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	24MHz
Connectivity	I²C, SPI, UART/USART, USB
Peripherals	POR, PWM, WDT
Number of I/O	50
Program Memory Size	16KB (16K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	1K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 5.25V
Data Converters	A/D 48x14b; D/A 2x9b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	56-VFQFN Exposed Pad
Supplier Device Package	56-QFN (8x8)
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/cy8c24794-24lfxit

The PSoC Core

The PSoC Core is a powerful engine that supports a rich feature set. The core includes a CPU, memory, clocks, and configurable GPIO (General Purpose IO).

The M8C CPU core is a powerful processor with speeds up to 24 MHz, providing a four MIPS 8-bit Harvard architecture microprocessor. The CPU utilizes an interrupt controller with up to 20 vectors, to simplify programming of real time embedded events. Program execution is timed and protected using the included Sleep and Watch Dog Timers (WDT).

Memory encompasses 16K of Flash for program storage, 1K of SRAM for data storage, and up to 2K of EEPROM emulated using the Flash. Program Flash utilizes four protection levels on blocks of 64 bytes, allowing customized software IP protection.

The PSoC device incorporates flexible internal clock generators, including a 24 MHz IMO (internal main oscillator) accurate to 8% over temperature and voltage. The 24 MHz IMO can also be doubled to 48 MHz for use by the digital system. A low power 32 kHz ILO (internal low speed oscillator) is provided for the Sleep timer and WDT. The clocks, together with programmable clock dividers (as a System Resource), provide the flexibility to integrate almost any timing requirement into the PSoC device. In USB systems, the IMO will self-tune to ± 0.25% accuracy for USB communication.

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

The Digital System

The Digital System is composed of 4 digital PSoC blocks. Each block is an 8-bit resource that can be used alone or combined with other blocks to form 8, 16, 24, and 32-bit peripherals, which are called user module references.
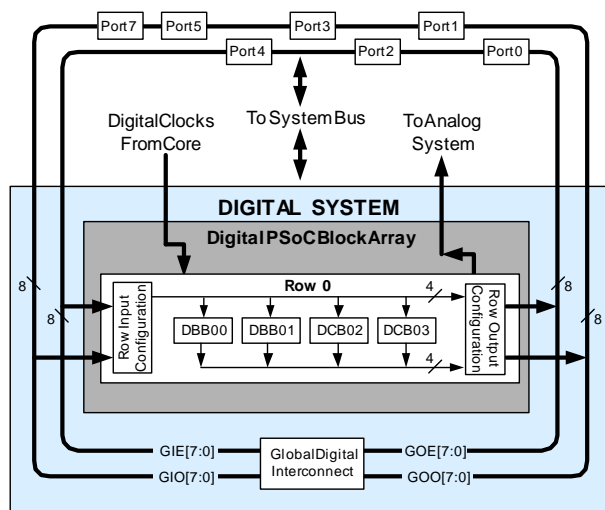
Digital System Block Diagram

Digital peripheral configurations include those listed below.

■ Full-Speed USB (12 Mbps)
■ PWMs (8 to 32 bit)
■ PWMs with Dead band (8 to 24 bit)
■ Counters (8 to 32 bit)
■ Timers (8 to 32 bit)
■ UART 8 bit with selectable parity
■ SPI master and slave
■ I2C slave and multi-master
■ Cyclical Redundancy Checker/Generator (8 to 32 bit)
■ IrDA
■ Pseudo Random Sequence Generators (8 to 32 bit)

The digital blocks can be connected to any GPIO through a series of global buses that can route any signal to any pin. The buses also allow for signal multiplexing and for performing logic operations. This configurability frees your designs from the constraints of a fixed peripheral controller.

Digital blocks are provided in rows of four, where the number of blocks varies by PSoC device family. This allows you the optimum choice of system resources for your application. Family resources are shown in the table titled "PSoC Device Characteristics" on page 3.

The Analog System

The Analog System is composed of 6 configurable blocks, each comprised of an opamp circuit allowing the creation of complex analog signal flows. Analog peripherals are very flexible and can be customized to support specific application requirements. Some of the more common PSoC analog functions (most available as user modules) are listed below.

■ Analog-to-digital converters (up to 2, with 6- to 14-bit resolution, selectable as Incremental, Delta Sigma, and SAR)
■ Filters (2 and 4 pole band-pass, low-pass, and notch)
■ Amplifiers (up to 2, with selectable gain to 48x)
■ Instrumentation amplifiers (1 with selectable gain to 93x)
■ Comparators (up to 2, with 16 selectable thresholds)
■ DACs (up to 2, with 6- to 9-bit resolution)
■ Multiplying DACs (up to 2, with 6- to 9-bit resolution)
■ High current output drivers (two with 30 mA drive as a PSoC Core Resource)
■ 1.3V reference (as a System Resource)
■ DTMF Dialer
■ Modulators
■ Correlators
■ Peak Detectors
■ Many other topologies possible

Getting Started

The quickest path to understanding the PSoC silicon is by reading this data sheet and using the PSoC Designer Integrated Development Environment (IDE). This data sheet is an overview of the PSoC integrated circuit and presents specific pin, register, and electrical specifications. For in-depth information, along with detailed programming information, reference the *PSoC™ Mixed-Signal Array Technical Reference Manual*.

For up-to-date Ordering, Packaging, and Electrical Specification information, reference the latest PSoC device data sheets on the web at http://www.cypress.com/psoc.

To determine which PSoC device meets your requirements, navigate through the PSoC Decision Tree in the Application Note AN2209 at http://www.cypress.com and select Application Notes under the Design Resources.

Development Kits

Development Kits are available from the following distributors: Digi-Key, Avnet, Arrow, and Future. The Cypress Online Store contains development kits, **C** compilers, and all accessories for PSoC development. Go to the Cypress Online Store web site at http://www.cypress.com, click the Online Store shopping cart icon at the bottom of the web page, and click *PSoC (Programmable System-on-Chip)* to view a current list of available items.

Technical Training

Free PSoC technical training is available for beginners and is taught by a marketing or application engineer over the phone. PSoC training classes cover designing, debugging, advanced analog, as well as application-specific classes covering topics such as PSoC and the LIN bus. Go to http://www.cypress.com, click on Design Support located on the left side of the web page, and select Technical Training for more details.

Consultants

Certified PSoC Consultants offer everything from technical assistance to completed PSoC designs. To contact or become a PSoC Consultant go to http://www.cypress.com, click on Design Support located on the left side of the web page, and select CYPros Consultants.

Technical Support

PSoC application engineers take pride in fast and accurate response. They can be reached with a 4-hour guaranteed response at http://www.cypress.com/support/login.cfm.

Application Notes

A long list of application notes will assist you in every aspect of your design effort. To view the PSoC application notes, go to the http://www.cypress.com web site and select Application Notes under the Design Resources list located in the center of the web page. Application notes are listed by date as default.

Development Tools

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 NT 4.0, Windows 2000, Windows Millennium (Me), or Windows XP. (Reference the PSoC Designer Functional Flow diagram below.)

