

# 1.8 V CapSense® Controller with SmartSense™ Auto-tuning

## 31 Buttons, 6 Sliders, Proximity Sensors

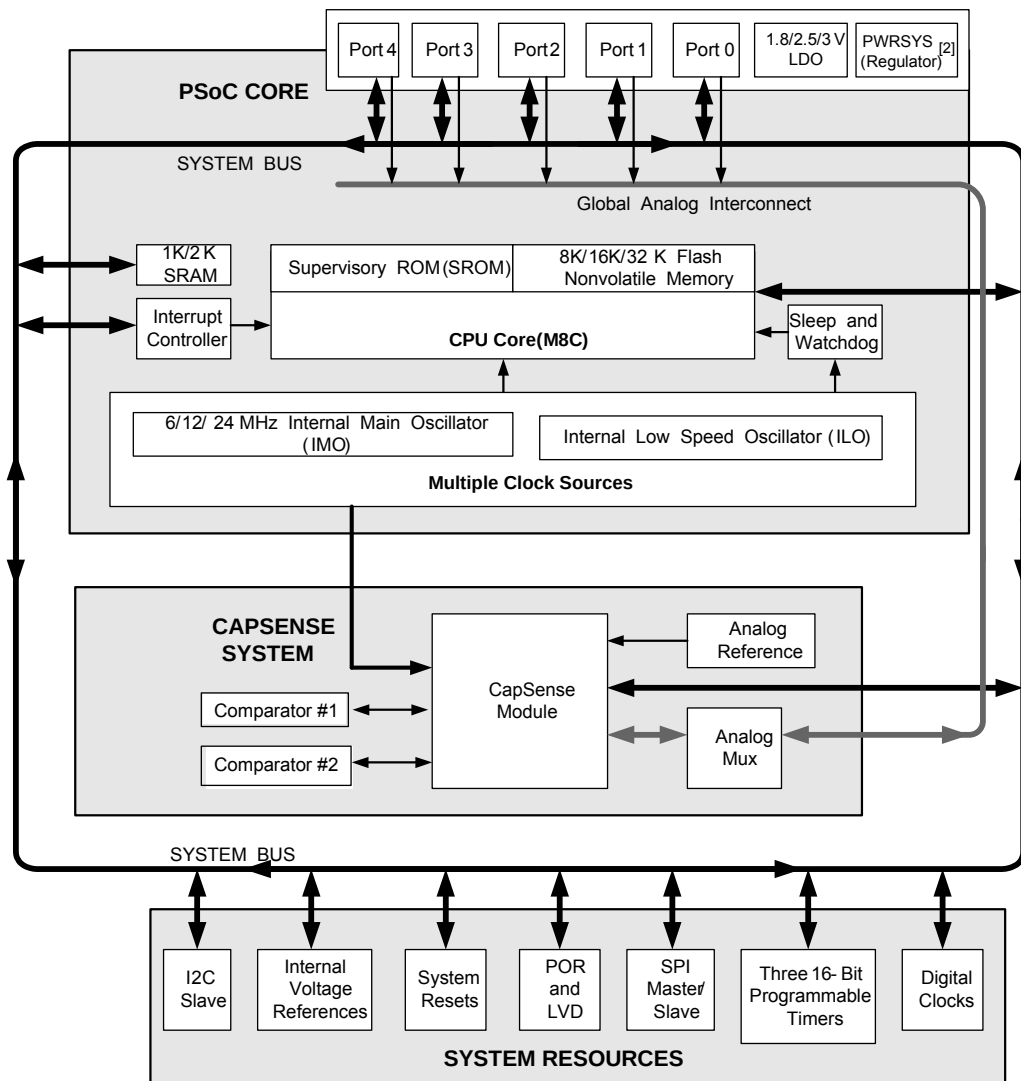
### Features

- **QuietZone™ Controller**
  - Patented Capacitive Sigma Delta PLUS (CSD PLUS™) sensing algorithm for robust performance
  - High Sensitivity (0.1 pF) and best-in-class SNR performance to support:
    - Overlay thickness of 15 mm for glass and 5 mm plastic
    - Proximity Solutions
  - Superior noise immunity performance against conducted and radiated noise and ultra low radiated emissions
    - Standardized user modules for overcoming noise
- **Low power CapSense® block with SmartSense Auto-tuning**
  - Low average power consumption –
    - 28 µA/sensor in run time (wake-up and scan once every 125 ms)
  - SmartSense\_EMC\_PLUS Auto-Tuning
    - Sets and maintains optimal sensor performance during run time
    - Eliminates system tuning during development and production
    - Compensates for variations in manufacturing process
- **Driven shield available on five GPIO pins**
  - Delivers best-in class water tolerant designs
  - Robust proximity sensing in the presence of metal objects
  - Supports longer trace lengths
  - Max load of 100 pF (3 MHz)
- **Powerful Harvard-architecture processor**
  - M8C CPU with a max speed of 24 MHz
- **Operating Range: 1.71 V to 5.5 V**
  - Standby Mode 1.1 µA (Typ)
  - Deep Sleep 0.1 µA (Typ)
- **Operating Temperature range: –40 °C to +85 °C**
- **Flexible on-chip memory**
  - 8 KB flash, 1 KB SRAM
  - 16 KB flash, 2 KB SRAM
  - 32 KB flash, 2 KB SRAM
  - 50,000 flash erase/write cycles
  - Read while Write with EEPROM emulation
  - In-system programming simplifies manufacturing process
- **4 Clock Sources**
  - Internal main oscillator (IMO): 6/12/24 MHz
  - Internal low-speed oscillator (ILO) at 32 kHz for watchdog and sleep timers
  - External 32 KHz Crystal Oscillator
  - External Clock Input
- **Programmable pin configurations**
  - Up to 34 general-purpose I/Os (GPIOs)
  - Dual mode GPIO (Analog and Digital)
  - High sink current of 25 mA per GPIO
    - Max sink current 120 mA for all I/Os combined
  - Source Current
    - 5 mA on ports 0 and 1
    - 1 mA on ports 2,3 and 4
  - Configurable internal pull-up, high-Z and open drain modes
  - Selectable, regulated digital I/O on port 1
  - Configurable input threshold on port 1
- **Versatile Analog functions**
  - Internal analog bus supports connection of multiple sensors to form ganged proximity sensor
  - Internal Low-Dropout voltage regulator for high power supply rejection ratio (PSRR)
- **Additional system resources**
  - I²C Slave:
    - Selectable to 50 kHz, 100 kHz, or 400 kHz
    - Selectable Clock stretch or Forced Nack Mode
    - I²C wake from sleep with Hardware address match
  - 12 MHz (Configurable) SPI master and slave
  - Three 16-bit timers
  - Watchdog and sleep timers
  - Integrated supervisory circuit
  - 10-bit incremental analog-to-digital converter (ADC) with internal voltage reference
  - Two general-purpose high speed, low power analog comparators
- **Complete development tools**
  - Free development tool (PSoC Designer™)
- **Sensor and Package options**
  - 10 Sensing Inputs – 16-pin QFN, 16-pin SOIC
  - 16 Sensing Inputs – 24-pin QFN
  - 24 Sensing Inputs – 30-pin WLCSP [1]
  - 25 Sensing Inputs – 32-pin QFN
  - 31 Sensing Inputs – 48-pin QFN

#### Note

1. Please contact your nearest sales office for additional details.

## Logic Block Diagram



**Note**

2. Internal voltage regulator for internal circuitry

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## 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 blocks of analog and digital logic, and programmable interconnect. This architecture makes it possible for you to create customized peripheral configurations, to match the requirements of each individual application. Additionally, a fast central processing unit (CPU), flash program memory, SRAM data memory, and configurable I/O are included in a range of convenient pinouts.

The architecture for this device family, as shown in the [Logic Block Diagram on page 2](#), consists of three main areas:

- The core
- CapSense analog system
- System resources

A common, versatile bus allows connection between I/O and the analog system.

Each CY8C20x37/47/67/S PSoC device includes a dedicated CapSense block that provides sensing and scanning control circuitry for capacitive sensing applications. Depending on the PSoC package, up to 34 GPIOs are also included. The GPIOs provide access to the MCU and analog mux.

### PSoC Core

The PSoC core is a powerful engine that supports a rich instruction set. It encompasses SRAM for data storage, an interrupt controller, sleep and watchdog timers, and IMO and I/O. The CPU core, called the M8C, is a powerful processor with speeds up to 24 MHz. The M8C is a 4-million instructions per second (MIPS), 8-bit Harvard-architecture microprocessor.

### CapSense System

The analog system contains the capacitive sensing hardware. Several hardware algorithms are supported. This hardware performs capacitive sensing and scanning without requiring external components. The analog system is composed of the CapSense PSoC block and an internal 1 V or 1.2 V analog reference, which together support capacitive sensing of up to 31 inputs<sup>[3]</sup>. Capacitive sensing is configurable on each GPIO pin. Scanning of enabled CapSense pins is completed quickly and easily across multiple ports.

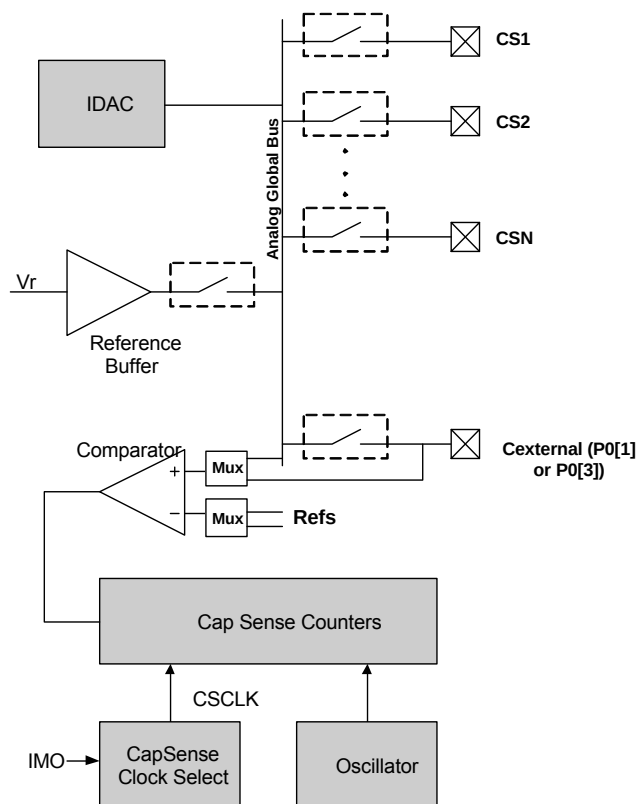
#### SmartSense™ Auto-tuning

SmartSense auto-tuning is an innovative solution from Cypress that removes manual tuning of CapSense applications. This solution is easy to use and provides robust noise immunity. It is the only auto-tuning solution that establishes, monitors, and maintains all required tuning parameters of each sensor during run time. SmartSense auto-tuning allows engineers to go from prototyping to mass production without retuning for manufacturing variations in PCB and/or overlay material properties.

#### Note

3. 34 GPIOs = 31 pins for capacitive sensing + 2 pins for I<sup>2</sup>C + 1 pin for modulator capacitor.

Figure 1. CapSense System Block Diagram



#### Analog Multiplexer System

The analog mux bus can connect to every GPIO pin. Pins are connected to the bus individually or in any combination. The bus also connects to the analog system for analysis with the CapSense block comparator.

Switch-control logic enables selected pins to precharge continuously under hardware control. This enables capacitive measurement for applications such as touch sensing. Other multiplexer applications include:

- Complex capacitive sensing interfaces, such as sliders and touchpads.
- Chip-wide mux that allows analog input from any I/O pin.
- Crosspoint connection between any I/O pin combinations.

## Additional System Resources

System resources provide additional capability, such as configurable I<sup>2</sup>C slave, SPI master/slave communication interface, three 16-bit programmable timers, various system resets supported by the M8C low voltage detection and power-on reset. The merits of each system resource are listed here:

- The I<sup>2</sup>C slave/SPI master-slave module provides 50/100/400 kHz communication over two wires. SPI communication over three or four wires runs at speeds of 46.9 kHz to 3 MHz (lower for a slower system clock).
- The I<sup>2</sup>C hardware address recognition feature reduces the already low power consumption by eliminating the need for CPU intervention until a packet addressed to the target device is received.
- The I<sup>2</sup>C enhanced slave interface appears as a 32-byte RAM buffer to the external I<sup>2</sup>C master. Using a simple predefined protocol, the master controls the read and write pointers into the RAM. When this method is enabled, the slave does not stall the bus when receiving data bytes in active mode. For usage details, see the application note [I2C Enhanced Slave Operation - AN56007](#).
- Low-voltage detection (LVD) interrupts can signal the application of falling voltage levels, while the advanced power-on reset (POR) circuit eliminates the need for a system supervisor.
- An internal reference provides an absolute reference for capacitive sensing.
- A register-controlled bypass mode allows the user to disable the LDO regulator.

## Getting Started

The quickest way to understand PSoC silicon is to read this datasheet and then use the PSoC Designer Integrated Development Environment (IDE). This datasheet is an overview of the PSoC integrated circuit and presents specific pin, register, and electrical specifications.

For in depth information, along with detailed programming details, see the [Technical Reference Manual](#) for the CY8C20x37/47/67/S PSoC devices.

For up-to-date ordering, packaging, and electrical specification information, see the latest PSoC device datasheets on the web at [www.cypress.com/psoc](http://www.cypress.com/psoc).

## Application Notes/Design Guides

Application notes and design guides are an excellent introduction to the wide variety of possible PSoC designs. They are located at [www.cypress.com/gocapsense](http://www.cypress.com/gocapsense). Select Application Notes under the Related Documentation tab.

## Development Kits

PSoC Development Kits are available online from Cypress at [www.cypress.com/shop](http://www.cypress.com/shop) and through a growing number of regional and global distributors, which include Arrow, Avnet, Digi-Key, Farnell, Future Electronics, and Newark. See [Development Kits on page 31](#).

## Training

Free PSoC and CapSense technical training (on demand, webinars, and workshops) is available online at [www.cypress.com/training](http://www.cypress.com/training). The training covers a wide variety of topics and skill levels to assist you in your designs.

## CYPros Consultants

Certified PSoC Consultants offer everything from technical assistance to completed PSoC designs. To contact or become a PSoC Consultant go to [www.cypress.com/cypros](http://www.cypress.com/cypros).

## Solutions Library

Visit our growing library of solution focused designs at [www.cypress.com/solutions](http://www.cypress.com/solutions). Here you can find various application designs that include firmware and hardware design files that enable you to complete your designs quickly.

## Technical Support

For assistance with technical issues, search KnowledgeBase articles and forums at [www.cypress.com/support](http://www.cypress.com/support). If you cannot find an answer to your question, create a technical support case or call technical support at 1-800-541-4736.

## Designing with PSoC Designer

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

1. Select [User Modules](#)
2. Configure User Modules
3. Organize and Connect
4. Generate and Verify

### Select Components

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

### Configure Components

Each of the User Modules you select establishes the basic register settings that implement the selected function. They also provide parameters and properties that allow you to tailor their precise configuration to your particular application. The user module parameters permit you to establish the pulse width and duty cycle. Configure the parameters and properties to correspond to your chosen application. Enter values directly or by selecting values from drop-down menus. All the user modules are documented in datasheets that may be viewed directly in PSoC Designer or on the Cypress website. These [user module datasheets](#) explain the internal operation of the User Module and provide performance specifications. Each datasheet describes the use of each user module parameter, and other information you may need to successfully implement your design.

## Organize and Connect

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

## Generate, Verify, and Debug

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

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

## Pinouts

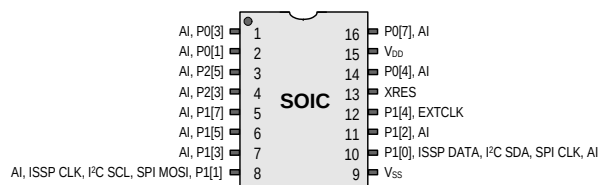
The CY8C20x37/47/67/S PSoC device is available in a variety of packages, which are listed and illustrated in the following tables. Every port pin (labeled with a “P”) is capable of digital I/O and connection to the common analog bus. However,  $V_{SS}$ ,  $V_{DD}$ , and XRES are not capable of digital I/O.

