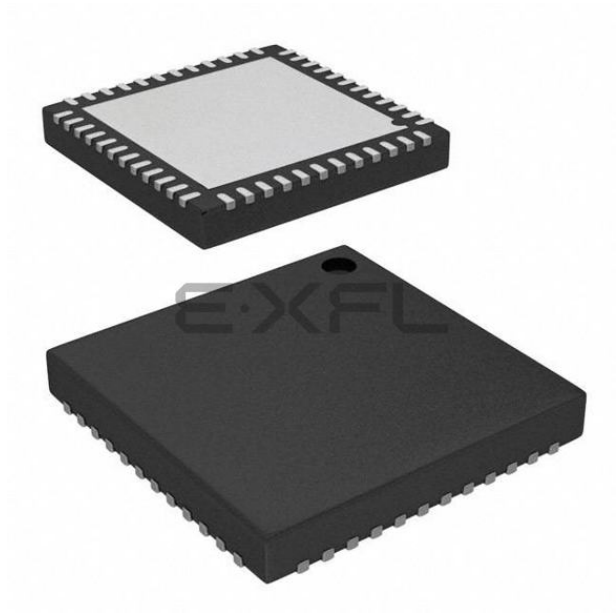


Welcome to E-XFL.COM

Embedded - Microcontrollers - Application Specific: Tailored Solutions for Precision and Performance

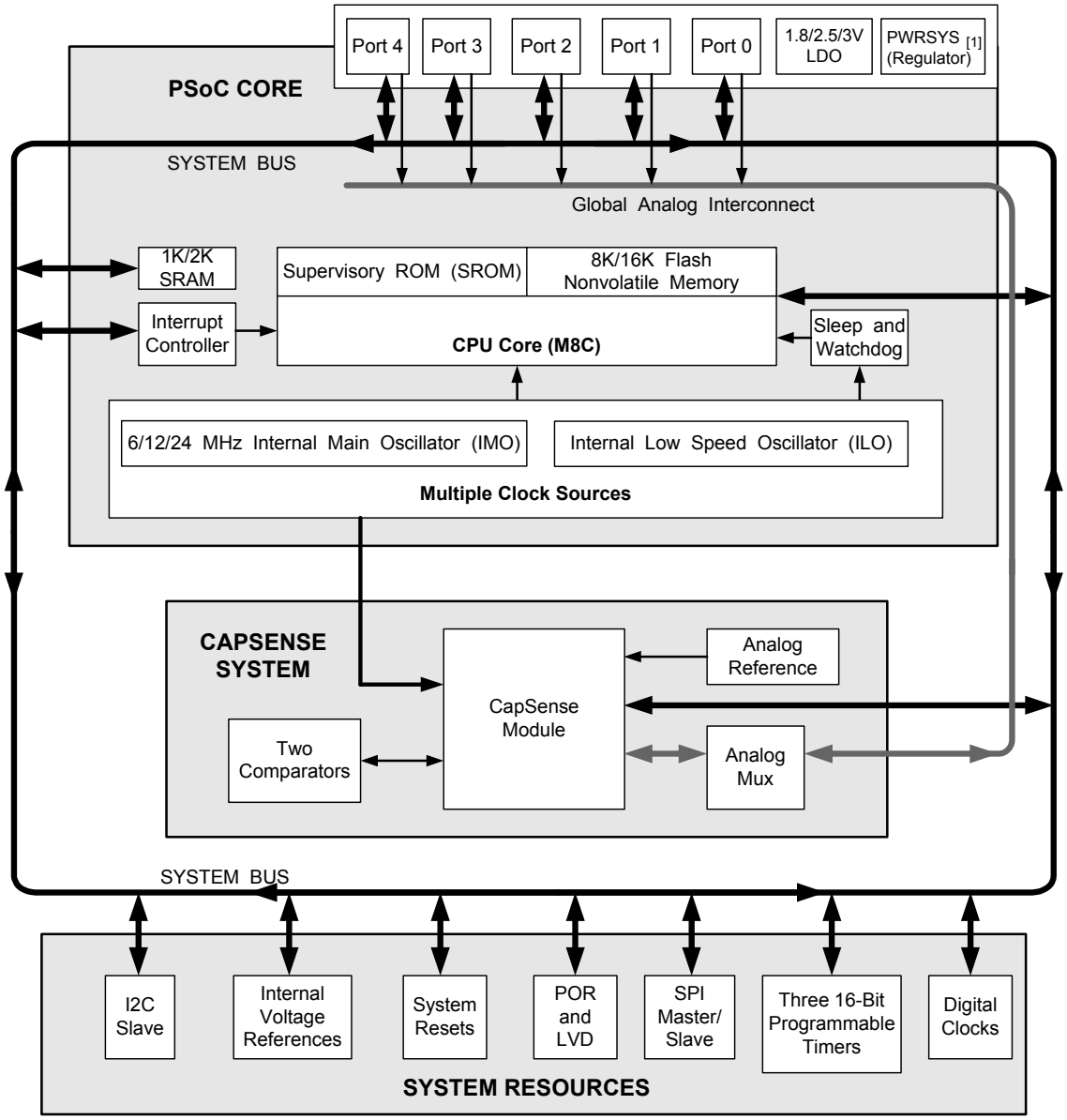
Embedded - Microcontrollers - Application Specific represents a category of microcontrollers designed with unique features and capabilities tailored to specific application needs. Unlike general-purpose microcontrollers, application-specific microcontrollers are optimized for particular tasks, offering enhanced performance, efficiency, and functionality to meet the demands of specialized applications.