PSoC Designer helps the customer to select an operating configuration for the PSoC, write application code that uses the PSoC, and debug the application. This system provides design database management by project, an integrated debugger with In-Circuit Emulator, in-system programming support, and the CYASM macro assembler for the CPUs.

PSoC Designer also supports a high-level C language compiler developed specifically for the devices in the family.
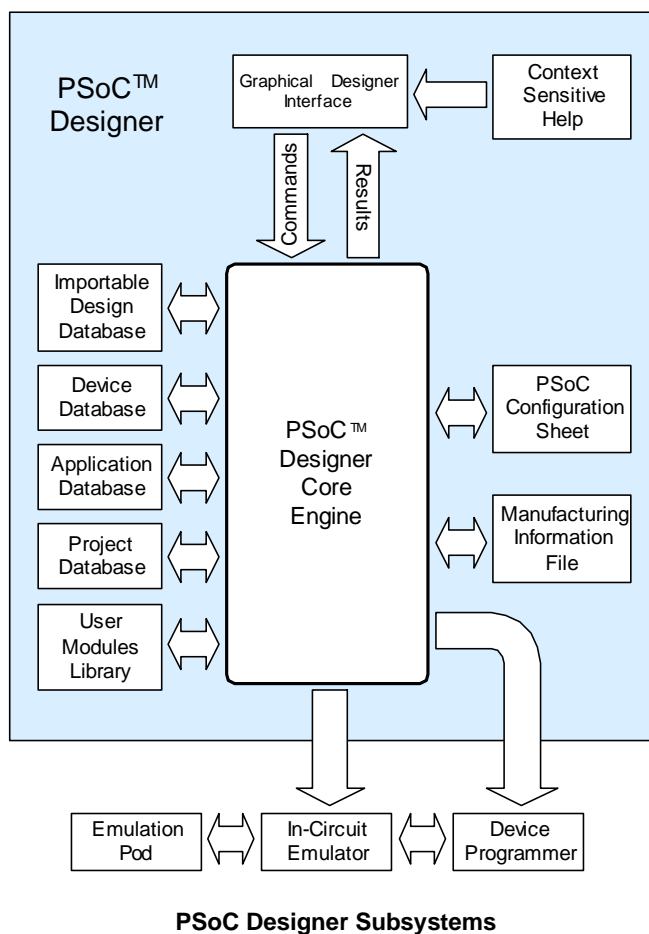
PSoC Designer Subsystems

PSoC Designer Software Subsystems

Device Editor

The Device Editor subsystem allows the user to select different onboard analog and digital components called user modules using the PSoC blocks. Examples of user modules are ADCs, DACs, Amplifiers, and Filters.

The device editor also supports easy development of multiple configurations and dynamic reconfiguration. Dynamic configuration allows for changing configurations at run time.

PSoC Designer sets up power-on initialization tables for selected PSoC block configurations and creates source code for an application framework. The framework contains software to operate the selected components and, if the project uses more than one operating configuration, contains routines to switch between different sets of PSoC block configurations at run time. PSoC Designer can print out a configuration sheet for a given project configuration for use during application programming in conjunction with the Device Data Sheet. Once the framework is generated, the user can add application-specific code to flesh out the framework. It's also possible to change the selected components and regenerate the framework.

Design Browser

The Design Browser allows users to select and import preconfigured designs into the user's project. Users can easily browse a catalog of preconfigured designs to facilitate time-to-design. Examples provided in the tools include a 300-baud modem, LIN Bus master and slave, fan controller, and magnetic card reader.

Application Editor

In the Application Editor you can edit your C language and Assembly language source code. You can also assemble, compile, link, and build.

Assembler. The macro assembler allows the assembly code to be merged seamlessly with C code. The link libraries automatically use absolute addressing or can be compiled in relative mode, and linked with other software modules to get absolute addressing.

C Language Compiler. A C language compiler is available that supports the PSoC family of devices. Even if you have never worked in the C language before, the product quickly allows you to create complete C programs for the PSoC family devices.

The embedded, optimizing C compiler provides all the features of C tailored to the PSoC architecture. It comes complete with embedded libraries providing port and bus operations, standard keypad and display support, and extended math functionality.

Debugger

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

Online Help System

The online help system displays online, context-sensitive help for the user. 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 getting started.

Hardware Tools

In-Circuit Emulator

A low cost, high functionality ICE (In-Circuit Emulator) is available for development support. This hardware has the capability to program single devices.

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

Designing with User Modules

The development process for the PSoC device differs from that of a traditional fixed function microprocessor. The configurable analog and digital hardware blocks give the PSoC architecture a unique flexibility that pays dividends in managing specification change during development and by lowering inventory costs. These configurable resources, called PSoC Blocks, have the ability to implement a wide variety of user-selectable functions. Each block has several registers that determine its function and connectivity to other blocks, multiplexers, buses and to the IO pins. Iterative development cycles permit you to adapt the hardware as well as the software. This substantially lowers the risk of having to select a different part to meet the final design requirements.

To speed the development process, the PSoC Designer Integrated Development Environment (IDE) provides a library of pre-built, pre-tested hardware peripheral functions, called "User Modules." User modules make selecting and implementing peripheral devices simple, and come in analog, digital, and mixed signal varieties. The standard User Module library contains over 50 common peripherals such as ADCs, DACs Timers, Counters, UARTs, and other not-so common peripherals such as DTMF Generators and Bi-Quad analog filter sections.

Each user module establishes the basic register settings that implement the selected function. It also provides parameters that allow you to tailor its precise configuration to your particular application. For example, a Pulse Width Modulator User Module configures one or more digital PSoC blocks, one for each 8 bits of resolution. The user module parameters permit you to establish the pulse width and duty cycle. User modules also provide tested software to cut your development time. The user module application programming interface (API) provides high-level functions to control and respond to hardware events at run-time. The API also provides optional interrupt service routines that you can adapt as needed.

The API functions are documented in user module data sheets that are viewed directly in the PSoC Designer IDE. These data sheets explain the internal operation of the user module and provide performance specifications. Each data sheet describes the use of each user module parameter and documents the setting of each register controlled by the user module.