### 16-pin SOIC (10 Sensing Inputs)

**Table 1. Pin Definitions – CY8C20237-24SXI, CY8C20247/S-24SXI** <sup>[4]</sup>

| Pin No. | Type    |        | Name     | Description                                                |
|---------|---------|--------|----------|------------------------------------------------------------|
|         | Digital | Analog |          |                                                            |
| 1       | I/O     | I      | P0[3]    | Integrating Input                                          |
| 2       | I/O     | I      | P0[1]    | Integrating Input                                          |
| 3       | I/O     | I      | P2[5]    | Crystal output (XOut)                                      |
| 4       | I/O     | I      | P2[3]    | Crystal input (XIn)                                        |
| 5       | I/O     | I      | P1[7]    | I2C SCL, SPI SS                                            |
| 6       | I/O     | I      | P1[5]    | I2C SDA, SPI MISO                                          |
| 7       | I/O     | I      | P1[3]    |                                                            |
| 8       | I/O     | I      | P1[1]    | ISSP CLK <sup>[5]</sup> , I2C SCL, SPI MOSI                |
| 9       | Power   |        | $V_{SS}$ | Ground connection                                          |
| 10      | I/O     | I      | P1[0]    | ISSP DATA <sup>[5]</sup> , I2C SDA, SPI CLK <sup>[6]</sup> |
| 11      | I/O     | I      | P1[2]    | Driven Shield Output (optional)                            |
| 12      | I/O     | I      | P1[4]    | Optional external clock (EXTCLK)                           |
| 13      | INPUT   |        | XRES     | Active high external reset with internal pull-down         |
| 14      | I/O     | I      | P0[4]    |                                                            |
| 15      | Power   |        | $V_{DD}$ | Supply voltage                                             |
| 16      | I/O     | I      | P0[7]    |                                                            |

**Figure 2. CY8C20237-24SXI, CY8C20247/S-24SXI Device**



**LEGEND** A = Analog, I = Input, O = Output, OH = 5 mA High Output Drive, R = Regulated Output.

#### Notes

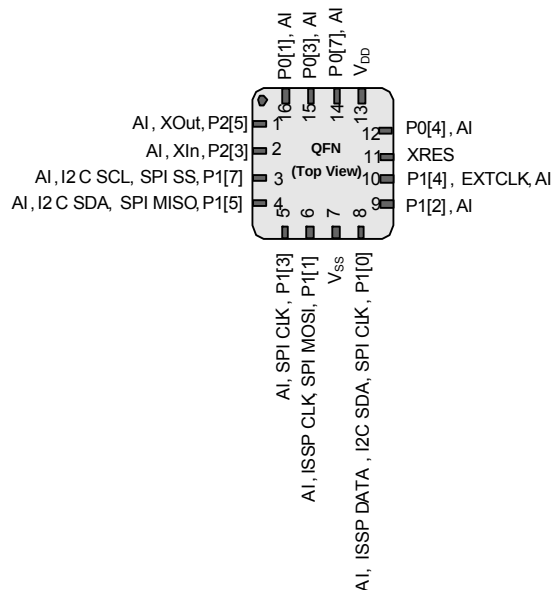
- 13 GPIOs = 10 pins for capacitive sensing+2 pins for I<sup>2</sup>C + 1 pin for modulator capacitor.
- On power-up, the SDA(P1[0]) drives a strong high for 256 sleep clock cycles and drives resistive low for the next 256 sleep clock cycles. The SCL(P1[1]) line drives resistive low for 512 sleep clock cycles and both the pins transition to high impedance state. On reset, after XRES de-asserts, the SDA and the SCL lines drive resistive low for 8 sleep clock cycles and transition to high impedance state. Hence, during power-up or reset event, P1[1] and P1[0] may disturb the I2C bus. Use alternate pins if you encounter issues.
- Alternate SPI clock.



**16-pin QFN (10 Sensing Inputs)<sup>[7]</sup>**
**Table 2. Pin Definitions – CY8C20237, CY8C20247/S <sup>[8]</sup>**

| Pin No. | Type    |        | Name            | Description                                                              |
|---------|---------|--------|-----------------|--------------------------------------------------------------------------|
|         | Digital | Analog |                 |                                                                          |
| 1       | I/O     | I      | P2[5]           | Crystal output (XOut)                                                    |
| 2       | I/O     | I      | P2[3]           | Crystal input (XIn)                                                      |
| 3       | IOHR    | I      | P1[7]           | I <sup>2</sup> C SCL, SPI SS                                             |
| 4       | IOHR    | I      | P1[5]           | I <sup>2</sup> C SDA, SPI MISO                                           |
| 5       | IOHR    | I      | P1[3]           | SPI CLK                                                                  |
| 6       | IOHR    | I      | P1[1]           | ISSP CLK <sup>[9]</sup> , I <sup>2</sup> C SCL, SPI MOSI                 |
| 7       | Power   |        | V <sub>SS</sub> | Ground connection                                                        |
| 8       | IOHR    | I      | P1[0]           | ISSP DATA <sup>[9]</sup> , I <sup>2</sup> C SDA, SPI CLK <sup>[10]</sup> |
| 9       | IOHR    | I      | P1[2]           | Driven Shield Output (optional)                                          |
| 10      | IOHR    | I      | P1[4]           | Optional external clock (EXTCLK)                                         |
| 11      | Input   |        | XRES            | Active high external reset with internal pull-down                       |
| 12      | IOH     | I      | P0[4]           |                                                                          |
| 13      | Power   |        | V <sub>DD</sub> | Supply voltage                                                           |
| 14      | IOH     | I      | P0[7]           |                                                                          |
| 15      | IOH     | I      | P0[3]           | Integrating input                                                        |
| 16      | IOH     | I      | P0[1]           | Integrating input                                                        |

**LEGEND** A = Analog, I = Input, O = Output, OH = 5 mA High Output Drive, R = Regulated Output.

**Figure 3. CY8C20237, CY8C20247/S Device**

**Notes**

7. No center pad.
8. 13 GPIOs = 10 pins for capacitive sensing+2 pins for I<sup>2</sup>C + 1 pin for modulator capacitor.
9. On power-up, the SDA(P1[0]) drives a strong high for 256 sleep clock cycles and drives resistive low for the next 256 sleep clock cycles. The SCL(P1[1]) line drives resistive low for 512 sleep clock cycles and both the pins transition to high impedance state. On reset, after XRES de-asserts, the SDA and the SCL lines drive resistive low for 8 sleep clock cycles and transition to high impedance state. Hence, during power-up or reset event, P1[1] and P1[0] may disturb the I<sup>2</sup>C bus. Use alternate pins if you encounter issues.
10. Alternate SPI clock.



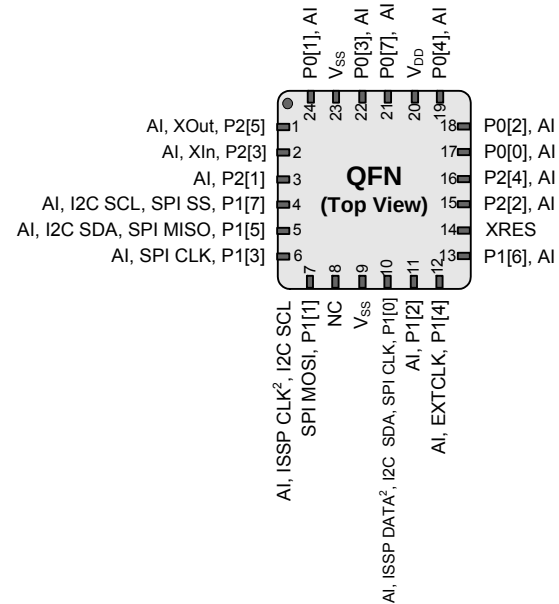
**24-pin QFN (16 Sensing Inputs)<sup>[11]</sup>**
**Table 3. Pin Definitions – CY8C20337, CY8C20347/IS<sup>[12]</sup>**

| Pin No. | Type    |        | Name            | Description                                                               |
|---------|---------|--------|-----------------|---------------------------------------------------------------------------|
|         | Digital | Analog |                 |                                                                           |
| 1       | I/O     | I      | P2[5]           | Crystal output (XOut)                                                     |
| 2       | I/O     | I      | P2[3]           | Crystal input (XIn)                                                       |
| 3       | I/O     | I      | P2[1]           |                                                                           |
| 4       | IOHR    | I      | P1[7]           | I <sup>2</sup> C SCL, SPI SS                                              |
| 5       | IOHR    | I      | P1[5]           | I <sup>2</sup> C SDA, SPI MISO                                            |
| 6       | IOHR    | I      | P1[3]           | SPI CLK                                                                   |
| 7       | IOHR    | I      | P1[1]           | ISSP CLK <sup>[13]</sup> , I <sup>2</sup> C SCL, SPI MOSI                 |
| 8       |         |        | NC              | No connection                                                             |
| 9       | Power   |        | V <sub>SS</sub> | Ground connection                                                         |
| 10      | IOHR    | I      | P1[0]           | ISSP DATA <sup>[13]</sup> , I <sup>2</sup> C SDA, SPI CLK <sup>[14]</sup> |
| 11      | IOHR    | I      | P1[2]           | Driven Shield Output (optional)                                           |
| 12      | IOHR    | I      | P1[4]           | Optional external clock input (EXTCLK)                                    |
| 13      | IOHR    | I      | P1[6]           |                                                                           |
| 14      | Input   |        | XRES            | Active high external reset with internal pull-down                        |
| 15      | I/O     | I      | P2[2]           | Driven Shield Output (optional)                                           |
| 16      | I/O     | I      | P2[4]           | Driven Shield Output (optional)                                           |
| 17      | IOH     | I      | P0[0]           | Driven Shield Output (optional)                                           |
| 18      | IOH     | I      | P0[2]           | Driven Shield Output (optional)                                           |
| 19      | IOH     | I      | P0[4]           |                                                                           |
| 20      | Power   |        | V <sub>DD</sub> | Supply voltage                                                            |
| 21      | IOH     | I      | P0[7]           |                                                                           |
| 22      | IOH     | I      | P0[3]           | Integrating input                                                         |
| 23      | Power   |        | V <sub>SS</sub> | Ground connection                                                         |
| 24      | IOH     | I      | P0[1]           | Integrating input                                                         |
| CP      | Power   |        | V <sub>SS</sub> | Center pad must be connected to ground                                    |

**LEGEND** A = Analog, I = Input, O = Output, OH = 5 mA High Output Drive, R = Regulated Output.

**Notes**

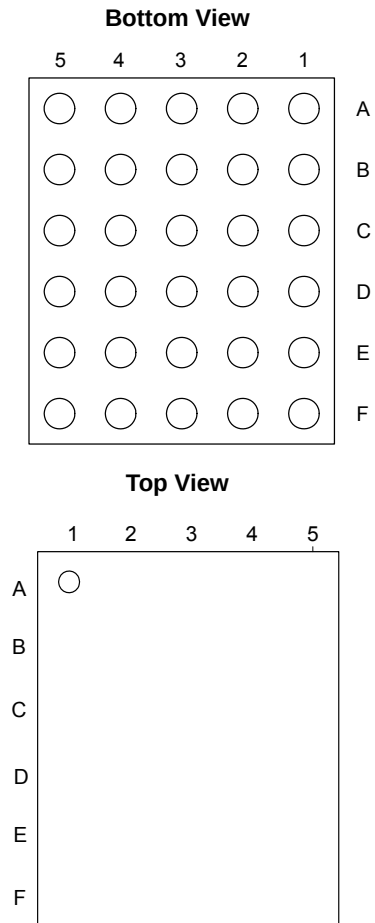
- The center pad (CP) on the QFN package must be connected to ground (V<sub>SS</sub>) for best mechanical, thermal, and electrical performance. If not connected to ground, it must be electrically floated and not connected to any other signal.
- 19 GPIOs = 16 pins for capacitive sensing+2 pins for I<sup>2</sup>C + 1 pin for modulator capacitor.
- On power-up, the SDA(P1[0]) drives a strong high for 256 sleep clock cycles and drives resistive low for the next 256 sleep clock cycles. The SCL(P1[1]) line drives resistive low for 512 sleep clock cycles and both the pins transition to high impedance state. On reset, after XRES de-asserts, the SDA and the SCL lines drive resistive low for 8 sleep clock cycles and transition to high impedance state. Hence, during power-up or reset event, P1[1] and P1[0] may disturb the I<sup>2</sup>C bus. Use alternate pins if you encounter issues.
- Alternate SPI clock.

**Figure 4. CY8C20337, CY8C20347/IS Device**


**30-ball WLCSP (24 Sensing Inputs)**
**Table 4. Pin Definitions – CY8C20767, CY8C20747 30-ball Part Pinout (WLCSP) <sup>[15]</sup>**

| Pin No. | Type    |        | Name            | Description                                                               |
|---------|---------|--------|-----------------|---------------------------------------------------------------------------|
|         | Digital | Analog |                 |                                                                           |
| A1      | IOH     | I      | P0[2]           | Driven Shield Output (optional)                                           |
| A2      | IOH     | I      | P0[6]           |                                                                           |
| A3      | Power   |        | V <sub>DD</sub> | Supply voltage                                                            |
| A4      | IOH     | I      | P0[1]           | Integrating Input                                                         |
| A5      | I/O     | I      | P2[7]           |                                                                           |
| B1      | I/O     | I      | P4[2]           |                                                                           |
| B2      | IOH     | I      | P0[0]           | Driven Shield Output (optional)                                           |
| B3      | IOH     | I      | P0[4]           |                                                                           |
| B4      | IOH     | I      | P0[3]           | Integrating Input                                                         |
| B5      | I/O     | I      | P2[5]           | Crystal Output (Xout)                                                     |
| C1      | I/O     | I      | P2[2]           | Driven Shield Output (optional)                                           |
| C2      | I/O     | I      | P2[4]           | Driven Shield Output (optional)                                           |
| C3      | I/O     | I      | P0[7]           |                                                                           |
| C4      | IOH     | I      | P3[2]           |                                                                           |
| C5      | I/O     | I      | P2[3]           | Crystal Input (Xin)                                                       |
| D1      | I/O     | I      | P2[0]           |                                                                           |
| D2      | I/O     | I      | P3[0]           |                                                                           |
| D3      | I/O     | I      | P3[1]           |                                                                           |
| D4      | I/O     | I      | P3[3]           |                                                                           |
| D5      | I/O     | I      | P2[1]           |                                                                           |
| E1      | Input   |        | XRES            | Active high external reset with internal pull-down                        |
| E2      | IOHR    | I      | P1[6]           |                                                                           |
| E3      | IOHR    | I      | P1[4]           | Optional external clock input (EXT CLK)                                   |
| E4      | IOHR    | I      | P1[7]           | I <sup>2</sup> C SCL, SPI SS                                              |
| E5      | IOHR    | I      | P1[5]           | I <sup>2</sup> C SDA, SPI MISO                                            |
| F1      | IOHR    | I      | P1[2]           | Driven Shield Output (optional)                                           |
| F2      | IOHR    | I      | P1[0]           | ISSP DATA <sup>[16]</sup> , I <sup>2</sup> C SDA, SPI CLK <sup>[17]</sup> |
| F3      | Power   |        | V <sub>SS</sub> | Supply ground                                                             |
| F4      | IOHR    | I      | P1[1]           | ISSP CLK <sup>[16]</sup> , I <sup>2</sup> C SCL, SPI MOSI                 |
| F5      | IOHR    | I      | P1[3]           | SPI CLK                                                                   |

**LEGEND:** A = Analog, I = Input, O = Output, OH = 5 mA High Output Drive, R = Regulated Output

**Figure 5. CY8C20767, CY8C20747 30-ball WLCSP**

**Notes**

15. 27 GPIOs = 24 pins for capacitive sensing+2 pins for I<sup>2</sup>C + 1 pin for modulator capacitor.

16. On power-up, the SDA(P1[0]) drives a strong high for 256 sleep clock cycles and drives resistive low for the next 256 sleep clock cycles. The SCL(P1[1]) line drives resistive low for 512 sleep clock cycles and both the pins transition to high impedance state. On reset, after XRES de-asserts, the SDA and the SCL lines drive resistive low for 8 sleep clock cycles and transition to high impedance state. Hence, during power-up or reset event, P1[1] and P1[0] may disturb the I<sup>2</sup>C bus. Use alternate pins if you encounter issues.

17. Alternate SPI clock.

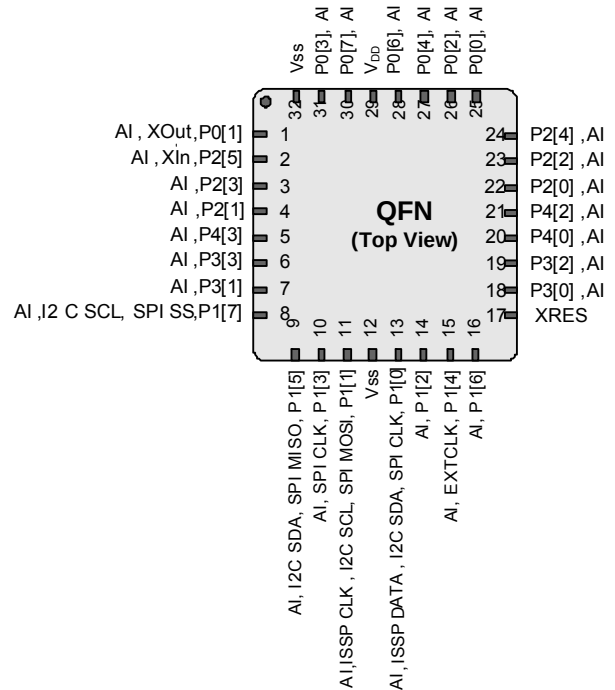
**32-pin QFN (25 Sensing Inputs)<sup>[18]</sup>**
**Table 5. Pin Definitions – CY8C20437, CY8C20447/S, CY8C20467/S <sup>[19]</sup>**

| Pin No. | Type    |        | Name            | Description                                                               |
|---------|---------|--------|-----------------|---------------------------------------------------------------------------|
|         | Digital | Analog |                 |                                                                           |
| 1       | IOH     | I      | P0[1]           | Integrating input                                                         |
| 2       | I/O     | I      | P2[5]           | Crystal output (XOut)                                                     |
| 3       | I/O     | I      | P2[3]           | Crystal input (XIn)                                                       |
| 4       | I/O     | I      | P2[1]           |                                                                           |
| 5       | I/O     | I      | P4[3]           |                                                                           |
| 6       | I/O     | I      | P3[3]           |                                                                           |
| 7       | I/O     | I      | P3[1]           |                                                                           |
| 8       | IOHR    | I      | P1[7]           | I <sup>2</sup> C SCL, SPI SS                                              |
| 9       | IOHR    | I      | P1[5]           | I <sup>2</sup> C SDA, SPI MISO                                            |
| 10      | IOHR    | I      | P1[3]           | SPI CLK.                                                                  |
| 11      | IOHR    | I      | P1[1]           | ISSP CLK <sup>[20]</sup> , I <sup>2</sup> C SCL, SPI MOSI.                |
| 12      | Power   |        | V <sub>SS</sub> | Ground connection                                                         |
| 13      | IOHR    | I      | P1[0]           | ISSP DATA <sup>[20]</sup> , I <sup>2</sup> C SDA, SPI CLK <sup>[21]</sup> |
| 14      | IOHR    | I      | P1[2]           | Driven Shield Output (optional)                                           |
| 15      | IOHR    | I      | P1[4]           | Optional external clock input (EXTCLK)                                    |
| 16      | IOHR    | I      | P1[6]           |                                                                           |
| 17      | Input   |        | XRES            | Active high external reset with internal pull-down                        |
| 18      | I/O     | I      | P3[0]           |                                                                           |
| 19      | I/O     | I      | P3[2]           |                                                                           |
| 20      | I/O     | I      | P4[0]           |                                                                           |
| 21      | I/O     | I      | P4[2]           |                                                                           |
| 22      | I/O     | I      | P2[0]           |                                                                           |
| 23      | I/O     | I      | P2[2]           | Driven Shield Output (optional)                                           |
| 24      | I/O     | I      | P2[4]           | Driven Shield Output (optional)                                           |
| 25      | IOH     | I      | P0[0]           | Driven Shield Output (optional)                                           |
| 26      | IOH     | I      | P0[2]           | Driven Shield Output (optional)                                           |
| 27      | IOH     | I      | P0[4]           |                                                                           |
| 28      | IOH     | I      | P0[6]           |                                                                           |
| 29      | Power   |        | V <sub>DD</sub> |                                                                           |
| 30      | IOH     | I      | P0[7]           |                                                                           |
| 31      | IOH     | I      | P0[3]           | Integrating input                                                         |
| 32      | Power   |        | V <sub>SS</sub> | Ground connection                                                         |
| CP      | Power   |        | V <sub>SS</sub> | Center pad must be connected to ground                                    |

