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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	M8C
Core Size	8-Bit
Speed	12MHz
Connectivity	I²C, SPI, UART/USART
Peripherals	POR, PWM, WDT
Number of I/O	16
Program Memory Size	4KB (4K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	256 x 8
Voltage - Supply (Vcc/Vdd)	2.4V ~ 5.25V
Data Converters	A/D 8x14b; D/A 2x9b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	20-SSOP (0.209", 5.30mm Width)
Supplier Device Package	20-SSOP
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/cy8c24223a-12pvxe

Contents

Additional System Resources

System Resources, some of which have been previously listed, provide additional capability useful for complete systems. Additional resources include a multiplier, decimator, low voltage detection, and power on reset. Brief statements describing the merits of each system resource follow:

- Digital clock dividers provide three customizable clock frequencies for use in applications. The clocks can be routed to both the digital and analog systems. Additional clocks can be generated using digital PSoC blocks as clock dividers.
- A multiply accumulate (MAC) provides a fast 8-bit multiplier with 32-bit accumulate, to assist in both general math as well as digital filters.
- The decimator provides a custom hardware filter for digital signal processing applications including the creation of Delta Sigma ADCs.
- The I^2C module provides 0 to 400 kHz communication over two wires. Slave, master, and multi-master modes are all supported.
- LVD interrupts can signal the application of falling voltage levels, while the advanced POR (Power On Reset) circuit eliminates the need for a system supervisor.
- An internal 1.3V voltage reference provides an absolute reference for the analog system, including ADCs and DACs.

Getting Started

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

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

Application Notes

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

Development Kits

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

Training

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

PSoC Device Characteristics

Depending on your PSoC device characteristics, the digital and analog systems can have a varying number of digital and analog blocks. The following table lists the resources available for specific PSoC device groups. The PSoC device covered by this data sheet is highlighted in Table 1.

Table 1. PSoC Device Characteristics

PSoC Part Number	Digital I/O	Digital Rows	Digital Blocks	Analog Inputs	Analog Outputs	Analog Columns	Analog Blocks	SRAM Size	Flash Size
CY8C29x66[2]	up to 64	4	16	12	4	4	12	2K	32K
CY8C27x43	up to 44	2	8	12	4	4	12	256 Bytes	16K
CY8C24x94	64	1	4	48	2	2	6	1K	16K
CY8C24x23A[2]	up to 24	1	4	12	2	2	6	256 Bytes	4K
CY8C23x33	up to	1	4	12	2	2	4	256 Bytes	8K
CY8C21x34[2]	up to 28	1	4	28	0	2	4[3]	512 Bytes	8K
CY8C21x23	16	1	4	8	0	2	4[3]	256 Bytes	4K
CY8C20x34	up to 28	0	0	28	0	0	3[3, 4]	512 Bytes	8K

CYPros Consultants

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

Solutions Library

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

Technical Support

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

Notes
2. Automotive qualified devices available in this group.
3. Limited analog functionality.
4. Two analog blocks and one CapSense™ block.

Development Tools

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

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

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

PSoC Designer Software Subsystems

Design Entry

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

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

Code Generation Tools

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

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

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

Debugger

PSoC Designer has a debug environment that provides hardware in-circuit emulation, allowing you to test the program in a physical system while providing an internal view of the PSoC device. Debugger commands allow you to read and program and read and write data memory, and read and write I/O registers. You can read and write CPU registers, set and clear breakpoints, and provide program run, halt, and step control. The debugger also allows you to create a trace buffer of registers and memory locations of interest.

Online Help System

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

In-Circuit Emulator

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

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

Pinouts

The automotive CY8C24x23A 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. However, Vss, Vdd, and XRES are not capable of Digital I/O.

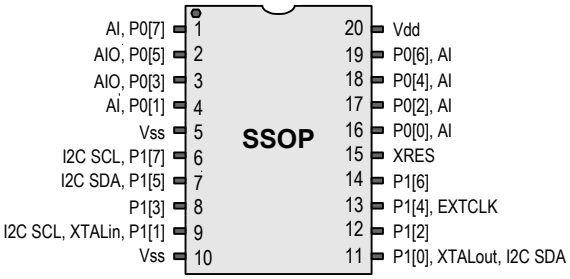
20-Pin Part Pinout

Table 3. 20-Pin Part Pinout (SSOP)

Pin No.	Type		Pin Name	Description
	Digital	Analog		
1	I/O	I	P0[7]	Analog column mux input
2	I/O	I/O	P0[5]	Analog column mux input and column output
3	I/O	I/O	P0[3]	Analog column mux input and column output
4	I/O	I	P0[1]	Analog column mux input
5	Power		Vss	Ground connection
6	I/O		P1[7]	I^2C Serial Clock (SCL)
7	I/O		P1[5]	I^2C Serial Data (SDA)
8	I/O		P1[3]	
9	I/O		P1[1]	Crystal Input (XTALin), I^2C Serial Clock (SCL), ISSP-SCLK[5]
10	Power		Vss	Ground connection
11	I/O		P1[0]	Crystal Output (XTALout), I^2C Serial Data (SDA), ISSP-SDATA[5]
12	I/O		P1[2]	
13	I/O		P1[4]	Optional External Clock Input (EXTCLK)
14	I/O		P1[6]	
15	Input		XRES	Active high external reset with internal pull down
16	I/O	I	P0[0]	Analog column mux input
17	I/O	I	P0[2]	Analog column mux input
18	I/O	I	P0[4]	Analog column mux input
19	I/O	I	P0[6]	Analog column mux input
20	Power		Vdd	Supply voltage

LEGEND: A = Analog, I = Input, and O = Output.

Figure 3. CY8C24223A 20-Pin PSoC Device



Note
5. These are the ISSP pins, which are not High Z when coming out of POR (Power On Reset). See the *PSoC Technical Reference Manual* for details.