The development process starts when you open a new project and bring up the Device Editor, a graphical user interface (GUI) for configuring the hardware. You pick the user modules you need for your project and map them onto the PSoC blocks with point-and-click simplicity. Next, you build signal chains by interconnecting user modules to each other and the IO pins. At this stage, you also configure the clock source connections and enter parameter values directly or by selecting values from drop-down menus. When you are ready to test the hardware configuration or move on to developing code for the project, you perform the "Generate Application" step. This causes PSoC Designer to generate source code that automatically configures the device to your specification and provides the high-level user module API functions.
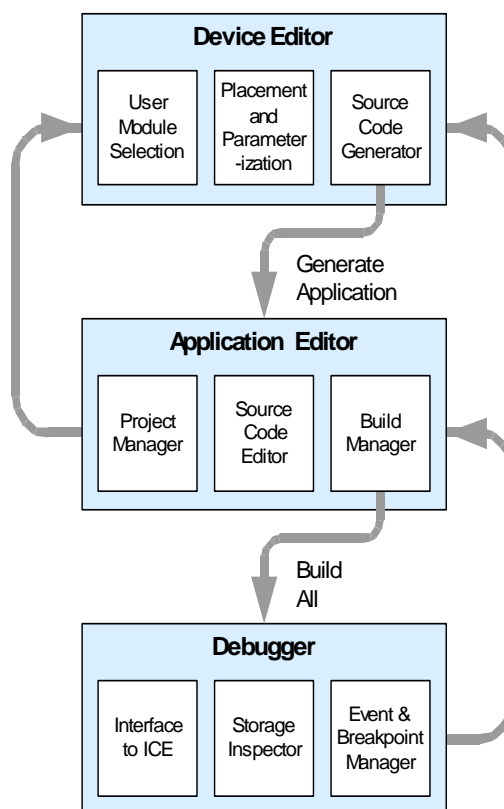
User Module and Source Code Development Flows

The next step is to write your main program, and any sub-routines using PSoC Designer's Application Editor subsystem. The Application Editor includes a Project Manager that allows you to open the project source code files (including all generated code files) from a hierarchal view. The source code editor provides syntax coloring and advanced edit features for both C and assembly language. File search capabilities include simple string searches and recursive "grep-style" patterns. A single mouse click invokes the Build Manager. It employs a professional-strength "makefile" system to automatically analyze all file dependencies and run the compiler and assembler as necessary. Project-level options control optimization strategies used by the compiler and linker. Syntax errors are displayed in a console window. Double clicking the error message takes you directly to the offending line of source code. When all is correct, the linker builds a HEX file image suitable for programming.

The last step in the development process takes place inside the PSoC Designer's Debugger subsystem. The Debugger downloads the HEX image to the In-Circuit Emulator (ICE) where it runs at full speed. Debugger capabilities rival those of systems costing many times more. In addition to traditional single-step, run-to-breakpoint and watch-variable features, the Debugger provides a large trace buffer and allows you define complex breakpoint events that include monitoring address and data bus values, memory locations and external signals.

2. Register Reference

This chapter lists the registers of the CY8C24794 PSoC device. For detailed register information, reference the *PSoC™ Mixed-Signal Array Technical Reference Manual*.

2.1 Register Conventions

2.1.1 Abbreviations Used

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

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

2.2 Register Mapping Tables

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

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

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	PMA0_WA	40	RW	ASC10CR0	80	RW	USBIO_CR2	C0	RW
PRT0DM1	01	RW	PMA1_WA	41	RW	ASC10CR1	81	RW	USB_CR1	C1	#
PRT0IC0	02	RW	PMA2_WA	42	RW	ASC10CR2	82	RW			
PRT0IC1	03	RW	PMA3_WA	43	RW	ASC10CR3	83	RW			
PRT1DM0	04	RW	PMA4_WA	44	RW	ASD11CR0	84	RW	EP1_CR0	C4	#
PRT1DM1	05	RW	PMA5_WA	45	RW	ASD11CR1	85	RW	EP2_CR0	C5	#
PRT1IC0	06	RW	PMA6_WA	46	RW	ASD11CR2	86	RW	EP3_CR0	C6	#
PRT1IC1	07	RW	PMA7_WA	47	RW	ASD11CR3	87	RW	EP4_CR0	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	
PRT3DM0	0C	RW		4C			8C			CC	
PRT3DM1	0D	RW		4D			8D			CD	
PRT3IC0	0E	RW		4E			8E			CE	
PRT3IC1	0F	RW		4F			8F			CF	
PRT4DM0	10	RW	PMA0_RA	50	RW		90		GDI_O_IN	D0	RW
PRT4DM1	11	RW	PMA1_RA	51	RW	ASD20CR1	91	RW	GDI_E_IN	D1	RW
PRT4IC0	12	RW	PMA2_RA	52	RW	ASD20CR2	92	RW	GDI_O_OU	D2	RW
PRT4IC1	13	RW	PMA3_RA	53	RW	ASD20CR3	93	RW	GDI_E_OU	D3	RW
PRT5DM0	14	RW	PMA4_RA	54	RW	ASC21CR0	94	RW		D4	
PRT5DM1	15	RW	PMA5_RA	55	RW	ASC21CR1	95	RW		D5	
PRT5IC0	16	RW	PMA6_RA	56	RW	ASC21CR2	96	RW		D6	
PRT5IC1	17	RW	PMA7_RA	57	RW	ASC21CR3	97	RW		D7	
	18			58			98		MUX_CR0	D8	RW
	19			59			99		MUX_CR1	D9	RW
	1A			5A			9A		MUX_CR2	DA	RW
	1B			5B			9B		MUX_CR3	DB	RW
PRT7DM0	1C	RW		5C			9C			DC	
PRT7DM1	1D	RW		5D			9D		OSC_GO_EN	DD	RW
PRT7IC0	1E	RW		5E			9E		OSC_CR4	DE	RW
PRT7IC1	1F	RW		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	CMP_GO_EN	64	RW		A4		VLT_CMP	E4	R
DBB01IN	25	RW	CMP_GO_EN1	65	RW		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	TMP_DR0	6C	RW		AC		MUX_CR4	EC	RW
DCB03IN	2D	RW	TMP_DR1	6D	RW		AD		MUX_CR5	ED	RW
DCB03OU	2E	RW	TMP_DR2	6E	RW		AE			EE	
	2F		TMP_DR3	6F	RW		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		DAC_CR	FD	RW
	3E			7E			BE		CPU_SCR1	FE	#
	3F			7F			BF		CPU_SCR0	FF	#

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

3.3.2 DC General Purpose IO Specifications

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

Table 3-5. 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	Vdd - 1.0	–	–	V	IOH = 10 mA, Vdd = 4.75 to 5.25V (8 total loads, 4 on even port pins (for example, P0[2], P1[4]), 4 on odd port pins (for example, P0[3], P1[5])). 80 mA maximum combined IOH budget.
V_{OL}	Low Output Level	–	–	0.75	V	IOL = 25 mA, Vdd = 4.75 to 5.25V (8 total loads, 4 on even port pins (for example, P0[2], P1[4]), 4 on odd port pins (for example, P0[3], P1[5])). 150 mA maximum combined IOL budget.
V_{IL}	Input Low Level	–	–	0.8	V	Vdd = 3.0 to 5.25.
V_{IH}	Input High Level	2.1	–		V	Vdd = 3.0 to 5.25.
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.

3.3.3 DC Full-Speed USB Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -10°C $\leq T_A \leq$ 85°C, or 3.0V to 3.6V and -10°C $\leq T_A \leq$ 85°C, respectively. Typical parameters apply to 5V and 3.3V at 25°C and are for design guidance only.