What Are Embedded - Microcontrollers - Application Specific?

Application-specific microcontrollers are engineered to

Details	
Product Status	Obsolete
Applications	Capacitive Sensing
Core Processor	M8C
Program Memory Type	FLASH (32kB)
Controller Series	CY8C20xx6A
RAM Size	2K x 8
Interface	I²C, SPI, USB
Number of I/O	36
Voltage - Supply	1.71V ~ 5.5V
Operating Temperature	-40°C ~ 85°C
Mounting Type	Surface Mount
Package / Case	48-VFQFN Exposed Pad
Supplier Device Package	48-QFN (7x7)
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/cy8c20066a-24ltxi

Logic Block Diagram



Note
1. Internal voltage regulator for internal circuitry

Contents

PSoC® Functional Overview 4
PSoC Core 4
CapSense System 4
Haptics TS2000 Controller 4
Additional System Resources 5
Getting Started 5
Application Notes 5
Development Kits 5
Training 5
CYPros Consultants 5
Solutions Library 5
Technical Support 5
Development Tools 6
PSoC Designer Software Subsystems 6
Designing with PSoC Designer 7
Select User Modules 7
Configure User Modules 7
Organize and Connect 7
Generate, Verify, and Debug 7
Pinouts 8
24-Pin QFN 8
32-Pin QFN 9
48-Pin QFN OCD 10
Electrical Specifications 11
Absolute Maximum Ratings 11
Operating Temperature 11
DC Chip-Level Specifications 12
DC General Purpose I/O Specifications 13
DC Analog Mux Bus Specifications 15
DC Low Power Comparator Specifications 15
Comparator User Module Electrical Specifications 16
ADC Electrical Specifications 16
DC POR and LVD Specifications 17
DC Programming Specifications 17
AC Chip-Level Specifications 18
AC General Purpose I/O Specifications 19
AC Comparator Specifications 20
AC External Clock Specifications 20
AC Programming Specifications 21
AC I2C Specifications 22
Packaging Information 26
Thermal Impedances 28
Capacitance on Crystal Pins 28
Solder Reflow Peak Temperature 28
Development Tool Selection 29
Software 29
Development Kits 29
Evaluation Tools 29
Device Programmers 30
Accessories (Emulation and Programming) 30
Third Party Tools 30
Build a PSoC Emulator into Your Board 30
Ordering Information 31
Ordering Code Definitions 31
Document Conventions 32
Acronyms Used 32
Units of Measure 32
Numeric Naming 32
Glossary 33
Reference Documents 33
Document History Page 34
Sales, Solutions, and Legal Information 35
Worldwide Sales and Design Support 35
Products 35
PSoC Solutions 35

Additional System Resources

System resources provide additional capability, such as configurable USB and I^2C slave, SPI master/slave communication interface, three 16-bit programmable timers, and various system resets supported by the M8C.

These system resources provide additional capability useful to complete systems. Additional resources include low voltage detection and power on reset. The merits of each system resource are listed here:

- The I^2C 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^2C 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^2C enhanced slave interface appears as a 32-byte RAM buffer to the external I^2C 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, refer to 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

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

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

Application Notes

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

Development Kits

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

Training

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

CYPros Consultants

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

Solutions Library

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

Technical Support

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

Pinouts

The CY8C20336H/CY8C20446H 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.

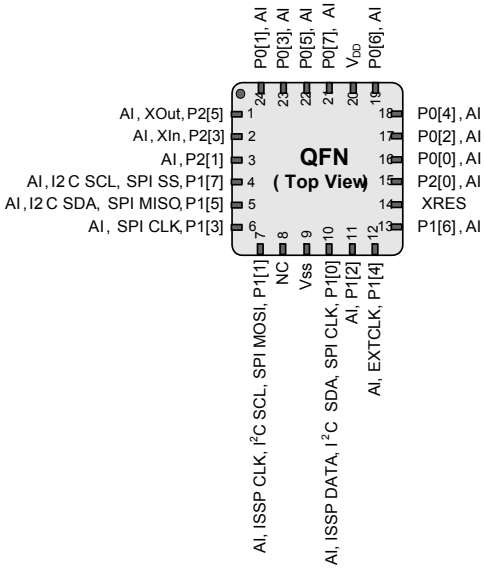
24-Pin QFN

Table 1. Pin Definitions - CY8C20336H [3, 4]