**LEGEND** A = Analog, I = Input, O = Output, OH = 5 mA High Output Drive, R = Regulated Output.

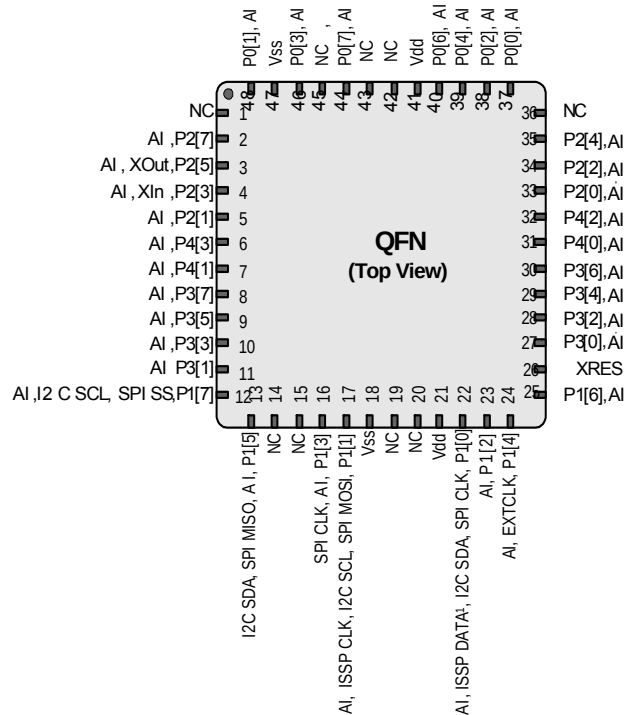
**Notes**

18. The center pad (CP) on the QFN package must be connected to ground (V<sub>SS</sub>) for best mechanical, thermal, and electrical performance. If not connected to ground, it must be electrically floated and not connected to any other signal.
19. 28 GPIOs = 25 pins for capacitive sensing+2 pins for I<sup>2</sup>C + 1 pin for modulator capacitor.
20. On power-up, the SDA(P1[0]) drives a strong high for 256 sleep clock cycles and drives resistive low for the next 256 sleep clock cycles. The SCL(P1[1]) line drives resistive low for 512 sleep clock cycles and both the pins transition to high impedance state. On reset, after XRES de-asserts, the SDA and the SCL lines drive resistive low for 8 sleep clock cycles and transition to high impedance state. Hence, during power-up or reset event, P1[1] and P1[0] may disturb the I<sup>2</sup>C bus. Use alternate pins if you encounter issues.
21. Alternate SPI clock.

**Figure 6. CY8C20437, CY8C20447/S, CY8C20467/S Device**


**48-pin QFN (31 Sensing Inputs)<sup>[22]</sup>**
**Table 6. Pin Definitions – CY8C20637, CY8C20647/S, CY8C20667/S<sup>[23]</sup>**

| Pin No. | Digital | Analog | Name            | Description                                                               |
|---------|---------|--------|-----------------|---------------------------------------------------------------------------|
| 1       |         |        | NC              | No connection                                                             |
| 2       | I/O     | I      | P2[7]           |                                                                           |
| 3       | I/O     | I      | P2[5]           | Crystal output (XOut)                                                     |
| 4       | I/O     | I      | P2[3]           | Crystal input (XIn)                                                       |
| 5       | I/O     | I      | P2[1]           |                                                                           |
| 6       | I/O     | I      | P4[3]           |                                                                           |
| 7       | I/O     | I      | P4[1]           |                                                                           |
| 8       | I/O     | I      | P3[7]           |                                                                           |
| 9       | I/O     | I      | P3[5]           |                                                                           |
| 10      | I/O     | I      | P3[3]           |                                                                           |
| 11      | I/O     | I      | P3[1]           |                                                                           |
| 12      | IOHR    | I      | P1[7]           | I <sup>2</sup> C SCL, SPI SS                                              |
| 13      | IOHR    | I      | P1[5]           | I <sup>2</sup> C SDA, SPI MISO                                            |
| 14      |         |        | NC              | No connection                                                             |
| 15      |         |        | NC              | No connection                                                             |
| 16      | IOHR    | I      | P1[3]           | SPI CLK                                                                   |
| 17      | IOHR    | I      | P1[1]           | ISSP CLK <sup>[24]</sup> , I <sup>2</sup> C SCL, SPI MOSI                 |
| 18      | Power   |        | V <sub>SS</sub> | Ground connection                                                         |
| 19      |         |        | NC              | No connection                                                             |
| 20      |         |        | NC              | No connection                                                             |
| 21      | Power   |        | V <sub>DD</sub> | Supply voltage                                                            |
| 22      | IOHR    | I      | P1[0]           | ISSP DATA <sup>[24]</sup> , I <sup>2</sup> C SDA, SPI CLK <sup>[25]</sup> |
| 23      | IOHR    | I      | P1[2]           | Driven Shield Output (optional)                                           |
| 24      | IOHR    | I      | P1[4]           | Optional external clock input (EXTCLK)                                    |
| 25      | IOHR    | I      | P1[6]           |                                                                           |
| 26      | Input   |        | XRES            | Active high external reset with internal pull-down                        |
| 27      | I/O     | I      | P3[0]           |                                                                           |
| 28      | I/O     | I      | P3[2]           |                                                                           |
| 29      | I/O     | I      | P3[4]           |                                                                           |

**Figure 7. CY8C20637, CY8C20647/S, CY8C20667/S Device**


| Pin No. | Digital | Analog | Name            | Description                            |
|---------|---------|--------|-----------------|----------------------------------------|
| 30      | I/O     | I      | P3[6]           |                                        |
| 31      | I/O     | I      | P4[0]           |                                        |
| 32      | I/O     | I      | P4[2]           |                                        |
| 33      | I/O     | I      | P2[0]           |                                        |
| 34      | I/O     | I      | P2[2]           | Driven Shield Output (optional)        |
| 35      | I/O     | I      | P2[4]           | Driven Shield Output (optional)        |
| 36      |         |        | NC              | No connection                          |
| 37      | IOH     | I      | P0[0]           | Driven Shield Output (optional)        |
| 38      | IOH     | I      | P0[2]           | Driven Shield Output (optional)        |
| 39      | IOH     | I      | P0[4]           |                                        |
| 40      | IOH     | I      | P0[6]           |                                        |
| 41      | Power   |        | V <sub>DD</sub> | Supply voltage                         |
| 42      |         |        | NC              | No connection                          |
| 43      |         |        | NC              | No connection                          |
| 44      | IOH     | I      | P0[7]           |                                        |
| 45      |         |        | NC              | No connection                          |
| 46      | IOH     | I      | P0[3]           | Integrating input                      |
| 47      | Power   |        | V <sub>SS</sub> | Ground connection                      |
| 48      | IOH     | I      | P0[1]           | Integrating input                      |
|         | CP      | Power  | V <sub>SS</sub> | Center pad must be connected to ground |

**LEGEND** A = Analog, I = Input, O = Output, NC = No Connection H = 5 mA High Output Drive, R = Regulated Output.

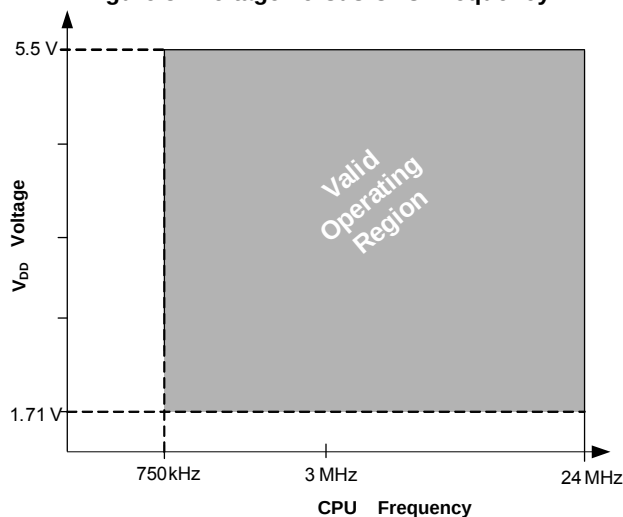
**Notes**

22. The center pad (CP) on the QFN package must be connected to ground (V<sub>SS</sub>) for best mechanical, thermal, and electrical performance. If not connected to ground, it must be electrically floated and not connected to any other signal.
23. 34 GPIOs = 31 pins for capacitive sensing+2 pins for I<sup>2</sup>C + 1 pin for modulator capacitor.
24. On power-up, the SDA(P1[0]) drives a strong high for 256 sleep clock cycles and drives resistive low for the next 256 sleep clock cycles. The SCL(P1[1]) line drives resistive low for 512 sleep clock cycles and both the pins transition to high impedance state. On reset, after XRES de-asserts, the SDA and the SCL lines drive resistive low for 8 sleep clock cycles and transition to high impedance state. Hence, during power-up or reset event, P1[1] and P1[0] may disturb the I<sup>2</sup>C bus. Use alternate pins if you encounter issues.
25. Alternate SPI clock.

## Electrical Specifications

This section presents the DC and AC electrical specifications of the CY8C20x37/47/67/S PSoC devices. For the latest electrical specifications, confirm that you have the most recent datasheet by visiting the web at <http://www.cypress.com/psoc>.

**Figure 8. Voltage versus CPU Frequency**



## Absolute Maximum Ratings

Exceeding maximum ratings may shorten the useful life of the device. User guidelines are not tested.

**Table 7. Absolute Maximum Ratings**

| Symbol           | Description                                | Conditions                                                                                                                                                                          | Min                   | Typ | Max                   | Units |
|------------------|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----|-----------------------|-------|
| T <sub>STG</sub> | Storage temperature                        | Higher storage temperatures reduce data retention time. Recommended Storage Temperature is +25 °C ± 25 °C. Extended duration storage temperatures above 85 °C degrades reliability. | -55                   | +25 | +125                  | °C    |
| V <sub>DD</sub>  | Supply voltage 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 tristate             | —                                                                                                                                                                                   | 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    |
| ESD              | Electro static discharge voltage           | Human body model ESD                                                                                                                                                                | 2000                  | —   | —                     | V     |
| LU               | Latch up current                           | In accordance with JESD78 standard                                                                                                                                                  | —                     | —   | 200                   | mA    |

## Operating Temperature

**Table 8. Operating Temperature**

| Symbol         | Description                  | Conditions                                                                                                                                                                                            | Min | Typ | Max  | Units |
|----------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------|-------|
| T <sub>A</sub> | Ambient temperature          | —                                                                                                                                                                                                     | -40 | —   | +85  | °C    |
| T <sub>C</sub> | Commercial temperature range | —                                                                                                                                                                                                     | 0   | —   | 70   | °C    |
| T <sub>J</sub> | Operational die temperature  | The temperature rise from ambient to junction is package specific. See the <a href="#">Thermal Impedances on page 30</a> . The user must limit the power consumption to comply with this requirement. | -40 | —   | +100 | °C    |

## DC Chip-Level Specifications

The following table lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

**Table 9. DC Chip-Level Specifications**

| Symbol                | Description                                   | Conditions                                                                                                           | Min  | Typ  | Max  | Units |
|-----------------------|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------|------|------|------|-------|
| $V_{DD}$ [26, 27, 28] | Supply voltage                                | See table <a href="#">DC POR and LVD Specifications on page 19</a>                                                   | 1.71 | –    | 5.50 | V     |
| $I_{DD24}$            | Supply current, IMO = 24 MHz                  | Conditions are $V_{DD} \leq 3.0$ V, $T_A = 25$ °C, CPU = 24 MHz. CapSense running at 12 MHz, no I/O sourcing current | –    | 2.88 | 4.00 | mA    |
| $I_{DD12}$            | Supply current, IMO = 12 MHz                  | Conditions are $V_{DD} \leq 3.0$ V, $T_A = 25$ °C, CPU = 12 MHz. CapSense running at 12 MHz, no I/O sourcing current | –    | 1.71 | 2.60 | mA    |
| $I_{DD6}$             | Supply current, IMO = 6 MHz                   | Conditions are $V_{DD} \leq 3.0$ V, $T_A = 25$ °C, CPU = 6 MHz. CapSense running at 6 MHz, no I/O sourcing current   | –    | 1.16 | 1.80 | mA    |
| $I_{SB0}$             | Deep sleep current                            | $V_{DD} \leq 3.0$ V, $T_A = 25$ °C, I/O regulator turned off                                                         | –    | 0.10 | 1.1  | μA    |
| $I_{SB1}$             | Standby current with POR, LVD and sleep timer | $V_{DD} \leq 3.0$ V, $T_A = 25$ °C, I/O regulator turned off                                                         | –    | 1.07 | 1.50 | μA    |
| $I_{SBI2C}$           | Standby current with I <sup>2</sup> C enabled | Conditions are $V_{DD} = 3.3$ V, $T_A = 25$ °C and CPU = 24 MHz                                                      | –    | 1.64 | –    | μA    |

### Notes

26. When  $V_{DD}$  remains in the range from 1.71 V to 1.9 V for more than 50 μs, the slew rate when moving from the 1.71 V to 1.9 V range to greater than 2 V must be slower than 1 V/500 μs to avoid triggering POR. The only other restriction on slew rates for any other voltage range or transition is the  $SR_{POWER\_UP}$  parameter.
27. If powering down in standby sleep mode, to properly detect and recover from a  $V_{DD}$  brown out condition any of the following actions must be taken:
  - a. Bring the device out of sleep before powering down.
  - b. Assure that  $V_{DD}$  falls below 100 mV before powering back up.
  - c. Set the No Buzz bit in the OSC\_CR0 register to keep the voltage monitoring circuit powered during sleep.
  - d. Increase the buzz rate to assure that the falling edge of  $V_{DD}$  is captured. The rate is configured through the PSSDC bits in the SLP\_CFG register. For the referenced registers, refer to the [Technical Reference Manual](#). In deep sleep/standby sleep mode, additional low power voltage monitoring circuitry allows  $V_{DD}$  brown out conditions to be detected and resets the device when  $V_{DD}$  goes lower than 1.1 V at edge rates slower than 1 V/ms.
28. For proper CapSense block functionality, if the drop in  $V_{DD}$  exceeds 5% of the base  $V_{DD}$ , the rate at which  $V_{DD}$  drops should not exceed 200 mV/s. Base  $V_{DD}$  can be between 1.8 V and 5.5 V.