Table 3-6. DC Full-Speed (12 Mbps) USB Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
USB Interface						
V_{DI}	Differential Input Sensitivity	0.2	–	–	V	| (D+) - (D-) |
V_{CM}	Differential Input Common Mode Range	0.8	–	2.5	V	
V_{SE}	Single Ended Receiver Threshold	0.8	–	2.0	V	
C_{IN}	Transceiver Capacitance	–	–	20	pF	
I_{IO}	High-Z State Data Line Leakage	-10	–	10	µA	0V < V_{IN} < 3.3V.
R_{EXT}	External USB Series Resistor	23	–	25	Ω	In series with each USB pin.
V_{UOH}	Static Output High, Driven	2.8	–	3.6	V	15 kΩ ± 5% to Ground. Internal pull-up enabled.
V_{UOHI}	Static Output High, Idle	2.7	–	3.6	V	15 kΩ ± 5% to Ground. Internal pull-up enabled.
V_{UOL}	Static Output Low	–	–	0.3	V	15 kΩ ± 5% to Ground. Internal pull-up enabled.
Z_O	USB Driver Output Impedance	28	–	44	Ω	Including R_{EXT} Resistor.
V_{CRS}	D+/D- Crossover Voltage	1.3	–	2.0	V	

3.3.5   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 ≤ 85°C, or 3.0V to 3.6V and -40°C ≤ T_A ≤ 85°C, respectively. Typical parameters apply to 5V and 3.3V at 25°C and are for design guidance only.

Table 3-9. 5V DC Analog Output Buffer Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
V_{OSOB}	Input Offset Voltage (Absolute Value)	–	3	12	mV	
TCV_{OSOB}	Average Input Offset Voltage Drift	–	+6	–	µV/°C	
V_{CMOB}	Common-Mode Input Voltage Range	0.5	–	Vdd - 1.0	V	
R_{OUTOB}	Output Resistance Power = Low Power = High	– –	0.6 0.6	– –	Ω Ω	
$V_{OHIGHOB}$	High Output Voltage Swing (Load = 32 ohms to Vdd/2) Power = Low Power = High	0.5 x Vdd + 1.1 0.5 x Vdd + 1.1	– –	– –	V V	
V_{OLOWOB}	Low Output Voltage Swing (Load = 32 ohms to Vdd/2) Power = Low Power = High	– –	– –	0.5 x Vdd - 1.3 0.5 x Vdd - 1.3	V 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	53	64	–	dB	(0.5 x Vdd - 1.3) ≤ V_{OUT} ≤ (Vdd - 2.3).

Table 3-10. 3.3V DC Analog Output Buffer Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
V_{OSOB}	Input Offset Voltage (Absolute Value)	–	3	12	mV	
TCV_{OSOB}	Average Input Offset Voltage Drift	–	+6	–	µV/°C	
V_{CMOB}	Common-Mode Input Voltage Range	0.5	-	Vdd - 1.0	V	
R_{OUTOB}	Output Resistance Power = Low Power = High	– –	1 1	– –	Ω Ω	
$V_{OHIGHOB}$	High Output Voltage Swing (Load = 1K ohms to Vdd/2) Power = Low Power = High	0.5 x Vdd + 1.0 0.5 x Vdd + 1.0	– –	– –	V V	
V_{OLOWOB}	Low Output Voltage Swing (Load = 1K ohms to Vdd/2) Power = Low Power = High	– –	– –	0.5 x Vdd - 1.0 0.5 x Vdd - 1.0	V V	
I_{SOB}	Supply Current Including Bias Cell (No Load) Power = Low Power = High	– –	0.8 2.0	2.0 4.3	mA mA	
$PSRR_{OB}$	Supply Voltage Rejection Ratio	34	64	–	dB	(0.5 x Vdd - 1.0) ≤ V_{OUT} ≤ (0.5 x Vdd + 0.9).

3.3.6 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 $\leq$ T$_A$ $\leq$ 85°C, or 3.0V to 3.6V and -40°C $\leq$ T$_A$ $\leq$ 85°C, respectively. Typical parameters apply to 5V and 3.3V at 25°C and are for design guidance only.

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

Table 3-11. 5V DC Analog Reference Specifications

Symbol	Description	Min	Typ	Max	Units
BG	Bandgap Voltage Reference	1.28	1.30	1.32	V
−	AGND = Vdd/2[a]	Vdd/2 - 0.04	Vdd/2 - 0.01	Vdd/2 + 0.007	V
−	AGND = 2 x BandGap[a]	2 x BG - 0.048	2 x BG - 0.030	2 x BG + 0.024	V
−	AGND = P2[4] (P2[4] = Vdd/2)[a]	P2[4] - 0.011	P2[4]	P2[4] + 0.011	V
−	AGND = BandGap[a]	BG - 0.009	BG + 0.008	BG + 0.016	V
−	AGND = 1.6 x BandGap[a]	1.6 x BG - 0.022	1.6 x BG - 0.010	1.6 x BG + 0.018	V
−	AGND Block to Block Variation (AGND = Vdd/2)[a]	-0.034	0.000	0.034	V
–	RefHi = Vdd/2 + BandGap	Vdd/2 + BG - 0.10	Vdd/2 + BG	Vdd/2 + BG + 0.10	V
–	RefHi = 3 x BandGap	3 x BG - 0.06	3 x BG	3 x BG + 0.06	V
–	RefHi = 2 x BandGap + P2[6] (P2[6] = 1.3V)	2 x BG + P2[6] - 0.113	2 x BG + P2[6] - 0.018	2 x BG + P2[6] + 0.077	V
–	RefHi = P2[4] + BandGap (P2[4] = Vdd/2)	P2[4] + BG - 0.130	P2[4] + BG - 0.016	P2[4] + BG + 0.098	V
–	RefHi = P2[4] + P2[6] (P2[4] = Vdd/2, P2[6] = 1.3V)	P2[4] + P2[6] - 0.133	P2[4] + P2[6] - 0.016	P2[4] + P2[6]+ 0.100	V
–	RefHi = 3.2 x BandGap	3.2 x BG - 0.112	3.2 x BG	3.2 x BG + 0.076	V
–	RefLo = Vdd/2 – BandGap	Vdd/2 - BG - 0.04	Vdd/2 - BG + 0.024	Vdd/2 - BG + 0.04	V
–	RefLo = BandGap	BG - 0.06	BG	BG + 0.06	V
–	RefLo = 2 x BandGap - P2[6] (P2[6] = 1.3V)	2 x BG - P2[6] - 0.084	2 x BG - P2[6] + 0.025	2 x BG - P2[6] + 0.134	V
–	RefLo = P2[4] – BandGap (P2[4] = Vdd/2)	P2[4] - BG - 0.056	P2[4] - BG + 0.026	P2[4] - BG + 0.107	V
–	RefLo = P2[4]-P2[6] (P2[4] = Vdd/2, P2[6] = 1.3V)	P2[4] - P2[6] - 0.057	P2[4] - P2[6] + 0.026	P2[4] - P2[6] + 0.110	V

a. AGND tolerance includes the offsets of the local buffer in the PSoC block. Bandgap voltage is 1.3V ± 0.02V.