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^2C SCL, SPI SS
5	IOHR	I	P1[5]	I^2C SDA, SPI MISO
6	IOHR	I	P1[3]	SPI CLK
7	IOHR	I	P1[1]	ISSP CLK[5], I^2C SCL, SPI MOSI
8			NC	No connection
9	Power		Vss	Ground connection
10	IOHR	I	P1[0]	ISSP DATA[5], I^2C SDA, SPI CLK
11	IOHR	I	P1[2]	
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[0]	
16	IOH	I	P0[0]	
17	IOH	I	P0[2]	
18	IOH	I	P0[4]	
19	IOH	I	P0[6]	
20	Power		V_{DD}	Supply voltage
21	IOH	I	P0[7]	
22	IOH	I	P0[5]	
23	IOH	I	P0[3]	Integrating input
24	IOH	I	P0[1]	Integrating input
CP	Power		V_{SS}	Center pad must be connected to ground

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

Figure 2. CY8C20336H PSoC Device



Notes
3. During power-up or reset event, device P1[1] and P1[0] may disturb the I^2C bus. Use alternate pins if you encounter any issues.
4. The center pad (CP) on the QFN package must be connected to ground (Vss) for best mechanical, thermal, and electrical performance. If not connected to ground, it must be electrically floated and not connected to any other signal.
5. These are the ISSP pins, which are not High Z at POR (Power On Reset).

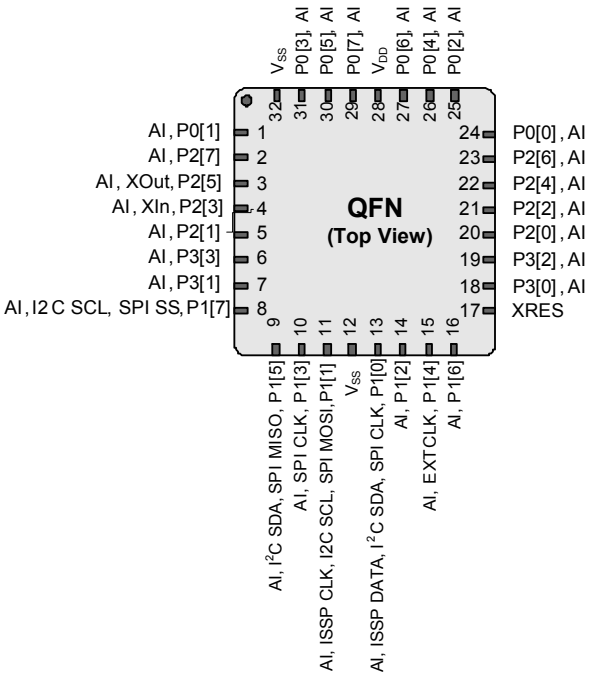
32-Pin QFN

Table 2. Pin Definitions - CY8C20446H PSoC Device [6, 7]

Pin No.	Type		Name	Description
	Digital	Analog		
1	IOH	I	P0[1]	Integrating input
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	P3[3]	
7	I/O	I	P3[1]	
8	IOHR	I	P1[7]	I^2C SCL, SPI SS
9	IOHR	I	P1[5]	I^2C SDA, SPI MISO
10	IOHR	I	P1[3]	SPI CLK.
11	IOHR	I	P1[1]	ISSP CLK[8], I^2C SCL, SPI MOSI.
12	Power		Vss	Ground connection.
13	IOHR	I	P1[0]	ISSP DATA[8], I^2C SDA., SPI CLK
14	IOHR	I	P1[2]	
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	P2[0]	
21	I/O	I	P2[2]	
22	I/O	I	P2[4]	
23	I/O	I	P2[6]	
24	IOH	I	P0[0]	
25	IOH	I	P0[2]	
26	IOH	I	P0[4]	
27	IOH	I	P0[6]	
28	Power		V_{DD}	Supply voltage
29	IOH	I	P0[7]	
30	IOH	I	P0[5]	
31	IOH	I	P0[3]	Integrating input
32	Power		V_{SS}	Ground connection
CP	Power		V_{SS}	Center pad must be connected to ground

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

Figure 3. CY8C20446H PSoC Device



Notes
6. During power-up or reset event, device P1[1] and P1[0] may disturb the I^2C bus. Use alternate pins if you encounter any issues.
7. The center pad (CP) on the QFN package must be connected to ground (Vss) for best mechanical, thermal, and electrical performance. If not connected to ground, it must be electrically floated and not connected to any other signal.
8. These are the ISSP pins, which are not High Z at POR (Power On Reset).