## DC GPIO Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 3.0 V to 5.5 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , 2.4 V to 3.0 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 1.71 V to 2.4 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 10. 3.0 V to 5.5 V DC GPIO Specifications**

| Symbol         | Description                                                                    | Conditions                                                                                                                                                                                                  | Min             | Typ       | Max  | Units         |
|----------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------|------|---------------|
| $R_{PU}$       | Pull-up resistor                                                               | –                                                                                                                                                                                                           | 4               | 5.60      | 8    | $k\Omega$     |
| $V_{OH1}$      | High output voltage<br>Port 2 or 3 pins                                        | $I_{OH} \leq 10\ \mu\text{A}$ , maximum of 10 mA source current in all I/Os                                                                                                                                 | $V_{DD} - 0.20$ | –         | –    | V             |
| $V_{OH2}$      | High output voltage<br>Port 2 or 3 Pins                                        | $I_{OH} = 1\ \text{mA}$ , maximum of 20 mA source current in all I/Os                                                                                                                                       | $V_{DD} - 0.90$ | –         | –    | V             |
| $V_{OH3}$      | High output voltage<br>Port 0 or 1 pins with LDO regulator Disabled for port 1 | $I_{OH} < 10\ \mu\text{A}$ , maximum of 10 mA source current in all I/Os                                                                                                                                    | $V_{DD} - 0.20$ | –         | –    | V             |
| $V_{OH4}$      | High output voltage<br>Port 0 or 1 pins with LDO regulator Disabled for port 1 | $I_{OH} = 5\ \text{mA}$ , maximum of 20 mA source current in all I/Os                                                                                                                                       | $V_{DD} - 0.90$ | –         | –    | V             |
| $V_{OH5}$      | High output voltage<br>Port 1 Pins with LDO Regulator Enabled for 3 V out      | $I_{OH} < 10\ \mu\text{A}$ , $V_{DD} > 3.1\ \text{V}$ , maximum of 4 I/Os all sourcing 5 mA                                                                                                                 | 2.85            | 3.00      | 3.30 | V             |
| $V_{OH6}$      | High output voltage<br>Port 1 pins with LDO regulator enabled for 3 V out      | $I_{OH} = 5\ \text{mA}$ , $V_{DD} > 3.1\ \text{V}$ , maximum of 20 mA source current in all I/Os                                                                                                            | 2.20            | –         | –    | V             |
| $V_{OH7}$      | High output voltage<br>Port 1 pins with LDO enabled for 2.5 V out              | $I_{OH} < 10\ \mu\text{A}$ , $V_{DD} > 2.7\ \text{V}$ , maximum of 20 mA source current in all I/Os                                                                                                         | 2.35            | 2.50      | 2.75 | V             |
| $V_{OH8}$      | High output voltage<br>Port 1 pins with LDO enabled for 2.5 V out              | $I_{OH} = 2\ \text{mA}$ , $V_{DD} > 2.7\ \text{V}$ , maximum of 20 mA source current in all I/Os                                                                                                            | 1.90            | –         | –    | V             |
| $V_{OH9}$      | High output voltage<br>Port 1 pins with LDO enabled for 1.8 V out              | $I_{OH} < 10\ \mu\text{A}$ , $V_{DD} > 2.7\ \text{V}$ , maximum of 20 mA source current in all I/Os                                                                                                         | 1.60            | 1.80      | 2.10 | V             |
| $V_{OH10}$     | High output voltage<br>Port 1 pins with LDO enabled for 1.8 V out              | $I_{OH} = 1\ \text{mA}$ , $V_{DD} > 2.7\ \text{V}$ , maximum of 20 mA source current in all I/Os                                                                                                            | 1.20            | –         | –    | V             |
| $V_{OL}$       | Low output voltage                                                             | $I_{OL} = 25\ \text{mA}$ , $V_{DD} > 3.3\ \text{V}$ , maximum of 60 mA sink current on even port pins (for example, P0[2] and P1[4]) and 60 mA sink current on odd port pins (for example, P0[3] and P1[5]) | –               | –         | 0.75 | V             |
| $V_{IL}$       | Input low voltage                                                              | –                                                                                                                                                                                                           | –               | –         | 0.80 | V             |
| $V_{IH}$       | Input high voltage                                                             | –                                                                                                                                                                                                           | 2.00            | –         | –    | V             |
| $V_H$          | Input hysteresis voltage                                                       | –                                                                                                                                                                                                           | –               | 80        | –    | mV            |
| $I_{IL}$       | Input leakage (Absolute Value)                                                 | –                                                                                                                                                                                                           | –               | 0.00<br>1 | 1    | $\mu\text{A}$ |
| $C_{PIN}$      | Pin capacitance                                                                | Package and pin dependent<br>Temp = $25^{\circ}\text{C}$                                                                                                                                                    | 0.50            | 1.70      | 7    | pF            |
| $V_{ILLVT3.3}$ | Input Low Voltage with low threshold enable set, Enable for Port1              | Bit3 of IO_CFG1 set to enable low threshold voltage of Port1 input                                                                                                                                          | 0.8             | V         | –    | –             |
| $V_{IHLVT3.3}$ | Input High Voltage with low threshold enable set, Enable for Port1             | Bit3 of IO_CFG1 set to enable low threshold voltage of Port1 input                                                                                                                                          | 1.4             | –         | –    | V             |
| $V_{ILLVT5.5}$ | Input Low Voltage with low threshold enable set, Enable for Port1              | Bit3 of IO_CFG1 set to enable low threshold voltage of Port1 input                                                                                                                                          | 0.8             | V         | –    | –             |
| $V_{IHLVT5.5}$ | Input High Voltage with low threshold enable set, Enable for Port1             | Bit3 of IO_CFG1 set to enable low threshold voltage of Port1 input                                                                                                                                          | 1.7             | –         | –    | V             |



**Table 11. 2.4 V to 3.0 V DC GPIO Specifications**

| Symbol                | Description                                                                    | Conditions                                                                                                                                                                     | Min                    | Typ  | Max  | Units |
|-----------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------|------|-------|
| R <sub>PU</sub>       | Pull-up resistor                                                               | –                                                                                                                                                                              | 4                      | 5.60 | 8    | kΩ    |
| V <sub>OH1</sub>      | High output voltage<br>Port 2 or 3 pins                                        | I <sub>OH</sub> < 10 μA, maximum of 10 mA source current in all I/Os                                                                                                           | V <sub>DD</sub> - 0.20 | –    | –    | V     |
| V <sub>OH2</sub>      | High output voltage<br>Port 2 or 3 Pins                                        | I <sub>OH</sub> = 0.2 mA, maximum of 10 mA source current in all I/Os                                                                                                          | V <sub>DD</sub> - 0.40 | –    | –    | V     |
| V <sub>OH3</sub>      | High output voltage<br>Port 0 or 1 pins with LDO regulator Disabled for port 1 | I <sub>OH</sub> < 10 μA, maximum of 10 mA source current in all I/Os                                                                                                           | V <sub>DD</sub> - 0.20 | –    | –    | V     |
| V <sub>OH4</sub>      | High output voltage<br>Port 0 or 1 pins with LDO regulator Disabled for Port 1 | I <sub>OH</sub> = 2 mA, maximum of 10 mA source current in all I/Os                                                                                                            | V <sub>DD</sub> - 0.50 | –    | –    | V     |
| V <sub>OH5A</sub>     | High output voltage<br>Port 1 pins with LDO enabled for 1.8 V out              | I <sub>OH</sub> < 10 μA, V <sub>DD</sub> > 2.4 V, maximum of 20 mA source current in all I/Os                                                                                  | 1.50                   | 1.80 | 2.10 | V     |
| V <sub>OH6A</sub>     | High output voltage<br>Port 1 pins with LDO enabled for 1.8 V out              | I <sub>OH</sub> = 1 mA, V <sub>DD</sub> > 2.4 V, maximum of 20 mA source current in all I/Os                                                                                   | 1.20                   | –    | –    | V     |
| V <sub>OL</sub>       | Low output voltage                                                             | I <sub>OL</sub> = 10 mA, maximum of 30 mA sink current on even port pins (for example, P0[2] and P1[4]) and 30 mA sink current on odd port pins (for example, P0[3] and P1[5]) | –                      | –    | 0.75 | V     |
| V <sub>IL</sub>       | Input low voltage                                                              | –                                                                                                                                                                              | –                      | –    | 0.72 | V     |
| V <sub>IH</sub>       | Input high voltage                                                             | –                                                                                                                                                                              | 1.40                   | –    | –    | V     |
| V <sub>H</sub>        | Input hysteresis voltage                                                       | –                                                                                                                                                                              | –                      | 80   | –    | mV    |
| I <sub>IL</sub>       | Input leakage (absolute value)                                                 | –                                                                                                                                                                              | –                      | 1    | 1000 | nA    |
| C <sub>PIN</sub>      | Capacitive load on pins                                                        | Package and pin dependent<br>Temp = 25 °C                                                                                                                                      | 0.50                   | 1.70 | 7    | pF    |
| V <sub>ILLVT2.5</sub> | Input Low Voltage with low threshold enable set, Enable for Port1              | Bit3 of IO_CFG1 set to enable low threshold voltage of Port1 input                                                                                                             | 0.7                    | V    | –    |       |
| V <sub>IHLVT2.5</sub> | Input High Voltage with low threshold enable set, Enable for Port1             | Bit3 of IO_CFG1 set to enable low threshold voltage of Port1 input                                                                                                             | 1.2                    |      | –    | V     |

**Table 12. 1.71 V to 2.4 V DC GPIO Specifications**

| Symbol           | Description                                                                    | Conditions                                                            | Min                    | Typ  | Max | Units |
|------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------|------------------------|------|-----|-------|
| R <sub>PU</sub>  | Pull-up resistor                                                               | –                                                                     | 4                      | 5.60 | 8   | kΩ    |
| V <sub>OH1</sub> | High output voltage<br>Port 2 or 3 pins                                        | I <sub>OH</sub> = 10 μA, maximum of 10 mA source current in all I/Os  | V <sub>DD</sub> - 0.20 | –    | –   | V     |
| V <sub>OH2</sub> | High output voltage<br>Port 2 or 3 pins                                        | I <sub>OH</sub> = 0.5 mA, maximum of 10 mA source current in all I/Os | V <sub>DD</sub> - 0.50 | –    | –   | V     |
| V <sub>OH3</sub> | High output voltage<br>Port 0 or 1 pins with LDO regulator Disabled for Port 1 | I <sub>OH</sub> = 100 μA, maximum of 10 mA source current in all I/Os | V <sub>DD</sub> - 0.20 | –    | –   | V     |
| V <sub>OH4</sub> | High output voltage<br>Port 0 or 1 Pins with LDO Regulator Disabled for Port 1 | I <sub>OH</sub> = 2 mA, maximum of 10 mA source current in all I/Os   | V <sub>DD</sub> - 0.50 | –    | –   | V     |

**Table 12. 1.71 V to 2.4 V DC GPIO Specifications (continued)**

| Symbol    | Description                    | Conditions                                                                                                                                                             | Min                  | Typ  | Max                  | Units |
|-----------|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------|----------------------|-------|
| $V_{OL}$  | Low output voltage             | $I_{OL} = 5$ mA, maximum of 20 mA sink current on even port pins (for example, P0[2] and P1[4]) and 30 mA sink current on odd port pins (for example, P0[3] and P1[5]) | –                    | –    | 0.40                 | V     |
| $V_{IL}$  | Input low voltage              | –                                                                                                                                                                      | –                    | –    | $0.30 \times V_{DD}$ | V     |
| $V_{IH}$  | Input high voltage             | –                                                                                                                                                                      | $0.65 \times V_{DD}$ | –    | –                    | V     |
| $V_H$     | Input hysteresis voltage       | –                                                                                                                                                                      | –                    | 80   | –                    | mV    |
| $I_{IL}$  | Input leakage (absolute value) | –                                                                                                                                                                      | –                    | 1    | 1000                 | nA    |
| $C_{PIN}$ | Capacitive load on pins        | Package and pin dependent<br>temp = 25 °C                                                                                                                              | 0.50                 | 1.70 | 7                    | pF    |

**Table 13. GPIO Current Sink and Source Specifications**

| Supply Voltage | Mode   | Port 1 per I/O (max) | Port 2/3/4 per I/O (max) | Total Current Even Pins (max) | Total Current Odd Pins (max) | Units |
|----------------|--------|----------------------|--------------------------|-------------------------------|------------------------------|-------|
| 1.71 – 2.4     | Sink   | 5                    | 5                        | 20                            | 30                           | mA    |
|                | Source | 2                    | 0.5                      | $10^{[29]}$                   |                              | mA    |
| 2.4 – 3.0      | Sink   | 10                   | 10                       | 30                            | 30                           | mA    |
|                | Source | 2                    | 0.2                      | $10^{[29]}$                   |                              | mA    |
| 3.0 – 5.0      | Sink   | 25                   | 25                       | 60                            | 60                           | mA    |
|                | Source | 5                    | 1                        | $20^{[29]}$                   |                              | mA    |

### DC Analog Mux Bus Specifications

The following table lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

**Table 14. DC Analog Mux Bus Specifications**

| Symbol    | Description                                     | Conditions | Min | Typ | Max | Units    |
|-----------|-------------------------------------------------|------------|-----|-----|-----|----------|
| $R_{SW}$  | Switch resistance to common analog bus          | –          | –   | –   | 800 | $\Omega$ |
| $R_{GND}$ | Resistance of initialization switch to $V_{SS}$ | –          | –   | –   | 800 | $\Omega$ |

The maximum pin voltage for measuring  $R_{SW}$  and  $R_{GND}$  is 1.8 V

### DC Low Power Comparator Specifications

The following table lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

**Table 15. DC Comparator Specifications**

| Symbol      | Description                            | Conditions                          | Min | Typ | Max | Units   |
|-------------|----------------------------------------|-------------------------------------|-----|-----|-----|---------|
| $V_{LPC}$   | Low power comparator (LPC) common mode | Maximum voltage limited to $V_{DD}$ | 0.2 | –   | 1.8 | V       |
| $I_{LPC}$   | LPC supply current                     | –                                   | –   | 10  | 80  | $\mu$ A |
| $V_{OSLPC}$ | LPC voltage offset                     | –                                   | –   | 2.5 | 30  | mV      |

#### Note

29. Total current (odd + even ports)

### Comparator User Module Electrical Specifications

The following table lists the guaranteed maximum and minimum specifications. Unless stated otherwise, the specifications are for the entire device voltage and temperature operating range:  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ ,  $1.71\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ .

**Table 16. Comparator User Module Electrical Specifications**

| Symbol            | Description              | Conditions                          | Min | Typ | Max | Units         |
|-------------------|--------------------------|-------------------------------------|-----|-----|-----|---------------|
| $T_{\text{COMP}}$ | Comparator response time | 50 mV overdrive                     | –   | 70  | 100 | ns            |
| Offset            |                          | Valid from 0.2 V to 1.5 V           | –   | 2.5 | 30  | mV            |
| Current           |                          | Average DC current, 50 mV overdrive | –   | 20  | 80  | $\mu\text{A}$ |
| PSRR              | Supply voltage > 2 V     | Power supply rejection ratio        | –   | 80  | –   | dB            |
|                   | Supply voltage < 2 V     | Power supply rejection ratio        | –   | 40  | –   | dB            |
| Input range       |                          | –                                   | 0.2 |     | 1.5 | V             |

### ADC Electrical Specifications

**Table 17. ADC User Module Electrical Specifications**

| Symbol                 | Description                  | Conditions                                                                                                          | Min                                         | Typ                                         | Max                                         | Units    |
|------------------------|------------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------|---------------------------------------------|---------------------------------------------|----------|
| <b>Input</b>           |                              |                                                                                                                     |                                             |                                             |                                             |          |
| $V_{\text{IN}}$        | Input voltage range          | –                                                                                                                   | 0                                           | –                                           | $V_{\text{REFADC}}$                         | V        |
| $C_{\text{IIN}}$       | Input capacitance            | –                                                                                                                   | –                                           | –                                           | 5                                           | pF       |
| $R_{\text{IN}}$        | Input resistance             | Equivalent switched cap input resistance for 8-, 9-, or 10-bit resolution                                           | $1/(500\text{fF} \times \text{data clock})$ | $1/(400\text{fF} \times \text{data clock})$ | $1/(300\text{fF} \times \text{data clock})$ | $\Omega$ |
| <b>Reference</b>       |                              |                                                                                                                     |                                             |                                             |                                             |          |
| $V_{\text{REFADC}}$    | ADC reference voltage        | –                                                                                                                   | 1.14                                        | –                                           | 1.26                                        | V        |
| <b>Conversion Rate</b> |                              |                                                                                                                     |                                             |                                             |                                             |          |
| $F_{\text{CLK}}$       | Data clock                   | Source is chip's internal main oscillator. See <a href="#">AC Chip-Level Specifications on page 21</a> for accuracy | 2.25                                        | –                                           | 6                                           | MHz      |
| S8                     | 8-bit sample rate            | Data clock set to 6 MHz.<br>sample rate = $0.001/(2^{\text{Resolution}}/\text{Data Clock})$                         | –                                           | 23.43                                       | –                                           | ksps     |
| S10                    | 10-bit sample rate           | Data clock set to 6 MHz.<br>sample rate = $0.001/(2^{\text{resolution}}/\text{data clock})$                         | –                                           | 5.85                                        | –                                           | ksps     |
| <b>DC Accuracy</b>     |                              |                                                                                                                     |                                             |                                             |                                             |          |
| RES                    | Resolution                   | Can be set to 8, 9, or 10 bit                                                                                       | 8                                           | –                                           | 10                                          | bits     |
| DNL                    | Differential nonlinearity    | –                                                                                                                   | –1                                          | –                                           | +2                                          | LSB      |
| INL                    | Integral nonlinearity        | –                                                                                                                   | –2                                          | –                                           | +2                                          | LSB      |
| $E_{\text{OFFSET}}$    | Offset error                 | 8-bit resolution                                                                                                    | 0                                           | 3.20                                        | 19.20                                       | LSB      |
|                        |                              | 10-bit resolution                                                                                                   | 0                                           | 12.80                                       | 76.80                                       | LSB      |
| $E_{\text{GAIN}}$      | Gain error                   | For any resolution                                                                                                  | –5                                          | –                                           | +5                                          | %FSR     |
| <b>Power</b>           |                              |                                                                                                                     |                                             |                                             |                                             |          |
| $I_{\text{ADC}}$       | Operating current            | –                                                                                                                   | –                                           | 2.10                                        | 2.60                                        | mA       |
| PSRR                   | Power supply rejection ratio | PSRR ( $V_{DD} > 3.0\text{ V}$ )                                                                                    | –                                           | 24                                          | –                                           | dB       |
|                        |                              | PSRR ( $V_{DD} < 3.0\text{ V}$ )                                                                                    | –                                           | 30                                          | –                                           | dB       |

## DC POR and LVD Specifications

The following table lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

**Table 18. DC POR and LVD Specifications**

| Symbol            | Description                      | Conditions                                                                                                               | Min                  | Typ  | Max  | Units |
|-------------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------|------|------|-------|
| V <sub>POR0</sub> | 1.66 V selected in PSoC Designer | V <sub>DD</sub> must be greater than or equal to 1.71 V during startup, reset from the XRES pin, or reset from watchdog. | 1.61                 | 1.66 | 1.71 | V     |
| V <sub>POR1</sub> | 2.36 V selected in PSoC Designer |                                                                                                                          | –                    | 2.36 | 2.41 |       |
| V <sub>POR2</sub> | 2.60 V selected in PSoC Designer |                                                                                                                          | –                    | 2.60 | 2.66 |       |
| V <sub>POR3</sub> | 2.82 V selected in PSoC Designer |                                                                                                                          | –                    | 2.82 | 2.95 |       |
| V <sub>LVD0</sub> | 2.45 V selected in PSoC Designer | –                                                                                                                        | 2.40                 | 2.45 | 2.51 | V     |
| V <sub>LVD1</sub> | 2.71 V selected in PSoC Designer |                                                                                                                          | 2.64 <sup>[30]</sup> | 2.71 | 2.78 |       |
| V <sub>LVD2</sub> | 2.92 V selected in PSoC Designer |                                                                                                                          | 2.85 <sup>[31]</sup> | 2.92 | 2.99 |       |
| V <sub>LVD3</sub> | 3.02 V selected in PSoC Designer |                                                                                                                          | 2.95 <sup>[32]</sup> | 3.02 | 3.09 |       |
| V <sub>LVD4</sub> | 3.13 V selected in PSoC Designer |                                                                                                                          | 3.06                 | 3.13 | 3.20 |       |
| V <sub>LVD5</sub> | 1.90 V selected in PSoC Designer |                                                                                                                          | 1.84                 | 1.90 | 2.32 |       |
| V <sub>LVD6</sub> | 1.80 V selected in PSoC Designer |                                                                                                                          | 1.75 <sup>[33]</sup> | 1.80 | 1.84 |       |
| V <sub>LVD7</sub> | 4.73 V selected in PSoC Designer |                                                                                                                          | 4.62                 | 4.73 | 4.83 |       |