Table 3-12. 3.3V DC Analog Reference Specifications

Symbol	Description	Min	Typ	Max	Units
BG	Bandgap Voltage Reference	1.28	1.30	1.32	V
−	AGND = Vdd/2[a]	Vdd/2 - 0.03	Vdd/2 - 0.01	Vdd/2 + 0.005	V
−	AGND = 2 x BandGap[a]	Not Allowed			
–	AGND = P2[4] (P2[4] = Vdd/2)	P2[4] - 0.008	P2[4] + 0.001	P2[4] + 0.009	V
−	AGND = BandGap[a]	BG - 0.009	BG + 0.005	BG + 0.015	V
−	AGND = 1.6 x BandGap[a]	1.6 x BG - 0.027	1.6 x BG - 0.010	1.6 x BG + 0.018	V
−	AGND Column to Column Variation (AGND = Vdd/2)[a]	-0.034	0.000	0.034	V
–	RefHi = Vdd/2 + BandGap	Not Allowed			
–	RefHi = 3 x BandGap	Not Allowed			
–	RefHi = 2 x BandGap + P2[6] (P2[6] = 0.5V)	Not Allowed			
–	RefHi = P2[4] + BandGap (P2[4] = Vdd/2)	Not Allowed			
–	RefHi = P2[4] + P2[6] (P2[4] = Vdd/2, P2[6] = 0.5V)	P2[4] + P2[6] - 0.075	P2[4] + P2[6] - 0.009	P2[4] + P2[6] + 0.057	V
–	RefHi = 3.2 x BandGap	Not Allowed			
–	RefLo = Vdd/2 - BandGap	Not Allowed			
–	RefLo = BandGap	Not Allowed			
–	RefLo = 2 x BandGap - P2[6] (P2[6] = 0.5V)	Not Allowed			
–	RefLo = P2[4] – BandGap (P2[4] = Vdd/2)	Not Allowed			
–	RefLo = P2[4]-P2[6] (P2[4] = Vdd/2, P2[6] = 0.5V)	P2[4] - P2[6] - 0.048	P2[4]- P2[6] + 0.022	P2[4] - P2[6] + 0.092	V

a. AGND tolerance includes the offsets of the local buffer in the PSoC block. Bandgap voltage is 1.3V ± 0.02V.

3.3.7   DC Analog PSoC Block 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 ≤ 85°C, or 3.0V to 3.6V and -40°C ≤ T_A ≤ 85°C, respectively. Typical parameters apply to 5V and 3.3V at 25°C and are for design guidance only.

Table 3-13. DC Analog PSoC Block Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
R_{CT}	Resistor Unit Value (Continuous Time)	–	12.2	–	kΩ	
C_{SC}	Capacitor Unit Value (Switched Capacitor)	–	80	–	fF	

3.3.8   DC POR and LVD 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 ≤ 85°C, or 3.0V to 3.6V and -40°C ≤ T_A ≤ 85°C, respectively. Typical parameters apply to 5V or 3.3V at 25°C and are for design guidance only.

Note The bits PORLEV and VM in the table below refer to bits in the VLT_CR register. See the *PSoC Mixed-Signal Array Technical Reference Manual* for more information on the VLT_CR register.

Table 3-14. DC POR and LVD Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
V_{PPOR0R} V_{PPOR1R} V_{PPOR2R}	Vdd Value for PPOR Trip (positive ramp) PORLEV[1:0] = 00b PORLEV[1:0] = 01b PORLEV[1:0] = 10b	–	2.91 4.39 4.55	–	V V V	
V_{PPOR0} V_{PPOR1} V_{PPOR2}	Vdd Value for PPOR Trip (negative ramp) PORLEV[1:0] = 00b PORLEV[1:0] = 01b PORLEV[1:0] = 10b	–	2.82 4.39 4.55	–	V V V	
V_{PH0} V_{PH1} V_{PH2}	PPOR Hysteresis PORLEV[1:0] = 00b PORLEV[1:0] = 01b PORLEV[1:0] = 10b	– – –	92 0 0	– – –	mV mV mV	
V_{LVD0} V_{LVD1} V_{LVD2} V_{LVD3} V_{LVD4} V_{LVD5} V_{LVD6} V_{LVD7}	Vdd Value for LVD Trip VM[2:0] = 000b VM[2:0] = 001b VM[2:0] = 010b VM[2:0] = 011b VM[2:0] = 100b VM[2:0] = 101b VM[2:0] = 110b VM[2:0] = 111b	2.86 2.96 3.07 3.92 4.39 4.55 4.63 4.72	2.92 3.02 3.13 4.00 4.48 4.64 4.73 4.81	2.98[a] 3.08 3.20 4.08 4.57 4.74[b] 4.82 4.91	V V V V V V V V	

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

3.4 AC Electrical Characteristics

3.4.1 AC 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 ≤ 85°C, or 3.0V to 3.6V and -40°C ≤ T_A ≤ 85°C, respectively. Typical parameters apply to 5V and 3.3V at 25°C and are for design guidance only.

Table 3-16. AC Chip-Level Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
$F_{IMO245V}$	Internal Main Oscillator Frequency for 24 MHz (5V)	23.04	24	24.96[a,b]	MHz	Trimmed for 5V operation using factory trim values.
$F_{IMO243V}$	Internal Main Oscillator Frequency for 24 MHz (3.3V)	22.08	24	25.92[a,c]	MHz	Trimmed for 3.3V operation using factory trim values.
F_{IMOUSB}	Internal Main Oscillator Frequency with USB Frequency locking enabled and USB traffic present.	23.94	24	24.06[b]	MHz	-10°C ≤ T_A ≤ 85°C
F_{CPU1}	CPU Frequency (5V Nominal)	0.93	24	24.96[a,b]	MHz	
F_{CPU2}	CPU Frequency (3.3V Nominal)	0.93	12	12.96[b,c]	MHz	
F_{BLK5}	Digital PSoC Block Frequency (5V Nominal)	0	48	49.92[a,b,d]	MHz	Refer to the AC Digital Block Specifications.
F_{BLK3}	Digital PSoC Block Frequency (3.3V Nominal)	0	24	25.92[b,d]	MHz	
F_{32K1}	Internal Low Speed Oscillator Frequency	15	32	64	kHz	
Jitter32k	32 kHz Period Jitter	–	100		ns	
Step24M	24 MHz Trim Step Size	–	50	–	kHz	
Fout48M	48 MHz Output Frequency	46.08	48.0	49.92[a,c]	MHz	Trimmed. Utilizing factory trim values.
Jitter24M1	24 MHz Period Jitter (IMO) Peak-to-Peak	–	300		ps	
F_{MAX}	Maximum frequency of signal on row input or row output.	–	–	12.96	MHz	
T_{RAMP}	Supply Ramp Time	0	–	–	µs	

a. 4.75V < Vdd < 5.25V.

b. Accuracy derived from Internal Main Oscillator with appropriate trim for Vdd range.

c. 3.0V < Vdd < 3.6V. See Application Note AN2012 "Adjusting PSoC Microcontroller Trims for Dual Voltage-Range Operation" for information on trimming for operation at 3.3V.

d. See the individual user module data sheets for information on maximum frequencies for user modules.