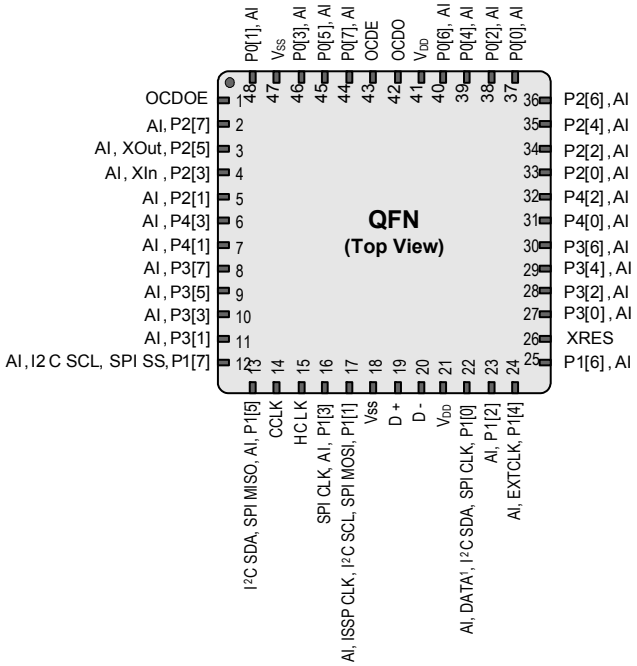
48-Pin QFN OCD

The 48-pin QFN part is for the CY8C20066A On-Chip Debug (OCD) PSoC device. Note that this part is only used for in-circuit debugging.[9]

Table 3. Pin Definitions - CY8C20066A PSoC Device [10, 11]

Pin No.	Digital	Analog	Name	Description
1			OCDOE	OCD mode direction pin
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^2C SCL, SPI SS
13	IOHR	I	P1[5]	I^2C SDA, SPI MISO
14			CCLK	OCD CPU clock output
15			HCLK	OCD high speed clock output
16	IOHR	I	P1[3]	SPI CLK.
17	IOHR	I	P1[1]	ISSP CLK[12], I^2C SCL, SPI MOSI
18	Power		Vss	Ground connection
19	I/O		D+	USB D+
20	I/O		D-	USB D-
21	Power		V_{DD}	Supply voltage
22	IOHR	I	P1[0]	ISSP DATA[12], I^2C SDA, SPI CLK
23	IOHR	I	P1[2]	
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]	
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]	
35	I/O	I	P2[4]	
36	I/O	I	P2[6]	
37	IOH	I	P0[0]	
38	IOH	I	P0[2]	
39	IOH	I	P0[4]	
40	IOH	I	P0[6]	
41	Power		V_{DD}	Supply voltage
42			OCDO	OCD even data I/O
43			OCDE	OCD odd data output
44	IOH	I	P0[7]	
45	IOH	I	P0[5]	
46	IOH	I	P0[3]	Integrating input
47	Power		V_{SS}	Ground connection
48	IOH	I	P0[1]	
CP	Power		V_{SS}	Center pad must be connected to ground

Figure 4. CY8C20066A PSoC Device



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

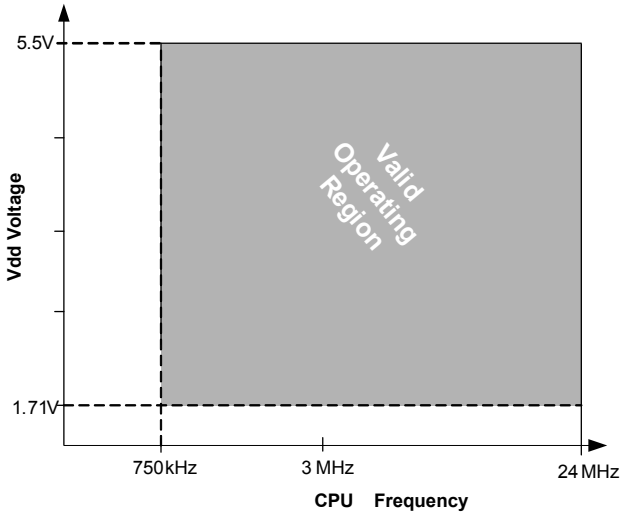
Notes

9. This part is available in limited quantities for In-Circuit Debugging during prototype development. It is not available in production volumes.
10. During power-up or reset event, device P1[1] and P1[0] may disturb the I^2C bus. Use alternate pins if you encounter any issues.
11. The center pad (CP) on the QFN package must be connected to ground (Vss) for best mechanical, thermal, and electrical performance. If not connected to ground, it must be electrically floated and not connected to any other signal.
12. These are the ISSP pins, which are not High Z at power on reset (POR).

Electrical Specifications

This section presents the DC and AC electrical specifications of the CY8C20x36H/46H PSoC devices. For the latest electrical specifications, confirm that you have the most recent data sheet by visiting the web at http://www.cypress.com/psoc.