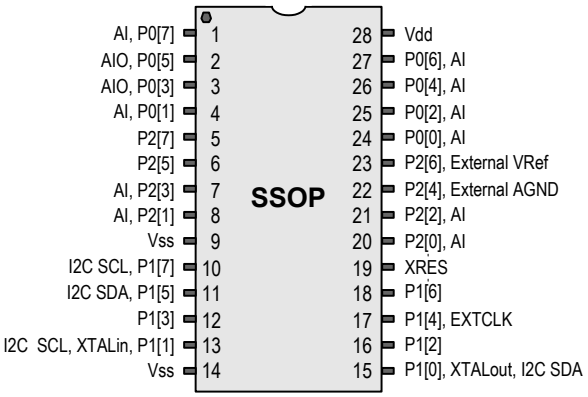
28-Pin Part Pinout

Table 4. 28-Pin Part Pinout (SSOP)

Pin No.	Type		Pin Name	Description
	Digital	Analog		
1	I/O	I	P0[7]	Analog column mux input
2	I/O	I/O	P0[5]	Analog column mux input and column output
3	I/O	I/O	P0[3]	Analog column mux input and column output
4	I/O	I	P0[1]	Analog column mux input
5	I/O		P2[7]	
6	I/O		P2[5]	
7	I/O	I	P2[3]	Direct switched capacitor block input
8	I/O	I	P2[1]	Direct switched capacitor block input
9	Power		Vss	Ground connection
10	I/O		P1[7]	I^2C Serial Clock (SCL)
11	I/O		P1[5]	I^2C Serial Data (SDA)
12	I/O		P1[3]	
13	I/O		P1[1]	Crystal Input (XTALin), I^2C Serial Clock (SCL), ISSP-SCLK[5]
14	Power		Vss	Ground connection
15	I/O		P1[0]	Crystal Output (XTALout), I^2C Serial Data (SDA), ISSP-SDATA[5]
16	I/O		P1[2]	
17	I/O		P1[4]	Optional External Clock Input (EXTCLK)
18	I/O		P1[6]	
19	Input		XRES	Active high external reset with internal pull down
20	I/O	I	P2[0]	Direct switched capacitor block input
21	I/O	I	P2[2]	Direct switched capacitor block input
22	I/O		P2[4]	External Analog Ground (AGND)
23	I/O		P2[6]	External Voltage Reference (VRef)
24	I/O	I	P0[0]	Analog column mux input
25	I/O	I	P0[2]	Analog column mux input
26	I/O	I	P0[4]	Analog column mux input
27	I/O	I	P0[6]	Analog column mux input
28	Power		Vdd	Supply voltage

LEGEND: A = Analog, I = Input, and O = Output.

Figure 4. CY8C24423A 28-Pin PSoC Device



Registers

Register Conventions

This section lists the registers of the automotive CY8C24x23A PSoC device. For detailed register information, refer to the *PSoC Technical Reference Manual*.

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

Table 5. Abbreviations

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

Register Mapping Tables

The PSoC device has a total register address space of 512 bytes. The register space is referred to as I/O space and is divided into two banks. The XIO bit in the Flag register (CPU_F) determines which bank the user is currently in. When the XIO bit is set the user is in Bank 1.

Note In the following register mapping tables, blank fields are Reserved and must not be accessed.

Table 7. Register Map Bank 1 Table: Configuration Space

Name	Addr (1,Hex)	Access	Name	Addr (1,Hex)	Access	Name	Addr (1,Hex)	Access	Name	Addr (1,Hex)	Access
PRT0DM0	00	RW		40		ASC10CR0	80	RW		C0	
PRT0DM1	01	RW		41		ASC10CR1	81	RW		C1	
PRT0IC0	02	RW		42		ASC10CR2	82	RW		C2	
PRT0IC1	03	RW		43		ASC10CR3	83	RW		C3	
PRT1DM0	04	RW		44		ASD11CR0	84	RW		C4	
PRT1DM1	05	RW		45		ASD11CR1	85	RW		C5	
PRT1IC0	06	RW		46		ASD11CR2	86	RW		C6	
PRT1IC1	07	RW		47		ASD11CR3	87	RW		C7	
PRT2DM0	08	RW		48			88			C8	
PRT2DM1	09	RW		49			89			C9	
PRT2IC0	0A	RW		4A			8A			CA	
PRT2IC1	0B	RW		4B			8B			CB	
	0C			4C			8C			CC	
	0D			4D			8D			CD	
	0E			4E			8E			CE	
	0F			4F			8F			CF	
	10			50		ASD20CR0	90	RW	GDI_O_IN	D0	RW
	11			51		ASD20CR1	91	RW	GDI_E_IN	D1	RW
	12			52		ASD20CR2	92	RW	GDI_O_OU	D2	RW
	13			53		ASD20CR3	93	RW	GDI_E_OU	D3	RW
	14			54		ASC21CR0	94	RW		D4	
	15			55		ASC21CR1	95	RW		D5	
	16			56		ASC21CR2	96	RW		D6	
	17			57		ASC21CR3	97	RW		D7	
	18			58			98			D8	
	19			59			99			D9	
	1A			5A			9A			DA	
	1B			5B			9B			DB	
	1C			5C			9C			DC	
	1D			5D			9D		OSC_GO_EN	DD	RW
	1E			5E			9E		OSC_CR4	DE	RW
	1F			5F			9F		OSC_CR3	DF	RW
DBB00FN	20	RW	CLK_CR0	60	RW		A0		OSC_CR0	E0	RW
DBB00IN	21	RW	CLK_CR1	61	RW		A1		OSC_CR1	E1	RW
DBB00OU	22	RW	ABF_CR0	62	RW		A2		OSC_CR2	E2	RW
	23		AMD_CR0	63	RW		A3		VLT_CR	E3	RW
DBB01FN	24	RW		64			A4		VLT_CMP	E4	R
DBB01IN	25	RW		65			A5			E5	
DBB01OU	26	RW	AMD_CR1	66	RW		A6			E6	
	27		ALT_CR0	67	RW		A7			E7	
DCB02FN	28	RW		68			A8		IMO_TR	E8	W
DCB02IN	29	RW		69			A9		ILO_TR	E9	W
DCB02OU	2A	RW		6A			AA		BDG_TR	EA	RW
	2B			6B			AB		ECO_TR	EB	W
DCB03FN	2C	RW		6C			AC			EC	
DCB03IN	2D	RW		6D			AD			ED	
DCB03OU	2E	RW		6E			AE			EE	
	2F			6F			AF			EF	
	30		ACB00CR3	70	RW	RDI0RI	B0	RW		F0	
	31		ACB00CR0	71	RW	RDI0SYN	B1	RW		F1	
	32		ACB00CR1	72	RW	RDI0IS	B2	RW		F2	
	33		ACB00CR2	73	RW	RDI0LT0	B3	RW		F3	
	34		ACB01CR3	74	RW	RDI0LT1	B4	RW		F4	
	35		ACB01CR0	75	RW	RDI0RO0	B5	RW		F5	
	36		ACB01CR1	76	RW	RDI0RO1	B6	RW		F6	
	37		ACB01CR2	77	RW		B7		CPU_F	F7	RL
	38			78			B8			F8	
	39			79			B9			F9	
	3A			7A			BA			FA	
	3B			7B			BB			FB	
	3C			7C			BC			FC	
	3D			7D			BD			FD	
	3E			7E			BE		CPU_SCR1	FE	#
	3F			7F			BF		CPU_SCR0	FF	#