## DC Programming Specifications

The following table lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

**Table 19. DC Programming Specifications**

| Symbol                | Description                                                                                 | Conditions                                                                                                                                                 | Min             | Typ | Max                    | Units |
|-----------------------|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----|------------------------|-------|
| V <sub>DDIWRITE</sub> | Supply voltage for flash write operations                                                   | –                                                                                                                                                          | 1.71            | –   | 5.25                   | V     |
| I <sub>DDP</sub>      | Supply current during programming or verify                                                 | –                                                                                                                                                          | –               | 5   | 25                     | mA    |
| V <sub>ILP</sub>      | Input low voltage during programming or verify                                              | See appropriate <a href="#">DC GPIO Specifications on page 15</a>                                                                                          | –               | –   | V <sub>IL</sub>        | V     |
| V <sub>IHP</sub>      | Input high voltage during programming or verify                                             | See appropriate <a href="#">DC GPIO Specifications on page 15</a>                                                                                          | V <sub>IH</sub> | –   | –                      | V     |
| I <sub>ILP</sub>      | Input current when Applying V <sub>ILP</sub> to P1[0] or P1[1] during programming or verify | Driving internal pull-down resistor                                                                                                                        | –               | –   | 0.2                    | mA    |
| I <sub>IHP</sub>      | Input current when applying V <sub>IHP</sub> to P1[0] or P1[1] during programming or verify | Driving internal pull-down resistor                                                                                                                        | –               | –   | 1.5                    | mA    |
| V <sub>OLP</sub>      | Output low voltage during programming or verify                                             |                                                                                                                                                            | –               | –   | V <sub>SS</sub> + 0.75 | V     |
| V <sub>OHP</sub>      | Output high voltage during programming or verify                                            | See appropriate <a href="#">DC GPIO Specifications on page 15</a> . For V <sub>DD</sub> > 3V use V <sub>OHP</sub> in <a href="#">Table 10 on page 15</a> . | V <sub>OH</sub> | –   | V <sub>DD</sub>        | V     |
| Flash <sub>ENPB</sub> | Flash write endurance                                                                       | Erase/write cycles per block                                                                                                                               | 50,000          | –   | –                      | –     |
| Flash <sub>DR</sub>   | Flash data retention                                                                        | Following maximum Flash write cycles; ambient temperature of 55 °C                                                                                         | 20              | –   | –                      | Years |

### Notes

- 30. Always greater than 50 mV above V<sub>PPOR1</sub> voltage for falling supply.
- 31. Always greater than 50 mV above V<sub>PPOR2</sub> voltage for falling supply.
- 32. Always greater than 50 mV above V<sub>PPOR3</sub> voltage for falling supply.
- 33. Always greater than 50 mV above V<sub>PPOR0</sub> voltage for falling supply.

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

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 3.0 V to 5.5 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , 2.4 V to 3.0 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 1.71 V to 2.4 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 20. DC I<sup>2</sup>C Specifications<sup>[34]</sup>**

| Symbol                           | Description      | Conditions                                    | Min                  | Typ | Max                                     | Units |
|----------------------------------|------------------|-----------------------------------------------|----------------------|-----|-----------------------------------------|-------|
| V <sub>IL</sub> I <sup>2</sup> C | Input low level  | $3.1\text{ V} \leq V_{DD} \leq 5.5\text{ V}$  | –                    | –   | $0.25 \times V_{DD}$                    | V     |
|                                  |                  | $2.5\text{ V} \leq V_{DD} \leq 3.0\text{ V}$  | –                    | –   | $0.3 \times V_{DD}$                     | V     |
|                                  |                  | $1.71\text{ V} \leq V_{DD} \leq 2.4\text{ V}$ | –                    | –   | $0.3 \times V_{DD}$                     | V     |
| V <sub>IH</sub> I <sup>2</sup> C | Input high level | $1.71\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ | $0.65 \times V_{DD}$ | –   | $V_{DD} + 0.7\text{ V}$ <sup>[35]</sup> | V     |

## Shield Driver DC Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 3.0 V to 5.5 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , 2.4 V to 3.0 V and  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , or 1.71 V to 2.4 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 21. Shield Driver DC Specifications**

| Symbol             | Description             | Conditions                                   | Min   | Typ | Max   | Units |
|--------------------|-------------------------|----------------------------------------------|-------|-----|-------|-------|
| V <sub>Ref</sub>   | Reference buffer output | $1.7\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ | 0.942 | –   | 1.106 | V     |
| V <sub>RefHi</sub> | Reference buffer output | $1.7\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ | 1.104 | –   | 1.296 | V     |

## DC IDAC Specifications

The following table lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

**Table 22. DC IDAC Specifications (8-bit IDAC)**

| Symbol       | Description               | Min | Typ | Max | Units | Notes                 |
|--------------|---------------------------|-----|-----|-----|-------|-----------------------|
| IDAC_DNL     | Differential nonlinearity | –1  | –   | 1   | LSB   |                       |
| IDAC_DNL     | Integral nonlinearity     | –2  | –   | 2   | LSB   |                       |
| IDAC_Current | Range = 4x                | 138 | –   | 169 | μA    | DAC setting = 127 dec |
|              | Range = 8x                | 138 | –   | 169 | μA    | DAC setting = 64 dec  |

**Table 23. DC IDAC Specifications (7-bit IDAC)**

| Symbol       | Description               | Min | Typ | Max | Units | Notes                 |
|--------------|---------------------------|-----|-----|-----|-------|-----------------------|
| IDAC_DNL     | Differential nonlinearity | –1  | –   | 1   | LSB   |                       |
| IDAC_DNL     | Integral nonlinearity     | –2  | –   | 2   | LSB   |                       |
| IDAC_Current | Range = 4x                | 137 | –   | 168 | μA    | DAC setting = 127 dec |
|              | Range = 8x                | 138 | –   | 169 | μA    | DAC setting = 64 dec  |

### Notes

34. Pull-up resistors on I<sup>2</sup>C interface cannot be connected to a supply voltage that is more than 0.7 V higher than the CY8C20xx7/S/H/L power supply. See the CY8C20xx7 Silicon Errata document for more details.

35. Please refer to Item # 6 of the [Silicon Errata for the CY8C20xx7/S Family](#)

## AC Chip-Level Specifications

The following table lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

**Table 24. AC Chip-Level Specifications**

| Symbol                               | Description                                                | Conditions                                | Min  | Typ | Max   | Units |
|--------------------------------------|------------------------------------------------------------|-------------------------------------------|------|-----|-------|-------|
| F <sub>IMO24</sub>                   | IMO frequency at 24 MHz Setting                            | –                                         | 22.8 | 24  | 25.2  | MHz   |
| F <sub>IMO12</sub>                   | IMO frequency at 12 MHz setting                            | –                                         | 11.4 | 12  | 12.6  | MHz   |
| F <sub>IMO6</sub>                    | IMO frequency at 6 MHz setting                             | –                                         | 5.7  | 6.0 | 6.3   | MHz   |
| F <sub>CPU</sub>                     | CPU frequency                                              | –                                         | 0.75 | –   | 25.20 | MHz   |
| F <sub>32K1</sub>                    | ILO frequency                                              | –                                         | 15   | 32  | 50    | kHz   |
| F <sub>32K_U</sub>                   | ILO untrimmed frequency                                    | –                                         | 13   | 32  | 82    | kHz   |
| DC <sub>IMO</sub>                    | Duty cycle of IMO                                          | –                                         | 40   | 50  | 60    | %     |
| DC <sub>ILO</sub>                    | ILO duty cycle                                             | –                                         | 40   | 50  | 60    | %     |
| SR <sub>POWER_UP</sub>               | Power supply slew rate                                     | V <sub>DD</sub> slew rate during power-up | –    | –   | 250   | V/ms  |
| t <sub>XRST</sub>                    | External reset pulse width at power-up                     | After supply voltage is valid             | 1    | –   | –     | ms    |
| t <sub>XRST2</sub>                   | External reset pulse width after power-up <sup>[36]</sup>  | Applies after part has booted             | 10   | –   | –     | μs    |
| t <sub>JIT_IMO</sub> <sup>[37]</sup> | 6 MHz IMO cycle-to-cycle jitter (RMS)                      | –                                         | –    | 0.7 | 6.7   | ns    |
|                                      | 6 MHz IMO long term N cycle-to-cycle jitter (RMS); N = 32  | –                                         | –    | 4.3 | 29.3  | ns    |
|                                      | 6 MHz IMO period jitter (RMS)                              | –                                         | –    | 0.7 | 3.3   | ns    |
|                                      | 12 MHz IMO cycle-to-cycle jitter (RMS)                     | –                                         | –    | 0.5 | 5.2   | ns    |
|                                      | 12 MHz IMO long term N cycle-to-cycle jitter (RMS); N = 32 | –                                         | –    | 2.3 | 5.6   | ns    |
|                                      | 12 MHz IMO period jitter (RMS)                             | –                                         | –    | 0.4 | 2.6   | ns    |
|                                      | 24 MHz IMO cycle-to-cycle jitter (RMS)                     | –                                         | –    | 1.0 | 8.7   | ns    |
|                                      | 24 MHz IMO long term N cycle-to-cycle jitter (RMS); N = 32 | –                                         | –    | 1.4 | 6.0   | ns    |
|                                      | 24 MHz IMO period jitter (RMS)                             | –                                         | –    | 0.6 | 4.0   | ns    |

### Note

36. The minimum required XRES pulse length is longer when programming the device (see [Table 28 on page 23](#)).

37. See the Cypress Jitter Specifications application note, [Understanding Datasheet Jitter Specifications for Cypress Timing Products – AN5054](#) for more information.

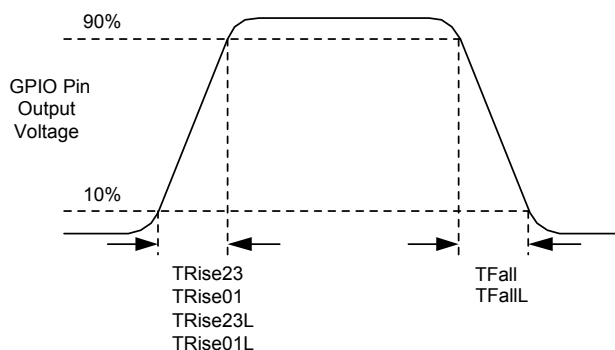
## AC General Purpose I/O Specifications

The following table lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

**Table 25. AC GPIO Specifications**

| Symbol        | Description                                                       | Conditions                                                      | Min | Typ | Max                                                                                 | Units |
|---------------|-------------------------------------------------------------------|-----------------------------------------------------------------|-----|-----|-------------------------------------------------------------------------------------|-------|
| $F_{GPIO}$    | GPIO operating frequency                                          | Normal strong mode Port 0, 1                                    | 0   | –   | 6 MHz for<br>1.71 V < $V_{DD}$ < 2.40 V<br>12 MHz for<br>2.40 V < $V_{DD}$ < 5.50 V | MHz   |
| $t_{RISE23}$  | Rise time, strong mode, Cload = 50 pF<br>Ports 2 or 3             | $V_{DD}$ = 3.0 to 3.6 V, 10% to 90%                             | 15  | –   | 80                                                                                  | ns    |
| $t_{RISE23L}$ | Rise time, strong mode low supply,<br>Cload = 50 pF, Ports 2 or 3 | $V_{DD}$ = 1.71 to 3.0 V, 10% to 90%                            | 15  | –   | 80                                                                                  | ns    |
| $t_{RISE01}$  | Rise time, strong mode, Cload = 50 pF<br>Ports 0 or 1             | $V_{DD}$ = 3.0 to 3.6 V, 10% to 90%<br>LDO enabled or disabled  | 10  | –   | 50                                                                                  | ns    |
| $t_{RISE01L}$ | Rise time, strong mode low supply,<br>Cload = 50 pF, Ports 0 or 1 | $V_{DD}$ = 1.71 to 3.0 V, 10% to 90%<br>LDO enabled or disabled | 10  | –   | 80                                                                                  | ns    |
| $t_{FALL}$    | Fall time, strong mode, Cload = 50 pF<br>all ports                | $V_{DD}$ = 3.0 to 3.6 V, 10% to 90%                             | 10  | –   | 50                                                                                  | ns    |
| $t_{FALLL}$   | Fall time, strong mode low supply,<br>Cload = 50 pF, all ports    | $V_{DD}$ = 1.71 to 3.0 V, 10% to 90%                            | 10  | –   | 70                                                                                  | ns    |

**Figure 9. GPIO Timing Diagram**



## AC Comparator Specifications

The following table lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

**Table 26. AC Low Power Comparator Specifications**

| Symbol    | Description                                  | Conditions                                          | Min | Typ | Max | Units |
|-----------|----------------------------------------------|-----------------------------------------------------|-----|-----|-----|-------|
| $t_{LPC}$ | Comparator response time,<br>50 mV overdrive | 50 mV overdrive does not include<br>offset voltage. | –   | –   | 100 | ns    |

## AC External Clock Specifications

The following table lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

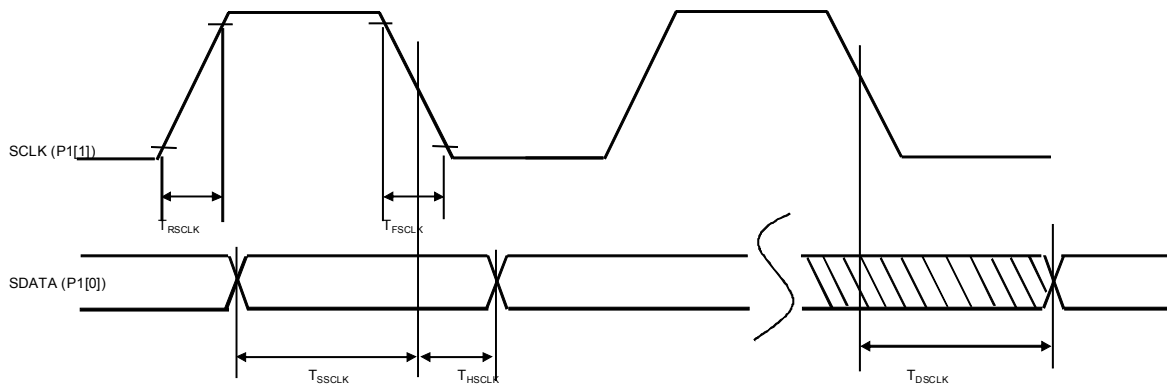
**Table 27. AC External Clock Specifications**

| Symbol       | Description                                  | Conditions | Min   | Typ | Max   | Units |
|--------------|----------------------------------------------|------------|-------|-----|-------|-------|
| $F_{OSCEXT}$ | Frequency (external oscillator<br>frequency) | –          | 0.75  | –   | 25.20 | MHz   |
|              | High period                                  | –          | 20.60 | –   | 5300  | ns    |
|              | Low period                                   | –          | 20.60 | –   | –     | ns    |
|              | Power-up IMO to switch                       | –          | 150   | –   | –     | μs    |



## AC Programming Specifications

Figure 10. AC Waveform



The following table lists the guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

Table 28. AC Programming Specifications

| Symbol               | Description                                                                     | Conditions                                                  | Min   | Typ | Max   | Units   |
|----------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------|-------|-----|-------|---------|
| $t_{RSCLK}$          | Rise time of SCLK                                                               | —                                                           | 1     | —   | 20    | ns      |
| $t_{FSCLK}$          | Fall time of SCLK                                                               | —                                                           | 1     | —   | 20    | ns      |
| $t_{SSCLK}$          | Data setup time to falling edge of SCLK                                         | —                                                           | 40    | —   | —     | ns      |
| $t_{HSCLK}$          | Data hold time from falling edge of SCLK                                        | —                                                           | 40    | —   | —     | ns      |
| $F_{SCLK}$           | Frequency of SCLK                                                               | —                                                           | 0     | —   | 8     | MHz     |
| $t_{ERASEB}$         | Flash erase time (block)                                                        | —                                                           | —     | —   | 18    | ms      |
| $t_{WRITE}$          | Flash block write time                                                          | —                                                           | —     | —   | 25    | ms      |
| $t_{DSCLK}$          | Data out delay from falling edge of SCLK                                        | $3.6 < V_{DD}$                                              | —     | —   | 60    | ns      |
| $t_{DSCLK3}$         | Data out delay from falling edge of SCLK                                        | $3.0 \leq V_{DD} \leq 3.6$                                  | —     | —   | 85    | ns      |
| $t_{DSCLK2}$         | Data out delay from falling edge of SCLK                                        | $1.71 \leq V_{DD} \leq 3.0$                                 | —     | —   | 130   | ns      |
| $t_{XRST3}$          | External reset pulse width after power-up                                       | Required to enter programming mode when coming out of sleep | 300   | —   | —     | $\mu$ s |
| $t_{XRES}$           | XRES pulse length                                                               | —                                                           | 300   | —   | —     | $\mu$ s |
| $t_{VDDWAIT}^{[38]}$ | $V_{DD}$ stable to wait-and-poll hold off                                       | —                                                           | 0.1   | —   | 1     | ms      |
| $t_{VDDXRES}^{[38]}$ | $V_{DD}$ stable to XRES assertion delay                                         | —                                                           | 14.27 | —   | —     | ms      |
| $t_{POLL}$           | SDAT high pulse time                                                            | —                                                           | 0.01  | —   | 200   | ms      |
| $t_{ACQ}^{[38]}$     | “Key window” time after a $V_{DD}$ ramp acquire event, based on 256 ILO clocks. | —                                                           | 3.20  | —   | 19.60 | ms      |
| $t_{XRESINI}^{[38]}$ | “Key window” time after an XRES event, based on 8 ILO clocks                    | —                                                           | 98    | —   | 615   | $\mu$ s |

**Note**

38. Valid from 5 to 50 °C. See the spec, [CY8C20X66](#), [CY8C20X46](#), [CY8C20X36](#), [CY7C643XX](#), [CY7C604XX](#), [CY8CTST2XX](#), [CY8CTMG2XX](#), [CY8C20X67](#), [CY8C20X47](#), [CY8C20X37](#), [Programming Spec](#) for more details.

