants           |
| CY8C28645   | All Variants           |
| CY8C28452   | All Variants           |
| CY8C28623   | All Variants           |

### Qualification Status

Engineering Samples

### Errata Summary

The following table defines the errata applicability to CY8C28xxx devices.

**Note** Each erratum in the table below is hyperlinked. Click on the item entry to jump to its description.

| Items                                              | MPN                                                                                                               | Silicon Revision | Fix Status                                                                 |
|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|------------------|----------------------------------------------------------------------------|
| 10-bit SAR ADC does not meet DNL/INL specification | CY8C28403<br>CY8C28413<br>CY8C28513<br>CY8C28433<br>CY8C28243<br>CY8C28643<br>CY8C28445<br>CY8C28545<br>CY8C28645 | *A               | Silicon fix is not planned. The workaround mentioned above should be used. |
| Wrong data read from IDAC_CRx and DACx_D registers | CY8C28413<br>CY8C28513<br>CY8C28433<br>CY8C28445<br>CY8C28545<br>CY8C28645<br>CY8C28452                           | *A               | Silicon fix is not planned. The workaround mentioned above should be used. |

## 1. 10-bit SAR ADC does not meet DNL/INL specification.

### ■ Problem Definition

The 10-bit hardware SAR ADC does not meet datasheet accuracy specifications for DNL and INL under some conditions.

### ■ Parameters Affected

INLSAR10: Integral nonlinearity

DNLSAR10: Differential nonlinearity

### ■ Trigger Condition(S)

The SAR ADC DNL has been measured greater than 2 LSB over temperature in all cases, as compared to the datasheet specification of 1.5 LSB.

When using the VPWR (Vdd) reference configuration, the SAR ADC DNL has been measured over temperature at 2 LSB for a supply voltage of 3.3 V. With a supply voltage of 5.5 V, the DNL has been measured greater than 3.5 LSB.

### ■ Scope of Impact

Inaccurate converted data.

### ■ Workaround

- Use an alternate ADC implementation (DeISig, ADCINC) available in CY8C28xxx devices.
- Avoid CPU operations that change the address and data buses while A-D conversion is running with internal Vpwr (Vdd) as Vref.
- Use un-buffered RefHi as ADC Vref. This may have a negative effect on the analog blocks in the analog array due to the noise introduced on RefHi reference.

### ■ Fix Status

Silicon fix is not planned. The workaround mentioned above should be used.

## 2. Wrong data read from IDAC\_CRx and DACx\_D registers.

### ■ Problem Definition

The CPU may read an incorrect value of bits 0, 3, 5, or 7 from the following registers:

- IDAC\_CR0
- IDAC\_CR1
- DAC0\_D
- DAC1\_D

### ■ Parameters Affected

F<sub>CPU1</sub> and F<sub>CPU2</sub> from the device data sheet.

### ■ Trigger Condition(S)

When CPU Clock is set at its highest frequency setting (24 MHz nominal).

### ■ Scope of Impact

Incorrect data read from affected registers.

### ■ Workaround

Temporarily slow down CPU Clock frequency to 12 MHz nominal (or lower) when affected registers are read.

## Document History Page

| Document Title: CY8C28243/CY8C28403/CY8C28413/CY8C28433/CY8C28445/CY8C28452/CY8C28513/CY8C28545/<br>CY8C28623/CY8C28643/CY8C28645, PSoC® Programmable System-on-Chip™<br>Document Number: 001-48111 |         |                  |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Revision                                                                                                                                                                                            | ECN     | Origin of Change | Submission Date | Description of Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| **                                                                                                                                                                                                  | 2593460 | BTK / PYRS       | 10/20/08        | New document (Revision **).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| *A                                                                                                                                                                                                  | 2652217 | BTK / PYRS       | 02/02/09        | Extensive updates to content.<br>Added registers maps.<br>Updated Getting Started section<br>Updated Development Tools section<br>Added some SAR10 ADC specifications.<br>Added more analog system figures                                                                                                                                                                                                                                                                                                                                                                                 |
| *B                                                                                                                                                                                                  | 2675937 | BTK              | 03/18/09        | Updated DC Analog Reference Specifications tables<br>Minor content updates                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| *C                                                                                                                                                                                                  | 2679015 | HMI              | 03/26/2009      | Post to external web.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| *D                                                                                                                                                                                                  | 2750217 | TDU              | 08/10/09        | Updates to Electrical Specifications section<br>Minor content updates                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| *E                                                                                                                                                                                                  | 2768143 | TDU              | 09/23/09        | Updated DC Operational Amplifier, DC Analog Reference, DC SAR10ADC, and DC POR specifications; Added Figure 15 and Figure 16; Updated AC TypeE-Operational and AC SAR10ADC specifications                                                                                                                                                                                                                                                                                                                                                                                                  |
| *F                                                                                                                                                                                                  | 2805324 | ALH              | 11/11/09        | Added Contents page. Updated <a href="#">Electrical Specifications</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| *G                                                                                                                                                                                                  | 2902396 | NJF              | 03/30/2010      | Updated Cypress website links.<br>Added T <sub>BAKETEMP</sub> and T <sub>BAKETIME</sub> parameters in <a href="#">Absolute Maximum Ratings</a> .<br>Updated <a href="#">DC SAR10 ADC Specifications</a> .<br>Modified Note 23.<br>Removed AC Analog Mux Bus Specifications, Third Party Tools and Build a PSoC Emulator into your Board.<br>Updated <a href="#">Packaging Information</a> and <a href="#">Ordering Code Definitions</a> .<br>Updated links in <a href="#">Sales, Solutions, and Legal Information</a> .                                                                    |
| *H                                                                                                                                                                                                  | 3063584 | NJF              | 10/20/10        | Added PSoC Device Characteristics table.<br>Added DC I2C Specifications table.<br>Added F32K_U max limit.<br>Added Tjit_IMO specification, removed existing jitter specifications.<br>Updated Analog reference tables.<br>Updated Units of Measure, Acronyms, Glossary, and References sections.<br>Updated solder reflow specifications.<br>No specific changes were made to AC Digital Block Specifications table and I2C Timing Diagram. They were updated for clearer understanding.<br>Updated Figure 13 since the labelling for y-axis was incorrect.<br>Template and styles update. |
| *I                                                                                                                                                                                                  | 3148779 | NJF              | 01/20/11        | Added Footnote # 34 to Thermal Impedances section.<br>Table 7. 56-Pin Part Pinout (SSOP) (page 15) - Pin#28 - Pin Name changed to "V <sub>SS</sub> ".<br>Table 5. 44-Pin Part Pinout (TQFP) (page 13) - Pin#17 - Pin Type changed to "Power".<br>Under DC SAR10 ADC Specifications table, for parameter V <sub>REFSAR10</sub> , Max value changed from 4.95 V to V <sub>DD</sub> - 0.3 V.<br>Updated <a href="#">Table 59, "Solder Reflow Specifications,"</a> on page 72 as per spec 25-00090.                                                                                            |
| *J                                                                                                                                                                                                  | 3598237 | LURE / XZNG      | 04/24/2012      | Changed the PWM description string from "8- to 32-bit" to "8- and 16-bit".                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| *K                                                                                                                                                                                                  | 3758002 | GULA             | 10/01/2012      | Updated <a href="#">Packaging Information</a> (spec 001-45616 (Changed revision from *B to *D), spec 51-85062 (Changed revision from *D to *F)).                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## Document History Page *(continued)*