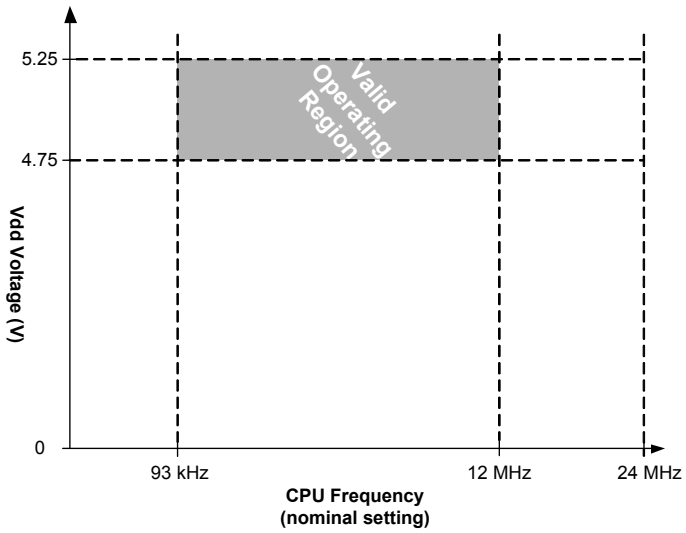
Blank fields are Reserved and must not be accessed. # Access is bit specific.

Electrical Specifications

This section presents the DC and AC electrical specifications of the automotive CY8C24x23A PSoC device. For the latest electrical specifications, visit http://www.cypress.com.

Specifications are valid for -40°C ≤ T_A ≤ 125°C and T_J ≤ 135°C, except where noted.

Figure 5. Voltage versus CPU Frequency



The following table lists the units of measure that are used in this section.

Table 8. Units of Measure

Symbol	Unit of Measure	Symbol	Unit of Measure
°C	degree Celsius	µVrms	microvolts root-mean-square
dB	decibels	µW	microwatts
fF	femto farad	mA	milli-ampere
Hz	hertz	ms	milli-second
KB	1024 bytes	mV	milli-volts
Kbit	1024 bits	nA	nanoampere
kHz	kilohertz	ns	nanosecond
kΩ	kilohm	nV	nanovolts
Mbaud	megabaud	Ω	ohm
Mbps	megabits per second	pA	picoampere
MHz	megahertz	pF	picofarad
MΩ	megaohm	pp	peak-to-peak
µA	microampere	ppm	parts per million
µF	microfarad	ps	picosecond
µH	microhenry	sps	samples per second
µs	microsecond	σ	sigma: one standard deviation
µV	microvolts	V	volts

DC Electrical Characteristics

DC Chip-Level Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 11. DC Chip-Level Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
Vdd	Supply Voltage	4.75	–	5.25	V	See table titled DC POR and LVD Specifications on page 20
I_{DD}	Supply Current	–	5	8	mA	Conditions are Vdd = 5.25V, -40°C ≤ T_A ≤ 125°C, CPU = 3 MHz, 48 MHz disabled, VC1 = 1.5 MHz, VC2 = 93.75 kHz, VC3 = 93.75 kHz, Analog power = off.
I_{SB}	Sleep (Mode) Current with POR, LVD, Sleep Timer, and WDT.[6]	–	4	13	µA	Conditions are with internal low speed oscillator active, Vdd = 5.25V, -40°C ≤ T_A ≤ 55°C. Analog power = off.
I_{SBH}	Sleep (Mode) Current with POR, LVD, Sleep Timer, and WDT at high temperature.[6]	–	4	100	µA	Conditions are with internal slow speed oscillator active, Vdd = 5.25V, 55°C < T_A ≤ 125°C. Analog power = off.
I_{SBXTL}	Sleep (Mode) Current with POR, LVD, Sleep Timer, WDT, and external crystal.[6]	–	6	15	µA	Conditions are with properly loaded, 1 µW max, 32.768 kHz crystal. Vdd = 5.25V, -40°C ≤ T_A ≤ 55°C. Analog power = off.
I_{SBXTLH}	Sleep (Mode) Current with POR, LVD, Sleep Timer, WDT, and external crystal at high temperature.[6]	–	6	100	µA	Conditions are with properly loaded, 1µW max, 32.768 kHz crystal. Vdd = 5.25V, 55°C < T_A ≤ 125°C. Analog power = off.
V_{REF}	Reference Voltage (Bandgap)	1.25	1.3	1.35	V	Trimmed for appropriate Vdd.

DC General Purpose I/O Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance.