Figure 5. Voltage versus CPU Frequency



Absolute Maximum Ratings

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

Table 4. Absolute Maximum Ratings

Symbol	Description	Conditions	Min	Typ	Max	Units
T_{STG}	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_{DD}	Supply voltage relative to V_{SS}		–0.5	–	+6.0	V
V_{IO}	DC input voltage		V_{SS} – 0.5	–	V_{DD} + 0.5	V
V_{IOZ}	DC voltage applied to tristate		V_{SS} –0.5	–	V_{DD} + 0.5	V
I_{MIO}	Maximum current into any port pin		–25	–	+50	mA
ESD	Electrostatic discharge voltage	Human body model ESD	2000	–	–	V
LU	Latch up current	In accordance with JESD78 standard	–	–	200	mA

Operating Temperature

Table 5. Operating Temperature

Symbol	Description	Conditions	Min	Typ	Max	Units
T_A	Ambient temperature		–40	–	+85	°C
T_C	Commercial temperature range		0	–	70	°C
T_J	Operational die temperature	The temperature rise from ambient to junction is package specific. Refer the table Thermal Impedances per Package on page 28. 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 6. DC Chip-Level Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
V_{DD}[13]	Supply voltage	Refer the table DC POR and LVD Specifications on page 17	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	–	3.32	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	–	1.86	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	–	1.13	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	0.50	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

Note

13. When V_{DD} remains in the range from 1.71 V to 1.9 V for more than 50 µsec, 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 usec to avoid triggering POR. The only other restriction on slew rates for any other voltage range or transition is the SR_{POWER_UP} parameter.

Table 8. 2.4 V to 3.0 V DC GPIO Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
R_{PU}	Pull-up resistor		4	5.60	8	kΩ
V_{OH1}	High output voltage port 2 or 3 pins	I_{OH} < 10 µA, maximum of 10 mA source current in all I/Os	V_{DD} – 0.20	–	–	V
V_{OH2}	High output voltage port 2 or 3 pins	I_{OH} = 0.2 mA, maximum of 10 mA source current in all I/Os	V_{DD} – 0.40	–	–	V
V_{OH3}	High output voltage port 0 or 1 pins with LDO regulator disabled for port 1	I_{OH} < 10 µA, maximum of 10 mA source current in all I/Os	V_{DD} – 0.20	–	–	V
V_{OH4}	High output voltage port 0 or 1 pins with LDO regulator disabled for port 1	I_{OH} = 2 mA, maximum of 10 mA source current in all I/Os	V_{DD} – 0.50	–	–	V
V_{OH5A}	High output voltage port 1 pins with LDO enabled for 1.8 V out	I_{OH} < 10 µA, V_{DD} > 2.4 V, maximum of 20 mA source current in all I/Os	1.50	1.80	2.10	V
V_{OH6A}	High output voltage port 1 pins with LDO enabled for 1.8 V out	I_{OH} = 1 mA, V_{DD} > 2.4 V, maximum of 20 mA source current in all I/Os	1.20	–	–	V
V_{OL}	Low output voltage	I_{OL} = 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_{IL}	Input low voltage		–	–	0.72	V
V_{IH}	Input high voltage		1.40	–	–	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 Temp = 25 °C	0.50	1.70	7	pF

Table 9. 1.71 V to 2.4 V DC GPIO Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
R_{PU}	Pull-up resistor		4	5.60	8	kΩ
V_{OH1}	High output voltage port 2 or 3 pins	I_{OH} = 10 µA, maximum of 10 mA source current in all I/Os	V_{DD} – 0.20	–	–	V
V_{OH2}	High output voltage port 2 or 3 pins	I_{OH} = 0.5 mA, maximum of 10 mA source current in all I/Os	V_{DD} – 0.50	–	–	V
V_{OH3}	High output voltage port 0 or 1 pins with LDO regulator disabled for port 1	I_{OH} = 100 µA, maximum of 10 mA source current in all I/Os	V_{DD} – 0.20	–	–	V
V_{OH4}	High output voltage port 0 or 1 pins with LDO regulator disabled for port 1	I_{OH} = 2 mA, maximum of 10 mA source current in all I/Os	V_{DD} – 0.50	–	–	V
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 × V_{DD}	V
V_{IH}	Input high voltage		0.65 × V_{DD}	–	–	V

Table 9. 1.71 V to 2.4 V DC GPIO Specifications *(continued)*

Symbol	Description	Conditions	Min	Typ	Max	Units
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 Temp = 25 °C	0.50	1.70	7	pF