Figure 3-2. 24 MHz Period Jitter (IMO) Timing Diagram

3.4.2 AC General Purpose IO Specifications

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

Table 3-17. AC GPIO Specifications

| Symbol	Description	Min	Typ	Max	Units	Notes
F_{GPIO}	GPIO Operating Frequency	0	–	12	MHz	Normal Strong Mode
TRiseF	Rise Time, Normal Strong Mode, Cload = 50 pF	3	–	18	ns	Vdd = 4.5 to 5.25V, 10% - 90%
TFallF	Fall Time, Normal Strong Mode, Cload = 50 pF	2	–	18	ns	Vdd = 4.5 to 5.25V, 10% - 90%
TRiseS	Rise Time, Slow Strong Mode, Cload = 50 pF	10	27	–	ns	Vdd = 3 to 5.25V, 10% - 90%
TFallS	Fall Time, Slow Strong Mode, Cload = 50 pF	10	22	–	ns	Vdd = 3 to 5.25V, 10% - 90%
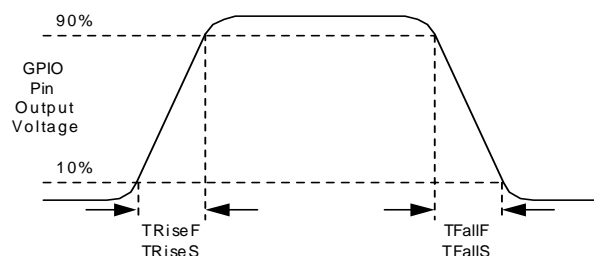
Figure 3-3. GPIO Timing Diagram

3.4.3 AC Full-Speed USB Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -10°C $\leq T_A \leq$ 85°C, or 3.0V to 3.6V and -10°C $\leq T_A \leq$ 85°C, respectively. Typical parameters apply to 5V and 3.3V at 25°C and are for design guidance only.

Table 3-18. AC Full-Speed (12 Mbps) USB Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
T_{RFS}	Transition Rise Time	4	–	20	ns	For 50 pF load.
T_{FSS}	Transition Fall Time	4	–	20	ns	For 50 pF load.
T_{RFMFS}	Rise/Fall Time Matching: (T_R/T_F)	90	–	111	%	For 50 pF load.
$T_{DRATEFS}$	Full-Speed Data Rate	12 - 0.25%	12	12 + 0.25%	Mbps	

3.4.4   AC 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 ≤ 85°C, or 3.0V to 3.6V and -40°C ≤ T_A ≤ 85°C, respectively. Typical parameters apply to 5V and 3.3V at 25°C and are for design guidance only.

Settling times, slew rates, and gain bandwidth are based on the Analog Continuous Time PSoC block.

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

Table 3-19. 5V AC Operational Amplifier Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
T_{ROA}	Rising Settling Time from 80% of ΔV to 0.1% of ΔV (10 pF load, Unity Gain)					
	Power = Low, Opamp Bias = Low	–	–	3.9	µs	
	Power = Medium, Opamp Bias = High	–	–	0.72	µs	
	Power = High, Opamp Bias = High	–	–	0.62	µs	
T_{SOA}	Falling Settling Time from 20% of ΔV to 0.1% of ΔV (10 pF load, Unity Gain)					
	Power = Low, Opamp Bias = Low	–	–	5.9	µs	
	Power = Medium, Opamp Bias = High	–	–	0.92	µs	
	Power = High, Opamp Bias = High	–	–	0.72	µs	
SR_{ROA}	Rising Slew Rate (20% to 80%)(10 pF load, Unity Gain)					
	Power = Low, Opamp Bias = Low	0.15	–	–	V/µs	
	Power = Medium, Opamp Bias = High	1.7	–	–	V/µs	
	Power = High, Opamp Bias = High	6.5	–	–	V/µs	
SR_{FOA}	Falling Slew Rate (20% to 80%)(10 pF load, Unity Gain)					
	Power = Low, Opamp Bias = Low	0.01	–	–	V/µs	
	Power = Medium, Opamp Bias = High	0.5	–	–	V/µs	
	Power = High, Opamp Bias = High	4.0	–	–	V/µs	
BW_{OA}	Gain Bandwidth Product					
	Power = Low, Opamp Bias = Low	0.75	–	–	MHz	
	Power = Medium, Opamp Bias = High	3.1	–	–	MHz	
	Power = High, Opamp Bias = High	5.4	–	–	MHz	
E_{NOA}	Noise at 1 kHz (Power = Medium, Opamp Bias = High)	–	100	–	nV/rt-Hz	

Table 3-20. 3.3V AC Operational Amplifier Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
T_{ROA}	Rising Settling Time from 80% of ΔV to 0.1% of ΔV (10 pF load, Unity Gain)					
	Power = Low, Opamp Bias = Low	–	–	3.92	µs	
	Power = Medium, Opamp Bias = High	–	–	0.72	µs	
T_{SOA}	Falling Settling Time from 20% of ΔV to 0.1% of ΔV (10 pF load, Unity Gain)					
	Power = Low, Opamp Bias = Low	–	–	5.41	µs	
	Power = Medium, Opamp Bias = High	–	–	0.72	µs	
SR_{ROA}	Rising Slew Rate (20% to 80%)(10 pF load, Unity Gain)					
	Power = Low, Opamp Bias = Low	0.31	–	–	V/µs	
	Power = Medium, Opamp Bias = High	2.7	–	–	V/µs	
SR_{FOA}	Falling Slew Rate (20% to 80%)(10 pF load, Unity Gain)					
	Power = Low, Opamp Bias = Low	0.24	–	–	V/µs	
	Power = Medium, Opamp Bias = High	1.8	–	–	V/µs	
BW_{OA}	Gain Bandwidth Product					
	Power = Low, Opamp Bias = Low	0.67	–	–	MHz	
	Power = Medium, Opamp Bias = High	2.8	–	–	MHz	
E_{NOA}	Noise at 1 kHz (Power = Medium, Opamp Bias = High)	–	100	–	nV/rt-Hz	

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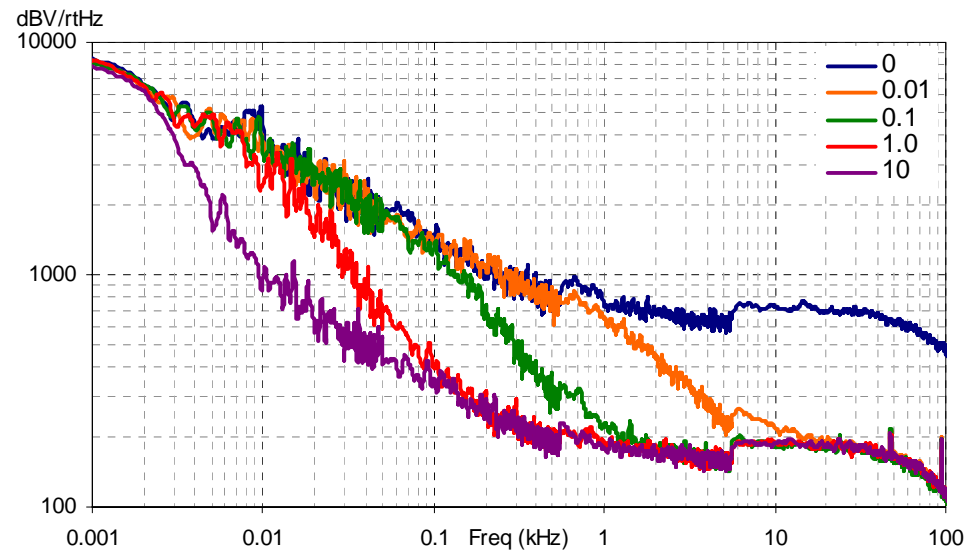