Table 12. DC GPIO Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
R_{PU}	Pull up Resistor	4	5.6	8	kΩ	
R_{PD}	Pull down Resistor	4	5.6	8	kΩ	
V_{OH}	High Output Level	3.5	–	–	V	I_{OH} = 10 mA, Vdd = 4.75 to 5.25V (maximum 40 mA on even port pins (for example, P0[2], P1[4]), maximum 40 mA on odd port pins (for example, P0[3], P1[5])). 80 mA maximum combined I_{OH} budget.
V_{OL}	Low Output Level	–	–	0.75	V	I_{OL} = 25 mA, Vdd = 4.75 to 5.25V (maximum 100 mA on even port pins (for example, P0[2], P1[4]), maximum 100 mA on odd port pins (for example, P0[3], P1[5])). 150 mA maximum combined I_{OL} budget.
I_{OH}	High Level Source Current	10	–	–	mA	V_{OH} ≥ Vdd-1.0V, see the limitations of the total current in the note for V_{OH}.
I_{OL}	Low Level Sink Current	25	–	–	mA	V_{OL} ≤ 0.75V, see the limitations of the total current in the note for V_{OL}.
V_{IL}	Input Low Level	–	–	0.8	V	

Note
6. Standby current includes all functions (POR, LVD, WDT, Sleep Timer) needed for reliable system operation. This must be compared with devices that have similar functions enabled.

Table 12. DC GPIO Specifications (continued)

Symbol	Description	Min	Typ	Max	Units	Notes
V_{IH}	Input High Level	2.1	–		V	
V_H	Input Hysterisis	–	60	–	mV	
I_{IL}	Input Leakage (Absolute Value)	–	1	–	nA	Gross tested to 1 μA
C_{IN}	Capacitive Load on Pins as Input	–	3.5	10	pF	Package and pin dependent. Temp = 25°C
C_{OUT}	Capacitive Load on Pins as Output	–	3.5	10	pF	Package and pin dependent. Temp = 25°C

DC Operational Amplifier Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

The Operational Amplifier is a component of both the Analog Continuous Time (CT) PSoC blocks and the Analog Switched Capacitor (SC) PSoC blocks. The guaranteed specifications are measured in the Analog Continuous Time (CT) PSoC blocks.

Table 13. DC Operational Amplifier Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
V_{OSOA}	Input Offset Voltage (absolute value) Low Power Input Offset Voltage (absolute value) Mid Power Input Offset Voltage (absolute value) High Power	– – –	1.6 1.3 1.2	11 9 9	mV mV mV	
TCV_{OSOA}	Input Offset Voltage Drift	–	7.0	35.0	μV/°C	
I_{EBOA}	Input Leakage Current (Port 0 Analog Pins)	–	200	–	pA	Gross tested to 1 μA
C_{INOA}	Input Capacitance (Port 0 Analog Pins)	–	4.5	9.5	pF	Package and pin dependent. Temp = 25°C.
V_{CMOA}	Common Mode Voltage Range Common Mode Voltage Range (high power or high opamp bias)	0.0 0.5	– –	Vdd Vdd - 0.5	V –	The common-mode input voltage range is measured through an analog output buffer. The specification includes the limitations imposed by the characteristics of the analog output buffer.
G_{OLOA}	Open Loop Gain Power = Low Power = Medium Power = High	 – – –	 80 80 80	 – – –	 dB dB dB	Specification is applicable at high power. For all other bias modes (except high power, high opamp bias), minimum is 60 dB.
$V_{OHIGHOA}$	High Output Voltage Swing (worst case internal load) Power = Low Power = Medium Power = High	 Vdd - 0.2 Vdd - 0.2 Vdd - 0.5	 – – –	 – – –	 V V V	
V_{OLOWOA}	Low Output Voltage Swing (worst case internal load) Power = Low Power = Medium Power = High	 – – –	 – – –	 0.2 0.2 0.5	 V V V	
I_{SOA}	Supply Current (including associated AGND buffer) Power = Low, Opamp Bias = Low Power = Low, Opamp Bias = High Power = Medium, Opamp Bias = Low Power = Medium, Opamp Bias = High Power = High, Opamp Bias = Low Power = High, Opamp Bias = High	 – – – – – –	 150 300 600 1200 2400 4600	 200 400 800 1600 3200 6400	 μA μA μA μA μA μA	
$PSRR_{OA}$	Supply Voltage Rejection Ratio	–	80	–	dB	Vss ≤ VIN ≤ (Vdd - 2.25) or (Vdd - 1.25V) ≤ VIN ≤ Vdd

DC Low Power Comparator Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 14. DC Low Power Comparator Specifications

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

DC Analog Output Buffer Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 15. DC Analog Output Buffer Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
V_{OSOB}	Input Offset Voltage (Absolute Value)	–	3	18	mV	
TCV_{OSOB}	Input Offset Voltage Drift	–	+6	–	µV/°C	
V_{CMOB}	Common-Mode Input Voltage Range	0.5	–	Vdd - 1.0	V	
R_{OUTOB}	Output Resistance	–	1	–	Ω	
$V_{OHIGHOB}$	High Output Voltage Swing (Load = 32Ω to Vdd/2)	0.5 x Vdd + 1.1	–	–	V	
V_{OLOWOB}	Low Output Voltage Swing (Load = 32Ω to Vdd/2)	–	–	0.5 x Vdd - 1.3	V	
I_{SOB}	Supply Current Including Bias Cell (No Load) Power = Low Power = High	 – –	 1.1 2.6	 5.1 8.8	 mA mA	
$PSRR_{OB}$	Supply Voltage Rejection Ratio	–	64	–	dB	