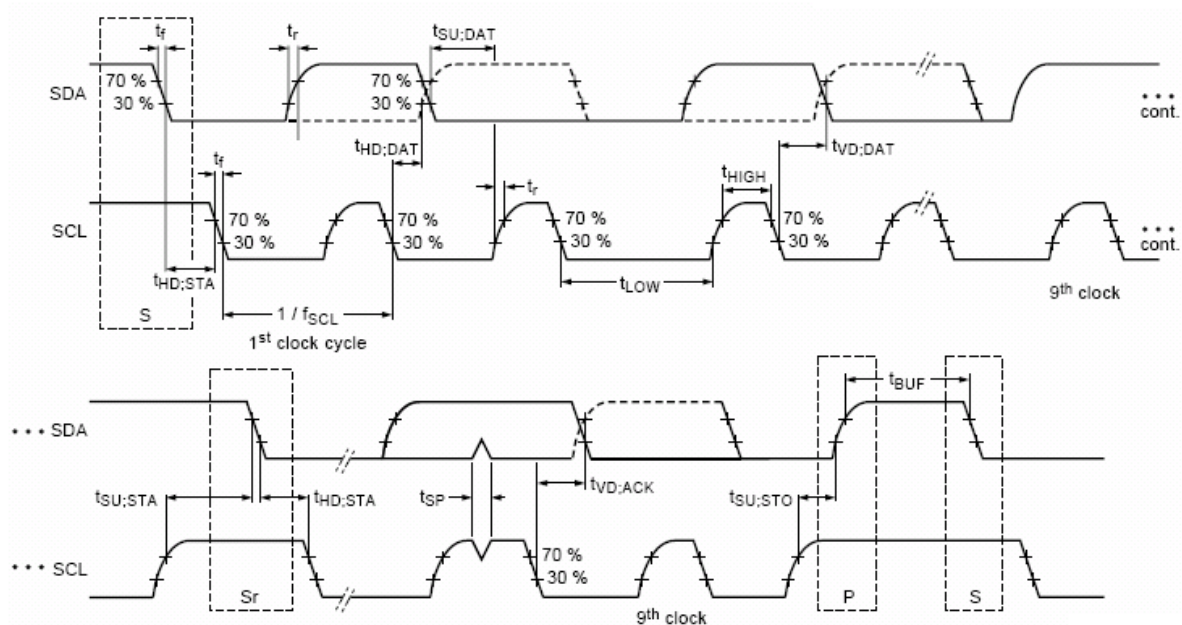
## AC I<sup>2</sup>C Specifications

The following table lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

**Table 29. AC Characteristics of the I<sup>2</sup>C SDA and SCL Pins**

| Symbol              | Description                                                                                 | Standard Mode |      | Fast Mode           |      | Units   |
|---------------------|---------------------------------------------------------------------------------------------|---------------|------|---------------------|------|---------|
|                     |                                                                                             | Min           | Max  | Min                 | Max  |         |
| $f_{SCL}$           | SCL clock frequency                                                                         | 0             | 100  | 0                   | 400  | kHz     |
| $t_{HD;STA}$        | Hold time (repeated) START condition. After this period, the first clock pulse is generated | 4.0           | –    | 0.6                 | –    | $\mu$ s |
| $t_{LOW}$           | LOW period of the SCL clock                                                                 | 4.7           | –    | 1.3                 | –    | $\mu$ s |
| $t_{HIGH}$          | HIGH Period of the SCL clock                                                                | 4.0           | –    | 0.6                 | –    | $\mu$ s |
| $t_{SU;STA}$        | Setup time for a repeated START condition                                                   | 4.7           | –    | 0.6                 | –    | $\mu$ s |
| $t_{HD;DAT}^{[39]}$ | Data hold time                                                                              | 20            | 3.45 | 20                  | 0.90 | $\mu$ s |
| $t_{SU;DAT}$        | Data setup time                                                                             | 250           | –    | 100 <sup>[40]</sup> | –    | ns      |
| $t_{SU;STO}$        | Setup time for STOP condition                                                               | 4.0           | –    | 0.6                 | –    | $\mu$ s |
| $t_{BUF}$           | Bus free time between a STOP and START condition                                            | 4.7           | –    | 1.3                 | –    | $\mu$ s |
| $t_{SP}$            | Pulse width of spikes are suppressed by the input filter                                    | –             | –    | 0                   | 50   | ns      |

**Figure 11. Definition for Timing for Fast/Standard Mode on the I<sup>2</sup>C Bus**



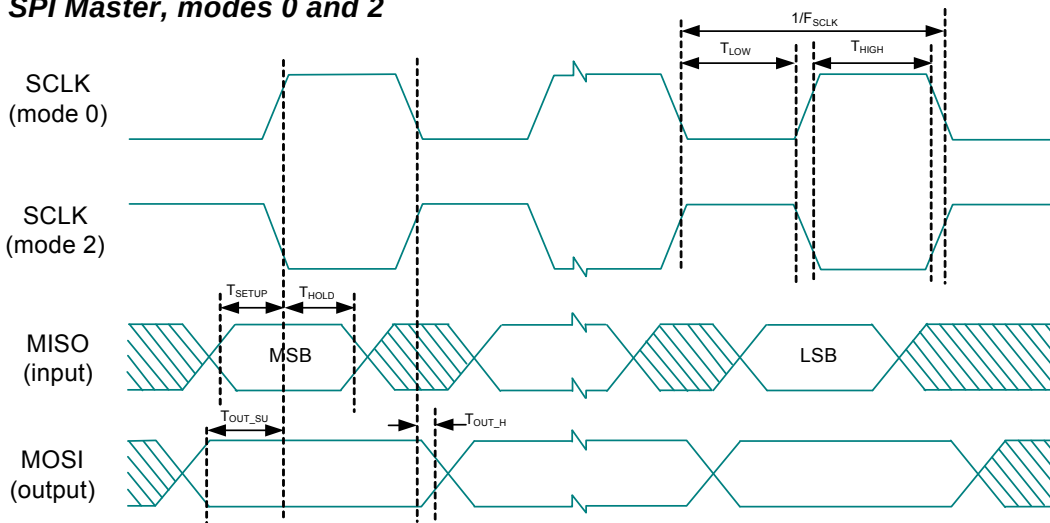
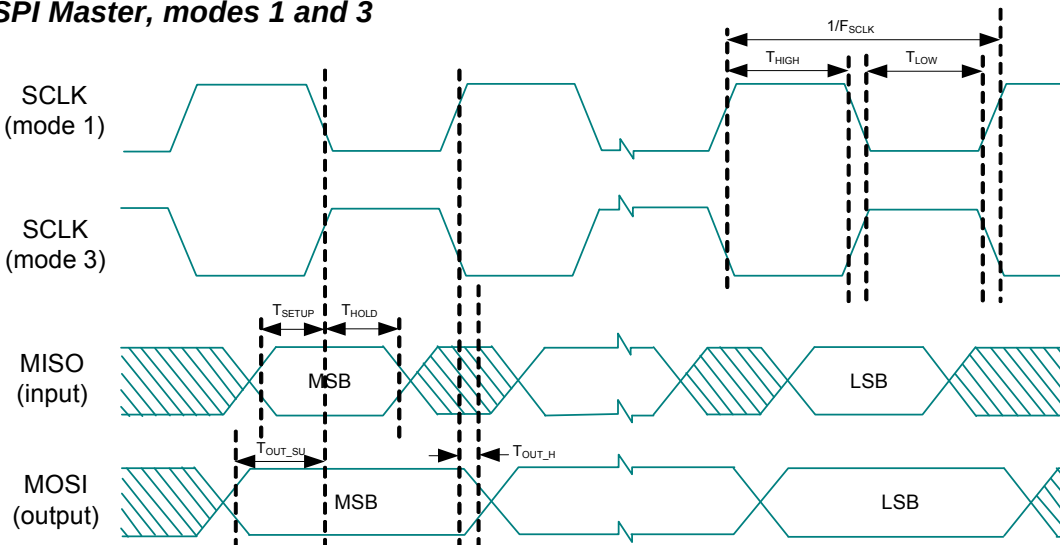
### Notes

39. To wake up from sleep using I2C hardware address match event, I2C interface needs 20 ns hold time on SDA line with respect to falling edge of SCL. See the CY8C20xx7 Silicon Errata document for more details.

40. 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  $t_{SU;DAT} \geq 250$  ns must then be met. This automatically be the case if the device does not stretch the LOW period of the SCL signal. If such device does stretch the LOW period of the SCL signal, it must output the next data bit to the SDA line  $t_{rmax} + t_{SU;DAT} = 1000 + 250 = 1250$  ns (according to the Standard-Mode I<sup>2</sup>C-bus specification) before the SCL line is released.

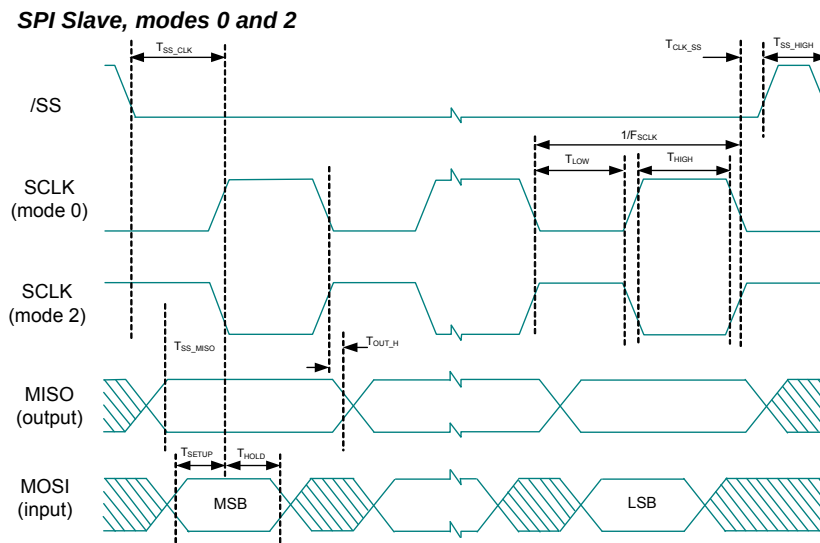
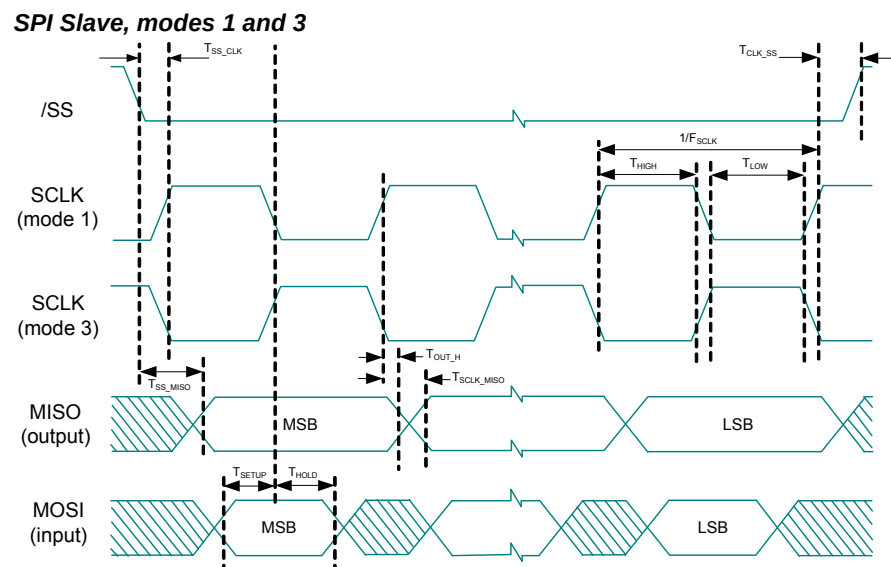
**Table 30. SPI Master AC Specifications**

| Symbol         | Description             | Conditions                                            | Min       | Typ    | Max    | Units      |
|----------------|-------------------------|-------------------------------------------------------|-----------|--------|--------|------------|
| $F_{SCLK}$     | SCLK clock frequency    | $V_{DD} \geq 2.4\text{ V}$<br>$V_{DD} < 2.4\text{ V}$ | –<br>–    | –<br>– | 6<br>3 | MHz<br>MHz |
| DC             | SCLK duty cycle         | –                                                     | –         | 50     | –      | %          |
| $t_{SETUP}$    | MISO to SCLK setup time | $V_{DD} \geq 2.4\text{ V}$<br>$V_{DD} < 2.4\text{ V}$ | 60<br>100 | –<br>– | –<br>– | ns<br>ns   |
| $t_{HOLD}$     | SCLK to MISO hold time  | –                                                     | 40        | –      | –      | ns         |
| $t_{OUT\_VAL}$ | SCLK to MOSI valid time | –                                                     | –         | –      | 40     | ns         |
| $t_{OUT\_H}$   | MOSI high time          | –                                                     | 40        | –      | –      | ns         |

**Figure 12. SPI Master Mode 0 and 2**
**SPI Master, modes 0 and 2**

**Figure 13. SPI Master Mode 1 and 3**
**SPI Master, modes 1 and 3**


**Table 31. SPI Slave AC Specifications**

| Symbol           | Description                    | Conditions | Min      | Typ | Max | Units |
|------------------|--------------------------------|------------|----------|-----|-----|-------|
| $F_{SCLK}$       | SCLK clock frequency           | —          | —        | —   | 4   | MHz   |
| $t_{LOW}$        | SCLK low time                  | —          | 42       | —   | —   | ns    |
| $t_{HIGH}$       | SCLK high time                 | —          | 42       | —   | —   | ns    |
| $t_{SETUP}$      | MOSI to SCLK setup time        | —          | 30       | —   | —   | ns    |
| $t_{HOLD}$       | SCLK to MOSI hold time         | —          | 50       | —   | —   | ns    |
| $t_{SS\_MISO}$   | SS high to MISO valid          | —          | —        | —   | 153 | ns    |
| $t_{SCLK\_MISO}$ | SCLK to MISO valid             | —          | —        | —   | 125 | ns    |
| $t_{SS\_HIGH}$   | SS high time                   | —          | 50       | —   | —   | ns    |
| $t_{SS\_CLK}$    | Time from SS low to first SCLK | —          | $2/SCLK$ | —   | —   | ns    |
| $t_{CLK\_SS}$    | Time from last SCLK to SS high | —          | $2/SCLK$ | —   | —   | ns    |

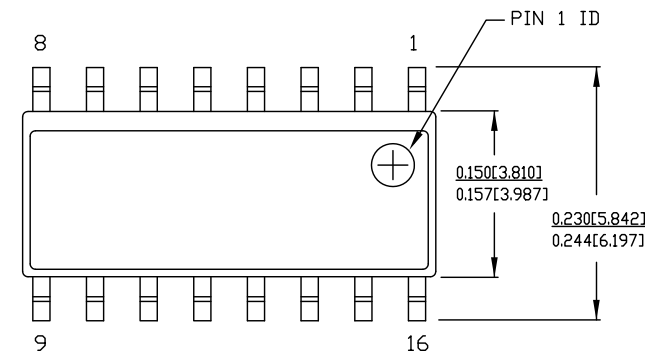
**Figure 14. SPI Slave Mode 0 and 2**

**Figure 15. SPI Slave Mode 1 and 3**


## Packaging Information

This section illustrates the packaging specifications for the CY8C20x37/47/67 PSoC device, along with the thermal impedances for each package.

**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 document titled *PSoC Emulator Pod Dimensions* at <http://www.cypress.com/design/MR10161>.