Table 10.DC Characteristics – USB Interface

Symbol	Description	Conditions	Min	Typ	Max	Units
Rusbi	USB D+ pull-up resistance	With idle bus	900	–	1575	Ω
Rusba	USB D+ pull-up resistance	While receiving traffic	1425	–	3090	Ω
Vohusb	Static output high		2.8	–	3.6	V
Volusb	Static output low		–	–	0.3	V
Vdi	Differential input sensitivity		0.2	–	–	V
Vcm	Differential input common mode range		0.8	–	2.5	V
Vse	Single-ended receiver threshold		0.8	–	2.0	V
Cin	Transceiver capacitance		–	–	50	pF
Iio	High-Z state data line leakage	On D+ or D- line	–10	–	+10	µA
Rps2	PS/2 pull-up resistance		3000	5000	7000	Ω
Rext	External USB series resistor	In series with each USB pin	21.78	22.0	22.22	Ω

DC Analog Mux Bus Specifications

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

Table 11. DC Analog Mux Bus Specifications

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

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 12. DC Comparator Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
V_{LPC}	Low power comparator (LPC) common mode	Maximum voltage limited to V_{DD}	0.0	–	1.8	V
I_{LPC}	LPC supply current		–	10	40	µA
V_{OSLPC}	LPC voltage offset		–	2.5	30	mV

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 °C ≤ TA ≤ 85 °C, 1.71 V ≤ V_{DD} ≤ 5.5 V.

Table 13. Comparator User Module Electrical Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
T_{COMP}	Comparator response time	50-mV overdrive	–	70	100	ns
Offset		Valid from 0.2 V to V_{DD} – 0.2 V	–	2.5	30	mV
Current		Average DC current, 50 mV overdrive	–	20	80	µA
PSRR	Supply voltage > 2 V	Power supply rejection ratio	–	80	–	dB
	Supply voltage < 2 V	Power supply rejection ratio	–	40	–	dB
Input Range			0	–	1.5	V

ADC Electrical Specifications

Table 14.ADC User Module Electrical Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
Input						
V_{IN}	Input voltage range		0	–	VREFADC	V
C_{IIN}	Input capacitance		–	–	5	pF
R_{IN}	Input resistance	Equivalent switched cap input resistance for 8-, 9-, or 10-bit resolution	1/(500fF × data clock)	1/(400fF × data clock)	1/(300fF × data clock)	Ω
Reference						
V_{REFADC}	ADC reference voltage		1.14	–	1.26	V
Conversion Rate						
F_{CLK}	Data clock	Source is chip's internal main oscillator. See AC Chip-Level Specifications on page 18 for accuracy	2.25	–	6	MHz
S8	8-bit sample rate	Data clock set to 6 MHz. Sample Rate = 0.001/ (2^Resolution/Data clock)	–	23.43	–	ksps
S10	10-bit sample rate	Data clock set to 6 MHz. Sample Rate = 0.001/ (2^Resolution/Data clock)	–	5.85	–	ksps
DC Accuracy						
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_{OFFSET}	Offset error	8-bit resolution	0	3.20	19.20	LSB
		10-bit resolution	0	12.80	76.80	LSB
E_{GAIN}	Gain error	For any resolution	–5	–	+5	%FSR
Power						
I_{ADC}	Operating current		–	2.10	2.60	mA
PSRR	Power supply rejection ratio	PSRR (V_{DD} > 3.0 V)	–	24	–	dB
		PSRR (V_{DD} < 3.0 V)	–	30	–	dB

AC Chip-Level Specifications

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

Table 17. AC Chip-Level Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
F_{IMO24}	IMO frequency at 24-MHz setting		22.8	24	25.2	MHz
F_{IMO12}	IMO frequency at 12-MHz setting		11.4	12	12.6	MHz
F_{IMO6}	IMO frequency at 6-MHz setting		5.7	6.0	6.3	MHz
F_{CPU}	CPU frequency		0.75	–	25.20	MHz
F_{32K1}	ILO frequency		19	32	50	kHz
F_{32K_U}	ILO untrimmed frequency		13	32	82	kHz
DC_{IMO}	Duty cycle of IMO		40	50	60	%
DC_{ILO}	ILO duty cycle		40	50	60	%
SR_{POWER_UP}	Power supply slew rate	V_{DD} slew rate during power-up	–	–	250	V/ms
T_{XRST}	External reset pulse width at power-up	After supply voltage is valid	1	–	–	ms
T_{XRST2}	External reset pulse width after power-up[18]	Applies after part has booted	10	–	–	µs

Note
18. The minimum required XRES pulse length is longer when programming the device (see Table 23 on page 21).