Figure 3-4. Typical AGND Noise with P2[4] Bypass

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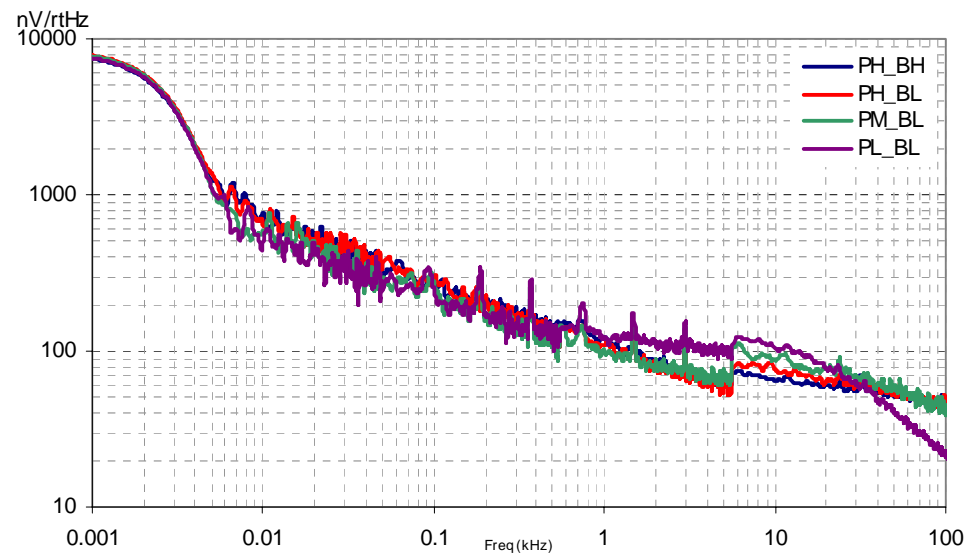

Figure 3-5. Typical Opamp Noise

3.4.5   AC Digital Block 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$_A$ ≤ 85°C, or 3.0V to 3.6V and -40°C ≤ T$_A$ ≤ 85°C, respectively. Typical parameters apply to 5V and 3.3V at 25°C and are for design guidance only.

Table 3-21. AC Digital Block Specifications

Function	Description	Min	Typ	Max	Units	Notes
Timer	Capture Pulse Width	50[a]	–	–	ns	
	Maximum Frequency, No Capture	–	–	49.92	MHz	4.75V < Vdd < 5.25V.
	Maximum Frequency, With Capture	–	–	25.92	MHz	
Counter	Enable Pulse Width	50[a]	–	–	ns	
	Maximum Frequency, No Enable Input	–	–	49.92	MHz	4.75V < Vdd < 5.25V.
	Maximum Frequency, Enable Input	–	–	25.92	MHz	
Dead Band	Kill Pulse Width:					
	Asynchronous Restart Mode	20	–	–	ns	
	Synchronous Restart Mode	50[a]	–	–	ns	
	Disable Mode	50[a]	–	–	ns	
	Maximum Frequency	–	–	49.92	MHz	4.75V < Vdd < 5.25V.
CRCPRS (PRS Mode)	Maximum Input Clock Frequency	–	–	49.92	MHz	4.75V < Vdd < 5.25V.
CRCPRS (CRC Mode)	Maximum Input Clock Frequency	–	–	24.6	MHz	
SPIM	Maximum Input Clock Frequency	–	–	8.2	MHz	Maximum data rate at 4.1 MHz due to 2 x over clocking.
SPIS	Maximum Input Clock Frequency	–	–	4.1	MHz	
	Width of SS_ Negated Between Transmissions	50[a]	–	–	ns	
Transmitter	Maximum Input Clock Frequency	–	–	24.6	MHz	Maximum data rate at 3.08 MHz due to 8 x over clocking.
Receiver	Maximum Input Clock Frequency	–	–	24.6	MHz	Maximum data rate at 3.08 MHz due to 8 x over clocking.

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

3.4.6   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$_A$ ≤ 85°C, or 3.0V to 3.6V and -40°C ≤ T$_A$ ≤ 85°C, respectively. Typical parameters apply to 5V and 3.3V at 25°C and are for design guidance only.

Table 3-22. AC External Clock Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
F$_{OSCEXT}$	Frequency for USB Applications	23.94	24	24.06	MHz	
–	Duty Cycle	47	50	53	%	
–	Power up to IMO Switch	150	–	–	μs	

3.4.7   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 $\leq$ T$_A$ $\leq$ 85°C, or 3.0V to 3.6V and -40°C $\leq$ T$_A$ $\leq$ 85°C, respectively. Typical parameters apply to 5V and 3.3V at 25°C and are for design guidance only.

Table 3-23. 5V AC Analog Output Buffer Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
T$_{ROB}$	Rising Settling Time to 0.1%, 1V Step, 100pF Load					
	Power = Low	–	–	2.5	µs	
	Power = High	–	–	2.5	µs	
T$_{SOB}$	Falling Settling Time to 0.1%, 1V Step, 100pF Load					
	Power = Low	–	–	2.2	µs	
	Power = High	–	–	2.2	µs	
SR$_{ROB}$	Rising Slew Rate (20% to 80%), 1V Step, 100pF Load					
	Power = Low	0.65	–	–	V/µs	
	Power = High	0.65	–	–	V/µs	
SR$_{FOB}$	Falling Slew Rate (80% to 20%), 1V Step, 100pF Load					
	Power = Low	0.65	–	–	V/µs	
	Power = High	0.65	–	–	V/µs	
BW$_{OBSS}$	Small Signal Bandwidth, 20mV$_{pp}$, 3dB BW, 100pF Load					
	Power = Low	0.8	–	–	MHz	
	Power = High	0.8	–	–	MHz	
BW$_{OBLS}$	Large Signal Bandwidth, 1V$_{pp}$, 3dB BW, 100pF Load					
	Power = Low	300	–	–	kHz	
	Power = High	300	–	–	kHz	

Table 3-24. 3.3V AC Analog Output Buffer Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
T$_{ROB}$	Rising Settling Time to 0.1%, 1V Step, 100pF Load					
	Power = Low	–	–	3.8	µs	
	Power = High	–	–	3.8	µs	
T$_{SOB}$	Falling Settling Time to 0.1%, 1V Step, 100pF Load					
	Power = Low	–	–	2.6	µs	
	Power = High	–	–	2.6	µs	
SR$_{ROB}$	Rising Slew Rate (20% to 80%), 1V Step, 100pF Load					
	Power = Low	0.5	–	–	V/µs	
	Power = High	0.5	–	–	V/µs	
SR$_{FOB}$	Falling Slew Rate (80% to 20%), 1V Step, 100pF Load					
	Power = Low	0.5	–	–	V/µs	
	Power = High	0.5	–	–	V/µs	
BW$_{OBSS}$	Small Signal Bandwidth, 20mV$_{pp}$, 3dB BW, 100pF Load					
	Power = Low	0.7	–	–	MHz	
	Power = High	0.7	–	–	MHz	
BW$_{OBLS}$	Large Signal Bandwidth, 1V$_{pp}$, 3dB BW, 100pF Load					
	Power = Low	200	–	–	kHz	
	Power = High	200	–	–	kHz	

3.4.9   AC I^{2}C 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$_A$ ≤ 85°C, or 3.0V to 3.6V and -40°C ≤ T$_A$ ≤ 85°C, respectively. Typical parameters apply to 5V and 3.3V at 25°C and are for design guidance only.