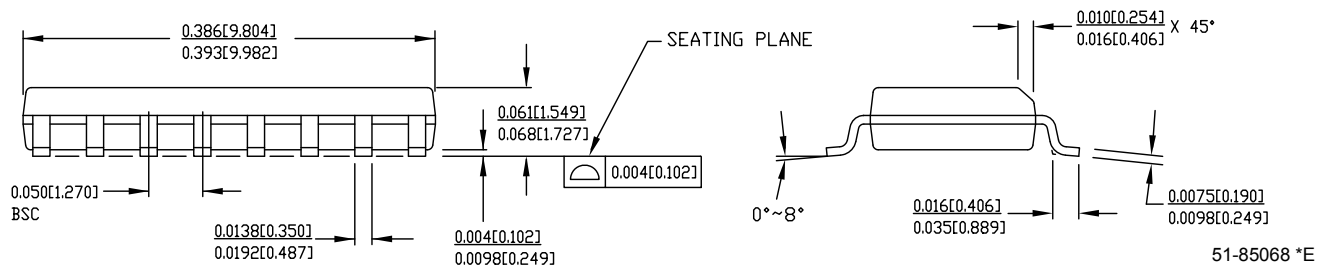
**Figure 16. 16-pin (150 Mil) SOIC**



NOTE:

1. DIMENSIONS IN INCHES[MM] **MAX.**
2. REFERENCE JEDEC MS-012
3. PACKAGE WEIGHT : refer to PMDD spec. 001-04308

| PART #  |                |
|---------|----------------|
| S16.15  | STANDARD PKG.  |
| SZ16.15 | LEAD FREE PKG. |

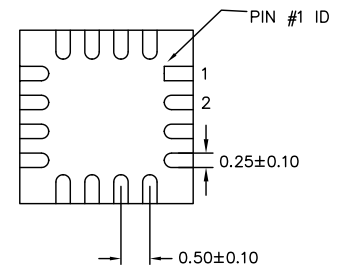
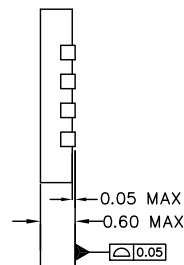
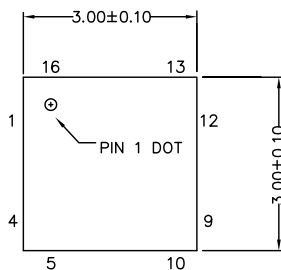


**Figure 17. 16-pin QFN No Center Pad (3 x 3 x 0.6 mm) Package Outline (Sawn)**

TOP VIEW

SIDE VIEW

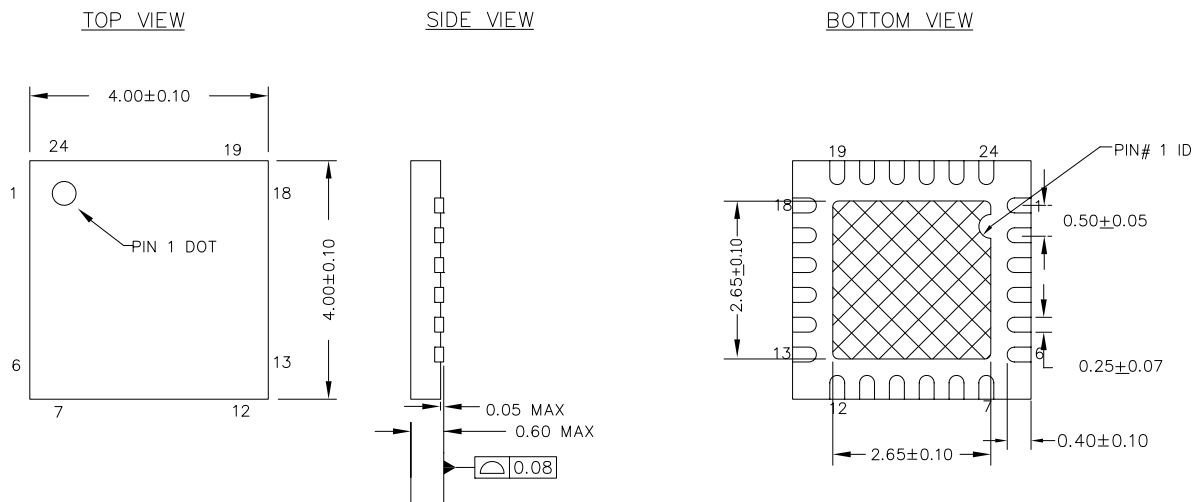
BOTTOM VIEW



### NOTES

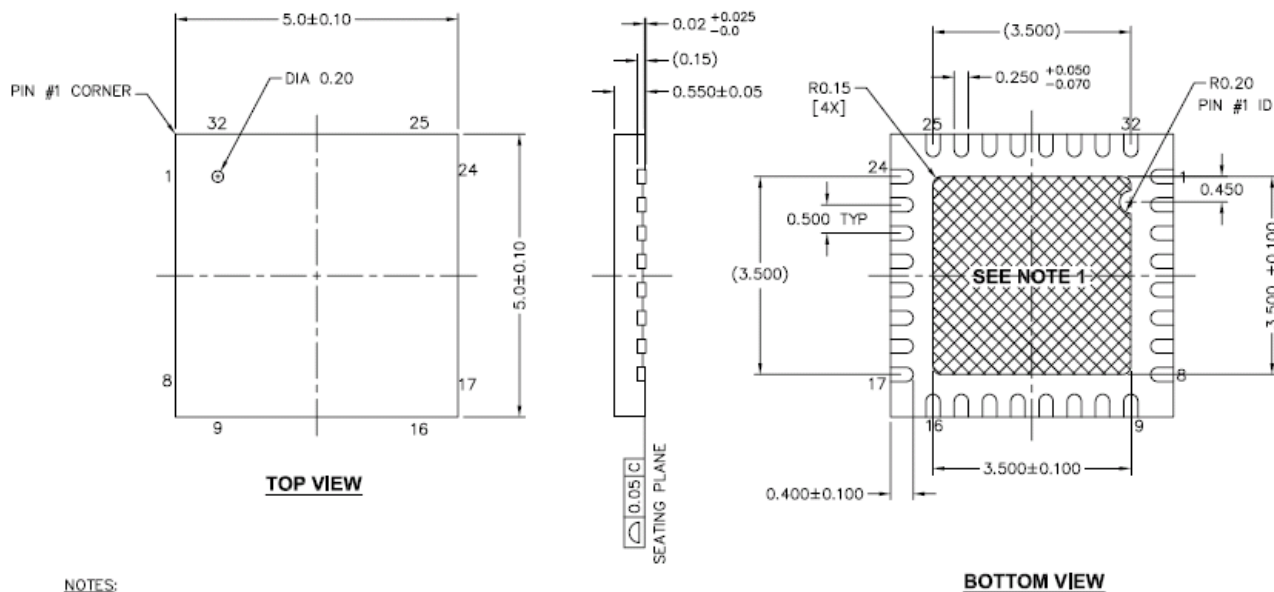
1. REFERENCE JEDEC # MO-220
2. PACKAGE WEIGHT: 14 ± 1 mg
3. ALL DIMENSIONS ARE IN MILLIMETERS

001-09116 \*G

**Figure 18. 24-Pin (4 × 4 × 0.6 mm) QFN**

**NOTES :**

1.  HATCH IS SOLDERABLE EXPOSED METAL.
2. REFERENCE JEDEC # MO-248
3. PACKAGE WEIGHT : 29 ± 3 mg
4. ALL DIMENSIONS ARE IN MILLIMETERS

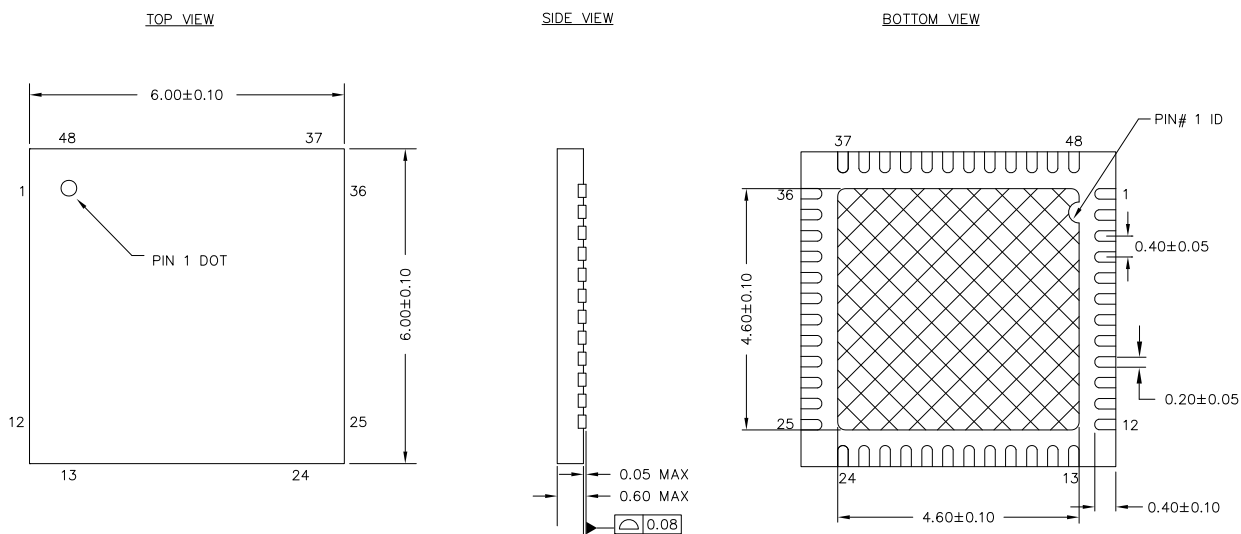
001-13937 \*E

**Figure 19. 32-Pin (5 × 5 × 0.6 mm) QFN**

**NOTES:**

1.  HATCH AREA IS SOLDERABLE EXPOSED PAD
2. BASED ON REF JEDEC # MO-248
3. PACKAGE WEIGHT: 0.0388g
4. DIMENSIONS ARE IN MILLIMETERS

**SIDE VIEW**
**BOTTOM VIEW**

001-42168 \*E

**Figure 20. 48-Pin (6 × 6 × 0.6 mm) QFN**

**NOTES:**

1.  HATCH AREA IS SOLDERABLE EXPOSED PAD
2. REFERENCE JEDEC # MO-248
3. PACKAGE WEIGHT: 68 ± 7 mg
4. ALL DIMENSIONS ARE IN MILLIMETERS

001-57280 \*E

**Important Notes**

- For information on the preferred dimensions for mounting QFN packages, see the following Application Note at [http://www.amkor.com/products/notes\\_papers/MLFAppNote.pdf](http://www.amkor.com/products/notes_papers/MLFAppNote.pdf).
- Pinned vias for thermal conduction are not required for the low power PSoC device.

## Thermal Impedances

**Table 32. Thermal Impedances per Package**

| Package                    | Typical $\theta_{JA}$ <sup>[41]</sup> |
|----------------------------|---------------------------------------|
| 16-Pin SOIC                | 95 °C/W                               |
| 16-Pin QFN                 | 33 °C/W                               |
| 24-Pin QFN <sup>[42]</sup> | 21 °C/W                               |
| 32-Pin QFN <sup>[42]</sup> | 20 °C/W                               |
| 48-Pin QFN <sup>[42]</sup> | 18 °C/W                               |
| 30-Ball WLCSP              | 54 °C/W                               |

## Capacitance on Crystal Pins

**Table 33. Typical Package Capacitance on Crystal Pins**

| Package    | Package Capacitance |
|------------|---------------------|
| 32-Pin QFN | 3.2 pF              |
| 48-Pin QFN | 3.3 pF              |

## Solder Reflow Peak Temperature

Table 34 shows the solder reflow temperature limits that must not be exceeded.

**Table 34. Solder Reflow Peak Temperature**

| Package       | Maximum Peak Temperature ( $T_C$ ) | Maximum Time above $T_C - 5\text{ °C}$ |
|---------------|------------------------------------|----------------------------------------|
| 16-pin SOIC   | 260 °C                             | 30 seconds                             |
| 16-pin QFN    | 260 °C                             | 30 seconds                             |
| 24-pin QFN    | 260 °C                             | 30 seconds                             |
| 32-pin QFN    | 260 °C                             | 30 seconds                             |
| 48-pin QFN    | 260 °C                             | 30 seconds                             |
| 30-ball WLCSP | 260 °C                             | 30 seconds                             |

### Notes

41.  $T_J = T_A + \text{Power} \times \theta_{JA}$ .

42. To achieve the thermal impedance specified for the QFN package, the center thermal pad must be soldered to the PCB ground plane.



## Development Tool Selection

### Software

#### *PSoC Designer™*

At the core of the PSoC development software suite is PSoC Designer, used to generate PSoC firmware applications. PSoC Designer is a Microsoft® Windows-based, integrated development environment for the Programmable System-on-Chip (PSoC) devices. The PSoC Designer IDE and application runs on Windows XP and Windows Vista.

This system provides design database management by project, in-system programming support, and built-in support for third-party assemblers and C compilers. PSoC Designer also supports C language compilers developed specifically for the devices in the PSoC family. PSoC Designer is available free of charge at <http://www.cypress.com/psocdesigner> and includes a free C compiler.

#### *PSoC Designer Software Subsystems*

You choose a base device to work with and then select different onboard analog and digital components called user modules that use the PSoC blocks. Examples of user modules are ADCs, DACs, Amplifiers, and Filters. You configure the user modules for your chosen application and connect them to each other and to the proper pins. Then you 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 allows for changing configurations at run time. Code Generation Tools PSoC Designer supports multiple third-party C compilers and assemblers. The code generation tools work seamlessly within the PSoC Designer interface and have been tested with a full range of debugging tools. The choice is yours.

**Assemblers.** The assemblers allow assembly code to be merged 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 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.

#### *PSoC Programmer*

PSoC Programmer is flexible enough and is used on the bench in development and is also suitable for factory programming. PSoC Programmer works either as a standalone programming application or operates 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 cost at <http://www.cypress.com/psocprogrammer>.

### Development Kits

All development kits are sold at the [Cypress Online Store](#).

### Evaluation Tools

All evaluation tools are sold at the [Cypress Online Store](#).

#### *CY3210-MiniProg1*

The **CY3210-MiniProg1 kit** allows you to program PSoC devices through the MiniProg1 programming unit. The MiniProg is a small, compact prototyping programmer that connects to the PC through 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
- Two 28-pin CY8C29466-24PXI PDIP PSoC device samples
- PSoC Designer software CD
- Getting Started guide
- USB 2.0 cable

### Device Programmers

All device programmers are purchased from the [Cypress Online Store](#).

#### *CY3216 Modular Programmer*

The **CY3216 Modular Programmer kit** features a modular programmer and the MiniProg1 programming unit. The modular programmer includes three programming module cards and supports multiple Cypress products. The kit includes:

- Modular programmer base
- Three programming module cards
- MiniProg programming unit
- PSoC Designer software CD
- Getting Started guide
- USB 2.0 cable

### 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** CY3207ISSP needs special software and is not compatible with PSoC Programmer. 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 35. Emulation and Programming Accessories**

| Part Number      | Pin Package | Flex-Pod Kit <sup>[43]</sup> | Foot Kit <sup>[44]</sup> | Adapter <sup>[45]</sup> |
|------------------|-------------|------------------------------|--------------------------|-------------------------|
| CY8C20237-24LKXI | 16 QFN      | CY3250-20246QFN              | CY3250-20246QFN-POD      | See note 42             |
| CY8C20247-24LKXI | 16 QFN      | CY3250-20246QFN              | CY3250-20246QFN-POD      | See note 45             |
| CY8C20337-24LQXI | 24 QFN      | CY3250-20346QFN              | CY3250-20346QFN-POD      | See note 42             |
| CY8C20347-24LQXI | 24 QFN      | CY3250-20346QFN              | CY3250-20346QFN-POD      | See note 45             |
| CY8C20437-24LQXI | 32 QFN      | CY3250-20466QFN              | CY3250-20466QFN-POD      | See note 42             |
| CY8C20447-24LQXI | 32 QFN      | CY3250-20466QFN              | CY3250-20466QFN-POD      | See note 45             |
| CY8C20467-24LQXI | 32 QFN      | CY3250-20466QFN              | CY3250-20466QFN-POD      | See note 45             |
| CY8C20637-24LQXI | 48 QFN      | CY3250-20666QFN              | CY3250-20666QFN-POD      | See note 45             |
| CY8C20647-24LQXI | 48 QFN      | CY3250-20666QFN              | CY3250-20666QFN-POD      | See note 45             |
| CY8C20667-24LQXI | 48 QFN      | CY3250-20666QFN              | CY3250-20666QFN-POD      | See note 45             |

### Third Party Tools

Several tools have been specially designed by the following third-party vendors to accompany PSoC devices during development and production. Specific details for each of these tools can be found at <http://www.cypress.com> under Documentation > Evaluation Boards.

### Build a PSoC Emulator into Your Board

For details on how to emulate your circuit before going to volume production using an on-chip debug (OCD) non-production PSoC device, see the Application Note [Debugging - Build a PSoC Emulator into Your Board – AN2323](#).

#### Notes

43. Flex-Pod kit includes a practice flex-pod and a practice PCB, in addition to two flex-pods.

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

45. 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 CY8C20x37/47/67/S PSoC devices' key package features and ordering codes.