DC Analog Reference Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

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

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

Table 16. DC Analog Reference Specifications

Symbol	Description	Min	Typ	Max	Units
BG	Bandgap Voltage Reference	1.25	1.30	1.35	V
–	AGND = Vdd/2[7]	Vdd/2 - 0.02	Vdd/2	Vdd/2 + 0.02	V
–	AGND = 2 x BandGap[7]	2.4	2.6	2.8	V
–	AGND = P2[4] (P2[4] = Vdd/2)[7]	P2[4] - 0.02	P2[4]	P2[4] + 0.02	V
–	AGND = BandGap[7]	1.23	1.30	1.37	V
–	AGND = 1.6 x BandGap[7]	1.98	2.08	2.14	V
–	AGND Column to Column Variation (AGND = Vdd/2)[7]	-0.035	0.000	0.035	V
–	RefHi = Vdd/2 + BandGap[8]	Vdd/2 + 1.15	Vdd/2 +1.30	Vdd/2 +1.45	V
–	RefHi = 3 x BandGap[8]	3.65	3.9	4.15	V
–	RefHi = 2 x BandGap + P2[6] (P2[6] = 1.3V)[8]	P2[6] + 2.4	P2[6] + 2.6	P2[6] + 2.8	V
–	RefHi = P2[4] + BandGap (P2[4] = Vdd/2)[8]	P2[4] + 1.24	P2[4] +1.30	P2[4] + 1.36	V
–	RefHi = P2[4] + P2[6] (P2[4] = Vdd/2, P2[6] = 1.3V)[8]	P2[4] + P2[6] - 0.1	P2[4] + P2[6]	P2[4] + P2[6] + 0.1	V
–	RefHi = 3.2 x BandGap[8]	3.9	4.16	4.42	V
–	RefLo = Vdd/2 – BandGap[8]	Vdd/2 - 1.45	Vdd/2 - 1.3	1.15	V
–	RefLo = BandGap[8]	1.15	1.3	1.45	V
–	RefLo = 2 x BandGap - P2[6] (P2[6] = 1.3V)[8]	2.4 - P2[6]	2.6 - P2[6]	2.8 - P2[6]	V
–	RefLo = P2[4] – BandGap (P2[4] = Vdd/2)[8]	P2[4] - 1.45	1.3	P2[4] - 1.15	V
–	RefLo = P2[4]-P2[6] (P2[4] = Vdd/2, P2[6] = 1.3V)[8]	P2[4] - P2[6] - 0.1	P2[4] - P2[6]	P2[4] - P2[6] + 0.1	V

Notes
7. This specification is only valid when CT Block Power = High. AGND tolerance includes the offsets of the local buffer in the PSoC block. Bandgap voltage is 1.3V ± 0.05V.
8. This specification is only valid when Ref Control Power = High.

AC Electrical Characteristics

AC Chip-Level Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 20. AC Chip-Level Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
F_{IMO24}	Internal Main Oscillator Frequency for 24 MHz	23.04[12]	24	24.96[12]	MHz	Trimmed using factory trim values.
F_{CPU1}	CPU Frequency (5V Vdd Nominal)	0.09[12]	12	12.48[12]	MHz	
F_{24M}	Digital PSoC Block Frequency	0	24	24.96[12, 13]	MHz	
F_{32K1}	Internal Low Speed Oscillator Frequency	15	32	64	kHz	This specification applies when the ILO has been trimmed.
F_{32KU}	Internal Low Speed Oscillator (ILO) Untrimmed Frequency	5	–	–	kHz	After a reset and before the M8C processor starts to execute, the ILO is not trimmed.
F_{32K2}	External Crystal Oscillator	–	32.768	–	kHz	Accuracy is capacitor and crystal dependent. 50% duty cycle.
F_{PLL}	PLL Frequency	–	23.986	–	MHz	A multiple (x732) of crystal frequency.
Jitter24M2	24 MHz Period Jitter (PLL)	–	–	800	ps	Refer to Figure 9 on page 22.
$T_{PLLSLEW}$	PLL Lock Time	0.5	–	10	ms	Refer to Figure 6 on page 22.
$T_{PLLSLEWSLOW}$	PLL Lock Time for Low Gain Setting	0.5	–	50	ms	Refer to Figure 7 on page 22.
T_{OS}	External Crystal Oscillator Startup to 1%	–	1700	2620	ms	Refer to Figure 8 on page 22.
T_{OSACC}	External Crystal Oscillator Startup to 100 ppm	–	2800	3800	ms	
Jitter32k	32 kHz Period Jitter	–	100	–	ns	Refer to Figure 10 on page 22.
T_{XRST}	External Reset Pulse Width	10	–	–	µs	
DC24M	24 MHz Duty Cycle	40	50	60	%	
DC_{ILO}	Internal Low Speed Oscillator (ILO) Duty Cycle	20	50	80	%	
Step24M	24 MHz Trim Step Size	–	50	–	kHz	
Jitter24M1P	24 MHz Period Jitter (IMO) Peak-to-Peak	–	600	–	ps	Refer to Figure 9 on page 22.
Jitter24M1R	24 MHz Period Jitter (IMO) Root Mean Squared	–	–	600	ps	
F_{MAX}	Maximum frequency of signal on row input or row output.	–	–	12.48[12]	MHz	
$SR_{POWERUP}$	Power Supply Slew Rate	–	–	250	V/ms	Vdd slew rate during power up.
$T_{POWERUP}$	Time between end of POR state and CPU code execution	–	16	100	ms	Power up from 0V.

Notes
12. Accuracy derived from Internal Main Oscillator with appropriate trim for Vdd range.
13. See the individual user module data sheets for information on maximum frequencies for user modules.