Table 19.AC Characteristics – USB Data Timings

Symbol	Description	Conditions	Min	Typ	Max	Units
T_{DRATE}	Full-speed data rate	Average bit rate	12 – 0.25%	12	12 + 0.25%	MHz
T_{JR1}	Receiver jitter tolerance	To next transition	–18.5	–	18.5	ns
T_{JR2}	Receiver jitter tolerance	To pair transition	–9	–	9	ns
T_{DJ1}	FS driver jitter	To next transition	–3.5	–	3.5	ns
T_{DJ2}	FS driver jitter	To pair transition	–4.0	–	4.0	ns
T_{FDEOP}	Source jitter for differential transition	To SE0 transition	–2	–	5	ns
T_{FEOPT}	Source SE0 interval of EOP		160	–	175	ns
T_{FEOPR}	Receiver SE0 interval of EOP		82	–		ns
T_{FST}	Width of SE0 interval during differential transition		–	–	14	ns

Table 20. AC Characteristics – USB Driver

Symbol	Description	Conditions	Min	Typ	Max	Units
T_{FR}	Transition rise time	50 pF	4	–	20	ns
T_{FF}	Transition fall time	50 pF	4	–	20	ns
T_{FRFM}[19]	Rise/fall time matching		90	–	111	%
Vcrs	Output signal crossover voltage		1.30	–	2.00	V

AC Comparator Specifications

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

Table 21. AC Low Power Comparator Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
T_{LPC}	Comparator response time, 50 mV overdrive	50 mV overdrive does not include offset voltage.	–	–	100	ns

AC External Clock Specifications

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

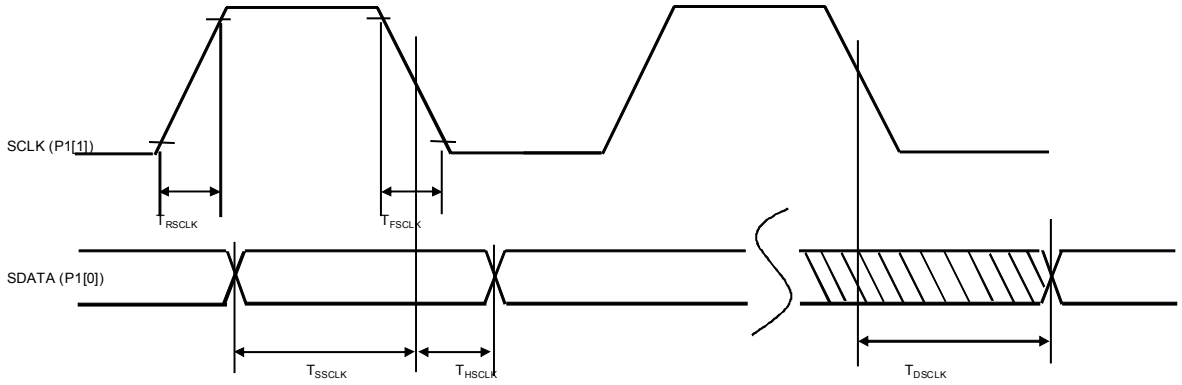
Table 22. AC External Clock Specifications

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

Note
19. T_{FRFM} is not met under all conditions. There is a corner case at lower supply voltages, such as those under 3.3 V. This condition does not affect USB communications. Signal integrity tests show an excellent eye diagram at 3.15 V.

AC Programming Specifications

Figure 7. AC Waveform



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

Table 23. 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	$3.0 \le V_{DD} \le 3.6$	–	–	85	ns
T_{DSCLK2}	Data out delay from falling edge of SCLK	$1.71 \le V_{DD} \le 3.0$	–	–	130	ns
T_{XRST3}	External reset pulse width after power-up	Required to enter programming mode when coming out of sleep	300	–	–	µs
T_{XRES}	XRES Pulse Length		300	–	–	µs
$T_{VDDWAIT}$	V_{DD} stable to wait-and-poll hold off		0.1	–	1	ms
$T_{VDDXRES}$	V_{DD} stable to XRES assertion delay		14.27	–	–	ms
T_{POLL}	SDATA high pulse time		0.01	–	200	ms
T_{ACQ}	“Key window” time after a V_{DD} ramp acquire event, based on 256 ILO clocks.		3.20	–	19.60	ms
$T_{XRESINI}$	“Key window” time after an XRES event, based on eight ILO clocks		98	–	615	µs