| Document Title: CY8C28243/CY8C28403/CY8C28413/CY8C28433/CY8C28445/CY8C28452/CY8C28513/CY8C28545/<br>CY8C28623/CY8C28643/CY8C28645, PSoC® Programmable System-on-Chip™<br>Document Number: 001-48111 |         |                  |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Revision                                                                                                                                                                                            | ECN     | Origin of Change | Submission Date | Description of Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| *L                                                                                                                                                                                                  | 3993399 | GVH              | 05/08/2013      | Updated <a href="#">Reference Documents</a> (Removed 001-17397 spec, 001-14503 spec related information).<br>Added <a href="#">Errata</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| *M                                                                                                                                                                                                  | 4138595 | GVH              | 09/27/2013      | Updated to new template.<br>Completing Sunset Review.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| *N                                                                                                                                                                                                  | 4476160 | ASRI / SEG       | 09/04/2014      | Replaced references of "Application Notes for Surface Mount Assembly of Amkor's MicroLeadFrame (MLF) Packages" with "Design Guidelines for Cypress Quad Flat No Extended Lead (QFN) Packaged Devices – AN72845" in all instances across the document.<br>Added <a href="#">More Information</a> .<br>Added <a href="#">PSoC Designer</a> .<br>Updated <a href="#">PSoC Functional Overview</a> :<br>Updated <a href="#">PSoC Device Characteristics</a> :<br>Updated <a href="#">Table 2</a> :<br>Added a column "Analog Mux Buses" at the end.<br>Removed "Getting Started".<br>Updated <a href="#">Electrical Specifications</a> :<br>Updated <a href="#">DC Electrical Characteristics</a> :<br>Updated <a href="#">DC I2C Specifications</a> :<br>Updated <a href="#">Table 42</a> :<br>Added $V_{OL2C}$ parameter and its details.<br>Updated <a href="#">Packaging Information</a> :<br>spec 51-85064 – Changed revision from *E to *F.<br>Completing Sunset Review.                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| *O                                                                                                                                                                                                  | 4914758 | ASRI             | 09/10/2015      | Updated Document Title to read as "CY8C28243/CY8C28403/CY8C28413/CY8C28433/CY8C28445/CY8C28452/CY8C28513/CY8C28545/CY8C28623/CY8C28643/CY8C28645, PSoC® Programmable System-on-Chip™".<br>Removed CY8C28533 related information in all instances across the document.<br>Updated <a href="#">Electrical Specifications</a> :<br>Updated <a href="#">DC Electrical Characteristics</a> :<br>Updated <a href="#">DC SAR10 ADC Specifications</a> :<br>Updated <a href="#">Table 38</a> :<br>Updated details in "Description" column of DNL <sub>SAR10</sub> parameter.<br>Updated <a href="#">Packaging Information</a> :<br>Updated <a href="#">Packaging Dimensions</a> :<br>spec 51-85077 – Changed revision from *E to *F.<br>spec 51-85079 – Changed revision from *E to *F.<br>spec 001-45616 – Changed revision from *D to *E.<br>Updated <a href="#">Development Tool Selection</a> :<br>Updated <a href="#">Accessories (Emulation and Programming)</a> :<br>Updated <a href="#">Table 60</a> :<br>Updated details in "Part #" column corresponding to 44-pin TQFP package.<br>Updated <a href="#">Ordering Information</a> :<br>Updated part numbers.<br>Updated <a href="#">Errata</a> :<br>Updated <a href="#">Part Numbers Affected</a> :<br>Updated table.<br>Updated <a href="#">Errata Summary</a> :<br>Updated table and also details below the table.<br>Updated to new template.<br>Completing Sunset Review. |
| *P                                                                                                                                                                                                  | 5723667 | ASRI             | 05/02/2017      | Updated the <a href="#">Packaging Information</a> .<br>Updated Cypress Logo and Copyright.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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