Figure 6. PLL Lock Timing Diagram

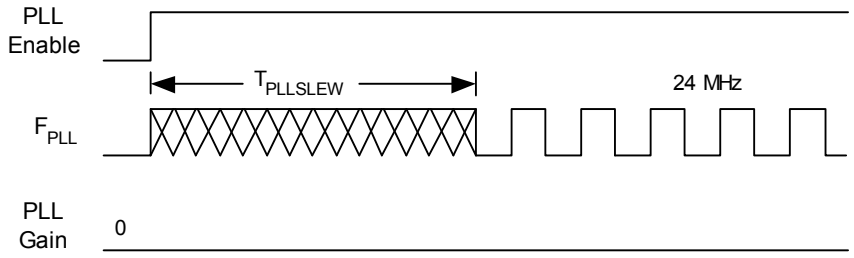


Figure 7. PLL Lock for Low Gain Setting Timing Diagram

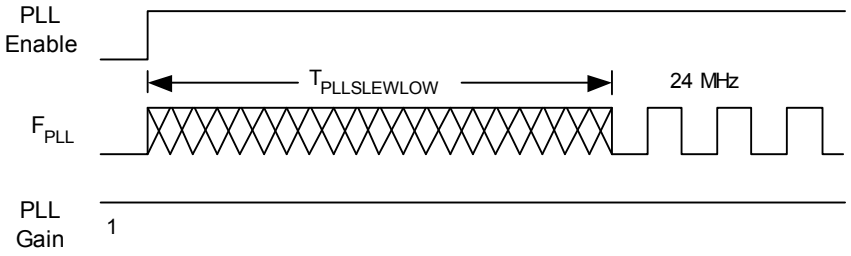


Figure 8. External Crystal Oscillator Startup Timing Diagram

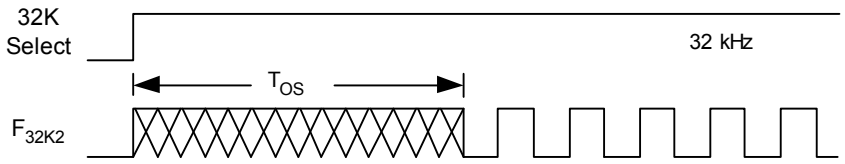


Figure 9. 24 MHz Period Jitter (IMO) Timing Diagram

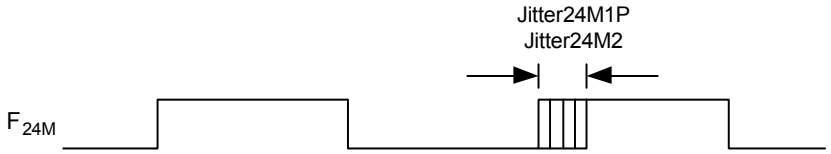
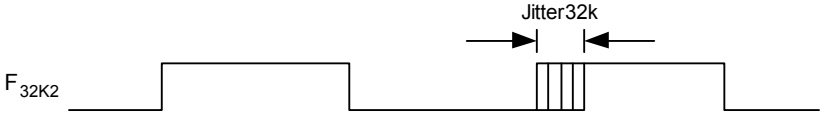


Figure 10. 32 kHz Period Jitter (ECO) Timing Diagram



AC Digital Block Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 24. AC Digital Block Specifications

Function	Description	Min	Typ	Max	Units	Notes
All Functions	Maximum Block Clocking Frequency	–	–	24.96[12]	MHz	
Timer	Capture Pulse Width	50[14]	–	–	ns	
	Maximum Frequency, No Capture	–	–	24.96[12]	MHz	
	Maximum Frequency, With Capture	–	–	24.96[12]	MHz	
Counter	Enable Pulse Width	50[14]	–	–	ns	
	Maximum Frequency, No Enable Input	–	–	24.96[12]	MHz	
	Maximum Frequency, Enable Input	–	–	24.96[12]	MHz	
Dead Band	Kill Pulse Width:					
	Asynchronous Restart Mode	20	–	–	ns	
	Synchronous Restart Mode	50[14]	–	–	ns	
	Disable Mode	50[14]	–	–	ns	
	Maximum Frequency	–	–	24.96[12]	MHz	
CRCPRS (PRS Mode)	Maximum Input Clock Frequency	–	–	24.96[12]	MHz	
CRCPRS (CRC Mode)	Maximum Input Clock Frequency	–	–	24.96[12]	MHz	
SPIM	Maximum Input Clock Frequency	–	–	4.16[12]	MHz	Maximum data rate is 2.08 Mbps due to 2 x over clocking.
SPIS	Maximum Input Clock Frequency	–	–	2.08[12]	MHz	
	Width of SS_ Negated Between Transmissions	50[14]	–	–	ns	
Transmitter	Maximum Input Clock Frequency	–	–	8.32[12]	MHz	Maximum baud rate is 1.04 Mbaud due to 8 x over clocking.
Receiver	Maximum Input Clock Frequency	–	–	24.96[12]	MHz	Maximum baud rate is 3.12 Mbaud due to 8 x over clocking.

Note
14. 50 ns minimum input pulse width is based on the input synchronizers running at 24 MHz (42 ns nominal period).

AC Analog Output Buffer Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 25. AC Analog Output Buffer Specifications

Symbol	Description	Min	Typ	Max	Units
T_{ROB}	Rising Settling Time to 0.1%, 1V Step, 100 pF Load Power = Low Power = High	 – –	 – –	 3 3	 µs µs
T_{SOB}	Falling Settling Time to 0.1%, 1V Step, 100 pF Load Power = Low Power = High	 – –	 – –	 3 3	 µs µs
SR_{ROB}	Rising Slew Rate (20% to 80%), 1V Step, 100 pF Load Power = Low Power = High	 0.6 0.6	 – –	 – –	 V/µs V/µs
SR_{FOB}	Falling Slew Rate (80% to 20%), 1V Step, 100 pF Load Power = Low Power = High	 0.6 0.6	 – –	 – –	 V/µs V/µs
BW_{OB}	Small Signal Bandwidth, 20mV_{pp}, 3dB BW, 100 pF Load Power = Low Power = High	 0.8 0.8	 – –	 – –	 MHz MHz
BW_{OB}	Large Signal Bandwidth, 1V_{pp}, 3dB BW, 100 pF Load Power = Low Power = High	 300 300	 – –	 – –	 kHz kHz

AC External Clock Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 26. AC External Clock Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
F_{OSCEXT}	Frequency	0.093	–	24.24	MHz	
–	High Period	20.6	–	–	ns	
–	Low Period	20.6	–	–	ns	
–	Power Up IMO to Switch	150	–	–	µs	

AC Programming Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 27. AC Programming Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
T_{RSCLK}	Rise Time of SCLK	1	–	20	ns	
T_{FSCLK}	Fall Time of SCLK	1	–	20	ns	
T_{SSCLK}	Data Set up 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)	–	20	80[9]	ms	
T_{WRITE}	Flash Block Write Time	–	80	320[9]	ms	
T_{DSCLK}	Data Out Delay from Falling Edge of SCLK	–	–	50	ns	
T_{PRGH}	Total Flash Block Program Time (T_{ERASEB} + T_{WRITE}), Hot	–	–	200[9]	ms	$T_J \geq 0°C$
T_{PRGC}	Total Flash Block Program Time (T_{ERASEB} + T_{WRITE}), Cold	–	–	400[9]	ms	$T_J < 0°C$