**Table 36. PSoC Device Key Features and Ordering Information**

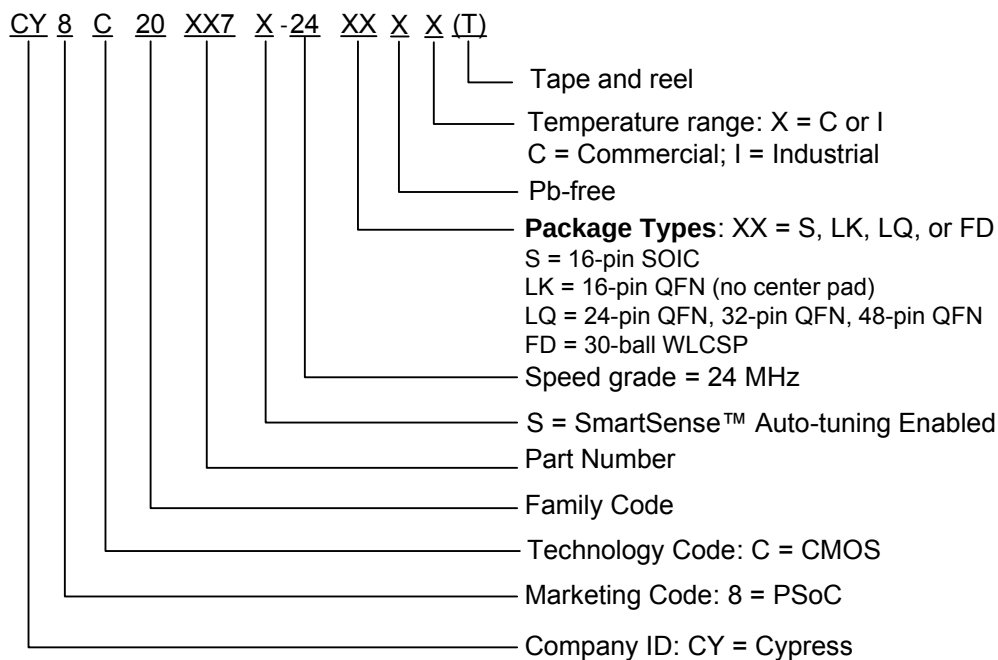
| Ordering Code       | Package                    | Flash (Bytes) | SRAM (Bytes) | CapSense Sensors | Digital I/O Pins | Analog Inputs <sup>[46]</sup> | XRES Pin | ADC |
|---------------------|----------------------------|---------------|--------------|------------------|------------------|-------------------------------|----------|-----|
| CY8C20237-24SXI     | 16-pin SOIC                | 8 K           | 1 K          | 10               | 13               | 13                            | Yes      | Yes |
| CY8C20247/S-24SXI   | 16-pin SOIC                | 16 K          | 2 K          | 10               | 13               | 13                            | Yes      | Yes |
| CY8C20247S-24SXI    | 16-pin SOIC                | 16 K          | 2 K          | 10               | 13               | 13                            | Yes      | Yes |
| CY8C20237-24LKXI    | 16-pin QFN                 | 8 K           | 1 K          | 10               | 13               | 13                            | Yes      | Yes |
| CY8C20237-24LKXIT   | 16-pin QFN (Tape and Reel) | 8 K           | 1 K          | 10               | 13               | 13                            | Yes      | Yes |
| CY8C20247/S-24LKXI  | 16-pin QFN                 | 16 K          | 2 K          | 10               | 13               | 13                            | Yes      | Yes |
| CY8C20247/S-24LKXIT | 16-pin QFN (Tape and Reel) | 16 K          | 2 K          | 10               | 13               | 13                            | Yes      | Yes |
| CY8C20247S-24LKXI   | 16-pin QFN                 | 16 K          | 2 K          | 10               | 13               | 13                            | Yes      | Yes |
| CY8C20247S-24LKXIT  | 16-pin QFN (Tape and Reel) | 16 K          | 2 K          | 10               | 13               | 13                            | Yes      | Yes |
| CY8C20337-24LQXI    | 24-pin QFN                 | 8 K           | 1 K          | 16               | 19               | 19                            | Yes      | Yes |
| CY8C20337-24LQXIT   | 24-pin QFN (Tape and Reel) | 8 K           | 1 K          | 16               | 19               | 19                            | Yes      | Yes |
| CY8C20347-24LQXI    | 24-pin QFN                 | 16 K          | 2 K          | 16               | 19               | 19                            | Yes      | Yes |
| CY8C20347-24LQXIT   | 24-pin QFN (Tape and Reel) | 16 K          | 2 K          | 16               | 19               | 19                            | Yes      | Yes |
| CY8C20347S-24LQXI   | 24-pin QFN                 | 16 K          | 2 K          | 16               | 19               | 19                            | Yes      | Yes |
| CY8C20347S-24LQXIT  | 24-pin QFN (Tape and Reel) | 16 K          | 2 K          | 16               | 19               | 19                            | Yes      | Yes |
| CY8C20437-24LQXI    | 32-pin QFN                 | 8 K           | 1 K          | 25               | 28               | 28                            | Yes      | Yes |
| CY8C20437-24LQXIT   | 32-pin QFN (Tape and Reel) | 8 K           | 1 K          | 25               | 28               | 28                            | Yes      | Yes |
| CY8C20447-24LQXI    | 32-pin QFN                 | 16 K          | 2 K          | 25               | 28               | 28                            | Yes      | Yes |
| CY8C20447-24LQXIT   | 32-pin QFN (Tape and Reel) | 16 K          | 2 K          | 25               | 28               | 28                            | Yes      | Yes |
| CY8C20447S-24LQXI   | 32-pin QFN                 | 16 K          | 2 K          | 25               | 28               | 28                            | Yes      | Yes |
| CY8C20447S-24LQXIT  | 32-pin QFN (Tape and Reel) | 16 K          | 2 K          | 25               | 28               | 28                            | Yes      | Yes |
| CY8C20467-24LQXI    | 32-pin QFN                 | 32 K          | 2 K          | 25               | 28               | 28                            | Yes      | Yes |
| CY8C20467-24LQXIT   | 32-pin QFN (Tape and Reel) | 32 K          | 2 K          | 25               | 28               | 28                            | Yes      | Yes |
| CY8C20467S-24LQXI   | 32-pin QFN                 | 32 K          | 2 K          | 25               | 28               | 28                            | Yes      | Yes |
| CY8C20467S-24LQXIT  | 32-pin QFN (Tape and Reel) | 32 K          | 2 K          | 25               | 28               | 28                            | Yes      | Yes |
| CY8C20637-24LQXI    | 48-pin QFN                 | 8 K           | 1 K          | 31               | 34               | 34                            | Yes      | Yes |
| CY8C20637-24LQXIT   | 48-pin QFN (Tape and Reel) | 8 K           | 1 K          | 31               | 34               | 34                            | Yes      | Yes |
| CY8C20647-24LQXI    | 48-pin QFN                 | 16 K          | 2 K          | 31               | 34               | 34                            | Yes      | Yes |
| CY8C20647-24LQXIT   | 48-pin QFN (Tape and Reel) | 16 K          | 2 K          | 31               | 34               | 34                            | Yes      | Yes |
| CY8C20647S-24LQXI   | 48-pin QFN                 | 16 K          | 2 K          | 31               | 34               | 34                            | Yes      | Yes |
| CY8C20647S-24LQXIT  | 48-pin QFN (Tape and Reel) | 16 K          | 2 K          | 31               | 34               | 34                            | Yes      | Yes |
| CY8C20667-24LQXI    | 48-pin QFN                 | 32 K          | 2 K          | 31               | 34               | 34                            | Yes      | Yes |
| CY8C20667-24LQXIT   | 48-pin QFN (Tape and Reel) | 32 K          | 2 K          | 31               | 34               | 34                            | Yes      | Yes |
| CY8C20667S-24LQXI   | 48-pin QFN                 | 32 K          | 2 K          | 31               | 34               | 34                            | Yes      | Yes |
| CY8C20667S-24LQXIT  | 48-pin QFN (Tape and Reel) | 32 K          | 2 K          | 31               | 34               | 34                            | Yes      | Yes |

**Note**

46. Dual-function Digital I/O Pins also connect to the common analog mux.

**Table 36. PSoC Device Key Features and Ordering Information** *(continued)*

| Ordering Code     | Package                      | Flash (Bytes) | SRAM (Bytes) | CapSense Sensors | Digital I/O Pins | Analog Inputs <sup>[46]</sup> | XRES Pin | ADC |
|-------------------|------------------------------|---------------|--------------|------------------|------------------|-------------------------------|----------|-----|
| CY8C20747-24FDXC  | 30-pin WLCSP                 | 16 K          | 1 K          | 24               | 27               | 27                            | Yes      | Yes |
| CY8C20747-24FDXCT | 30-pin WLCSP (Tape and Reel) | 16 K          | 1 K          | 24               | 27               | 27                            | Yes      | Yes |
| CY8C20767-24FDXC  | 30-pin WLCSP                 | 32 K          | 2 K          | 24               | 27               | 27                            | Yes      | Yes |
| CY8C20767-24FDXCT | 30-pin WLCSP (Tape and Reel) | 32 K          | 2 K          | 24               | 27               | 27                            | Yes      | Yes |

**Ordering Code Definitions**


## Acronyms

The following table lists the acronyms that are used in this document.

**Table 37. Acronyms Used in this Document**

| Acronym          | Description                             |
|------------------|-----------------------------------------|
| AC               | alternating current                     |
| ADC              | analog-to-digital converter             |
| API              | application programming interface       |
| CMOS             | complementary metal oxide semiconductor |
| CPU              | central processing unit                 |
| DAC              | digital-to-analog converter             |
| DC               | direct current                          |
| ESD              | electrostatic discharge                 |
| FSR              | full scale range                        |
| GPIO             | general purpose input/output            |
| I <sup>2</sup> C | inter-integrated circuit                |
| ICE              | in-circuit emulator                     |
| ILO              | internal low speed oscillator           |
| IMO              | internal main oscillator                |
| I/O              | input/output                            |
| ISSP             | in-system serial programming            |
| LCD              | liquid crystal display                  |
| LDO              | low dropout (regulator)                 |
| LED              | light-emitting diode                    |
| LPC              | low power comparator                    |
| LSB              | least-significant bit                   |
| LVD              | low voltage detect                      |
| MCU              | micro-controller unit                   |
| MIPS             | million instructions per second         |
| MISO             | master in slave out                     |
| MOSI             | master out slave in                     |
| MSB              | most-significant bit                    |
| OCD              | on-chip debug                           |
| PCB              | printed circuit board                   |
| POR              | power on reset                          |
| PSRR             | power supply rejection ratio            |
| PWRSYS           | power system                            |
| PSoC             | programmable system-on-chip             |
| QFN              | quad flat no-lead                       |
| SCLK             | serial I <sup>2</sup> C clock           |
| SDA              | serial I <sup>2</sup> C data            |
| SDATA            | serial ISSP data                        |
| SOIC             | small outline integrated circuit        |
| SPI              | serial peripheral interface             |
| SRAM             | static random access memory             |
| SS               | slave select                            |
| USB              | universal serial bus                    |
| WLCSP            | wafer level chip scale package          |

## Reference Documents

- *Technical reference manual for CY20xx7 devices*
- *In-system Serial Programming (ISSP) protocol for 20xx7*
- *Host Sourced Serial Programming for 20xx7 devices*

## Document Conventions

### Units of Measure

Table 38 lists all the abbreviations used to measure the PSoC devices.

**Table 38. Units of Measure**

| Symbol | Unit of Measure         |
|--------|-------------------------|
| °C     | degree Celsius          |
| dB     | decibel                 |
| kHz    | kilohertz               |
| ksps   | kilo samples per second |
| kΩ     | kilohm                  |
| MHz    | megahertz               |
| μA     | microampere             |
| μs     | microsecond             |
| mA     | milliampere             |
| mm     | millimeter              |
| ms     | millisecond             |
| mV     | millivolt               |
| nA     | nanoampere              |
| ns     | nanosecond              |
| Ω      | ohm                     |
| %      | percent                 |
| pF     | picofarad               |
| V      | volt                    |
| W      | watt                    |

## Numeric Naming

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', 'b', or 0x are decimal.

## Glossary

|                                     |                                                                                                                                                                                                             |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Crosspoint connection               | Connection between any GPIO combination via analog multiplexer bus.                                                                                                                                         |
| Differential non linearity          | Ideally, any two adjacent digital codes correspond to output analog voltages that are exactly one LSB apart. Differential non-linearity is a measure of the worst case deviation from the ideal 1 LSB step. |
| Hold time                           | Hold time is the time following a clock event during which the data input to a latch or flip-flop must remain stable in order to guarantee that the latched data is correct.                                |
| I <sup>2</sup> C                    | It is a serial multi-master bus used to connect low speed peripherals to MCU.                                                                                                                               |
| Integral nonlinearity               | It is a term describing the maximum deviation between the ideal output of a DAC/ADC and the actual output level.                                                                                            |
| Latch-up current                    | Current at which the latch-up test is conducted according to JESD78 standard (at 125 degree Celsius)                                                                                                        |
| Power supply rejection ratio (PSRR) | The PSRR is defined as the ratio of the change in supply voltage to the corresponding change in output voltage of the device.                                                                               |
| Scan                                | The conversion of all sensor capacitances to digital values.                                                                                                                                                |
| Setup time                          | Period required to prepare a device, machine, process, or system for it to be ready to function.                                                                                                            |
| Signal-to-noise ratio               | The ratio between a capacitive finger signal and system noise.                                                                                                                                              |
| SPI                                 | Serial peripheral interface is a synchronous serial data link standard.                                                                                                                                     |

## Document History Page

| Document Title: CY8C20xx7/S, 1.8 V CapSense® Controller with SmartSense™ Auto-tuning 31 Buttons, 6 Sliders, Proximity Sensors<br>Document Number: 001-69257 |         |                 |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Revision                                                                                                                                                    | ECN     | Orig. of Change | Submission Date | Description of Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| **                                                                                                                                                          | 3276782 | DST             | 06/27/2011      | New silicon and document                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| *A                                                                                                                                                          | 3327230 | DST             | 07/28/2011      | Changed 48-pin dimensions to 6 × 6 × 0.6 mm QFN<br>Updated pins name in <a href="#">Table 3 on page 9</a> and removed USB column and updated dimensions for 48-pin parts in <a href="#">Table 36 on page 33</a><br>Updated <a href="#">Figure 20 on page 29</a><br>Removed ICE and Debugger sections.<br>Removed CY3215 Development Kit and CY3280-20x66 UCC sections.<br>Updated <a href="#">Ordering Information</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| *B                                                                                                                                                          | 3403111 | YVA             | 10/12/2011      | Moved status from Advance to Preliminary.<br>Updated <a href="#">Ordering Information</a><br>Removed the row named "48-Pin (6 × 6 mm) QFN (OCD)".<br>Changed all 48-pin ordering code column from CY8C20XXX-24LTxx to CY8C20XXX-24LQxx.<br>Updated 16-pin SOIC and 16-pin QFN package drawings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| *C                                                                                                                                                          | 3473317 | DST             | 12/23/2011      | Updated <a href="#">Features</a> .<br>Updated <a href="#">Pinouts</a> (Removed PSoC in captions of <a href="#">Figure 2</a> , <a href="#">Figure 3</a> , <a href="#">Figure 4</a> , <a href="#">Figure 6</a> , and <a href="#">Figure 7</a> ).<br>Updated <a href="#">DC Chip-Level Specifications</a> under <a href="#">Electrical Specifications</a> (Updated typical value of I <sub>DD24</sub> parameter from 3.32 mA to 2.88 mA, updated typical value of I <sub>DD12</sub> parameter from 1.86 mA to 1.71 mA, updated typical value of I <sub>DD6</sub> parameter from 1.13 mA to 1.16 mA, updated maximum value of I <sub>SB0</sub> parameter from 0.50 µA to 1.1 µA, added I <sub>SB12C</sub> parameter and its details).<br>Updated <a href="#">DC GPIO Specifications</a> under <a href="#">Electrical Specifications</a> (Added the parameters namely V <sub>ILLVT3.3</sub> , V <sub>IHLVT3.3</sub> , V <sub>ILLVT5.5</sub> , V <sub>IHLVT5.5</sub> and their details in <a href="#">Table 10</a> , added the parameters namely V <sub>ILLVT2.5</sub> , V <sub>IHLVT2.5</sub> and their details in <a href="#">Table 11</a> ).<br>Added the following sections namely <a href="#">DC I2C Specifications</a> , <a href="#">Shield Driver DC Specifications</a> , and <a href="#">DC IDAC Specifications</a> under <a href="#">Electrical Specifications</a> .<br>Updated <a href="#">AC Chip-Level Specifications</a> (Added the parameter namely t <sub>JIT_IMO</sub> and its details).<br>Updated <a href="#">Ordering Information</a> (updated <a href="#">Table 36</a> ). |
| *D                                                                                                                                                          | 3510277 | YVA/DST         | 02/16/2012      | Added CY8C20x37/37S/47/47S/67/67S part numbers and changed title to "1.8 V CapSense® Controller with SmartSense™ Auto-tuning 31 Buttons, 6 Sliders"<br>Updated <a href="#">Features</a> .<br>Modified comparator blocks in <a href="#">Logic Block Diagram</a> .<br>Replaced SmartSense with SmartSense auto-tuning.<br>Added CY8C20xx7S part numbers in Pin Definitions.<br>Added footnote for <a href="#">Table 20</a> .<br>Updated <a href="#">Table 21</a> and <a href="#">Table 22</a> and added <a href="#">Table 23</a> .<br>Updated F <sub>32K1</sub> min value.<br>Updated data hold time min values.<br>Updated CY8C206x7 part information in <a href="#">Table 35</a> .<br>Updated <a href="#">Ordering Information</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| *E                                                                                                                                                          | 3539259 | DST             | 03/01/2012      | Changed Datasheet status from Preliminary to Final.<br>Updated all <a href="#">Pinouts</a> to include Driven Shield Output (optional) information.<br>Updated Min value for V <sub>LPC</sub> <a href="#">Table 15</a> .<br>Updated Offset and Input range in <a href="#">Table 16</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |



**Document History Page** *(continued)*

| Document Title: CY8C20xx7/S, 1.8 V CapSense® Controller with SmartSense™ Auto-tuning 31 Buttons, 6 Sliders, Proximity Sensors<br>Document Number: 001-69257 |         |                 |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Revision                                                                                                                                                    | ECN     | Orig. of Change | Submission Date | Description of Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| *F                                                                                                                                                          | 3645807 | DST/BVI         | 07/03/2012      | Updated F <sub>SCLK</sub> parameter in the <a href="#">Table 31, "SPI Slave AC Specifications," on page 26</a><br>Changed t <sub>OUT_HIGH</sub> to t <sub>OUT_H</sub> in <a href="#">Table 30, "SPI Master AC Specifications," on page 25</a><br>Updated Features section, "Programmable pin configurations" bullet:<br>■ Included the following sub-bullet point -<br>5 mA source current on port 0 and 1 and 1 mA on port 2,3 and 4<br>■ Changed the bullet point "High sink current of 25 mA for each GPIO" to "High sink current of 25 mA for each GPIO. Total 120 mA maximum sink current per chip"<br>■ Added "QuietZone™ Controller" bullet and updated "Low power CapSense® block with SmartSense™ auto-tuning" bullet.<br>Updated package diagrams 001-13937 to *D and 001-57280 to *C revisions. |
| *G                                                                                                                                                          | 3800055 | DST             | 11/23/2012      | Changed document title.<br>Part named changed from CY8C20xx7 to CY8C20xx7/S<br>Table 20: Update to VIH2C to match Item #6 in K2 Si Errata document (001-75370)<br>Updated package diagrams:<br>51-85068 to *E<br>001-09116 to *G<br>001-13937 to *E<br>001-42168 to *E<br>001-57280 to *E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| *H                                                                                                                                                          | 3881332 | SRLI            | 02/04/2013      | Updated <a href="#">Features</a> :<br>Added Note <a href="#">1</a> and referred the same note in "24 Sensing Inputs – 30-pin WLCSP".                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |



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