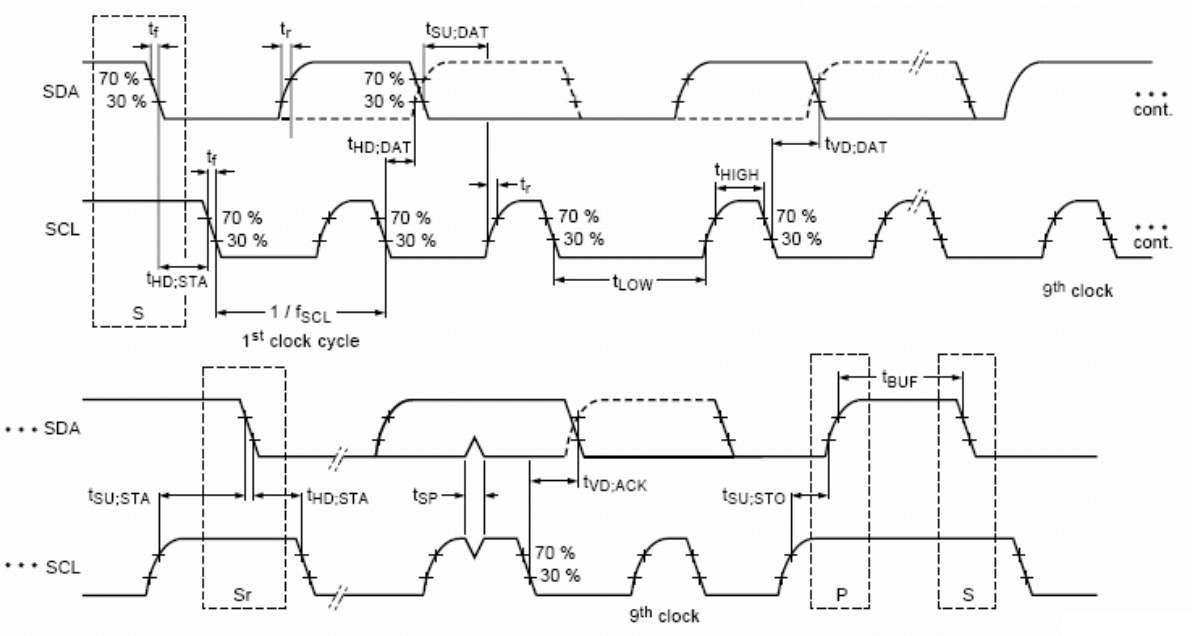
AC I²C Specifications

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

Table 24. AC Characteristics of the I²C 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	–	µs
t_{LOW}	LOW period of the SCL clock	4.7	–	1.3	–	µs
t_{HIGH}	HIGH period of the SCL clock	4.0	–	0.6	–	µs
$t_{SU;STA}$	Setup time for a repeated START condition	4.7	–	0.6	–	µs
$t_{HD;DAT}$	Data hold time	0	3.45	0	0.9	µs
$t_{SU;DAT}$	Data setup time	250	–	100[20]	–	ns
$t_{SU;STO}$	Setup time for STOP condition	4.0	–	0.6	–	µs
t_{BUF}	Bus-free time between a STOP and START condition	4.7	–	1.3	–	µs
t_{SP}	Pulse width of spikes are suppressed by the input filter.	–	–	0	50	ns

Figure 8. Definition for Timing for Fast/Standard Mode on the I²C Bus



Note

20. A Fast-Mode I²C-bus device can be used in a Standard Mode I²C-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 I²C-bus specification) before the SCL line is released.

Table 25. SPI Master AC Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
F_{SCLK}	SCLK clock frequency	$V_{DD} \geq 2.4$ V $V_{DD} < 2.4$ V	– –	– –	6 3	MHz
DC	SCLK duty cycle		–	50	–	%
T_{SETUP}	MISO to SCLK setup time	$V_{DD} \geq 2.4$ V $V_{DD} < 2.4$ V	60 100	– –	– –	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

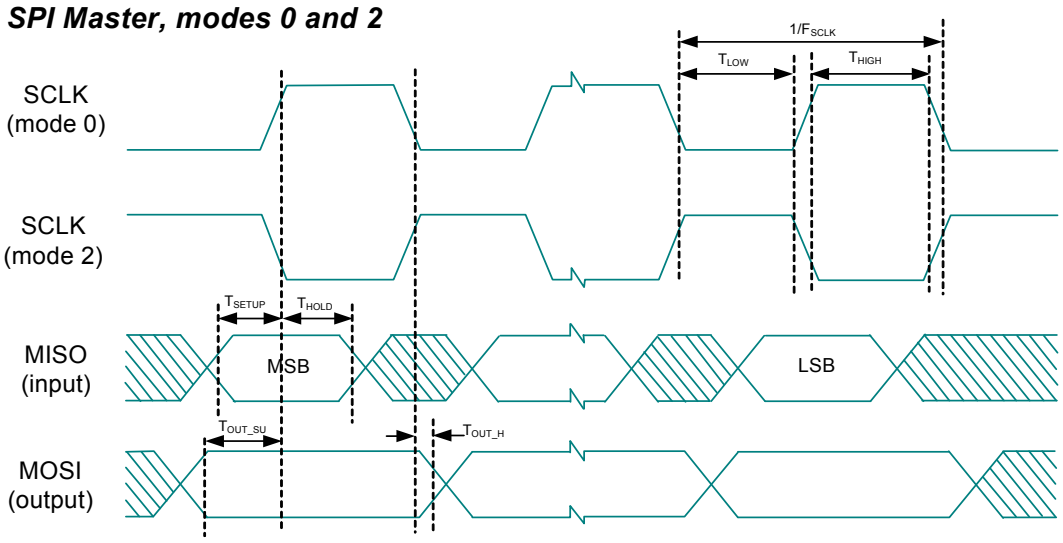



Figure 9. SPI Master Mode 0 and 2