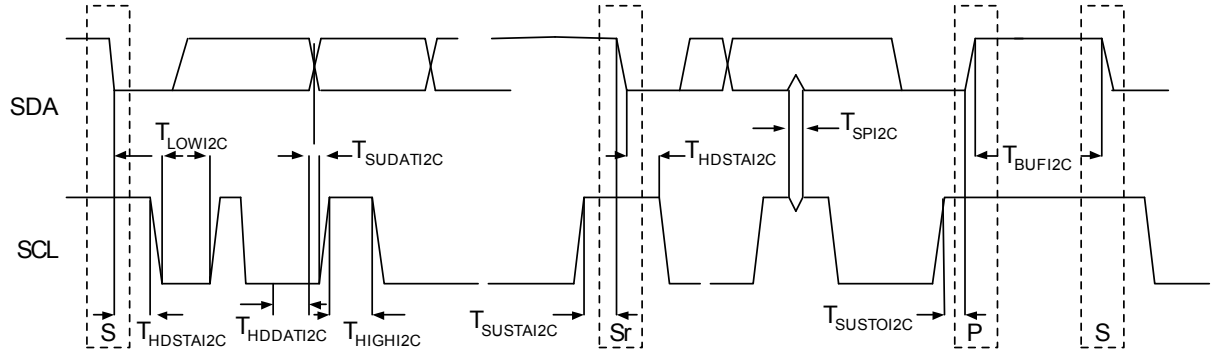
AC I²C Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 125°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 28. AC Characteristics of the I²C SDA and SCL Pins

Symbol	Description	Standard Mode		Fast Mode		Units
		Min	Max	Min	Max	
F_{SCLI2C}	SCL Clock Frequency	0	100[15]	0	400[15]	kHz
$T_{HDSTAI2C}$	Hold Time (repeated) START Condition. After this period, the first clock pulse is generated.	4.0	–	0.6	–	µs
T_{LOWI2C}	LOW Period of the SCL Clock	4.7	–	1.3	–	µs
$T_{HIGHI2C}$	HIGH Period of the SCL Clock	4.0	–	0.6	–	µs
$T_{SUSTAI2C}$	Setup Time for a Repeated START Condition	4.7	–	0.6	–	µs
$T_{HDDATI2C}$	Data Hold Time	0	–	0	–	µs
$T_{SUDATI2C}$	Data Setup Time	250	–	100[16]	–	ns
$T_{SUSTOI2C}$	Setup Time for STOP Condition	4.0	–	0.6	–	µs
T_{BUFI2C}	Bus Free Time Between a STOP and START Condition	4.7	–	1.3	–	µs
T_{SPI2C}	Pulse Width of spikes are suppressed by the input filter.	–	–	0	50	ns

Figure 14. Definition for Timing for Fast/Standard Mode on the I²C Bus



Notes

15. F_{SCLI2C} is derived from SysClk of the PSoC. This specification assumes that SysClk is operating at 24 MHz, nominal. If SysClk is at a lower frequency, then the F_{SCLI2C} specification adjusts accordingly.
16. A Fast-Mode I²C-bus device can be used in a Standard-Mode I²C-bus system, but the requirement $T_{SUDATI2C} \geq 250$ ns must then be met. This is automatically the case if the device does not stretch the LOW period of the SCL signal. If such device does stretch the LOW period of the SCL signal, it must output the next data bit to the SDA line $t_{rmax} + T_{SUDATI2C} = 1000 + 250 = 1250$ ns (according to the Standard-Mode I²C-bus specification) before the SCL line is released.

Packaging Information

This section illustrates the packaging specifications for the automotive CY8C24x23A PSoC device, along with the thermal impedances for each package and the typical package capacitance on crystal pins.