Table 3-26. AC Characteristics of the I^{2}C SDA and SCL Pins for Vdd

Symbol	Description	Standard Mode		Fast Mode		Units	Notes
		Min	Max	Min	Max		
F$_{SCLI2C}$	SCL Clock Frequency	0	100	0	400	kHz	
T$_{HDSTAI2C}$	Hold Time (repeated) START Condition. After this period, the first clock pulse is generated.	4.0	–	0.6	–	µs	
T$_{LOWI2C}$	LOW Period of the SCL Clock	4.7	–	1.3	–	µs	
T$_{HIGHI2C}$	HIGH Period of the SCL Clock	4.0	–	0.6	–	µs	
T$_{SUSTAI2C}$	Set-up Time for a Repeated START Condition	4.7	–	0.6	–	µs	
T$_{HDDATI2C}$	Data Hold Time	0	–	0	–	µs	
T$_{SUDATI2C}$	Data Set-up Time	250	–	100[a]	–	ns	
T$_{SUSTOI2C}$	Set-up 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	

a. A Fast-Mode I2C-bus device can be used in a Standard-Mode I2C-bus system, but the requirement t$_{SU;DAT}$ ≥ 250 ns must then be met. This will 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 I2C-bus specification) before the SCL line is released.
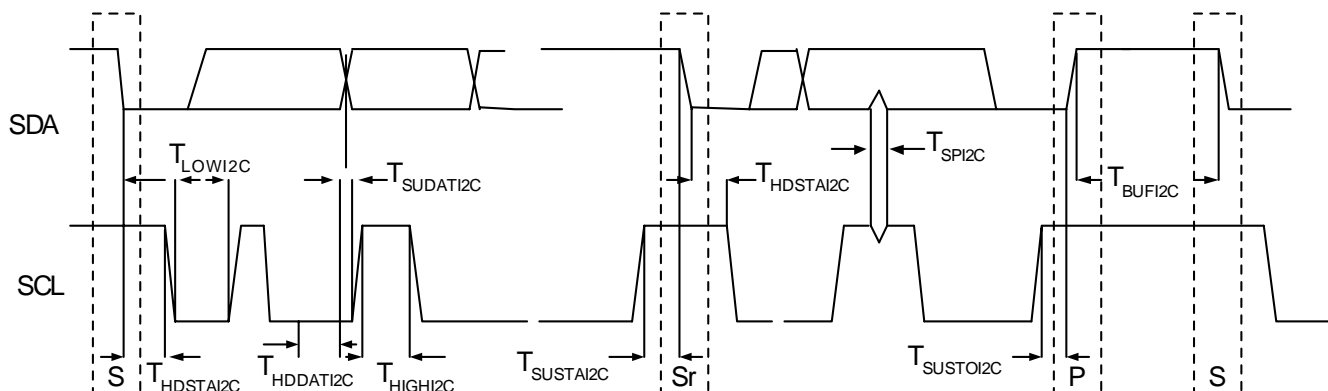

Figure 3-6. Definition for Timing for Fast/Standard Mode on the I^{2}C Bus

4. Packaging Information

This chapter illustrates the package specification for the CY8C24794 PSoC device, along with the thermal impedance for the 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/support/link.cfm?mr=poddim.

4.1   Packaging Dimensions

Figure 4-1. 56-Lead (8x8 mm) MLF

Important Note For information on the preferred dimensions for mounting MLF packages, see the following Application Note at http://www.amkor.com/products/notes_papers/MLFAppNote.pdf.

4.2   Thermal Impedance

Table 4-1. Thermal Impedance for the Package

Package	Typical θ_{JA} *
56 MLF	20 $^oC/W$

* $T_J = T_A + POWER \times \theta_{JA}$

4.3   Solder Reflow Peak Temperature

Following is the minimum solder reflow peak temperature to achieve good solderability.

Table 4-2. Solder Reflow Peak Temperature

Package	Minimum Peak Temperature*	Maximum Peak Temperature
56 MLF	240^oC	260^oC

*Higher temperatures may be required based on the solder melting point. Typical temperatures for solder are 220+/-5^oC with Sn-Pb or 245+/-5^oC with Sn-Ag-Cu paste. Refer to the solder manufacturer specifications.

6. Sales and Company Information

To obtain information about Cypress Semiconductor or PSoC sales and technical support, reference the following information.

Cypress Semiconductor
2700 162nd Street SW, Building D
Lynnwood, WA 98037
Phone: 800.669.0557   Facsimile: 425.787.4641

Web Sites: Company Information – http://www.cypress.com
                                         Sales – http://www.cypress.com/aboutus/sales_locations.cfm
                       Technical Support – http://www.cypress.com/support/login.cfm

6.1   Revision History

Table 6-1. CY8C24794 Data Sheet Revision History

Document Title: CY8C24794 PSoC Mixed-Signal Array Final Data Sheet				
Document Number: 38-12018				
Revision	**ECN #**	**Issue Date**	**Origin of Change**	**Description of Change**
**	133189	01.27.2004	NWJ	New silicon and new document – Advance Data Sheet.
*A	251672	See ECN	SFV	First Preliminary Data Sheet. Changed title to encompass only the CY8C24794 because the CY8C24494 and CY8C24694 are not being offered by Cypress MicroSystems.
*B	289742	See ECN	HMT	Add standard DS items from SFV memo. Add Analog Input Mux on pinouts. 2 MACs. Change 512 bytes of SRAM to 1K. Add dimension key to package. Remove HAPI. Update diagrams, registers and specs.
*C	335236	See ECN	HMT	Add CY logo. Update CY copyright. Update new CY.com URLs. Re-add ISSP programming pinout notation. Add Reflow Temp. table. Update features (MAC, Oscillator, and voltage range), registers (INT_CLR2/MSK2, second MAC), and specs. (Rext, IMO, analog output buffer...).
*D	344318	See ECN	HMT	Add new color and logo. Expand analog arch. diagram. Fix IO #. Update Electrical Specifications.
*E	346774	See ECN	HMT	Add USB temperature specifications. Make data sheet Final.
*F	349566	See ECN	HMT	Remove USB logo. Add URL to preferred dimensions for mounting MLF packages.
Distribution: External/Public		**Posting**: None		

6.2   Copyrights and Code Protection