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

Figure 15. 20-Pin (210-Mil) SSOP

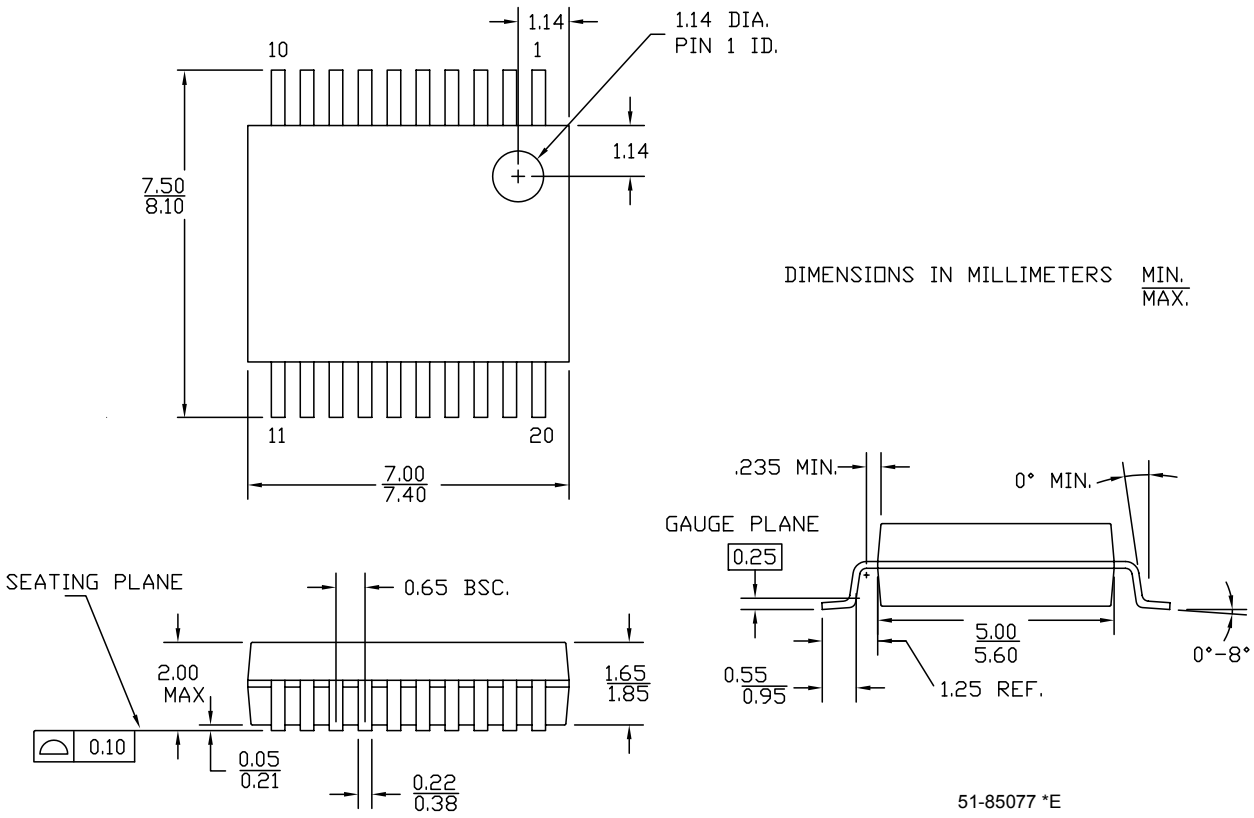
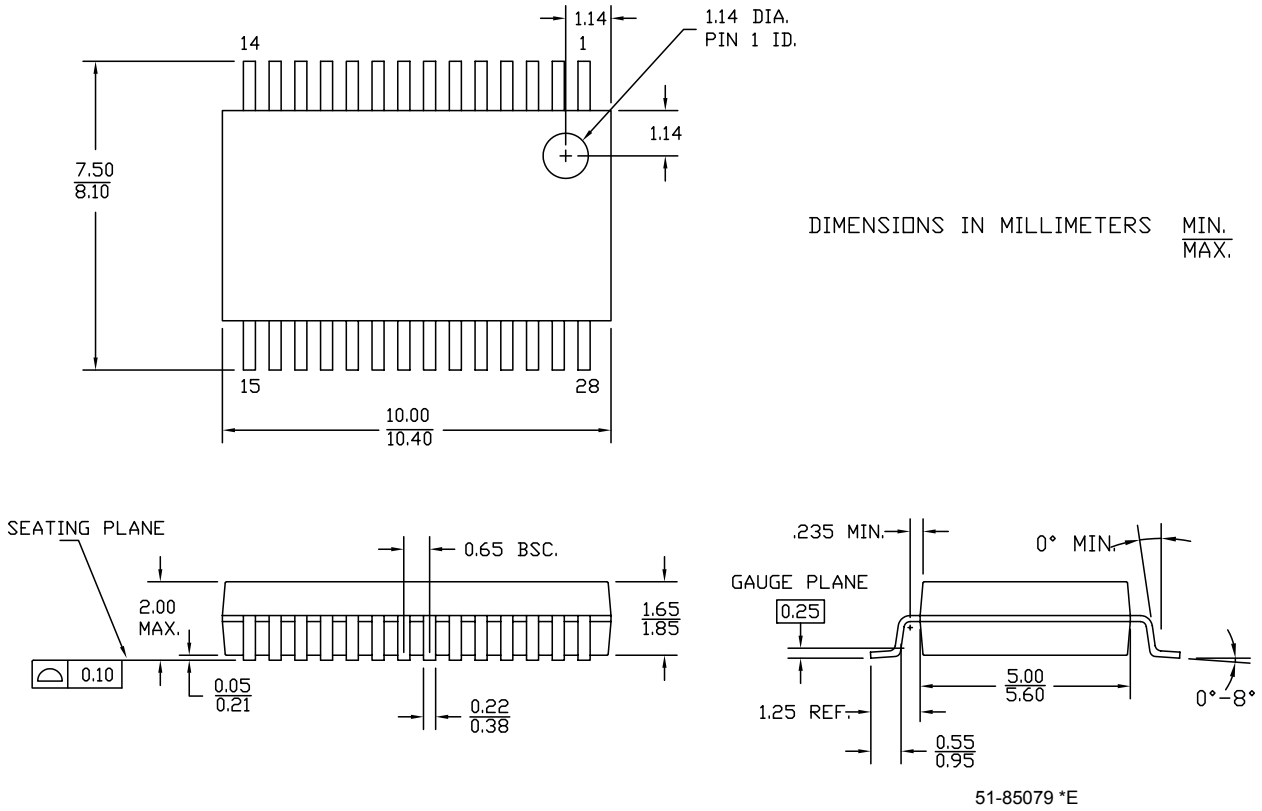


Figure 16. 28-Pin (210-Mil) SSOP



Thermal Impedances

Package	Typical θ_{JA} [17]
20 SSOP	117 °C/W
28 SSOP	101 °C/W

Capacitance on Crystal Pins

Package	Package Capacitance
20 SSOP	2.6 pF
28 SSOP	2.8 pF

Solder Reflow Specifications

The following table shows the solder reflow temperature limits that must not be exceeded.

Package	Maximum Time above T_C – 5 °C	Maximum Peak Temperature
20 SSOP	30 seconds	260°C
28 SSOP	30 seconds	260°C

Note
17. $T_J = T_A + POWER \times \theta_{JA}$

Device Programmers

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

CY3210-MiniProg1

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

- MiniProg Programming Unit
- MiniEval Socket Programming and Evaluation Board
- 28-Pin CY8C29466-24PXI PDIP PSoC Device Sample
- 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. This software is free and can be downloaded from http://www.cypress.com. The kit includes:

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

Accessories (Emulation and Programming)

Table 29. Emulation and Programming Accessories

Part Number	Pin Package	Pod Kit[18]	Foot Kit[19]	Adapter[20]
CY8C24223A-12PVXE	20 SSOP	CY3250-24X23A	CY3250-20SSOP-FK	Adapters can be found at http://www.emulation.com.
CY8C24423A-12PVXE	28 SSOP	CY3250-24X23A	CY3250-28SSOP-FK	

Notes
18. Pod kit contains an emulation pod, a flex-cable (connects the pod to the ICE), two feet, and device samples.
19. Foot kit includes surface mount feet that can be soldered to the target PCB.
20. 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.